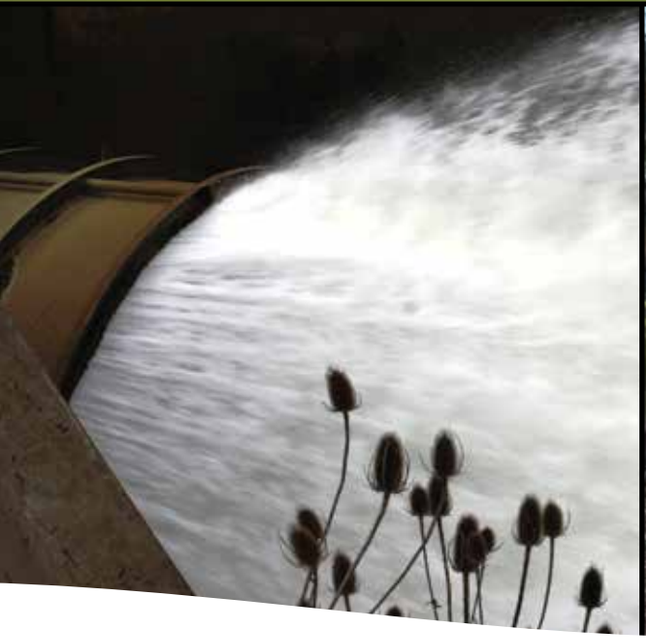
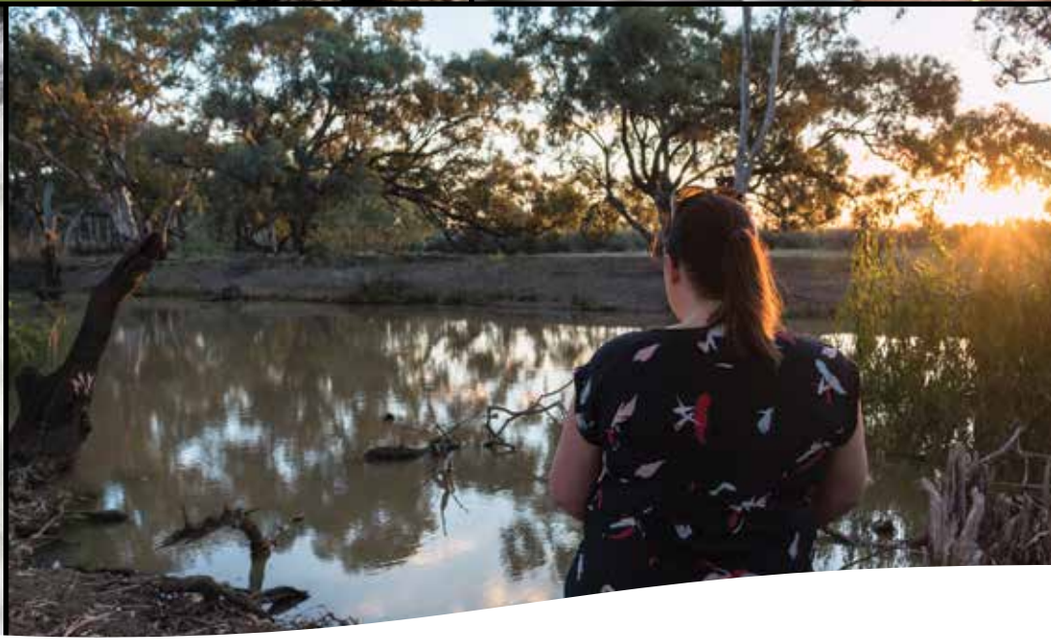
Seasonal Watering Plan

2018–19





VICTORIAN ENVIRONMENTAL WATER HOLDER

VICTORIA State Government

Acknowledgement of Traditional Owners

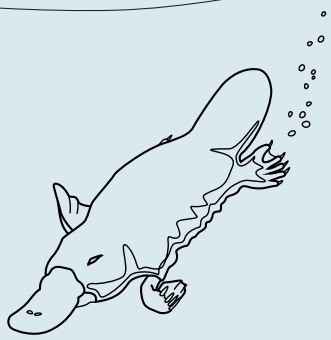
The VEWH proudly acknowledges Victoria's Aboriginal community and their rich culture, and pays respect to their Elders past and present.

The VEWH acknowledges Aboriginal people as Australia's first peoples and as Traditional Owners and custodians of the land and water on which we rely.

The VEWH recognises and value the ongoing contribution of Aboriginal people and communities to Victorian life and how this enriches us. The VEWH embraces the spirit of reconciliation, working towards equality of outcomes and ensuring an equal voice.

For tens of thousands of years, Aboriginal people have occupied Australia. There have been very different clan and Nation boundaries to those that exist today, often embodying deep cultural relationships with the land and waterways. In this Seasonal Watering Plan, the VEWH has endeavoured, using the best available information, to name the Traditional Owner groups and their Nations that lived in the area we now call Victoria, and who continue to maintain and enhance long-standing culture and tradition. The groups and their association with particular areas are not definitive and the VEWH does not claim this information to be exact.

Foreword



I am delighted to present Victoria's eighth seasonal watering plan for managing water for the environment for healthy waterways.

Each year, the Victorian Environmental Water Holder (VEWH) draws on a wealth of local and scientific knowledge to make informed decisions that will deliver water for the environment as efficiently and effectively as possible. Traditional Owners, the local community, government agencies and scientists have provided input into the development of regional proposals that inform this statewide seasonal watering plan.

The VEWH invests in continually building the knowledge base about environmental flows through monitoring and community engagement programs, which complement research such as the Victorian Environmental Flows Monitoring and Assessment Program (VEFMAP) and the Wetlands Monitoring and Assessment Program (WetMAP). These knowledge-building investments and research continue to strengthen and improve the environmental watering program, to ensure watering is built on the best-available science and community input.

Variable rainfall and run-off conditions in a changing climate have highlighted the ongoing importance of being flexible in our water delivery and planning each year for all scenarios, from drought through to very wet. This variability was evident in 2017. Winter rainfall in 2017 was below average across most of the state, particularly across the central and south-eastern districts. Overall, it was Victoria's driest winter since 2006, a pattern that is often repeating. This dry winter was followed by a record wet start to summer, which ended with drier-than-average conditions in February.

Despite it being a very dry year in 2017–18, the VEWH and other environmental water holders held large allocations of water for the environment following the previous wet year. These allocations were used to deliver large flows to selected sites. This consolidated the positive environmental outcomes that were triggered by natural floods in 2016.

The internationally significant Hattah Lakes received over 110 GL of water for the environment in winter–spring 2017, providing the largest inundation of the floodplain lakes since the 1970s. Water was used effectively for environmental outcomes by capitalising on the flooding of the previous year. This was a boon for the environment, improving conditions for the growth and recovery of black box trees.

Looking towards the 2018–19 watering year, most systems still have good volumes of water for the environment available. This provides waterway managers with the opportunity to build on the gains made in the previous two years and increase resilience in the ecosystem so that plants and animals can withstand future dry years. If the year continues to be dry and inflows to storages low, then in some systems water carried over from last year will be critical to deliver outcomes in 2018–19, and water use may be more conservative to ensure we can provide minimum flows in the years ahead.

I am heartened to see improvements in the health of Victoria's waterways over the short time that we have been using water returned to the environment. We are seeing fish species returning to rivers, birds flocking to wetlands in numbers not seen for many years, threatened vegetation and tree species beginning to thrive and landscapes coming back to life. We want to work with communities to continue this momentum for the environment and for everyone to enjoy.

Improving waterway health in Victoria is a long-term plan to alleviate some of the damage to rivers, wetlands and catchments that has been prevalent over the last century. Water for the environment alone will not address the damage to waterways. To be fully effective, our seasonal watering plan requires complementary actions that address threats (such as barriers to fish migration, high nutrient loads and invasive species). We will continue to look for innovative ways to maximise environmental benefits in our rivers and wetlands, working closely with program partners.

The *Seasonal Watering Plan 2018–19* is an exemplary demonstration of the ongoing commitment of program partners — waterway managers, other environmental water holders, storage managers and land managers — to achieve the best-possible environmental watering outcomes for the health of Victoria's waterways and communities.

I commend those who have provided input and will be involved in the delivery of this plan over the coming year.

Denis Flett
Chairperson, Victorian Environmental Water Holder

Section 1

Introduction

Canoeing at the Glenelg River, by George Turner

1.1 The Victorian environmental watering program

The Victorian environmental watering program is the ongoing collaborative management of water available for environmental purposes and used to improve the health of Victoria's rivers and wetlands and the native plants and animals that depend on them.

This seasonal watering plan previews the potential that may be delivered across Victoria under the program in 2018–19.

In this section ...

1.1.1 Why do we need an environmental watering program?

As Victoria's population has grown, many of its rivers and wetlands have been significantly modified to provide water for communities to grow and thrive. In some rivers, up to half of the water that would have naturally flowed in them is removed each year to provide water for homes, farms and industry. As a result, these waterways are not able to function as they would naturally.

Reduced river flows and less-frequent wetland inundation have disrupted breeding cycles for native fish, frogs, waterbirds, platypus and other animals; restricted the growth and recruitment of native plants; and reduced the overall productivity of waterways. Our waterways still support a range of native species, but the total abundance of native plants and animals has substantially declined and the aesthetic value and environmental services those waterways provide have diminished.

Healthy waterways are essential for the plants and animals that live in them and for the people and industries that rely on clean water and the ecosystem services that waterways provide. Many rivers and wetlands with altered water regimes can no longer look after themselves. It is therefore necessary to actively manage how water flows through them. Water that is used to improve water regimes to achieve specific environmental outcomes is called 'water for the environment' or 'environmental flows'.

Water for the environment is set aside in storages and released into rivers and wetlands to support them, the plants that grow in them and the native animals that live, feed and breed in them.

The Victorian environmental watering program seeks to collaboratively manage water for the environment to improve the health of river and wetland systems including their biodiversity, ecological function, water quality and other uses that depend on environmental condition.

By improving the health of rivers, wetlands and floodplains, water for the environment also provides benefits to communities.

Healthy rivers and wetlands support vibrant and healthy communities. They sustain people by supplying water for towns, farms and businesses. They also contribute to local agriculture, fishing, real estate, recreation and tourism activity.

Healthy rivers and wetlands make cities and towns more liveable and support the physical and mental wellbeing of communities. Most of Victoria's towns are located near a river or lake that the community identify with, and many people travel to their favourite waterways for holidays and to pursue recreational activities. Rivers and wetlands provide places for people to play, relax and connect with nature, and they sustain healthy Country for Aboriginal communities.

1.1.2 How does water for the environment work?

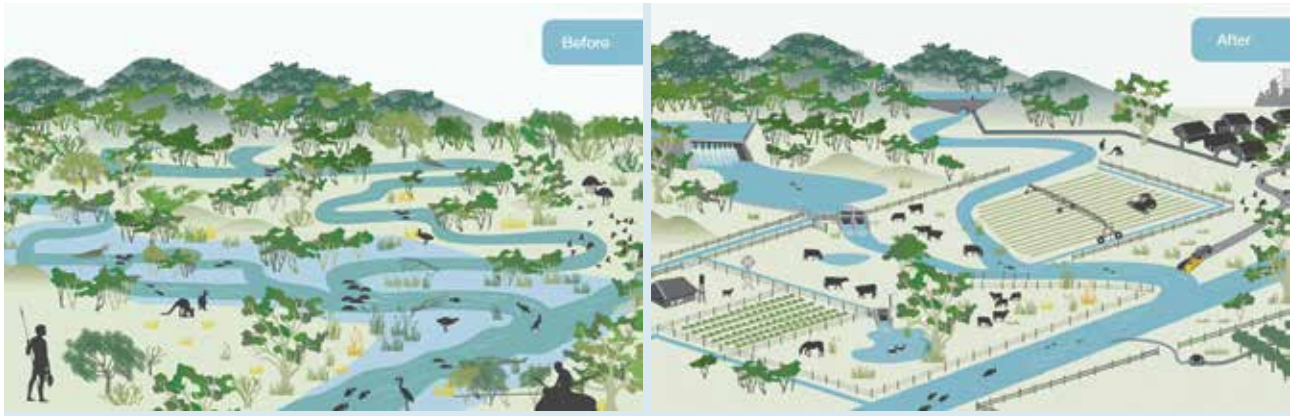
Water for the environment is released into rivers to mimic some of the flows that would have occurred naturally, before the construction of dams, weirs and channels. This is vital for maintaining the physical, chemical and biological health of rivers.

Managers of water for the environment generally focus on returning some of the small- and medium-sized river flows that are essential in the life cycles of native plants and animals. These flows can move sediment and nutrients through river systems, connect habitats and improve water quality.

The timing, duration and volume of water delivery is designed to support the plants and animals that rely on those flows. For example, fish such as the Australian grayling rely on an increase in river flow in autumn to signal them to migrate downstream for spawning (when fish release eggs). Breeding waterbirds require wetlands to retain water for long enough to allow their chicks to grow and fledge, and floodplain forests require inundation every few years to ensure the survival and recruitment of iconic tree species such as river red gums and black box.

Many wetlands are now either disconnected from the rivers that used to naturally fill them or are permanently connected to rivers or channels. This means that some wetlands do not get enough water, and others get too much.

In wetlands, managers of water for the environment focus on mimicking the natural wetland wetting and drying cycles that so many plants and animals depend on for survival, recruitment and long-term resilience. For example, where wetlands and floodplains have been cut off from natural river flows, water for the environment can be used to reconnect these areas, sometimes via irrigation infrastructure (such as pumps, channels and regulators).



Before and after the development of dams, weirs and channels

Rivers and wetlands provide water and land that is important to farms, towns and industry. As a result, many of Victoria's rivers and wetlands have been highly modified. For example, instead of water flowing across the landscape naturally, water is captured in storages by dams and weirs, diverted via pipelines, levees and constructed channels and used for towns, cities, industry and farming.

Some of our rivers give up more than a third, and sometimes half, of their water for farms, homes and businesses. Instead of flowing naturally, with high flows in winter and low flows in the hotter summer months, many rivers now run higher when water needs to be delivered for farming and urban use.

These changes have affected water quality and interrupted many of the natural river and wetland processes native plants and animals need to survive, feed and breed.

1.1.3 Who is involved in the Victorian environmental watering program?

The Victorian environmental watering program involves a range of groups and organisations. Relationships between local communities, waterway managers, storage managers, environmental water holders and land managers are the foundation of the program.

Many public authorities collaborate to deliver the program. These authorities are referred to as program partners.

Waterway managers (catchment management authorities [CMAs] and Melbourne Water) are the regional planning and delivery arm of the program. In consultation with local communities, waterway managers develop proposals for environmental watering in rivers and wetlands in their region. Waterway managers also order water for the environment from storage managers and monitor the outcomes.

Storage managers (largely water corporations) deliver water for all water users, including waterway managers and environmental water holders.

Environmental water holders (the Victorian Environmental Water Holder [VEWH], Commonwealth Environmental Water Holder [CEWH] and the Murray–Darling Basin Authority [MDBA]) commit water for the environment to different rivers and wetlands. They work together to ensure the coordinated delivery of water available under different environmental entitlements and must prioritise how water is used across northern Victoria and the Wimmera system.

Public land managers (such as Parks Victoria, Department of Environment, Land, Water and Planning [DELWP] and Traditional Owner land management boards) are closely involved in planning and delivering water for the environment for public land (such as state forests and national parks). Their responsibilities include controlling infrastructure (such as pumps, outlets, gates and channels) and public signage. Some environmental watering also occurs on private land, in partnership with landholders or corporations.

To effectively manage water for the environment, it is important to understand the environmental values of Victoria's rivers and wetlands. This understanding draws on the knowledge of local communities and scientists.

Local communities, including Traditional Owners, help identify the important environmental values in each region and help monitor the success of environmental watering. Local communities are often actively involved with local rivers and wetlands and bring important environmental, cultural, social and economic perspectives to the program.

Scientists provide indispensable advice about how water for the environment will support native plants and animals in the short and long term and work with waterway managers to monitor, evaluate and report on the outcomes of environmental watering.

Citizen scientists are increasingly monitoring the outcomes of environmental watering. In some regions, Birdlife Australia volunteers help monitor environmental watering outcomes at wetlands, and Waterwatch volunteers collect water-quality information to inform management decisions for some rivers. In the Western Region, Budj Bim and Barengi Gadjin Land Council Aboriginal Corporation rangers are monitoring environmental watering outcomes (including the presence of platypus) in the Glenelg River. Barapa Barapa Traditional Owners are monitoring environmental watering outcomes in Gunbower Forest and Dja Dja Wurrung will soon monitor environmental watering outcomes in Lake Boort.

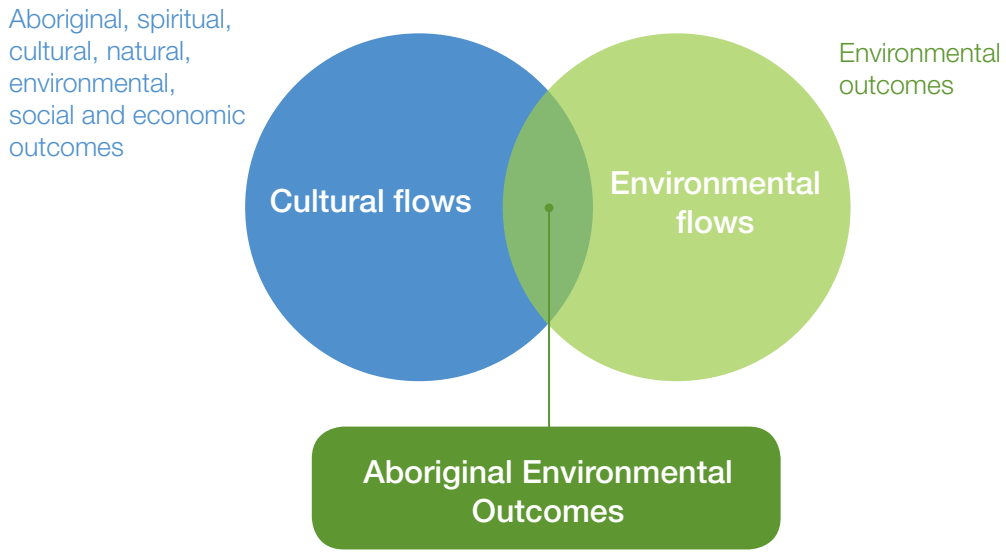
How are Traditional Owners engaged in the environmental watering program?

Traditional Owners and their Nations in Victoria have a deep and enduring connection to Victoria's rivers, wetlands and floodplains, spanning tens of thousands of years. The VEWH and environmental watering program partners recognise the intersection between environmental flows objectives and outcomes for Traditional Owners and Aboriginal Victorians, and acknowledge that genuine, enduring partnerships with Aboriginal people in planning and managing water for the environment adds value to the benefits it can provide. Figure 1.1.1 illustrates the intersection between the environmental watering program and Aboriginal cultural flows.

In many regions of Victoria, Traditional Owner Nations have strong relationships with environmental watering program partners, and they are working to better realise Aboriginal Victorians' aspirations and incorporate Traditional Owners' objectives into environmental flows management. These initiatives and ongoing contributions to the program are highlighted in the regional introductions in this seasonal watering plan.

The VEWH and program partners support the need to develop enduring partnerships with Traditional Owner Nations who wish to participate in the management of water for the environment. The VEWH is funding some projects to help waterway managers and Traditional Owners identify opportunities to better align environmental watering objectives and actions with Aboriginal objectives.

Figure 1.1.1 Illustration of intersection between the environmental watering program and Aboriginal cultural flows



1.1.4 What is the role of the Victorian Environmental Water Holder?

The VEWH is an independent body, established by the Victorian Government in 2011. It is responsible for managing Victoria's water for the environment. Set up under the *Water Act 1989*, the VEWH manages environmental entitlements — a legal right to access a share of water available at a location — to improve the environmental values and health of Victoria's rivers, wetlands and floodplains, and the plants and animals that rely on them.

The role of the VEWH is to:

- make decisions about the most effective use of the environmental entitlements, including for use, carryover and trade (see section 1.4.2)
- commit water and authorise waterway managers to implement watering decisions (see section 1.3.2)
- work with storage managers and other water holders to coordinate and optimise environmental outcomes from the delivery of all water (see section 1.4)
- commission projects to demonstrate the ecological outcomes of environmental flows at key sites and to help improve the management of water for the environment
- publicly communicate environmental watering decisions and outcomes.

The VEWH consists of four part-time commissioners, supported by a small team.

The commissioners are Denis Flett (Chairperson), Geoff Hocking (Deputy Chairperson) Chris Chesterfield (Commissioner) and Rueben Berg (Commissioner). Commissioners are appointed by the Governor in Council on the recommendation of the Minister for Water.

1.1.5 How does the Victorian environmental watering program fit within broader integrated catchment and waterway management?

The VEWH's operations fit within broader Victorian Government policies for integrated catchment and waterway management. Key policy documents influencing the VEWH from a Victorian context include *Water for Victoria*, *Victorian Waterway Management Strategy* and regional sustainable water strategies. Regional waterway strategies determine priority waterways, in consultation with local communities, and outline integrated waterway management actions.

Water for Victoria is a plan for a future with less water as Victoria responds to the impact of climate change and a growing population. The actions in the plan support a healthy environment, a prosperous economy with growing agricultural production and thriving communities. Implementing the actions in the plan will improve the operation of the water and catchment management industry, including the VEWH.

Water for Victoria recognises that protecting and improving waterway health is a long-term commitment needing coordinated action. Integrated catchment management is a holistic way of managing land, water and biodiversity from the top to the bottom of a catchment. Although better-integrated catchment management will greatly benefit Victoria's waterways, the full benefits of strategic, long-term investments in waterway health may not be realised for 30 years or more. *Water for Victoria* identifies 36 priority waterways for large-scale projects over this timeframe and many of these waterways are planned for environmental flows in this seasonal watering plan.

Complementary water management activities are often needed to achieve environmental watering outcomes. These include invasive species control, riparian (streamside) land management, sustainable agriculture, sustainable land use planning and development, integrated urban water management and other waterway management activities (such as providing fish passage and improved in-stream habitat, for example snags). A lack of fish passage due to dams and weirs continues to be a problem in some Victorian rivers where environmental flows aim to increase the breeding success and recruitment of native fish. Figure 1.1.2 shows examples of complementary waterway management activities in Victorian waterways that receive water for the environment.

In most systems, water for the environment is delivered using existing infrastructure (such as dam outlet gates and water supply channels) built for and still used for the supply of water for agriculture, industry and communities. Permanent and temporary pumps are also used in some cases to deliver water for the environment to wetlands. Capacity constraints with these types of infrastructure and the need to avoid flooding on private land restrict the size and timing of deliveries of water for the environment. In some systems, these constraints mean only a fraction of the required environmental flows can be delivered to waterways, which significantly reduces the environmental outcomes that can be achieved.

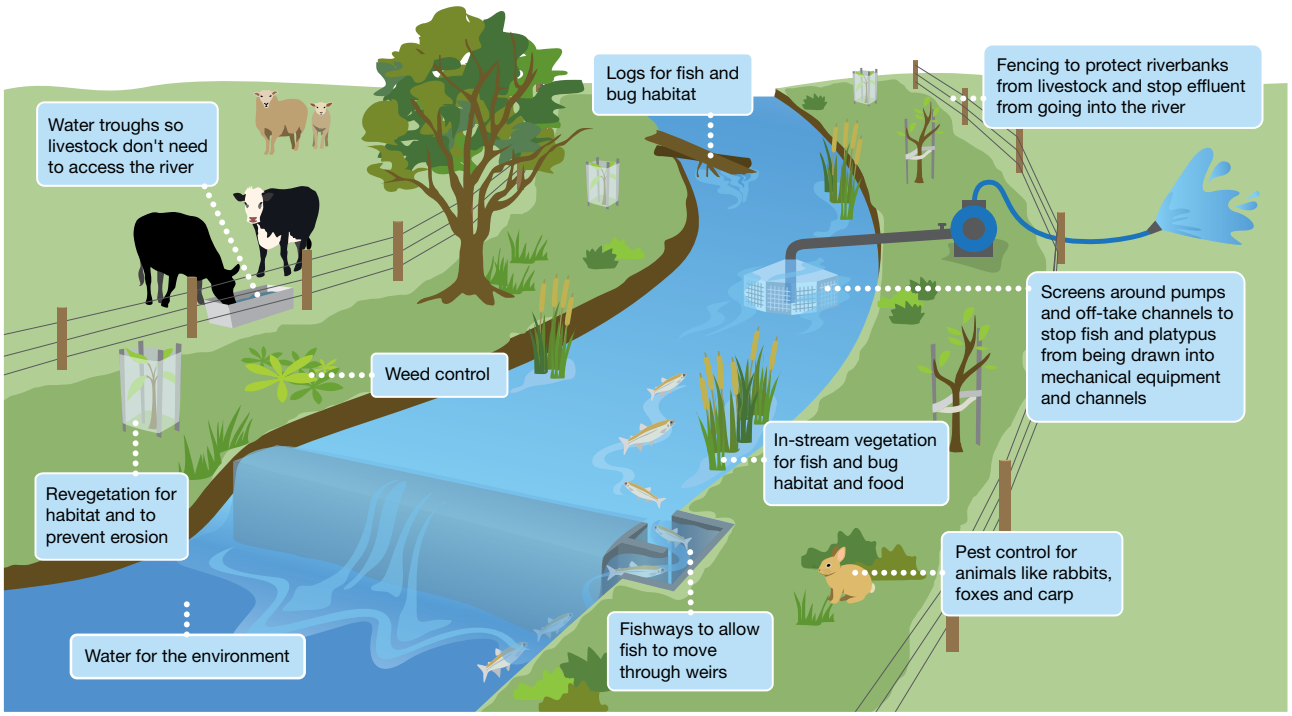
Victoria's environmental watering program is integral to the success of the following three strategies and plans.

Our Catchments, Our Communities is Victoria's first statewide strategy for integrated catchment management. Its aims are more effective community engagement, better connections between different levels of planning and stronger regional catchment strategies. The strategy also aims to clarify roles, strengthen accountabilities and coordination and improve monitoring, evaluation and reporting. CMAs will lead 10 new integrated catchment management projects across the state from 2016 to 2019 in collaboration with catchment management partners. The Caring for Campaspe and Living Moorabool projects involve environmental watering actions.

Protecting Victoria's Environment – Biodiversity 2037 aims to ensure Victoria has a modern and effective approach to protecting and managing Victoria's biodiversity. Providing water for the environment is essential to supporting Victoria's biodiversity. The plan will be implemented together with the outcomes of reviews of the *Flora and Fauna Guarantee Act 1988* and Victoria's native vegetation clearing regulations.

The *Basin Plan 2012* for the Murray–Darling Basin is another key reform influencing the VEWH's operations, particularly its planning and reporting framework in northern and western Victorian systems which form part of the basin. The VEWH continues to work closely with the Victorian Government and other agencies to implement the Basin Plan.

Figure 1.1.2 Examples of complementary management actions



1.1.6 Where can I find more information about the Victorian environmental watering program?

There is more information about the program on the VEWH website at vewh.vic.gov.au, or contact the VEWH on (03) 9637 8951 or by email to general.enquiries@vewh.vic.gov.au.

You can get more detailed information about water for the environment in your region by contacting your local waterway manager using the contact details in section 6.3.

Water for the environment fact sheets

The VEWH's fact sheets answer questions about water for the environment. They are:

- What is environmental water?
- Why is environmental watering important?
- What does environmental watering aim to achieve?
- What does environmental watering involve?
- How do we know if environmental watering is successful?
- What is environmental water trading?

The fact sheets are on the VEWH website, or you can get hard copies by emailing general.enquiries@vewh.vic.gov.au.

1.2 The seasonal watering plan

The seasonal watering plan is a statewide plan that guides environmental watering decisions in Victoria. It provides program partners, stakeholders and communities with a sense of what to expect during the water year.

In this section ...

The plan previews the potential environmental flows that could be implemented using water available under all environmental water entitlements held in Victoria. This includes water available under the VEWH's environmental water entitlements and water held by other environmental water holders (see section 1.4.1).

The plan for the upcoming water year is released by 30 June each year. The 2018–19 plan and any variations are valid for this water year (1 July 2018 to 30 June 2019) or until the subsequent seasonal watering plan is released.

1.2.1 What does 'seasonal' mean?

'Seasonal' refers to the variability of climatic conditions in a given year. It includes normal differences between summer, autumn, winter and spring as well as an assessment of whether a particular year is drier or wetter than average. Environmental watering objectives and water availability may differ depending on seasonal conditions, so it is important that planning for water for the environment considers the range of potential seasonal condition or water availability scenarios that may unfold, ranging from drought to very wet (see Figure 1.2.1). This scenario planning provides a guide for the VEWH and waterway managers throughout the year when it comes to deciding what environmental flows to go ahead with.

For each river and wetland system, the potential environmental flows under each seasonal condition or water availability scenario is explained under 'Scenario planning' in the relevant section.

Figure 1.2.1 Examples of environmental watering objectives under different planning scenarios

Drought

Main objective: PROTECT

- Avoid critical loss
- Maintain key refuges
- Avoid catastrophic events

Dry

Main objective: MAINTAIN

- Maintain river functioning with reduced reproductive capacity
- Maintain key functions of high-priority wetlands
- Manage within dry-spell tolerances

Average

Main objective: RECOVER

- Improve ecological health and resilience
- Improve recruitment opportunities for key animal and plant species

Wet to very wet

Main objective: ENHANCE

- Restore key floodplain and wetland linkages
- Enhance recruitment opportunities for key animal and plant species

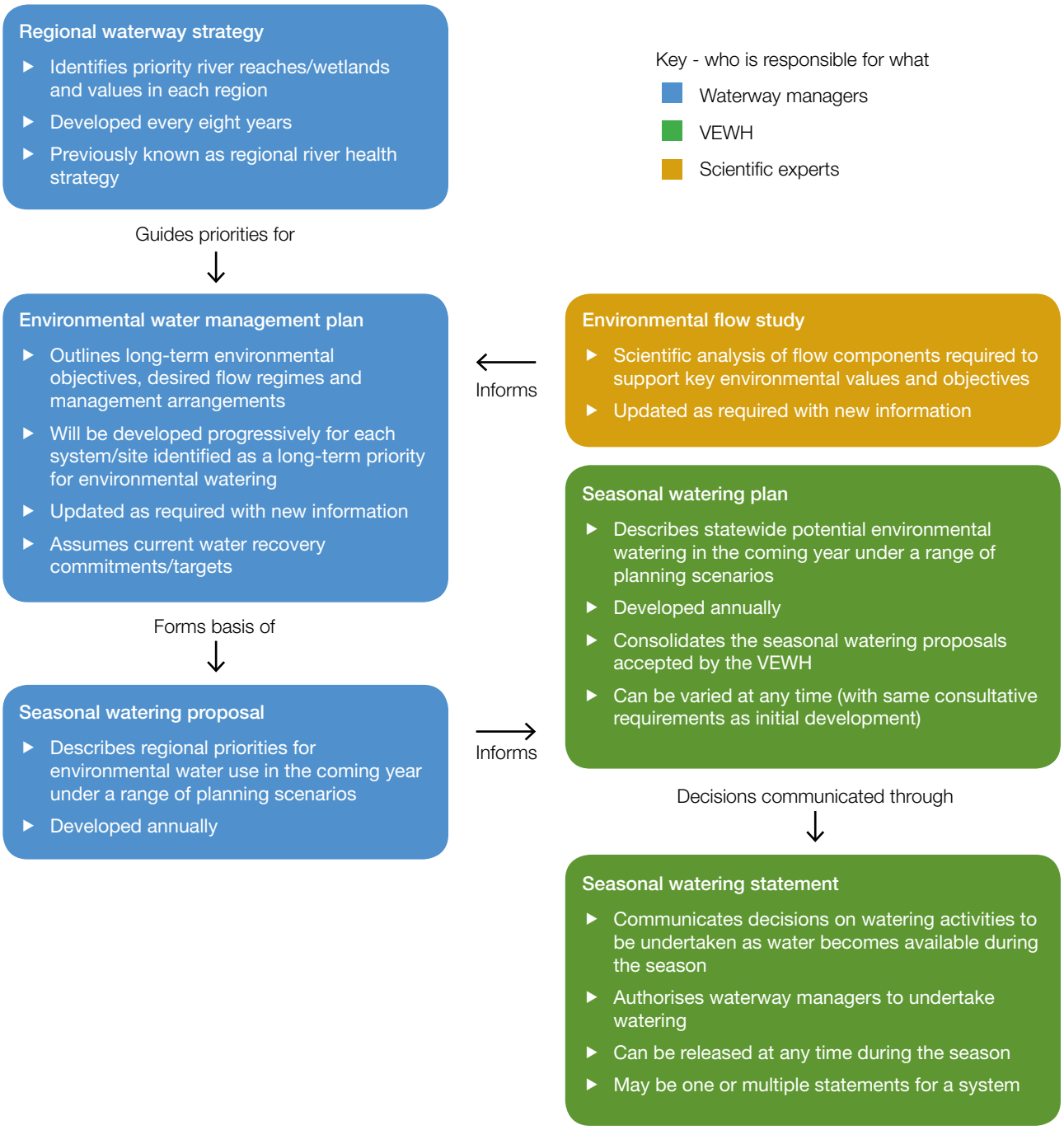
1.2.2 How does the seasonal watering plan fit into the environmental water planning process?

Each year, waterway managers scope the potential environmental watering actions for their regions for the coming year in seasonal watering proposals. The proposals draw on environmental flow studies and on longer-term plans (such as environmental water management plans, regional waterway strategies and regional catchment strategies). Environmental flow studies and environmental water management plans for Victorian waterways are available on the VEWH's website at vewh.vic.gov.au. Waterway strategies and regional catchment strategies are published on the relevant CMA websites. The seasonal watering proposals incorporate information and advice from local communities and Traditional Owners.

The VEWH reviews the proposed watering actions in each seasonal watering proposal and works with waterway managers to identify the potential watering actions for each region and across the state. This seasonal watering plan is a collated summary of the agreed actions from all the seasonal watering proposals.

The different stages of environmental water planning, including the different strategies and plans, are shown in Figure 1.2.2. There is more information about each of these strategies and plans at vewh.vic.gov.au.

Figure 1.2.2 Victorian environmental watering program planning framework



1.2.3 Who contributes to the seasonal watering plan?

Stakeholder engagement on potential environmental watering actions occurs during the development of regional seasonal watering proposals. The level and method of engagement varies across the state, reflecting the differing systems, watering actions and stakeholders. In some regions, formal environmental water advisory groups provide the opportunity for waterway managers and interested community members to discuss potential environmental flows in their system or locality for the coming year. In other systems, engagement occurs one-on-one between waterway managers and interested stakeholders. The most interested stakeholders tend to be Traditional Owners, irrigators, farmers, members of the community living close to or with an interest in a specific waterway, members of recreational groups and members of local environmental groups.

Land managers and storage managers also consider and endorse the seasonal watering proposals to ensure planned watering aligns with land and storage management objectives and can feasibly be delivered through planned system operations.

For each system, there is a summary of the engagement activities waterway managers undertook when developing seasonal watering proposals (see sections 2 to 5).

1.2.4 Can the seasonal watering plan be changed?

Under the Victorian *Water Act 1989*, the VEWH can only authorise use of water for the environment where it is consistent with a seasonal watering plan. This is to ensure transparency about what environmental flows are planned and how they are managed.

To ensure flexibility to adapt to changing conditions, the Act allows the VEWH to vary any section of a seasonal watering plan. Variations may be needed to incorporate new knowledge or to address circumstances that were not identified before the start of the water year.

The VEWH makes all variations publicly available at vewh.vic.gov.au as separate attachments to the original seasonal watering plan. You can email general.enquiries@vewh.vic.gov.au for a hard copy.

1.2.5 When isn't a formal variation required to the seasonal watering plan?

In some instances, there may be unforeseen circumstances that will call for use of water for the environment that does not require a variation to the seasonal watering plan. These include:

- minor operational adjustments to specific environmental watering actions
- water for the environment being used for environmental emergency management situations
- small volumes of water for the environment being used for technical investigations or infrastructure maintenance
- facilitating the delivery of water for the environment held by other water holders for downstream objectives
- environmental watering actions that continue beyond the year of the plan (even if there are unforeseen delays releasing the following year's plan).

As the VEWH cannot anticipate the specifics of these circumstances, it cannot include further details about them in this plan.

Minor operational adjustments

Minor operational adjustments to environmental watering actions may occur from time to time. For example, the targeted river reaches, flow rates, timing and durations detailed in sections 2 to 5 may need to be adjusted slightly due to changes in predicted rainfall or other water orders, delivery infrastructure constraints, emerging ecological knowledge or the timing of specific ecological triggers (such as a bird-breeding event). In all cases, environmental watering actions will still aim to optimise the environmental outcomes achieved, in line with the objectives set out in the seasonal watering plan.

Environmental emergency management situations

Water for the environment may be needed for an environmental emergency management situation. This may include reducing the impact of natural blackwater or bushfire events, preventing fish deaths or mitigating the effects of blue-green algae blooms. It could also include smoothing the transition to or from a high-natural-flow event (for example, supplementing natural flows with water for the environment to provide a more gradual rise and fall to minimise the threat of riverbanks slumping).

Small technical investigations and maintenance

There may be instances where a small volume of water for the environment may be used for research and development purposes, or small-scale infrastructure testing or maintenance. Such instances are considered on a case-by-case basis and must aim to enhance knowledge and improve environmental watering management. It must not compromise the potential to achieve the environmental objectives in the seasonal watering plan.

Facilitating the delivery of water held by other water holders for downstream objectives

Some water held by other water holders is stored in Victorian storages and is sometimes called on to meet downstream demands beyond the scope of this plan (such as for the Coorong, Lower Lakes and Murray Mouth area in SA). Delivery of this water is sometimes needed at a time and flow rate that was not scoped in the seasonal watering plan. The VEWH facilitates and authorises such deliveries, provided the risk of adverse impacts on Victoria's rivers, wetlands and floodplains and other risks are appropriately managed.

Environmental watering actions that continue beyond the year of the plan

Nature doesn't keep to strict timelines, so some potential environmental flows scoped in a seasonal watering plan may begin before, or continue beyond, the year of the plan. This means environmental watering actions that start either before July 2018 or continue after June 2019 are still consistent with the plan, especially if there are unforeseen delays releasing the *Seasonal Watering Plan 2019–20*.

Hattah Lakes at Bitterang Crossing, by Mallee CMA

1.3 Implementing the seasonal watering plan

The seasonal watering plan scopes potential environmental watering for the coming year, but many factors influence decisions about what water for the environment is actually committed and delivered.

In this section ...

- **How are watering decisions made throughout the year?**
- **When does the VEWH commit and authorise use of water for the environment?**
- **How does the VEWH prioritise different watering actions when there is not enough water for the environment available?**
- **Do seasonal conditions affect how water for the environment is used?**
- **How are shared social, recreational, Traditional Owner, cultural and economic benefits considered in environmental watering decisions?**
- **How are risks managed?**

Some factors that influence decisions about committing and delivering water for the environment are:

- seasonal conditions, weather forecasts and catchment conditions
- river and system operations (such as unregulated flows, catchment inflows, storage levels, other water users' needs and potential delivery constraints)
- ecological or biological factors and triggers (such as plant and animal responses to natural flows or temperature)
- water availability
- risks associated with an environmental watering action
- the opportunity to deliver shared benefits.

It is important there is flexibility to respond to these different factors, as they can significantly influence the environmental outcomes and shared benefits that can be achieved.

1.3.1 How are watering decisions made throughout the year?

As the season unfolds, many of the uncertainties associated with seasonal conditions, water availability and operational context become clearer and this clarity informs decisions about what environmental flows should proceed. Many on-ground factors do not become clear until very close to the anticipated time of delivering the water.

To guide environmental watering decisions, a flexible and adaptive approach is adopted that involves the environmental water management stakeholders. This process of review and adjustment ensures that water for the environment is used in an efficient and seasonally appropriate manner to optimise ecological outcomes across the state.

Waterway managers, storage managers and land managers provide advice about which watering actions are needed and can be delivered in each region during the year. Environmental water holders use that information to decide which watering actions to authorise. All program partners have a role in identifying potential watering actions and enabling the delivery of water for the environment (as explained in section 1.3.3).

If planned watering actions need to be significantly changed during the season to respond to unforeseen circumstances, further scientific or community input may be sought to inform decision-makers.

The VEWH regularly publishes updated information about current and anticipated environmental watering actions on its website at vewh.vic.gov.au.

1.3.2 When does the VEWH commit and authorise use of water for the environment?

The VEWH aims to commit as much water as is sensibly possible, as early as possible, to provide waterway managers with certainty to proceed with the planned environmental watering actions.

The VEWH (like other environmental water holders) can commit its water at any point before or during the water year. The VEWH commits water via seasonal watering statements, which authorise waterway managers to use water for the environment. The VEWH publishes seasonal watering statements on its website at vewh.vic.gov.au.

The VEWH can make a seasonal watering statement at any time of the year. Depending on the nature of the system and the entitlement being used, it may make one or multiple statements for a system during the water year. Before issuing a seasonal watering statement, the VEWH must be sure the required delivery arrangements (including any risk management measures) are in place and any costs it must meet are acceptable.

Where many environmental watering actions across different systems require access to the same environmental water entitlement, decisions to commit water to particular actions may require more thorough consideration. This may require prioritisation of one river or wetland over another, or prioritisation of one flow component over another. Section 1.3.3 has further information about how prioritisation decisions are made.

In some instances, the VEWH may commit water very close to the anticipated delivery time. This may be necessary because the water demand arises at short notice due to environmental, operational or weather conditions. For example, a colonial waterbird nesting event in Barmah Forest may trigger a need for water for the environment to maintain shallow flooding long enough for the birds to fledge.

There may also be instances where planned environmental flows are not delivered to a particular site. For example, an ecological trigger or seasonal conditions could nullify the potential benefit of the planned delivery, or a lack of catchment inflows may mean there is not enough water for the planned watering action.

The CEWH and MDBA (through the Living Murray program) commit water for use in Victoria with similar logic to that outlined above. The VEWH then formally authorises the use of that water through seasonal watering statements.

Can environmental water holders change their minds after a seasonal watering statement has been issued?

The VEWH may withdraw a seasonal watering statement at any point during the year, in consultation with the waterway manager and storage manager for that river or wetland system. It might do so, for example, to address emerging risks or changes in operating conditions or water availability.

Similarly, a waterway manager or storage manager may decide, in consultation with the VEWH, not to proceed with an environmental watering action after a seasonal watering statement has been issued. This could occur as a result of environmental triggers indicating the water was no longer required, resourcing constraints or new information that the potential environmental or public risk of watering is too high.

1.3.3 How does the VEWH prioritise different watering actions when there is not enough water for the environment available?

The VEWH makes decisions about why, where, when and how its available water and funds for the environment are used, carried over or traded to get maximum benefit for the state's waterways — our rivers, wetlands, estuaries and floodplains — and the wildlife that depend on them.

In implementing this program, it is important to recognise the dynamic nature of the VEWH's work. Seasonal conditions can vary considerably between years, which affects both the requirements of particular sites for water for the environment (the demand) and the availability of water for the environment (the supply).

A shortfall in supply might arise because of:

- significant, high-value demands for water for the environment
- drought or low water availability.

To meet a shortfall, the VEWH may look to use tools such as carryover and trade (as explained in section 1.4.2). If there is still a shortfall of water, the VEWH, in collaboration with waterway managers and other water holders if relevant, must prioritise environmental watering actions.

Many factors influence prioritisation decisions (such as the likely environmental outcomes, the previous watering history in that river or wetland, environmental or public risk considerations and seasonal conditions in the region). Trade-offs may need to be made about watering actions undertaken in one year or at one site, and water may need to be provided at the expense of watering actions in the next year or at another site. Trade-offs may also need to be made about foregoing watering actions to sell water allocation and use the resulting revenue for complementary works and measures; it may also be used to improve knowledge and capability to deliver better environmental outcomes in the short or longer term.

In deciding to prioritise one environmental watering action or site over another, the VEWH always seeks to optimise environmental outcomes across the state.

What criteria are used to guide prioritisation decisions?

In deciding how to use the available Water Holdings in any given year, the VEWH considers:

- decisions by other water holders about the use of their water for the environment
- State and Commonwealth government decisions about water resource policy
- the resources, knowledge and capability of the VEWH and its program partners
- storage managers meeting their obligations to the environment associated with the right to harvest and distribute water sustainably
- complementary works and measures being undertaken
- the availability of funds
- services associated with management of the Water Holdings and delivery of water for the environment.

Figure 1.3.1 shows the criteria considered when making the trade-off decisions and prioritising specific watering actions. Waterway managers provide information about how different watering actions meet these criteria, and about opportunities for shared benefits, in their seasonal watering proposals.

Prioritisation has historically occurred on a site-by-site basis, but many of the ecological processes that underpin waterway health operate at a landscape scale. The prioritisation process is currently evolving to consider the combination of watering actions that are needed across multiple waterways in a region to achieve the best environmental outcomes. The prioritisation criteria shown in Figure 1.3.1 can be equally applied at individual sites or at the broader landscape scale.

Figure 1.3.1 Criteria for prioritising environmental watering actions

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

Who is involved in the prioritisation process?

Waterway managers, environmental water holders, storage managers and communities (recreational user groups, environmental groups, Traditional Owners and farming groups) all have a role in prioritising environmental watering actions, depending on the nature and scale of the decision being made. There is a list of partners and stakeholders engaged in developing the seasonal watering proposal for each system in this plan.

Waterway managers are best placed to advise about the extent and significance of an environmental watering action and about the highest priorities in their region.

The VEWH and other environmental water holders determine the highest watering priorities across regions. The VEWH's decisions are intended to provide the best-possible environmental outcomes for the state. The VEWH makes these decisions in consultation with waterway managers and other program partners as relevant.

Advice from storage managers is generally the key to understanding the feasibility of delivering a watering action, including the flexibility of delivery timing and operational constraints.

Land managers provide consent to deliver environmental flows on their land and will advise on the feasibility of delivery after considering land management activities, public access and the risks and benefits of the environmental watering action.

The annual prioritisation process is informed by longer-term site prioritisation by waterway managers in consultation with their communities. This prioritisation is detailed in plans such as regional catchment strategies, regional waterway strategies and environmental water management plans. These plans draw on community and scientific knowledge and prioritise sites for water for the environment (and other river health activities) that have high environmental, cultural, social and economic value to the community.

Additional input from the community about prioritising water for the environment is provided annually where needed.

1.3.4 Do seasonal conditions affect how water for the environment is used?

In the same way that rainfall patterns influence how people water their gardens or paddocks, different climatic conditions influence how water for the environment is managed.

Seasonal conditions drive what water will be available during the water year and the environmental watering objectives to be pursued (as explained in section 1.2.1). Waterway managers take seasonal conditions into account when prioritising the water for the environment needed at each site. Seasonal planning scenarios describe the range of watering actions that may occur under drought to very wet climatic conditions.

Waterway managers work with the program partners to decide how to optimise the ecological outcomes they can achieve using water for the environment by considering factors including:

- the environmental objectives under each climatic scenario including consideration of any essential water for the environment needs
- how rainfall, natural flooding or the delivery of water for consumptive use may contribute to the achievement of the environmental objectives
- how water for the environment may be used to build on natural flows or irrigation deliveries to meet the environment's needs
- natural climatic cues that might increase the likelihood of achieving an ecological outcome.

Planning scenarios are presented in the seasonal watering plan and provide the basis for the adaptive management of water for the environment as the season unfolds. They also provide an early indication of the amount of water that may be used at different sites and whether the VEWH may need to trade water during the season to meet identified environmental needs (as explained in section 1.4).

Figure 1.3.2 provides an example of how different planning scenarios may influence decisions about how water for the environment is managed in a year.

Figure 1.3.2 Example planning scenarios for a river system under a range of climatic conditions

Planning scenario	Drought	Dry	Average	Wet to very wet
Expected Catchment Conditions	No unregulated flows	One or two brief unregulated flow peaks in winter/spring	One to three unregulated flow peaks plus extended low flows in winter/spring	Extended unregulated high flows with some overbank flooding in winter/spring
Environmental Objectives	Protect critical refuge habitat for native fish	Maintain native fish habitat	Encourage fish movement and spawning Improve habitat for waterbugs Support the establishment and maintenance of bank vegetation	Encourage movement and spawning of native fish Enhance condition and extent of bank vegetation Where possible, provide opportunities for the exchange of nutrients and carbon between the river and floodplain
Potential Environmental Watering	Provide low flows and trigger-based freshes to maintain water quality in deep refuge pools	Provide summer/autumn low flows to manage water quality and maintain connectivity Extend the duration of flow peaks to freshen water quality in deep pools	Provide year-round baseflows to maintain habitat connectivity and support fish movement Extend the duration and/or magnitude of peaks to provide spawning cues for fish Provide seasonal freshes to support the establishment of bank vegetation	Maintain year-round low flows and seasonal freshes to encourage the recovery of in-stream and bank vegetation and trigger the spawning and movement of native fish Where possible, maintain connectivity and the exchange of nutrients between the river and floodplain Slow the recession of natural peaks to avoid bank slumping and erosion Top up natural flows if needed, to meet targets for winter base flows and spring peaks

1.3.5 How are shared social, recreational, Traditional Owner, cultural and economic benefits considered in environmental watering decisions?

Environmental flows are essential for maintaining and improving the health of rivers, wetlands and floodplains. The plants, animals and broader health of these waterways provide shared benefits for recreation, cultures and economies. Community benefits may be direct (for example, water for the environment can increase populations of popular angling fish species, sustain healthy Country and totem species for Aboriginal communities and improve water quality to the benefit of irrigators) or opportunistic (for example, timing the delivery of an environmental flow to increase opportunities for kayakers and telling the public about the flow so they can take advantage of it).

In planning for environmental flows, the primary purpose is to optimise environmental benefits. Year by year and case by case, the VEWH and its partners consider opportunities raised by communities to use water for the environment to provide additional social, Traditional Owner, cultural and recreational benefits. Where possible, these opportunities are incorporated into watering decisions, if they do not compromise environmental outcomes.

Shared benefits of water for the environment can sometimes be actively optimised by making decisions around the storage, delivery and use of water for the environment to support community events (such as local fishing, waterskiing or rowing competitions).

When planning for and delivering water for the environment, the VEWH and program partners look for opportunities to achieve shared benefits in both the short and long-term, where environmental outcomes are not compromised. Longer-term community benefits may sometimes require short-term community inconvenience. For example, floodplain watering in Gunbower Forest may limit access and therefore inconvenience campers in one year, but the environmental benefits of the watering will likely improve tourism and recreational opportunities in the forest over the longer-term.

Waterway managers work with communities to identify the environmental, social, cultural and economic values of waterways through regional catchment strategies, regional waterway strategies, environmental water management plans and seasonal watering proposals. The values for each system are summarised in sections 2 to 5. Program partners will continue to work with stakeholders to look for opportunities to achieve shared benefits from water for the environment.

1.3.6 How are risks managed?

Risk management is an integral part of managing water for the environment. Program partners consider it throughout management of water for the environment (that is, during long-term and annual planning, implementation and review).

The VEWH, in collaboration with its program partners, has developed a risk management framework that addresses interagency risk, respects the risk management practices of each partner, documents roles and responsibilities in operating arrangements and is applied as part of program management. The key elements of the framework are described below.

The seasonal watering proposals on which this seasonal watering plan is based identify potential risks associated with the specific watering actions proposed for the coming water year. As part of developing the proposals, partners jointly assess risks and identify and commit to mitigation actions. A collaborative approach is the best way to manage the shared environmental watering risks.

Table 1.3.1 shows the main shared risks with water for the environment. Program partners consider and reassess these and other potential risks as the season unfolds and planned watering actions are due to commence.

Some risks may only eventuate at the time of delivery. For example, forecast heavy rain at the time of a planned delivery of water for the environment could increase the risk of nuisance flooding. Program partners review risks immediately before a planned delivery of water for the environment and implement measures or actions required to mitigate the risks as agreed with all relevant program partners. Watering actions will not be implemented if unacceptable risks to the public or the environment cannot be mitigated.

Even with best-practice risk management controls, there may be unintended impacts from environmental flows or situations where environmental flows cannot be delivered as planned. In those situations, program partners work together to respond to incidents and then learn and adapt their management of risks. The VEWH has developed an agreed approach to incident management to help program partners report, investigate and respond to risks.

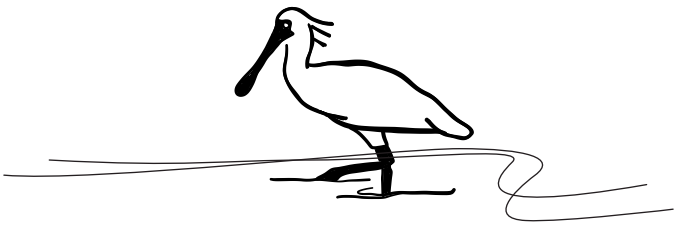


Table 1.3.1 Main shared risks of environmental watering

Type of risk	Example mitigating actions
Environmental watering contributes to third-party impacts	• Identify and understand water system capacities and monitor water levels at key locations to inform daily water release decisions and ensure impacts do not eventuate. • Consider potential catchment run-off from forecast rainfall before deciding on the timing of releases of water for the environment. • Implement a communication strategy which may include media releases, public notices and signage before environmental flows, to ensure people are informed of significant deliveries of water for the environment and can adjust their behaviour accordingly. This includes early liaison with potentially affected stakeholders. • Restrict access by closing gates and tracks.
Inability to achieve or demonstrate ecological outcomes from environmental watering	• Undertake intervention monitoring within available resources to identify the ecological response. • Conduct research to better understand responses to water for the environment. • Communicate the outcomes of monitoring and incorporate learnings into future environmental flows. • Consider the need for complementary works to help achieve environmental watering outcomes as part of integrated catchment management, and the likely timeframe for ecological responses to all management actions.
Environmental watering has negative effects on the environment (for example blackwater, bank erosion and the spread of weeds)	• Monitor environmental watering outcomes and reassess future deliveries and/or scientific recommendations if necessary. • Plan the timing, frequency, duration and variability of environmental flows to limit conditions that are favourable to non-native plants and animals or which have negative effects.

Ovens River at Gapsted, by Natalie Ord

1.4 Managing available water for the environment

Environmental entitlements are held in 15 water supply systems across Victoria. Sections 2 to 5 detail where water made available under these entitlements may be delivered in 2018–19.

In this section ...

- **How much water is available to use as part of the Victorian environmental watering program?**
- **What options are available to effectively and efficiently manage water for the environment?**

To the extent possible, the VEWH and other environmental water holders try to avoid water supply shortfalls by efficiently using water for the environment and by using tools such as carryover and trade. If there is still a shortfall of water, the VEWH in collaboration with waterway managers (and other water holders if relevant) will prioritise environmental watering actions.

1.4.1 How much water is available to use as part of the Victorian environmental watering program?

VEWH environmental entitlements

Water for the environment is made available under the environmental entitlements held by the VEWH. Table 1.4.1 shows the entitlements held by the VEWH as at 30 June 2018, including those held in trust for the Living Murray program. The VEWH's environmental entitlements can be viewed at waterregister.vic.gov.au/water-entitlements/bulk-entitlements.

The water available to use under these entitlements varies from year to year depending on entitlement rules, seasonal conditions (including rainfall and run-off in the catchments) and the water already available in storages.

Table 1.4.1 Environmental entitlements held by the VEWH (as at 30 June 2018)[1]

System	Entitlement	Volume (ML)	Class of entitlement
Central Region			
Barwon	Barwon River Environmental Entitlement 2011	N/A[2]	Unregulated
	Upper Barwon River Environmental Entitlement 2018	2,000[3]	Share of inflow
Moorabool	Moorabool River Environmental Entitlement 2010[4]	7,086[3]	Share of inflow
Tarago	Tarago and Bunyip Rivers Environmental Entitlement 2009	3,000[3]	Share of inflow
Werribee	Werribee River Environmental Entitlement 2011	N/A[3]	Share of inflow
Yarra	Yarra Environmental Entitlement 2006[4]	17,000 55	High Unregulated
Gippsland Region			
Latrobe	Latrobe River Environmental Entitlement 2011	N/A[2]	Unregulated
	Blue Rock Environmental Entitlement 2013	18,737[3]	Share of inflow
Macalister	Macalister River Environmental Entitlement 2010	12,461 6,230	High Low
Thomson	Bulk Entitlement (Thomson River – Environment) Order 2005[4]	10,000 8,000[3]	High Share of inflow

Table 1.4.1 Environmental entitlements held by the VEWH (as at 30 June 2018)[1] *continued*

System	Entitlement	Volume (ML)	Class of entitlement
Northern Region			
Campaspe	Environmental Entitlement (Campaspe River – Living Murray Initiative) 2007	126 5,048	High Low
	Campaspe River Environmental Entitlement 2013	20,652 2,966	High Low
Goulburn	Goulburn River Environmental Entitlement 2010	8,851 3,140	High Low
	Environmental Entitlement (Goulburn System – Living Murray) 2007	39,625 156,980	High Low
	Environmental Entitlement (Goulburn System – NVIRP Stage 1) 2012	34,2556	High
	Bulk Entitlement (Goulburn System – Snowy Environmental Reserve) Order 2004	30,252 8,156	High Low
	Water Shares – Snowy River Environmental Reserve	8,321 17,852	High Low
	Silver and Wallaby Creeks Environmental Entitlement 2006[4]	N/A	Passing flow only
Loddon	Bulk Entitlement (Loddon River – Environmental Reserve) Order 2005[4]	10,970 2,024	High Low
	Environmental Entitlement (Birch Creek – Bullarook System) 2009[4]	100	N/A[7]
	Water Shares – Snowy River Environmental Reserve	470	High
Murray	Bulk Entitlement (River Murray – Flora and Fauna) Conversion Order 1999	29,782 3,894 40,000	High Low Unregulated
	Bulk Entitlement (River Murray – Flora and Fauna) Conversion Order 1999 – Barmah–Millewa Forest Environmental Water Allocation	50,000 25,000	High Low
	Bulk Entitlement (River Murray – Flora and Fauna) Conversion Order 1999 – Living Murray	9,589 101,850 34,300	High Low Unregulated
	Environmental Entitlement (River Murray – NVIRP Stage 1) 2012	26,230[6]	High
	Bulk Entitlement (River Murray – Snowy Environmental Reserve) Conversion Order 2004	29,794	High
	Water shares – Snowy Environmental Reserve	14,671 6,423	High Low
Western Region			
Wimmera and Glenelg	Wimmera and Glenelg Rivers Environmental Entitlement 2010[4,5]	40,560 1,000	Pipeline product Wetland product

1 *While the VEWH does not hold any entitlements in the Maribyrnong system, water allocation was purchased in this system together with Melbourne Water in 2013–14, 2014–15, 2015–16, 2016–17 and 2017–18.*

2 *Use of these entitlements depends on suitable river heights, as specified in both the Latrobe and Barwon environmental entitlements (rather than a permitted volume).*

3 *Water is accumulated continuously according to a share of inflows (Blue Rock Reservoir 9.5 percent, Tarago Reservoir 10.3 percent, Werribee system 10.0 percent, Moorabool system 11.9 percent, Thomson Reservoir 3.9 percent, West Barwon Reservoir 3.8 percent) and this volume represents the maximum that can be stored at any time. The actual volume available in any year varies according to inflows.*

4 *In addition to volumetric entitlement, the entitlement also includes passing flows.*

5 *In addition to volumetric entitlement, the entitlement also includes unregulated water.*

6 *This entitlement volume is equal to one-third of the total water savings from the Goulburn-Murray Water Connections Project Stage 1, as verified in the latest audit (including mitigation water).*

7 *Allocation against this entitlement is made subject to specific triggers, as specified in the entitlement.*

Water donations

The VEWH may receive water donations from individuals, community groups and other organisations. This water could be used for environmental watering in the water year it was donated (including for actions identified in the seasonal watering plan), or it could be carried over for use in the future (see section 1.4.2 for more information about carryover). Some donors may identify a specific use for the water they donate (such as environmental watering in a specific wetland or to protect a certain tree species). In these instances, the VEWH would consider the costs and benefits of each donor proposal before agreeing to accepting a donation.

Water available from other environmental water holders

In northern and western Victoria, the VEWH coordinates with other environmental water holders to deliver environmental outcomes at the broader Murray–Darling Basin scale. One of the VEWH's important roles is to coordinate with Murray–Darling Basin environmental water holders (the CEWH, MDBA and program partners in NSW and SA) to optimise the benefits of all water for the environment in Victorian waterways. The seasonal watering plan considers the use of all water for the environment held in Victorian river systems.

Usually, when Commonwealth or MDBA water is to be delivered in Victoria, the CEWH and MDBA transfer the agreed amount of water to the VEWH. That amount then becomes part of the Victorian Environmental Water Holdings until used or transferred back.

Table 1.4.2 shows the environmental water entitlements held by the CEWH and MDBA in Victoria. The CEWH and MDBA also hold water in NSW and SA, which could potentially be made available for environmental watering in Victoria.

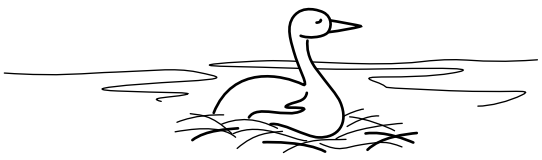
Table 1.4.2 Environmental water entitlements held in Victoria by other water holders (as at 31 March 2018)

System	Volume (ML)	Class of entitlement
MDBA environmental water entitlements		
Murray	12,267	High-reliability water share
Goulburn	5,559	High-reliability water share
Commonwealth environmental water entitlements (held by CEWH)		
Ovens	123	High-reliability water share
Murray	324,116 25,489	High-reliability water share Low-reliability water share
Broken	534 4	High-reliability water share Low-reliability water share
Goulburn	279,881 29,435	High-reliability water share Low-reliability water share
Campaspe	6,624 395	High-reliability water share Low-reliability water share
Loddon	3,356 527	High-reliability water share Low-reliability water share
Wimmera-Mallee	28,000	Low-reliability product

Water for the environment and non-government agencies

In 2007, the Murray Darling Wetlands Working Group (MDWWG) and the Nature Conservancy (both non-government organisations) partnered to own and manage the Environmental Water Trust. To date, the MDWWG has been very active in wetland protection and management in NSW through partnerships with state and federal governments. In 2017–18, the MDWWG partnered with Goulburn Broken CMA to deliver water for the environment to wetlands in Victoria for the first time. The MDWWG is currently focusing its efforts on wetlands that are on private land, and given the deliveries are outside the Victorian Water Holdings, they are not specifically covered by this seasonal watering plan.

For more information about the MDWWG and the Environmental Water Trust, see www.murraydarlingwetlands.com.au and environmentalwatertrust.org.au.



1.4.2 What options are available to effectively and efficiently manage water for the environment?

Other water sources

Water for the environment is not the only type of water that can support river, wetland and floodplain health. Waterway managers and environmental water holders in consultation with storage managers consider the potential for environmental watering objectives to be met by other types of water. The timing of environmental releases can be coordinated with other sources of water to achieve greater benefits than an environmental release alone could produce. Other sources of water can include:

- **system operating water** (including passing flows) which maintains a baseflow in many rivers to which water for the environment can be added
- **heavy rainfall** (resulting in unregulated flows) which can naturally meet an environmental objective, so water available under environmental water entitlements is not needed
- **alterations to the timing and route for delivery of consumptive water** which can achieve environmental objectives without detriment to consumptive water users: in some cases, water for the environment may be used to reimburse consumptive water entitlements for losses associated with the altered delivery of consumptive water.

These types of water are considered in the development and implementation of the seasonal watering plan to ensure effective system operations and efficient use of water for the environment, and to achieve the greatest benefit to the environment.

Return flows

In some systems, water for the environment delivered through upstream sites can be used again downstream. This helps to ensure water for the environment is used efficiently and effectively to achieve the greatest environmental benefits.

This reuse policy, known as return flows, is available in many systems across northern Victoria. It makes use of water for the environment more efficient, and it helps reduce the volume of water that needs to be recovered for the environment from consumptive water users.

The VEWH's access to return flows is enabled through rules in its environmental water entitlements. Reuse of return flows is also available to the CEWH and MDBA when the VEWH delivers water on their behalf.

Where possible, return flows are reused to provide benefits at Victorian environmental sites. If not needed in Victoria, the VEWH, Living Murray and CEWH return flows will continue to flow across the border to SA where they will be used to provide environmental benefits at sites such as the Coorong, Lower Lakes and Murray Mouth area.

Carryover

Some entitlements allow the VEWH to carry over unused water to the following water year. This means that water allocated in one year can be kept in storages for use in the following year, subject to certain conditions.

Carryover provides flexibility and enables water for the environment to be delivered when it is of the greatest value to the environment. For example, carryover can help ensure environmental water holders can meet high winter and spring demands when there is a risk there will be little water available under entitlements at the beginning of the water year.

Carryover can also be used to set water aside to maintain key refuge areas and avoid catastrophic events in drought periods.

Water trading

Water trading allows the VEWH to smooth out some of the variability in water availability across systems and across years. Under certain circumstances, it can enable the VEWH to move water to the systems where it is most needed. The VEWH can trade water allocated to its entitlements by:

- administrative water transfers between the VEWH's entitlements
- administrative water transfers with other environmental water holders
- purchasing water allocation
- selling water allocation.

Administrative water transfers are the most common trades the VEWH undertakes. These occur between the VEWH's entitlements (or accounts) to move water to where it is most needed. Other environmental water holders also transfer their water to the VEWH for delivery in Victoria. These types of water trades are often referred to as administrative water transfers as there is no financial consideration associated with the trade.

The VEWH can also buy or sell water allocation where it is in line with its statutory objectives: that is, if it benefits the environment. The VEWH has bought or sold a small amount of water allocation each year since it was established in 2011.

Water has been purchased to enhance environmental outcomes in systems where insufficient water for the environment was available, and it has been sold where foreseeable environmental demands could be met. The VEWH may also decide to sell water to invest in complementary works and measures, technical studies or other priorities to improve waterway health and the performance of Victoria's environmental watering program.

The VEWH can use revenue raised from the sale of a water allocation to:

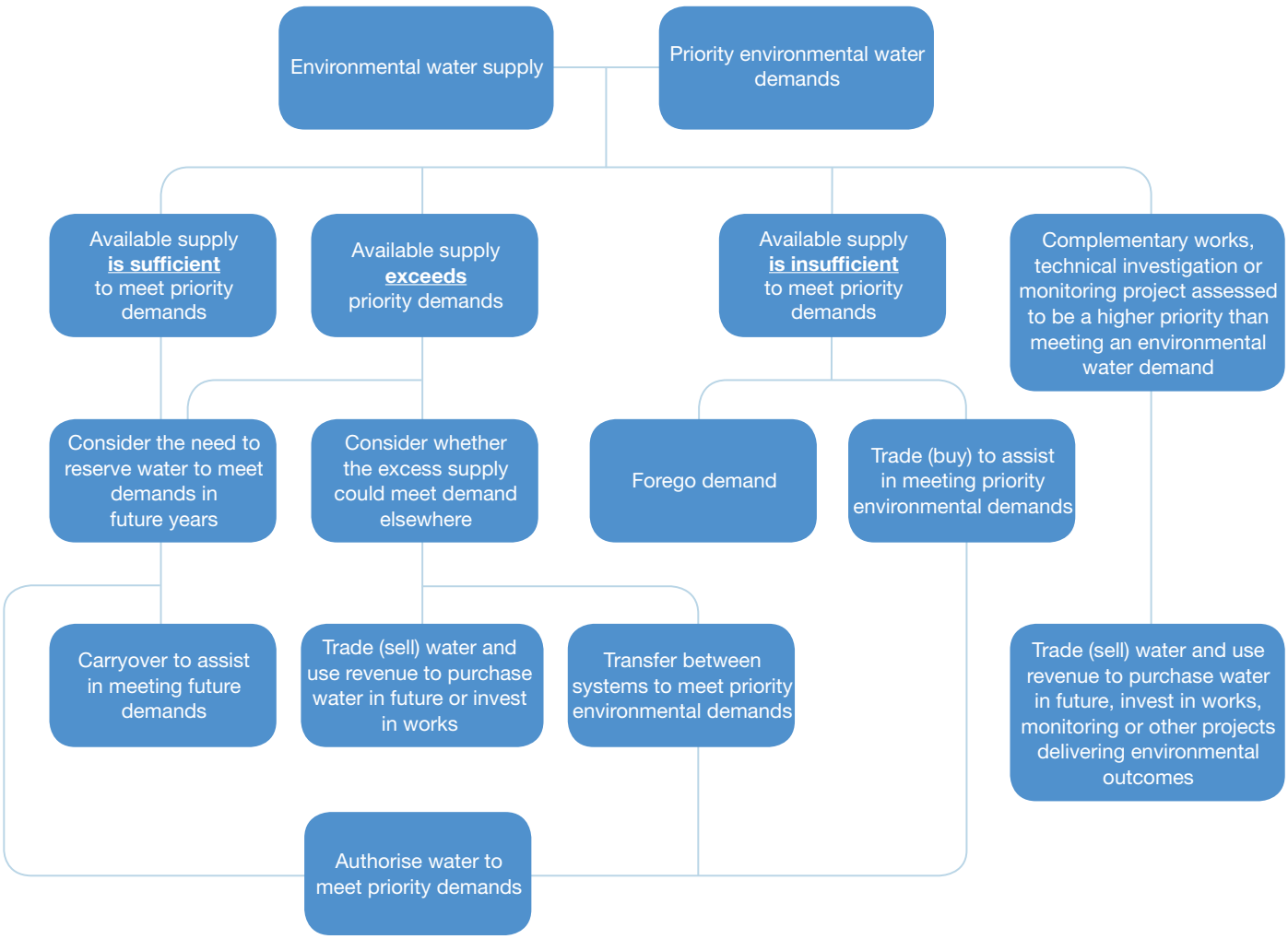
- purchase water to meet shortfalls in any Victorian system
- invest in monitoring or technical studies that will improve future management of water for the environment
- invest in structural works and other on-ground activities that will improve the performance of Victoria's environmental watering program.

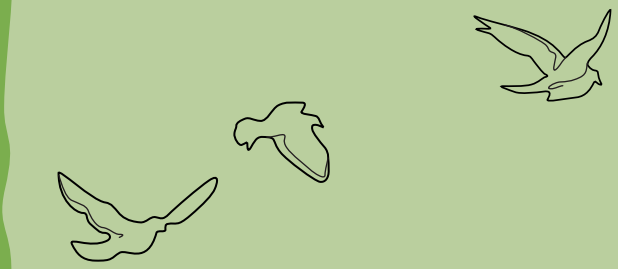
Subject to the approval of the Minister for Water, the VEWH can also trade its water entitlements (referred to as a permanent trade). However, it has not undertaken permanent trades to date.

Figure 1.4.1 shows the key considerations that guide the VEWH's use, carryover and trade decisions.

There is more information about the VEWH's trading activity, including its annual trading strategy, on its website at vewh.vic.gov.au.

Figure 1.4.1 Key considerations guiding use, carryover and trade decisions

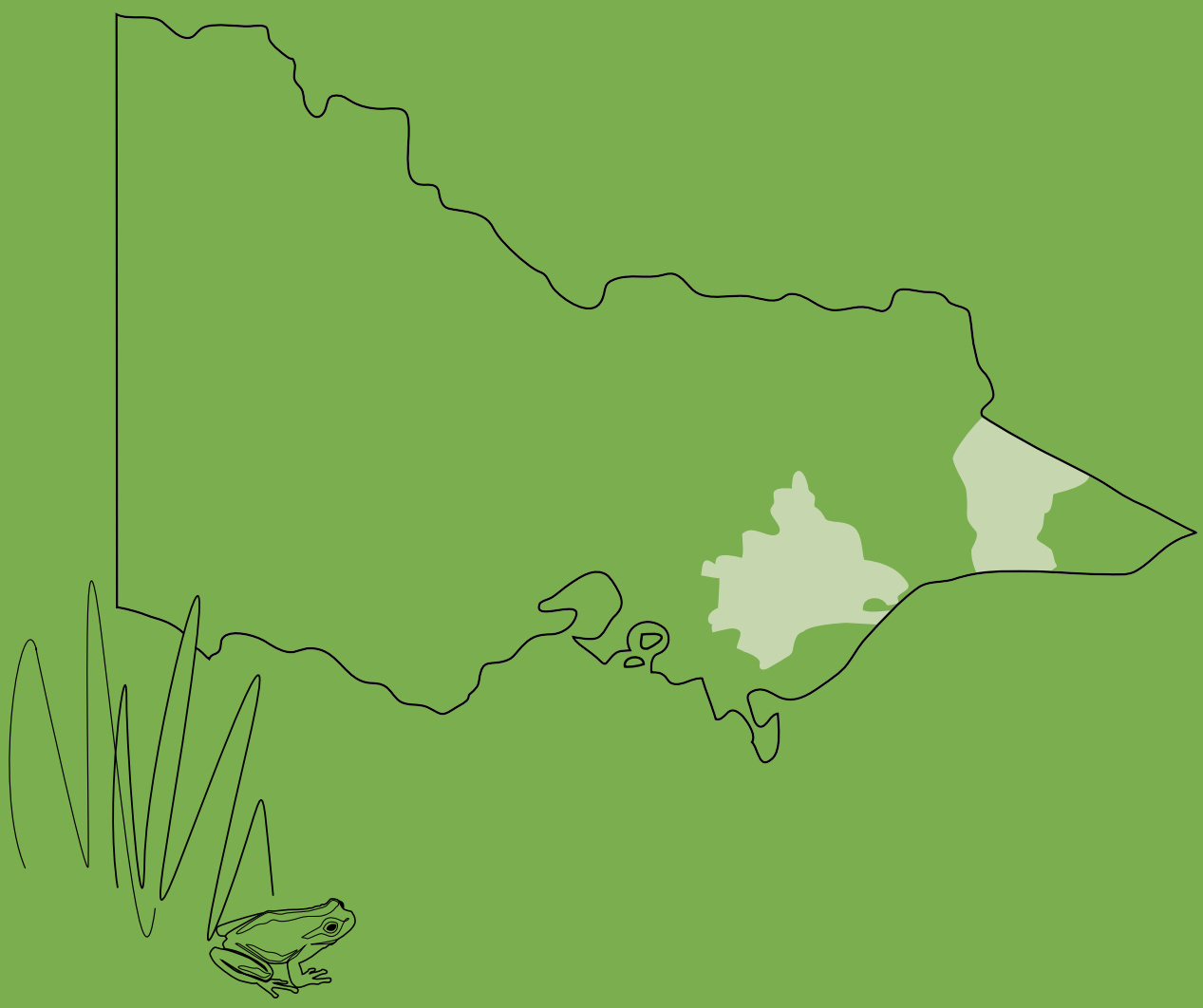




Upper Latrobe River, Sweetwater Creek Conservation Reserve, by West Gippsland CMA

Section 2

Gippsland Region



2.1 Gippsland Region overview

The four river systems in the Gippsland Region that can receive water from the VEWH's environmental entitlements are the Latrobe (including the Latrobe River and lower Latrobe wetlands), Thomson River, Macalister River and Snowy River.

Environmental, social and economic values, recent conditions, environmental watering objectives and planned actions for each system in the Gippsland Region are presented in the sections that follow.

Traditional Owners in the Gippsland Region

Traditional Owners and their Nations in the Gippsland Region continue to have a deep connection to the region's rivers, wetlands and floodplains. The VEWH acknowledges the Traditional Owners of Gippsland and pays respect to their Elders past, present and future. It recognises that water has significant cultural importance and value for Traditional Owners and Aboriginal people.

The Registered Aboriginal Party (RAP) for part of the Gippsland Region in Victoria is the Gunaikurnai Land and Waters Aboriginal Corporation (GLaWAC). In 2010, the Victorian Government and the Gunaikurnai people entered into the Gunaikurnai Settlement Agreement under the *Traditional Owner Settlement Act 2010*. Under the agreement, the Gunaikurnai Traditional Owner Land Management Board was established to jointly manage parks and reserves between Warragul and Orbost.

The West Gippsland CMA has been working with GLaWAC for many years, and a memorandum of understanding between West Gippsland CMA and GLaWAC is in place to support working arrangements between the organisations. West Gippsland CMA and GLaWAC work together to identify actions and priorities to improve knowledge of cultural values, protect cultural heritage, incorporate traditional ecological knowledge and provide opportunities for cross-cultural learning and participation in CMA projects. West Gippsland CMA also works with the Boon Wurrung Foundation, Bunurong Land Council and Wurundjeri Tribal Council.

The NSW Department of Primary Industries (Water) have historically worked with Aboriginal communities that have a strong connection to waterways in the Snowy Mountains. These include the Maneroo-Ngarigo, Bidwell Maap, Southern Monero (Monero-Ngarigo / Yuin / Bolga), Wongalu and Wiradjuri people.

Community considerations

When planning to use water for the environment, the potential social, economic, Aboriginal cultural and community recreational benefits which could arise from the water's use are considered. Some scoped opportunities for shared community benefits of water for the environment in the Gippsland Region in 2018–19 include:

- timing environmental flows over long weekends in the upper Thomson River (where there is an overlap with migratory fish spawning and recruitment seasons), to increase whitewater rafting opportunities for kayakers and canoeists: for example, a spring fresh for Australian grayling recruitment in 2018 might be delivered over the Melbourne Cup weekend
- releasing environmental flows to support downstream migration and recruitment of Australian bass in the Thomson and Macalister rivers and estuary perch in the Thomson River, which increases opportunities for recreational anglers.

The ability of the VEWH and its partners to deliver these benefits will depend on the weather, on climate variations, on the available water and on the way the system is being operated to deliver water for other purposes (such as for home, farm and business use).

In addition to these opportunities, water for the environment has indirect benefits (such as improving amenity that benefits walkers, cyclists, birdwatchers and hunters around the lower Latrobe wetlands).

For more information about scoped opportunities for shared community benefits in 2018–19, contact the VEWH or the relevant waterway manager.

Integrated catchment management

Altered water regimes are one of many threats to the health of Victoria's waterways. To be effective, planning and releases of water for the environment need to be part of an integrated approach to catchment management. Many of the environmental objectives in this seasonal watering plan will not be fully met without also addressing issues such as excessive catchment erosion, barriers to fish movement, high nutrient loads, loss of stream bank vegetation and invasive species, to name just some issues.

Victorian and Australian government agencies, community groups and private landowners collectively implement programs and activities to protect and improve the environmental condition and function of land, soils and waterways throughout Victoria's catchments. Examples in the region of such programs and activities coordinated with environmental flows include:

- works to protect and enhance streambanks along priority reaches of rivers and their tributaries including fencing to exclude stock, revegetation of riverbanks, invasive species control (including willow) and waterway stabilisation
- working with farmers along the Thomson and Macalister rivers on grazing and soil management, and on nutrient and water-use-efficiency projects that help improve water quality and river health outcomes
- planning to build a fishway on the Thomson River, to improve fish passage near the heritage-listed Horseshoe Bend Tunnel; this project will allow migratory fish including Australian grayling, which are specifically targeted with releases of water for the environment, to move into an additional 85 km of river habitat in the upper reaches of the Thomson catchment
- a program of remote weed and willow control in the Snowy River catchment, which has led to 200 km of the river now being willow-free; native vegetation is flourishing in areas where willows have been removed and it provides a valuable food source and habitat for animals.

For more information about integrated catchment management programs in the Gippsland Region refer to the West Gippsland and East Gippsland regional catchment strategies and waterway strategies.

Upper Macalister River, by West Gippsland CMA

Seasonal outlook 2018–19

Water for the environment for the Latrobe, Thomson and Macalister systems is held in Blue Rock Reservoir, Thomson Reservoir and Lake Glenmaggie respectively.

The Thomson system receives a secure annual allocation which is available on 1 July each year, in addition to a share of the daily inflows to the Thomson Reservoir. In the Latrobe and Macalister systems, water availability depends on system inflows to Lake Glenmaggie and Blue Rock Lake. Most of these inflows occur in winter and spring, so annual allocations are usually known before the start of summer.

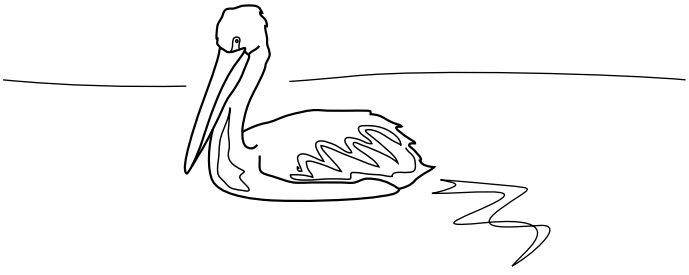
In all three systems, the VEWH will carry over water from 2017–18 into 2018–19. In the Macalister system, the carryover will be used to deliver priority flows in July and August, and we will rely on further inflows to provide sufficient allocations to meet high-priority watering demands later in 2018–19. In the Thomson and Latrobe systems, carryover water will be set aside to use in late winter and spring, by which time there should be more-reliable estimates of seasonal allocations and the overall availability of water for the environment in all three systems.

The probability of exceeding median rainfall in the Gippsland Region in early winter 2018 is better than average, but it has been particularly dry during summer and autumn 2018 and the catchments are very dry. The catchments will need significant rain to saturate the ground before there is any marked effect on streamflow. There will be high reliance holdings of water for the environment to provide critical-flow components until natural run-off and unregulated flows increase.

Current holdings of water for the environment are likely to be sufficient to deliver the highest-priority watering actions in the Latrobe, Thomson and Macalister rivers in the first half of 2018–19. A return to drought conditions may significantly limit allocations of water for the environment during 2018–19 and therefore deliveries of water for the environment later in the year will need to be managed to provide enough carryover to meet critical demands in 2019–20. Additional water for the environment may be sought via transfers from within the Gippsland system or from another region, if allocations are inadequate to deliver important environmental outcomes.

Under an average-to-wet scenario, there will be sufficient water to meet all identified potential watering actions for the Macalister, Thomson and Latrobe systems. High inflows will also boost Water Holdings for 2019–20. Under a wet scenario, the Latrobe wetlands may be filled with natural flushing flows that have not occurred on a large-scale since 2011–12.

Planning of water for the environment in the Snowy system is managed by the NSW Department of Industry, which consults the Victorian and Australian governments and stakeholder groups about water for the environment released to the Snowy River. The total volume for release and daily release targets for the Snowy River from May 2018 to April 2019 are set in place and daily releases will not vary unless flows increase the risk of flooding downstream.



2.2 Latrobe system

Waterway manager – West Gippsland Catchment Management Authority

Storage manager – Southern Rural Water

Environmental water holder – Victorian Environmental Water Holder

The Latrobe system includes the Latrobe River and lower Latrobe wetlands: Sale Common, Dowd Morass and Heart Morass.

The Latrobe River, its tributaries and the Latrobe wetlands continue to be important places for Traditional Owners and their Nations. The Registered Aboriginal Party (RAP) in the region is the Gunaikurnai Land and Waters Aboriginal Corporation.

Engagement

Table 2.2.1 shows the partners with which West Gippsland CMA engaged when preparing the Latrobe system seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional catchment strategies, regional waterway strategies, environmental flow studies, water management plans and other studies. These incorporate a range of environmental, cultural, social and economic perspectives and longer-term integrated catchment and waterway management objectives. For further details, refer to the *West Gippsland Regional Catchment Strategy* and *West Gippsland Waterway Strategy*.

Table 2.2.1 Partners and stakeholders engaged in developing the Latrobe system seasonal watering proposal

Partner and stakeholder engagement
• Field and Game Australia
• Latrobe Valley Field Naturalists Club
• Local irrigators and famers
• Parks Victoria
• Southern Rural Water
• Victorian Environmental Water Holder
• Wetlands Environmental Taskforce, a registered environmental organisation that purchases and restores wetlands in Victoria

2.2.1 Latrobe River

The Latrobe River originates on the Mount Baw Baw Plateau and passes through relatively flat to undulating plains cleared for agriculture, before flowing into Lake Wellington (the westernmost point of the Gippsland Lakes). Notable tributaries include the Tanjil River, Narracan Creek, Morwell River, Tyers River, Traralgon Creek and the Thomson River.

Environmental values

The upper Latrobe River flows through state forest and remains relatively intact and ecologically healthy. It contains some continuous stands of river red gums and intact riparian vegetation. This section of the Latrobe also supports native animal species including barred galaxias, river blackfish, Gippsland spiny crayfish and nankeen night herons.

The lower Latrobe River flows through the Latrobe Valley and is highly degraded due to historic river management practices. Most snags have been removed from the river and many sections have been artificially straightened. These practices have caused significant erosion and widened the channel, which has in turn reduced the quality and quantity of habitat for aquatic plants and animals.

Endangered and vulnerable vegetation communities are found in all but the most-modified sections of the Latrobe River. The banks along the lower reaches support stands of swamp scrub, characterised by swamp paperbark and tea tree. Mature river red gums grow adjacent to the lower Latrobe wetlands and provide nesting habitat for sea eagles and other birds of prey that hunt in the wetlands. The Latrobe River supports several native estuarine and freshwater fish species including black bream, Australian bass, Australian grayling and short- and long-finned eel.

The Latrobe River and its tributaries provide an essential source of freshwater to the Gippsland Lakes system, of which the lower Latrobe wetlands are an important component.

Social and economic values

The Latrobe Valley remains central to Victoria's energy industry, and water extracted from the Latrobe River is used in the electricity generation process. The Latrobe River also provides water for irrigation, stock and domestic licences, commercial and industrial licences and urban water supplies. These industries, along with the businesses that exist to service them, provide employment opportunities in the region.

Water storages throughout the catchment are popular recreation areas. Lake Narracan hosts annual waterskiing events and Blue Rock Reservoir is becoming increasingly popular for recreational fishing. The lower Latrobe River is commercially fished for eel and carp. It also contains black bream and estuary perch, which are favoured by recreational fishers. Many of the region's wetlands attract walkers, birdwatchers and hunters.

Environmental watering objectives in the Latrobe River

	Form in-stream bars to help stabilise the structure and condition of the river channel: this will help to reduce the load of sediment and nutrients flowing into the Gippsland Lakes
	Establish native plants on bars and lower parts of the banks to stabilise the river channel
	Improve in-stream habitat for native fish including black bream and estuary perch
	Improve in-stream habitat for waterbugs

System overview

Water for the environment is supplied to the Latrobe River from Blue Rock Reservoir on the Tanjil River. Blue Rock Reservoir also supplies water for electricity generators in the Latrobe Valley and town water.

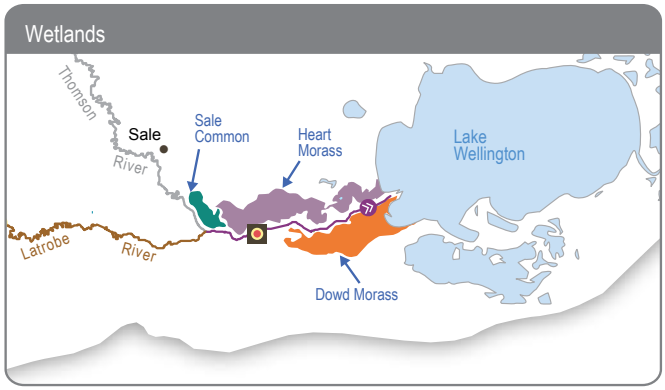
The Latrobe River from Rosedale to the Thomson River confluence (reach 5) is the priority reach for water for the environment because it contains endangered plant communities that have good potential for rehabilitation.

Upper Latrobe River, by Rachael Millar, West Gippsland CMA

Figure 2.2.1 The Latrobe system

Reach 1 Upstream of Willow Grove
Reach 2 Willow Grove to Lake Narracan
Reach 3 Lake Narracan to Scarnes Bridge
Reach 4 Scarnes Bridge to Rosedale
Reach 5 Rosedale to Thomson River confluence
Reach 6 Downstream of Thomson confluence
Reach 7 Lake Wellington
Reach 8 Tanjil River
Water infrastructure
Measurement point
Town
Indicates direction of flow

Grey river reaches have been included for context. The numbered reaches indicate where relevant environmental flow studies have been undertaken. Coloured reaches can receive environmental water.



Recent conditions

Climatic conditions in West Gippsland were warmer and drier than average during the 2017–18 water year. The only significant natural flow events were a minor flood in the Latrobe River that lasted less than six days in mid-September and an event downstream of the Thomson confluence in early December. More environmental flows were delivered to the Latrobe River in 2017–18 than in previous years. Freshes were delivered in November 2017 and March and April 2018.

The environmental flow provided in November was a first for the Latrobe River at that time of year. Several natural freshes had already occurred due to heavy rainfall and minor spills from Blue Rock Reservoir, and an extra release was necessary to bolster vegetation growth on the banks of the lower Latrobe during the peak growing season in spring. The fresh was also coordinated with releases made in the Thomson and Macalister rivers to deliver a large pulse through the system to support native fish migration.

Environmental flows in March 2018 complemented three smaller, unregulated freshes that occurred in January. The release in April 2018 was combined with releases made to the Thomson and Macalister rivers to maintain bank vegetation and improve water quality in the lower Latrobe River estuary.

Low-flow recommendations were achieved from passing flows and unregulated flows during July to December 2017, but summer/autumn low flows were below the minimum-flow recommendation. Low flows were not augmented with environmental flow releases because the two freshes were considered sufficient to provide in-stream habit throughout summer and autumn.

Scope of environmental watering

Table 2.2.2 shows potential environmental watering actions and their environmental objectives.

Table 2.2.2 Potential environmental watering actions and objectives for the Latrobe River

Potential environmental watering	Environmental objectives
Spring/summer freshes (1,300 ML/day for 2–4 days during September to February)	• Encourage vegetation zonation along lower banks and recruitment/maintenance of in-stream vegetation
Autumn/winter freshes (1,300 ML/day for 2–4 days during March to August)	
Winter/spring low flows (690–1,500 ML/day from June–November)	• Encourage the formation of in-stream bars (deposit sediment and gravel on slightly elevated features in the river channel)
Summer/autumn low flows (up to 690 ML/day from December to May)	• Provide in-stream habitat for aquatic biota, (especially waterbugs, fish and vegetation)

Scenario planning

Under drought and dry scenarios, there will not be many natural freshes in the regulated parts of the system, so water for the environment will likely be needed to deliver spring and summer freshes to achieve the vegetation objectives. Freshes and low flows may also be needed during winter–spring to help form in-stream bars and allow fish movement.

In average and wet scenarios, spring freshes are likely to be met naturally by spills from the Blue Rock Reservoir. If this occurs, water for the environment may not be used until summer or autumn.

Under the Blue Rock environmental entitlement, the VEWH accrues a share of inflows daily. It is important to consider rainfall, climate, river conditions and entitlement inflows between July and November when prioritising use of water for the environment. Environmental Water Holdings at the beginning of 2018–19 are lower than has been the case in previous years, due to the delivery of multiple freshes in 2017–18. Water Holdings are expected to increase with inflows under all climate scenarios, which will enable delivery of all high-priority flows.

Table 2.2.3 outlines the potential environmental watering and expected water use under a range of planning scenarios.

Habitat rehabilitation is the priority for environmental flows management in the Latrobe River, as it will help reduce sediment and nutrient loads in the river and support populations of native fish. To achieve these goals, spring freshes are prioritised for each planning scenario to encourage the recruitment and maintenance of in-stream vegetation and prevent the encroachment of terrestrial plants into the stream channel.

Under drought and dry scenarios, there will be few natural freshes in the regulated parts of the system, so environmental flows will likely be needed to deliver spring and summer freshes to achieve the vegetation objectives. Freshes and low flows may also be needed during winter–spring, to help form in-stream bars and allow fish movement.

In average and wet scenarios, spring freshes are likely to be met naturally by spills from the Blue Rock Reservoir. If this occurs, water for the environment may not be used until summer or autumn.

Under the Blue Rock environmental entitlement, the VEWH accrues a share of inflows daily. It is important to consider rainfall, climate, river conditions and entitlement inflows between July and November when prioritising use of water for the environment. Environmental Water Holdings at the beginning of 2018–19 are lower than has been the case in previous years, due to the delivery of multiple freshes in 2017–18. Water Holdings are expected to increase with inflows under all climate scenarios, which will enable delivery of all high-priority flows.

Table 2.2.3 Potential environmental watering for the Latrobe River under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Small contributions from unregulated reaches and tributaries of the Latrobe River with little opportunity for freshes to occur naturally • Consumptive demand from Blue Rock Reservoir will be very high and regular releases to the Tanjil River will contribute substantially to low flows	• There will be some unregulated flows that contribute to low flows and freshes • Consumptive demand from Blue Rock Reservoir will be high and contribute to low flows	• Unregulated flows will provide low flows throughout the year, and multiple freshes (most likely in winter and spring) • Some spills are likely and there will be releases for consumptive users which will partly contribute to low flows	• Strong summer and autumn low flows • Multiple spills from Blue Rock Reservoir will provide extended durations of freshes, high flows and overbank flows • No significant releases from consumptive entitlements in Blue Rock Reservoir are likely
Expected availability of environmental water	• 12,000–15,000 ML	• 12,000–17,000 ML	• 12,000–22,000 ML	• 12,000–30,000 ML
Potential environmental watering	• 1 spring/summer fresh • 1 autumn/winter fresh • Winter/spring low flows	• Up to three spring/summer freshes • Up to two autumn/winter freshes • Winter/spring low flows • Summer/autumn low flows	• Up to three spring/summer freshes • Up to two autumn/winter freshes • Winter/spring low flows • Summer/autumn low flows	• Up to four spring/summer freshes • Up to four autumn/winter freshes • Winter/spring low flows • Summer/autumn low flows
Possible volume of environmental water required to achieve objectives	• 12,300 ML	• 11,200 ML	• 15,900 ML	• 0–11,000 ML

Risk management

Environmental watering program partners have considered and assessed risks and identified mitigating strategies relating to environmental flows in 2018–19. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

2.2.2 Lower Latrobe wetlands

The lower Latrobe wetlands (Dowd Morass, Heart Morass and Sale Common) are an important component of the internationally recognised Gippsland Lakes Ramsar site, and provide habitat for a variety of waterbirds of state, national and international conservation significance. The wetlands are located on the floodplain of the Latrobe River between its confluence with the Thomson River, and they form part of the Gippsland Lakes system, with Dowd Morass and Heart Morass adjoining Lake Wellington.

Environmental values

Sale Common is one of only two remaining freshwater wetlands in the Gippsland Lakes system, and it provides sheltered feeding, breeding and resting habitat for a large range of waterbirds.

Dowd Morass is a large, brackish wetland that regularly supports rookeries of colonial nesting waterbirds including Australian white ibis, straw-necked ibis, little black and little pied cormorants, royal spoonbills and great egrets.

Heart Morass is also a large brackish wetland, with open expanses providing shallow, feeding habitat for waterbirds including black swans, Eurasian coots and many species of ducks.

Together, the lower Latrobe wetlands function as a diverse and complementary ecological system. Colonial waterbirds breed among swamp paperbark trees at Dowd Morass in spring. Migratory shorebirds feed on the mudflats that are exposed as the wetlands draw down and dry over summer. Waterfowl and fish-eating birds use open-water habitat at the wetlands year-round. The wetlands also contain vegetation types that are threatened (such as swamp scrub, brackish herbland and aquatic herbland).

Social and economic values

Sale Common, which is located close to the city of Sale, is a state game refuge with extensive walking tracks and boardwalks that provide opportunities for passive recreation including walking, bike riding and observing native plants and animals. Dowd Morass is a state game reserve commonly used for duck hunting. Heart Morass consists of mostly private landholdings and is also used for duck hunting.

Environmental watering objectives in the lower Latrobe wetlands

	Support the dispersal, germination and survival of wetland plant communities Manage the extent and density of invasive plants, particularly the spread of giant rush at Sale Common
	Provide foraging and breeding habitat for waterbirds including threatened, migratory and colonial nesting species
	Reduce the abundance of carp
	Provide breeding habitat for frogs including threatened species such as the green and golden bell frog and the growling grass frog
	Mitigate impacts of adverse salinity and acid sulphate soils, particularly at Dowd Morass and Heart Morass Oxygenate surface soils and break down accumulated organic matter

System overview

River regulation and water extraction from the Latrobe, Thomson and Macalister rivers has reduced the frequency of small and medium-sized floods that naturally inundate the lower Latrobe wetlands. Construction of levees and drains and filling in of natural depressions have also altered water movement into and through the wetlands. The drainage and flooding regime in all three wetlands is now managed to some extent with regulators connected to the Latrobe River.

Recent conditions

Climatic conditions in West Gippsland were warmer and drier than average during the 2017–18 water year. Minor flooding in the Latrobe River occurred in September and December 2017, but the flows were not of sufficient duration to deliver meaningful inflows to the wetlands.

The regulator to Dowd Morass was opened from October to December 2017 and again in April 2018. The regulator was opened when the Latrobe River was high, to allow low-salinity water from the Latrobe River to reduce salinity in Dowd Morass.

At Heart Morass, flows through the regulator raised the water level by 5 cm and surface coverage at the wetland increased from about 40 to 80 percent. The managed inflows reduced salinity in the wetland and inundated the aquatic grasses, which provided food for waterbirds. Water was allowed to draw down naturally in Heart Morass and Dowd Morass from the middle of summer.

Sale Common was fully dry in June 2017, and after three days of inflows in September 2017 it was one-third full. By November 2017, the site was completely dry, apart from the long waterhole. Large stands of amphibious wetland vegetation (such as knotweed and club-rush) dominated the wetland over summer. By autumn, the amphibious vegetation began to desiccate and was replaced by terrestrial grasses. Sale Common has a more-varied water regime than Heart Morass and Dowd Morass, mainly because it is smaller but also because it received managed and unregulated inflows and drawdowns.

Scope of environmental watering

Environmental watering in the lower Latrobe wetlands aims to maintain and improve existing values and manage threats. Specific threats to the wetlands include saltwater intrusion and invasive species.

Saltwater intrusion from the Gippsland Lakes is a constant threat to Dowd Morass and Heart Morass. Rising sea levels due to climate change and reduced flows from the Latrobe River increase the threat. Heart Morass' vegetation has been degraded by many years of grazing, but much of the wetland is now recovering with the aid of restoration programs.

The lower Latrobe wetlands are affected by several invasive species. Carp limit the growth and recruitment of native aquatic vegetation in all wetlands. Brazilian milfoil, which is an invasive aquatic weed, has colonised much of the fringe of Sale Common; higher salinity levels have likely limited its spread to Heart Morass and Dowd Morass.

Table 2.2.4 shows potential environmental watering actions and their environmental objectives.

Table 2.2.4 Potential environmental watering actions and objectives for the lower Latrobe wetlands

Potential environmental watering	Environmental objectives
Sale Common	
Partial fill (any time)	• Control of invasive vegetation and algae • Mimic the natural inundation regime
Fill or partial fill (July–November)	• Encourage the growth and recruitment of wetland plants, particularly tall marsh, aquatic herbland and aquatic sedgeland • Provide feeding and breeding habitat for wetland animals, particularly waterbirds and frogs
Fill or partial fill (February–May)	• Provide feeding and sheltering habitat for wetland animals, particularly waterbirds and frogs • Discourage the spread of giant rush
Partial drawdown (primarily August–March)	• Oxygenate surface soils, break down accumulated organic matter and cycle nutrients • Encourage the growth and recruitment of wetland plants across the wetland bed • Reduce the abundance of carp
Dowd Morass and Heart Morass	
Partial fill (Dowd Morass: July–November) (Heart Morass: July–December)	• Encourage colonial waterbird breeding • Reduce salinity • Encourage the growth and recruitment of wetland plants, particularly swamp scrub, tall marsh, aquatic herbland and brackish herbland • Provide feeding and breeding habitat for wetland animals, particularly waterbirds and frogs
Partial drawdown (year-round, primarily August–March)	• Oxygenate surface soils, break down accumulated organic matter and cycle nutrients • Increase the growth and recruitment of wetland plants, particularly swamp shrub, tall marsh, aquatic herbland and brackish herbland • Reduce the abundance of carp
Partial fill (any time)	• Avoid or mitigate risks to wetland plants due to adverse salinity and pH • Mimic the natural inundation regime
Fill or partial fill (February–May)	• Provide feeding habitat for wetland animals, particularly waterbirds

Scenario planning

Table 2.2.5 outlines the potential environmental watering and expected water use under a range of planning scenarios.

Unregulated flows, climatic conditions and site observations are important considerations for managing the lower Latrobe wetlands. The planned approach in 2018–19 is to permit water levels to fluctuate in accordance with natural seasonality and mimic natural events with small-scale inflows, when conditions and environmental objectives allow.

It is highly likely that under drought and dry conditions, the wetlands will be drawn down and completely dry by the end of summer or during autumn, but small-scale inflows to the wetlands will still be provided through managed environmental flows through regulators at any time. Small-scale inflows will quickly dissipate and evaporate, and they are important to provide temporary, open-water habitat and to mitigate the risks of increasing salinity and acid sulphate soils in Heart Morass and Dowd Morass.

Under average conditions, the wetlands are likely to receive moderate, unregulated flows in winter and spring and partially draw down in summer and autumn. Under average conditions, the rate and extent of a drawdown is likely to be moderated by small-scale natural or managed environmental flows through regulators, while in wet conditions unregulated flows are likely to cause greater inundation and widespread drying is unlikely.

Under each planning scenario in Table 2.2.5, there are multiple potential watering actions in each scenario; and in some cases the timing of watering actions overlaps. This enables a flexible approach whereby small-scale inflows and drainage to and from wetlands through regulators can be managed to mimic natural conditions and optimise environmental outcomes.

Swan nest at Sale Common, by David Stork, West Gippsland CMA

Table 2.2.5 Potential environmental watering for the lower Latrobe wetlands under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected catchment conditions	• No natural inflows from the Latrobe River and wetlands are likely to dry completely	• Minor natural inflows from the Latrobe River in winter/spring; expect moderate-to-substantial drawndown in summer	• Moderate winter and spring flows in the Latrobe River likely to fill or partially fill the wetlands; expect minor drawdown in summer	• Major flows in the Latrobe River in winter /spring and possibly autumn/winter, likely to fill all wetlands with very little drawdown over summer
Sale Common[1]				
Potential environmental watering	• Complete drawdown (July–June) • Partial or complete fill (any time)	• Partial or complete fill (July–November) • Partial or complete fill (any time) • Drawdown (August–April)	• Partial or complete fill (July– November) • Partial or complete fill (any time) • Partial drawdown (August–March) • Partial or complete fill (February–May)	• Partial or complete fill (July–November) • Partial or complete fill (any time) • Partial drawdown (December–March) • Partial or complete fill (February–May)
Possible volume of water for the environment required to achieve objectives	• 0–1,300 ML	• 0–2,600 ML	• 0–2,600 ML	• 0 ML
Dowd Morass[1]				
Potential environmental watering	• Complete drawdown (July–June) • Partial or complete fill (any time)	• Partial or complete fill (July–November) • Partial or complete fill (any time) • Drawdown (August–April) • Partial or complete fill (February–May)	• Partial or complete fill (July–November) • Partial or complete fill (any time) • Partial drawdown (August–March) • Partial or complete fill (February–May)	• Partial or complete fill (July–November) • Partial or complete fill (any time) • Partial drawdown (December–March) • Partial or complete fill (February–May)
Possible volume of water for the environment required to achieve objectives	• 0–5,800 ML	• 0–11,600 ML	• 0–11,600 ML	• 0 ML
Heart Morass[1]				
Potential environmental watering	• Complete drawdown (July–June) • Partial or complete fill (any time)	• Partial or complete fill (July–December) • Partial or complete fill (any time) • Drawdown (August–April) • Partial or complete fill (February–May)	• Partial or complete fill (July–December) • Partial or complete fill (any time) • Partial drawdown (August–March) • Partial or complete fill (February–May)	• Partial or complete fill (July– December) • Partial or complete fill (any time) • Partial drawdown (December–March) • Partial or complete fill (February–May
Possible volume of water for the environment required to achieve objectives	• 0–7,100 ML	• 0–14,200 ML	• 0–14,200 ML	• 0 ML

[1] *Potential watering actions are listed in priority order for each scenario and timing. The order and timing may vary within scenarios depending on prevailing seasonal conditions*

Risk management

Environmental watering program partners have considered and assessed risks and identified mitigating strategies relating to environmental flows in 2018–19. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

2.3 Thomson system

Waterway manager – West Gippsland Catchment Management Authority

Storage managers – Melbourne Water (Thomson Reservoir), Southern Rural Water (Cowwarr Weir)

Environmental water holder – Victorian Environmental Water Holder

The Thomson River flows from the slopes of the mountains of the Baw Baw Plateau to join the Latrobe River south of Sale. The major tributaries of the Thomson River are the Aberfeldy and Jordan rivers in the upper reaches and the Macalister River in the lowest reach. Most unregulated flows originate from the Aberfeldy River. Two major structures regulate flow on the Thomson River: Thomson Reservoir — the largest water supply storage for metropolitan Melbourne — and Cowwarr Weir — a regulating structure which supplies irrigation water to parts of the Macalister Irrigation District.

The Thomson River and its tributaries continue to be an important place for Traditional Owners and their Nations. The Registered Aboriginal Party in the region is the Gunaikurnai Land and Waters Aboriginal Corporation.

Environmental values

The Thomson River supports six species of migratory fish that need to move between the sea and freshwater environments to complete their life cycles. A focus for environmental flows management is the Australian grayling, which has national conservation importance. Australian grayling spawn in response to autumn high flows, and the larvae and juveniles spend time at sea before returning to the freshwater sections of coastal rivers.

The composition and condition of riparian vegetation varies throughout the Thomson River catchment. The vegetation is intact and near-natural upstream of Thomson Reservoir in the Baw Baw National Park. Riparian vegetation between Thomson Reservoir and Cowwarr Weir is mostly in good condition, but is affected by exotic weeds including blackberry and gorse. Downstream of the Cowwarr Weir, the vegetation is degraded due to stock access and widespread weed invasion.

Social and economic values

Thomson Reservoir is the largest storage in Melbourne's water supply system, and it supplies water for irrigation, industry and towns in Gippsland. The Macalister Irrigation District is the largest irrigation area in southern Victoria and a major economic driver for the region.

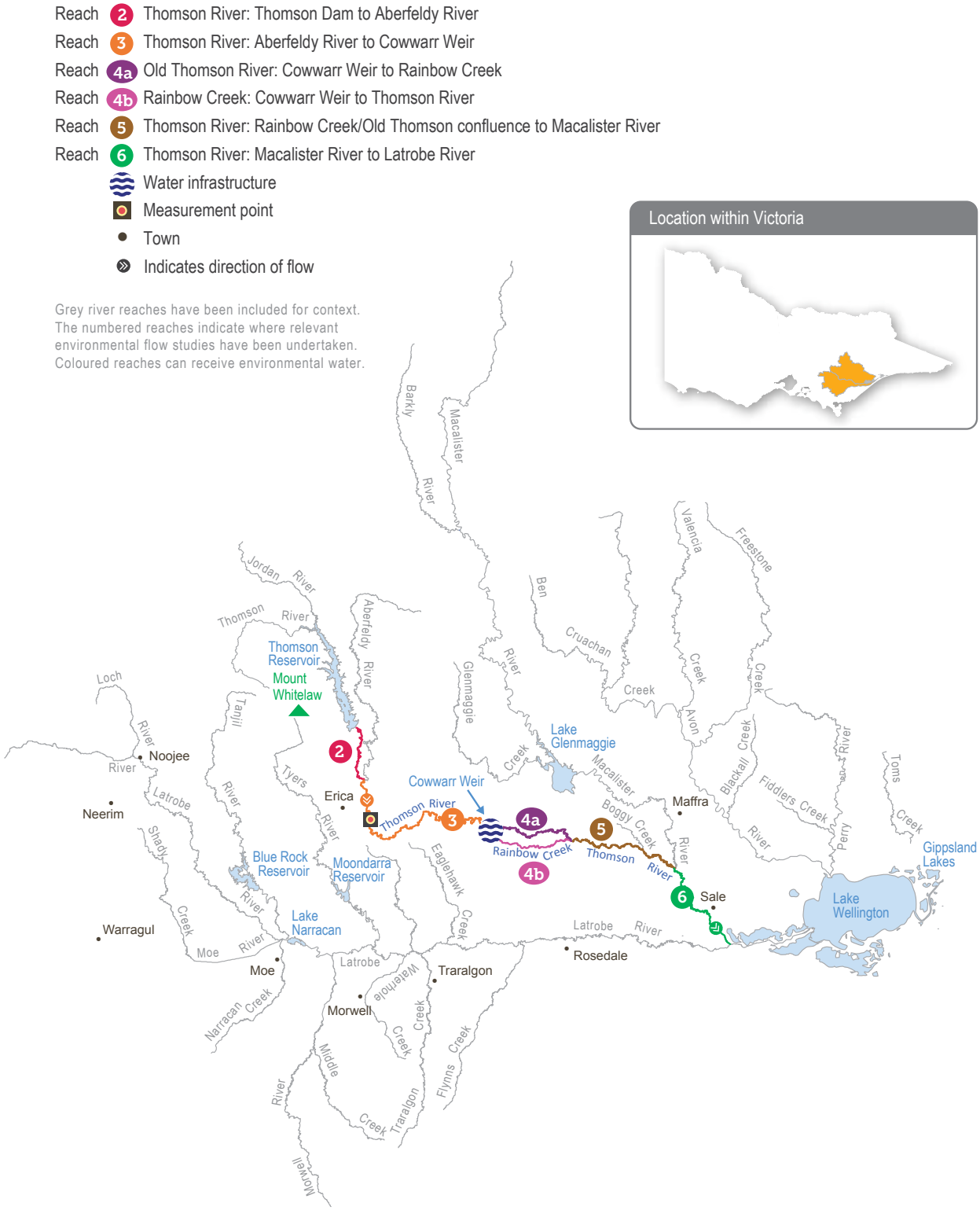
The upper reaches of the Thomson River — from Thomson Reservoir to Cowwarr Weir — and its tributary the Aberfeldy River — in the Baw Baw National Park — are classified as heritage river areas under the *Heritage Rivers Act 1992*, based on their ecological, historical and recreational values. The Horseshoe Bend tunnel is an important European heritage site in this area; it is a legacy of early gold mining in the area. The tunnel is a significant barrier to fish movement and therefore limits the ability to meet all environmental flow objectives in the upper reaches of the system.

The Thomson River is highly valued for recreation downstream of the Thomson Reservoir to Cowwarr Weir. The area is popular for camping, kayaking and canoeing. Avid kayakers, canoeists and outdoor recreational operators often take advantage of the whitewater conditions provided with releases of water for the environment in the upper reaches of the Thomson River. The local communities have a strong connection with the waterways and the visual amenity and recreational opportunities they provide.

Environmental watering objectives in the Thomson system

	Restore populations of native fish, specifically Australian grayling, by providing pool habitat and flows for fish to move and to cue spawning
	Scour silt build-up within the river bed to improve the quality of in-stream habitat for aquatic plants and animals Prevent encroachment of terrestrial vegetation into the stream channel
	Increase recruitment and growth of native riparian vegetation Prevent encroachment of terrestrial vegetation into the stream channel
	Provide waterbug habitat

Figure 2.3.1 The Thomson system



System overview

Due to the size of Thomson Reservoir, most flows from the Thomson River upper catchment are harvested in the reservoir and do not make it through to the rest of the river. The Aberfeldy River is an unregulated river and the major tributary of the Thomson River in the upper catchment. It meets the Thomson River downstream of Thomson Reservoir, and its unregulated flows are essential for providing natural freshes and high flows in the Thomson River.

Water for the environment is held in the Thomson Reservoir and released to the Thomson River. Reach 3 of the Thomson River (from the Aberfeldy River confluence to Cowwarr Weir) is the highest priority for environmental watering due to its heritage river status, high-value native riparian vegetation, high-quality in-stream habitat and low abundance of exotic fish species.

At Cowwarr Weir, the Thomson River splits in two and water can flow down the old Thomson River course (reach 4a) and Rainbow Creek (reach 4b). The preference is to deliver water for the environment to the old Thomson River course to allow for fish migration, as Cowwarr Weir is a barrier to fish migration through Rainbow Creek. Throughout the year, passing flows are split two-thirds down reach 4a and one-third down 4b to avoid impacts to irrigators located on Rainbow Creek.

Recent conditions

Releases of water for the environment in recent years have focused on providing autumn and spring freshes for spawning and recruitment opportunities for native fish species including Australian grayling, tupong and Australian bass. Low flows have also been provided to enable fish to move between habitats along the river.

The Thomson system has experienced variable climate conditions over the past two years. There was average-to-above-average rainfall in winter and spring 2016–17 resulting in several unregulated flow peaks and minor flooding, while dry conditions followed in summer, autumn and winter. Dry conditions persisted into 2017–18 with below-average rainfall throughout most of the year. Environmental flows in 2017–18 aimed to deliver freshes to provide spawning and recruitment opportunities for Australian grayling and low flows in winter and spring to maintain the quality of fish habitat.

Passing flows in the Thomson River were modified for July 2017 to allow some water for the environment to be saved for use later in the year. The modification was agreed by the VEWH, West Gippsland CMA, Southern Rural Water, Gippsland Water and Melbourne Water, and it saved 2,500 ML of water for the environment. Those savings, and additional allocations associated with the new environmental entitlement for the Thomson River which was gazetted in June 2017, enabled a range of environmental flows to be delivered through spring, summer and autumn.

From October to November 2017, spring low flows were delivered to allow fish to move between habitats in individual river reaches. An unregulated event provided a short fresh in mid-September 2017, and water for the environment was used to extend its duration to attract Australian grayling into the upper reaches of the river. Low flows in May to June 2018 were met through a combination of managed releases for environmental and consumptive use. In April 2018, an autumn fresh was provided to prompt migration and spawning of Australian grayling.

Scope of environmental watering

Table 2.3.1 shows potential environmental watering actions and their environmental objectives.

Table 2.3.1 Potential environmental watering actions and objectives for the Thomson system

Potential environmental watering	Environmental objectives
Spring freshes (1–2 freshes of 800 ML/day for 4 days each in October–November)	• Encourage juvenile Australian grayling to recruit into the river from the estuary or ocean
Autumn/winter low flows (up to 230 ML/day from May–July)[1]	• Provide passage along the river to enable localised fish movement between habitats
Spring low flows (230 ML/day November)	• Provide improved passage along the river to enable fish to move between habitats
Winter freshes (up to 4 freshes of 800 ML/day for 4 days in June–August)	• Provide a migration and spawning cue for migratory fish species including tupong and Australian bass • Maintain diversity and increase riparian vegetation
Autumn freshes (1–2 freshes of 800 ML/day for 4 days each in April–May)	• Provide a migration and spawning cue for migratory fish species including tupong and Australian bass • Maintain diversity and increase riparian vegetation
Summer/autumn freshes (up to 7 freshes of 230 ML/day for 4 days in December–April)	• Provide habitat for native fish • Maintain diversity and increase growth of submerged aquatic vegetation • Scour sediment exposing fresh habitat areas • Provide habitat for waterbugs

[1] *Passing flows may be flexibly managed at rates less than 230 ML per day in July.*

Scenario planning

Table 2.3.2 outlines the potential environmental watering and expected water use under a range of planning scenarios.

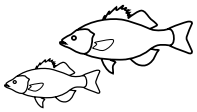
The highest priorities for water for the environment in the Thomson River in 2018–19 are spring freshes, autumn low flows and spring low flows. Spring freshes encourage recruitment of juvenile migratory fish to move into the river from the estuary. Low flows over autumn and winter provide opportunities for fish to move along the river between habitats. There is sufficient water for the environment available to deliver these flow components under all climate scenarios.

In average-to-wet scenarios, unregulated flows are likely to meet many environmental flow objectives (such as winter freshes to maintain riparian vegetation or scour sediment). In these scenarios, spring freshes and additional winter freshes provide further recruitment and migration opportunities for native fish. Under all scenarios, 5,600 to 8,200 ML of water for the environment is expected to be carried over at the end of the 2018–19 water year to meet critical minimum demands for water for the environment at the start of 2019–20.

Table 2.3.2 Potential environmental watering for the Thomson system under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Unregulated flows very limited • Large volumes of consumptive water released from storage	• Unregulated flows from the Aberfeldy River and other tributaries contribute to baseflows and freshes • Moderate volumes of consumptive water released from storage	• Unregulated flows from the Aberfeldy River and other tributaries contribute to baseflows, freshes and high flows • Some consumptive water released from storage	• Unregulated flows from the Aberfeldy River and other tributaries contribute to baseflows, freshes and sustained high flows • Minimal consumptive water released from storage
Expected availability of water for the environment	• 12,500–21,800 ML	• 15,500–24,800 ML	• 18,500–27,800 ML	• 21,500–>30,800 ML
Potential environmental watering – tier 1 (high priorities)	• 1 spring fresh • Spring low flows • Autumn/winter low flows • 1 autumn fresh • Summer freshes as required	• 1 spring fresh • Spring low flows • Autumn/winter low flows • 1 autumn fresh • Summer freshes as required	• 1 spring fresh • Spring low flows • Autumn/winter low flows • 1 autumn fresh • Summer freshes as required • 1 winter fresh	• 1 spring fresh • Spring low flows • Autumn/winter low flows • 1 autumn fresh • Summer freshes as required • 1 winter fresh
Potential environmental watering – tier 2 (additional priorities)	• 1 winter fresh	• 1 winter fresh	• 1 additional spring fresh	• 1 additional winter fresh
Possible volume of water for the environment required to achieve objectives[1]	• 9,500 ML (tier 1) • 5,200 ML (tier 2)	• 9,500 ML (tier 1) • 5,200 ML (tier 2)	• 20,500 ML (tier 1) • 3,900 ML (tier 2)	• 23,600 ML (tier 1) • 5,200 ML (tier 2
Priority carryover requirements	• 5,600–8,200 ML			

[1] *Water for the environment requirements for tier 2 actions are additional to tier 1 requirements.*



Risk management

Environmental watering program partners have considered and assessed risks and identified mitigating strategies relating to environmental flows in 2018–19. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

Engagement

Table 2.3.3 shows the partners with which West Gippsland CMA engaged when preparing the Thomson system seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional catchment strategies, regional waterway strategies, environmental flow studies, water management plans and other studies. These incorporate a range of environmental, cultural, social and economic perspectives and longer-term integrated catchment and waterway management objectives. For further details, refer to the *West Gippsland Regional Catchment Strategy* and *West Gippsland Waterway Strategy*.

Table 2.3.3 Partners engaged in developing the Thomson system seasonal watering proposal

Partner engagement
• Melbourne Water • Southern Rural Water • Victorian Environmental Water Holder

Thomson River, by West Gippsland CMA

2.4 Macalister system

Waterway manager – West Gippsland Catchment Management Authority

Storage manager – Southern Rural Water

Environmental water holder – Victorian Environmental Water Holder

The Macalister River flows from Mt Howitt in the Alpine National Park and joins the Thomson River south of Maffra. The river winds its way in a south-easterly direction through mostly forested, confined valleys and narrow floodplains upstream of Lake Glenmaggie. The downstream reaches flow through wide alluvial floodplains that have been cleared for agriculture. The Wellington River and Glenmaggie Creek are the main tributaries of the Macalister River.

Lake Glenmaggie is the major water-harvesting storage regulating the Macalister River, and the Maffra Weir is a small diversion weir located further downstream in Maffra.

The Macalister River and its tributaries continue to be an important place for Traditional Owners and their Nations. The Registered Aboriginal Party (RAP) in the region is the Gunaikurnai Land and Waters Aboriginal Corporation. The West Gippsland CMA engaged with representatives from the RAP during the preparation of the Macalister River seasonal watering proposal.

Environmental values

Seven migratory native fish species move between the Macalister River, the Latrobe River estuary and the sea to complete their life cycle. These species include the Australian grayling, short- and long-finned eel, tupong, Australian bass, short-headed lamprey and common galaxias. Yelloweye mullet, which are an estuarine species, has been recorded in the river. Platypus and water rats are widely distributed through the Macalister River and its tributaries.

The riparian vegetation corridor along the regulated reaches of the Macalister River is fragmented. Immediately downstream of Lake Glenmaggie, the vegetation is in good condition and includes remnant river red gums and good-quality stands of shrubs, particularly in areas where there has been revegetation and from which stock have also been excluded. Further downstream, the vegetation is degraded. In recent years, the cover of in-stream vegetation has declined, which may be due to a combination of increased water turbidity, erosion and a lack of an appropriate water regime to encourage plants to grow. The cover of non-woody plants (such as reeds, sedges and rushes) along the fringes of the river is patchy.

Social and economic values

Lake Glenmaggie is the primary source of water for the Macalister Irrigation District, a major economic driver in the area and highly valued by the local community. As a result, there is strong interest in the health of the Macalister River, particularly around water quality, erosion and vegetation condition issues. The river is also a popular location for recreational fishing and birdwatching.

Environmental watering objectives in the Macalister system

	Increase the range and population size of native fish species including Australian grayling and other native fish Improve spawning and recruitment opportunities for native migratory fish
	Restore aquatic vegetation Improve native emergent and fringing vegetation communities
	Increase the abundance of waterbugs Maintain water quality throughout the year for waterbug habitat
	Improve and maintain the form of the riverbank and bed
	Increase abundance of aquatic mammals

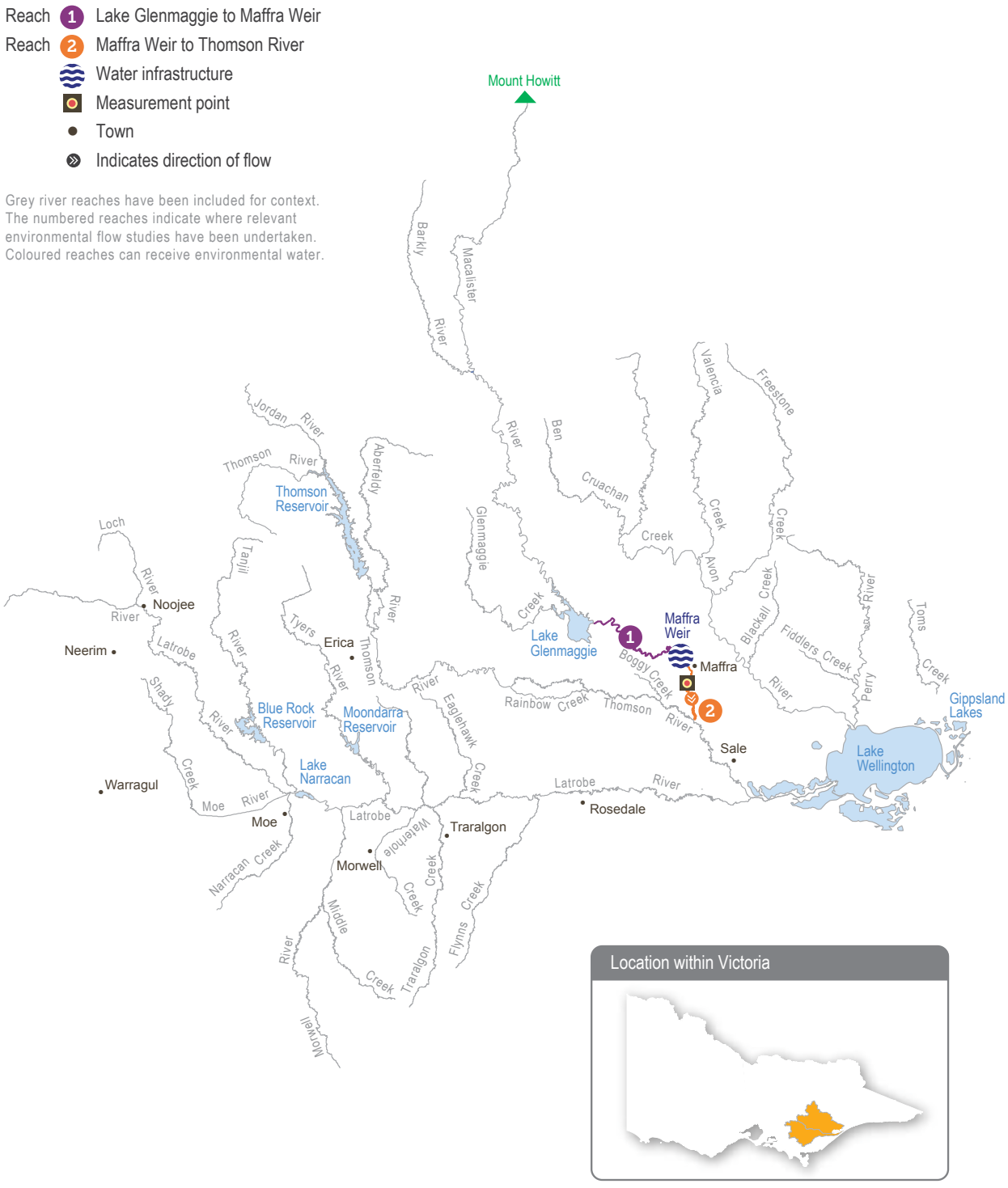
System overview

Before the construction of Lake Glenmaggie, the Macalister River would regularly receive high and medium flows in winter and spring. Although Lake Glenmaggie regularly spills, high flows are less frequent than they were before regulation because much of the water is captured by the storage. A notable impact of irrigation and water harvesting is reversed seasonality of flows between Lake Glenmaggie and Maffra Weir, where summer flows are much higher than natural due to the delivery of irrigation water. Winter flows are lower than natural because a high proportion of the inflows are captured and there are no irrigation demands over winter. Downstream of Maffra Weir, most flows are diverted for irrigation in summer and autumn. The changed hydrology restricts fish migration, limits the growth and recruitment of in-stream and riparian plants and reduces the quality of in-stream habitat.

Water for the environment is stored in Lake Glenmaggie and released to the Macalister River. The river is divided into two reaches for the purposes of managing water for the environment: Lake Glenmaggie to Maffra Weir (reach 1) and Maffra Weir to the Thomson River (reach 2).

Maffra Weir is a major barrier to fish movement along the river, so environmental watering actions to achieve migratory fish objectives mainly focus on reach 2, which is downstream of the weir. All other objectives apply to both reaches 1 and 2.

Figure 2.4.1 The Macalister system



Recent conditions

Climatic conditions in the Macalister River catchment have varied widely over the last two years. Winter and spring 2016 had above-average rainfall and minor flooding, but the rest of the 2016–17 water year was significantly drier than average. Dry conditions persisted through much of 2017–18, and the only moderate-to-large. Unregulated flows occurred in December 2017 and January 2018.

In response to the dry conditions, irrigation demands have been high, and the reach of the Macalister River between Lake Glenmaggie and Maffra Weir has therefore carried consistently high irrigation flows since the start of the irrigation season in August 2017. Water for the environment was used to provide freshes in autumn, winter and spring and increased baseflows over the autumn/winter period, when there was less irrigation demand.

Dry conditions in the second half of 2016–17 restricted environmental allocations at the start of the 2017–18 water year, and water for the environment carried over from 2016–17 was needed to deliver target low flows and freshes through winter and spring 2017. A winter fresh was delivered in August 2017 to trigger migration and spawning of tupong and Australian bass. A spring fresh was delivered in early November 2017, to encourage juvenile fish to migrate into the Macalister River from the sea and to wet bankside vegetation and enable native seed dispersal. Lake Glenmaggie spilled in early December 2017, but it was a comparatively small spill and later in the year than is usually the case. The storage manager (Southern Rural Water) managed flows during and after the spill to prevent a sudden drop in water levels that might have stranded fish or caused banks to slump. An autumn fresh was delivered in April 2018 to trigger Australian grayling to migrate and spawn.

Scope of environmental watering

Table 2.4.1 shows potential environmental watering actions and their environmental objectives.

Table 2.4.1 Potential environmental watering actions and objectives for the Macalister system

Potential environmental watering	Environmental objectives
Macalister River reaches 1 and 2	
Autumn/winter low flow (90 ML/day in May–August)	• Provide longitudinal connectivity • Provide habitat for waterbugs • Maintain water quality in pools • Maintain areas of slow-moving water for submerged aquatic vegetation
Spring low flow (90 ML/day in September–December)	• Provide longitudinal connectivity
Spring fresh (1,500 ML/day for 3 days in September–October)	• Scour sediment exposing fresh habitat areas • Provide food and habitat for waterbugs
Macalister River reach 2	
Autumn fresh (350 ML/day for 4–5 days in April–May)	• Trigger downstream migration and spawning of Australian grayling
Winter fresh (700 ML/day for 4–5 days in June–August)	• Trigger downstream migration and spawning of tupong and Australian bass
Spring/summer fresh (700 ML/day for up to 5 days in September–December)	• Trigger upstream migration and recruitment for juvenile fish • Trigger upstream migration for lampreys and eels
Summer/autumn fresh (140 ML/day for 3 days in December–May)	• Provide sufficient depth to allow fish to move throughout the reach • Flush pools to maintain water quality

Scenario planning

Table 2.4.2 outlines the potential environmental watering and expected water use under a range of planning scenarios.

Providing year-round low flows and freshes in winter, spring and autumn are the highest priorities for 2018–19 under all climate scenarios, to provide connectivity through the river system so fish and other biota can move. Spring freshes are needed to encourage migratory fish in their first year of life to move into the Macalister River from the Latrobe River estuary and the sea. In some years, spring freshes are delivered by spills from Lake Glenmaggie, but early forecasts suggest Lake Glenmaggie may not spill in spring 2018 and therefore a managed spring fresh has been prioritised under all scenarios. In a drought scenario, a summer fresh may also be required to improve water quality and to prevent low levels of dissolved oxygen affecting aquatic biota.

Autumn freshes are needed in the Macalister River to cue Australian grayling to breed. Australian grayling only live for up to three years, so autumn freshes are a priority in most years and under most climate scenarios, to ensure regular recruitment and the ongoing sustainability of the population.

If additional water for the environment is available in average or wet conditions, winter freshes may be provided to trigger tupong and Australian bass to migrate downstream to the sea. Carrying over some water into July 2019 is a high priority under all scenarios to ensure there is sufficient water for the environment available to deliver winter low flows in July 2019.

Table 2.4.2 Potential environmental watering for the Macalister system under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• No unregulated flows • Passing flows at Maffra Weir reduced	• Possible spills from Lake Glenmaggie in spring, minor flood levels may occur • Passing flows at Maffra Weir may be reduced	• Regular spills from Lake Glenmaggie in spring, minor to moderate flood levels may occur	• Large and frequent spills from Lake Glenmaggie, moderate to major flood levels may occur
Expected availability of water for the environment	• 11,600 ML	• 14,900 ML	• 16,900 ML	• 21,400 ML
Potential environmental watering – tier 1 (high priorities)	• Autumn/winter low flow (reach 1 & 2) • Spring low flow (reach 1 & 2) • 1 spring fresh (reach 2) • 1 summer fresh (reach 2) • 1 autumn fresh (reach 2)	• Autumn/winter low flow (reach 1 & 2) • Spring low flow (reach 1 & 2) • 1 spring fresh (reach 1 & 2) • 1 autumn fresh (reach 2)	• Autumn/winter low flow (reach 1 & 2) • Spring low flow (reach 1 & 2) • 1 spring fresh (reach 2) • 1 autumn fresh (reach 2) • 2 winter freshes (reach 2)	• Autumn/winter low flow (reach 1 & 2) • Spring low flow (reach 1 & 2) • 1 spring fresh (reach 2) • 1 autumn fresh (reach 2) • 2 winter freshes (reach 2)
Potential environmental watering – tier 2 (additional priorities)	• 1 winter fresh	• 1 winter fresh	• Increase duration of spring fresh	• 1 winter fresh
Possible volume of water for the environment required to meet objectives[1]	• 10,700 ML (tier 1) • 4,000 ML (tier 2)	• 13,400 ML (tier 1) • 4,000 ML (tier 2)	• 15,600 ML (tier 1) • 1,200 ML (tier 2)	• 19,000 ML (tier 1) • 4,000 ML (tier 2)
Priority carryover requirements	• 900 to 1,800 ML			

[1] *Water for the environment requirements for tier 2 actions are additional to tier 1 requirements.*

Risk management

Environmental watering program partners have considered and assessed risks and identified mitigating strategies relating to environmental flows in 2018–19. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

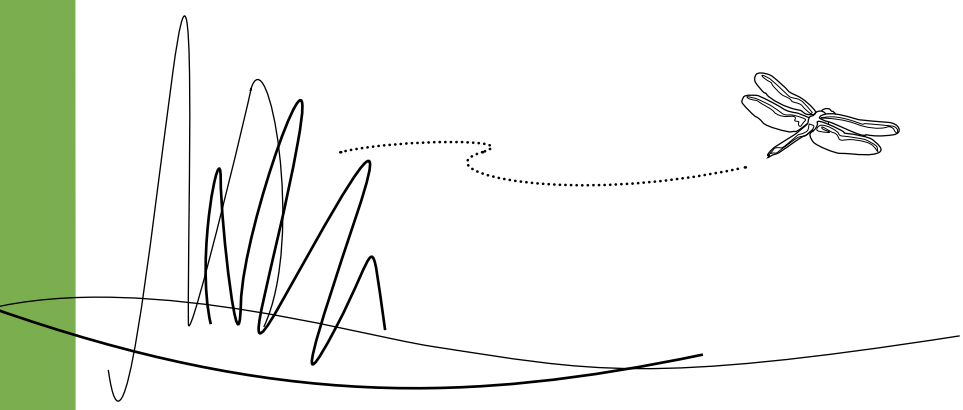
Engagement

Table 2.4.3 shows the partners and stakeholder organisations with which West Gippsland CMA engaged when preparing the Macalister system seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional catchment strategies, regional waterway strategies, environmental flow studies, water management plans and other studies. These incorporate a range of environmental, cultural, social and economic perspectives and longer-term integrated catchment and waterway management objectives. For further details, refer to the *West Gippsland Regional Catchment Strategy* and *West Gippsland Waterway Strategy*.

Table 2.4.3 Partners and stakeholders engaged in developing the Macalister system seasonal watering proposal

Partner and stakeholder engagement
• Environment Victoria • Gippsland Water • Gurnaikurnai Land and Waters Aboriginal Corporation • Macalister Irrigation District irrigators and diverters • Maffra & Districts Landcare Network • Native Fish Australia • Southern Rural Water • Victorian Environmental Water Holder • VRFish • Wellington Shire Council



2.5 Snowy system

Waterway managers – New South Wales Department of Industry and East Gippsland CMA

Storage manager – Snowy Hydro Limited

Environmental water holders – Victorian Environmental Water Holder and New South Wales Department of Industry

The Snowy River originates on the slopes of Mount Kosciuszko. It drains the eastern slopes of the Snowy Mountains in NSW before flowing through the Snowy River National Park in Victoria and into Bass Strait.

The Snowy River and its tributaries continue to be an important place for Traditional Owners and their Nations. This includes the Gunaikurnai, the Maneroo-Ngarigo, the Bidwell Maap, the southern Monero people (Monero-Ngarigo / Yuin / Bolga), the Wongalu and the Wiradjuri people.

In recognition of Traditional Owner groups, five high-flow releases to the Snowy River in 2017–18 were given Aboriginal names: Djuran (running water), Waawii (water spirit), Billa bidgee kaap (big water season), Wai-garl (river blackfish) and Bundrea Nooruun Bundbararn (waterhole big lizard).

Environmental values

Construction and operation of the Snowy Mountains Hydro-electric Scheme previously diverted 99 percent of the Snowy River's mean annual natural flow at Jindabyne. The loss of flow changed the structure and function of the river, reduced the opening of the Snowy River entrance to Bass Strait and resulted in a decline in environmental values.

The remaining environmental values in the upper reaches and tributaries of the Snowy River include freshwater fish (such as river blackfish and Australian grayling). The lower reaches support estuary perch and Australian bass that move between saltwater and freshwater systems. The estuary contains estuarine and saltwater species such as flathead, mulloway and black bream. The floodplain wetlands of the Snowy River near Marlo provide feeding and breeding areas for wetland and migratory birds.

Social and economic values

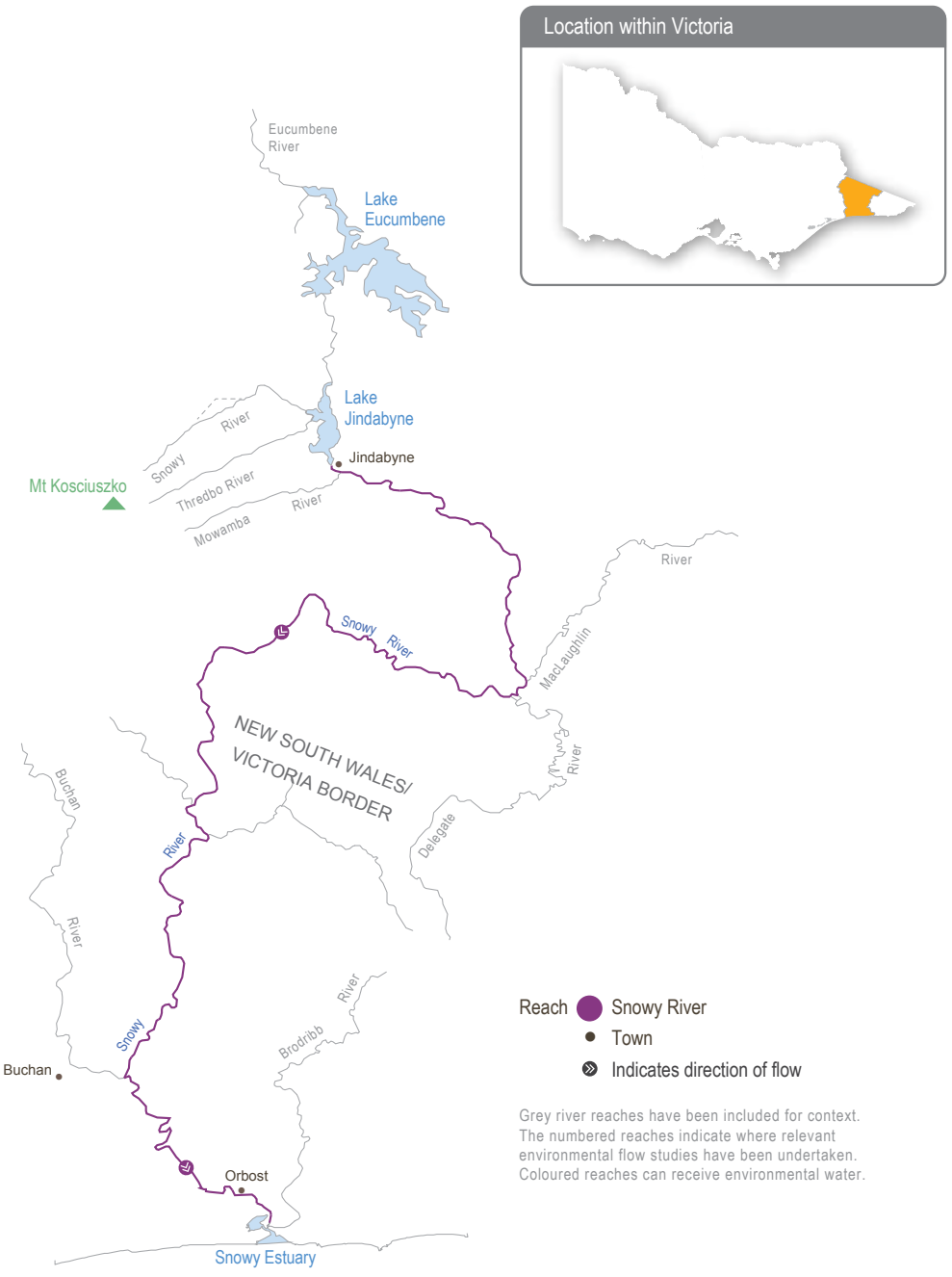
The Snowy Mountains Hydro-electric Scheme provides substantial economic value as a major generator of renewable electricity. Water diverted from the Snowy River also supports irrigated agriculture in NSW and Victorian parts of the Murray–Darling Basin. The Snowy River and its estuary are a drawcard for the many tourists who enjoy camping, boating, kayaking, swimming and recreational fishing.

System overview

There are four major dams and multiple diversion weirs in the upper Snowy River catchment that divert water to the Murrumbidgee and River Murray valleys. The hydrological effects of the Snowy Scheme are substantial, but they are partly alleviated by the contribution of flows from tributaries (such as the Delegate River in NSW and the Buchan and Brodribb rivers in Victoria).

The Victorian, NSW and Commonwealth governments have recovered water to help restore damage done by decades of limited flow. Victorian water for the environment available for use in the Snowy system is held in the Murray, Goulburn and Loddon systems. This water is made available for environmental flows in the Snowy River via a substitution method, whereby Victorian water for the environment replaces water that was earmarked for transfer from the Snowy to Victoria to support irrigation demands.

Figure 2.5.1 The Snowy system



Recent conditions

The water year in the Snowy system runs from May to April. In the 2017–18 water year, 214,400 ML of water for the environment was released to the Snowy River, which is the largest volume of water ever released from Lake Jindabyne to the Snowy River in one year. The water for the environment was used to deliver five, high-flow events, with peak flows up to 8,000 ML per day in winter and spring.

Scope of environmental watering

Environmental watering from May 2018 to April 2019 aims to mimic the typical flow pattern of a mixed snowmelt/rainfall river system characteristic of the Snowy Mountains. The releases aim to support ecological processes in the Snowy River below Jindabyne Dam and maintain a healthy river that is much smaller than the natural channel that existed before the river was regulated.

The aim of environmental flows in the Snowy River is to restore physical and ecological processes that support aquatic habitats and productivity. East Gippsland CMA has monitored the lower reaches and estuary over the past six years. The results show that the managed environmental flows contribute to these physical and ecological outcomes.

Five peak flows are scheduled between August and October 2018. A large, flushing flow is scheduled for mid-October 2018 and includes an eight-hour peak equivalent to 4,800 ML per day. Other peak flows will mimic winter rainfall events. These peak flows aim to improve the physical attributes of the river by scouring and depositing sediment and increasing available aquatic habitat. High flows are sustained from July–December to help mix water in the estuary for the benefit of plants and fish (such as Australian bass). Low flows will then be released until the end of the water year in April 2019.

The total volume planned for release in 2018–19 (including contributions from water savings in Victoria and NSW) is 136,677 ML.

Risk management

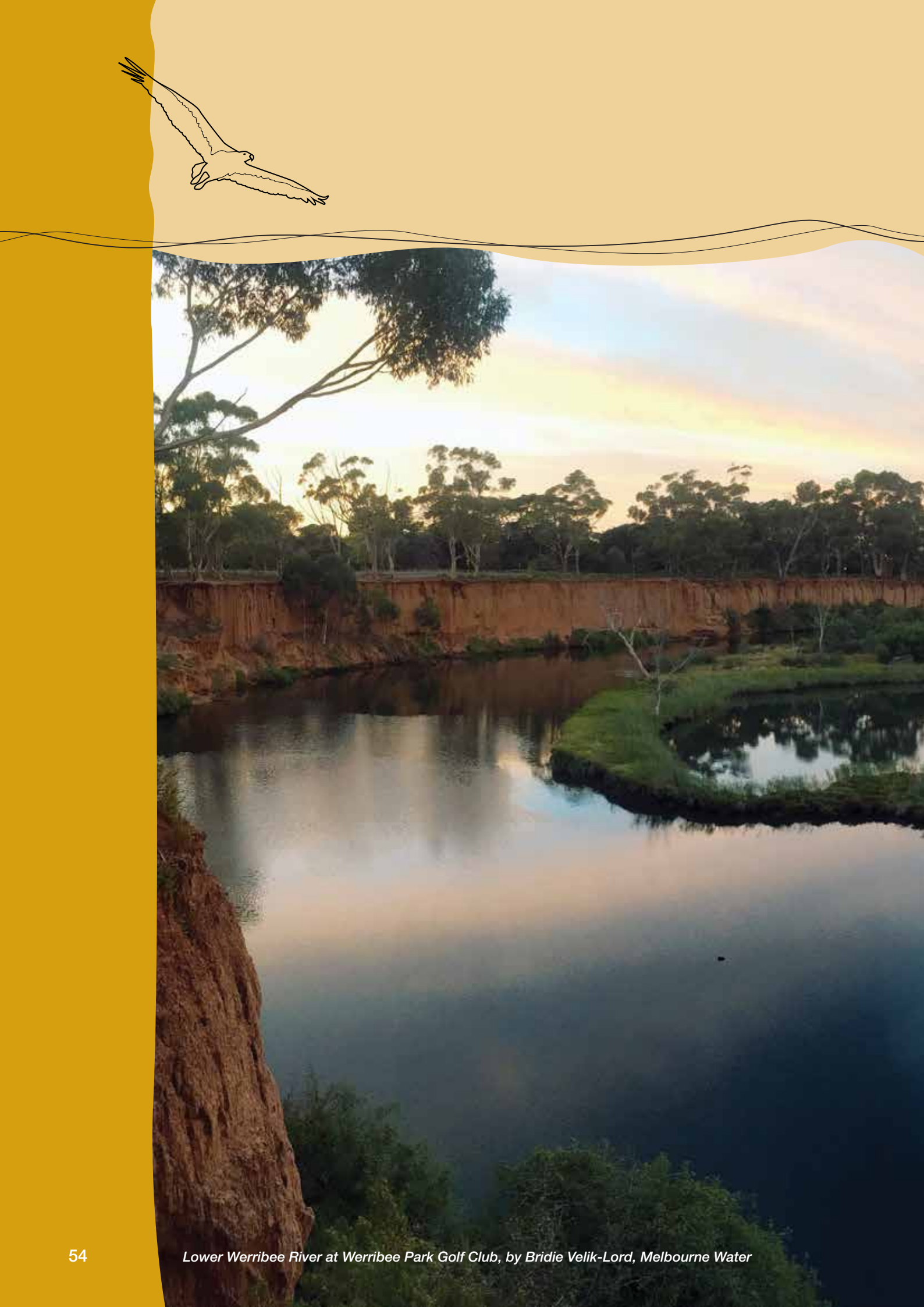
When weather conditions cause increased risk of flooding, The NSW Department of Industry works with the NSW State Emergency Service, the Bureau of Meteorology, East Gippsland CMA and the VEWH to provide information to the community regarding the management of planned releases. Releases may be cancelled or rescheduled to limit flood impacts to private land.

Engagement

The NSW Government is responsible for planning environmental flow releases in the Snowy River and consults the Victorian Government about the planned releases.

In 2018, the Snowy Advisory Committee will be formed. Its members will represent Aboriginal, local community and environmental interests, alongside relevant NSW and Victorian government agencies. The role of the Snowy Advisory Committee will be to provide community and expert input about the pattern of environmental flow releases to the Snowy River and Snowy montane rivers, to ensure their ongoing health.

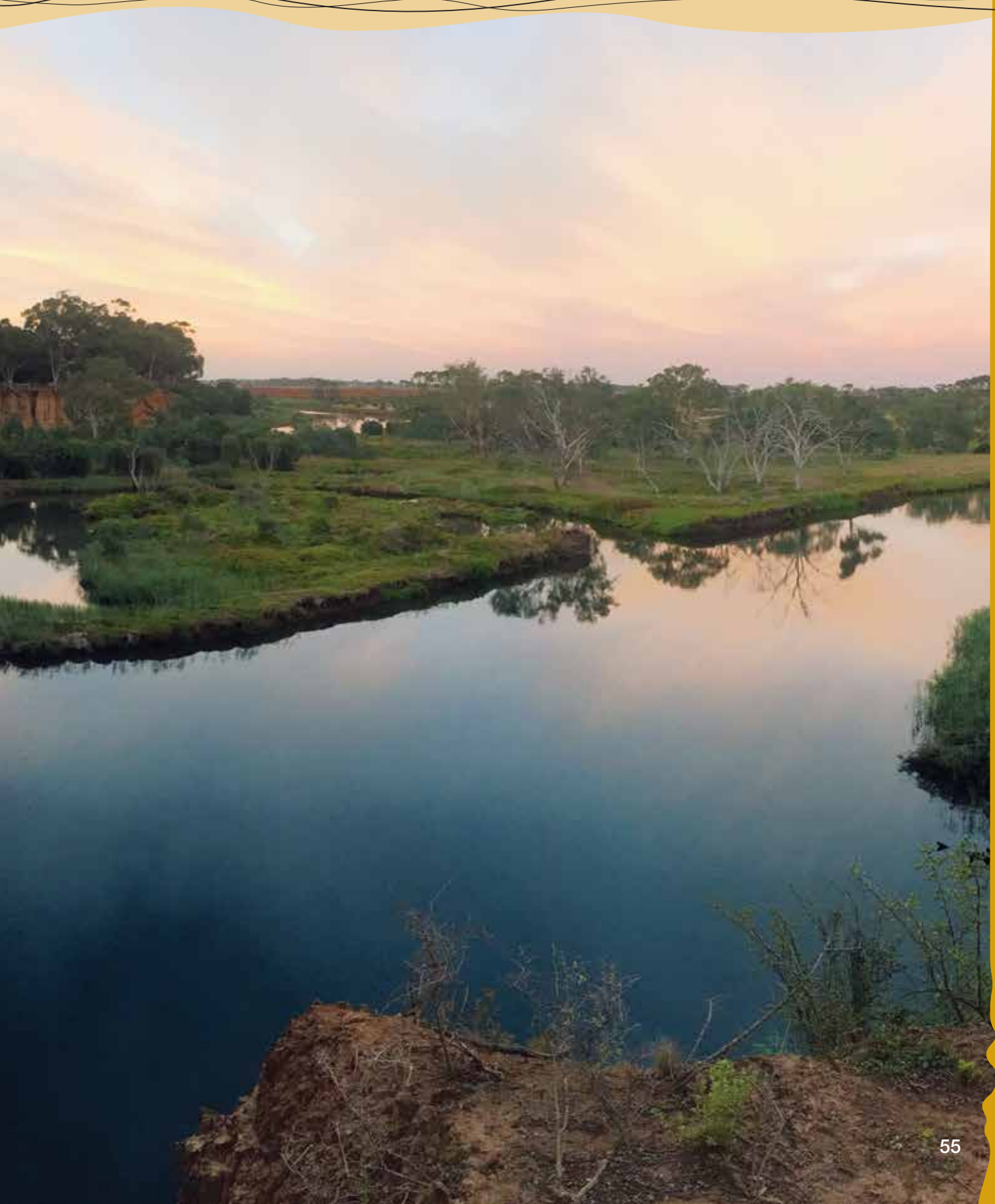
Snowy River, by East Gippsland CMA



Lower Werribee River at Werribee Park Golf Club, by Bridie Velik-Lord, Melbourne Water

Section 3

Central Region



3.1 Central Region overview

There are six systems in the Central Region that can receive managed environmental flows: the Yarra and Tarago in the east and the Werribee, Maribyrnong, Moorabool and Barwon (upper Barwon River and lower Barwon wetlands) in the west. It is possible to move water between these systems through trade, but most water for the environment in these systems is prioritised to provide benefits for the river where it is stored.

Environmental, social and economic values, recent conditions, environmental watering objectives and planned actions for each system in the Central Region are presented in the system sections that follow.

Traditional Owners in the Central Region

Traditional Owners and their Nations in the Central Region continue to have a deep connection to the region's rivers, wetlands and floodplains. The VEWH acknowledges the Traditional Owners in and around greater Melbourne, Ballarat and Geelong areas and pays its respect to their Elders past, present and future. The VEWH recognises that water has significant cultural importance and value for Traditional Owners and Aboriginal people.

The Registered Aboriginal Parties (RAPs) in parts of the Central Region are the Wurundjeri Land and Compensation Cultural Heritage Aboriginal Corporation, the Bunurong Land Council Aboriginal Corporation and the Gunaikurnai Land and Waters Aboriginal Corporation and Wathaurung Aboriginal Corporation.

Examples of engagement and activities with Traditional Owner groups and Aboriginal communities relating to water for the environment in the Central Region include:

- modifying the timing of a summer fresh in the Moorabool River to coincide with the 'Mooroobull Yaluk Kuwiyn River Day' for the first time in 2018; event activities included a fishing clinic, Waterwatch activities and a barbecue hosted by Corangamite CMA for the local Wathaurung community
- watering of Bolin Bolin Billabong, an ancient Wurundjeri gathering place on the Yarra River floodplain; 2017–18 was the first year water for the environment was delivered to Bolin Bolin and was endorsed by Wurundjeri Traditional Owners
- continuing a joint cultural mapping project with the VEWH, Melbourne Water and Wurundjeri Traditional Owners
- inclusion of a Traditional Owner representative — a member of the Wathaurung Aboriginal Corporation — on the Environmental Flows Technical Panel for the Barwon River FLOWS study update in 2018.

Community considerations

When planning to use water for the environment, the potential social, economic, Aboriginal cultural and community recreational benefits for communities which could arise from the water's use are considered. Some scoped opportunities for shared community benefits of water for the environment in the Central Region for 2018–19 include:

- timing environmental flows in rivers (specifically the Yarra, Tarago and Werribee rivers) to coincide with weekends, for recreational enjoyment
- increasing opportunities for birdwatching at billabongs along the Yarra River
- improving water quality in the rivers and Werribee estuary, resulting in more recreational fishing opportunities.

The ability of the VEWH and its partners to deliver these benefits will depend on the weather, on climate variations, on the available water and on the way the system is being operated to deliver water for other purposes (such as for home, farm and business use).

Environmental watering will also have indirect benefits (such as improving amenity for walkers, cyclists and others at parklands adjacent to the Yarra River).

For more information about scoped opportunities for shared community benefits in 2018–19, contact the VEWH or the relevant waterway manager.

Integrated catchment management

Altered water regimes are one of many threats to the health of Victoria's waterways. To be effective, planning and releases of water for the environment need to be part of an integrated approach to catchment management. Many of the environmental objectives in this seasonal watering plan will not be fully met without also addressing issues such as excessive catchment erosion, barriers to fish movement, high nutrient loads, loss of stream bank vegetation and invasive species, to name just some issues.

Victorian and Australian government agencies, community groups and private landowners collectively implement programs and activities to protect and improve the environmental condition and function of land, soils and waterways throughout Victoria's catchments. *Water for Victoria* identifies 36 priority waterways across Victoria. In the Central Region, the Moorabool River is an initial priority for investment in works to complement outcomes achievable with environmental flows in the river.

Examples in the region of such programs and activities coordinated with environmental flows include:

- Melbourne Water's Rural Land Program which offers landholders on agricultural properties assistance and funding to undertake works to keep soil and nutrients on their farm and out of waterways, reducing the negative impact of land management activities on water quality
- planning to retrofit the weir on the Moorabool River at Batesford with a fishway to allow fish passage further upstream, capitalising on the fishway recently installed on the lower Barwon tidal barrage
- continued works to protect and enhance streambbanks along priority reaches in the Barwon and Yarra catchments including willow removal, revegetation and fencing to exclude stock.

For more information about integrated catchment management programs in the Central Region refer to Melbourne Water's *Healthy Waterways Strategy*, the Port Phillip and Western Port and Corangamite regional catchment strategies and the *Corangamite Waterway Strategy*.

Seasonal outlook 2018–19

Catchments to the west of Melbourne generally experience drier climatic conditions than those to the east. In the Central Region, it is not uncommon for individual systems to experience different climatic conditions at the same time. Environmental water entitlements in the Yarra system are more reliable than the other systems, which makes water availability more certain, irrespective of catchment conditions. Water delivery infrastructure limits the volume of water for the environment that can be delivered to the region's systems, and deliveries of water for the environment are usually planned to supplement unregulated flows and make up shortfalls associated with low flows and small-to-medium-sized freshes. Catchment conditions and seasonal hydrological patterns, rather than water availability, influence which flow components are prioritised in most years.

Annual water for the environment allocations in the Werribee, Tarago and Moorabool systems are linked to catchment inflows, so dry conditions will result in less water being available. Carryover of unused allocations from wet years helps meet environmental demands in these systems in dry years. As well, the Werribee and Maribyrnong (for which there is no environmental entitlement) systems rely heavily on trade from Melbourne Water shares to achieve priority watering actions.

Winter and spring are usually the wettest seasons in the Central Region and contribute most of the annual inflow to system storages. Average rainfall and higher-than-average temperatures are predicted for the region through winter 2018. Climate outlooks indicate the 2018–19 winter storage filling season in the region is likely to be later than average, owing to below-average soil moisture.

If 2018–19 is very dry, deliveries of water for the environment throughout the region will aim to maintain critical refuges for water-dependent plants and animals, to allow recolonisation when conditions are more favourable. If conditions are closer to average or wet, environmental releases will aim to improve the health of the environment by increasing the quality and quantity of aquatic habitat for animals and trigger native fish to migrate and possibly spawn.

Moorabool River at Dog Rocks, by Andrew Sharpe

3.2 Yarra system

Waterway manager – Melbourne Water

Storage manager – Melbourne Water

Environmental water holder – Victorian Environmental Water Holder

Yarra River system: *The Yarra River was originally named 'Birrarrung', meaning 'place of mists and shadows', by the Wurundjeri people. In 1835, surveyor John Wedge asked local Aboriginals what they called the lower section of the river and they replied "Yarro Yarro", meaning 'it flows', which was misheard and became known as Yarra.*

Source: Melbourne Water

The Yarra River flows west from the Yarra Ranges upstream of Warburton, through the Yarra Valley and then opens out into a wider plain as it meanders through the suburbs and city of Melbourne before entering Port Phillip Bay. The Upper Yarra Reservoir, O'Shannassy Reservoir and Maroondah Reservoir harvest water from headwater tributaries and a pump station at Yering is used to divert water from the Yarra River to Sugarloaf Reservoir.

The Yarra River and its tributaries continue to be an important place for Traditional Owners and their Nations. The Wurundjeri Land and Compensation Cultural Heritage Council Aboriginal Corporation is the Registered Aboriginal Party (RAP) for much of the region. Melbourne Water and the VEWH are continuing to work with the RAP to understand how management of water for the environment in the Yarra River can better support Aboriginal aspirations through a joint cultural values mapping project.

In September, landmark legislation protecting the Yarra River — the *Yarra River Protection (Wilip-gin Birrarung murron) Act 2017* — passed the Victorian Parliament. It identifies the Yarra River and the many hundreds of parcels of land it flows through as one living, integrated, natural entity. It combines the wisdom of Traditional Owners with modern river management expertise. The Act gives an independent voice to the river by way of the Birrarung Council, a statutory advisory body which must have at least two Traditional Owner representatives on it.

Environmental values

The upper Yarra River (reaches 1–3) provides habitat for a range of native fish species including the river blackfish, spotted galaxias and common galaxias, and contains good-quality riparian and aquatic vegetation. The lower river (reaches 4–6) flows through forested gorges, cleared floodplains and some highly-urbanised areas, and supports several populations of native fish including Australian grayling, river blackfish, Macquarie perch and tupong.

Macquarie perch were introduced to the Yarra River last century and the population is now considered one of the largest and most important in Victoria.

Billabongs are an important feature of the Yarra River floodplain between Millgrove and Yering Gorge as well as of the reach around Banyule Flats near Heidelberg. The billabongs support distinct vegetation communities, and they provide foraging and breeding habitat for waterbirds and frogs. Except in very high flows, most billabongs are disconnected from the Yarra River.

Social and economic values

The upper reaches of the Yarra River provide 70 percent of Melbourne's drinking water. The river also provides social and recreational opportunities for the more than four million people who live in the greater Melbourne area. Swimming and kayaking are popular in some sections, and many sections have aesthetic appeal for walkers and cyclists. The Yarra River corridor supports more than 2,450 ha of urban parklands and public open space that are valued by communities for their tree-dominated landscapes and views of and access to the river. Private tourism and recreation industries also make use of the corridor; for example, there are more than 10 golf courses along the river's length.

Environmental watering objectives in the Yarra system

	Increase, strengthen and maintain plant life on the riverbank and in the channel, as well as on the upper Yarra floodplain and in the billabongs along the river
	Protect and increase populations of native fish including threatened species (such as the Australian grayling, Macquarie perch and river blackfish)
	Maintain the form of the riverbank and bed Scour silt build-up and clean cobbles in the river to ensure fish, platypus and other water animals have access to healthy habitat pools and places to feed, spawn and shelter
	Protect and increase communities of waterbugs, which break down dead organic matter and support the river's food chain
	Improve water quality in river pools, ensuring adequate dissolved oxygen concentrations in the water to support fish, crustaceans and waterbugs

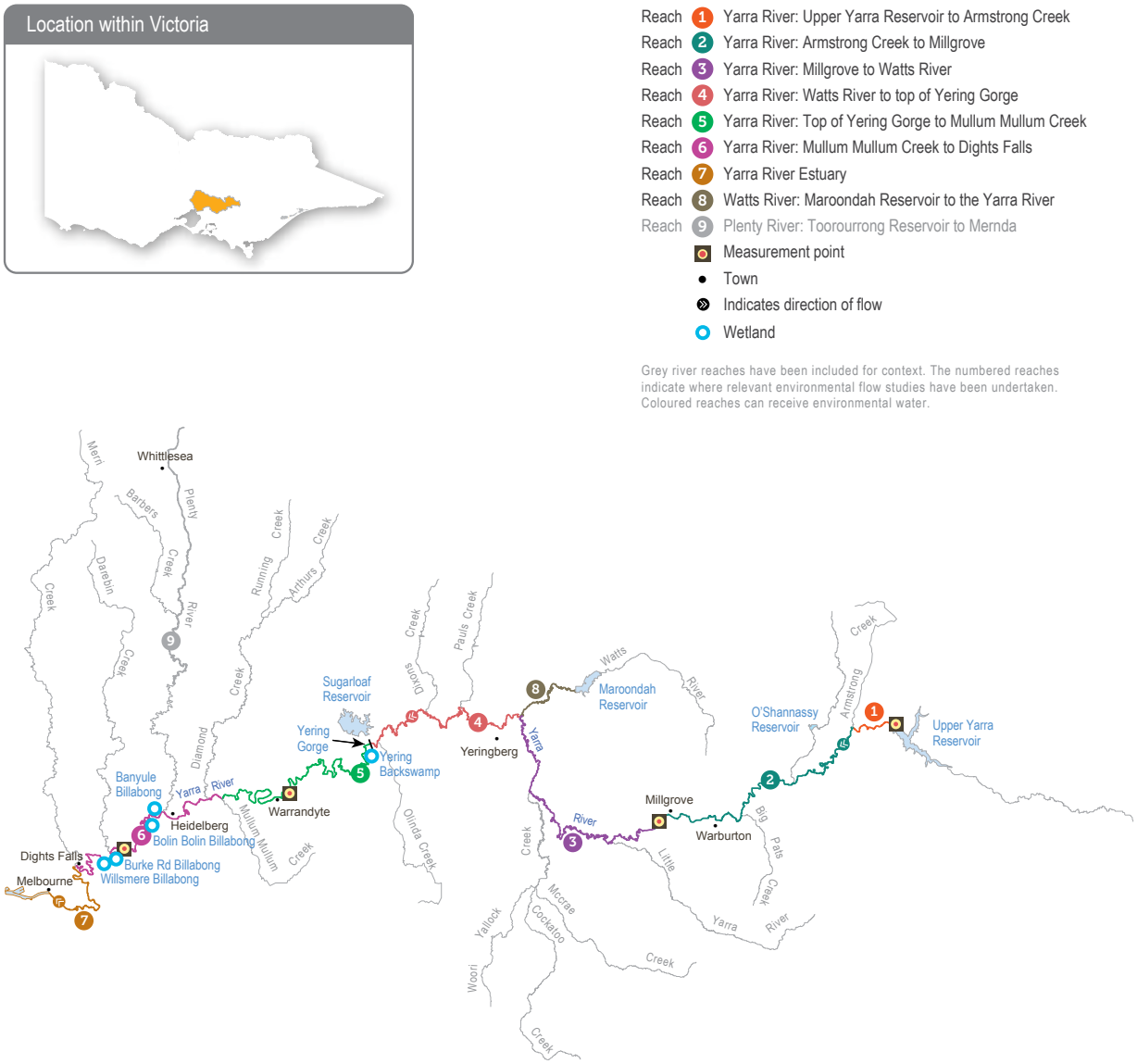
System overview

Flows through the Yarra system have become highly regulated due to the construction of major water storages that capture natural run-off and allow the controlled removal of water for consumptive use. Over time, the lower Yarra River has been straightened, widened and cleared of natural debris as Melbourne has grown around its banks. The earliest recorded alterations to its course date back to 1879. Water for the environment aims to reinstate selected flows that support ecological processes and environmental outcomes throughout the length of the system.

Water for the environment can be released from the Upper Yarra, Maroondah and O'Shannassy reservoirs. Priority reaches for water for the environment are reaches 2 and 5, as flow compliance can be measured. Delivery of water to these reaches is expected to also achieve flow targets in neighbouring reaches. The environmental flow reaches in the Yarra system are shown in Figure 3.2.1. In the upper reaches, the system is influenced by tributaries (such as Armstrong Creek, MacMahons Creek, Starvation Creek, Woori Yallock Creek, Watts River and Little Yarra River). In the lower reaches, urbanised tributaries (such as Olinda Creek, Mullum Mullum Creek, Diamond Creek, Plenty River and Merri Creek) provide additional water to the Yarra River.

Yering Backswamp, by Melbourne Water

Figure 3.2.1 The Yarra system



Recent conditions

The Yarra River catchment experienced dry conditions at the start of the 2017–18 water year and water for the environment was used to meet winter baseflow objectives. Higher-than-average rainfall in August 2017 saw the river transition towards an average climate scenario by September 2017, which was then maintained for the remainder of the water year (to June 2018). As a result, many of the minimum environmental flow recommendations were met naturally throughout the main stem of the Yarra during the spring and early summer months.

Water for the environment was used to deliver a high flow in spring to trigger Australian grayling migration back up the system and to scour sediments in the mid-reaches to improve spawning habitat for Macquarie perch. Summer freshes were also delivered along the river to maintain habitat for macroinvertebrates, allow fish movement and improve water quality.

Bolin Bolin and Yering Backswamp billabongs received water for the environment in spring, and frogs were quick to respond as evidenced by an increase in the number of species detected. This was followed by natural filling of Spadonis and Bolin Bolin billabongs from a large storm in early December 2017.

The 2017–18 water year was the first time that Bolin Bolin Billabong received water for the environment. Watering was endorsed by the Wurundjeri Traditional Owners, who have strong cultural connections to the billabong. Data collected during the watering, as well as the existing knowledge held by the Wurundjeri Land and Compensation Cultural Heritage Council Aboriginal Corporation and the experiences of being on Country as part of the monitoring for Bolin Bolin will inform future management objectives and practices.

Scope of environmental watering

Table 3.2.1 shows potential environmental watering actions and their environmental objectives.

Table 3.2.1 Potential environmental watering actions and objectives for the Yarra system

Potential environmental watering[1]	Environmental objectives
Year-round low flows[2] (varying rates from 10– >350 ML/day)	• Maintain access to riffle and pool habitat for waterbugs and fish • Allow riverbank vegetation to dry • Limit the growth of fringing/riparian/terrestrial vegetation into the stream channel • Maintain and/or rehabilitate in-stream vegetation
Summer/autumn freshes (1–4 freshes of varying rates between 60–750 ML/day for 2–4 days each in December–May)	• Maintain habitat by scouring sediments and cleaning cobbles in faster-flowing areas • Provide access to suitable habitat and migration opportunities for native fish • Maintain flood-tolerant vegetation on the low banks • Improve water quality in pools
Autumn high flow (1 event of between 560 ML/day and 1,300 ML/day for 7–14 days in April–May)	• Provide spawning conditions for Australian grayling • Rehabilitate populations of other nonmigratory and migratory native fish by providing improved habitat and connectivity • Maintain flood-tolerant vegetation higher up on the banks
Winter/spring freshes (2 or more freshes of varying rates between 100–2,500 ML/day for at least 2–7 days in June–September)	• Maintain habitat by scouring sediments and cleaning cobbles in faster-flowing areas • Maintain flood-tolerant vegetation on the low banks • Maintain access to habitat for bugs and fish • Provide migration opportunities for native fish • Improve water quality in pools
Targeted billabong watering (Yering Backswamp, Bolin Bolin, Willsmere, Burke Road and Banyule billabongs)	• Support native vegetation and improve habitat availability for wetland plants and animals
Spring high flow (1 high flow of 700–2,500 ML/day for 14 days in September–November)[3]	• Promote spawning and migration of native fish species • Maintain channel form

1 *The magnitude and duration of potential environmental watering depends on the reach being targeted, with the lower range generally applying to the upper reaches (for example, reach 1) and higher range applying to the lower reaches (for example, reach 6).*

2 *Low flows are generally provided by passing flows under the environmental entitlement, but during dry conditions, it may be necessary to supplement low flows using managed water for the environment.*

3 *A spring high flow will only be achieved with significant unregulated flow due to release constraints in the upper reaches of the system. Ceasing harvest at Yering during a natural high flow may help meet the desired flow target in reaches 5 and 6.*

Scenario planning

Table 3.2.2 outlines the potential environmental watering and expected water use under a range of planning scenarios.

Under a dry scenario, environmental flows will mainly focus on meeting the low-flow objectives throughout the year to provide sufficient habitat and water quality for fish and autumn high flows to support fish breeding and targeted billabong watering. These watering actions are also a high priority under average and wet scenarios, but water for the environment may also be used to deliver summer/autumn freshes if conditions allow. The autumn high flow aims to trigger Australian grayling migration and spawning and is a high priority as the fish have a short lifespan and spawning was not achieved last year. Less water for the environment is expected to be used under the wet scenario, because many of the priority watering actions are likely to be met by natural flows.

The high security of the environmental entitlement in the Yarra system and an ability to carry over means there should be sufficient water for the environment to achieve all the potential watering actions for each planning scenario in 2018–19.

A minimum of 5,000 ML carryover into 2019–20 is required (in addition to the 17,000 ML annual allocation) to deliver the highest-priority flows if average conditions continue into next year.

Table 3.2.2 Potential environmental watering for the Yarra system under a range of planning scenarios

Planning scenario	Dry	Average	Wet
Expected river conditions	• Low streamflows year-round • Lack of unregulated freshes and high flows • Passing flows are not likely to meet the minimum environmental flow recommendations	• Minimum passing-flow requirements are likely to be met • High winter flows with small storages likely to spill • Unregulated flows may provide some freshes but their duration and/or magnitude will likely be less than target flows	• Minimum passing-flow requirements are likely to be met • High winter and spring flows with good variability • Unregulated flows over summer/autumn will provide freshes and possibly high flows • Some natural inundation of billabongs may occur
Expected availability of water for the environment	• 14,000 ML carryover • 17,000 ML allocation • 31,000 ML total		
Potential environmental watering – tier 1	• Summer/autumn low flows • Winter/spring low flows • Autumn high flows • Targeted billabong watering	• Summer/autumn low flows • Summer/autumn freshes • Winter/spring low flows • Autumn high flows • Targeted billabong watering	• Summer/autumn freshes • Autumn high flows • Targeted billabong watering
Potential environmental watering — tier 2	• Winter/spring high flows	• Winter/spring high flows	• Winter/spring high flows
Possible volume of water for the environment required to achieve objectives	• 15,000 ML (tier 1) • 16,000 ML (tier 2)	• 22,000 ML (tier 1) • 13,000 ML (tier 2)	• 10,000 ML (tier 1) • 10,000 ML (tier 2)
Priority carryover requirements	• 5,000 ML		

Risk management

Environmental watering program partners have considered and assessed risks and identified mitigating strategies relating to environmental flows in 2018–19. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

Engagement

Table 3.2.3 shows the partners and stakeholder organisations with which Melbourne Water engaged when preparing the Yarra system seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional catchment strategies, regional waterway strategies, environmental flow studies, water management plans and other studies. These incorporate a range of environmental, cultural, social and economic perspectives and longer-term integrated catchment and waterway management objectives. For further details, refer to the *Port Phillip and Western Port Regional Catchment Strategy* and Melbourne Water's *Healthy Waterways Strategy*.

Table 3.2.3 Partners and stakeholders engaged in developing the Yarra system seasonal watering proposal

Partner and stakeholder engagement
• Yarra River Environmental Water Advisory Group including representatives of local government, Native Fish Australia, VR Fish, Canoeing Victoria, Whitehorse Canoe Club, Warburton Holiday Park, Wurundjeri Tribe and Compensation Cultural Heritage Council, Environment Victoria, Yarra Riverkeeper Association, Yarra Valley Water, Environment Protection Authority, Port Philip and Westernport CMA and Parks Victoria • Melbourne Water (Water Supply Operations and Integrated Planning) • Victorian Environmental Water Holder

Electrofishing around Wonga Park, by Melbourne Water

3.3 Tarago system

Waterway manager – Melbourne Water

Storage manager – Melbourne Water

Environmental water holder – Victorian Environmental Water Holder

The Tarago River rises in the Tarago State Forest and flows into the Tarago Reservoir at Neerim, which sits in the upper reaches of the Tarago River and harvests inflow from all upstream tributaries. Downstream of the reservoir, the river flows close to the town of Rokeby before meeting the Bunyip River (of which it is a major tributary) at Longwarry North. From there, the Bunyip River flows through a modified, straightened channel — Bunyip Main Drain — to flow into Western Port. This downstream reach supplies many irrigators in the catchment.

The Tarago River continues to be an important place for Traditional Owners and their Nations. The Registered Aboriginal Parties (RAP) covering small sections of the Tarago catchment are the Bunurong Land Council Aboriginal Corporation and the Gunaikurnai Land and Waters Aboriginal Corporation.

Environmental values

The Tarago system contains several significant and threatened native plant and animal species including the Australian grayling, long pink-bells, tree geebung and swamp bush-pea. The upper catchment has healthy riparian vegetation and highly diverse in-stream habitat that supports native fish including river blackfish and mountain galaxias. While the lower catchment has been highly modified, it contains patches of remnant vegetation and healthy populations of Australian grayling and platypus.

Social and economic values

There are several reserves, picnic areas and designated fishing locations along the length of the Tarago system as well as a popular caravan park and public land in the headwaters. These all contribute to the social and recreational value of the Bunyip and Tarago rivers. Many irrigators rely on water from the Tarago system and the reservoir also supplies some urban demand.

Environmental watering objectives in the Tarago system

	Improve health and increase diversity of native riverside vegetation
	Protect and increase native fish populations including threatened species (the Australian grayling and river blackfish) by providing habitat and triggers for fish to migrate and spawn
	Maintain and improve habitat availability for macroinvertebrates Provide habitat and food for waterbugs
	Maintain and improve foraging habitat for platypus

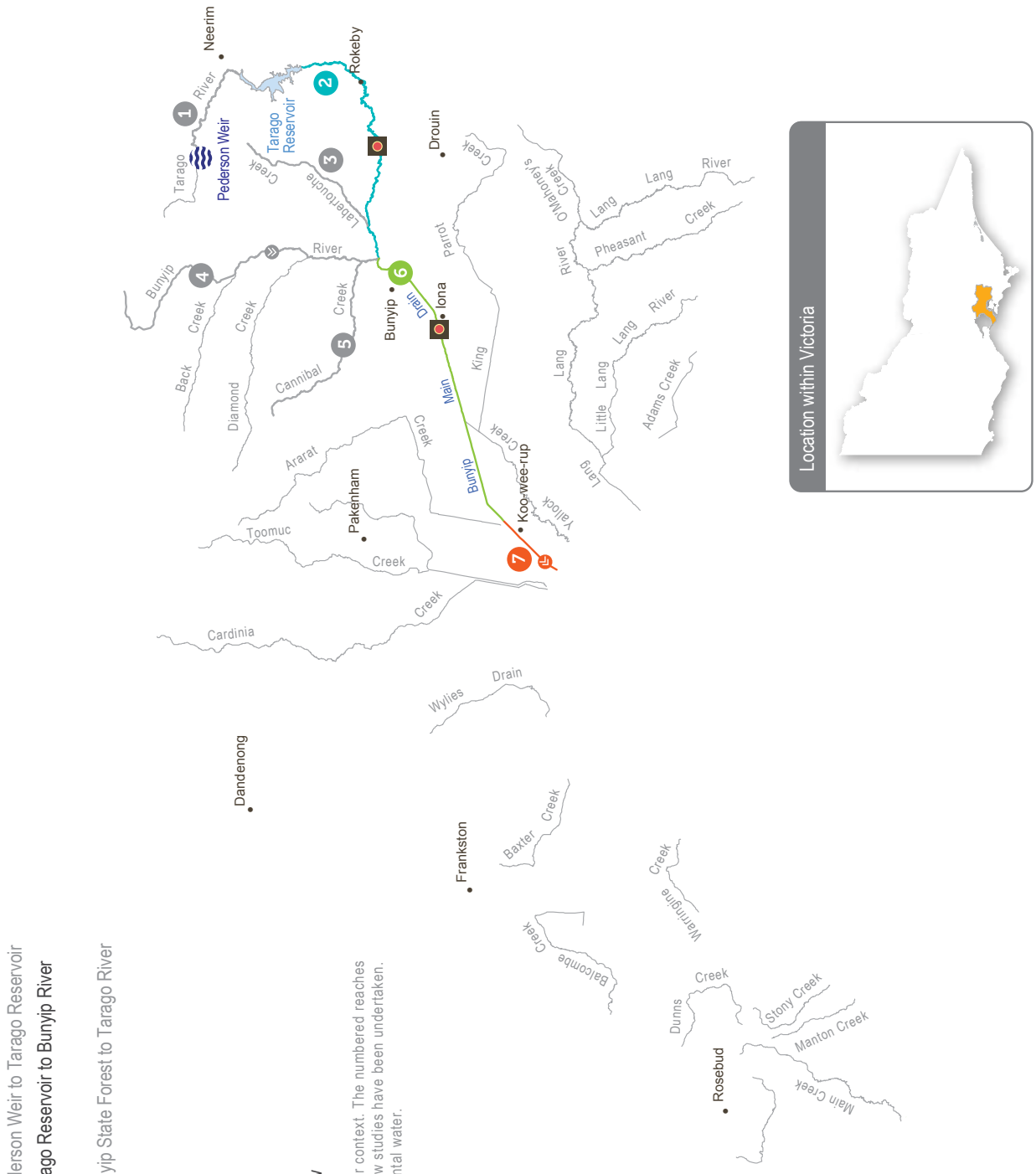
System overview

Water available under the Tarago environmental entitlement is stored in and released from Tarago Reservoir. Reach 2, from below the reservoir to the confluence of the Tarago and Bunyip rivers, is the target reach as it has a high diversity of native fish, patches of native fringing vegetation, and supports populations of platypus. Deliveries of water for the environment to reach 2 often achieve the desired flows in reach 6.

Year-round passing flows in the Bunyip and Tarago rivers are stipulated under both the environmental entitlement and Melbourne Water's bulk entitlement. Downstream of Tarago Reservoir, this equates to the lesser of 5 ML per day or natural inflows to the reservoir. This is small compared with the desired flow components, but it is enough to meet low-flow objectives during some parts of the year.

Water can be released at various times of the year to meet irrigation demands, creating a variable flow pattern throughout the system. Melbourne Water continues to work with Southern Rural Water to maximise the shared value derived from irrigation releases.

Figure 3.3.1 The Tarago system



Recent conditions

Conditions were generally drier and warmer than average in 2017–18, but the catchment also had high rainfall in September and December 2017.

The current environmental flow recommendations for the Tarago River include a high flow in spring to inundate barriers to allow fish movement within and between reaches. The recommended spring high flow did not occur in 2017–18 (either naturally or through releases of water for the environment), but monitoring demonstrated that fish are moving through the system at lower flows. This knowledge will be incorporated into the revised FLOWS assessment for the river, which is being currently undertaken.

Water for the environment was used in the drier, summer months — February 2018 had much-lower-than-average rainfall — to provide freshening flows to maintain water quality. An autumn high flow was delivered in May 2018 to trigger the downstream dispersal and spawning of Australian grayling.

Scope of environmental watering

Table 3.3.1 shows potential environmental watering actions and their environmental objectives.

Table 3.3.1 Potential environmental watering actions and objectives for the Tarago River

Potential environmental watering	Environmental objectives
Summer/autumn freshes (up to 5 freshes of 75–100 ML/day for 2–4 days each in December–May)	• Prevent vegetation growing on sand bars, scour holes in the riverbed, improve water quality and allow the migration to suitable habitat of aquatic species, particularly fish
Autumn high flow (1 event with peak of 100 ML/day maintained for 2 days in a minimum 7 day event duration in April–May)	• Trigger downstream dispersal and spawning of Australian grayling
Spring high flow (1 event in September–December with 2–4 days at peak of 200–300 ML/day)	• Trigger migration of juvenile Australian grayling
Winter/spring freshes (up to 4 events of 100–280 ML/day at peak for 2–3 days during June–November)	• Mobilise sand and sediment to maintain and create habitat for waterbugs and maintain riparian vegetation
Winter/spring low flows (75–100 ML/day [or natural] during June–November)[1]	• Inundate littoral habitats for juvenile fish • Increase river bed habitat for waterbugs • Promote recruitment and increase diversity of native riparian vegetation and prevent terrestrial vegetation encroachment
Summer/autumn low flows (12–20 ML/day [or natural] during December–May)[2]	• Maintain water quality and provide habitat for river blackfish, Australian grayling, platypus and waterbugs

[1] *Winter/spring low flows are unlikely to be delivered as the volume required would severely affect the ability to provide other environmental flow events.*

[2] *Summer/autumn low flows are generally provided by passing flows under the environmental entitlement but during dry conditions it may be necessary to supplement these flows using managed water for the environment.*

Scenario planning

Table 3.3.2 outlines the potential environmental watering and expected water usage under a range of planning scenarios.

The highest-priority releases in the Tarago system are summer/autumn freshes — to allow fish to disperse throughout the system and improve water quality — and an autumn high flow — to provide migration cues for Australian grayling.

It is important to deliver an autumn high flow in most years, as Australian grayling are short-lived (to around three years old), so they need successful breeding every 1–2 years. There may not be enough water in drought conditions to deliver the autumn high flow, but this type of flow event has been provided in seven of the past eight years, so not delivering it in 2018–19 does not pose a significant risk. Under wetter conditions, it is expected that water for the environment may also be used to increase the magnitude or extend the duration of some unregulated events throughout winter and spring to improve habitat for waterbugs and allow fish movement along the river.

Another priority release is the spring high flow to support the movement of juvenile Australian grayling back into the Tarago system. This event can occur naturally under wet conditions, but it may only be partially met in dry years. Monitoring has shown that the Australian grayling and other diadromous fish move on these partial events (lower flows), and the recommended magnitude of the spring fresh is currently being reviewed.

The number of watering actions increases from the drought to the wet scenarios, thus increasing the volume of water for the environment required. Carrying water over into 2019–20 is important under all conditions, to ensure that there is sufficient water to deliver summer and autumn freshes in the following year.

Table 3.3.2 Potential environmental watering for the Tarago system under a range of planning scenarios

Planning scenario	Very dry	Dry	Average	Wet
Expected river conditions	• Very low streamflows • Reduced passing flows • Irrigation releases likely	• Low streamflows • Some reduction to passing flows • Irrigation releases likely	• Average streamflows • Partial freshes naturally provided • Some irrigation releases likely	• Above-average streamflows • Partial-to-full freshes naturally provided • Irrigation releases unlikely
Expected availability of water for the environment	• 1,500 ML carryover • 200 ML allocation • 1,700 ML total	• 1,500 ML carryover • 500–1,000 ML allocation • 2,000–2,500 ML total	• 1,500 ML carryover • 1,000–2,200 ML allocation • 2,500–3,700 ML total	• 1,500 ML carryover • 2,200–3,500 ML allocation • 3,700–5,000 ML total
Potential environmental watering – tier 1 (high priorities)	• Summer/autumn freshes	• Summer/autumn freshes • Autumn high flow (partial event)	• Summer/autumn freshes • Autumn high flow • Spring high flow (partial event)	• Summer/autumn freshes • Autumn high flow • Spring high flow • Winter/spring freshes
Potential environmental watering – tier 2 (additional priorities)	• Spring high flow (partial event)	• Spring high flow (partial event) • Autumn high flow (full event)	• Spring high flow (full event)	• N/A
Possible volume of water for the environment required to achieve objectives[1]	• 1,000 ML (tier 1) • 800 ML (tier 2)	• 1,000–1,500 ML (tier 1) • 1,200 ML (tier 2)	• 1,500–2,700 ML (tier 1) • 1,200 ML (tier 2)	• Up to 3,500 ML (tier 1)
Priority carryover requirements	• 1,000 ML[2]			

[1] *Water for the environment requirements for tier 2 actions are additional to tier 1 requirements.*

[2] *Under drought conditions, the full priority carryover target cannot be met.*

Risk management

Environmental watering program partners have considered and assessed risks and identified mitigating strategies relating to environmental flows in 2018–19. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

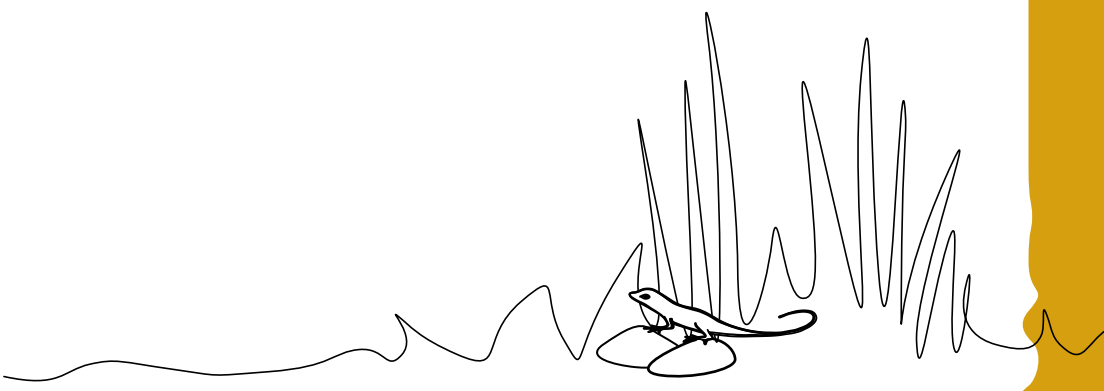
Engagement

Table 3.3.3 shows the partners and stakeholder organisations with which Melbourne Water engaged when preparing the Tarago system seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional catchment strategies, regional waterway strategies, environmental flow studies, water management plans and other studies. These incorporate a range of environmental, cultural, social and economic perspectives and longer-term integrated catchment and waterway management objectives. For further details, refer to the *Port Phillip and Western Port Regional Catchment Strategy* and Melbourne Water's *Healthy Waterways Strategy*.

Table 3.3.3 Partners and stakeholders engaged in developing the Tarago system seasonal watering proposal

Partner and stakeholder engagement
• Baw Baw Shire and Cardinia Shire councils • Environmental Protection Authority • Landcare groups • Landholders / farmers • Melbourne Water (Water Supply – Optimisation and Support, service delivery) • Parks Victoria • Port Philip and Westernport CMA • Robin Hood Reserve Friends Group • Southern Rural Water • Tarago and Bunyip Rivers Environmental Flow Advisory Group • Victorian Environmental Water Holder • VRFish and local anglers • Waterwatch coordinators



3.4 Maribyrnong system

Waterway manager – Melbourne Water

Storage manager – Southern Rural Water

Environmental water holder – N/A

Maribyrnong River system: *The name Maribyrnong is a version of the Aboriginal term 'Mirring-gnay-bir-nong', which translates as 'I can hear a ringtail possum'.*

Source: Melbourne Water

The Maribyrnong catchment is located to the north-west of Melbourne. Water flows from the headwaters around Mount Macedon to form Jacksons Creek, which flows into Rosslynne Reservoir near Gisborne. Water is released from Rosslynne Reservoir back into Jacksons Creek, and where it joins with Deep Creek (flowing from the north) the Maribyrnong River is formed at Keilor North. The river runs south through Yarraville in inner Melbourne before meeting the Yarra River and flowing into Port Phillip Bay.

The Maribyrnong system continues to be an important place for Traditional Owners and their Nations. The Registered Aboriginal Party (RAP) in the Maribyrnong River area is the Wurundjeri Land and Compensation Cultural Heritage Council Aboriginal Corporation. RAP representatives were involved in preparing the Maribyrnong system seasonal watering proposal.

Environmental values

The upper Maribyrnong catchment contains areas of intact streamside vegetation, which provide important habitat for native fish including migratory short-finned eels, common and ornate galaxias, flathead gudgeon, tupong and Australian smelt. A large population of waterbugs provides an abundant food source for a significant platypus population in several reaches in the Maribyrnong system.

Social and economic values

The Maribyrnong River, fed by Jackson's Creek and Deep Creek, is located in the western suburbs of Melbourne and supplies water (primarily from Rosslynne Reservoir on Jacksons Creek) to urban and rural users.

From Gisborne to Yarraville, the river corridor's parklands, creeks and rivers provide opportunities for boating, fishing, cycling, walking and picnicking. The river at Keilor is used for canoeing and has three ponding points, which have been designed to enable children and adults to catch fish with a hand net. There are nine boat landings along the river (most notably at Canning Reserve, Maribyrnong Park and Fairbairn Park) and the river hosts water-based events including the University of Melbourne intercollegiate regatta, Canoeing Victoria's Winter Marathon Series and Scouts Australia paddling events.

Environmental watering objectives in the Maribyrnong system

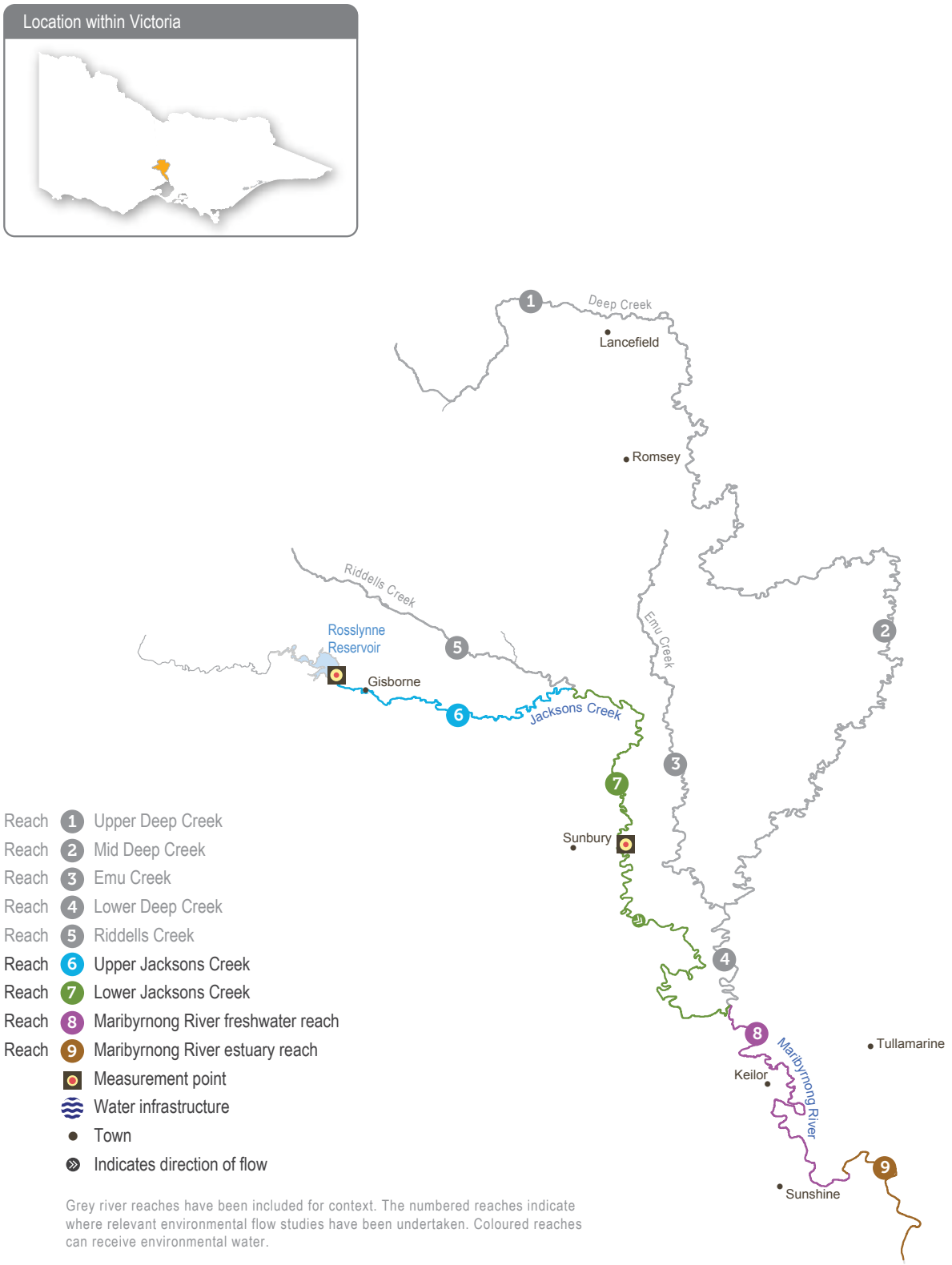
	Maintain or rehabilitate in-stream vegetation and reduce invasive terrestrial plants from encroaching into the riparian zone
	Maintain and increase feeding and breeding habitat for native fish Protect and increase populations of native, small-bodied fish by providing flows for them to move upstream and downstream
	Support a wide range and high biomass of waterbugs to break down dead organic matter and support the river's food chain
	Maintain water quality, particularly dissolved oxygen concentrations, by flushing pools

System overview

Rosslynne Reservoir is the only major storage in the Maribyrnong catchment, and it is located in the upper reaches of Jacksons Creek. The release capacity of 20 ML per day from the reservoir is a significant constraint on the outcomes that can be achieved by environmental flow deliveries in the priority river reaches. The priority river reaches that can be influenced by water for the environment in the Maribyrnong system are reaches 6 and 7 (upper and lower Jacksons Creek respectively) downstream of Rosslynne Reservoir and above the confluence of Deep Creek, where it forms the Maribyrnong River at Keilor North.

The VEWH does not hold an environmental entitlement in the Maribyrnong system, and it relies on opportunistic, temporary trade to meet demands. Each year for the last five years, Melbourne Water and the VEWH have worked with local diversion licence holders to purchase unused water that can then be delivered specifically for environmental outcomes in the system. This arrangement is negotiated each year and will only occur with the agreement of all parties involved.

Figure 3.4.1 The Maribyrnong system



Grey river reaches have been included for context. The numbered reaches indicate where relevant environmental flow studies have been undertaken. Coloured reaches can receive environmental water.

Recent conditions

Rainfall and run-off into storages and waterways of the Maribyrnong system have remained below average since summer 2016–17. Dry conditions through winter/spring 2017 meant that winter/spring low-flow requirements in reaches 6 and 7 were either not met or only partially met.

Conditions remained dry over summer and into autumn 2018. Water for the environment was used to deliver freshes to reaches 6 and 7 in autumn 2018, to prevent adverse water-quality conditions. Maintaining adequate dissolved oxygen concentrations is essential for fish and waterbugs and for platypus, which feed on waterbugs. The autumn freshes also provided opportunities for fish to move throughout the reaches and helped support aquatic plants.

Scope of environmental watering

Table 3.4.1 shows potential environmental watering actions and their environmental objectives.

Table 3.4.1 Potential environmental watering actions and objectives for the Maribyrnong system

Potential environmental watering[1]	Environmental objectives
Summer/autumn freshes (up to 5 events of 20–40 ML/day for up to 7 days) in December–May	• Maintain water quality by flushing pools • Support in-stream vegetation • Provide passage for small-bodied native fish
Winter/spring high flows (20–40 ML/day) in June–November	• Maintain or rehabilitate in-stream vegetation and disturb invasive terrestrial vegetation • Provide passage for small-bodied fish
Summer/autumn low flows (4–6 ML/day) in December–May	• Maintain waterbug habitat by providing suitable depth over riffles

[1] *All potential environmental watering actions apply to both reaches 6 and 7.*

Scenario planning

Table 3.4.2 outlines the potential environmental watering actions and expected water use under a range of planning scenarios.

Under drought or dry conditions, any available water for the environment would be used to maintain suitable habitat for plants and animals in Jacksons Creek (reaches 6 and 7). Summer/autumn low flows and freshes aim to maintain the health of native fish, waterbugs and platypus populations, by providing access to food and habitat resources in drier conditions.

Under average and wet conditions, unregulated flows are expected to meet some of the environmental flow objectives. Water for the environment may be used to improve and enhance environmental outcomes for aquatic plants and animals, by filling gaps not met by unregulated flows (additional freshes) or by extending the duration of unregulated events.

Table 3.4.2 Potential environmental watering for the Maribyrnong system under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Unregulated flows unlikely • Passing flows ceased	• Low volumes of unregulated flows • Passing flows may meet some low-flows objectives	• Unregulated flows meet some objectives • Passing flows may meet several low-flows objectives	• Unregulated flows meet most objectives • Passing flows may meet most low-flows objectives
Potential environmental watering – tier 1 (high priorities)	• Summer/autumn low flows • Summer/autumn freshes (2 events)	• Summer/autumn freshes (3 events)	• Summer/autumn freshes (3 events) • Winter/spring low flows (up to 14 days)	• Summer/autumn freshes (3 events) • Winter/spring low flows (up to 21 days)
Potential environmental watering – tier 2 (lower priorities)	• Summer/autumn freshes (2 additional events)	• Summer/autumn freshes (2 additional events)	• Summer/autumn freshes (2 additional events) • Increased duration winter/spring low flows	• Summer/autumn freshes (2 additional events) • Increased duration winter/spring low flows
Volume of water for the environment required to achieve objectives	• 200 ML (tier 1) • 200 ML (tier 2)	• 300 ML (tier 1) • 200 ML (tier 2)	• 600 ML (tier 1) • 500 ML (tier 2)	• 700 ML (tier 1) • 600 ML (tier 2)

Risk management

Environmental watering program partners have considered and assessed risks and identified mitigating strategies relating to environmental flows in 2018–19. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

Engagement

Table 3.4.3 shows the partners, stakeholder organisations and individuals Melbourne Water consulted when preparing the Maribyrnong system seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional catchment strategies, regional waterway strategies, environmental flow studies, water management plans and other studies. These incorporate a range of environmental, cultural, social and economic perspectives and longer-term integrated catchment and waterway management objectives. For further details, refer to the *Port Phillip and Western Port Regional Catchment Strategy* and Melbourne Water's *Healthy Waterways Strategy*.

Table 3.4.3 Partners and stakeholders engaged in developing the Maribyrnong system seasonal watering proposal

Partner and stakeholder engagement
• Department of Environment, Land, Water and Planning • Environment groups (Landcare and friends' groups, including Jacksons Creek EcoNetwork and Friends of the Maribyrnong Valley) • Keilor irrigators • Melbourne Water (Diversions Group) • Southern Rural Water • Victorian Environmental Water Holder • Western Water • Wurundjeri Land and Compensation Cultural Heritage Council Aboriginal Corporation

3.5 Werribee system

Waterway manager – Melbourne Water

Storage manager – Southern Rural Water

Environmental water holder – Victorian Environmental Water Holder

The Werribee River flows south-east from the Wombat State Forest near Ballan before dropping through the Werribee Gorge to Bacchus Marsh and then flowing into Port Phillip Bay at Werribee. The Lerderderg River is a major tributary that joins the river at Bacchus Marsh. The main storages in the Werribee system are Pykes Creek Reservoir, Melton Reservoir and Merrimu Reservoir.

The Werribee River and its tributaries continue to be a place of significance for Traditional Owners and their Nations. The Registered Aboriginal Parties (RAPs) in the Werribee River area are the Wathaurung Aboriginal Corporation (on the western side of the Werribee River) and the Wurundjeri Land and Compensation Cultural Heritage Council Aboriginal Corporation (on the eastern side of the river in the upper catchment).

Environmental values

The Werribee system supports a range of native fish including river blackfish, flathead gudgeon, short-finned eel, tupong, Australian smelt, several species of galaxiids, and a large population of black bream in the estuary. A highly diverse community of frogs and waterbugs inhabit the upper reaches and platypus are present in the lower reaches. The freshwater-saltwater interface of the Werribee River estuary is a regionally significant ecosystem due to the many aquatic plants and animals it supports, providing nursery habitat for juvenile freshwater fish species and estuarine species such as black bream.

Social and economic values

The Werribee River is a resource for agriculture, industry, recreation and tourism. The system provides irrigation water for agricultural industries throughout the Bacchus Marsh and Werribee areas (including the Werribee market gardens) and domestic water for Melton and Bacchus Marsh.

The Werribee River and its tributary the Lerderderg River support popular camping and hiking spots in the Wombat State Forest and Lerderderg State Park. Along its length, the Werribee River provides opportunities for recreational activities including fishing, birdwatching, canoeing, kayaking and bushwalking.

In the lower reaches, the river meanders through the Werribee River Park and Werribee Park Tourism Precinct (which includes the Open Range Zoo, National Equestrian Centre, Shadowfax Winery, Mansion Hotel and Spa, Western Treatment Plant, Refectory and Golf Club) which attracts more than a million visitors a year to the region. The Werribee River Trail and Federation Trail bike paths are popular recreational cycling routes.

Environmental watering objectives in the Werribee system

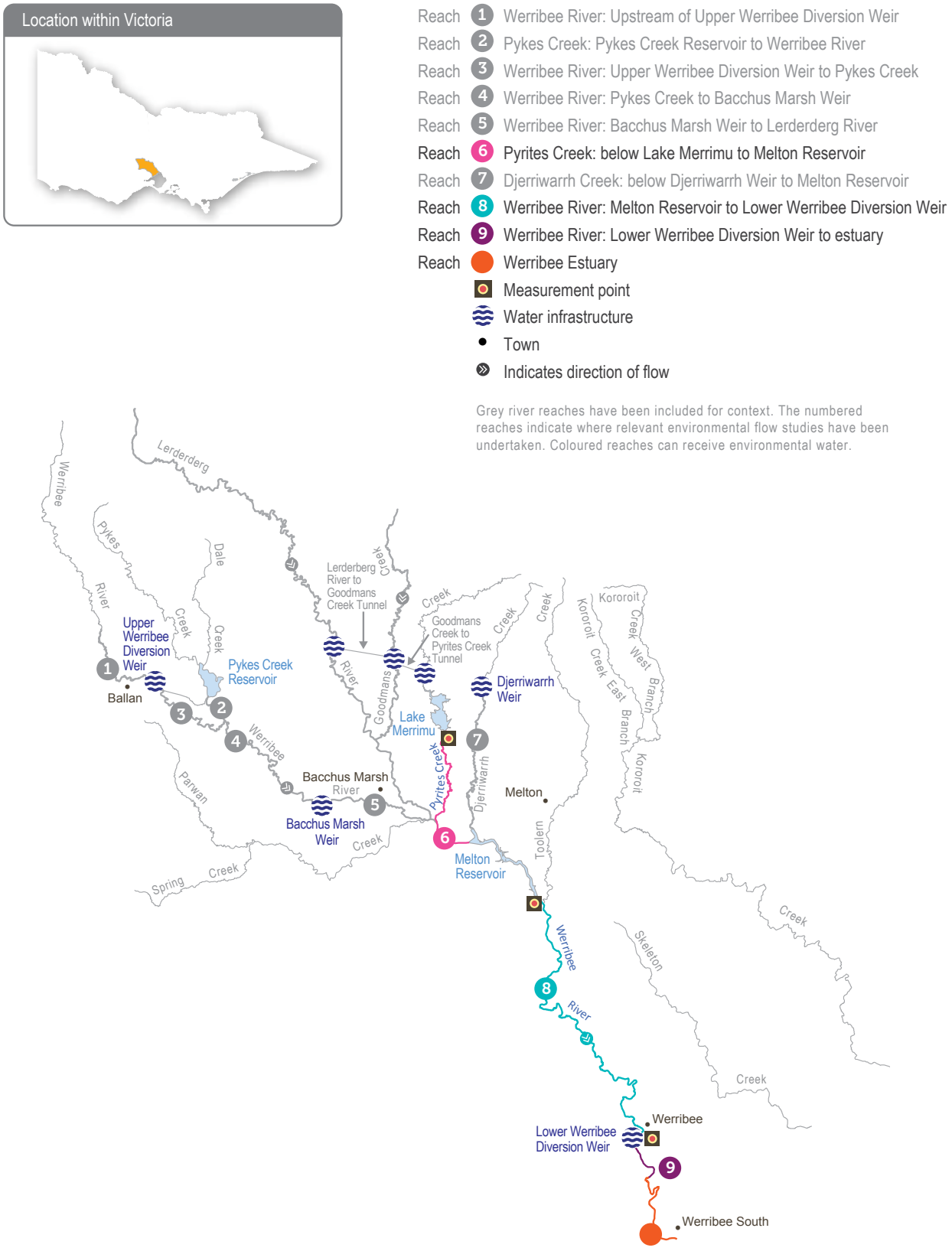
	Maintain the cover of in-stream, riverside and estuary plants
	Protect and increase populations of native fish by improving pool habitat and stimulating fish including black bream and galaxiids to migrate and spawn
	Maintain populations of frogs by providing suitable habitat
	Maintain populations of waterbugs to break down dead organic matter and support the river's food chain
	Maintain pool water quality for native fish, frogs, waterbugs and platypus

System overview

The four reaches of the Werribee River that can receive water for the environment are Pyrites Creek (reach 6) between Lake Merrimu and Melton Reservoir, the Werribee River between Melton Reservoir and the Werribee Diversion Weir (reach 8), the Werribee Diversion Weir to Werribee Park Tourism Precinct (reach 9) and below the precinct to Port Phillip Bay at Werribee South (the estuary).

The system supports many native fish species, waterbugs and platypus. Managed flows that target environmental objectives in reach 9 and the estuary are released from Melton Reservoir and can therefore provide benefit to reach 8 en route. Water for the environment released from Lake Merrimu is reharvested in Melton Reservoir, where it can be held and rereleased to achieve environmental objectives in the lower Werribee River. Flows are measured downstream of Lake Merrimu (reach 6), downstream of Melton Reservoir (reach 8) and at the Werribee Diversion Weir for reach 9 and the estuary.

Figure 3.5.1 The Werribee system



Recent conditions

After a wet 2016–17, winter 2017 was one of the driest winters on record for the Werribee system. Drier conditions prevailed across the catchment with below-average rainfall and higher-than-average temperatures in spring, summer and autumn 2017–18. Small volumes of water for the environment were delivered to protect and maintain current ecological objectives in the Werribee system.

Water for the environment was delivered into Pyrites Creek (reach 6) from Lake Merrimu in spring 2017. High flows were delivered at the beginning of October 2017 and flows were reharvested in Melton Reservoir for later use. A second fresh in November 2017 was passed through Melton Reservoir to meet flow objectives in the lower Werribee River. These flows flushed organic matter from benches and supported the recruitment and growth of native vegetation along the creek. No water for the environment was released from Lake Merrimu to Pyrites Creek in summer/autumn, as a wet winter/spring followed by a dry (cease-to-flow) summer/autumn is the natural cycle of this creek.

Flows in the lower Werribee River in 2017–18 were low all year, except for a few freshes that resulted from storms in spring/summer. The fresh delivered to Pyrites Creek in November 2017, combined with water held in storage — reharvested flows from Pyrites Creek low flows and the October fresh — was released from Melton Reservoir to deliver a large fresh to the lower Werribee River. Water for the environment was delivered in the lower Werribee River in autumn 2017, to maintain water quality and support native fish habitat and recruitment. Monitoring in the last two years in the lower Werribee River has detected a higher catch rate of young-of-year galaxiid species following high freshes in November 2016 and November 2017. These flows provide suitable conditions for diadromous native fish to complete their lifecycles — to disperse and breed — in southern Victoria's coastal rivers.

Another exciting discovery in the lower Werribee River was the presence of a young-of-year Australian grayling caught in November 2016 and an another, older one, caught in autumn 2017. These represent the first and second records of Australian grayling in the Werribee River system, and it is likely due to improved fish passage in the Werribee River thanks to recently constructed fishways and managed flows.

Scope of environmental watering

Table 3.5.1 shows potential environmental watering actions and their environmental objectives.

Werribee River, by Melbourne Water

Table 3.5.1 Potential environmental watering actions and objectives for the Werribee system

Potential environmental watering[1]	Environmental objectives
Pyrites Creek (reach 6)	
Spring/summer freshes (up to 3 freshes of 30 ML/day for 2 days in September–December)	• Improve waterbug habitat by scouring silt and sand from riffles • Promote vegetation growth
Spring/summer high flows (up to 3 high flows of 130 ML/day for 2 days in September–December)	• Flush organic matter from benches • Increase the recruitment and growth of riparian vegetation
Winter/spring/summer low flows (2 ML/day [or natural] in June–December)	• Provide frog and waterbug habitat • Promote growth of aquatic plants • Allow fish movement between pools
Lower Werribee River (reaches 8, 9 and the estuary)	
Spring/summer freshes (up to 2 freshes of 50–80 ML/day for 2 days in November–December)	• Promote juvenile black bream recruitment • Promote longer-distance movement of native fish through reach 9, including black bream
Winter/spring/summer low flows (10 ML/day in June–December)	• Maintain suitable conditions for black bream spawning and recruitment • Provide habitat for waterbugs and native fish, and support plant growth in reach 9
Autumn low flows 10 ML/day during March–May[1]	• Provide flows to allow native diadromous fish to move between the freshwater river and saltwater estuary to complete their life cycle • Provide habitat for waterbugs and native fish, and support plant growth in reach 9
Summer/autumn/winter freshes (up to 3 freshes of 80 ML/day[2] for 2 days during January–May)	• Maintain pool water quality for fish and platypus in reach 9 • Increase the recruitment of juvenile black bream in the estuary • Scour silt and algae from riffles in reach 8
Winter/spring/summer freshes (up to 4 freshes of 350 ML/day for 3 days during June–December)	• Increase the diversity of riparian vegetation in reaches 8 and 9 • Provide fish movement cues (all) • Inundate saltmarsh vegetation with brackish water in the estuary

[1] *The original recommendation from the flow study (Ecological Associates 2005, Jacobs 2014) is for 89 ML per day for four days throughout autumn. Construction of a fishway has reduced the required flow rate. This is usually the last watering action in a year, so duration is matched to remaining available water in Melton Reservoir.*

[2] *Original recommendation from the flow study (Ecological Associates 2005, Jacobs 2014) is for 137 ML delivered in one day. The recommendation has been revised due to operational constraints to be 160 ML delivered over two days. Monitoring has shown that this achieves the hydraulic and water quality objective.*

Scenario planning

Table 3.5.2 outlines the potential environmental watering and expected water usage under a range of planning scenarios.

The critical environmental flows to deliver under the drought and dry scenarios focus on deliveries to Pyrites Creek (reach 6) and freshes to maintain water quality in the lower Werribee River. The amount of water available may not be sufficient to meet all these demands, particularly under drought conditions and therefore releases will need to be made according to the greatest need. When possible, winter releases from Lake Merrimu to Pyrites Creek (reach 6) will be captured in Melton Reservoir and used for environmental flow releases to the lower Werribee River later in the water year. This is an essential management option to enable the best use of limited water for the environment under drought and dry conditions.

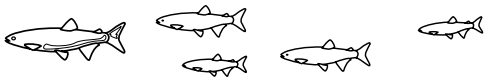
Under average or wet conditions, Melton Reservoir is likely to spill, meaning releases from upstream will spill through the reservoir and provide a small increase in unregulated flow to the lower Werribee River. More water for the environment is needed under average and wet conditions due to the inability to re-harvest releases from Merrimu Reservoir in Melton Reservoir.

Carrying over some water into 2019–20 is essential to help protect the health of Pyrites Creek (reach 6) in the following year under dry conditions.

Table 3.5.2 Potential environmental watering for the Werribee system under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• No unregulated flows • Minimal consumptive releases out of storage into reach 8 in summer/ autumn	• No unregulated flows below Melton Reservoir, minimal passing flows to reach 6 • Consumptive releases out of storage into reach 8 in summer/ autumn	• Unregulated spills in winter/spring from Melton into reaches 8 and 9 and the estuary; most reach 6 low flows met by passing flows • Consumptive releases out of storage into reach 8 in summer/ autumn	• Unregulated spills in winter/spring from Melton into reaches 8 and 9 and the estuary; all reach 6 low flows provided • Consumptive releases out of storage into reach 8 in summer/autumn
Expected availability of water for the environment	• 765 ML carryover • 50 ML allocation • 0 ML inflows • 815 ML total	• 765 ML carryover • 500 ML allocation • 200 ML inflows • 1,465 ML total	• 765 ML carryover • 700 ML allocation • 400 ML inflows • 1,865 ML total	• 765 ML carryover • >800 ML allocation • >900 ML inflows • >2,465 ML total
Potential environmental watering – tier 1 (high priorities)	• Winter/spring/ summer low flows (reach 6) • 2 spring/summer freshes (reach 6) • 2 summer/autumn/ winter freshes (lower reaches) • Autumn low flows (lower reaches)	• Winter/spring/ summer low flows (reach 6) • 3 spring/summer freshes (reach 6) • 2 summer/autumn/ winter freshes (lower reaches) • Autumn low flows (lower reaches) • 1 spring/summer fresh (lower reaches)	• 3 spring/summer freshes (reach 6) • 2 summer/autumn/ winter freshes (lower reaches) • Autumn low flows (lower reaches) • 2 spring/summer freshes (lower reaches) • Winter/spring/ summer low flows (lower reaches)	• 3 spring/summer freshes (reach 6) • 3 spring/summer high flows (reach 6) • 2 summer/autumn/ winter freshes (lower reaches) • Autumn low flows (lower reaches) • 2 spring/summer freshes (lower reaches) • Winter/spring/ summer low flows (lower reaches)
Potential environmental watering – tier 2 (additional priorities)	• Winter/spring/ summer freshes (lower reaches)	• Winter/spring/ • summer freshes (lower reaches)	• Winter/spring/ summer freshes (lower reaches)	• Winter/spring/ summer freshes (lower reaches)
Possible volume of water for the environment required to achieve objectives[1]	• 350 ML (tier 1) • 1,300 ML (tier 2)	• 700 ML (tier 1) • 1,300 ML (tier 2)	• 900 ML (tier 1) • 1,300 ML (tier 2)	• 1,200 ML (tier 1) • 1,300 ML (tier 2)
Priority carryover requirements	• 200 ML			

[1] *Water for the environment requirements for tier 2 actions are additional to tier 1 requirements.*



Risk management

Environmental watering program partners have considered and assessed risks and identified mitigating strategies relating to environmental flows in 2018–19. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

Engagement

Table 3.5.3 shows the partners, stakeholder organisations and individuals with which Melbourne Water engaged when preparing the Werribee system seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional catchment strategies, regional waterway strategies, environmental flow studies, water management plans and other studies. These incorporate a range of environmental, cultural, social and economic perspectives and longer-term integrated catchment and waterway management objectives. For further details, refer to the *Port Phillip and Western Port Regional Catchment Strategy* and Melbourne Water's *Healthy Waterways Strategy*.

Table 3.5.3 Partners and stakeholders engaged in developing the Werribee system seasonal watering proposal

Partner and stakeholder engagement
• Department of Environment, Land, Water and Planning • Landholders including Zoos Victoria • Southern Rural Water • Victorian Environmental Water Holder • Werribee River Community Advisory Group including representatives of Melton and Wyndham councils, Werribee Riverkeeper, Werribee South Fishing Club, Werribee and District Anglers Club, Western Water, Port Phillip and Westernport CMA

3.6 Moorabool system

Waterway manager – Corangamite Catchment Management Authority

Storage operator – Central Highlands Water

Environmental water holder – Victorian Environmental Water Holder

Moorabool River system: *In the Wadawurrung language, 'Moorabool' means 'monster' – the name of the stone curlew bird who lives by the river and is renowned for its eerie wails.*

Source: Corangamite CMA

The Moorabool River is a tributary of the Barwon River. It flows south from the Central Highlands between Ballarat and Ballan to join the Barwon River at Fyansford just north of Geelong. The Moorabool River is a highly regulated catchment with major storages that include Lal Lal, Moorabool and Bostock reservoirs. Despite substantial extraction and many years of drought, the river retains significant environmental values.

The Moorabool River and its tributaries continue to be an important place for Traditional Owners and their Nations. The Registered Aboriginal Party (RAP) in the region is the Wathaurung Aboriginal Corporation. RAP representatives were engaged in the preparation of the Moorabool system seasonal watering proposal.

Water for Victoria identifies the Moorabool River as a priority for restoration. The Living Moorabool project includes activities to protect and improve riparian land and to remove fish barriers in the Moorabool River catchment. Complementary water management activities such as these are needed to optimise the environmental outcomes achievable with environmental flows.

Environmental values

The Moorabool River is home to native fish species including the Australian grayling, river blackfish, Australian smelt, flat-headed gudgeon, southern pygmy perch, short-finned eel, spotted galaxias, and tupong. The system contains extensive areas of endangered remnant vegetation including streambank shrubland and riparian woodland ecological vegetation communities. Platypus, water rats and a range of waterbugs are also present. The Moorabool River flows into the Barwon River, connecting it to the Ramsar-listed lower Barwon wetlands.

Social and economic values

The Moorabool River has important social, cultural, recreational and economic values. It supplies potable water to large communities in and around Ballarat and Geelong. The surrounding catchment is heavily farmed, with about three-quarters of the catchment area used for agriculture. Its confined valley provides spectacular scenery and its reaches include parks, picnic sites, lookouts, swimming holes, fishing and camping spots and historic bridges. Many local people in the region have a connection to and a long history with the river. They have been active in protecting and restoring the river, and are strong advocates for the *Moorabool River Environmental Entitlement 2011*.

Environmental watering objectives in the Moorabool system

	Maintain remnant vegetation communities including a range of macrophytes (large water plants) within the river channel; these plant communities provide shade and food for organisms further up the food chain
	Protect and increase native fish populations including Australian grayling, southern pygmy perch, spotted galaxias, tupong and short-finned eel by maintaining habitat throughout the catchment and by providing flows for fish to move upstream and downstream as well as suitable conditions for fish to spawn
	Flush silt and scour biofilms in the stream bed, scour pools and maintain channel form to ensure fish and other water animals have a range of habitat pools and places to shelter
	Improve water quality during the year, particularly during summer
	Maintain a wide range and high biomass of waterbugs to break down dead organic matter and support the river's food chain

System overview

There are several large water storages in the upper reaches of the Moorabool River including Lal Lal Reservoir. In the lower reach (between She Oaks and Batesford), there are nine private diversion weirs that are significant barriers to fish. These barriers have increased the extent of slow-flowing habitat and reduced habitat diversity in the lower reach of the Moorabool.

The Moorabool is a water supply catchment for Barwon Water and Central Highlands Water. Central Highlands Water releases water from Lal Lal Reservoir to She Oaks Weir for urban water supply. These releases contribute to environmental outcomes in reach 3a and 3b and allow more efficient delivery of water for the environment to reach 4. Barwon Water and Corangamite CMA work together to maximise these benefits.

Water allocated to the Moorabool River environmental entitlement is stored in Lal Lal Reservoir and includes passing flows that help maintain flows in the river. Passing flows are a significant component of annual streamflows and help maintain baseflows through winter. The priority reaches for deliveries of water for the environment are between Lal Lal Reservoir and She Oaks Weir (reaches 3a and 3b, as shown in Figure 3.6.1), as that is where the small amount of available water for the environment can have the most benefit. Water for the environment may also provide some benefits to flow-dependant values in reach 4, which flows from She Oaks Weir at Meredith down to the confluence with the Barwon River in Geelong.

Recent conditions

High rainfall in 2016 filled Lal Lal Reservoir and ensured strong allocations against the environmental entitlement for the start of the 2017–18 water year. Water for the environment was used to deliver a winter/spring fresh, winter/spring low flow, two summer freshes and summer low flows.

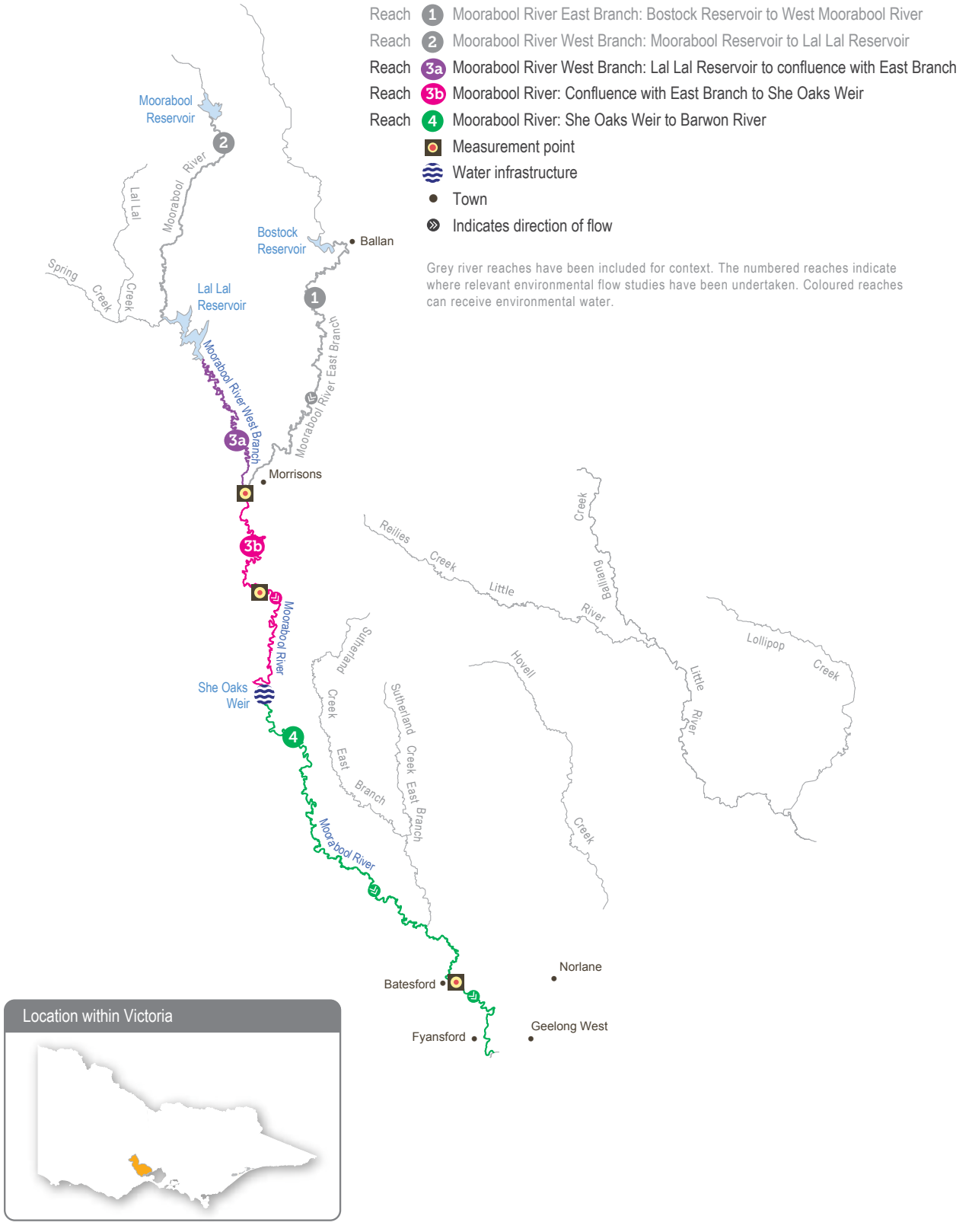
Monitoring as part of the Victorian Environmental Flows Monitoring and Assessment Program (VEFMAP) indicates that in-stream and fringing vegetation along the Moorabool River has benefited from flow management and that freshes have been sufficient to eradicate many exotic species.

While passing flows were delivered for all of 2017 and into the early months of 2018, dry summer/autumn conditions meant there were reduced or no passing flows from Lal Lal Reservoir. Water for the environment provided the only flow downstream of Lal Lal Reservoir from late summer and into autumn.

As a response to the continued dry conditions in autumn, the duration of summer low flows was extended to prevent flows ceasing. This meant that water use exceeded the planned 2,500 ML for the year. The environmental entitlement allows for this greater use; a maximum 7,500 ML can be used in any consecutive three years, and water use in the previous two years totalled 2,205 ML. However, the decision to use extra water in 2017–18 will potentially restrict the volume of water that can be delivered in 2018–19 and 2019–20.

Winter fresh release from Lal Lal Reservoir to the Moorabool River, by Saul Vermeeren

Figure 3.6.1 The Moorabool system



Scope of environmental watering

Table 3.6.1 shows potential environmental watering actions and associated environmental objectives.

Table 3.6.1 Potential environmental watering actions and objectives for the Moorabool system

Potential environmental watering[1]	Environmental objectives
Summer/autumn low flows (5–20 ML/day in December–May)	• Maintain pool and riffle habitats for fish, waterbugs, platypus and submerged aquatic vegetation • Maintain water quality
Winter/spring low flows (10–86 ML/day in June–November)	• Allow fish movement throughout the system • Restrict spread of land-based vegetation into the river channel
Summer/autumn freshes (1–2 freshes targeting 30–60 ML/day for 3–5 days in December–May)	• Allow fish and platypus movement and maintain access to habitat • Flush silt and scour biofilms and algae from stream bed • Maintain vegetation on the riverbank • Trigger downstream spawning migration of adult short-finned eel and Australian grayling • Maintain water quality, top-up refuge pools and avoid critical loss of biota
Winter/spring fresh (1 fresh targeting 80–162 ML/day for up to 10 days in May–November)	• Allow fish and platypus movement and maintain access to habitat • Trigger downstream spawning migration of adult tupong and upstream migration of juvenile galaxias, tupong, short-finned eel and Australian grayling • Flush silt and scour biofilms and algae from the streambed and transport organic matter • Increase the growth and recruitment of native riparian vegetation including woody shrubs and maintain vegetation zonation on the banks

[1] *The target reaches for environmental watering are reaches 3a, 3b and 4 of the Moorabool system unless otherwise stated.*

Scenario planning

Table 3.6.2 outlines the potential environmental watering and expected water use under a range of planning scenarios based on the flow recommendations for reach 3b of the Moorabool River.

Under all climate scenarios, the main priorities for the use of water for the environment in the Moorabool River in 2018–19 will be to provide recommended low flows all year and freshes throughout summer and autumn to maintain water quality and habitat for fish, and to deliver a winter fresh to allow fish and platypus to move up and down the river and promote vegetation growth. Water quality is monitored throughout summer to identify when freshes need to be released to avoid dangerously low levels of dissolved oxygen or dangerously high levels of salinity. If more water for the environment becomes available under any scenario, it may be used to increase the number of freshes and/or the magnitude of summer low flows. It is expected most of the proposed flow components will be partly met under a dry scenario and will be mostly met under a wet scenario.

The priorities for delivery of water for the environment in the Moorabool River have changed slightly from previous years, to address the shortfall that often occurs in summer/autumn. Where previously multiple winter freshes have been delivered, the intention is to only release one winter fresh in 2018–19, to ensure more water is available in summer/autumn.

Although environmental watering in the Moorabool River primarily targets outcomes in reaches 3a and 3b, deliveries will be planned where possible to also provide benefits in reach 4. For example, increasing the magnitude of summer freshes, when water availability allows, will provide some increased flow through reach 4. The Corangamite CMA prioritises carryover of 750 ML each year (if possible) to allow delivery of trigger-based freshes in the following year, if there is a low allocation.

Table 3.6.2 Potential environmental watering for the Moorabool system under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Minimal catchment inflows • Limited passing flows	• Low catchment inflows • Passing flows	• Moderate catchment inflows • Unregulated and passing flows	• High catchment inflows • Unregulated and passing flows
Expected availability of water for the environment	• 2,500 ML carryover • 200 ML inflows • 2,700 ML total	• 2,500 ML carryover • 1,000 ML inflows • 3,500 ML total	• 2,500 ML carryover • 2,000 ML inflows • 4,500 ML total	• 2,500 ML carryover • 4,000 ML inflows • 6,500 ML total
Potential environmental watering – tier 1 (high priorities)	• Summer/autumn freshes (trigger-based)[1] • Summer low flows • Winter baseflows • Autumn fresh	• Summer/autumn freshes (trigger-based)[1] • Summer low flows • Winter baseflows • Autumn fresh • Spring fresh	• Summer/autumn freshes (trigger-based)[1] • Summer low flows • Winter baseflows • Autumn fresh • Winter fresh • Summer fresh	• Summer/autumn freshes (trigger-based)[1] • Summer low flows • Winter baseflows • Autumn fresh • Spring freshes • Summer fresh • Winter fresh
Potential environmental watering – tier 2 (additional priorities)	• Spring freshes • Summer freshes • Winter fresh	• Spring fresh • Winter fresh • Additional summer fresh	• Additional winter fresh • Additional summer fresh	• Additional summer fresh
Possible volume required to achieve objectives[2]	• 1,000 ML (tier 1)[3] • 7,500 ML (tier 2)	• 2,500 ML (tier 1)[3] • 6,000 ML (tier 2)	• 2,500 ML (tier 1)[3] • 5,000 ML (tier 2)	• 2,500 ML (tier 1)[3] • 2,000 ML (tier 2)
Priority carryover requirements	• 1,000 ML	• 1,000 ML	• 1,000 ML	• 1000 ML

[1] *Given the volume of water in storage at the beginning of 2018–19, it is not expected that trigger-based freshes will be required.*

[2] *Water for the environment requirements for tier 2 actions are additional to tier 1 requirements.*

[3] *Under the environmental entitlement, a maximum of 7,500 ML may be used in any three-year period. Corangamite CMA has chosen to cap its use at 2,500 ML a year in the past, but use in 2017–18 was more than 2,500 ML. This will limit the volume of water that can be delivered in 2018–19 and 2019–20 to less than 2,500 ML a year on average.*

Risk management

Environmental watering program partners have considered and assessed risks and identified mitigating strategies relating to environmental flows in 2018–19. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

Engagement

Table 3.6.3 shows the partners and stakeholder organisations with which Corangamite CMA engaged when preparing the Moorabool system seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional catchment strategies, regional waterway strategies, environmental flow studies, water management plans and other studies. These incorporate a range of environmental, cultural, social and economic perspectives and longer-term integrated catchment and waterway management objectives. For further details, refer to the *Corangamite Regional Catchment Strategy* and the *Corangamite Waterway Strategy*.

Table 3.6.3 Partners and stakeholders engaged in developing the Moorabool system seasonal watering proposal

Partner and stakeholder engagement
• Barwon Water • Central Highlands Water • Department of Environment, Land, Water and Planning • Moorabool Stakeholder Advisory Committee (with representatives of People for a Living Moorabool, Geelong Landcare Network, Southern Rural Water, Central Highlands Water, Parks Victoria, Barwon Water, the Victorian Environmental Water Holder and the local community) • Parks Victoria • People for a Living Moorabool and other local community groups • Southern Rural Water • Victorian Environmental Water Holder • Wathaurung Aboriginal Corporation

3.7 Barwon system

The Barwon River flows east from the Otway Ranges passing the towns of Forrest, Birregurra, Winchelsea and Inverleigh and the City of Geelong before discharging into Bass Strait at Barwon Heads. The Leigh and Moorabool rivers are major tributaries, joining the Barwon River at Inverleigh and Fyansford respectively. Other tributaries including Birregurra, Boundary, Callahan, Dewing, Matthews, Pennyroyal, Deans Marsh and Gosling creeks are all important contributors to the upper Barwon River, flowing into the Barwon from the western part of the catchment upstream of Winchelsea.

The Barwon estuary contains a Ramsar-listed system of wetlands and lakes collectively called the lower Barwon wetlands. Water for the environment can be used to manage water levels in Reedy Lake and Hospital Swamps, which connect to the Barwon River. The main storages in the Barwon River catchments are the West Barwon and Wurdee Boluc reservoirs.

The Barwon River and its wetlands continue to be an important place for Traditional Owners and their Nations. The Registered Aboriginal Party (RAP) in the region is the Wathaurung Aboriginal Corporation. RAP representatives were the Barwon system seasonal watering proposal.

3.7.1 Upper Barwon River

A new entitlement was established in April 2018, which will enable water for the environment to be used in the upper Barwon River for the first time in 2018–19. The entitlement provides 1,000 ML per year on average from the West Barwon Reservoir. Given the small amount of available environmental water, deliveries will target the reach between the West Barwon Reservoir and Birregurra Creek confluence, as this is where it can have the most benefit.

Environmental values

The upper Barwon River is home to native fish species including the Australian grayling, river blackfish, short-finned eel, southern pygmy perch and Australian smelt and various galaxias. The system retains some submerged aquatic vegetation, undercut banks, overhanging vegetation and riffle-pool sequences: these provide important habitat for fish and other water animals.

Social and economic values

The Barwon River has important social and economic values. It is a major water supply for Geelong and for towns and farms in the region. The river provides recreational opportunities to visitors (such as fishing, bushwalking and picnicking).

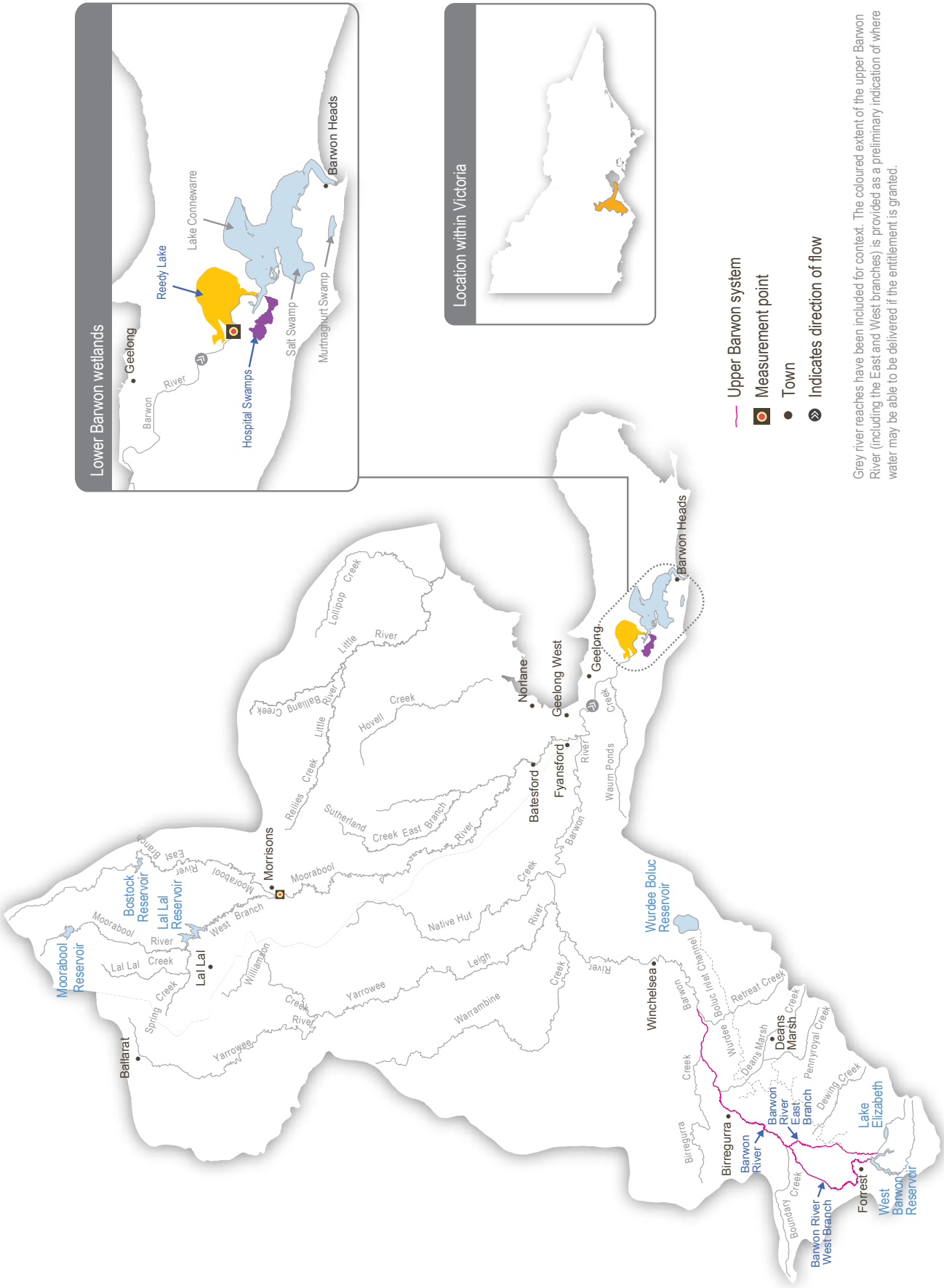
Environmental watering objectives in the upper Barwon River

	Protect and increase populations of native fish including dwarf galaxid by improving pool habitat and providing links between refuges
	Improve and maintain plants on the riverbank and in the river channel
	Create and extend habitat for waterbugs

System overview

Flows in the upper Barwon River are regulated by the operation of the West Barwon Reservoir upstream of Forrest and by diversions from tributary streams upstream of Birregurra into the Wurdee Boluc Inlet and then the Wurdee Boluc Reservoir. Barwon Water releases passing flows from the West Barwon Reservoir into the West Barwon River. Flood spills from the reservoir and natural inflows from unregulated and partly regulated tributaries add to the passing flows. Water for the environment for the upper Barwon River is held in the West Barwon Reservoir, and it can be released directly into the main channel of the Barwon River at a maximum rate of 320 ML per day. Figure 3.7.1 shows the reaches of the upper Barwon River.

Figure 3.7.1 The Barwon system



Recent conditions

Flows in the upper Barwon River were lower than average across most of 2017–18. The main exception was September 2017, when high rainfall delivered two high flow freshes (>2,500 ML per day) upstream of Ricketts Marsh. Natural inflows have delivered similar high flow events in spring in six of the past eight years. Recommended minimum flows for summer and the winter low-flow period have only been met in one of the past eight years. The new environmental entitlement, which was established in April 2018, will provide an opportunity to partly address some of the shortfalls in recommended flows from 2018–19 onwards.

Scope of environmental watering in 2018–19

Table 3.7.1 shows potential environmental watering actions and their environmental objectives. The new environmental entitlement is not large enough to meet all potential watering actions. Where possible, water for the environment will be used to supplement existing passing flows and natural tributary inflows to wholly or partly meet some of the proposed watering actions.

Table 3.7.1 Potential environmental watering actions and objectives for the upper Barwon River

Potential environmental watering	Environmental objectives
Continuous low flows (5 ML/day)	• Maintain the growth of aquatic plants and animals • Maintain refuge pools for small fish and waterbugs
Summer freshes (up to 2 freshes of 215 ML/day for 2 days)	• Inundate pools at the margin of the channel, sustaining perennial vegetation (such as milfoil)
Winter baseflow (50 ML/day)	• Sustain perennial vegetation (such as milfoil) • Provide migration and dispersal opportunities for native fish • Support growth and reproduction of waterbugs
Winter small high flow fresh (up to 3 freshes of 153 ML/day for 5 days)	• Maintain the growth of aquatic plants and animals • Increase the availability of riverbank habitat for waterbugs • Support breeding of native fish

Scenario planning

Table 3.7.2 outlines the potential environmental watering and expected water use under a range of planning scenarios. There is not enough water for the environment available to meet all flow objectives for the upper Barwon River under any scenario.

In drought conditions, existing passing flows and tributary inflows will probably not be sufficient to maintain continuous flows year-round in the upper Barwon River. The entire water for the environment reserve may also not be sufficient to maintain continuous flows, but environmental watering would be used to minimise the period during which flows cease over summer and autumn, to avoid major loss of fauna and flora. In dry and average scenarios, passing flows and tributary inflows will likely provide near-continuous flows for much of the year; therefore, water for the environment may be used to help deliver the recommended summer freshes. In a wet scenario, it is expected that natural flows will achieve many of the recommended flow components; the requirement for water for the environment would therefore be reduced.

Table 3.7.2 Potential environmental watering for the upper Barwon River under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• No flow at Ricketts Marsh for 6 months • Disconnected pools	• No flow at Ricketts Marsh for 4 months • Cease-to-flow events	• Low summer flows, high peaks in winter	• High flows through-out winter with very high peaks; consistent, steady summer flows
Expected availability of water for the environment	• 1000 ML carryover + 500 ML allocation	• 1000 ML carryover + 800 ML allocation	• 1000 ML carryover + 1000 ML allocation	• 1000 ML carryover + 1000 ML allocation
Potential environmental watering – tier 1 (high priorities)	• Continuous low flows (partially achieved)	• Continuous low flows • Up to 2 summer freshes (full or partially achieved)	• Continuous low flows • Up to 2 summer freshes	• Continuous low flows if required
Potential environmental watering – tier 2 (additional priorities)	• Continuous low flows • Summer freshes • Testing of flows components to inform the new FLOWS study[2]	• Testing of flows components to inform the new FLOWS study	• Testing of flows components to inform the new FLOWS study	• Testing of flows components to inform the new FLOWS study
Possible volume of water for the environment required to achieve objectives[1]	• 500 ML (tier 1)	• 800 ML (tier 1)	• 1,000 ML (tier 1)	• 500 ML (tier 1)
Priority carryover requirements	• 500 ML			

[1] *Water for the environment requirements for tier 2 actions are undefined and additional to tier 1 requirements.*

[2] *In 2018, Corangamite CMA are reviewing the 2006 Flows study for the upper Barwon River. Additional water may be used to trial new flows recommendations, with the results informing the hydrology and hydraulics of the study.*

Risk management

Environmental watering program partners have considered and assessed risks and identified mitigating strategies relating to environmental flows in 2018–19. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

Engagement

Table 3.7.3 shows the partners, stakeholder organisations and individuals with which Corangamite CMA engaged when preparing the upper Barwon seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional catchment strategies, regional waterway strategies, environmental flow studies, water management plans and other studies. These incorporate a range of environmental, cultural, social and economic perspectives and longer-term integrated catchment and waterway management objectives. For further details, refer to the *Corangamite Regional Catchment Strategy* and the *Corangamite Waterway Strategy*.

The Corangamite CMA consulted widely when preparing the upper Barwon seasonal watering proposal, given 2018–19 will be the first year of delivery of water for the environment. The CMA established the Upper Barwon Surface Water Advisory Group specifically for this process.

The group comprises representatives of community groups and government agencies and individuals with extensive knowledge of the Barwon River. The group, working with an independent scientific advisory team, is helping inform an update to the existing flow recommendations for the river.

Table 3.7.3 Partners and stakeholders engaged in developing the upper Barwon River seasonal watering proposal

Partner and stakeholder engagement
• Colac Otway Shire Council • Department of Environment, Land, Water and Planning • Southern Rural Water • Upper Barwon Surface Water Advisory Group comprising representatives of the Upper Barwon Landcare Network, Land and Water Resources - Otway Catchment Group, Geelong Environment Council, Geelong Field Naturalists Club, the Winchelsea farming community, People for a Living Moorabool, Wathaurung Aboriginal Corporation, Barwon Water and the Victorian Environmental Water Holder • other stakeholders are invited as needed including science and engineering consultants and the Department of Economic Development, Jobs, Transport and Resources

3.7.2 Lower Barwon wetlands

The estuarine reach of the Barwon River contains a system of wetlands and lakes including Lake Connewarre, Reedy Lake, Hospital Swamps, Salt Swamp and Murtnaghurt Lagoon. Water for the environment can be used to manage water levels in Reedy Lake and Hospital Swamps, which connect to the Barwon River.

Environmental values

Reedy Lake and Hospital Swamps form part of the internationally recognised Port Phillip Bay (Western Shoreline) and Bellarine Peninsula Ramsar site, which are used by many thousands of migratory birds from around the world. The wetlands support about 47 threatened flora and fauna species and communities. These include some of Victoria's rarest species (such as the brolga, orange-bellied parrot, Australasian bittern, growling grass frog, Australian grayling and dwarf galaxias) and subtropical and temperate coastal saltmarsh communities.

Reedy Lake supports a range of vegetation communities including coastal saltmarsh, herbfields and reed beds. Reedy Lake was originally a partly-ephemeral system, but river regulation meant the lake was permanently inundated from the 1970s until 2016. Permanent inundation favoured the reed bed community in the lake and over time it has increased its extent and replaced much of the coastal saltmarsh and herbfield communities and open-water habitat. While reed beds form an important part of the lake's ecosystem, their continued expansion has reduced habitat diversity and the number and diversity of internationally-important migratory waterbirds that were able to use the wetland.

The Corangamite CMA has implemented the first two years of a four-year watering regime at Reedy Lake which includes three years of partial summer/autumn drying and one year of full summer inundation. This has already helped to control carp numbers and improve conditions for communities of coastal saltmarsh and herbfields. Achieving a more-natural wetting and drying regime is the single most important management activity to protect the ecology of the lower Barwon wetlands.

Hospital Swamps is made up of five unique wetland basins that support important ecological processes and significant ecological values including large areas of threatened coastal saltmarsh and diverse waterbird populations. Vegetation communities in Hospital Swamps have remained largely unchanged over time due to the maintenance of natural wetting and drying cycles.

Social and economic values

The lower Barwon wetlands are located close to Geelong, which is the second-largest city in Victoria. The wetlands form a very important part of the region's social fabric and are valued for their beauty, ecological significance and recreational uses. In particular, the wetlands are used heavily by Geelong Field and Game for hunting and by Geelong Field Naturalists for birdwatching and recreation. The system also supports a commercial eel fishery.

Environmental watering objectives in the lower Barwon wetlands

	Provide suitable foraging habitat including mud flats and shallow water for wading birds, and refuge for waterbirds and shorebirds
	Provide habitat for fish breeding and growth and improved conditions for migration and dispersal when wetlands are connected to the Barwon River
	Provide varying water levels and conditions to promote soil salinisation to support the persistence and growth of threatened salt-dependant ecological vegetation communities
	Maintain the high diversity of ecological vegetation communities in the wetlands Increase the growth and extent of coastal saltmarsh, herbfields and lignum shrubland ecological vegetation communities

System overview

Water for the environment can be actively managed at Reedy Lake and Hospital Swamps using regulating structures.

The environmental entitlement for the lower Barwon wetlands does not provide access to water held in storage. Instead, it allows water to be diverted from the Barwon River into Reedy Lake and Hospital Swamps when river levels are above 0.7 m AHD (Australian Height Datum). High water levels in the Barwon River can also result in natural inundation of the wetlands.

Recent conditions

High streamflow in the Lower Barwon River in winter 2017 led to three flood events that filled Reedy Lake and Hospital Swamps. The Corangamite CMA closed the inlet regulators after floodwaters receded, and it left them closed over summer to allow the wetlands to dry.

The outlet to Reedy Lake was opened in summer to allow water levels to draw down naturally to between 0.1–0.3 m AHD, implementing the second year of a three-year partial summer/autumn drying regime. Before 2016–17, the lake had been kept at a constant water level for over eight years.

It is likely to take several years for the lake's ecosystem to adjust to the new water regime, but monitoring at Reedy Lake has already shown minor changes to the diversity and abundance of plants and animals since the drying regime was implemented. Also, initial investigations have confirmed the partial drying regime will not be detrimental to native fish species or increase the risk of acid sulphate soils.

A natural pattern of wetting and drying has been implemented in Hospital Swamps for longer than Reedy Lake. Inflows from the Barwon River are allowed to enter the wetland in the winter/spring period, and water is then actively drawn down over the drier summer months. High rainfall in spring 2017 increased water levels in Hospital Swamps above the normal winter-fill level, extending the subsequent period for drying and drawing down. The wetland needs to dry regularly to maintain the balance between freshwater and saltwater processes required to support the diverse mix of vegetation communities and provide feeding and breeding habitat for waterbirds and native fish.

Scope of environmental watering in 2018–19

Table 3.7.4 shows potential environmental watering actions and associated environmental objectives.

The main objective for environmental watering in the lower Barwon wetlands is to implement natural wetting and drying cycles. Reedy Lake and Hospital Swamps will be filled in winter and spring when water levels in the Barwon River are high, and they will be allowed to draw down over summer. These water regimes will be managed using regulators that control flow in either direction between the Barwon River and the wetlands.

Hospital Swamps has had an appropriate wetting and drying regime for many years and there is no plan to change its management in 2018–19. The plan for Reedy Lake will be to implement the third year of the partial drying regime. Reedy Lake will be allowed to fill in winter and spring and then draw down in summer, to reduce the extent of reed beds and allow other vegetation communities to recolonise. Unlike previous years when the outlet has been manipulated to maintain the water level at about 0.3 m AHD, water levels will be allowed to naturally fluctuate between 0.1–0.3 m AHD, as a result of tidal influences. This approach is practical from an operational perspective as it requires less-frequent adjustment of the regulators and will allow natural fluctuations in salinity.

Outlet to Barwon River from West Barwon Reservoir, by Andrew Sharpe

Table 3.7.4 Potential environmental watering actions and objectives for the lower Barwon wetlands

Potential environmental watering	Environmental objectives
Reedy Lake	
Autumn/winter/spring fill and top-ups (March/April–October) [1] *The inlet to Reedy Lake will be opened in autumn in response to a sustained increase in flows in the Barwon River*	• Maintain connectivity with the Barwon River • Provide feeding habitat for waterbirds in flooded vegetation and the wetland fringe • Stimulate fish breeding
Spring/early summer drawdown (October–January) and then variable low water levels (around 0.1–0.3m AHD) throughout summer/autumn (January–March/April) *The inlet to Reedy Lake will be closed and the outlet opened to allow water levels to drop to about 0.1–0.3 m AHD; during this period, the inlet and outlet may be manipulated if required to maximise the drawdown or to introduce saltwater to the lake*	• Reduce the extent of tall reeds in the system by increasing the salt content of the water and soil • Reduce the threat of carp and associated impacts on plants and animals • Promote suitable conditions for threatened vegetation communities (such as coastal saltmarsh, herbfields and lignum shrubland) • Provide increased habitat diversity (including salt pans, mudflats and shallow water) • Provide wading bird habitat in summer • Provide summer waterbird refuge and foraging habitat • Improve lake shore salinity and increase soil salinisation • Initiate decomposition of organic matter on the wetland bed, to increase lake productivity when it is refilled • Improve soil health and allow weathering of heavy metals in lake fringe soils • Allow seasonal recruitment of aquatic macrophytes at wetland fringes
Hospital Swamps	
Autumn/winter/spring fill and top-ups (March/April–December) [1] *Hospital Swamps will be connected to the Barwon River for at least 6 weeks by keeping the inlet and outlet open*	• Create habitat and support waterbug populations • Stimulate fish and waterbird breeding • Allow fish to colonise the wetland from the river • Allow soil and surface water salts to be diluted over winter • Promote and sustain the growth of important wetland vegetation communities
Summer/autumn drawdown (December–March/April) *The inlet to Hospital Swamps will be closed to allow water levels to drop through evaporation; during this period, the outlet will be opened for short periods of time if a summer storm increases water levels above 0.85 m AHD*	• Reduce the threat of carp and associated impacts on plants and animals • Prevent the expansion of tall reeds in the system by increasing the salt content of the water and soil • Provide increased habitat diversity (including salt pans, mudflats and shallow water) • Provide wading bird habitat in early summer • Provide early summer waterbird refuge and foraging habitat • Improve lake shore salinity and increase soil salinisation • Initiate the decomposition of organic matter on the wetland bed, to increase lake productivity when it is refilled • Improve soil health and allow weathering of heavy metals in lake fringe soils • Provide suitable conditions for threatened vegetation communities (such as coastal saltmarsh, herbfields and lignum shrubland) • Allow seasonal recruitment of aquatic macrophytes at wetland fringes

[1] *Water can only be diverted into the lower Barwon wetlands when water levels in the Barwon River are above 0.7 m AHD at the lower barrage gauging station, in line with provisions for accessing water conditions of the environmental entitlement.*

Scenario planning

Table 3.7.5 outlines the potential environmental watering and expected water use under a range of planning scenarios.

Inundation of the wetlands over the winter period and drawdown in summer are priority actions under all scenarios, but the extent of the wetting and drying will vary in response to natural conditions. Under a wet scenario, the Barwon River is likely to experience more sustained high flows and therefore the extent of inundation may be higher and the amount of drawdown lower compared with a dry scenario. Partial drying is expected at all wetlands under all scenarios and is important to maintain or increase vegetation diversity and soil salinisation and to provide a variety of feeding and breeding habitat for waterbirds. The wetlands will be managed adaptively throughout the year in response to climatic conditions to maximise environmental outcomes.

Corangamite CMA will monitor water levels, water quality and environmental condition throughout the drawdown period and adjust the water levels as needed.

Table 3.7.5 Potential environmental watering for the lower Barwon wetlands under a range of planning scenarios

Planning scenario	Dry	Average	Wet
Expected catchment conditions	• Some natural inflows from the Barwon River in winter/spring • Dry conditions over summer will assist in the drawdown of the wetlands	• Some natural inflows from the Barwon River in winter/spring • Conditions over summer may assist drawdown of the wetland water levels	• Overbank flows likely to inundate the wetlands as a result of higher river flows, stormwater inflows and local rain/run-off • Extensive drawdown of wetlands is unlikely
Reedy Lake			
Potential environmental watering	• Autumn/winter/spring filling flows (March/April–October) • Spring/early summer/autumn drawdown and low water levels (0.1–0.3 m AHD) (October–March/April)		
Hospital Swamps			
Potential environmental watering	• Autumn/winter/spring filling flows (March/April–December) • Summer/autumn drawdown (December–March/April)		

Risk management

Environmental watering program partners have considered and assessed risks and identified mitigating strategies relating to environmental flows in 2018–19. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

Engagement

Table 3.7.6 shows the partners, stakeholder organisations and individuals with which Corangamite CMA engaged when preparing the lower Barwon wetlands seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional catchment strategies, regional waterway strategies, environmental flow studies, water management plans and other studies. These incorporate a range of environmental, cultural, social and economic perspectives and longer-term integrated catchment and waterway management objectives. For further details, refer to the *Corangamite Regional Catchment Strategy* and the *Corangamite Waterway Strategy*.

Over the last six years, the Corangamite CMA has consulted extensively about the planned watering regimes for Reedy Lake and Hospital Swamps with diverse stakeholders and interest groups representing over 1,500 people. These people have been involved in developing the original environmental flows study and in subsequent scientific work about ecological risks, vegetation monitoring, alternative management approaches and infrastructure operations. The results of this work show that lowering water levels at Reedy Lake is the only feasible management practice that will mitigate threats to the ecological health of the wetland and ensure all user groups can continue to use the system in future.

Table 3.7.6 Partners and stakeholders engaged in developing the lower Barwon wetlands seasonal watering proposal

Partner and stakeholder engagement
• Lower Barwon Community Advisory Committee, with representatives of Field and Game Geelong Branch, Geelong Environment Council, Geelong Field Naturalists Club, Geelong Gun and Rod Association, Federation University, RMIT University, Department of Environment, Land, Water and Planning, Environment Victoria, VR Fish, Barwon Water, local landowners, community members, Parks Victoria, Southern Rural Water and the Victorian Environmental Water Holder; additional stakeholders are invited as needed and include science and engineering consultants and Department of Economic Development, Jobs, Transport and Resources representatives • Other stakeholders include Fisheries Victoria, commercial eel fishers and the members for South Barwon, Bellarine and Western Victoria

Coastal saltmarsh at Hospital Swamps, by Saul Vermeeren, Corangamite CMA

Lower Glenelg River, by Graeme Broderick

Section 4

Western Region

4.1 Western Region overview

In the Western Region, regulated environmental flows can be delivered to the Wimmera River system, the Glenelg River and the Wimmera-Mallee wetlands. The Wimmera River system and Wimmera-Mallee wetlands are part of the Murray–Darling Basin.

Water for the environment in the Western Region is supplied from the Wimmera-Mallee headworks system. The Wimmera and Glenelg systems share an environmental entitlement and the VEWH works with the Wimmera and Glenelg CMAs to determine how the available allocation will be used in each river in a given year. Water for the environment available to the Wimmera-Mallee wetlands is supplied from a separate entitlement.

Environmental, social and economic values, recent conditions, environmental watering objectives and planned actions for each system in the Western Region are presented in the system sections that follow.

Traditional Owners in the Western Region

Traditional Owners and their Nations in western Victoria continue to have a deep and enduring connection to the region's rivers, wetlands and floodplains. The VEWH acknowledges the Traditional Owners of the Western Region and pays respect to their Elders past, present and future. It recognises that water has significant cultural importance and value for Traditional Owners and Aboriginal people.

Traditional Owner groups in and around western Victoria include the Bindjali, Bungandidj, Dja Wurrung, Djagurd Wurrung, Gunditjmara, Jaadwa, Jadawadjali, Jupagulk, Wamba Wemba, Wadawurrung, Wergaia, Wotjobaluk and Yupagail people among others. The Registered Aboriginal Parties (RAPs) in this region are Barengi Gadjin Land Council Aboriginal Corporation (BGLC), Dja Dja Wurrung Clans Aboriginal Corporation and Gunditj Mirring Traditional Owners Aboriginal Corporation (GMTOAC) and Martang Pty Ltd.

Two formal agreements with RAPs in the Western Region are in place under the *Traditional Owners Settlement Act 2010*:

- in 2005, the Victorian Government entered into a native title settlement agreement with BGLC
- in 2007 the Victorian Government entered into a native title settlement agreement with GMTOAC.

Both settlement agreements include cooperative management agreements to improve collaboration in the management of Traditional Owner Country in the Wimmera and Glenelg areas.

The Glenelg Hopkins CMA and the Wimmera CMA have been working with GMTOAC and BGLC to understand how management of water for the environment in the Glenelg and Wimmera rivers can better support Aboriginal aspirations, particularly around caring for Country and protecting important story places and cultural resources. The following two initiatives will support Traditional Owners' aspirations for water for the environment in western Victoria in 2018–19.

A trial watering is proposed for the Ranch Billabong near Dimboola, on land managed by BGLC. The intent is to pump water into the billabong system in winter or spring to restore native plant and animal habitats, control invasive weeds and improve amenity. The billabong is a place of high significance to the Traditional Owners and their Nations, and it was the home of many generations of Wotjobaluk peoples.

If climate and catchment conditions permit, a fresh may be delivered in autumn 2019 in the Glenelg River to again coincide with the Johnny Mullagh Cup, a cricket championship held at Harrow between the Gunditj Mirring and Barengi Gadjin Traditional Owners. Glenelg Hopkins CMA will liaise with Traditional Owners in the lead-up to the match about the feasibility of providing the fresh, which freshens the water for native plants and animals, improves the river's usability and amenity for the cricketers, spectators and others, and supports cultural heritage values (such as scarred trees and native plants, which are sources of traditional foods and medicines).

Community considerations

When planning to use water for the environment, the potential social, economic, Aboriginal-cultural and recreational benefits for communities which could arise from the water's use are considered.

A landmark study was conducted in 2017 to quantify the socioeconomic benefits of the Wimmera River and other waterways in the Wimmera and Southern Mallee area. Three of the sites surveyed along the Wimmera River (in Dimboola, Horsham and Jeparit) illustrated the enormous benefits the river and the water for the environment delivered provided to the community in 2016–17, including a $4.75 million contribution to the area's economy and $2.5 million in mental and physical health benefits. As well, residents that used the Wimmera River exceeded Australian government guidelines for physical activity.

Some scoped opportunities for shared community benefits of water for the environment in western Victoria for 2018–19 include:

- managing deliveries of water for the environment where possible in the Wimmera River to support the Horsham, Dimboola and Jeparit fishing competitions, waterskiing at the Kanamaroo festival, the Dimboola Regatta and Head of the Wimmera rowing competitions and the Horsham Triathlon
- improving water quality in the Glenelg River, which will improve amenity and provide more opportunities for swimming, fishing and canoeing at popular campgrounds in the upper reaches
- increasing opportunities for yabbying and birdwatching at some of the Wimmera-Mallee wetlands
- improving habitat for native fish species resulting in increased recreational fishing opportunities along the Glenelg, Wimmera and MacKenzie rivers and Burnt and Mt William creeks.

The ability of the VEWH and its partners to deliver these benefits will depend on the weather, on climate variations, on the available water and on the way the system is being operated to deliver water for other purposes (such as for home, farm and business use).

Environmental watering is also expected to have indirect benefits such as improving amenity at walking tracks in Horsham, Dimboola and Jeparit; at Dadswells Bridge along the Wimmera River and at Burnt and Mt William creeks; and along the Glenelg River including the River Walk at Harrow, the Kelpie Trail and the Glenelg River Walk at Casterton.

For more information about scoped opportunities for shared community benefits in 2018–19, contact the VEWH or the relevant waterway manager.

Integrated catchment management

Altered water regimes are one of many threats to the health of Victoria's waterways. To be effective, planning and releases of water for the environment need to be part of an integrated approach to catchment management. Many of the environmental objectives in this seasonal watering plan will not be fully met without also addressing issues such as excessive catchment erosion, barriers to fish movement, high nutrient loads, loss of stream bank vegetation and invasive species, to name just some issues.

Victorian and Australian government agencies, community groups and private landowners collectively implement programs and activities to protect and improve the environmental condition and function of land, soils and waterways throughout Victoria's catchments. Examples in the region of such programs and activities coordinated with environmental flows include:

- erosion control in the upper Wimmera catchment to improve water quality
- stock exclusion fencing along priority waterways throughout the Wimmera and Glenelg catchments to support the reestablishment of riparian and in-stream vegetation, with over 600 farming families involved along the Glenelg River alone
- major works to improve fish passage at Sandford Weir and Dergholm Gauge, in combination with delivery of water for the environment to facilitate the movement of migratory fish from the estuary to the upstream reaches of the Glenelg and Wannon rivers
- carp management activities in both the Wimmera and Glenelg systems to reduce the number of carp and to build understanding about their behaviour in both rivers to facilitate better environmental watering outcomes

Camping by the Glenelg River, by George Turner

- extensive snag installation in Glenelg River reach 2 using red gum trunks and root balls to restore complex habitat
- control of invasive species in the Wimmera-Mallee wetlands.

For more information about integrated catchment management programs in the Western Region refer to the Glenelg Hopkins, Wimmera, North Central and Mallee regional catchment strategies and waterway strategies.

Seasonal outlook 2018–19

The first few months of the 2017–18 water year were characterised by average rainfall, which generated natural flows to rivers, wetlands and system storages. In contrast, rainfall from late spring to the end of autumn was well-below average and temperatures were above average. Inflows to Wimmera-Mallee storages from July 2017 to April 2018 were 67,250 ML, which is 38 percent of the historic average of inflows.

The winter 2017 average conditions and water held in Wimmera-Mallee storages from 2016–17 meant that allocations against the environmental entitlement reached 81 percent by September 2017. There were no measurable inflows between November 2017 and April 2018, and as a result there were no further allocations to the environmental entitlement for the remainder of 2017–18. The CEWH did not receive any allocation in 2017–18, but water that was allocated to the CEWH in 2016–17 was carried over and used for the first time in the Wimmera system, to support environmental objectives in the Wimmera River through autumn/winter 2018.

Natural flows met most of the planned winter/spring 2017 environmental watering objectives for rivers, creeks and wetlands in the region, so little water for the environment was delivered between July and September. Passing flows in the Wimmera and Glenelg rivers were suspended at times during winter and spring 2017. In the Glenelg system, suspending the passing flows avoided exacerbating flood risks to downstream landowners in the Glenelg River. Passing flows in the Wimmera system were suspended as flow requirements were met by a combination of natural flows and operational water in the Wimmera system. Water that would have been delivered as passing flows was accrued and used later in the season to meet planned flow objectives when drier conditions returned. Water for the environment was used to meet remaining flow objectives once the accrued passing flows were exhausted.

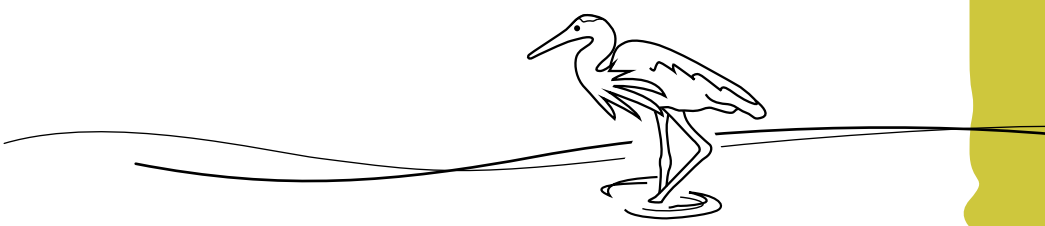
Below-average rainfall and higher-than-average temperatures are predicted for the Western Region through winter 2018. If dry conditions persist into 2018–19, environmental watering in the region will focus on protecting water quality to maintain habitat and build the resilience of in-stream native plants and animals. The carryover available going into 2018–19 will be particularly important in the drier climatic scenarios predicted, as allocation to the wetland entitlement is not expected to be made before October 2018, and may be very small or zero depending on inflows during winter and early spring. The VEWH's allocation is expected to remain below 60 percent, and no allocations to the CEWH entitlement are expected in 2018–19. If conditions become wetter and environmental allocations increase, priority will be given to reserving water for use in 2019–20 and delivering some larger winter/spring flows. The continuing focus of environmental watering in the Wimmera-Mallee wetlands will be to provide refuge and maintain habitat in the dry landscape to support local plants and animals.

The Basin Plan 2012

The Wimmera system forms part of the larger Murray–Darling Basin and water diversions and deliveries of water for the environment in this region are also subject to the requirements of the *Basin Plan 2012*.

The VEWH's environmental planning and delivery is consistent with the requirements of the Basin Plan. The potential environmental watering outlined in section 4 fulfils Victoria's obligations under section 8.26 of the plan to identify annual environmental watering priorities for Victoria's water resource areas.

Refer to section 5 for further information about the Basin Plan.



4.2 Glenelg system

Waterway manager – Glenelg Hopkins Catchment Management Authority

Storage manager – GWMWater

Environmental water holder – Victorian Environmental Water Holder

Glenelg River system: *The Glenelg River, known as 'Bochara' in the Dhawurd Wurrung language, features in creation stories from the south-west Victoria region and is a traditional boundary between the Gunditjmara, Boandik and Jadawadjali people.*

Source: Glenelg Hopkins CMA

The Glenelg River rises in the Grampians and flows west through Harrow and then south to Casterton and Dartmoor for over 500 km, making it one of the longest rivers in Victoria. A short stretch of the estuary winds through South Australia before returning to Victoria and flowing into the sea at Nelson.

The Glenelg River continues to be an important place for Traditional Owners and their Nations. The Registered Aboriginal Parties (RAPs) in the Glenelg River catchment are the Gunditj Mirring Traditional Owner Aboriginal Corporation and the Barengi Gadjin Land Council. Representatives from both RAPs were engaged during the preparation of the Glenelg system seasonal watering proposal.

Environmental values

The lower section of the Glenelg River has been recognised as one of Australia's 15 national biodiversity hotspots due to the aquatic life it supports, including the endangered Glenelg freshwater mussel and Glenelg spiny crayfish. It is also home to platypus and populations of native fish including river blackfish, estuary perch, tupong and several species of pygmy perch. Some of these fish species migrate long distances upstream from the Glenelg River estuary to complete their lifecycles. Frasers Swamp is another important feature of the upper Glenelg system, and is home to a healthy growling grass frog population.

The Glenelg River supports a variety of riparian vegetation communities including the endangered Wimmera bottlebrush. Riparian and floodplain vegetation is comprised of river red gum woodlands with paperbark, bottlebrush and tea tree understorey.

Social and economic values

The Glenelg system is highly valued by recreational anglers and several fishing competitions are held on the river throughout the year along with high profile events such as an Australian Bream Tournament and the Victorian Fisheries Authority's annual 'great perch search', where volunteer anglers catch broodfish perch. Other recreational activities including walking, sightseeing boat cruises, canoeing, birdwatching and camping are popular along parts of the river. Many landholders rely on the Glenelg River for stock water, and they use the productive floodplains for grazing. The river provides tourism opportunities and supports businesses in Balmoral, Harrow, Casterton, Dartmoor and Nelson, among other towns.

Environmental watering objectives in the Glenelg system

	Promote in-stream and riverside plants to flower, set seed and germinate Maintain and increase the health of in-stream and riparian vegetation (such as river red gums and Wimmera River bottlebrush)
	Protect and increase populations of native fish Cue fish movement and spawning to increase the recruitment of species such as the short-finned eel, black bream, estuary perch and tupong
	Maintain a wide range and large number of waterbugs to provide energy, break down organic matter and support the river's food chain
	Maintain and increase the resident platypus population by providing places to rest, breed and feed, as well as opportunities for juveniles to disperse to the lower sections of the river
	Move built-up sand on the river bed to provide healthy habitat pools for native fish, platypus, the critically endangered Glenelg freshwater mussel and the endangered Glenelg spiny crayfish
	Maintain water quality for fish, waterbugs, aquatic vegetation and other water-dependent animals

System overview

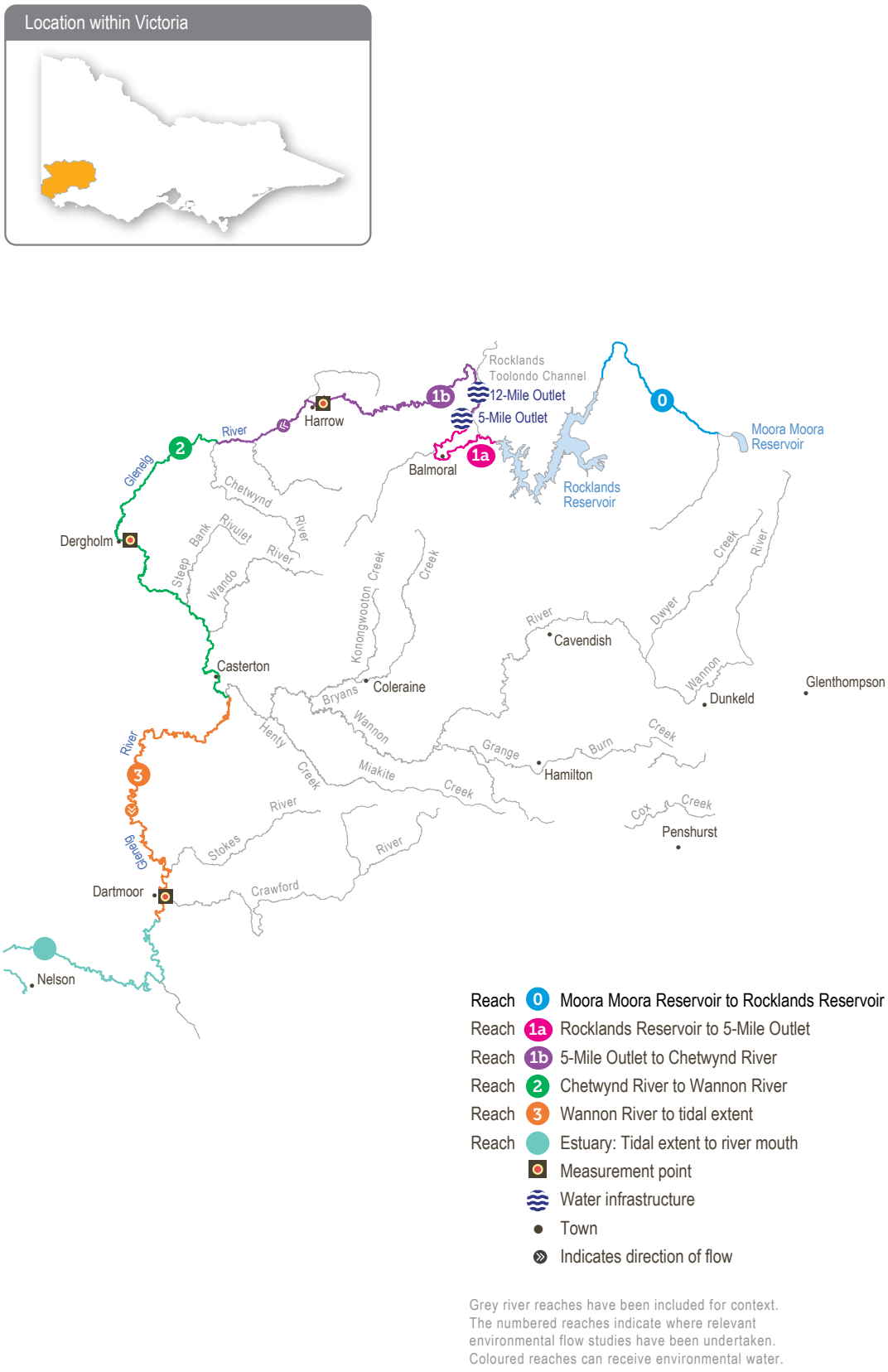
The Glenelg River is an integral part of the Wimmera-Mallee headworks system, which supplies towns and properties across the Western Region. Moora Moora Reservoir and Rocklands Reservoir, in the upper Glenelg catchment and three weirs on the upper Wannon River, are all used to divert water from the Glenelg system to the Wimmera catchment. Water for the environment is actively managed in the main stem of the Glenelg River between Moora Moora Reservoir and Rocklands Reservoir and below Rocklands Reservoir. Passing-flow rules are in place for the Glenelg River and upper Wannon River.

The priority reaches of the Glenelg River that can be targeted by environmental flow releases are Moora Moora Reservoir to Rocklands Reservoir (reach 0), Rocklands Reservoir to 5-Mile Outlet (reach 1a), 5-Mile Outlet to the confluence with the Chetwynd River (reach 1b) and Chetwynd River to the Wannon River (reach 2). Water for the environment in the Glenelg system is released from Rocklands Reservoir for reach 1a via the reservoir wall outlet and for reach 1b via the 5-Mile and 12-Mile outlets. Releases are made at these points to meet objectives in these reaches as well as reach 2. The Glenelg River reach 3 and estuary benefit from releases of water for the environment to upstream reaches, but releases are not currently targeted at these reaches.

The Glenelg River above Rocklands Reservoir (reach 0) runs mostly through the Grampians National Park and retains significant environmental values. Flows through this reach are affected by the operation of Moora Moora Reservoir and work is continuing in 2018–19 to confirm its flow requirements. Work is also continuing to better understand the role environmental releases from Rocklands Reservoir play in the health of the Glenelg River estuary, which is listed as a heritage river reach and which has just been listed as a site of international significance under the Ramsar Convention.

Glenelg River estuary, by Paulina Ramos

Figure 4.2.1 The Glenelg system



Recent conditions

Average rainfall during winter 2017 contributed to high natural flows in the Glenelg catchment. The high flows met many of the environmental flow objectives for winter and spring, and it eliminated the need for managed environmental flow releases. Passing flows were also suspended at various times during winter and spring to reduce the flood risk to communities downstream of Rocklands Reservoir. Water accumulated as a result of the suspended passing flows was used to help meet environmental objectives in summer.

The high natural flows during winter/spring and the provision of water for the environment during the summer/autumn period maintained connectivity from Rocklands Reservoir to the estuary at Nelson throughout 2017–18. Seasonal fluctuations in flows and water levels throughout the year provided opportunities for aquatic plants and animals to disperse between river reaches and to also access a variety of habitats throughout the system. The flows also supported the health of riparian vegetation and the transfer of nutrients and debris from the riverbanks into the river channel. Continuous low flows maintained the quality and quantity of water in riffle-pool habitats. Occasional freshes reduced salinity and water temperature and increased dissolved oxygen concentrations in deeper pools along the river system.

The natural and managed flows in the Glenelg River during 2017–18 provided habitat for native fish and opportunities for fish dispersal, migration and spawning. Young-of-year tupong and estuary perch were recorded more than 40 km upstream of the estuary in summer 2017–18. Strong migration of these fish species from the estuary corresponds with managed releases of water for the environment, which trigger migration and facilitate movement across habitats that are impassable at lower flows.

Allocations to the environment reached 81 percent in September 2017, based on water reserves from the wet 2016–17 season and good inflows into storages during early winter 2017. Conditions turned to dry during spring, with below-average rainfall and no inflow to storages between November 2017 and April 2018. As a result, there were no additional allocations to the environment after September 2017. Accumulated passing flows were used to meet environmental demands between late spring and mid-January 2018. Water allocated to the environmental entitlement was used to meet demand after that.

In November 2017, the first-ever release of water for the environment was delivered to reach 0 from Moora Moora Reservoir. The release aimed to improve understanding of water movement in the reach and how water can be delivered from the reservoir. Temporary gauges installed in reach 0 showed a significant rise of the river level following the release, but due to a significant rainfall event the full extent of the flow could not be measured accurately. Despite the measurement uncertainty, the trial release improved understanding of the potential for releases of water for the environment to support the important environmental values in reach 0 in the future.

Scope of environmental watering

Table 4.2.1 shows potential environmental watering actions and their environmental objectives

Table 4.2.1 Potential environmental watering actions and objectives for the Glenelg system

Potential environmental watering	Environmental objectives
Summer/autumn freshes targeting reach 1a (2 freshes of 60 ML/day for 2–3 days each in December–May)	• Maintain or increase the abundance and variety of waterbugs • Scour sand from pools to increase the quality and quantity of fish habitat • Maintain the condition of emergent vegetation on the lower banks • Flush pools to improve water quality and lower temperatures to improve habitat for Glenelg spiny crayfish, waterbugs and fish
Summer/autumn freshes targeting reaches 1b (2 freshes of 100 ML/day for 2–3 days each in December–May)	
Summer/autumn freshes targeting reach 2 (2 freshes of 150 ML/day for 2–3 days each in December–May)	
Summer/autumn low flows targeting reach 1a (10 ML/day or natural in December–May)[1]	• Protect against rapid water-quality decline over low-flow period • Maintain edge habitats, pools and shallow-water habitat for fish, waterbugs and platypus • Maintain a near-permanent inundated stream channel to prevent excessive in-stream terrestrial species growth and promote in-stream vegetation
Summer/autumn low flows targeting reach 1b (15 ML/day or natural in December–May)[1]	
Summer/autumn low flows targeting reach 2 (25 ML/day or natural in December–May)[1]	

Table 4.2.1 Potential environmental watering actions and their environmental objectives *continued*

Potential environmental watering	Environmental objectives
Winter/spring freshes targeting reach 1b (1–5 freshes of 250 ML/day for 1–5 days in June–November)[2]	• Wet benches to the improve condition of emergent vegetation and to maintain habitat diversity • Provide adequate depth for fish passage and cue fish movement • Support platypus habitat and breeding including triggers for burrow selection • Scour sand from pools to improve the quality of fish habitat • Maintain or increase vegetation diversity in the river and on channel benches
Winter/spring freshes targeting reach 2 (1–5 freshes of 300 ML/day for 1–5 days in June–November)	
Winter/spring low flows targeting reach 1a (60 ML/day or natural in June–November)[1, 3]	• Maintain water quality for fish, waterbugs and aquatic vegetation • Maintain shallow-water habitat for fish, waterbugs and platypus
Winter/spring low flows targeting reach 1b (100 ML or natural per day in June–November)[1, 3]	
Winter/spring low flows targeting reach 2 (160 ML/day or natural in June–November)[1, 3]	
Trial release to reach 0 (up to 50 ML/day over a 4 to 5 day period)	• Develop an operational understanding of our ability to deliver environmental flows to support values in this reach including the capacity of infrastructure, metering and safety considerations

1 *Cease-to-flow events occur naturally in the Glenelg system and may be actively managed with deliveries of water for the environment to reduce stress on environmental values. In the most-recent flows study, the recommendation is that cease-to-flow events should occur as infrequently as possible and not exceed the duration of events that might have occurred naturally. Cease-to-flow events ideally should be followed with a fresh event.*

2 *Winter/spring freshes in reach 1a are important to the health of the Glenelg River but due to operational constraints and potential flooding risks they can only be achieved through natural events.*

3 *Passing flows provided under the environmental entitlement generally provide winter/spring low flows. However, if passing flows are reduced, managed releases of water for the environment may be required to supplement them or to ensure appropriate rates of rise and fall and provide appropriate conditions in freshes.*

Scenario planning

Table 4.4.2 outlines the potential environmental watering and expected water use under a range of planning scenarios. While the actions are similar in each climatic scenario, the magnitude, duration and/or frequency differ between scenarios, so the volume required under each scenario also differs.

Under a drought or dry scenario, there may be periods of cease-to-flow in summer. Where possible, the duration of these cease-to-flow periods will be carefully managed and monitored to minimise adverse impacts. The priority is to protect water quality and refuge pools to ensure habitat is available for native fish and other animals (such as platypus and Glenelg spiny crayfish) in the warmer months when the risks are highest. Under a drought or dry scenario, low flows will be provided for some periods in reach 1b and reach 2, but they may not be delivered to reach 1a. Summer/autumn freshes will be used to maintain some pool habitats in reach 1a.

Under a wet climate scenario, the priority will be to increase the magnitude, frequency and duration of planned watering actions through summer and autumn and to deliver more of the recommended winter/spring flows. Natural river flows and passing flows are likely to help meet many of the environmental flow objectives in a wet year. Reserving water for carry over into the 2019–20 water year will be a priority under all scenarios.

Under dry to average climate scenarios, a second trial release to reach 0 from Moora Moora Reservoir is planned, to better understand the feasibility of delivering water for the environment to support environmental values in this reach. In wet seasonal conditions, no trial release is planned as natural catchment inflows could make data about the effects of environmental flows in reach 0 unreliable.

Table 4.4.2 Potential environmental watering for the Glenelg system under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected availability of water for the environment[1]	• 32,100 ML carryover • 14,196 ML allocation • 46,296 ML total	• 32,100 ML carryover • 23,525 ML allocation • 55,625 ML total	• 32,100 ML carryover • 32,854 ML allocation • 64,954 ML total	• 32,100 ML carryover • 40,560 ML allocation • 72,660 ML total
Expected river conditions	• Some passing, compensation and low unregulated flows, particularly in winter/spring	• Some passing, compensation and low unregulated flows, particularly in winter/spring	• Some passing, compensation and unregulated flows, particularly in winter/spring	• Passing flows and unregulated flows meet some watering requirements in winter/spring
Potential environmental watering – tier 1 (high priorities)	• Summer/autumn freshes reach 1b • Summer/autumn freshes reach 2 • Summer/autumn low flows reach 1b • Summer/autumn low flows reach 2 • Winter/spring freshes reach 1b • Winter/spring freshes reach 2 • Summer/autumn freshes reach 1a	• Summer/autumn freshes reach 1b • Summer/autumn freshes reach 2 • Summer/autumn low flows reach 1b • Summer/autumn low flows reach 2 • Winter/spring freshes reach 1b • Winter/spring freshes reach 2 • Summer/autumn freshes reach 1a	• Summer/autumn freshes reach 1b • Summer/autumn freshes reach 2 • Summer/autumn low flows reach 1a • Summer/autumn low flows reach 1b • Summer/autumn low flows reach 2 • Winter/spring freshes reach 1b • Winter/spring freshes reach 2 • Summer/autumn freshes reach 1a • Winter/spring low flows reach 1a • Trial release reach 0	• Summer/autumn low flows reach 1a • Summer/autumn low flows reach 2 • Summer/autumn freshes reach 1a • Summer/autumn freshes reach 1b • Summer/autumn freshes reach 2 • Summer/autumn low flows reach 1b • Winter/spring freshes 1b • Winter/spring low flows reach 1a
Potential environmental watering – tier 2 (additional priorities)	• Summer/autumn low flows reach 1a • Winter/spring low flows reach 1a • Winter/spring low flows reach 1b • Winter/spring low flows reach 2 • Trial release reach 0	• Summer/autumn low flows reach 1a • Winter/spring low flows reach 1a • Winter/spring low flows reach 1b • Winter/spring low flows reach 2 • Trial release reach 0	• Winter/spring low flows reach 1b • Winter/spring low flows reach 2	• Winter/spring low flows reach 1b • Winter/spring low flows reach 2 • Winter/spring freshes reach 2 • Trial release reach 0
Possible volume of water for the environment required to achieve objectives[2]	• 9,880 ML (tier 1) • 11,910 ML (tier 2)	• 12,280 ML (tier 1) • 10,370 ML (tier 2)	• 27,810 ML (tier 1) • 25,480 ML (tier 2)	• 27,010 ML (tier 1) • 20,930 ML (tier 2)

[1] *Water for the environment in the Wimmera–Glenelg system is shared between the Glenelg and Wimmera systems. The volumes specified show the likely availability of the VEWH environmental entitlement for both systems. A prioritisation process will be undertaken in consultation with the Wimmera and Glenelg Hopkins CMAs to determine the potential watering actions that will be undertaken in each system in the 2018–19 year.*

[2] *Water for the environment requirements for tier 2 actions are additional to tier 1 requirements.*

Risk management

Environmental watering program partners have considered and assessed risks and identified mitigating strategies relating to environmental flows in 2018–19. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

Engagement

Table 4.2.3 shows the partners, stakeholder organisations and individuals with which Glenelg Hopkins CMA engaged when preparing the Glenelg system seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional catchment strategies, regional waterway strategies, environmental flow studies, water management plans and other studies. These incorporate a range of environmental, cultural, social and economic perspectives and longer-term integrated catchment and waterway management objectives. For further details, refer to the *Glenelg Hopkins Regional Catchment Management Strategy* and *Glenelg Hopkins Waterway Strategy* for further details.

Table 4.2.3 Partners and stakeholders engaged in developing the Glenelg system seasonal watering proposal

Partner and stakeholder engagement
• Aboriginal groups (Gunditj Mirring Traditional Owner Corporation and Barengi Gadjin Land Council) • Community members and landholders • Department of Environment, Land, Water and Planning • Environment groups: Glenelg River User Group and Friends of the Glenelg River • Fisheries Victoria • Glenelg Hopkins CMA Advisory Group including representatives of stakeholder groups and landholders in the region • GWMWater • Local tourism and sand extraction businesses and community service organisations based in Balmoral, Coleraine, Winnap, Nelson and the western Grampians • Parks Victoria • Recreational groups: Balmoral Angling Club, Casterton Angling Society, Dartmoor Angling Club, VRFish, Fishcare Victoria, the South West Fishing Report, individual anglers • Victorian Environmental Water Holder • Wimmera CMA

4.3 Wimmera system

Waterway manager – Wimmera Catchment Management Authority

Storage manager – GWMWater

Environmental water holders – Victorian Environmental Water Holder and Commonwealth Environmental Water Holder

The Wimmera River rises in the Pyrenees Range near Elmhurst and flows through Horsham, Dimboola and Jeparit before terminating at Lake Hindmarsh, which is Victoria's largest freshwater lake and the first of a series of terminal lakes. The Wimmera receives flows from several regulated tributaries including the MacKenzie River and the Mount William and Burnt creeks. These tributaries, Bungalally Creek and the Wimmera River downstream of Mount William Creek can receive environmental water. In exceptionally wet periods, Lake Hindmarsh may overflow into Outlet Creek and on to Lake Albacutya, an internationally recognised Ramsar-listed wetland. There are several wetlands beyond Lake Albacutya as well.

The waterways in the Wimmera system hold significance for Traditional Owners and their Nations. The Registered Aboriginal Parties (RAPs) in the Wimmera River catchment are the Barengi Gadjin Land Council Aboriginal Corporation (BGLC) and Martang Pty Ltd. Representatives of the BGLC were engaged during the preparation of this section. A trial watering is proposed for the Ranch Billabong near Dimboola, on land managed by BGLC. The intent is to provide a more-natural flooding regime in the billabong system to restore native plant and animal habitats that have been disconnected by levies and changed watering regimes in the Wimmera River. Ranch Billabong is also very significant to the Traditional Owners and their Nations, and it was the home of many generations of Wotjobaluk peoples.

Environmental values

The Wimmera system is home to many plant and animal species. It supports populations of native fish including one of Victoria's few self-sustaining populations of freshwater catfish, as well as flat-headed gudgeon, carp gudgeon, river blackfish, southern pygmy perch and Australian smelt. It also has the critically endangered Wimmera bottlebrush.

The Wimmera River supports abundant native fish, waterbird, turtle, frog and native water rat populations and one of Victoria's few self-sustaining populations of freshwater catfish.

The MacKenzie River contains the only self-sustaining population of platypus in the Wimmera and supports populations of native fish, including river blackfish, waterbugs, threatened Glenelg spiny crayfish and turtles. During dry periods, the middle and upper reaches of the MacKenzie River maintain regular flow (due to managed releases from Lake Wartook) and provide refuge for these populations.

Vegetation along Burnt and Bungalally creeks provide habitat corridors for terrestrial and riparian wildlife and upper Burnt Creek contains an important native fish community and a population of threatened western swamp crayfish. Mount William Creek supports regionally important populations of river blackfish, southern pygmy perch and threatened western swamp crayfish.

Dock Lake is a natural wetland that was modified and used as part of the Wimmera-Mallee headworks system. When it is inundated, Dock Lake supports large populations of feeding and breeding waterbirds. It also supports frogs and small-bodied native fish. It is no longer used for water storage and is frequently dry.

Social and economic values

The Wimmera system offers many popular recreational activities including walking, boating, rowing, waterskiing, fishing and camping, and it provides important amenity for local communities. Events held on waterways throughout the Wimmera catchment include waterskiing at the annual Kanamaroo Festival in Horsham, the Horsham Triathlon, the Dimboola Rowing Regatta and the Horsham, Jeparit and Dimboola fishing competitions.

Environmental watering objectives in the Wimmera system

	Protect and increase populations of native fish, including one of Victoria's few self-sustaining populations of freshwater catfish
	Maintain and improve water quality to provide suitable conditions for waterbugs, native fish and other water-dependent plants and animals
	Maintain and increase the resident platypus population by providing places to rest, breed and feed, as well as opportunities for juveniles to disperse
	Improve the condition, abundance and diversity of aquatic, emergent and riparian vegetation
	Increase the abundance and diversity of waterbugs, which break down dead organic matter and support the waterway's food chain

System overview

Water in the Wimmera system is stored in three on-stream reservoirs — Lake Wartook on the MacKenzie River, Lake Lonsdale on Mount William Creek and Lake Bellfield on Fyans Creek — and in several off-stream storages — Taylors Lake, Lake Fyans and Toolondo Reservoir. A channel system enables water to be moved between several storages. Water can also be transferred from Rocklands Reservoir in the Glenelg system to the Wimmera system via the Rocklands–Toolondo Channel and from Moora Moora Reservoir via the Moora Channel. The connected storages and channels are collectively called the Wimmera-Mallee System Headworks, and harvested water is used for towns and stock and domestic supply throughout the Wimmera catchment and parts of the Avoca, Hopkins, Loddon, Glenelg and Mallee catchments. Passing flows are provided to the Wimmera River and to lower Mount William and Fyans creeks.

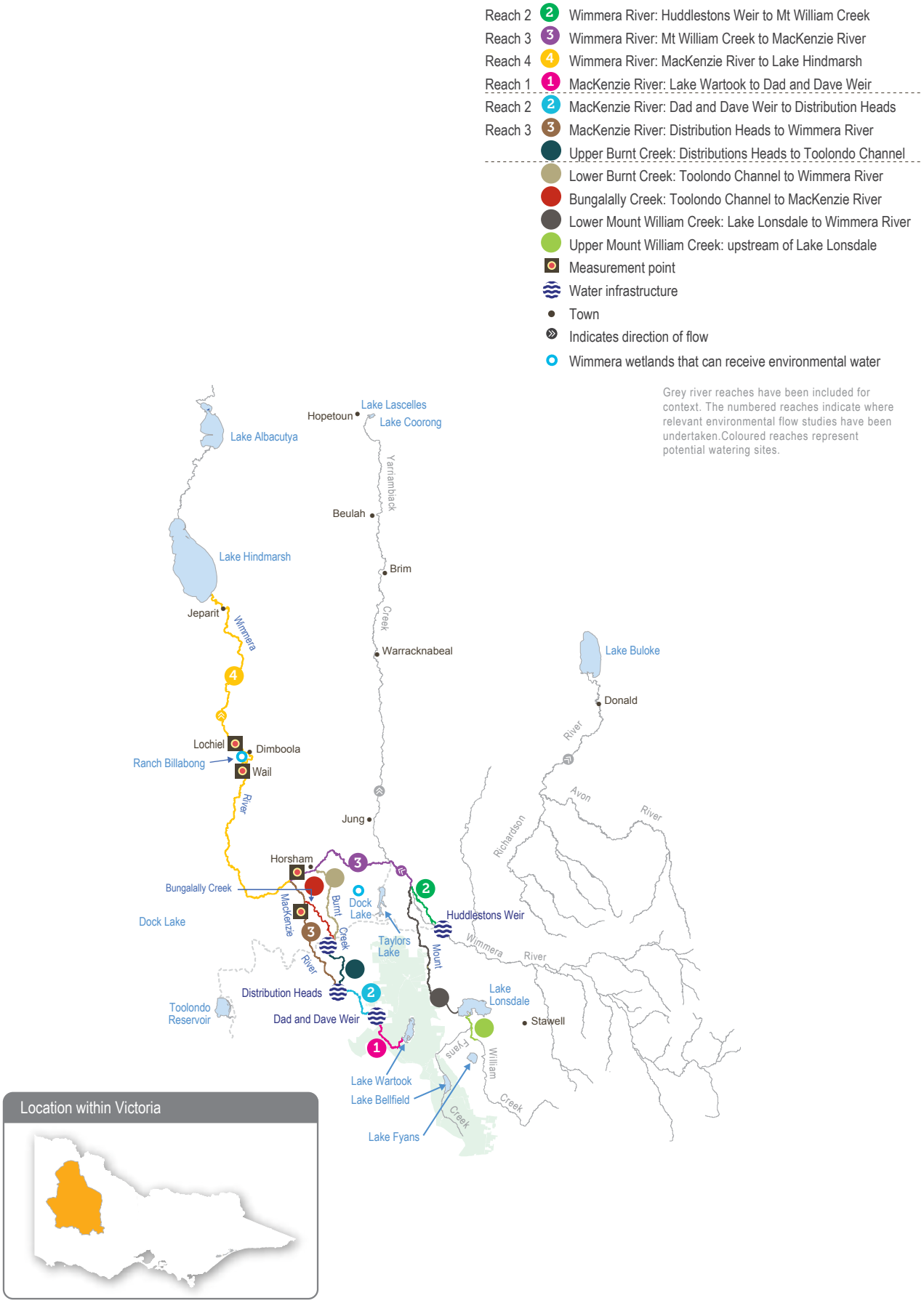
Priority reaches for environmental watering in the Wimmera system are Wimmera River reach 4, MacKenzie River reaches 2 and 3, upper and lower Mount William Creek, upper and lower Burnt Creek and Bungalally Creek.

Yarriambiack Creek is a distributary of the upper Wimmera River that would have naturally received some flows during high-flow events. Modifications to the Yarriambiack Creek offtake increase flow rates in Yarriambiack Creek, but potentially reduce the transfer of water for the environment to the high-priority reaches of the Wimmera River. In line with past practice during dry years, flows entering Yarriambiack Creek may be blocked to ensure watering objectives in the Wimmera River are not compromised.

Dock Lake, one of the Wimmera's large terminal lakes near Horsham, would have naturally filled when the nearby Green Lake filled and overflowed. Modifications in the 1930s changed the way water flowed into Dock Lake, when the wetland became to be used as a water storage for irrigation supply in the Wimmera-Mallee system. Dock Lake was removed from the supply system after 1999, and as such no water has been delivered to the wetland. 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.

Mount William Creek refuge pool, by John Tiddy

Figure 4.3.1 The Wimmera system



Recent conditions

Average rainfall during winter 2017 led to modest, unregulated flows in the Wimmera River's western tributaries, although rainfall in the eastern catchment was below average. During winter and spring, many of the environmental flow objectives in the Wimmera system were met naturally due to unregulated flows or through releases of water from Lake Wartook. Passing flows that were available at Lake Lonsdale were temporarily suspended and released later in the year to meet Wimmera River flow objectives.

Allocations to the environmental entitlement reached 81 percent in September 2017, based on water reserves set aside during the wet conditions during the 2016–17 season. Spring, summer and autumn 2017–18, had below-average rainfall and little-to-no inflow to storages; as a result, there were no additional allocations to the environment after September 2017. Accumulated passing flows were used to meet environmental demand between late spring and mid-January 2018. Water allocated to the environmental entitlement was used to meet demand after that.

The CEWH did not receive any allocation in 2017–18. The water that was allocated to the CEWH in 2016–17 was carried over to 2017–18 and used for the first time in the Wimmera system to support environmental outcomes in the Wimmera River and Mount William Creek.

The wet conditions in winter and spring 2017–18 and deliveries of water for the environment have improved the condition of the rivers and creeks in the Wimmera system.

Fish monitoring in the Wimmera River in March 2017 showed that populations of golden perch and freshwater catfish have been maintained along all reaches, and there is a healthy population of small-bodied native fish. Fish surveys in the MacKenzie River and Burnt Creek showed that southern pygmy perch successfully recruited in summer 2017–18. In autumn 2018, high abundances of young-of-year fish were found at many sites, which coincided with priority reaches that had received environmental flows. Other native fish identified include river blackfish, flat-headed gudgeon, Australian smelt, obscure galaxiids and carp gudgeon. The threatened western swamp crayfish was also found in MacKenzie River and Burnt Creek in 2017. Platypus surveys in MacKenzie River in both 2017 and 2018 also showed the platypus population is slowly increasing in abundance, with three young individuals caught for the first time.

Scope of environmental watering

Table 4.3.1 shows potential environmental watering actions and their environmental objectives.

Table 4.3.1 Potential environmental watering actions and objectives for the Wimmera system

Potential environmental watering	Environmental objectives
Wimmera River (reach 4)	
Summer/autumn low flows (15–30 ML/day or natural[1] in December–May)	• Maintain in-stream habitat to support native fish populations and waterbugs • Maintain near-permanent inundated stream channel for riparian vegetation and to prevent the growth of terrestrial plants in the stream bed
Winter/spring low flows (15–30 ML/day in June–November)	• Provide flow variability to maintain various habitat types
Summer/autumn freshes (1–3 freshes of 70 ML/day for 2–7 days in December–May)	• Flush pools to improve water quality and maintain habitat for fish and waterbugs • Provide fish passage to allow fish to move through the reach
Winter/spring freshes (1–5 freshes of 70 ML/day for 1–4 days in June–November)	• Stimulate fish movement and provide fish passage to allow fish to move through the reach • Maintain water quality to support fish populations
Winter/spring freshes (1–3 freshes of 200 ML/day for 1–3 days in June–November[2])	• Wet lower benches to entrain organic debris and promote habitat diversity
Winter/spring freshes (1–2 freshes of up to 1,300 ML/day for 2–3 days in June–November)	• Flush surface sediments from hard substrates to improve habitat quality and support waterbugs • Wet higher benches to entrain organic debris and promote habitat diversity • Maintain the quality, diversity and extent of submerged and emergent aquatic vegetation for fish habitat

Table 4.3.1 Potential environmental watering actions and objectives for the Wimmera system *continued*

Potential environmental watering	Environmental objectives
MacKenzie River (reach 2 and 3)	
Year-round low flows (of 2–27 ML/day or natural, year-round)[1]	• Maintain edge habitats and deeper pools and runs for waterbugs • Maintain near-permanent inundated stream channel for riparian vegetation and to prevent the growth of terrestrial plants including the Wimmera bottlebrush in the stream bed, and support growth of aquatic vegetation for fish habitat • Maintain sufficient area of pool habitat for native fish populations • Facilitate the annual dispersal of juvenile platypus into the Wimmera River
Summer/autumn freshes (3–4 freshes of 5–50 ML/day for 2–7 days each in December–May)	• Provide variable flows during the low-flow season for waterbugs, for fish movement and to maintain water quality and habitat diversity
Winter/spring freshes (5 freshes of 35–55 ML/day for 2–7 days in June–November)	• Stimulate fish movement and maintain water quality and habitat diversity
Winter/spring freshes (1–5 freshes of up to 130–190 ML/day for 1–4 days in June–November)	• Stimulate fish movement and maintain water quality • Flush sediments from hard substrates to support waterbugs • Wet higher benches to entrain organic debris and promote habitat diversity
Burnt Creek	
Year-round low flows targeting upper Burnt Creek (1 ML/day or natural, year-round)[1]	• Maintain edge habitats and shallow-water habitat for waterbugs • Maintain the inundated stream channel to protect riparian vegetation and prevent excessive streambed colonisation by terrestrial vegetation species • Maintain a sufficient area of pool habitat for native fish populations
Summer/autumn freshes targeting upper Burnt Creek (3 freshes of 30 ML/day for 2–7 days each in December–May)	• Prevent a decline in water quality by flushing pools during low flows
Winter/spring freshes targeting upper Burnt Creek (1–5 freshes of 55 ML/day for 3–7 days in June–November)	• Allow fish to move throughout the reach • Flush sediments from hard substrates to increase biofilm production and food for waterbugs
Winter/spring freshes targeting upper Burnt Creek (1–3 freshes of up to 160 ML/day for 1–3 days in June–November)	• Disturb biofilms present on rocks or woody debris to stimulate new growth and provide food for waterbugs
Year-round fresh targeting lower Burnt Creek (1 fresh of 45 ML/day or natural for 2 days at any time)	• Inundate riparian vegetation to maintain condition and facilitate recruitment • Move organic debris in the channel to support waterbugs • Maintain the structural integrity of the channel
Lower Burnt Creek bankfull (any time)[3]	• Inundate riparian vegetation to maintain its condition and to facilitate recruitment • Move organic debris in the channel to support waterbugs • Maintain the structural integrity of the channel

Table 4.3.1 Potential environmental watering actions and objectives for the Wimmera system *continued*

Potential environmental watering	Environmental objectives
Mount William Creek	
Top-up of upper Mount William Creek pools	• Maintain habitat for native fish and waterbugs
Year-round low flows targeting lower Mount William Creek (5 ML/day or natural, year-round) [1]	• Maintain edge habitats and shallow-water habitat for waterbugs and endemic fish • Maintain near-permanent inundated stream channel for riparian vegetation and to prevent the growth of terrestrial plants in the stream bed
Summer/autumn freshes targeting lower Mount William Creek (3 freshes of 20–30 ML/day for 2–7 days in December–May)	• Prevent a decline in water quality by flushing pools during low flows • Provide variable flows during the low-flow season for waterbugs, for fish movement and to maintain water quality and habitat diversity
Winter/spring freshes targeting lower Mount William Creek (1–5 freshes of up to 100 ML/day for 1–7 days in June–November)	• Wet benches, entrain organic debris and promote habitat diversity • Flush surface sediments from hard substrates to support waterbugs
Winter/spring freshes targeting lower Mount William Creek (1–3 freshes of up to 500 ML/day for 1–3 days in June–November)	• Wet the highest benches, entrain organic debris and promote habitat diversity
Bungalally Creek	
Bankfull (any time)[3]	• Inundate the riparian zone to maintain its condition and facilitate the recruitment of riparian vegetation communities • Maintain the structural integrity of the channel and prevent the loss of channel capacity
Dock Lake	
Partial fill (winter/spring)	• Maintain and improve the diversity and abundance of wetland vegetation • Support feeding and breeding habitat for waterbirds, frogs, waterbugs and turtles
The Ranch Billabong	
Fill (winter/spring/summer)	• Maintain and improve wetland vegetation diversity and abundance

[1] *Cease-to-flow events occur naturally in the Wimmera system and may be actively managed with deliveries of water for the environment to reduce stress on environmental values. In the most-recent flow study, the recommendation is that cease-to-flow events should occur as infrequently as possible and not exceed the duration of events that might have occurred naturally. Cease-to-flow events ideally should be followed with a fresh event.*

[2] *Depending on catchment conditions, the timing of this fresh may vary to optimise environmental outcomes.*

[3] *These actions will only occur if on-ground works have been completed to prevent third-party impacts potentially caused by bankfull events in these creeks.*

Scenario planning

Table 4.3.2 outlines the potential environmental watering and expected water use under a range of planning scenarios. While the type of actions is similar in each climate scenario, the magnitude, duration and frequency of specific watering actions may differ within and between each climate scenario. What may be a low-priority action in a dry climate scenario may become a high priority in a wet scenario when there is ample water — unregulated flows and/or allocation to the entitlement — to meet larger flow objectives, and vice versa. Therefore, the volume required differs under each climate scenario. For example, in Wimmera River reach 4, one summer/autumn fresh of 70 ML per day for 2–7 days is proposed under extreme drought and dry climate scenarios, but under a wet scenario the recommendation is to deliver three freshes. In upper Burnt Creek, summer/autumn low flows in the extreme drought and very dry scenarios allow for four periods of cease-to-flows, but in wet scenarios no cease-to-flows are to occur.

Under most scenarios, there will likely be periods of cease-to-flow in all the target environmental flow reaches. The priority is to protect water quality and refuge pools in rivers and creeks to ensure habitat is available for native fish and aquatic animals (such as platypus) during the warmer months, when the risks are highest.

Natural unregulated flows and increased allocations of water for the environment will allow more environmental water objectives to be met under an average or wet climate scenario. The priority under these scenarios will be to increase the magnitude, frequency and duration of planned watering actions throughout summer and autumn and to deliver recommended flows in winter/spring. Natural river flows and passing flows are also likely to contribute to achieving these objectives.

In lower Burnt Creek and Bungalally Creek, a bankfull flow is planned in average and wet seasonal conditions to maintain channel structure, support aquatic plants and animals and freshen deeper pool habitats. Water for the environment will be used to fill the pools in these creeks before larger releases.

A partial fill of Dock Lake is planned in average or wet seasonal conditions, to build on the outcomes from water diverted to Dock Lake by GWMWater during the 2016–17 floods. This would be the first time water for the environment would be delivered to Dock Lake. It is likely that water for the environment would be delivered when the adjoining Green Lake had filled, to manage system losses and maximise delivery rates to Dock Lake.

Under dry, average and wet climate scenarios, water for the environment may be delivered to the Ranch Billabong near Dimboola to support wetland and riparian vegetation. This would be the first time that water for the environment would have been delivered to Ranch Billabong, which has been isolated from Wimmera River flows by levee banks.

Reserving water to carry over into the 2019–20 water year will be a priority under all scenarios.

Bungalally Creek, by Chloe Wiesenfeld

Table 4.3.2 Potential environmental watering for the Wimmera system under a range of planning scenarios

Planning scenario	Extreme drought	Very dry	Dry	Average	Wet
Expected river conditions	• No passing flows or unregulated flows	• Some passing flows but no unregulated flows	• Some passing flows but no unregulated flows	• Passing and unregulated flows particularly in winter/spring	• Passing flows and unregulated flows
Expected availability of water for the environment entitlements [1,2]	• 34,100 ML VEWH carryover • 7,200 ML CEWH carryover • 8,112 ML VEWH • 0 ML CEWH • 50,412 ML total	• 34,100 ML VEWH carryover • 7,200 ML CEWH carryover • 14,196 ML VEWH • 0 ML CEWH • 55,496 ML total	• 34,100 ML VEWH carryover • 7,200 ML CEWH carryover • 23,525 ML VEWH • 0 ML CEWH • 64,825 ML total	• 34,100 ML VEWH carryover • 7,200 ML CEWH carryover • 32,854 ML VEWH • 0 ML CEWH • 74,154 ML total	• 34,100 ML VEWH carryover • 7,200 ML CEWH carryover • 40,560 ML VEWH • 0 ML CEWH • 81,860 ML total
Potential environmental watering – tier 1 (high priorities)[3]					
MacKenzie River reaches 2 & 3	• Summer/ autumn low flows • Summer/ autumn freshes (3 events) • Winter/spring low flows • Winter/spring freshes (5 events)	• Summer/ autumn low flows • Summer/ autumn freshes (3 events) • Winter/spring low flows • Winter/spring freshes (5 events)	• Summer/ autumn low flows • Summer/ autumn freshes (3 events) • Winter/spring low flows • Winter/spring freshes (5 events)	• Summer/ autumn low flows • Summer/ autumn freshes (3 events) • Winter/spring low flows • Winter/spring freshes (5 events)	• Summer/ autumn low flows • Summer/ autumn freshes (3 events) • Winter/spring low flows • Winter/spring freshes (5 events)
Wimmera River reach 4	• Summer/ autumn low flows • Summer/ autumn freshes (1 event) • Winter/spring low flows • Winter/spring freshes (1 event)	• Summer/ autumn low flows • Summer/ autumn freshes (1 event) • Winter/spring low flows • Winter/spring freshes (1 event)	• Summer/ autumn low flows • Summer/ autumn freshes (2 events) • Winter/spring low flows • Winter/spring freshes (3 events)	• Summer/ autumn low flows • Summer/ autumn freshes (2 events) • Winter/spring low flows • Winter/spring freshes (5 events)	• Summer/ autumn low flows • Summer/ autumn freshes (3 events) • Winter/spring low flows • Winter/spring freshes (5 events)

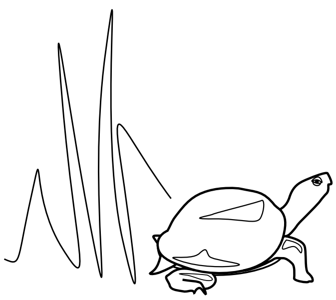


Table 4.3.2 Potential environmental watering for the Wimmera system under a range of planning scenarios *continued*

Planning scenario	Extreme drought	Very dry	Dry	Average	Wet
Upper Burnt Creek	• Summer/ autumn low flows • Summer/ autumn freshes (3 events) • Winter/spring low flows • Winter/spring freshes (1 event)	• Summer/ autumn low flows • Summer/ autumn freshes (3 events) • Winter/spring low flows • Winter/spring freshes (1 event)	• Summer/ autumn low flows • Summer/ autumn freshes (3 events) • Winter/spring low flows • Winter/spring freshes (3 events)	• Summer/ autumn low flows • Summer/ autumn freshes (3 events) • Winter/spring low flows • Winter/spring freshes (5 events)	• Summer/ autumn low flows • Summer/ autumn freshes (3 events) • Winter/spring low flows • Winter/spring freshes (5 events)
Upper Mt William Creek	• Top-ups	• Top-ups	• Top-ups	• N/A	• N/A
Lower Mt William Creek	• Summer/ autumn low flows • Summer/ autumn freshes (3 events) • Winter/spring low flows • Winter/spring freshes (1 event)	• Summer/ autumn low flows • Summer/ autumn freshes (3 events) • Winter/spring low flows • Winter/spring freshes (1 event)	• Summer/ autumn low flows • Summer/ autumn freshes (3 events) • Winter/spring low flows • Winter/spring freshes (3 events)	• Summer/ autumn low flows • Summer/ autumn freshes (3 events) • Winter/spring low flows • Winter/spring freshes (5 events)	• Summer/ autumn low flows • Summer/ autumn freshes (3 events) • Winter/spring low flows • Winter/spring freshes (5 events)
Lower Burnt Creek	• N/A	• N/A	• N/A	• Bankfull	• Bankfull
Bungalally Creek	• N/A	• N/A	• N/A	• Bankfull	• Bankfull
Dock Lake	• N/A	• N/A	• N/A	• Partial fill	• Partial fill
Ranch Billabong	• N/A	• N/A	• Fill	• Fill	• Fill
Potential environmental watering – tier 2 (additional priorities)					
MacKenzie River reaches 2 & 3	• N/A	• Increased duration summer/ autumn low flows • Increased duration summer/ autumn freshes • Additional winter/spring low flows	• Increased duration summer/ autumn low flows • Increased duration summer/ autumn freshes • Increased duration winter/spring low flows	• Increased duration summer/ autumn low flows • Increased duration summer/ autumn freshes • Increased duration winter/spring low flows	• Increased duration summer/ autumn freshes • Increased duration winter/spring low flows

Table 4.3.2 Potential environmental watering for the Wimmera system under a range of planning scenarios *continued*

Planning scenario	Extreme drought	Very dry	Dry	Average	Wet
Wimmera River reach 4	• N/A	• Increased duration summer/ autumn low flows • Increased duration summer/ autumn freshes • Increased duration winter/spring low flows • Increased duration winter/spring freshes • winter/spring low flows (reach 3)	• Increased duration summer/ autumn low flows • Increased duration summer/ autumn freshes • Increased duration winter/spring low flows • Increased duration winter/spring freshes • Winter/spring low flows (reach 3)	• Increased duration summer/ autumn low flows • Increased duration summer/ autumn freshes • Winter/spring low flows (reach 3)	• Increased duration summer/ autumn freshes • Winter/spring low flows (reach 3)
Upper Burnt Creek	• N/A	• Increased duration summer/ autumn low flows • Increased duration summer/ autumn freshes	• Increased duration summer/ autumn low flows • Increased duration summer/ autumn freshes	• Increased duration summer/ autumn low flows • Increased duration summer/ autumn freshes	• Increased duration summer/ autumn freshes
Lower Mount William Creek	• N/A	• Increased duration summer/ autumn low flows • Increased duration summer/ autumn freshes	• Increased duration summer/ autumn low flows • Increased duration summer/ autumn freshes	• Increased duration summer/ autumn low flows • Increased duration summer/ autumn freshes	• Increased duration summer/ autumn freshes
Possible volume of water for the environment required to achieve objectives[4]	• 24,295 ML (tier 1)	• 24,450 ML (tier 1) • 23,810 ML (tier 2)	• 25,675 ML (tier 1) • 23,395 ML (tier 2)	• 27,970 ML (tier 1) • 26,775 ML (tier 2)	• 29,435 ML (tier 1) • 28,705 ML (tier 2)

[1] *Water for the environment in the Wimmera–Glenelg system held by the VEWH is shared between the Glenelg and Wimmera systems. The VEWH volumes specified show the likely availability of the VEWH's environmental entitlement for both systems.*

[2] *Water for the environment held by the Commonwealth Environmental Water Holder is only available for use in the Wimmera system.*

[3] *A prioritisation process will be undertaken in consultation with the Wimmera and Glenelg Hopkins CMAs to determine the potential watering actions that will be undertaken in each system in the 2018–19 year, taking into consideration both VEWH and CEWH environmental entitlements.*

[4] *Water for the environment requirements for tier 2 actions are additional to tier 1 requirements.*

Risk management

Environmental watering program partners have considered and assessed risks and identified mitigating strategies relating to environmental flows in 2018–19. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

Engagement

Table 4.3.3 shows the partners and stakeholder organisations with which Wimmera CMA engaged when preparing the Wimmera system seasonal watering proposal. Other stakeholders and individuals are consulted throughout the year to help the Wimmera CMA implement the seasonal watering plan.

Seasonal watering proposals are informed by longer-term regional catchment strategies, regional waterway strategies, environmental flow studies, water management plans and other studies. These incorporate a range of environmental, cultural, social and economic perspectives and longer-term integrated catchment and waterway management objectives. For further details, refer to the *Wimmera Regional Catchment Strategy* and the *Wimmera Waterway Strategy*.

Wimmera CMA holds its annual Environmental Water Management Forum, where community groups and agencies with an interest in water for the environment in the region provide feedback about the effectiveness of environmental watering, drought actions and other issues.

Table 4.3.3 Partners and stakeholders engaged in developing the Wimmera system seasonal watering proposal

Partner and stakeholder engagement
• Barengi Gadjin Land Council Aboriginal Corporation
• Commonwealth Environmental Water Holder
• Dimboola and Jeparit town committees
• Dimboola Fishing Classic, Wimmera Anglers' Association, Jeparit Anglers' Club, Native Fish Australia (Wimmera), Murtoa Angling Club, Dimboola Anglers' Club, Warracknabeal Angling Club, Mid-Northern Association of Angling Clubs and Horsham Fishing Competition Committee
• Dimboola Rowing Club, Horsham Triathlon Committee
• Friends of Bungalally Creek, Friends of Burnt Creek, Lake Lonsdale Action Group
• Glenelg Hopkins CMA
• GWMWater
• Hindmarsh Shire Council, Horsham Rural City Council, Northern Grampians Shire Council and Yarriambiack Shire Council
• Natimuk Field and Game
• Natimuk Lake Water Ski Club, Dimboola Water Ski Club, Hindmarsh Ski Club
• Parks Victoria
• Victorian Environmental Water Holder
• VRFish
• Victorian Fisheries Authority

Sunrise over the Wimmera River at Horsham, by David Fletcher

4.4 Wimmera-Mallee wetlands

Waterway managers – Mallee, North Central and Wimmera catchment management authorities

Storage manager – GWMWater

Environmental water holder – Victorian Environmental Water Holder

The Wimmera-Mallee wetlands include 51 wetlands on public and private land spread across north-west Victoria.

The Wimmera-Mallee wetlands continue to hold significance for the Traditional Owners and their Nations. The Registered Aboriginal Parties (RAPs) in the region are the Barengi Gadjin Land Council Aboriginal Corporation and Dja Dja Wurrung Clans Aboriginal Corporation. Representatives of the RAPs were engaged during the preparation of the Wimmera-Mallee wetlands seasonal watering proposal.

Environmental values

There are a wide range of wetland types in the Wimmera-Mallee wetlands system including freshwater meadows, open freshwater lakes and freshwater marshes. This diversity is important to provide a range of different wetland habitats for plants and animals in the western part of the state. The wetlands also vary in size, consist of many different vegetation communities and are home to native waterbird populations including brolgas, egrets, blue-billed ducks, freckled ducks, Australian painted snipes and glossy ibis. The wetlands are used by the vulnerable growling grass frog, turtles and many other native animals that rely on them as drought refuges and drinking holes. Rare and vulnerable vegetation species (such as spiny lignum, ridged water milfoil and cane grass) are also present in some wetlands.

Social and economic values

The Wimmera-Mallee wetlands are highly valued by the community and provide places for recreational activities including canoeing, camping, yabbying, duck and quail hunting and birdwatching.

Environmental watering objectives in the Wimmera-Mallee wetlands

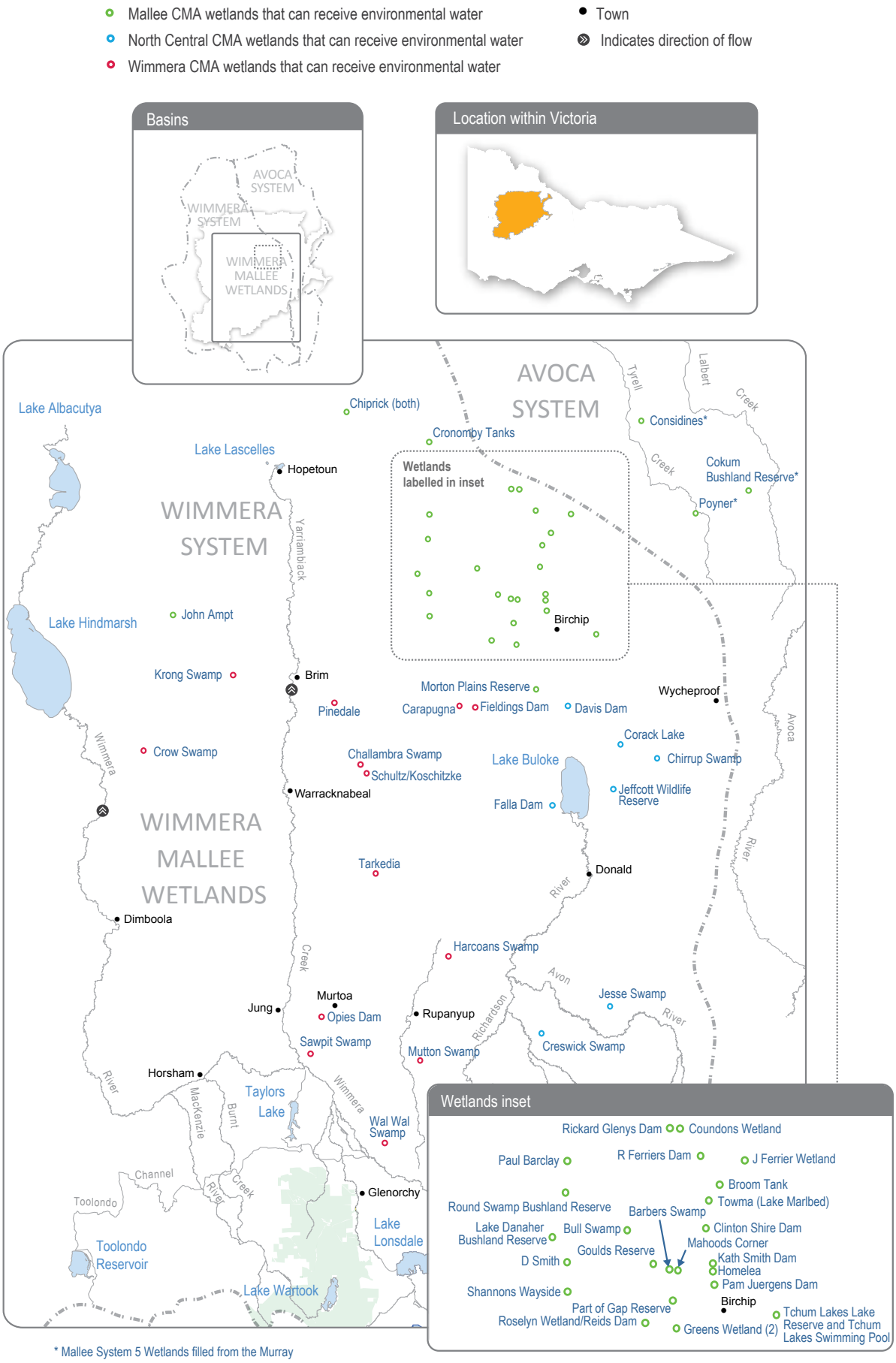
	Maintain and improve plant life in and around the wetlands including fringing lignum, river red gum and black box communities
 	Provide habitat and food to maintain frogs and turtles
	Provide resting, feeding and breeding habitat for waterbirds and other native birds

System overview

Historically, the wetlands received water most years from the open channels associated with the Wimmera Stock and Domestic Supply System. The Wimmera-Mallee Pipeline Project (WMPP) replaced stock and domestic supply dams with tanks, and the open-channel distribution system with pipelines, to improve water efficiency. The WMPP saved a lot of water, which was partly converted to an environmental entitlement to improve the condition of the area's flow-stressed rivers, creeks and wetlands and partly used to create regional development opportunities. The WMPP also reduced the amount of open-water habitat in areas that were formerly supplied by the open-channel system, so a separate 1,000 ML environmental entitlement was created to water a selection of wetlands that were previously supplied through the channel system. In 2011, a project identified priority wetlands for receiving water from the new environmental entitlement, and 51 wetlands have been connected to the Wimmera-Mallee pipeline system to receive that water.

Delivery of water for the environment to the wetlands relies on there being sufficient capacity in the Wimmera-Mallee pipeline system, so supply to the wetlands can be affected by demand from other pipeline customers. The North Central, Mallee and Wimmera CMAs work closely with GWMWater and land managers (including Parks Victoria, the Department of Environment, Land, Water and Planning and private landowners) to take account of pipeline capacity constraints when managing environmental deliveries to wetlands.

Figure 4.4.1 The Wimmera-Mallee wetlands



Recent conditions

The Wimmera-Mallee received near-average rainfall in winter/spring 2017–18 and some of the wetlands filled naturally. The allocation to the wetland environmental entitlement increased to 25 percent in October 2017, but dry conditions through summer and autumn prevented further allocations for the year.

Water for the environment was delivered to 46 Wimmera-Mallee wetlands in 2017–18: 27 wetlands in the Mallee area, seven in the north-central area and 12 in the Wimmera area. Deliveries were made in winter/spring 2017 and autumn/winter 2018 to maintain and improve ecological outcomes from natural or managed flows in previous years. Some wetlands received water once during 2017–18, while others received multiple deliveries to maintain their water-dependent values.

Water for the environment delivered to the Wimmera-Mallee wetlands maintained and improved the health of native plants and provided feeding and breeding habitat for many animals (such as lace monitors, kangaroos, wallabies, turtles, carpet pythons, egrets, herons, ducks, grebes, stilts and other water and woodland birds, frogs, yabbies and eastern long-necked turtles). Aquatic and fringing plant communities in wetlands that received water (naturally or through managed deliveries) in 2017–18 have responded well, with flushes of new growth including of nardoo, water milfoil, water ribbons, black box, lignum and cane grass.

Water for the environment was delivered to the Tchum Lakes wetland for the first time in 2017–18. The autumn delivery caused thousands of waterbirds to flock to the wetland and many frogs used the wetland for feeding and breeding.

Scope of environmental watering

Table 4.4.1 shows potential environmental watering actions and their environmental objectives. Watering actions for the Wimmera-Mallee wetlands will typically be in winter/spring 2018 or autumn/winter 2019, but they may occur at any time of the year depending on environmental need, seasonal conditions and pipeline capacity.

Table 4.4.1 Potential environmental watering actions and objectives for the Wimmera-Mallee wetlands

Potential environmental watering	Environmental objectives
North Central wetlands	
Davis Dam	• Maintain black box and cane grass vegetation • Provide drought refuge and a watering point for waterbirds and terrestrial animals
Creswick Swamp	• Maintain and improve the range of native aquatic plants including reestablish threatened marbled marshwort • Provide refuge, feeding and breeding opportunities for frogs and turtles
Chirrup Dam	• Provide drought refuge and a watering point for animals (particularly frogs, birds and turtles) • Facilitate the recolonisation of Chirrup Swamp with frogs and turtles, when it is naturally inundated
Corack Lake	• Maintain and improve native aquatic plants • Provide refuge and nursery habitat for turtles and frogs • Provide a variety of feeding habitats for waterbirds
Falla Dam	• Maintain it as a drought refuge and a watering point for terrestrial species • Provide feeding and breeding habitat for turtles and frogs
Jeffcott Wildlife Reserve	• Maintain a range of native aquatic plants • Provide drought refuge, feeding and breeding habitats for frogs, waterbugs, turtles and waterbirds
Jesse Swamp	• Maintain and improve the range of native aquatic plants including reestablish threatened marbled marshwort • Provide feeding habitat for frogs and waterbirds, including brolga

Table 4.4.1 Potential environmental watering actions and objectives for the Wimmera-Mallee wetlands *continued*

Potential environmental watering	Environmental objectives
Wimmera wetlands	
Carapugna	• Provide feeding and breeding habitat for waterbirds, woodland birds and frogs • Maintain and improve the number and health of wetland plants including ridged water milfoil • Maintain the health of black box and spiny lignum
Challambra Swamp	
Crow Swamp	
Fieldings Dam	
Harcoans Swamp	
Krong Swamp	
Mutton Swamp	
Opies Dam	
Pinedale	
Sawpit Swamp	
Schultz/Koschitzke	
Tarkedia	
Wal Wal Swamp	
Mallee wetlands	
Barbers Swamp	• Maintain the health of lignum and black box communities • Provide suitable feeding and breeding habitat for waterbirds
Bull Swamp	
Cokum Bushland Reserve	
Morton Plains Reserve	
Tchum Lakes Lake Reserve (North Lake – Wetland)	
Tchum Lakes Swimming Pool (North Lake – Dam)	
Broom Tank	• Maintain the health of lignum and black box communities • Provide drought refuge and a watering point for animals including woodland birds, wallabies and reptiles
Clinton Shire Dam	
Considines	
Greens Wetland	
Pam Juergens Dam	
Poyner	
Roselyn Wetland	
Goulds Reserve	• Maintain the health of lignum and black box communities
Newer Swamp	
Part of Gap Reserve	
Towma (Lake Marlbed)	

Table 4.4.1 Potential environmental watering actions and objectives for the Wimmera-Mallee wetlands *continued*

Potential environmental watering	Environmental objectives
Mallee wetlands	
Coundons Wetland J Ferrier Wetland	• Maintain the health of lignum and black box communities • Provide drought refuge and a watering point for animals including woodland birds, wallabies and reptiles • Provide foraging, refuge and breeding habitat for turtles and frogs
Mahoods Corner Shannons Wayside	• Provide feeding and breeding habitat for waterbirds
Chiprick D Smith Wetland Homelea Wetland John Ampt Kath Smith Dam Paul Barclay R Ferriers Dam Rickard Glenys Dam	• Provide drought refuge and a watering point for animals including woodland birds, wallabies and reptiles
Cronomby Tanks Lake Danaher Bushland Reserve	• Maintain the health of wetland plants including lignum and black box • Provide refuge, feeding and breeding habitat for turtles and frogs

Scenario planning

Table 4.4.2 outlines the potential environmental watering and expected water use under a range of planning scenarios.

The wetlands considered for potential environmental watering in 2018–19 have been determined after assessing their water requirements and recent watering history, and considering climatic conditions, water availability and the expected capacity in the Wimmera-Mallee pipeline system.

Under drought conditions, small volumes of water may be delivered to wetlands to provide drought refuge for wetland plants and animals including waterbirds, turtles and frogs. Under average and wet climate scenarios, more water may become available through allocations to the environmental entitlement, and lower demand from stock and domestic customers may free up delivery capacity in the pipeline system. Natural inflows may partially or fully fill some wetlands, and increased water availability may be used to top-up, fill or over-top wetlands to improve wetland plant growth and provide additional habitat for waterbirds, frogs and turtles.

Allocations to the environmental entitlement to supply wetlands in the Wimmera-Mallee wetland system is highly variable, and the ability to carry over unused water from one year to other years allows waterway managers to effectively manage the systems in dry periods. The North Central, Mallee and Wimmera CMAs have determined that at least 145–152 ML should be carried over at the end of 2018–19 to support critical environmental demands in 2019–20.

Table 4.4.2 Potential environmental watering for the Wimmera-Mallee wetlands under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected catchment 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	• 1,000 ML carryover • 0 ML allocation • 1,000 ML available	• 1,000 ML carryover • 0 ML allocation • 1,000 ML available	• 1,000 ML carryover • 250 ML allocation • 1,250 ML available	• 1,000 ML carryover • 1,000 ML allocation • 2,000 ML available
Potential environmental watering	• Barbers Swamp • Bull Swamp • Carapugna • Challambra Swamp • Chiprick • Chirrup Swamp • Clinton Shire Dam • Cokum Bushland Reserve[1] • Considines[1] • Corack Lake • Creswick Swamp • Cronomby Tanks • Crow Swamp • D Smith Wetland • Fieldings Dam • Greens Wetland • Harcoans • J Ferrier Wetland • Jeffcott Wildlife Reserve • Jesse Swamp • John Ampt • Krong Swamp • Lake Danaher Bushland Reserve • Mahoods Corner • Morton Plains Reserve • Mutton Swamp • Newer Swamp • Opies Dam • Paul Barclay • Pinedale	• Barbers Swamp • Broom Tank • Bull Swamp • Carapugna • Challambra Swamp • Chiprick • Chirrup Swamp • Clinton Shire Dam • Cokum Bushland Reserve[1] • Considines[1] • Corack Lake • Creswick Swamp • Cronomby Tanks • Crow Swamp • D Smith Wetland • Davis Dam • Falla Dam • Fieldings Dam • Greens Wetland • Harcoans • J Ferrier Wetland • Jeffcott Wildlife Reserve • Jesse Swamp • John Ampt • Krong Swamp • Lake Danaher Bushland Reserve • Mahoods Corner • Morton Plains Reserve • Mutton Swamp • Newer Swamp	• Barbers Swamp • Broom Tank • Bull Swamp • Carapugna • Challambra Swamp • Chiprick • Chirrup Swamp • Clinton Shire Dam • Cokum Bushland Reserve[1] • Considines[1] • Corack Lake • Coundons wetland • Creswick Swamp • Cronomby Tanks • Crow Swamp • D Smith Wetland • Davis Dam • Falla Dam • Fieldings Dam • Goulds Reserve • Greens Wetland • Harcoans • J Ferrier Wetland • Jeffcott Wildlife Reserve • Jesse Swamp • John Ampt • Krong Swamp • Lake Danaher Bushland Reserve • Mahoods Corner • Morton Plains Reserve	• Barbers Swamp • Broom Tank • Bull Swamp • Carapugna • Challambra Swamp • Chirrup Swamp • Chiprick • Clinton Shire Dam • Cokum Bushland Reserve[1] • Considines[1] • Corack Lake • Coundons wetland • Creswick Swamp • Cronomby Tanks • Crow Swamp • D Smith Wetland • Davis Dam • Falla Dam • Fieldings Dam • Goulds Reserve • Greens Wetland • Harcoans • Homelea • J Ferrier Wetland • Jeffcott Wildlife Reserve • Jesse Swamp • John Ampt • Kath Smith Dam • Krong Swamp • Lake Danaher Bushland Reserve

Table 4.4.2 Potential environmental watering for the Wimmera-Mallee wetlands under a range of planning scenarios *continued*

Planning scenario	Drought	Dry	Average	Wet
Potential environmental watering	• Poyner1 • R Ferriers Dam • Rickard Glenys Dam • Roselyn Wetland/ Reids Dam • Sawpit Swamp • Schultz/ Koschitzke • Shannons Wayside • Tarkedia Dam • Towma (Lake Marlbed) • Wal Wal Swamp	• Opies Dam • Pam Juergens Dam • Part of Gap Reserve • Paul Barclay • Pinedale • Poyner1 • R Ferriers Dam • Rickard Glenys Dam • Roselyn Wetland/ Reids Dam • Sawpit Swamp • Schultz/Koschitzke • Shannons Wayside • Tarkedia Dam • Tchum Lakes Swimming Pool (North Lake - Dam) • Towma (Lake Marlbed) • Wal Wal Swamp	• Mutton Swamp • Newer Swamp • Opies Dam • Pam Juergens Dam • Part of Gap Reserve • Paul Barclay • Pinedale • Poyner1 • R Ferriers Dam • Rickard Glenys Dam • Roselyn Wetland/ Reids Dam • Sawpit Swamp • Schultz/Koschitzke • Shannons Wayside • Tarkedia Dam • Tchum Lakes Lake Reserve (North Lake - Wetland) • Tchum Lakes Swimming Pool (North Lake - Dam) • Towma (Lake Marlbed) • Wal Wal Swamp	• Mahoods Corner • Morton Plains Reserve • Mutton Swamp • Opies Dam • Pam Juergens Dam • Part of Gap Reserve • Paul Barclay • Pinedale • Poyner1 • R Ferriers Dam • Rickard Glenys Dam • Roselyn Wetland/ Reids Dam • Newer Swamp • Sawpit Swamp • Schultz/Koschitzke • Shannons Wayside • Tarkedia Dam • Tchum Lakes Lake Reserve (North Lake - Wetland) • Tchum Lakes Swimming Pool (North Lake - Dam) • Towma (Lake Marlbed) • Wal Wal Swamp
Possible volume of water for the environment required to achieve objectives	• 250ML	• 309 ML	• 643 ML	• 794 ML
Priority carryover requirements	• 145 ML	• 152 ML	• 152 ML	• 152 ML

[1] *Water supplied to these wetlands in supply system 5 is made available from GWMWater allocations.*

Risk management

Environmental watering program partners have considered and assessed risks and identified mitigating strategies relating to environmental flows in 2018–19. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

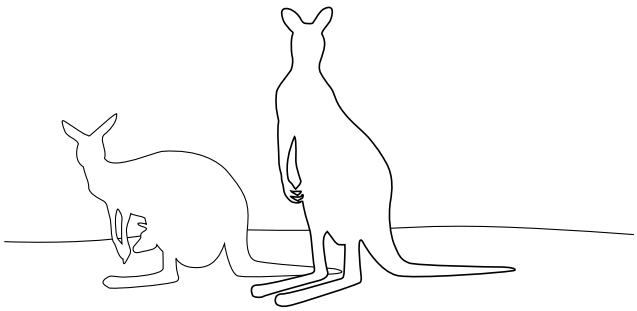
Engagement

Table 4.4.3 shows the partners, stakeholder organisations and individuals with which the Wimmera, Mallee and North Central CMAs engaged when preparing the Wimmera-Mallee wetlands seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional catchment management strategies, regional waterway strategies, environmental water management plans and other studies, which incorporate environmental, cultural, social and economic considerations. For further details, refer to the Wimmera, North Central and Mallee regional catchment strategies and waterway strategies.

Table 4.4.3 Partners and stakeholders engaged in developing the Wimmera-Mallee wetlands seasonal watering proposal

Partner and stakeholder engagement
All CMAs • Barengi Gadjin Land Council Aboriginal Corporation • GWMWater • Parks Victoria • Victorian Environmental Water Holder
Mallee CMA • Buloke Shire Council • Department of Environment, Land, Water and Planning • Landcare groups • Landholders with wetlands on their properties in the Mallee area • North Central and Wimmera CMAs • Wimmera Bushwalking Club • Yarriambiack Shire Council
North Central CMA • Department of Environment, Land, Water and Planning • Dja Dja Wurrung Clans Aboriginal Corporation • Landcare groups • Landholders with wetlands on their properties in the North Central CMA area • Mallee and Wimmera CMAs • Wimmera-Mallee Wetlands Environmental Water Advisory Group comprising community members, interest groups, a North Central CMA Community Consultative Committee representative, a North Central CMA Board member, the Department of Environment, Land, Water and Planning, Parks Victoria and the Victorian Environmental Water Holder
Wimmera CMA • Field and game representatives • Landholders with wetlands on their properties in the Wimmera CMA area • North Central and Mallee CMAs



Ibis roosting at Hird Swamp, by Zarleen Blakeley

Section 5

Northern Region

5.1 Northern Region overview

The Northern Region has six river systems, four major floodplain sites and many wetlands that can receive environmental water. The Broken, Campaspe, Goulburn, Loddon and Ovens river systems are tributaries of the River Murray. The five major floodplain sites along the River Murray corridor are Barmah Forest, Gunbower Forest, Hattah Lakes and Lindsay, Wallpolla and Mulcra islands. The other wetlands are distributed across the Broken, Goulburn, Loddon and Murray floodplains.

The water systems of the Northern Region are often connected through infrastructure (such as Goulburn Weir and the Waranga Western Channel), which allows water to be physically delivered from the Goulburn River to the Loddon and Campaspe systems. Water trading also enables transfers of allocation between systems. Within the limitations of each mechanism, water for the environment can be moved between systems for delivery to environmental sites across northern Victoria, although most water for the environment is usually used to provide benefits in the systems in which the water is held.

Northern Victoria and the southern Murray–Darling Basin

Rivers, creeks and floodplains in northern Victoria form part of the southern-connected Murray–Darling Basin. Water flows directly from the Victorian rivers and floodplains into the River Murray, which means that environmental flows delivered in northern Victorian systems can achieve ecological objectives at multiple sites throughout the Murray–Darling Basin. For example, water for the environment delivered in the Goulburn River flows into the River Murray and can be shepherded all the way to the Lower Lakes and Coorong in South Australia, providing environmental outcomes at Gunbower Forest, Hattah Lakes, Lindsay Island and the Chowilla floodplain along the way.

The *Basin Plan 2012* and the 2014 *Basin-wide environmental watering strategy* guide the planning and delivery of water for the environment in the Murray–Darling Basin. Under the Basin Plan, environmental objectives are met by achieving outcomes for connectivity, native vegetation, waterbirds and native fish.

Objectives and outcomes under the Basin Plan reflect local site- and state-based objectives, though these are often broader in scope and cover additional values (such as frogs, turtle, waterbugs and physical processes like sediment movement). There are also significant benefits for many species that rely on the surrounding landscape (such as squirrel gliders living along the lower Campaspe River or flocks of regent parrots moving into the Hattah Lakes floodplain after watering).

The VEWH coordinates its activities with other environmental water holders in northern Victoria, NSW and SA to achieve environmental outcomes at the southern-connected Murray–Darling Basin scale. Collaborative planning focuses on how upstream and downstream objectives align and how the broader operation of the River Murray system can help support environmental outcomes. Delivery of water for the environment occurs in the same way, with an increasing emphasis on coordinating water deliveries to achieve landscape-scale environmental outcomes. Examples include:

- delivering a winter fresh in the Goulburn River, which subsequently passed through to the Lower Lakes in South Australia and through the barrages to the Coorong to trigger upstream migration of fish (such as lamprey)
- delivering flows through Victorian and NSW tributaries of the River Murray to encourage juvenile golden perch and silver perch to migrate from their nursery habitats in the Darling River and mid-Murray to increase populations throughout the southern-connected Murray–Darling Basin.

The VEWH holds environmental entitlements for water recovered under interstate projects and agreements — Living Murray and River Murray Increased Flows (RMIF) entitlements — and these require coordinated decision-making about where they are used. The primary objective of Living Murray entitlements is to support Murray icon sites, which include the Barmah Forest, Gunbower Forest, Hattah Lakes and the Lindsay–Mulcra–Wallpolla islands in Victoria. RMIF also support environmental objectives along the Murray system in Victoria, NSW and SA. Recommendations for the coordinated use of Living Murray allocation and RMIF are made by the Southern Connected Basin Environmental Watering Committee.

The VEWH partners with the Commonwealth Environmental Water Office to maximise the benefits of water for the environment held by the Commonwealth Environmental Water Office (CEWH) and delivered in Victorian systems. Delivery of Living Murray and Commonwealth water for the environment to meet Victorian water for the environment objectives is included in this section.

Water for the environment delivered through northern Victorian waterways can often be reused to achieve further environmental benefits downstream. If return flows are not reused at Victorian environmental sites, the VEWH, Living Murray and CEWH return flows continue to flow across the border to South Australia where they will be used to provide environmental benefits along the River Murray and in the Coorong, Lower Lakes and Murray Mouth area.

The VEWH may also order, or authorise waterway managers to order, Living Murray and Commonwealth water for downstream sites, provided there are no adverse effects on the environment in Victoria. As well, the VEWH may order water for delivery in the Murray system to non-Victorian sites under river operating rules that help improve environmental outcomes while maintaining the reliability of entitlements for all water users. In previous years, this has included deliveries to the Murray from the lower Darling, orders for delivery from Lake Victoria and orders for delivery to the River Murray itself.

Environmental, social and economic values, recent conditions, environmental watering objectives and planned actions for each system in the Northern Region are presented in the system sections that follow.

Traditional Owners in the Northern Region

Traditional Owners and their Nations in the Northern Region continue to have a deep connection to the region's rivers, wetlands and floodplains. The VEWH acknowledges the Traditional Owners of northern Victoria and pays respect to their Elders past, present and future. It recognises that water has significant cultural importance and value for Traditional Owners and Aboriginal people.

The Traditional Owner groups in and around northern Victoria include Barapa Barapa, Dhudhuroa, Latji Latji, Mutti Mutti, Nari Nari, Ngintait, Ngurai-illiam wurrung, Nyeri Nyeri, Tatti Tatti, Wadi Wadi, Wamba Wemba, Waywurru, Wegi Wegi, Yaithmathang, Yita Yita among others. The Registered Aboriginal Parties (RAPs) in the Northern Region are the Dja Dja Wurrung Clans Aboriginal Corporation, Taungurung Clans Aboriginal Corporation and Yorta Yorta Nation Aboriginal Corporation.

Two formal agreements with Traditional Owners in the Northern Region are in place:

- in 2013, the Dja Dja Wurrung entered into a recognition and settlement agreement under the *Traditional Owner Settlement Act 2010* in Victoria. Under the agreement, Dja Dja Wurrung has rights to access and use water for traditional purposes, providing the take of water does not affect other parties
- in 2004, the Victorian Government entered into a cooperative management agreement with the Yorta Yorta to improve collaboration in the management of their Country including Barmah State Forest and reserves along the Goulburn River.

Examples of engagement with Traditional Owner groups and scoped opportunities for Traditional Owner aspirations with water for the environment in the Northern Region include:

- North Central CMA is working with Barapa Barapa and Dja Dja Wurrung to understand how management of water for the environment can better support Aboriginal aspirations
- North Central CMA is also planning to pump water for the environment for the first time to Reed Bed Swamp in Guttrum Forest. The presence of water in the wetland will support many culturally important plant and animal species as well as provide value for Barapa Barapa Traditional Owners. North Central CMA is also planning to provide employment opportunities for some Traditional Owners, to undertake aspects of the planning and monitoring of the pumping trial
- Barapa Barapa Traditional Owners have planned a cultural burn for the ceremonial ground at Reedy Lagoon in Gunbower Forest, to reduce weed cover and help with the identification and care of cultural sites. Water for the environment delivered to Gunbower Forest will help contain the fire and support the continuation of culture on Country
- Goulburn Broken CMA is planning to deliver water for the environment to maintain and improve turtle habitat in Barmah Forest. The broad-shelled turtle is a totemic species for the Yorta Yorta people
- North Central CMA is running a project to train Traditional Owners to do plant and animal assessments at Lake Boort, to inform future watering regimes
- Mallee CMA is engaging with Traditional Owners in the Mallee through its Aboriginal Reference Group.

Community considerations

When planning to use water for the environment, the potential social, economic, Aboriginal cultural, and community recreational benefits associated with the water's use are considered. Some scoped opportunities for shared community benefits in northern Victoria for 2018–19 include:

- timing water delivery to Gunbower Forest to achieve environmental objectives, while also providing enough time to deliver up to 85 GL of water for the environment to inundate the river red gum floodplain, floodrunners and wetlands without reducing other water users' access to delivery channels, and also by allowing water to draw down in early summer so Parks Victoria can prepare the national park for visitors during the busy summer holiday period
- improving movement and dispersal of fish (such as golden perch, silver perch and Murray cod in the Loddon River and Pyramid Creek), which increases fishing opportunities for anglers
- Mallee CMA improving walking, cycling and canoeing facilities at Merbein Common, to build on the success of providing environmental flows at Cowanna and Brickworks billabongs.

The indirect benefits of environmental watering also include improving amenity for campers at many reserves, crossings and towns along the Loddon and the Campaspe rivers including the popular Aysons Reserve on the Campaspe near Elmore: the reserve draws hundreds of campers during the school holidays.

The ability of the VEWH and its partners to deliver these benefits will depend on the weather, on climate variations, on the available water and on the way the system is being operated to deliver water for other purposes (such as for home, farm and business use).

Integrated catchment management

Altered water regimes are one of many threats to the health of Victoria's waterways. To be effective, planning and releases of water for the environment need to be part of an integrated approach to catchment management. Many of the environmental objectives in this seasonal watering plan will not be fully met without also addressing issues such as excessive catchment erosion, barriers to fish movement, high nutrient loads, loss of stream bank vegetation and invasive species, to name just some issues.

Victorian and Australian government agencies, community groups and private landowners collectively implement programs and activities to protect and improve the environmental condition and function of land, soils and waterways throughout Victoria's catchments. *Water for Victoria* identifies 36 priority waterways across Victoria. In the Northern Region, the Campaspe River is an initial priority for investment in works to complement outcomes achievable with environmental flows in the river.

A good example of integrated catchment management is the North Central CMA's implementation of its *Gunbower and Lower Loddon Native Fish Recovery Plan*. Covering the Torrumbarry Irrigation Area and encompassing Gunbower Creek, Pyramid Creek, the lower Loddon River and the associated wetlands, the plan aims to increase native fish populations by improving waterway connectivity, habitat and flows. The VEWH and Goulburn-Murray Water are also collaborating on the plan, which has so far seen the:

- construction of the Box Creek regulator fish lock to allow fish to move into Kow Swamp from Pyramid Creek
- near-completion of the installation of an irrigation channel screen at Cohuna Weir to prevent native fish from entering an irrigation channel off the Cohuna Weir pool
- reinstatement of snags in Pyramid Creek to improve habitat for Murray cod, golden perch and silver perch
- use of a combination of irrigation water and water for the environment to provide flows to support fish movement and spawning.

Other examples of integrated catchment management in the region include:

- fox baiting in Barmah Forest by the Yorta Yorta Nation Aboriginal Corporation's works crew to protect turtle nests from predation
- the removal of willows from Birchs Creek
- the placement of artificial snags in Broken Creek and the Goulburn River in partnership with local fishing clubs.

Six natural resource management (NRM) agencies from Victoria, NSW and SA along the River Murray corridor are integrating programs under the Tri-State Murray NRM Regional Alliance. The alliance was formed in 2015 on the basis that NRM agencies that work in isolation may not provide the best and most cost-effective social, economic and environmental outcomes.

For more information about integrated catchment management programs in the Northern Region, see the Mallee, North Central, North East and Goulburn Broken regional catchment strategies and waterway strategies.

Flock of regent parrots at Hattah Lakes, by Mallee CMA

Seasonal outlook 2018–19

Very wet conditions in 2016–17 replenished storages across northern Victoria, resulting in good allocations at the start of 2017–18. Conditions in 2017–18 were mostly warm and dry, and as of May 2018, rainfall was needed to wet-up most catchments before there could be significant run-off into waterways and storages. Forecasts leading into the 2018–19 water year are generally neutral, with no clear indication of whether winter and spring 2018 rainfall will be above or below average.

Each year on 15 May, the Northern Victoria Resource Manager releases a water availability outlook for northern Victoria for the coming year. These seasonal outlooks are updated monthly once the season begins, and are available at www.nvrm.net.au.

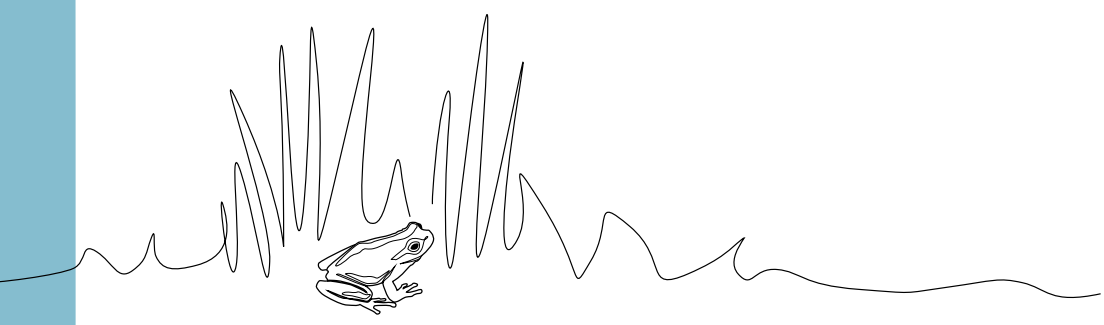
The 2018–19 outlook at 15 May 2018 indicated that early-season water availability is expected to be moderate in most systems. The opening, high-reliability entitlement allocation is expected to be at least 20 percent in the Goulburn and Loddon systems, 40 percent in the Murray system and 100 percent in the Campaspe system, with all systems expected to reach 100 percent by October 2018 under average conditions. Under an extreme dry to dry scenario – that is, if inflows are similar to the lowest 1 to 10 percent of inflows on record — most systems are unlikely to reach 100 percent high-reliability allocation. Allocation against low-reliability entitlements is possible in 2018–19 under average-to-wet conditions.

Demands for water for the environment in northern Victoria are usually highest in winter and spring. Opening allocations combined with some carryover should be sufficient to meet expected environmental demand for winter flows in creeks and rivers, as well as floodplain watering of Gunbower Forest. In 2017–18, a large volume (around 250,000 ML) of RMIF water was released from the Snowy storages because of Snowy Hydro releases for electricity generation. A portion of this RMIF was used in 2017–18 for environmental outcomes in the Murray system, with the remainder carried over to meet 2018–19 environmental demands in Victoria, NSW and SA.

Large rainfall events may result in unregulated flows that meet or exceed many of the environmental water flow targets in downstream waterways. Unregulated flows can reduce the amount of water for the environment that needs to be delivered to meet the highest-priority objectives, allowing additional watering actions during the year. However, if spills from storages occur, some or all unused water carried over from 2017–18 may be deducted from environmental water accounts.

What is the Basin Plan 2012?

Northern Victoria is a part of the Murray–Darling Basin and deliveries of water for the environment in the Northern Region are subject to the requirements of the *Basin Plan 2012*, also known as the Murray–Darling Basin Plan. The MDBA developed the plan under the *Commonwealth Water Act 2007* and it became law in November 2012. The plan sets legal limits on the amount of water that can be taken from the Murray–Darling Basin's surface and groundwater resources. Chapter 8 of the plan also sets out a high-level environmental watering plan, which defines environmental objectives to protect, restore and build the resilience of water-dependent ecosystems and their associated functions. The VEWH's environmental planning and delivery is consistent with the requirements of the plan. The potential environmental watering outlined in sections 4 and 5 of this seasonal watering plan fulfil Victoria's obligations to identify annual environmental watering priorities for Victoria's water resource areas under section 8.26 of the *Basin Plan 2012*.



5.2 Victorian Murray system

Waterway managers – Goulburn Broken, North Central and Mallee catchment management authorities

Storage managers – Goulburn-Murray Water, Lower Murray Water, Murray–Darling Basin Authority (River Murray Operations)

Environmental water holders – Victorian Environmental Water Holder, Murray–Darling Basin Authority (the Living Murray program), Commonwealth Environmental Water Holder

The Victorian Murray system contains many significant floodplains and wetland systems covering the Goulburn Broken, North Central and Mallee CMA areas. The Barmah Forest, Kerang wetlands and Hattah Lakes are internationally significant, Ramsar-listed sites due to the abundance and range of waterbird species that use them. Many other wetlands in the system are either nationally or regionally significant.

Water for the environment can be supplied from a range of sources to meet demands in the Victorian Murray system. These include entitlements held by the VEWH, the Living Murray program and the CEWH; reuse of return flows; and in some instances use of consumptive water en route. The source of the water and the ability to deliver all watering actions will depend on water availability, water commitments by other environmental water holders and operational conditions. As a result, the following Victorian Murray system sections do not specify the expected availability of water for the environment.

5.2.1 Barmah Forest

The Barmah–Millewa Forest covers 66,000 ha and spans the NSW and Victorian borders between the townships of Tocumwal, Deniliquin and Echuca (Figure 5.2.1). It is an internationally significant, Ramsar-listed wetland due to its outstanding natural values, and it is one of six icon sites for environmental outcomes in the Living Murray initiative. The forest's Victorian component is the Barmah National Park and part of the River Murray Reserve, covering 28,500 ha of forest and wetlands.

The Barmah Forest floodplain continues to be an important place for Traditional Owners and their Nations. The Registered Aboriginal Party (RAP) in the region is the Yorta Yorta Nation Aboriginal Corporation. Barmah Forest is jointly managed by the Yorta Yorta Nation and Parks Victoria, which were involved in preparing the Barmah Forest seasonal watering proposal.

Environmental values

The Barmah–Millewa Forest is the largest river red gum forest in Australia and the most-intact freshwater floodplain system along the River Murray. The forest supports important floodplain vegetation communities including the threatened Moira grass plains and is a significant feeding and breeding site for waterbirds including bitterns, ibis, egrets, spoonbills and night herons. Significant populations of native fish, frogs and turtles also live in the forest's waterways. Barmah Forest is known to support 74 plant and animal species protected under state and national legislation.

Social and economic values

The Barmah Forest supports a variety of recreational and tourism activities (such as bushwalking, boating, fishing, river cruises and birdwatching). Camping is popular along much of the 112 km frontage to the River Murray, a destination people choose for its majestic river red gums, sandy beaches and varied wildlife. Four canoe trails have been developed in the park and the forest also provides excellent fishing opportunities, particularly for Murray cod, golden perch, freshwater catfish and yabbies.

Barmah Forest is also valued for its European heritage values, largely associated with past forestry and grazing practices.

Environmental watering objectives in Barmah Forest

	Enhance the health of river red gum communities and aquatic vegetation in the wetlands and watercourses and on the floodplain Promote the growth of floodplain marsh vegetation communities, particularly the extent of Moira grass growing in these areas
	Provide feeding and nesting habitat for the successful recruitment of colonial nesting waterbirds
	Maintain or increase the habitat available for turtles including the broad-shelled turtle
	Enable nutrient cycling (particularly carbon) between the floodplain and river through connectivity Provide early-season flushing of the lower floodplain to cycle nutrients during cooler conditions and reduce the risk of poor water-quality events in summer
	Maintain or increase available habitat for frogs
	Provide native fish with access to a range of floodplain, riverine and refuge habitats including by delivering variable flows that promote spawning

System overview

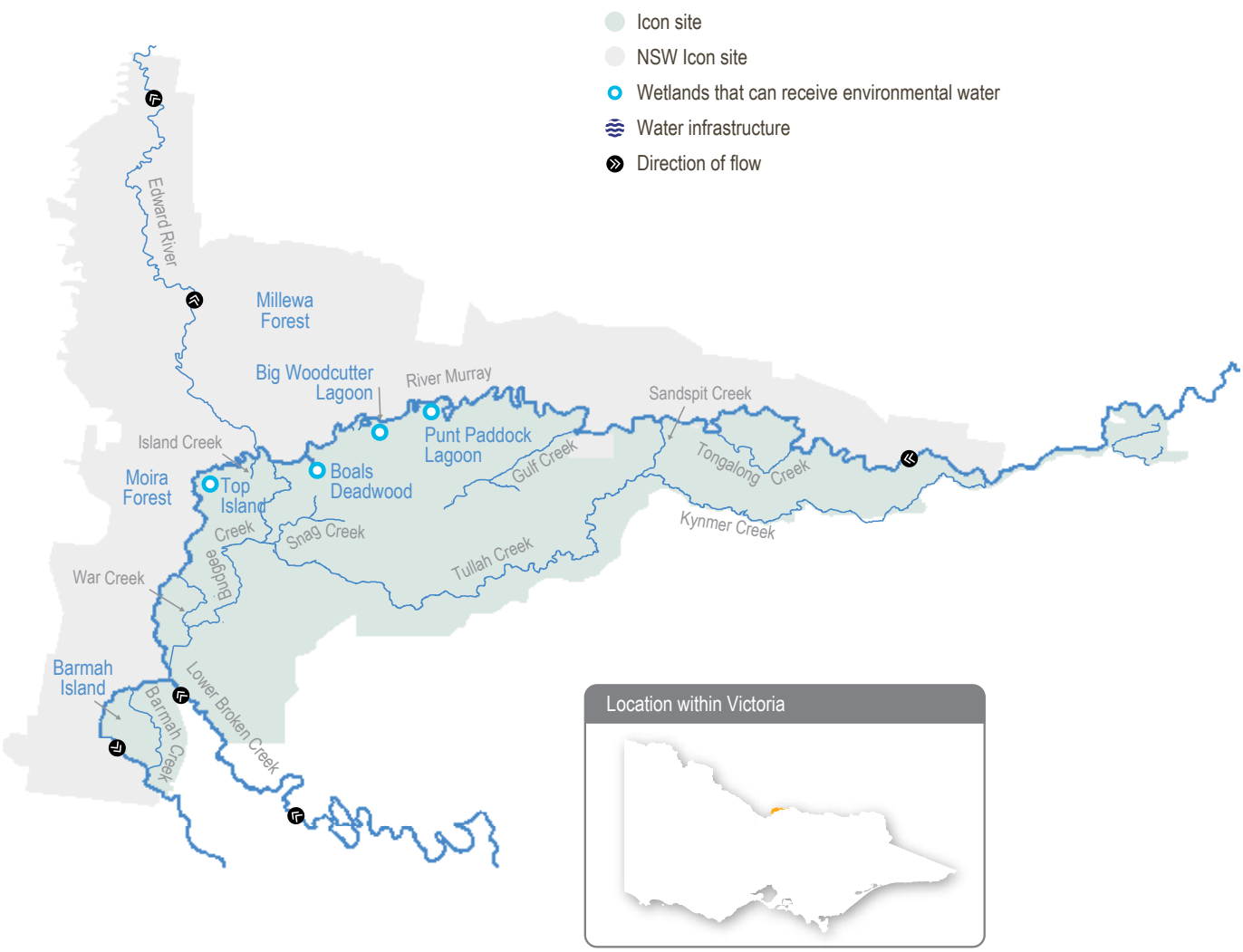
Flooding in the Barmah–Millewa Forest depends on flows in the River Murray. A natural narrowing of the river (known as the Barmah choke) restricts flow and results in overbank flooding when flows downstream of Yarrawonga Weir exceed the channel's capacity. This restriction influences both the operation of the weir and the upper limit of environmental flows that can be delivered to the forests.

The delivery of irrigation water during summer and autumn is capped at 8,800 ML per day to prevent unseasonal flooding of the forest. Regulators along the River Murray remain closed during summer and autumn to restrict the inflow of water through lower-lying flood runners. The delivery of water to Barmah Forest is also constrained by an imposed flow constraint downstream of Yarrawonga Weir to prevent flooding of private land. The current cap limits releases to a maximum of 18,000 ML per day until the end of September and to 15,000 ML per day for the rest of the year. To overcome this constraint, most water for the environment delivered is directed via the forest regulators into either Barmah or Millewa forests to optimise outcomes within the operational constraints. It is currently not possible to achieve the desired flooding depth and duration for floodplain marsh vegetation in both forests at the same time without natural flooding.

Water management at Barmah–Millewa Forest seeks to build on unregulated flows and the delivery of consumptive water en route to maximise environmental outcomes when possible. As Barmah–Millewa Forest is located towards the upper reaches of the River Murray, water for the environment delivered to the forest can often be used again at sites further downstream, as part of multisite watering events.

Aerial view of Boals Deadwood, by Keith Ward

Figure 5.2.1 Barmah Forest



Recent conditions

Barmah Forest was inundated in 2017–18 through managed and natural flooding. In 2017–18, a new approach to regulator operation was trialled at Barmah–Millewa Forest. Most forest regulators remained open between July and November 2017, as low flows (below choke capacity) were passed through to allow a more-natural rise and fall in the forest's waterways. This improved habitat in the forest's waterways by providing variable flows, and the same approach is planned for 2018–19.

A natural flood in August 2017 (35,000 ML per day) inundated 40 to 45 percent of the active floodplain; another in early December 2017 (20,000 ML per day) reached 17 to 20 percent of the floodplain. Flow levels between these two peaks were sustained by delivering water for the environment (15,000 ML per day through October and November 2017) to meet the water needs of the floodplain's marshlands.

Excellent vegetation and fish outcomes were recorded in 2017–18, including strong Moira grass growth and flowering as well as native fish breeding. Water for the environment was delivered to colonial waterbird breeding sites in Barmah Forest, with delivery ending early at one site due to the abandonment of nests after predation by feral pigs.

Scope of environmental watering

Table 5.2.1 shows potential environmental watering actions and their environmental objectives.

Table 5.2.1 Potential environmental watering actions and objectives for Barmah Forest

Potential environmental watering	Environmental objectives
Winter/spring low flows to various waterways in Barmah Forest (variable flow rates in July–December)	• Maintain fish and turtle habitat in forest waterways • Facilitate the movement of native fish between floodplain waterways and the river • Remove accumulated organic matter: cycle carbon to the river system and minimise the risk of anoxic blackwater
Spring/summer freshes (in-channel) in the River Murray channel (up to 3 events of 500 ML/day for 8 days in October–December)	• Trigger spawning of native fish species, primarily golden and silver perch
Spring/summer freshes (drought) to Gulf and Boals creeks (100 ML/day for 3–5 days as required in November–April)	• Maintain critical drought-refuge areas in Barmah Forest • Protect fish and turtle populations in permanent waterways • Maintain water quality
Spring/summer/autumn low flows to floodplain waterways including Sandspit, Gulf, Big Woodcutter, Boals, Island and Punt Paddock Lagoon (200 ML/day for 30–60 days between November–April) [1]	• Replenish refuge areas and maintain water quality in those areas • Maintain fish and turtle populations in permanent waterways • Maintain connectivity to the river • Remove accumulated organic matter: cycle carbon to the river system and minimise the risk of anoxic blackwater
Spring inundation of floodplain marshes (variable flow rates for 3 months in September–December)[2]	• Provide flooding of sufficient duration to allow growth of floodplain marsh vegetation in open plains • Create foraging ground for birds and increase available habitat for turtles, frogs and small-bodied native fish
Targeted wetland watering to Boals Deadwood, Reedy Lagoon and Top Island wetlands (200–400 ML/day for 4.5 months in September–February)	• Initiate and/or maintain breeding habitat for colonial nesting and flow-dependent waterbirds
Autumn/winter low flows (up to 5,000 ML/day downstream of Yarrawonga in May to August)	• Increase habitat for large-bodied native fish in the River Murray and anabranches in Barmah–Millewa Forest

[1] *May be delivered across multiple events.*

[2] *Water for the environment is limited to flow rates outlined in the MDBA's Objectives and Outcomes for River Operations in the River Murray System (MDBA, 2016).*

Scenario planning

Table 5.2.2 outlines the potential environmental watering and expected water use under a range of planning scenarios.

The ecological objectives at Barmah–Millewa Forest require sustained river flows, peaking with high flows in spring. These are achieved using a suite of small-scale works to improve water management. Demands for water for the environment vary significantly for Barmah Forest in response to natural conditions. Under dry conditions, objectives focus on maintaining refuges to sustain fish and turtle populations. Under average or wet conditions, the focus shifts to building resilience in the system by increasing responses to natural flood events. Specific actions may include extending the duration of natural flooding to increase the germination of wetland plants (such as Moira grass) in floodplain marshes, or extending watering in river red gum forests to increase the recruitment and survival of young plants. Water for the environment may also be used from May to August to provide increased native fish habitat.

Targeted wetland watering may occur under a range of conditions to support the breeding of colonial nesting waterbirds and other flood-dependent birds.

Table 5.2.2 Potential environmental watering for Barmah Forest under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Unregulated flow periods unlikely • Flows in the River Murray will remain within channel all year	• Some small unregulated flows in late winter/spring • Low chance of overbank flows in late winter/spring	• Likely chance of small-to-medium unregulated flows in winter/spring • Likely chance of overbank flows in winter/spring	• High probability of moderate-to-large unregulated flows in winter/spring • Expected large overbank flows
Potential environmental watering	• Winter/spring low flows • Spring/summer freshes (in-channel) • Spring/summer freshes (drought)	• Winter/spring low flows • Spring/summer freshes (in-channel) • Spring/summer/ autumn low flows • Targeted wetland watering	• Winter/spring low flows • Spring/summer freshes (in-channel) • Spring/summer/ autumn low flows • Spring inundation of floodplain marshes • Targeted wetland watering • Autumn/winter low flows	• Winter/spring low flows • Spring/summer freshes (in-channel) • Spring inundation of floodplain marshes • Targeted wetland watering • Autumn/winter low flows
Possible volume of water for the environment required to achieve objectives[1]	• 30,000 ML (no return flows)	• 130,000 ML (with return flows)	• 550,000 ML (with return flows)	• 315,000 ML (with return flows)

[1] *The possible volumes of water for the environment required in Barmah Forest are estimates. The actual volume delivered is measured and depends seasonal conditions. Unregulated and/or operational flows may meet a portion of the demand.*

Risk management

Environmental watering program partners have considered and assessed risks and identified mitigating strategies relating to environmental flows in 2018–19. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

Engagement

Table 5.2.3 shows the partners organisations with which Goulburn Broken CMA engaged when preparing the Barmah Forest seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional catchment strategies, regional waterway strategies, environmental flow studies, water management plans and other studies. These incorporate a range of environmental, cultural, social and economic perspectives and longer-term integrated catchment and waterway management objectives. For further details, refer to the *Goulburn Broken Regional Catchment Strategy* and the *Goulburn Broken Waterway Strategy*.

Table 5.2.3 Partners engaged in developing the Barmah Forest seasonal watering proposal

Partner and stakeholder engagement
• Commonwealth Environmental Water Office • Department of Environment, Land, Water and Planning • Murray–Darling Basin Murray–Darling Basin Authority (River Murray Operations and Living Murray program) • NSW National Parks and Wildlife Service • NSW Office of Environment and Heritage • Parks Victoria • Victorian Environmental Water Holder • Yorta Yorta Nation Aboriginal Corporation

5.2.2 Gunbower Creek and Forest

Gunbower Forest is a large, flood-dependent forest situated on the River Murray floodplain in northern Victoria between Torrumbarry and Koondrook (Figure 5.2.2). Covering 19,450 ha, it is bounded by the River Murray to the north and Gunbower Creek to the south.

Gunbower Creek and Forest continue to be important places for Traditional Owners and their Nations. The Registered Aboriginal Party (RAP) in the southern region is the Yorta Yorta Nation Aboriginal Corporation. Representatives from the RAP and from Barapa Barapa Nations Traditional Owners were engaged during the preparation of the Gunbower seasonal watering proposal.

Environmental values

Gunbower Forest contains a range of important environmental values including rare and diverse wetland habitats, vulnerable and endangered plants and animals and large areas of remnant vegetation communities (such as river red gum forest). The forest provides habitats for many bird species, and it is known to support internationally recognised migratory waterbirds.

Gunbower Creek provides important habitat for native fish (such as Murray cod, golden perch and freshwater catfish). It is a valuable refuge for native fish, and it provides a source of fish to recolonise surrounding waterways.

Social and economic values

The forest provides economic values through timber production, apiculture (bee keeping), educational courses, recreation and tourism. The forest supports numerous recreational activities when it is wet and dry. Popular activities include kayaking, canoeing, camping, photography and birdwatching. The Gunbower Heritage River Trail is a popular tourist attraction that passes through many Indigenous and European cultural heritage sites. The River Red Gum Drive is one of Victoria's iconic, four-wheel-drive routes that follows the River Murray through the Gunbower National Park.

Gunbower Creek is the major carrier for the delivery of irrigation supply to the surrounding agricultural land. The creek is also a hotspot for tourism, with businesses taking advantage of the presence of flows year-round and recreational activities (such as boating, canoeing, stand-up paddle-boarding, kayaking and fishing). The Cohuna Bridge to Bridge, a popular charity event held in autumn each year, allows participants to either swim or paddle along large sections of the creek or ride up to 50 km along the banks.

Environmental watering objectives in Gunbower Creek and Forest

	Maintain the health and support the recruitment of plants in permanent and semipermanent wetlands Maintain and improve the health of river red gums, black box and grey box communities
	Maintain and increase the healthy populations of large- and small-bodied native fish Provide flows for native fish (such as Murray cod, golden perch, carp gudgeon and freshwater catfish) to swim, feed and breed in Gunbower Creek
	Use flows to connect the floodplain to Gunbower Creek and the River Murray to enable native fish, turtles and carbon to move between them, supporting the life cycles of water-dependent plants and animals
	Provide feeding, breeding and refuge habitat for waterbirds including colonial nesting species
	Increase the population of frogs in the forest by providing feeding and breeding habitat

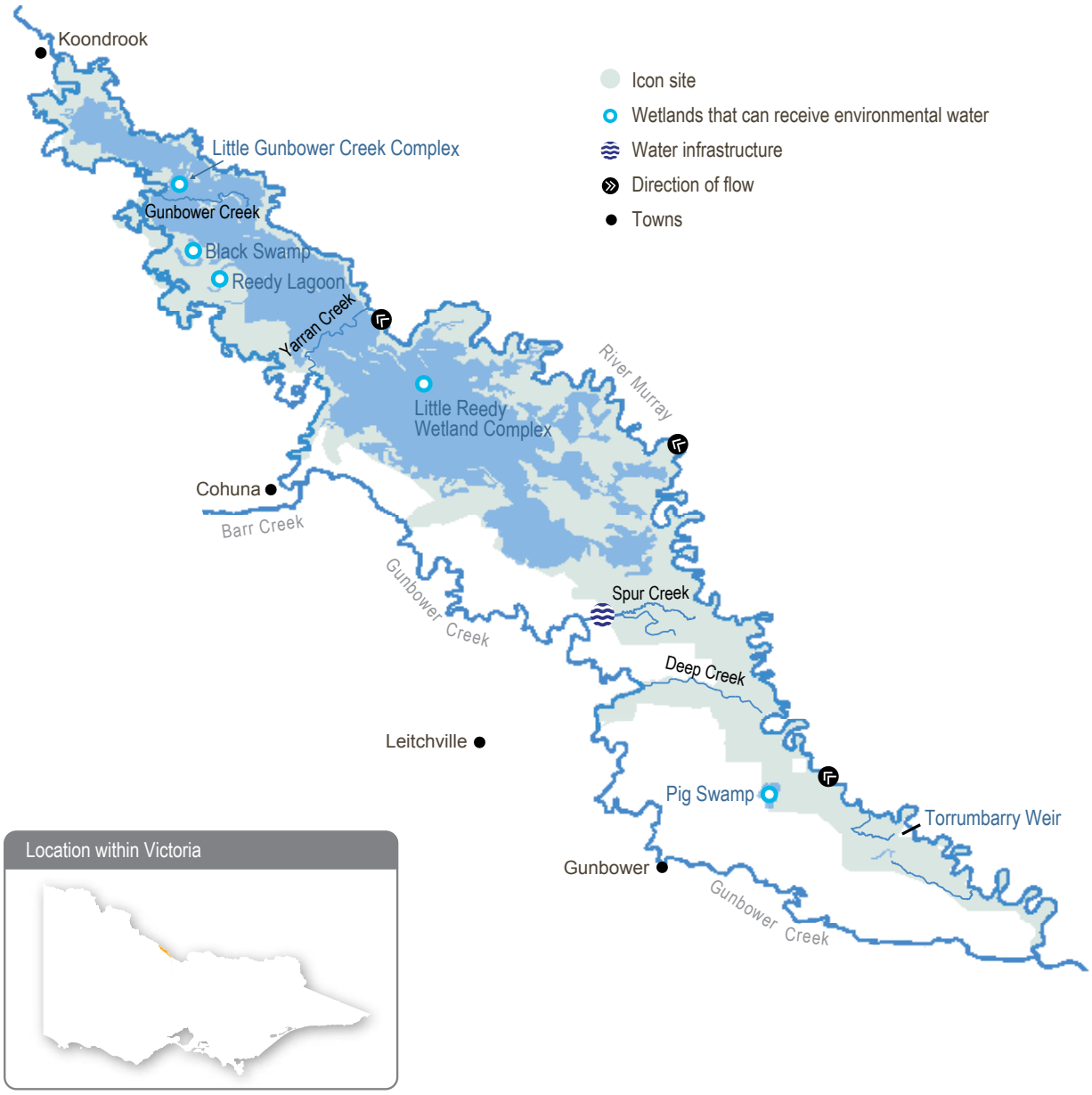
System overview

Gunbower Forest is an internationally significant site under the Ramsar Convention and forms part of the Living Murray Gunbower–Koondrook–Perricoota icon site. River regulation and water extraction from the River Murray and Gunbower Creek has reduced the frequency, duration and magnitude of flood events in Gunbower Forest. This has affected the extent and condition of floodplain habitats and the health of plant and animal communities (such as river red gum and black box communities, fish, birds, platypus, frogs and turtles) that depend on those habitats.

Gunbower Creek is managed primarily as an irrigation carrier and supplies the Torrumbarry Irrigation Area from the River Murray. Daily variations in water levels in the creek through spring, summer and autumn are much higher now than under natural conditions, due to changing irrigation demand. Frequent or rapid fluctuations in water levels can greatly affect native fish populations and other ecological processes. Water for the environment is used to reduce water level fluctuations by filling the gaps in flows caused by irrigation demand within the creek. This action supports fish migration and breeding and promotes other ecological processes while maintaining water delivery for irrigation needs.

The Living Murray structural works program in the middle and lower forest was completed in 2013. The works allow up to 3,800 ha of the wetlands and floodplain to be watered with considerably less water than would be required if the new watering infrastructure was not in place. The works enable efficient watering through Gunbower Creek and the forest to maintain wetland and floodplain condition, and they provide a link between the creek, forest floodplain and the River Murray. Frequent connections between the river and floodplain habitats allow biota to move between habitats, and they also support critical ecosystem functions (such as carbon exchange).

Figure 5.2.2 Gunbower Creek and Forest



Recent conditions

Monitoring conducted after natural floods in late 2016 detected a large population of carp in Gunbower Forest's wetlands. The carp were damaging wetland vegetation and causing high turbidity. To manage the impact of the carp, the floodplain and wetlands were intentionally left to draw down and dry after the natural inflows in late 2016, with no water for the environment delivered to the forest for the remainder of the 2016–17 year. The North Central CMA used the drying conditions to remove 1,170 kg of carp (mostly large adults) from Reedy Lagoon and Black Swamp.

Water for the environment was used to partially fill Reedy Lagoon and Black Swamp in late spring 2017. In the absence of large-bodied carp, aquatic plants flourished and were able to germinate, establish and set seed. In Reedy Lagoon, the managed delivery triggered a dense cover of vulnerable river swamp wallaby-grass. In Black Swamp, the number and distribution of aquatic plants was the highest on record and several plant species not commonly observed were recorded including river swamp wallaby-grass and wavy marshwort.

High rainfall in early December 2017 increased flows in the River Murray and delivered minor flows through deeper floodrunners and creeks in upper Gunbower Forest. To maintain the carp exclusions, these flows were prevented from connecting to Reedy Lagoon and Black Swamp. In the absence of large-bodied carp, vegetation in both wetlands proliferated over summer and autumn as water levels receded. A small volume of water remains in both wetlands and is expected to persist in deeper areas to the end of 2017–18.

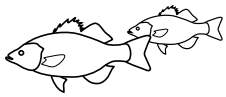
The improved extent and condition of aquatic vegetation in Reedy Lagoon and Black Swamp provided excellent feeding habitat for many waterbirds, including eastern great egrets and white-faced heron. It also provided breeding habitat for Australasian grebes, white-bellied sea eagles and black swans.

The success of environmental watering in Reedy Lagoon and Black Swamp highlights the benefits of coordinating deliveries of water for the environment with other management actions to maximise environmental outcomes. Carp exclusion plots, established by the Living Murray Intervention Monitoring Program in 2014–15, were again monitored in a few of the forest wetlands. These trial plots demonstrate how floodplain vegetation responds at different stages of their wetting and drying cycles in the absence of large-bodied fish (including carp) as well as grazing by waterbirds and marsupials. Plots that excluded carp, waterbirds and kangaroos had more-abundant and more-diverse vegetation than plots that only excluded one species.

In 2017–18, flows in Gunbower Creek allowed large-bodied fish, especially Murray cod, to migrate, spawn, feed and breed. Since implementing managed environmental flows in Gunbower Creek in 2011, the native fish population has steadily increased. Higher flows provided in winter/spring 2017 helped maintain fish nursery habitats, and Gunbower Creek now supports a healthy population of Murray cod of varying ages and greater numbers of golden perch, silver perch and freshwater catfish.

In mid-June 2018, water for the environment was delivered to Gunbower Forest to support river red gums and the flood-dependent understory. The water delivery was timed to maximise deliveries into the forest before irrigation orders (due to resume from 15 August) were to take up much of the capacity of Gunbower Creek. The delivery of environmental water to Gunbower Forest is planned to continue during winter/spring 2018–19.

River swamp wallaby grass at Reedy Lagoon, by North Central CMA



Scope of environmental watering

Table 5.2.4 shows potential environmental watering actions and their environmental objectives.

Table 5.2.4 Potential environmental watering actions and objectives for Gunbower Creek and Forest

Potential environmental watering	Environmental objectives
Gunbower Forest	
Inundation of Gunbower Forest floodplain, floodrunners and wetlands (fill in winter/spring and provide top-ups if a significant bird-breeding event occurs)	• Improve the health of river red gum, black box and grey box communities • Maintain/enhance healthy populations of native fish in wetlands and increase opportunities for riverine fish to access floodplain resources • Maintain suitable feeding, breeding and refuge habitat for waterbirds including colonial nesting species • Support a significant bird-breeding event
Semipermanent and permanent forest wetlands (fill in winter/spring and provide top-ups if a significant bird-breeding event occurs) Reedy Lagoon and Black Swamp (fill in winter/spring and provide top-ups if a significant bird-breeding event occurs)	• Maintain the health and resilience of vegetation communities in permanent wetlands • Maintain suitable feeding and refuge habitat for waterbirds • Support a significant bird-breeding event
Winter/spring fresh in Yarran Creek (variable flow rates and duration based on water levels in Gunbower Forest and flows in the River Murray and Gunbower Creek)	• Provide connectivity between Gunbower Creek and River Murray through the Yarran Creek and Shillinglaws regulators, to increase flowing habitat for the lateral movement of native fish, turtles and seed propagules • Provide migration and spawning opportunities for native fish
Extend natural flooding in Gunbower Forest floodplain, floodrunners and wetlands (with variable flow rates to maintain appropriate inundation extent)	• Improve the health of river red gum communities • Maintain/enhance healthy populations of native fish in wetlands and increase opportunities for riverine fish to access floodplain resources • Maintain suitable feeding, breeding and refuge habitat for waterbirds including colonial nesting species • Support a significant bird-breeding event
Reedy Lagoon and Black Swamp (top-ups in autumn/winter)	• Maintain/enhance the health and resilience of vegetation communities in permanent wetlands • Maintain suitable feeding, breeding and refuge habitat for waterbirds including colonial nesting species
Inundation of Gunbower Forest floodplain, floodrunners and wetlands (fill in autumn/winter 2019)	• Improve the health of river red gum, black box and grey box communities • Maintain/enhance healthy populations of native fish in wetlands and increase opportunities for riverine fish to access floodplain resources • Maintain suitable feeding, breeding and refuge habitat for waterbirds including colonial nesting species
Gunbower Creek	
Winter low flows (up to 400 ML/day between May–August)	• Increase the survival and maintain the growth of native fish (such as Murray cod) by maintaining access to food and habitat resources
Spring/summer high flows (targeting a gradual increase in flows up to 650 ML/day including various periods of stable flows in August–January)	• Increase the recruitment, growth and survival of native fish (such as Murray cod) by maintaining access to breeding habitat and food resources
Year-round low flows (above 400 ML/day between August–May)	• Maintain native fish survival and growth by increasing access to habitat and food resources

Table 5.2.4 Potential environmental watering actions and objectives for Gunbower Creek and Forest *continued*

Potential environmental watering	Environmental objectives
Summer/autumn low flows (above 300 ML/day, between January–May)	• Maintain native fish survival and growth by increasing access to habitat and food resources
Increased low flows (up to 550 ML/day year-round if unregulated conditions occur in the River Murray)[1]	• Increase native fish recruitment by providing cues for migration and spawning, in line with larger flows in the River Murray • Increase the growth and survival of native fish (such as Murray cod) by maintaining access to breeding habitat and food resources
Spring/summer/autumn freshes (up to 550 ML/day between October-April)[1]	• Increase native fish recruitment from the River Murray populations into the Creek by providing cues for migration and spawning, in line with larger flows in the River Murray • Maintain water quality below Koondrook Weir to dilute low-dissolved-oxygen water that may exit Gunbower Forest

[1] *Increased low flows and freshes may be provided opportunistically in Gunbower Creek if unregulated conditions eventuate in the River Murray and the Hipwell Road Channel regulator is not being used.*

Scenario planning

Table 5.2.5 outlines the potential environmental watering and expected water use under a range of planning scenarios.

Floodplain watering of Gunbower Forest started in June 2018 and needs to continue into 2018–19 to meet target inundation levels. Continuation of that watering event is therefore the highest priority in all climate scenarios. The main objective for this event is to inundate the floodplain, floodrunners and wetlands in Gunbower Forest during winter/spring 2018, to support the flood-dependent understorey and continue the recovery of wetland plant communities since the Millennium Drought. Water for the environment can inundate about 16 percent of Gunbower Forest, and this area has received either natural or managed flows in five of the last 10 years. Water delivered in 2018–19 will improve and protect the health of river red gums higher on the floodplain that have not received water since the natural floods in 2016.

Managed flows to Gunbower Forest will maintain water levels in wetlands to ensure the wetland vegetation remains in good condition and to increase the success of any significant colonial waterbird-breeding event that may be triggered by managed flows. If bird breeding occurs, water for the environment will be used to maintain an adequate water depth at selected wetlands until juvenile birds are successfully fledged or the breeding event fails due to other factors.

In wetter scenarios, when flows in the River Murray exceed 15,000 ML per day in winter/spring for more than two weeks, a fresh may be delivered in Yarran Creek to allow carbon, fish, turtles and seed propagules to move between Gunbower Creek, Gunbower Forest and the River Murray.

Flows above 20,000 ML per day in the River Murray will force water into the forest. If natural flooding occurs during or before planned deliveries of water for the environment, the managed inflows may be cancelled, suspended or reduced. Water for the environment may be delivered at the end of a natural flood to extend the duration or extent of inundation throughout the forest, to increase ecological outcomes.

In a dry to wet scenario, water for the environment may be used to inundate the river red gum floodplain for a second time in autumn/winter 2019. This water delivery will build on the vegetation outcomes of the winter/spring 2018 event and improve the condition of river red gums in the forest.

Gunbower Creek is a highly regulated system. As a result, natural conditions (such as flooding and rainfall) do not greatly influence the objectives or flow requirements in the system. Management of water for the environment will aim to support all aspects of native fish life cycles, ensuring there are sufficient habitat and food resources for native fish throughout the year.

In all climate scenarios, the highest priority for water for the environment for Gunbower Creek is to maintain flowing habitat and access to feeding resources for native fish during winter. The second-highest priority is to smooth out flows during the irrigation season to provide opportunities for native fish (especially Murray cod) to breed and for their larvae to disperse.

In a wet climate scenario, unregulated flows may trigger the use of additional water for the environment to provide short freshes or increased low flows in Gunbower Creek. Increased flows may facilitate native fish movement between Gunbower Creek and the River Murray and cue spawning at a time when fish populations are likely to be responding to larger flows in the River Murray and other connected tributaries.

In 2018–19, the planned delivery to Gunbower Forest will reduce the capacity to deliver the full range of flows for large-bodied fish in Gunbower Creek. Flows will be managed to maintain flowing habitat to support the existing native fish population. A fresh may be delivered downstream of Koondrook Weir to dilute low-dissolved-oxygen water, if flows exit the forest during or after the floodplain watering action.

Table 5.2.5 Potential environmental watering for Gunbower Creek and Forest under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• No natural inflows into Gunbower Forest	• Minor natural inflows into Gunbower Forest may occur in winter/spring	• Some natural inflows into Gunbower Forest are likely in winter/spring but unlikely to be significant	• Overbank flows are likely in winter/spring
Potential environmental watering – tier 1 (high priorities)[1]	• Inundation of Gunbower Forest floodplain, floodrunners and wetlands (winter/spring) • Semipermanent and permanent forest wetlands (winter/spring) • Gunbower Creek winter low flows • Gunbower Creek spring/summer/autumn low flows	• Inundation of Gunbower Forest floodplain, floodrunners and wetlands (winter/spring) • Semipermanent and permanent forest wetlands (winter/spring) • Gunbower Creek winter low flows • Gunbower Creek spring/summer/autumn low flows	• Inundation of Gunbower Forest floodplain, floodrunners and wetlands (winter/spring) • Semipermanent and permanent forest wetlands (winter/spring) • Gunbower Creek winter low flows • Gunbower Creek spring/summer/autumn low flows • Yarran Creek winter/spring fresh	• Inundation of Gunbower Forest floodplain, floodrunners and wetlands (winter/spring) • Semipermanent and permanent forest wetlands (winter/spring) • Gunbower Creek winter low flows • Gunbower Creek spring/summer/autumn low flows • Yarran Creek winter/spring fresh
Potential environmental watering – tier 2 (additional priorities)	• Yarran Creek winter/spring fresh • Reedy Lagoon and Black Swamp (autumn/winter)	• Yarran Creek winter/spring fresh • Inundation of Gunbower Forest floodplain, floodrunners and wetlands (autumn/winter)	• Inundation of Gunbower Forest floodplain, floodrunners and wetlands (autumn/winter)	• Gunbower Creek autumn/winter/spring increased low flows • Gunbower Creek spring/summer/autumn freshes • Inundation of Gunbower Forest floodplain, floodrunners and wetlands (autumn/winter)
Possible volume of water for the environment required to meet objectives[2,3]	• 87,100 ML (tier 1) • 4,500 ML (tier 2)	• 87,100 ML (tier 1) • 38,250 ML (tier 2)	• 88,600 ML (tier 1) • 36,750 ML (tier 2)	• 88,600 ML (tier 1) • 39,750 ML (tier 2)
Priority carryover requirements	• 74,100 ML	• 74,100 ML	• 74,100 ML	• 74,100 ML

[1] *In dry to average planning scenarios, an addition 2,000 ML has been included to support a significant bird-breeding event that may be triggered by Gunbower floodplain inundation, under tier 1 actions.*

[2] *Represents the estimated volume of water required to underwrite the losses associated with the delivery of consumptive water en route (except for discrete wetland watering actions) in Gunbower Creek and Gunbower Forest.*

[3] *Water for the environment requirements for tier 2 are additional to tier 1 requirements.*

Risk management

Environmental watering program partners have considered and assessed risks and identified mitigating strategies relating to environmental flows in 2018–19. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

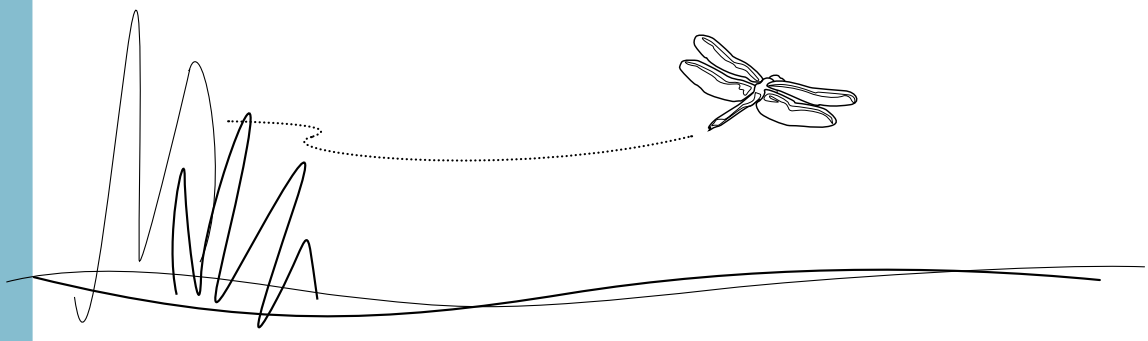
Engagement

Table 5.2.6 shows the partners and stakeholder organisations with which North Central CMA engaged when preparing the Gunbower Creek and Forest seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional catchment strategies, regional waterway strategies, environmental flow studies, water management plans and other studies. These incorporate a range of environmental, cultural, social and economic perspectives and longer-term integrated catchment and waterway management objectives. For further details, refer to the *North Central Regional Catchment Strategy* and *North Central Waterway Strategy*.

Table 5.2.6 Partners and stakeholders engaged in developing the Gunbower Creek and Forest seasonal watering proposal

Partner and stakeholder engagement
• Gannawarra Shire Council, Campaspe Shire Council and Cohuna Progress Association • Gunbower Island Community Reference Group (with representation from the Cohuna Progress Association, bird observers, Field & Game Australia, BirdLife Australia, Gunbower Landcare Group, irrigators and general community members) • Gunbower Operations Advisory Group (with representation from Goulburn-Murray Water, Parks Victoria, Department of Environment, Land, Water and Planning, Vic Forests, State Forests NSW, North Central CMA, Murray–Darling Basin Authority, Commonwealth Environmental Water Holder and the Victorian Environmental Water Holder • Gunbower Technical Working Group (with representatives of Department of Environment, Land, Water and Planning [Threatened Flora and Fauna]; and specialist fish, vegetation and bird consultants and ecologists) • Yorta Yorta Nation Aboriginal Corporation and Barapa Barapa Nations Traditional Owners



5.2.3 Central Murray wetlands

The central Murray wetlands are located on the lower Loddon River and River Murray floodplains (Figure 5.2.3). The wetland system consists of Round Lake, Lake Cullen, Lake Elizabeth, Lake Murphy, Johnson Swamp, Hird Swamp, Richardsons Lagoon, McDonalds Swamp, the Wirra-Lo wetland complex and Benwell and Guttrum state forests.

Wetlands in this region continue to be important places for Traditional Owners and their Nations. The Registered Aboriginal Party (RAP) in the region is the Yorta Yorta Nation Aboriginal Corporation. Representatives from Barapa Barapa and Wamba Wemba Nations' Traditional Owners were engaged during the development of seasonal watering proposals to propose environmental watering actions that would support culturally significant wetland plants in Guttrum Forest. Those proposals have been incorporated in this seasonal watering plan. Traditional Owners in the region have an ongoing connection to the central Murray wetlands.

Environmental values

The wetlands in the central Murray system support vulnerable or endangered species including the Australasian bittern, Murray hardyhead, Australian painted snipe and growling grass frog. The wetlands provide habitat for many threatened bird species (including the great egret and white-bellied sea eagle) listed under legislation and international agreements. There are internationally recognised, Ramsar-listed wetlands in the system including Lake Cullen, Hird Swamp and Johnson Swamp, while the other wetlands in the central Murray system have bioregional significance.

Social and economic values

The central Murray wetlands are used for recreational activities including birdwatching and bushwalking; some wetlands are also used for duck hunting. Tourism to the region supports the local economy. Other indirect economic benefits associated with the wetlands include groundwater recharge and carbon storage.

Environmental watering objectives in the central Murray wetlands

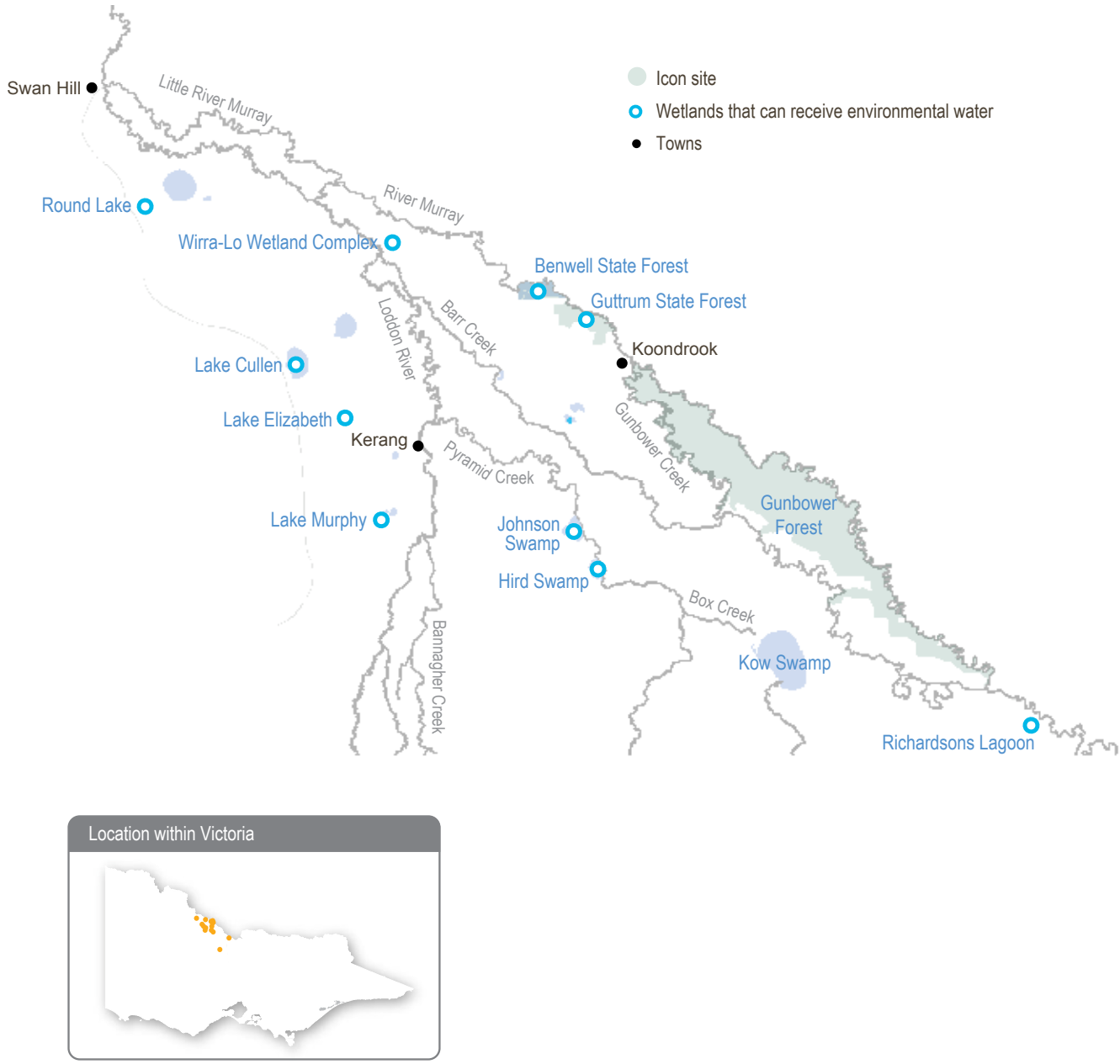
	Maintain and rehabilitate river red gum, black box, lignum woodland and wetland plant communities Provide appropriate wetting and drying conditions that support seed germination, seedling survival and recruitment including of semiaquatic plant species in damp areas of wetlands Manage the extent and density of invasive plant species including tall marsh vegetation Support a mosaic of wetland plant communities to provide feeding and breeding habitat for native fauna
	Maintain habitat for the critically endangered Murray hardyhead
	Provide habitat for waterbird resting, feeding and breeding including for threatened species (such as Australasian bittern, little bittern and brolga)
	Provide habitat for the endangered growling grass frog

System overview

The central Murray wetlands are almost wholly contained within the Torrumbarry Irrigation Area and are all wetlands of regional or international significance. The area has experienced dramatic changes since European settlement with the construction of levees, roads and channels. Most of the wetlands are now cut off from natural flow paths and very rarely flood naturally. They rely on water for the environment to maintain their ecological character and health.

Nine of the central Murray wetlands can receive water for the environment from permanent infrastructure: Lake Cullen, Hird Swamp, Johnson Swamp, Round Lake, McDonalds Swamp, Lake Elizabeth, Lake Murphy, Richardsons Lagoon and the Wirra-Lo wetland complex. To date, neither Guttrum or Benwell forests, which border the River Murray, have permanent infrastructure to deliver environmental water. Temporary pumps may be used to deliver water for the environment from the River Murray to some semipermanent wetlands in the Guttrum and Benwell forests.

Figure 5.2.3 Central Murray wetlands



Recent conditions

Higher-than-average rainfall at the start of the 2017–18 water year saw the Murray system seasonal determination rise from an opening 66 percent to 100 percent high-reliability water shares by October 2017. Despite high rainfall in November and December 2017, natural inflows to the central Murray wetlands were limited by artificial barriers (such as channels, roads and levees). Water for the environment was therefore the primary source of water for most wetlands in the region. Water for the environment was delivered to seven of the central Murray wetlands in 2017–18.

In Round Lake and Lake Elizabeth, water for the environment was used to periodically top-up water levels to maintain suitable water-quality conditions for endangered Murray hardyhead. Round Lake maintains a stable population of Murray hardyhead. Recent monitoring undertaken as part of the statewide Wetland Monitoring and Assessment Program (WetMAP) for environmental watering detected more than 20 Murray hardyhead at Lake Elizabeth, which indicates that the translocation of Murray hardyhead in 2016 was successful; and there is evidence of subsequent recruitment. This is an extremely positive result for the site, as it only started receiving water for the environment in 2014.

Water for the environment was used to support waterbirds, plants and other animals typical of temporary freshwater marshes at Richardsons Lagoon, Wirra-Lo wetland complex, Hird Swamp, McDonalds Swamp and Lake Murphy.

The filling of Richardsons Lagoon marked the completion of the three-year watering cycle recommended in the Richardsons Lagoon Environmental Water Management Plan. Waterbird monitoring has demonstrated that the lagoon and its surrounding woodland support up to 52 bird species including 28 waterbird species. The number of bird species recorded at Richardsons Lagoon in 2017–18 was slightly higher than in recent wet years. Observations of juvenile black swans and nankeen night herons suggests there has been successful bird breeding at the wetland. Richardsons Lagoon will be allowed to draw down and dry over about three years, before it is due to receive more environmental water.

Delivery of water for the environment to Wirra-Lo wetland complex at Duck Creek North and Duck Creek South in spring/summer 2017 aimed to provide refuge habitat and suitable breeding conditions for the nationally-endangered growling grass frog as well as create high-quality feeding and breeding habitat for waterbirds. Growling grass frogs were heard calling at Wirra-Lo wetland complex in summer 2017–18, and this is the first record of growling grass frogs on the Murrabit West floodplain since 2008. The return of the growling grass frog to Wirra-Lo wetland complex within four years of rehabilitation works demonstrates the benefits of providing water for the environment.

Water for the environment supported large numbers of waterbirds at Hird Swamp in 2017–18. Regular monitoring consistently recorded about 40 waterbird species at Hird Swamp between October and December 2017. The greatest abundance of waterbirds recorded in a single survey at Hird Swamp was 2,743 individuals in November including 600 Australasian grebes. Many threatened species were recorded at Hird Swamp in 2017–18 including Baillon's crake, whiskered tern, glossy ibis, royal spoonbill, eastern great egret, Australasian bittern, Australasian little bittern, magpie goose, white-bellied sea eagle, musk duck and nankeen night heron. There was also evidence of bird breeding at Hird Swamp in spring and summer 2017–18 as juvenile waterbirds from various species including black swan, banded rail and brown quail were recorded. A brolga nest with two eggs was discovered in early February 2018, but these were later reported missing, likely due to predation.

No water for the environment was delivered to Johnson Swamp, Lake Cullen or Guttrum and Benwell forests in 2017–18. Johnson Swamp and Lake Cullen were managed for drying and drawing down respectively. Some parts of the Guttrum and Benwell forests received natural inflows during early summer 2017 from high flows in the River Murray. However, most of the forest understorey and wetlands remain in poor condition. The forests require a more-natural watering regime to support recovery from the Millennium Drought and historical grazing pressure.

Scope of environmental watering

Table 5.2.7 shows potential environmental watering actions (including wetland drying) and their environmental objectives.

Spoonbill in flight over Hird Swamp at sunrise, by Zarleen Blakeley

Table 5.2.7 Potential environmental watering actions and objectives for central Murray wetlands

Potential environmental watering	Environmental objectives
Wetland watering	
Guttrum and Benwell forests (fill Reed Bed Swamp and Little Reed Bed Swamp in winter/spring and autumn/winter, top-ups to support bird breeding)[1]	• Rehabilitate aquatic vegetation, semiaquatic vegetation and river red gum communities in semipermanent wetlands • Provide feeding, breeding and refuge habitat for waterbirds, frogs and turtles • Support colonial waterbird breeding, if it occurs
Johnson Swamp (fill in spring)	• Provide feeding and breeding habitats for waterbirds • Minimise the growth of tall marsh vegetation
Lake Cullen (spring fill)	• Support waterbird populations by providing suitable roosting and feeding habitat • Increase the growth and recruitment of aquatic vegetation
Lake Elizabeth (top-ups as required to maintain water-quality targets)	• Maintain habitat for translocated Murray hardyhead • Support submerged salt-tolerant aquatic plant assemblage and a high diversity of waterbirds
Lake Murphy (partial fill in autumn/winter)	• Promote the growth of a variety of vegetation communities (including recently planted juvenile river red gums) to support waterbird and frog feeding and breeding habitats
McDonalds Swamp (fill in spring and provide top-ups if required to support bird breeding)	• Increase the variety of vegetation communities by supporting the survival and growth of juvenile river red gums and reducing the spread of tall marsh • Facilitate early plant germination and provide suitable conditions for winter frog breeding
Round Lake (top-ups as required to maintain water-quality targets)	• Maintain habitat for Murray hardyhead • Maintain suitable waterbird habitat
Wirra-Lo wetland complex (top-ups as required to support a mosaic of wet and dry habitat)	• Rehabilitate river red gum and a variety of aquatic vegetation communities, providing suitable habitat for the growling grass frog and a high diversity of waterbirds including brolga • Provide habitat for water-dependent animals
Wetland drying	
Hird Swamp, Richardsons Lagoon	• Not to be actively watered in 2018–19 • Seasonal drying helps to maintain the health of existing trees in the bed of the wetlands • The drying phase of Hird Swamp will help to manage tall reed vegetation and promote herbland species

[1] *Infrastructure projects for Guttrum and Benwell forests are being assessed as part of the Sustainable Diversion Limit Offset component of the Basin Plan. Until works are approved and completed, only semipermanent wetlands that can receive water pumped from the River Murray will be considered for watering.*

Scenario planning

Table 5.2.8 outlines the potential environmental watering and expected water use under a range of planning scenarios.

North Central CMA has undertaken landscape-scale planning for these wetlands to optimise the wetland watering regimes over multiple years. An important consideration in this planning is to ensure there is a large variety of habitat types available across the region to support waterbirds and other water-dependent animals at any time.

The wetlands of highest priority (tier 1) for management of water for the environment in the central Murray wetlands in 2018–19 under all planning scenarios are Round Lake, Lake Elizabeth and the Wirra-Lo wetland complex. Round Lake supports what is considered to be the only stable population of the critically endangered Murray hardyhead in the Kerang area, and it is used to stock hardyhead in other wetlands across Victoria including Lake Elizabeth. The Wirra-Lo wetland complex is a permanent drought refuge for waterbirds and other threatened species (such as the nationally listed growling grass frog).

The Guttrum and Benwell forests have not received water for the environment to date and have only received natural inflows in five of the past 10 years. The forests are still recovering from the Millennium Drought and grazing pressures in previous years, and they need more-frequent inundation. Providing water for the environment in line with a more-natural flooding regime in winter/spring 2018 is also a high priority for 2018–19 in all scenarios, to rehabilitate the wetland plants and river red gum forest in Reed Bed Swamp and Little Reed Bed Swamp. The delivery of water for the environment will also provide an opportunity to collect hydrological and hydraulic information to inform the design of future, permanent infrastructure projects.

If water availability increases under all planning scenarios, water for the environment may be delivered to additional wetlands or for additional watering actions (under tier 2) to help meet native plant, animal and waterbird objectives. Under drought and dry conditions, water for the environment may be used to fill some wetlands that did not receive water for the environment or natural inflows in 2017–18, or to maintain water depth in wetlands that received water for the environment in the previous year.

Under very wet conditions, large floods may partially or completely fill some of the central Murray wetlands, but water for the environment may be required to maintain water depth to support waterbird breeding and vegetation condition.

Lake Cullen may receive a top-up in spring 2018, depending on the outcomes of an investigation into groundwater interactions between the lake and the neighbouring Avoca Marshes. Top-ups to the lake will provide important refuge for waterbirds to rest and feed.

Johnson Swamp is scheduled to receive a fill in spring, if there is enough environmental allocation. Johnson Swamp has dried over the last two and a half years, and watering in spring aims to provide feeding and breeding opportunities for waterbirds. Some flows will also be managed through Johnson Swamp, with outflows of carbon-rich water being delivered to Pyramid Creek during a planned spring fresh. These through-flows aim to boost the carbon supply to Pyramid Creek and increase the productivity of the riverine foodweb. They are good examples of how water for the environment is used to support fundamental ecological processes and maximise ecological outcomes across multiple waterways.

No water for the environment is planned for delivery to Hird Swamp or Richardsons Lagoon. These wetlands are planned to undergo a drying phase to promote the growth of herbland species and fringing vegetation.

Table 5.2.8 Potential environmental watering for central Murray wetlands under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected catchment conditions	• Catchment run-off and unregulated flows into the wetlands are unlikely	• Some catchment run-off and unregulated flows into the wetlands are possible, particularly in winter/spring	• Low-to-moderate catchment run-off and unregulated flows into the wetlands are likely, particularly in winter/spring	• Catchment run-off and unregulated flows into the wetlands may significantly contribute to water levels in some wetlands, particularly in winter/spring
Potential environmental watering – tier 1 (high priorities)	• Round Lake • Lake Elizabeth • Wirra-Lo wetland complex • Guttrum and Benwell forests (winter/spring)	• Round Lake • Lake Elizabeth • Wirra-Lo wetland complex • Guttrum and Benwell forests (winter/spring) • Lake Cullen[1] • McDonalds Swamp • Lake Murphy	• Round Lake • Lake Elizabeth • Wirra-Lo wetland complex • Guttrum and Benwell forests (winter/spring) • Lake Cullen[1] • McDonalds Swamp • Lake Murphy • Johnson Swamp	• Round Lake • Lake Elizabeth • Wirra-Lo wetland complex • Guttrum and Benwell forests[3] • Lake Cullen[1] • McDonalds Swamp • Lake Murphy • Johnson Swamp
Potential environmental watering – tier 2 (additional priorities)	• McDonalds Swamp • Lake Murphy	• Johnson Swamp • Guttrum and Benwell forests (autumn/winter)	• Johnson Swamp • Guttrum and Benwell forests (autumn/winter)	• N/A
Possible volume of water for the environment required to meet objectives[2]	• 14,900ML (tier 1) • 6,600 ML (tier 2)	• 18,000 ML (tier 1) • 4,500 ML (tier 2)	• 21,500 ML (tier 1) • 700 ML (tier 2)	• 21,100 ML (tier 1)[3]
Priority carryover requirements	• 3,700 ML	• 2,900 ML	• 2,900 ML	• 2,300 ML

1 *Dependent on the outcomes of the Lake Cullen groundwater investigation.*

2 *Possible water for the environment requirements for tier 2 are additional to tier 1 requirements.*

3 *Natural inflows may fill Guttrum and Benwell forests in a wet scenario; and if a significant bird-breeding event is triggered, water for the environment may be pumped to the wetlands if appropriate.*

Risk management

Environmental watering program partners have considered and assessed risks and identified mitigating strategies relating to environmental flows in 2018–19. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

Engagement

Table 5.2.9 shows the partners, stakeholder organisations and individuals with which North Central CMA engaged when preparing the central Murray wetlands seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional catchment strategies, regional waterway strategies, environmental flow studies, water management plans and other studies. These incorporate a range of environmental, cultural, social and economic perspectives and longer-term integrated catchment and waterway management objectives. For further details, refer to the *North Central Regional Catchment Strategy* and the North Central Waterway Strategy.

Table 5.2.9 Partners and stakeholders engaged in developing the central Murray wetlands seasonal watering proposal

Partner and stakeholder engagement
• Barapa Barapa Nations Traditional Owners • Birdlife Australia • Central Murray Wetlands Environmental Water Advisory Group (made up of community members, private landholders, interest groups including Game Management Authority, North Central CMA project staff and Board representation) • Commonwealth Environmental Water Office • Community members • Department of Environment, Land, Water and Planning • Field & Game Australia • Gannawarra Shire Council • Goulburn-Murray Water • Gunbower Operations Advisory Group (with representation from Goulburn-Murray Water, Parks Victoria, Department of Environment, Land, Water and Planning, Vic Forests, State Forests NSW, North Central CMA, Murray–Darling Basin Authority, Commonwealth Environmental Water Holder and the Victorian Environmental Water Holder) • Landholders owning a wetland that receives environmental water • Loddon Shire Council • North Central CMA Board • Parks Victoria • Swan Hill Rural City Council • Victorian Environmental Water Holder • Wamba Wemba Nations Traditional Owners

5.2.4 Hattah Lakes

Hattah-Kulkyne National Park is situated in north-western Victoria adjacent to the River Murray (Figure 5.2.4) The national park contains a complex of more than 20 semipermanent freshwater lakes known collectively as Hattah Lakes. The ecology of the lakes and floodplain is strongly influenced by flooding regimes of the River Murray. The construction of a permanent pump station, regulators and levees at Hattah Lakes in 2013 has enabled greater volumes of water for the environment to be delivered to the site, to return a more-natural, healthy pattern of flooding to the lakes.

Hattah Lakes is an important place for Traditional Owners and their Nations. Currently there is no Registered Aboriginal Party for the region and the Mallee CMA involves the region's Traditional Owners in the management of Hattah Lakes through its Aboriginal Reference Group, which includes First Peoples of the Millewa-Mallee and the Wadi Wadi and Tati Tati Traditional Owners.

Environmental values

Hattah Lakes is home to a diverse range of flood-dependent vegetation that changes with the topography of the landscape. Vegetation types range from wetland communities in lower-lying areas that require almost annual flooding to lignum and black box communities situated higher on the floodplain that only need flooding every four to five years. Regulation of the River Murray has resulted in less-frequent floods of shorter duration, and many of the vegetation communities across the site do not receive enough water without the delivery of environmental water. A combination of natural flooding and delivery of water for the environment since 2010 has improved canopy health and recruitment of black box communities.

Hattah Lakes provides important waterbird breeding sites in an arid landscape. A total of 34 species of waterbirds are known to breed at the lakes when conditions are suitable. Another six species of waterbirds breed in the surrounding floodplain. Wetland drought-refuge sites are limited in the region, making Hattah Lakes critically important habitat for native fish and terrestrial animals. The endangered freshwater catfish is known to inhabit the lakes.

Social and economic values

Hattah-Kulkyne National Park is a popular location for camping, canoeing, birdwatching and photography. Local businesses in the area benefit from increased visitation following environmental watering and natural flooding events.

Environmental watering objectives in the Hattah Lakes

	Rehabilitate a healthy and diverse mix of wetland and floodplain plant life to maintain the ecological character of this internationally protected site
	Provide feeding and breeding habitat for a range of waterbird species including threatened and migratory species and colonial nesting species (such as the spoonbill and egret)

System overview

The Hattah Lakes system is filled when there are high flows in the River Murray, and some lakes hold water for several years after flood waters recede. Regulation of the River Murray has significantly reduced the frequency and magnitude of natural floods in the Hattah Lakes system. Over time, this has degraded vegetation communities and reduced the diversity and abundance of animals that use the vegetation and wetlands for habitat and food.

Large-scale engineering works were completed under the Living Murray program to allow water regimes in Hattah Lakes to be more effectively managed over a range of River Murray flows. Those works include building a permanent pump station and levees that allow water to be pumped from the River Murray to the Hattah Lakes via Chalka Creek. Regulators were also built and are operated to retain water in the lakes and then release it at specific times and rates to support the environmental values of the system.

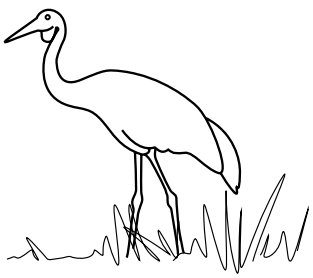
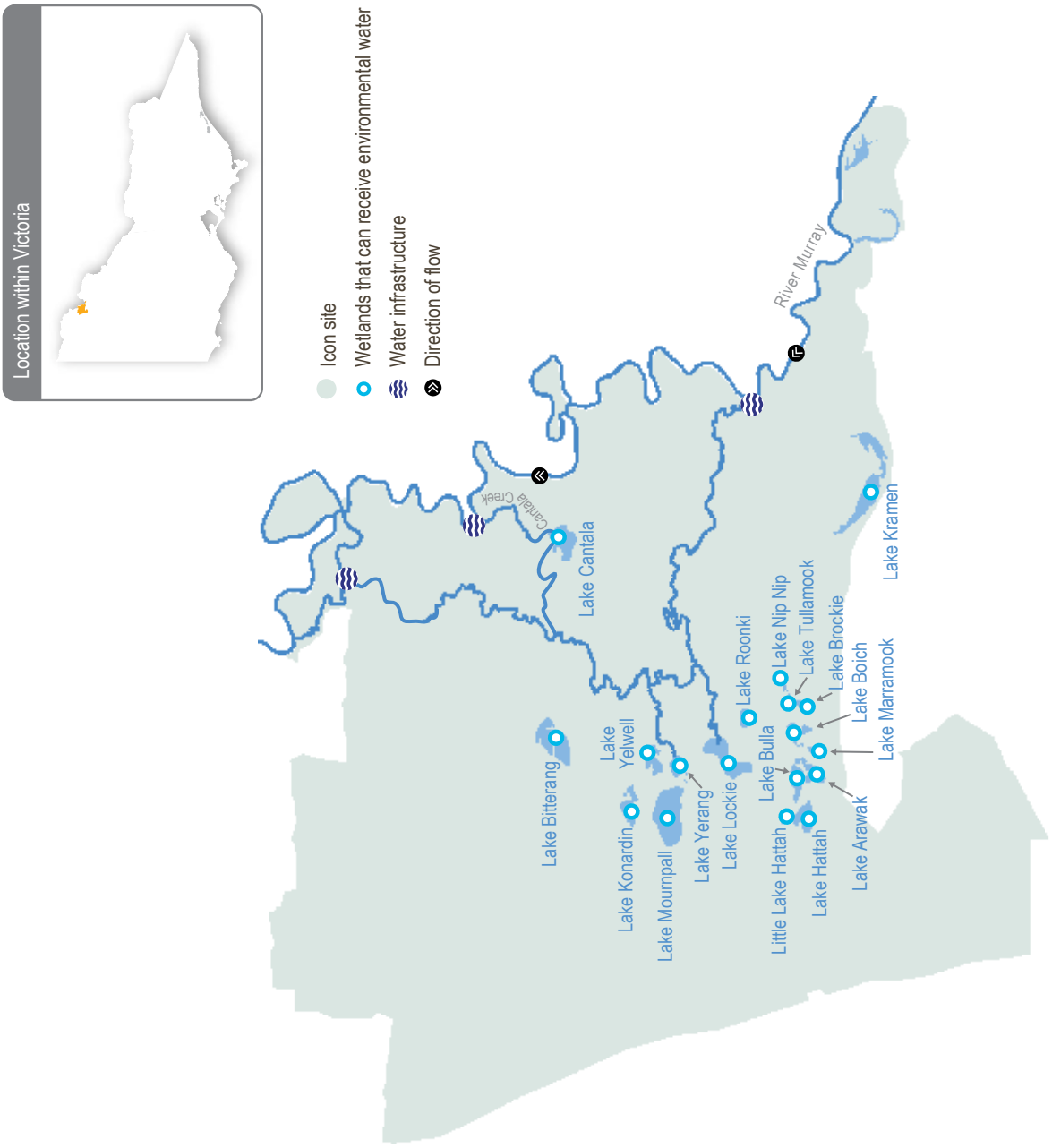


Figure 5.2.4 Hattah Lakes



Recent conditions

Environmental watering in 2017–18 aimed to improve the health of black box woodland on the Hattah Lakes floodplain and to consolidate some of the ecological outcomes that were triggered by natural floods in spring 2016.

Looking back two years to July 2016, it was not anticipated that any water for the environment would be provided to Hattah Lakes. The seasonal outlook was dry and some of the lower-lying lakes had received water three times in the previous four years, so wetland drying was considered appropriate to draw down lake levels to allow seeds to germinate and plants to establish themselves on the edges of the wetland.

Winter and spring 2016 were wetter than expected, so a decision was made to deliver water for the environment to Hattah Lakes during September and October 2016 to align with the wet conditions. Late October and November 2016 brought the largest floods in the River Murray in the last two decades. The Hattah Lakes and floodplain were inundated for 16 consecutive weeks and reached a maximum level of 44.6 m AHD (Australian Height Datum), providing perfect conditions for the recovery of black box trees that had not been flooded since the 1990s.

The ecological productivity boost and increase in new plant growth associated with floods can be short-lived without significant watering in the subsequent year. Over 110 GL of water for the environment was delivered to the Hattah Lakes between July and October 2017 to support the further germination, growth and recovery of black box trees. The water delivery aimed to inundate as much of the Hattah Lakes as possible within the constraints of the available infrastructure. Water levels throughout the lakes reached 44.85 m AHD, which is the highest inundation by environmental or flood water since the 1970s. Recent monitoring indicates that black box health has improved, with tree canopy cover increasing in areas that received water for the environment in 2017–18.

Scope of environmental watering

Table 5.2.10 shows potential environmental watering actions and their environmental objectives.

Table 5.2.10 Potential environmental watering actions and objectives for the Hattah Lakes

Potential environmental watering[1]	Environmental objectives
Wetland watering	
Natural inundation of Chalka Creek and Hattah Lakes	• Allow natural connectivity between Hattah Lakes and the River Murray • Allow exchange of carbon, nutrients and biota between the wetlands and the River Murray
Wetland drying	
Drying of Hattah Lakes	• Maintain the lake bed herbland as water levels recede • Allow drying of lakes to manage carp and improve wetland condition

[1] *The Hattah Lakes pump station may also be operated at any time of year to meet annual maintenance requirements.*

Scenario planning

Table 5.2.11 outlines potential environmental watering and expected water use under a range of planning scenarios.

The Hattah Lakes have received water for the environment in every year since 2012–13, so the priority in 2018–19 will be to allow the lakes and surrounding floodplain to naturally dry. Watering requirements for woodlands and semipermanent wetlands have been met and these communities now need time to dry and allow new understory to develop. Widespread drawdowns in lake water levels will enable seeds to germinate and plants to grow and become established in the littoral zone. Exposed mudflats and shallow-water habitats established by drying will provide feeding habitat for waterbirds. Drying the lakes will also help to manage non-native fish species (such as carp), which threaten the environmental values of the site.

No delivery of water for the environment is planned for 2018–19, but the regulator gates will remain open to allow any natural floods to enter and leave the floodplain, allowing connectivity between the lakes and river for the exchange of carbon, nutrients and biota. The Hattah Lakes pump station may need to use some water for the environment for annual maintenance, testing and commissioning of updated infrastructure. A contingency of 4,000 ML has been set aside for that purpose.

Table 5.2.11 Potential environmental watering for the Hattah Lakes under a range of planning scenarios

Planning scenario	Drought	Dry	Near-average	Very wet
Expected conditions	• Low flows year-round in the River Murray and no natural inflows to Hattah Lakes; substantial wetland drying will occur	• Rare high-flow events in the River Murray and no natural inflows to Hattah Lakes; substantial wetland drying will occur	• Short periods of high flows, most likely in late winter and spring, providing minor inflows to Hattah Lakes	• Lengthy periods of high flows with major spills from storages resulting in widespread inundation of Hattah Lakes and floodplain
Potential environmental watering	• Wetland drying	• Wetland drying	• Wetland drying with some minor, natural inflows	• Natural inundation of Chalka Creek and Hattah Lakes
Possible volume	• 0 ML	• 0 ML	• 0 ML	• 0 ML

Risk management

Environmental watering program partners have considered and assessed risks and identified mitigating strategies relating to environmental flows in 2018–19. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

Engagement

Table 5.2.12 shows the partners and stakeholder organisations who have assisted the Mallee CMA prepare the Hattah Lakes seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional catchment strategies, regional waterway strategies, environmental flow studies, water management plans and other studies. These incorporate a range of environmental, cultural, social and economic perspectives and longer-term integrated catchment and waterway management objectives. For further details, refer to the *Mallee Regional Catchment Strategy* and the *Mallee Waterway Strategy*.

Table 5.2.12 Partners and stakeholders engaged in developing the Hattah Lakes seasonal watering proposal

Partner and stakeholder engagement
• Birdlife Australia (Mildura)
• Commonwealth Environmental Water Office
• Department of Environment, Land, Water and Planning
• Goulburn-Murray Water
• Landcare Groups (Kulkyne Way Landcare, Red Cliffs and District Landcare, Annuello [Robinvale and District] Landcare, Robinvale Indigenous Landcare, Sea Lake Landcare and Manangatang Landcare)
• Mallee CMA Aboriginal Reference Group including First Peoples of the Millewa-Mallee and members of the Wadi Wadi and Tati Tati Traditional Owners groups
• Mallee CMA Water Technical Advisory Committee (an advisory group to Mallee CMA comprising community members)
• Mid-Murray Field Naturalists
• Mildura Rural City Council
• Mildura 4WD Inc.
• Murray–Darling Basin Authority
• Parks Victoria
• Sunraysia bushwalkers
• Sustainable Living Mildura
• Victorian Environmental Water Holder
• Wildside Outdoors

5.2.5 Lower Murray wetlands

The lower Murray wetlands are found across the floodplain of the River Murray between Swan Hill and the South Australian border (Figure 5.2.5. The system includes a myriad of interconnected creeks, wetlands and floodplains that are ecologically important and reflect the natural character and attributes of the River Murray floodplain. While the number of wetlands across the lower Murray region are undefined, 66 of them are considered in the environmental watering program, and 54 of these have received water for the environment to date.

The wetlands of the lower Murray wetlands system hold significance for Traditional Owners and their Nations. For thousands of years, the wetlands provided resources (such as food and materials) to the Latji Latji, Wadi Wadi, Dadi Dadi and Wamba Wemba people. There is currently no Registered Aboriginal Party for the lower Murray wetlands. The Mallee CMA involves the region's Aboriginal communities in water management through the Aboriginal Reference Group, which includes First Peoples of the Millewa-Mallee, Wadi Wadi and Tati Tati Traditional Owners groups.

Cowanna and Brickworks billabongs are nationally significant wetlands located at Merbein Common, next to the River Murray near Mildura. Merbein Common has been identified as a priority for investment under *Water for Victoria*. Investment to improve walking, cycling and canoeing facilities at Merbein Common complements the success of providing environmental flows at Cowanna and Brickworks billabongs.

Environmental values

The lower Murray wetlands are comprised of multiple wetlands, creeks and billabongs on the floodplain of the River Murray. Depending on their location in the landscape, interactions with groundwater and their management history, the wetlands may be permanent or temporary, freshwater or saline. Differences in water regime and water quality between the wetlands provide a range of habitats for plants and animals. For example, permanent, saline wetlands (such as Brickworks Billabong) provide vital habitat for the endangered Murray hardyhead fish. Ephemeral wetlands provide important habitat and support different ecological processes in their wet and dry phases. During the wet phase, they provide short-term boom periods when river red gum trees and wetland plants grow, spread and provide habitat for aquatic animals (such as waterbugs, birds, frogs and in some cases fish). During the dry phase, sediments aerate and oxygen is replaced, and terrestrial plants grow and complete life cycles.

Social and economic values

There are several irrigation districts in the Sunraysia area that are supplied by the River Murray and contribute significant wealth to the local economy. Camping, fishing and other water-based recreational activities are popular along the River Murray including at some wetlands in the lower Murray system. Waterbirds attract birdwatchers throughout the year and duck hunting is allowed during declared seasons.

Environmental watering objectives in the lower Murray wetlands

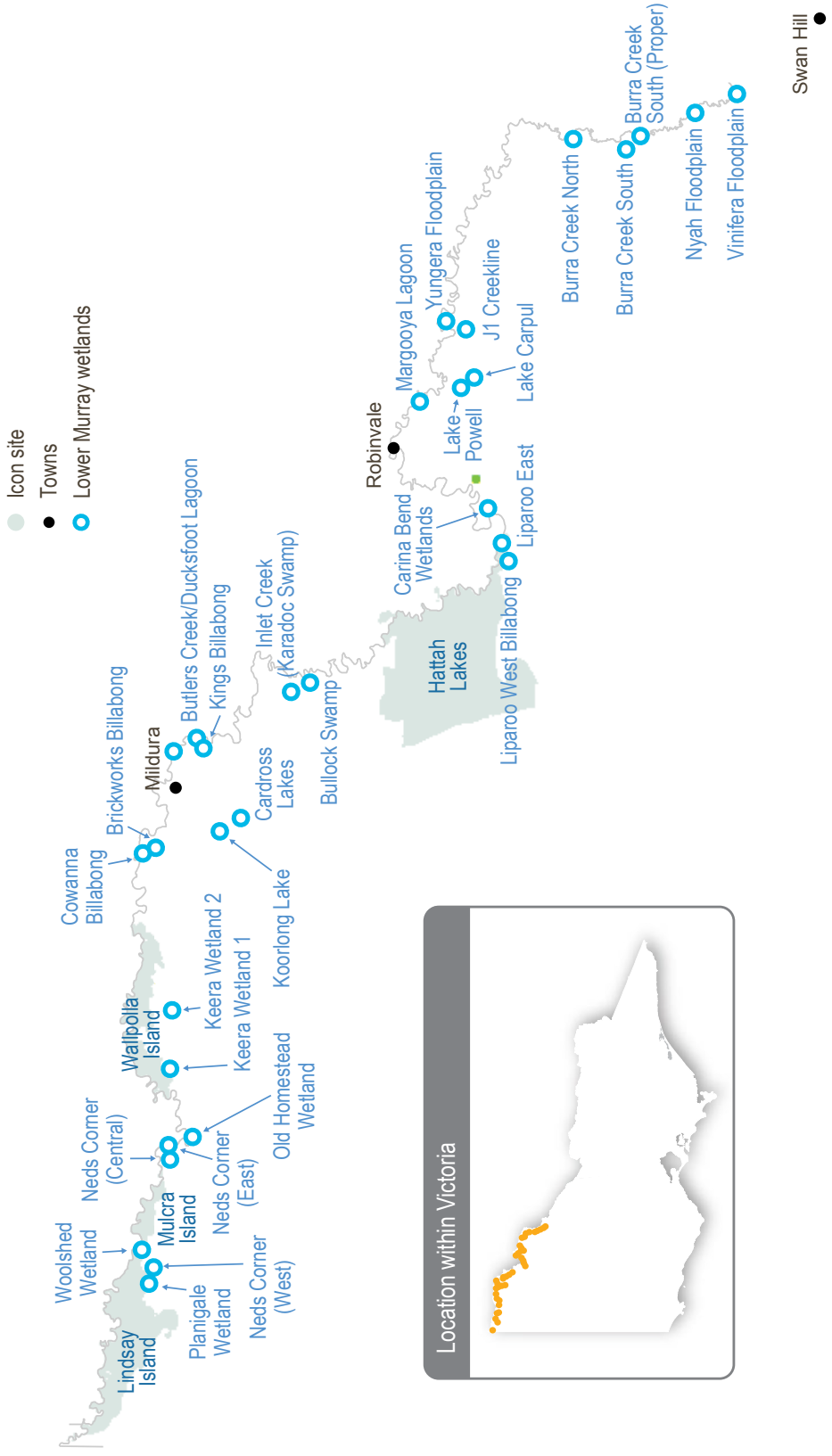
	Increase the diversity, extent and abundance of wetland plants
	Improve the condition of river red gums, black box and lignum to provide habitat for large terrestrial animals (such as lace monitors and bats)
	Provide feeding and breeding habitat for a range of waterbird species including threatened and migratory species and colonial species (such as egrets)
	Improve water quality and increase habitat for fish

System overview

Regulation and diversion of River Murray flows has substantially reduced the frequency and duration of the high river flows that are needed to provide water to the lower Murray wetlands. This change to the water regime has caused a decline in the environmental values associated with billabongs and other floodplain habitats.

Water for the environment can be delivered to some wetlands in the region through a combination of direct pumping from the River Murray and use of irrigation supply infrastructure. Most wetlands that receive water for the environment can be managed independently of each other.

Figure 5.2.5 Lower Murray wetlands



Recent conditions

Apart from a storm-driven flow pulse in early December 2017, the River Murray had lower-than-average inflows for much of 2017–18. Water for the environment was delivered to 11 wetlands in the lower Murray system during the year. Most of this water was used to partially or completely fill wetlands in spring, to consolidate ecological responses triggered by widespread floods in 2016–17. With continued dry conditions through the second half of summer and into autumn, the focus of deliveries of water for the environment shifted to protecting critical habitat. Top-up flows were delivered to Lake Hawthorn to provide habitat for waterbirds and to Brickworks Billabong to support the critically endangered Murray hardyhead.

The December flow pulse in the River Murray flooded the Nyah and Vinifera floodplains, Margooya Lagoon and Yungera Island, extending the period of inundation and providing connectivity between the floodplain and the River Murray. Rainfall, irrigation drainage and stormwater run-off were sufficient to meet ecological objectives at Koorlong Lake. Recent monitoring found over 700 Murray hardyhead in Koorlong Lake, proving that the population in the wetland is self-sustaining and robust.

Deliveries of water for the environment to Neds Corner in spring 2017 were halted on the advice of the Arthur Rylah Institute after monitoring through the Victorian Government's Wetland Monitoring and Assessment Program identified 15 rare, vulnerable or threatened plants in Neds Corner Central that had not been detected in the wetland before. Continuation of the watering may have displaced these plants. Management of the wetland has changed to reflect this finding: the approach is now to allow at least five years between inundation events where possible, to allow these threatened plants to establish. The wetland was last filled in 2016, so deliberate watering will not occur until at least 2021–22.

Scope of environmental watering

Table 5.2.13 shows potential environmental watering actions and their environmental objectives.

Environmental watering in 2018–19 will focus on maintaining and improving vegetation condition, habitat quality and availability throughout the wetlands, floodplains and waterways in the lower Murray area. Water for the environment may also be used to rehabilitate some salt-affected wetlands.

Table 5.2.13 Potential environmental watering actions and objectives for the lower Murray wetlands

Potential environmental watering	Environmental objectives
Wetland watering	
Bidgee Lagoons (fill in spring/summer)	• Maintain and promote the growth of vegetation that aligns with floodplain grassy wetland, pond herbland and shrubby riverine woodland ecological vegetation classes
Butlers Creek/Ducksfoot Lagoon (fill in spring/summer)	• Provide feeding habitat for waterbirds • Control noogoora burr
Brickworks Billabong (fill in spring or partial fill in autumn, as needed to maintain water-quality targets and minimum water level)	• Maintain and improve the condition of aquatic vegetation and water quality to increase the population of Murray hardyhead
Cardross Lakes Basin 1 East and West (partial fill in spring or as required to maintain water-quality targets and minimum water level)	
Koorlong Lake (partial fill as needed to maintain water-quality targets and minimum water level)	
Bullock Swamp (fill in winter/spring)	• Provide freshwater inflows and flushing flows to reduce salinity levels and improve the condition and diversity of wetland vegetation. • Improve ecological function
Burra Creek North (fill in winter/spring)	• Rehabilitate seasonal connectivity along Burra Creek • Improve the health and structure of the vegetation • Stimulate the growth of emergent and semiemergent aquatic vegetation
Burra Creek South (fill in winter/spring)	
Burra Creek South Proper (fill in winter/spring)	
Carina Bend wetlands (fill in winter/spring)	• Improve the condition of mature river red gum • Provide aquatic habitat to support fish and frogs • Provide habitat for waterfowl
Cowanna Billabong (fill in winter/spring)	• Increase wetland productivity • Provide feeding habitat for waterbirds

Table 5.2.13 Potential environmental watering actions and objectives for the lower Murray wetlands *continued*

Potential environmental watering	Environmental objectives
Inlet Creek Karadoc Swamp (fill in winter)	• Improve the condition of mature black box trees • Provide habitat to support frogs and fish • Provide habitat for waterbirds
Keera Wetland 1 (fill in spring) Keera Wetland 2 (fill in spring)	• Promote the growth of vegetation that aligns with the intermittent swampy woodland, lignum shrubland and lignum swampy woodland ecological vegetation classes
Lake Hawthorn (partial fill in spring or as required to maintain water at the minimum level)	• Support the growth of aquatic vegetation • Reintroduce saline marsh habitat • Provide habitat for waterbirds
Liparoo East (fill in winter) Liparoo West (fill in winter)	• Support seasonal habitat for small native fish • Provide feeding habitat for waterbirds • Maintain aquatic vegetation
Margooya Lagoon (fill in winter/spring/summer)	• Improve the condition of river red gums • Improve the native fish assemblage of the lagoon • Rehabilitate submerged aquatic vegetation in the open-water areas of the wetland
Nyah Floodplain (fill in spring/summer) Vinifera Floodplain (fill in spring/summer)	• Improve the condition and structure of wetland vegetation • Provide seasonal feeding and reproductive opportunities for native fish • Reestablish resident populations of frogs and small fish • Provide breeding habitat for waterbirds including colonial nesting species • Rehabilitate floodplain productivity to maintain the resident populations of terrestrial animals including carpet pythons, sugar gliders and grey-crowned babblers
Planigale Wetland (fill in winter/spring)	• Promote the growth of vegetation that aligns with the intermittent swampy woodland, lignum swampy woodland and riverine chenopod ecological vegetation classes • Improve habitat for mammals and reptiles • Support growling grass frogs
Tata North (fill in winter/spring)	• Maintain the health and structure of river red gum communities
Sandilong Creek (fill in spring/summer)	• Support catfish recruitment • Maintain fringing terrestrial vegetation
Woolshed Creek (fill in winter/spring)	• Improve the condition of woodland vegetation • Improve habitat for mammals and reptiles • Support growling grass frogs
Yungera Wetland (fill in winter/spring)	• Maintain and improve the health of river red gum and other floodplain trees
Wakool Creek (fill in spring/summer)	• Promote healthy and productive lignum shrubland • Provide habitat for waterbird nesting and roosting
Wetland drying	
Bridge Creek, Heywood Lake, J1 Creekline, Kings Billabong, Lake Carpul, Lake Powell, Little Heywood Lake, Neds Corner Central, Neds Corner East, Pound Bend Eastern wetlands, Robertson Wetland, Sandilong Billabong, Tata South	• These wetlands will not be actively watered in 2018–19 • Drying will promote the growth and establishment of vegetation in and surrounding the wetland, priming the system to support a wide range of wetland-dependent birds and animals

Scenario planning

Table 5.2.14 outlines the potential environmental watering and expected water use under a range of planning scenarios.

The highest-priority wetlands for environmental watering in 2018–19 under all climate scenarios and particularly in a drought scenario are Cardross Lakes, Lake Koorlong and Brickworks Billabong, as these sites support the critically endangered Murray hardyhead.

Depending on seasonal conditions and water availability, water deliveries to remaining wetlands are prioritised considering their recommended water regimes and the condition of the environmental values at each site. Under wetter scenarios, additional wetlands will be watered to mimic conditions that would naturally occur. In this way, the environmental responses are maximised as plants and animals respond to natural environmental cues.

Some wetlands will not be actively watered in 2018–19 and will be allowed to dry. This will allow some types of vegetation to germinate and establish, and it will increase the diversity of habitats available for aquatic plants and animals during the next wet phase. The dry phase will also provide opportunities for terrestrial animals to access temporary habitat and food.

Table 5.2.14 Potential environmental watering for lower Murray wetlands under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected catchment conditions	• No unregulated flows in the River Murray year-round and wetlands rely on delivery of water for the environment; very low rainfall year-round and extremely hot and dry conditions in summer/autumn causes substantial wetland drying	• Short periods of high flows in the River Murray are possible, however overbank flows to wetlands do not occur; low rainfall and very warm summer/autumn	• Sustained periods of high flows in the River Murray in late winter and early spring will provide some opportunity for low-lying wetlands to be naturally inundated but most wetlands will still rely on delivery of water for the environment • Local rainfall may be high and provide catchment flows to some wetlands	• Lengthy periods of high flows and floods with major spills from storages, resulting in widespread inundation of the floodplain and most wetlands • Some reliance on water for the environment to achieve target water levels • Local rainfall may be high and will provide catchment flows to most wetlands
Potential environmental watering – tier 1 (high priorities)	• Brickworks Billabong • Cardross Lakes • Koorlong Lake	• Brickworks Billabong • Burra Creek North • Burra Creek South • Burra Creek South Proper • Butlers Creek • Cardross Lakes • Cowanna Billabong • Koorlong Lake • Lake Hawthorn • Margooya Lagoon • Nyah Floodplain • Sandilong Creek • Vinifera Floodplain • Yungera Wetland	• Brickworks Billabong • Bullock Swamp North • Burra Creek North • Burra Creek South • Burra Creek South Proper • Butlers Creek • Cardross Lakes Basin 1 East and West • Carina Bend wetlands • Cowanna Billabong • Koorlong Lake • Lake Hawthorn • Liparoo East • Liparoo West Billabong • Margooya Lagoon	• Brickworks Billabong • Bullock Swamp North • Burra Creek North • Burra Creek South • Burra Creek South Proper • Butlers Creek • Cardross Lakes Basin 1 East and West • Carina Bend wetlands • Cowanna Billabong • Koorlong Lake • Lake Hawthorn • Liparoo East • Liparoo West Billabong • Margooya Lagoon

Table 5.2.14 Potential environmental watering for lower Murray wetlands under a range of planning scenarios *continued*

Planning scenario	Drought	Dry	Average	Wet
Potential environmental watering – tier 1 (high priorities)			• Nyah Floodplain • Planigale Wetland • Sandilong Creek • Vinifera Floodplain • Woolshed Wetland • Yungera Wetland	• Nyah Floodplain • Planigale Wetland • Sandilong Creek • Vinifera Floodplain • Woolshed Wetland • Yungera Wetland
Potential environmental watering – tier 2 (additional priorities)		• Bidgee Lagoons • Tata Creek North • Wakool Creek	• Bidgee Lagoons • Tata Creek North • Wakool Creek	• Inlet Creek (Karadoc) • Keera Wetland 1 • Keera Wetland 2
Possible volume of water for the environment required to meet objectives[1]	• 1,400 ML (tier 1) • 0 ML (tier 2)	• 5,950 ML (tier 1) • 2,700 ML (tier 2)	• 10,300 ML (tier 1) • 2,700 ML (tier 2)	• 2,950 ML (tier 1) • 1,450 ML (tier 2)

[1] *Water for the environment requirements for tier 2 actions are additional to tier 1 requirements.*

Risk management

Environmental watering program partners have considered and assessed risks and identified mitigating strategies relating to environmental flows in 2018–19. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

Engagement

Table 5.2.15 shows the partners and stakeholder organisations with which Mallee CMA engaged when preparing the lower Murray wetlands seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional catchment strategies, regional waterway strategies, environmental flow studies, water management plans and other studies. These incorporate a range of environmental, cultural, social and economic perspectives and longer-term integrated catchment and waterway management objectives. For further details, refer to the *Mallee Regional Catchment Strategy* and the *Mallee Waterway Strategy*.

Table 5.2.15 Partners and stakeholders engaged in developing the lower Murray wetlands seasonal watering proposal

Partner and stakeholder engagement
• Commonwealth Environmental Water Office
• Department of Environment, Land, Water and Planning
• Environmental groups (Trust for Nature, Nyah and Districts Action Group, Nyah and Districts Weed Warriors, Sustainable Living in the Mallee, Mallee Fowl Recovery Group, Mid-Murray Field Naturalists)
• Four friends groups
• Goulburn-Murray Water
• Lake Lascelles Committee
• Lake Tchum Committee
• 25 Landcare groups
• Lower Murray Water
• Mallee Aboriginal Reference Group
• Mallee CMA Water Technical Advisory Committee (an advisory group to Mallee CMA comprising community members)
• Mallee District Aboriginal Services
• Meringur Historical Society
• Mildura Birdlife, Wildside outdoors – canoeing, Mildura 4WD Inc.
• Mildura Rural City and Swan Hill Rural City councils
• Murray–Darling Basin Authority
• Parks Victoria
• Recreational groups (Sunraysia Apiarists Association, Riverside Golf Course, Sunraysia Bushwalkers
• Victorian Environmental Water Holder

5.2.6 Lindsay, Mulcra and Wallpolla islands

The Lindsay, Mulcra and Wallpolla islands cover over 26,100 ha of Victorian floodplain in the Murray-Sunset National Park (Figure 5.2.6). They form part of the Chowilla Floodplains–Lindsay–Wallpolla Islands Living Murray icon site that straddles the Victoria and South Australia border. Lindsay Island, Wallpolla Island and Lake Wallawalla are recognised as nationally-important wetlands.

The wetlands and waterways in the Lindsay, Mulcra and Wallpolla islands system hold significance for Traditional Owners and their Nations. Currently there is no Registered Aboriginal Party for the region and the Mallee Catchment Management Authority involves the region's Traditional Owners in in the management of Lindsay, Mulcra and Wallpolla islands through its Aboriginal Reference Group, which includes First Peoples of the Millewa-Mallee and the Wadi Wadi and Tati Tati Traditional Owners.

Environmental values

The Lindsay, Mulcra and Wallpolla islands represent three separate anabranch systems including streams, billabongs, large wetlands and swamps. When flooded, waterways and wetlands within these systems provide habitat for native fish, frogs, turtles and waterbirds. Terrestrial animals (such as woodland birds) also benefit from the improved productivity and food resources when the system floods. During dry periods, large floodplain wetlands (such as Lake Wallawalla) can retain water and provide important refuge areas for wetland-dependent species and support terrestrial animals (such as small mammals and reptiles).

Mullaroo Creek and the Lindsay River are renowned for supporting one of the most-significant populations of Murray cod in the lower River Murray. These waterways provide fast-flowing habitat that Murray cod favour, and they contrast with the slow-flowing and still habitats in the nearby River Murray. Mature breeding fish in these waterways are an important source of juveniles for the overall Murray system. Waterways and wetlands throughout the icon site also support several other threatened fish species (such as the freshwater catfish, silver perch, Murray-Darling rainbowfish and unspecked hardyhead).

The reduced frequency and duration of floods in the River Murray has degraded the water-dependent vegetation communities, which has in turn caused declines in the diversity and abundance of animals that rely on healthy vegetation for habitat.

Environmental watering objectives in Lindsay, Wallpolla and Mulcra islands

	Increase the diversity, extent and abundance of wetland plants
	Increase the diversity, abundance and distribution of native fish Provide flows for large-bodied fish (including Murray cod and golden perch) to feed and breed
	Provide feeding and breeding habitat for a range of waterbird species including threatened, migratory and colonial nesting species (such as egrets)

Social and economic values

Lindsay, Mulcra and Wallpolla islands offer recreation opportunities in a remote location with camping, boating, fishing popular with residents of nearby communities and long-distance travellers. The area provides many birdwatching opportunities: over 200 aquatic and arid species are known to use the site.

System overview

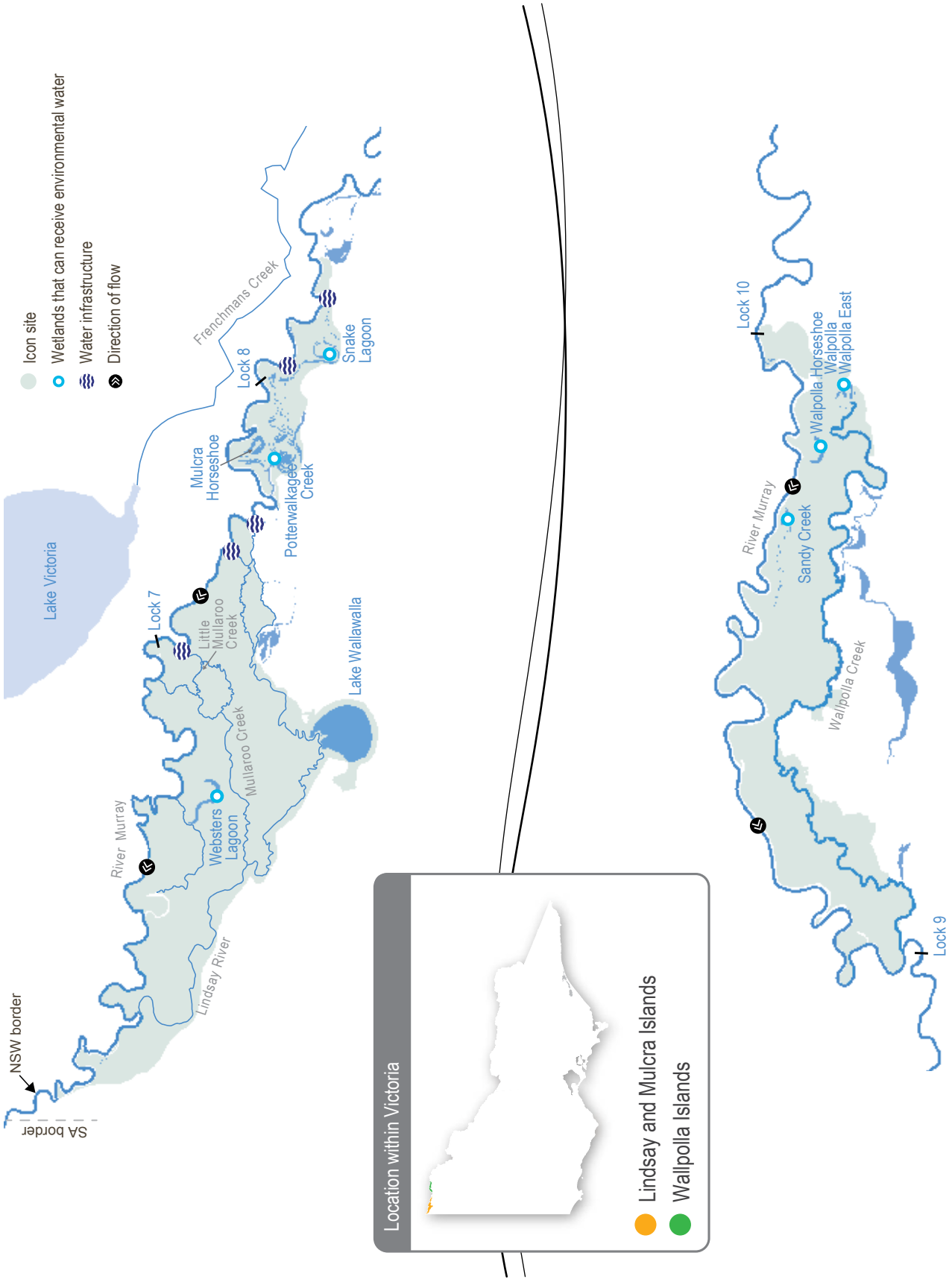
The Lindsay, Mulcra and Wallpolla islands floodplain is characterised by a network of permanent waterways, small creeks and wetlands. The Lindsay River, Potterwalkagee Creek and Wallpolla Creek form the southern boundaries of the site and create large floodplain islands with the River Murray to the north.

In their natural state, these waterways and wetlands would regularly flow and fill in response to high water levels in the River Murray. Large floods still occur, but regulation of the River Murray has significantly reduced the frequency of small- to moderate-sized floods.

Under current system operations, most flows through Lindsay, Mulcra and Wallpolla islands are regulated by the River Murray locks 6 to 9. Depending on weir pool height, water can be diverted from the River Murray to the Lindsay River and to Mullaroo and Potterwalkagee creeks through several regulators and at varying flow rates. Levees and regulators have also been built throughout the Lindsay, Mulcra and Wallpolla floodplain to direct, retain and release water as needed to improve the environmental values at the site.

The Murray–Darling Basin Authority is responsible for managing weir pool levels in the River Murray. Multiple agencies work together to coordinate flows and weir pool levels to achieve environmental outcomes in the River Murray and within the Lindsay, Mulcra and Wallpolla islands icon site.

Figure 5.2.6 Lindsay, Mulcra and Wallpolla islands



Recent conditions

Much of the Lindsay, Mulcra and Wallpolla islands floodplain remained dry during the Millennium Drought. Floods in 2010–11 filled the wetlands and inundated black box woodland and lignum shrubland for the first time in more than 15 years. The floods in 2016 were larger, with peak flows in the River Murray ranging from about 105,000 ML per day at Wentworth and 95,000 ML per day at the South Australian border.

Water for the environment is delivered through anabranch waterways and to individual wetlands to supplement natural floods and support ecological values and processes that rely on more-frequent inundation. The focus of deliveries of water for the environment in 2017–18 was to maintain flowing habitat for fish recruitment and survival by providing flow through Mullaroo Creek, Lindsay River and Potterwalkagee Creek. Water for the environment was also pumped to Lake Wallawalla to maintain waterbird habitat and increase wetland plant growth and productivity.

Scope of environmental watering

Table 5.2.16 shows potential environmental watering actions and their environmental objectives.

Table 5.2.16 Potential environmental watering actions and objectives for the Lindsay, Mulcra and Wallpolla islands

Potential environmental watering	Environmental objectives
Lindsay Island – Mullaroo Creek	
Year-round low flows (600–800 ML/day)	• Maintain flowing water habitat for native fish species (such as Murray cod, silver perch and golden perch)
Spring high flow (up to 1,200 ML/day for up to 3 months between September–November)	• Initiate fish movement and improve spawning and recruitment opportunities for native fish
Autumn high flow (up to 1,000 ML/day for 1 month between April–May)	• Provide an early-season flow to stimulate return of large-bodied fish
Lindsay Island – Lindsay River	
Year-round low flows (40 ML/day via the northern regulator)	• Maintain flowing water habitat for native fish species such as Murray cod, silver perch and golden perch
Spring high flow (up to 450 ML/day for up to 3 months between September–November via the northern regulator)	• Initiate fish migration and improve spawning and recruitment opportunities for native fish
Spring high flow (up to 200 ML/day for up to 3 months between September–November via the southern regulator)	• Extend flowing water habitat for native fish species, providing spawning and recruitment opportunities
Autumn high flow (up to 200 ML/day for 1 month between April–May via the northern regulator)	• Provide an early-season flow to stimulate return of large-bodied fish
Lindsay Island wetlands	
Lake Wallawalla (partial fill in autumn)	• Stimulate an increase in available food sources and productivity levels for aquatic and wetland plant species • Maintain habitat for waterbirds
Websters Lagoon (partial or complete fill at any time)	• Maintain wetland habitat for fish and waterbirds
Mulcra Island – Potterwalkagee Creek	
Year-round low flows in lower Potterwalkagee Creek (100–400 ML/day via the Stony Crossing regulator)	• Maintain flowing water habitat for native fish species (such as Murray cod, silver perch and golden perch)
Winter/spring/summer low flows in upper Potterwalkagee Creek (up to 100 ML/day between June–February via the upper Potterwalkagee Creek regulator)	• Maintain seasonal flowing water habitat for native fish species (such as Murray cod, silver perch and golden perch)

Table 5.2.16 Potential environmental watering actions and objectives for the Lindsay, Mulcra and Wallpolla islands *continued*

Potential environmental watering	Environmental objectives
Spring/summer high flows in lower Potterwalkagee Creek (up to 400 ML/day for 3 months between September–January via the Stony Crossing regulator and upper Potterwalkagee Creek Regulator)	• Initiate fish movement and improve spawning and recruitment opportunities for native fish
Spring/summer high flows in upper Potterwalkagee Creek (up to 150 ML/day for 3 months between September–January via the upper Potterwalkagee Creek regulator)	
Mulcra Island wetlands	
Snake Lagoon (partial or complete fill in winter/spring)	• Improve wetland productivity and provide habitat for wetland birds and fish
Mulcra Horseshoe (partial or complete fill in winter/spring)	
Wallpolla Island	
Wallpolla Horseshoe (partial or complete fill any time)	• Maintain variable water levels in the littoral zone to improve wetland productivity • Control river red gum saplings
Wallpolla East (partial or complete fill in spring or autumn)	• Improve condition of the riverine grassy woodland and floodway pond herbland ecological vegetation classes • Provide temporary habitat for aquatic species with productivity transferred to creek lines
Sandy Creek (partial or complete fill in spring or autumn)	• Improve the condition of the grassy riverine forest and floodway pond herbland ecological vegetation classes

Scenario planning

Table 5.2.17 outlines the potential environmental watering and expected water use under a range of planning scenarios.

The main focus of environmental watering in 2018–19 is to provide variable, flowing water habitat through Lindsay River, Mullaroo Creek and Potterwalkagee Creek. Low flows must be provided all year round in Lindsay River (via the northern regulator), Potterwalkagee Creek (via the Stony Crossing regulator) and Mullaroo Creek, to protect resident fish populations. While low flows are required under all climate scenarios, their magnitude may vary depending on seasonal conditions and weir pool operations.

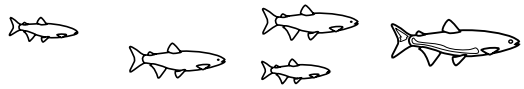
Apart from dry or drought scenarios, a long-duration high flow in spring is a high priority for all waterways, to stimulate fish movement and breeding. Under very wet conditions, an autumn fresh may be needed to stimulate the return of fish from the River Murray to the anabranches. Any managed high flows will be provided through all regulators that connect with the River Murray and will be coordinated with weir pool operations.

A high priority under wetter conditions is delivery of up to 8,000 ML of water for the environment to Lake Wallawalla in autumn. Water levels in Lake Wallwalla are receding after water for the environment was delivered in spring 2017, and a partial fill in autumn 2019 will prime the wetland for a complete fill in spring 2019. On Wallpolla Island, small-scale deliveries of water for the environment to Sandy Creek, Wallpolla East and Wallpolla Horseshoe are planned under all scenarios.

Table 5.2.17 Potential environmental watering for Lindsay, Mulcra and Wallpolla islands under a range of planning scenarios

Planning scenario	Very dry	Dry	Average	Very wet
Expected conditions	• Year-round low flows in the River Murray and no natural floodplain inundation; substantial wetland drying will occur	• Rare high-flow events in the River Murray and no natural floodplain inundation; substantial wetland drying will occur	• Short periods of high flows, most likely in late winter and spring, providing minor inundation of the floodplain	• Long periods of high flows with major spills from storages resulting in widespread inundation of the floodplain and inundation of most wetlands
Lindsay Island				
Mullaroo Creek and Lindsay River	• Year-round low flow	• Year-round low flow	• Year-round low flow • 1 spring high flow	• Year-round low flow • 1 spring high flow • 1 autumn high flow
Wetlands			• Lake Wallawalla (partial fill) • Websters Lagoon (partial to complete fill)	• Lake Wallawalla (partial fill) • Websters Lagoon (complete fill)
Water demand[1]	• <2,000 ML	• <2,000 ML	• < 2,000–10,000 ML	• < 2,000–10,000 ML
Mulcra Island				
Lower Potterwalkagee Creek via regulators	• Year-round low flow	• Year-round low flow	• Year-round low flow • 1 spring high flow	• Year-round low flow • 1 spring high flow
Upper Potterwalkagee Creek via regulator	• Year-round low flow	• Year-round low flow	• Year-round low flow • 1 spring high flow	• Year-round low flow • 1 spring high flow
Wetlands and floodplain				• Snake Lagoon (complete fill) • Mulcra Horseshoe (complete fill)
Water demand[1]	• <2,000 ML	• <2,000 ML	• <2,000 ML	• <2,000 ML
Wallpolla island				
Wetlands	• Wallpolla Horseshoe (partial fill)	• Wallpolla Horseshoe (partial fill)	• Wallpolla Horseshoe (complete fill) • Sandy Creek (partial or complete fill)	• Wallpolla Horseshoe (complete fill) • Sandy Creek (partial or complete fill) • Wallpolla East (partial or complete fill)
Water demand	• 1,000 ML	• 1,000 ML	• 1,600 ML	• 2,300 ML–2,600 ML

[1] *Volume includes the estimated volume of water for the environment required to underwrite the losses associated with the delivery of consumptive water en route (for flows in Mullaroo Creek, Lindsay River, Potterwalkagee Creek and Mulcra Island).*



Risk management

Environmental watering program partners have considered and assessed risks and identified mitigating strategies relating to environmental flows in 2018–19. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

Engagement

Table 5.2.18 shows the partners and stakeholder organisation with which Mallee CMA engaged when preparing the Lindsay, Mulcra and Wallpolla islands seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional catchment strategies, regional waterway strategies, environmental flow studies, water management plans and other studies. These incorporate a range of environmental, cultural, social and economic perspectives and longer-term integrated catchment and waterway management objectives. For further details, refer to the *Mallee Regional Catchment Strategy* and *Mallee Waterway Strategy*.

Table 5.2.18 Partners and stakeholders engaged in developing the Lindsay, Mulcra and Wallpolla islands seasonal watering proposal

Partner and stakeholder engagement
• Commonwealth Environmental Water Office • Department of Environment, Land, Water and Planning • Four friends groups • Goulburn-Murray Water • Lake Lascelles Committee • 24 Landcare groups (24) • Mallee CMA Aboriginal Reference Group, including First Peoples of the Millewa-Mallee and members of the Wadi Wadi and Tati Tati Traditional Owners groups • Mallee CMA Water Technical Advisory Committee (an advisory group to Mallee CMA comprising community members) • Mallee Fowl Recovery Group • Meringur Historical Society • Mid-Murray Field Naturalists • Mildura Rural City Council • Murray–Darling Basin Authority • Parks Victoria Recreational users (Sunraysia bushwalkers, Birdlife Australia (Mildura), Mildura 4WD Inc.) • Sustainable Living in the Mallee • Victorian Environmental Water Holder

5.3 Ovens system

Waterway manager – North East Catchment Management Authority

Storage manager – Goulburn-Murray Water

Environmental water holder – Commonwealth Environmental Water Holder

The Ovens River rises in the steep, forested mountains of the Great Dividing Range near Mount Hotham and flows about 150 km to join the River Murray in the backwaters of Lake Mulwala. The system contains two small water storages: Lake Buffalo on the Buffalo River and Lake William Hovell on the King River. The regulated reaches of the Ovens system include the Buffalo and King rivers downstream of these storages and the Ovens River from its confluence with the Buffalo River to the River Murray.

The Ovens River and its floodplain continue to be places of significance for Traditional Owners and their Nations including the Yorta Yorta, Bangarang, Taungurung and Dhudhuroa peoples. The Registered Aboriginal Parties in the Ovens system are the Yorta Yorta Nation Aboriginal Corporation in the Lower Ovens and the Taungurung Clans Aboriginal Corporation in the upper King area.

Environmental values

The diverse aquatic habitat and abundant food resources associated with the Ovens system support a wide range of native fish species including the Murray cod, trout cod, golden perch and fly-specked hardyhead. The Buffalo River provides valuable habitat for large fish species during part of their breeding cycle, while trout cod have a large range within the system and are found as far up the King River as Whitfield. The Ovens system has seen a successful recovery project for trout cod, and efforts to reintroduce Macquarie perch are continuing.

Frogs (such as the giant bullfrog and growling grass frog) are abundant in the lower reaches of the Ovens River and associated wetlands and in the King River upstream of Cheshunt. The lower Ovens wetland complex containing over 1,800 wetlands is listed as nationally significant and is home to a variety of waterbirds including egrets, herons, cormorants and bitterns. The riparian vegetation along the rivers consist mainly of river red gum forest and woodland, which are among the healthiest in Victoria.

Environmental watering objectives in the Ovens system

	Provide flows for native fish to move between pools and over rocky or shallow parts of the river
	Maintain the form of the riverbank and channel plus a range of different river bed surfaces to support all stream life
	Maintain water quality for all river life
	Provide habitat for a wide range of waterbugs which break down organic matter and support the river's food chain

Social and economic values

The Ovens River supports various recreational activities including fishing, boating, kayaking, swimming and bushwalking. Irrigation supports the food and wine industries that attract tourists to the region. The lower Ovens–River Murray weir pool associated with Lake Mulwala is another tourist drawcard.

System overview

As its storages are quite small and spill regularly, the Ovens system maintains a large proportion of its natural flow regime (particularly in winter/spring) and has a relatively small need for water for the environment compared with other large, more highly regulated rivers in Victoria.

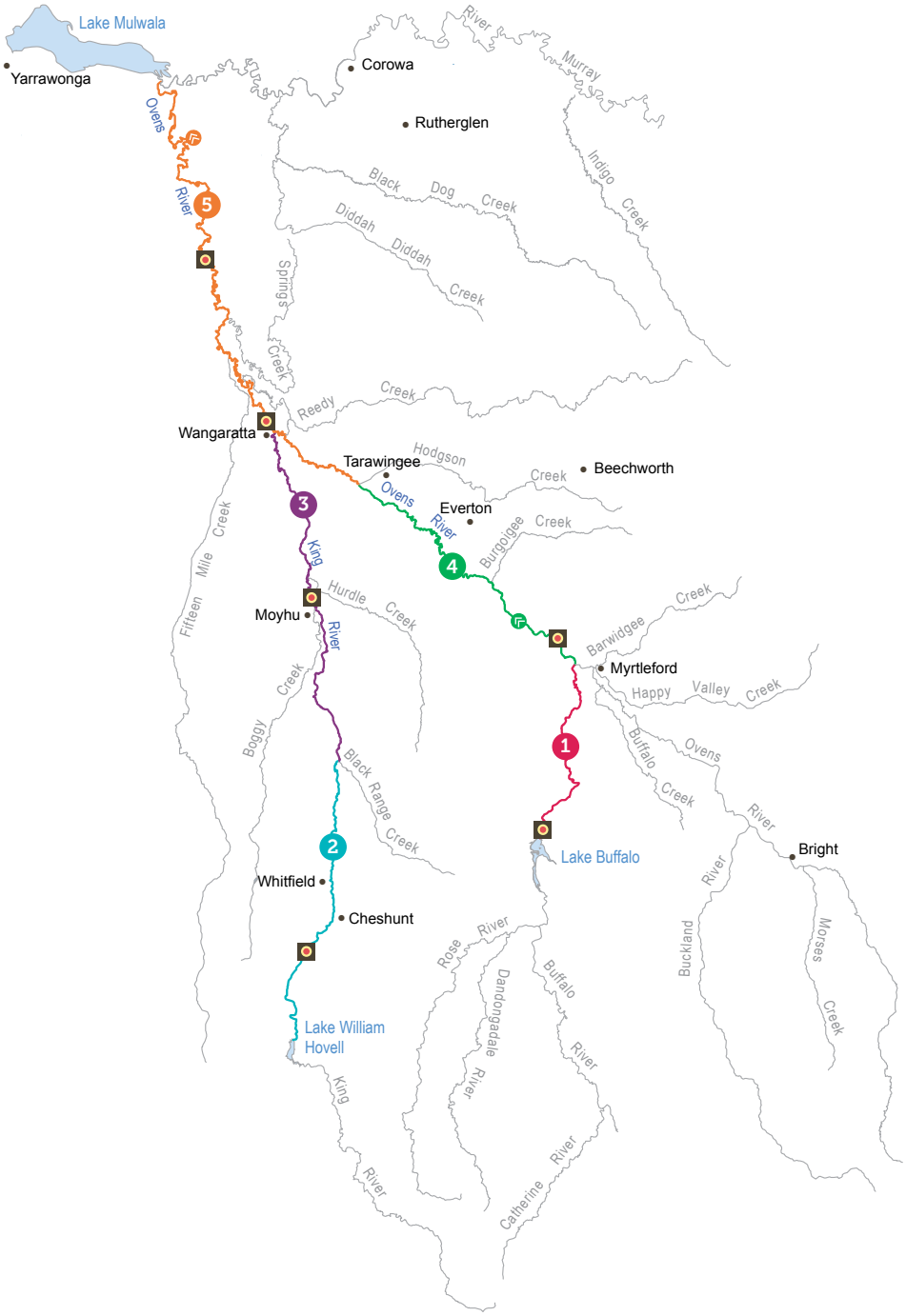
The Ovens River flows into Lake Mulwala on the River Murray, the largest weir pool on the Murray regulated system. Ovens River flows contribute to the reliability and variability of the flow regime for the River Murray and support many downstream uses including irrigation, urban supply and watering of iconic floodplain sites (such as Barmah Forest).

Water for the environment is held in Lake Buffalo and in Lake William Hovell and can be released when the storages are not spilling. Five reaches in the Ovens system can benefit from releases of water for the environment. While all are important, there is a relatively small volume (123 ML) of water for the environment available and it is well short of the volume required to meet all flow objectives. Despite the small volume, the use of water for the environment is carefully planned to deliver the greatest possible benefit. Water for the environment can be used to directly manage parts of the flow regime in reaches immediately downstream of the two main storages, or it can be paired with consumptive water releases to influence flow further downstream in the lower Ovens River.

Figure 5.3.1 The Ovens system

Reach 1 Buffalo River: Lake Buffalo to the Ovens River
Reach 2 King River: Lake William Hovell to Moyhu
Reach 3 King River: Moyhu to the Ovens River
Reach 4 Ovens River: Buffalo River to Everton/Tarrawingee
Reach 5 Ovens River: Everton/Tarrawingee to the Murray River at Lake Mulwala
Measurement point
Town
Indicates direction of flow

Grey river reaches have been included for context. The numbered reaches indicate where relevant environmental flow studies have been undertaken. Coloured reaches can receive environmental water.



Recent conditions

High rainfall and large-scale flooding in the Ovens River catchment in winter/spring 2016 filled Lake Buffalo and Lake Hume Hovell. Since then, the winter/spring and summer of 2017–18 was warmer than average, with below-average rainfall resulting in lower-than-average inflows to Lake Buffalo and Lake William Hovell in most months. Despite the drier conditions, the storages filled and spilled, resulting in natural flow patterns downstream and in the lower Ovens River. Lake William Hovell was full for most of winter/spring, while Lake Buffalo filled and spilled following a large rainfall event in December 2017. In autumn 2018, 73 ML of water for the environment was released from Lake Buffalo to maintain flow variability and water quality in the Buffalo River, and 50 ML was released from Lake William Hovell to meet similar objectives in the King River.

Scope of environmental watering

Table 5.3.1 shows potential environmental watering actions and their environmental objectives.

Table 5.3.1 Potential environmental watering actions and objectives for the Ovens system

Potential environmental watering	Environmental objectives
Summer/autumn low-flow fresh in reaches 1, 4 and 5 (1 fresh of 430 ML/day for 3 days in reaches 1 and 4, 130–260 ML/day in reach 5 in December–May)	Provide flow cues to stimulate movement of native fish Maintain connectivity between pools for fish movement and water quality Provide small variations in river levels to move sediment and maintain waterbug habitat Scour biofilm from the river bed
Provide low-flow variability[1] in reaches 1, 2 and 3	Maintain connectivity between pools for fish movement and water quality Provide small variations in river levels to move sediment and maintain waterbug habitat

[1] *Operational releases from storage can vary, with water for the environment used to provide some variability over one or two days.*

Scenario planning

Table 5.3.2 outlines the potential environmental watering and expected water use under a range of planning scenarios.

The climatic conditions and inflows into storages have a large effect on how water for the environment is likely to be used. Under dry conditions, water for the environment aims to provide low-flow variability and avoid flows ceasing in the reaches immediately below the storages. As conditions become wetter, there are more opportunities to piggyback environmental releases on consumptive water releases from Lake Buffalo and achieve environmental outcomes over a much greater length of river. Water for the environment cannot be released if the storages are spilling or if there is a risk that private land will be flooded because of releases. Under wet conditions, the storages are very likely to spill due to their small capacity. The recommended environmental flows through the Ovens system are likely to be achieved naturally through storage spills and unregulated tributary inflows under wet conditions. The water for the environment holdings in the Ovens system have a high level of security and are expected to be fully available under all scenarios.

Table 5.3.2 Potential environmental watering for the Ovens system under a range of planning scenarios

Planning scenario	Dry	Average	Wet[1]
Expected river conditions	• Possible winter/early spring unregulated flows • Highly likely low summer/ autumn flows • Bulk water release unlikely	• High winter/spring unregulated flows • Possible summer/autumn low flows • Bulk water release likely	• High unregulated flows throughout most of the year • Bulk water release likely • All flow objectives achieved naturally
Expected availability of water for the environment	• 50 ML Lake William Hovell • 73 ML Lake Buffalo • 123 ML total		
Potential environmental watering	• Summer/autumn low flows	• Summer/autumn fresh • Summer/autumn low flows	• None required
Possible volume of water for the environment required to meet objectives	• 123 ML	• 123 ML	• 0 ML

[1] *Spill conditions likely to mean water for the environment cannot be released under wet conditions.*

Risk management

Environmental watering program partners have considered and assessed risks and identified mitigating strategies relating to environmental flows in 2018–19. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

Engagement

Table 5.3.3 shows the partners with which North East CMA engaged when preparing the Ovens system seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional catchment strategies, regional waterway strategies, environmental flow studies, water management plans and other studies. These incorporate a range of environmental, cultural, social and economic perspectives and longer-term integrated catchment and waterway management objectives. For further details, refer to the *North East Regional Catchment Strategy* and *North East Waterway Strategy*.

Table 5.3.3 Partners engaged in developing the Ovens system seasonal watering proposal

Partner engagement
• Commonwealth Environmental Water Office • Goulburn-Murray Water • Victorian Environmental Water Holder

5.4 Goulburn system

Waterway manager – Goulburn Broken Catchment Management Authority

Storage manager – Goulburn-Murray Water

Environmental water holders – Commonwealth Environmental Water Holder, Victorian Environmental Water Holder, Murray–Darling Basin Authority (the Living Murray program)

The Goulburn is Victoria's largest river basin, covering over 1.6 million ha or 7.1 percent of the state. The Goulburn River flows for 570 km from the Great Dividing Range upstream of Woods Point to the River Murray east of Echuca. It is an iconic heritage river because of its environmental, Aboriginal cultural heritage and recreational values. It supports large areas of intact river red gum forest and floodplain wetlands, and it provides habitat for threatened and endangered bird and fish species. Several wetlands in the Goulburn Broken catchment are formally recognised for their conservation significance.

There are several environmental water holders in the Goulburn system. The Commonwealth Environmental Water Holder (CEWH) is the largest holder of water for the environment and use of Commonwealth water for the environment is critical to achieving outcomes in the Goulburn River. Water for the environment held on behalf of the Living Murray program may also assist in meeting objectives in the Goulburn system en route to icon sites in the Murray system (see section 1.4.2). Water held by the VEWH in the Goulburn system is used to meet environmental objectives in the river and the Goulburn wetlands.

Engagement

Table 5.4.1 shows the partners and stakeholder organisations that Goulburn Broken CMA engaged when preparing the Goulburn River and Goulburn wetlands seasonal watering proposal.

Seasonal watering proposals are informed by longer-term regional catchment strategies, regional waterway strategies, environmental flow studies, water management plans and other studies. These incorporate a range of environmental, cultural, social and economic perspectives and longer-term integrated catchment and waterway management objectives. For further details, refer to the *Goulburn Broken Regional Catchment Strategy* and *Goulburn Broken Waterway Strategy*.

Table 5.4.1 Partners and stakeholders engaged in developing the Goulburn system seasonal watering proposal

Partner and stakeholder engagement
• Commonwealth Environmental Water Office
• Goulburn Environmental Water Advisory Group (includes recreational users, local environment groups and landholders)
• Goulburn-Murray Water
• Parks Victoria
• Taungurung Clans Aboriginal Corporation
• Victorian Environmental Water Holder
• Yorta Yorta Nation Aboriginal Corporation

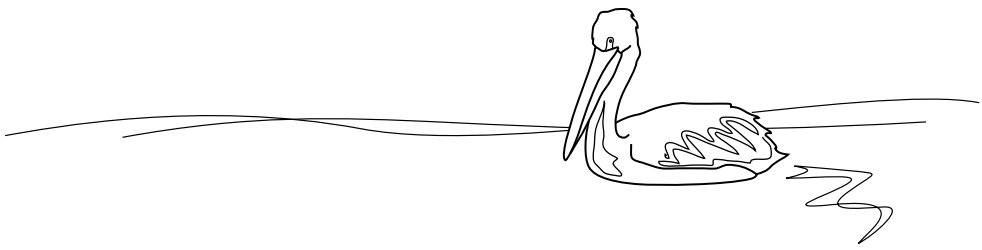
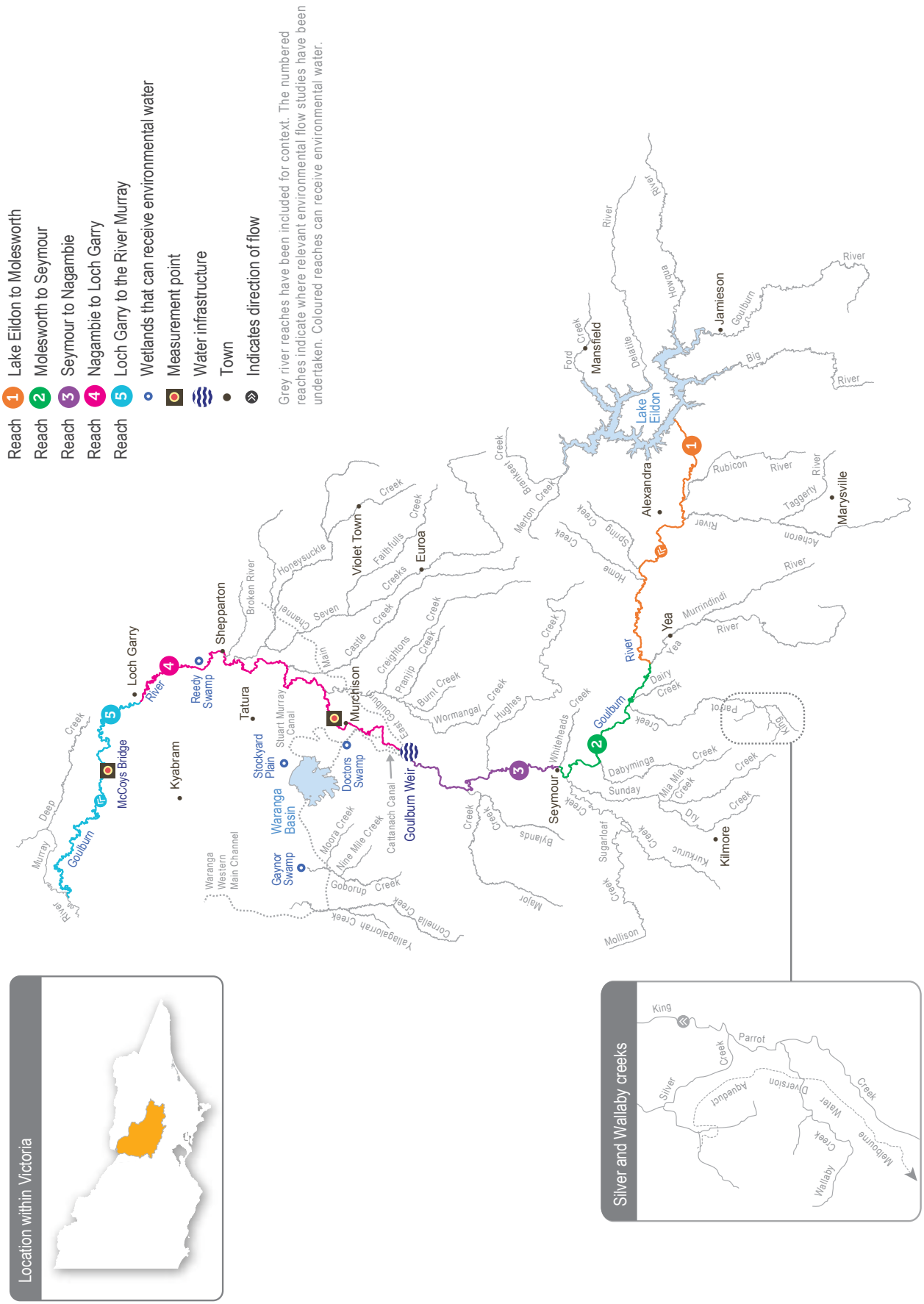


Figure 5.4.1 The Goulburn system



5.4.1 Goulburn River

The Goulburn River flows for 570 km from the Great Dividing Range upstream of Woods Point to the River Murray east of Echuca.

The Goulburn River and its floodplain continue to be places of importance for Traditional Owners and their Nations including the Yorta Yorta and Taungurung Peoples. The Registered Aboriginal Parties (RAPs) in the Goulburn River catchment are the Yorta Yorta Nation Aboriginal Corporation and the Taungurung Clans Aboriginal Corporation. Both the Yorta Yorta Nation and Taungurung Clans Aboriginal Corporations were engaged during development of the Goulburn River seasonal watering proposal.

Environmental values

The Goulburn River and its tributaries support a range of native fish species including golden perch, silver perch, Murray cod, trout cod, Macquarie perch and freshwater catfish. Its aquatic vegetation, scour holes and structural, woody debris provide high-quality habitat for adult and juvenile fish. The bank vegetation is dominated by river red gums, which provide stream shading and habitat for many species including the squirrel glider. Birds (such as egrets, herons and cormorants) use trees along the river to roost and feed, while frogs benefit from shallowly inundated vegetation along the river fringes and in adjacent wetlands.

The Goulburn River system is an important conservation area for threatened species. Mid-Goulburn River tributaries between Lake Eildon and Goulburn Weir host some of the last remaining Macquarie perch populations in the Murray–Darling Basin, while freshwater catfish can be found in lagoons connected to the Goulburn River in reach 3. Monitoring in the lower Goulburn River below the Goulburn Weir shows successful spawning in response to environmental flows of golden and silver perch and trout cod.

Social and economic values

The Goulburn Broken catchment covers two percent of the area of the Murray–Darling Basin and contributes 11 percent of the total water for use in the basin, with the majority contributed from the Goulburn River. Most of the water taken from the Goulburn system is used to irrigate crops and pasture, with the rest providing water for towns and stock and domestic users. The Goulburn River is popular for recreation, fishing and boating. Fishing in particular provides substantial economic and social benefits to the region.

Environmental watering objectives in the Goulburn River

	Increase aquatic and flood-tolerant plants in the river channel and on the lower banks, to provide shelter and food for animals and to stabilise the riverbank
	Protect and boost populations of native fish (including golden perch) by increasing the availability of habitat and by encouraging fish to migrate and spawn
	Maintain the form of the riverbank and channel, including a high diversity of river bed surfaces to support all stream life
	Provide habitat and food for waterbugs, which break down organic matter and support the river's food chain

System overview

The construction and operation of Lake Eildon and Goulburn Weir have significantly altered the natural flow regime of the Goulburn River. Water harvesting during naturally wet periods and regulated releases to meet irrigation and other consumptive demands during dry periods mean that flow downstream of these structures is typically low in winter and spring and high in summer and autumn. This effectively reverses the natural seasonal flow pattern. Land use changes and the construction of small dams and drainage schemes have further modified the Goulburn River's flow regime. Levees and other structures prevent water inundating the floodplain and filling many of the natural wetlands and billabongs. Several tributaries including the Yea River and the Broken River outfall downstream of Lake Eildon and add some flow variation on top of the regulated flow regime in the Goulburn River. Large floods that cause the Goulburn River storages to fill and spill are also important for the overall flow regime and associated environmental values.

Water for the environment may need to be delivered through the Goulburn system to meet environmental objectives at downstream sites. These releases generally target Living Murray icon sites and where possible are delivered in a way that provides environmental benefits to the Goulburn River en route.

Environmental targets can also be met by the coordinated delivery of consumptive water being transferred from Lake Eildon to the River Murray (known as inter-valley transfers). These transfers occur during the irrigation season between spring and autumn and may meet environmental flow objectives without the need to release environmental water.

The priority environmental flow reaches in the Goulburn River are downstream of Goulburn Weir (reaches 4 and 5), which are collectively referred to as the lower Goulburn River. They are the most-flow-stressed sections of the river and support abundant and diverse native fish communities. The mid-Goulburn River extends from Lake Eildon to Goulburn Weir (reaches 1 to 3). From early spring to late autumn, large volumes of water are delivered from Lake Eildon to Goulburn Weir to supply the irrigation system. During that period, flow in the mid-Goulburn River is usually well above the recommended environmental targets, so it has little need for environmental water. Deliveries of water for the environment have the most benefit in the mid-Goulburn River (especially in reach 1 immediately downstream of Lake Eildon) outside the irrigation season, when flow is much lower than natural.

Recent conditions

The Goulburn catchment has experienced mainly dry conditions over the last five years, except in 2016–17 when unregulated flows caused overbank flooding. Most of the flow variation in the lower Goulburn River in 2017–18 was due to releases of water for the environment rather than natural (unregulated) flows. The exceptions were two unregulated flow events in August (peaking at 6,400 ML per day at Shepparton) and December 2017 (peaking at 23,000 ML per day at Shepparton). The high flows in December caused an influx of organic matter that, coupled with warmer weather, lowered the dissolved oxygen concentration in the river. A similar, unregulated event in 2016–17 caused a hypoxic blackwater event, but water for the environment was successfully used during the December 2017 event to prevent the further decline of oxygen levels and avoid stress to aquatic animals.

Water for the environment was used to deliver a winter fresh in late-June to early-July 2017 to improve bank vegetation, water quality and waterbug and fish habitat. Improving the condition of bank vegetation early in the year increases the resilience of plant communities and enables them to better withstand the effects of high river flows due to irrigation deliveries in the following summer and autumn.

Water for the environment was used when necessary throughout the year to meet minimum low flow requirements in the lower Goulburn River, to maintain habitat for in-stream animals and to support bank vegetation. Low flows of 400 ML per day were also delivered for the first time in reach 1 of the Goulburn River between July and September 2017 to maintain riffle habitats that are often exposed at that time.

Managers of water for the environment provided advice to river operators about how to shape a summer inter-valley transfer in a way that provided some environmental benefits. Inter-valley transfers can significantly exceed the recommended summer flows and compromise environmental outcomes. In this case, the transfers were shaped to produce two peak flows of 2,900 ML per day over 20 days in summer, to encourage juvenile golden perch and silver perch to move from the River Murray into the lower Goulburn River. Water for the environment is planned to be used to deliver a winter fresh event in June and July 2018 to maintain bank vegetation as well as waterbug and fish habitat in the lower Goulburn.

The vast majority of water for the environment delivered in the Goulburn River is reused at downstream sites along the River Murray. In 2017–18, Goulburn water was reused to meet native fish objectives in Gunbower Creek, to achieve large-scale floodplain inundation in Hattah Lakes, to fill Lake Wallawalla at Lindsay Island and to benefit native fish in the Lower Lakes, Coorong and Murray Mouth in South Australia.

Goulburn River near Swing Bridge, Shepparton, by Goulburn Broken CMA

Scope of environmental watering

Table 5.4.2 shows potential environmental watering actions and their environmental objectives.

Table 5.4.2 Potential environmental watering actions and objectives for the Goulburn River

	Potential environmental watering[1]	Environmental objectives
1	Year-round low flows (500 ML/day in reach 4 and 540 ML/day in reach 5)	• Maximise habitat and movement opportunities for large and small-bodied native fish • Provide conditions that support habitat and food for waterbugs; these include maintaining suitable water quality, submerging snags and encouraging plankton production • Maintain lower bank and emergent vegetation
2	Spring fresh (1 fresh of up to 10,000 ML/day with flows above 6,000 ML/day for 14 days in reach 4 and 5 in September–November)	• Maintain the bank vegetation by watering banks and benches to provide soil moisture to sustain growth and stimulate flowering and seed development • Increase the vegetation extent by distributing seed to river banks and stimulating germination • Maintain macrophyte, waterbug and fish habitat by mobilising fine sediments, submerging snags and replenishing slackwater habitat
3a	Increased year-round low flows (830 ML/day in reach 4 and/or 940 ML/day in reach 5)	• Maintain lower bank and emergent vegetation • Provide conditions that support habitat and food for waterbugs including by maintaining suitable water quality, submerging additional snags, entraining leaf litter and disrupting biofilms
3b	Winter/spring variable low flows (up to 1,500 ML/day in reach 4 in June–November)	• Increase sediment and seed deposition on banks and benches • Increase and improve habitat for waterbugs
4	Autumn fresh (1 fresh of up to 6,000 ML/day for two days in March–May)	• Maintain vegetation established during the spring fresh and encourage new seed germination • Provide conditions that support waterbugs including improved water quality and increased biofilm availability by mobilising fine sediment
5	Winter fresh (1 fresh of up to 15,000 ML/day with flows above 6,600 ML/day for 14 days in June–July 2019)	• Maintain macrophyte, waterbug and fish habitat by mobilising fine sediments, submerging snags and replenishing slackwater habitat
6	Autumn/winter/spring low flows (400 ML/day in reach 1 in April–September)	• Maintain and improve habitat for small-bodied native fish, waterbugs and aquatic vegetation
7[2]	Spring/summer fresh (1 fresh of up to 10,000 ML/day for 2 days in reach 4 and reach 5 in November–December)	• Initiate spawning and pre-spawning migrations and recruitment of golden perch • Maintain macrophyte, waterbug and fish habitat by mobilising fine sediments, submerging snags and replenishing slackwater habitat
8[2]	Summer fresh (1 fresh of up to 4,600 ML/day for 10 days in reach 4 and reach 5 in January–November)	• Stimulate the migration of juvenile native fish into the Goulburn River from the River Murray

[1] *Water for the environment may be used to slow the recession of unregulated flows or operational releases to reduce damage to banks and vegetation from rapid drops in water levels, or to add pulses following unregulated flows to maximise the ecological benefits of these events. This also helps prevent waterbugs and fish from being stranded in small pools on riverbanks or benches following higher flows.*

[2] *These watering actions are included as contingency actions only and are not planned to be delivered under the expected scenarios in 2018–19.*

Scenario planning

Table 5.4.3 outlines the potential environmental watering actions and expected water use under a range of planning scenarios.

Various triggers for action are applied as part of the adaptive management of water for the environment in the Goulburn system. For example, carrying over water for the environment to provide low flows in winter and spring 2019 is only required in dry or very dry conditions. The need to carry over water is lessened in wetter scenarios, because high reservoir inflows increase the likelihood of high water allocation at the start of 2019–20. This means that instead of carrying over water into the next season, it can be used to contribute to environmental watering events planned for 2018–19.

The highest-priority watering actions in 2018–19 aim to sustain the growth, flowering and seed development of emergent and bank vegetation. The long duration of high flows in summer 2017–18 mean that lower, bank-fringing vegetation has been under water for much of the past 18 months. Maintaining and encouraging germination of fringing vegetation is the primary focus of environmental watering in the Goulburn River for 2018–19.

In the last few years, deliveries of water for the environment supported native fish spawning and migration. Although water has not been specifically set aside to provide specific fish spawning or migration flows in 2018–19, fish passage and habitat will be provided through year-round low flows below Goulburn Weir (reaches 4 and 5). As well, these low flows encourage the establishment of aquatic and amphibious vegetation and provide habitat and food for waterbugs and small-bodied fish by submerging snags and encouraging plankton production.

Under extreme dry conditions, there is less water for the environment available and some actions may only be partially delivered or not delivered at all. Under dry conditions, almost all actions can be delivered although the magnitude and duration of the autumn fresh may need to be reduced, and there may be less opportunity to build on naturally occurring events. Under average conditions, it is expected that all actions will be delivered except a winter fresh, and under wet conditions all actions can be delivered in full. Delivering more watering actions will have the biggest benefit to the health of the river. Tier 2 actions may be implemented if more water becomes available.

Goulburn Weir, by Courtney Johnson

Table 5.4.3 Potential environmental watering for the Goulburn River under a range of planning scenarios

Planning scenario	Extremely dry	Dry	Average	Wet
Expected river conditions	• No unregulated flows	• Unregulated flows expected to provide some low flows between winter to mid-spring and likely small winter/spring freshes	• Unregulated flows expected to provide low flows for most of the year and likely medium winter/spring freshes	• Unregulated flows expected to provide low flows and multiple overbank flows events in winter/spring
	• Normal minimum passing flows at reach 5 of 400 ML/day from July–October and 350 ML/day from November–June			
Expected availability of water for the environment	• 25,000 ML carryover • 6,000 ML VEWH • 106,000 ML CEWH • 15,000 ML Living Murray • 152,000 ML total	• 25,000 ML carryover • 13,000 ML VEWH • 234,000 ML CEWH • 33,000 ML Living Murray • 305,000 ML total	• 25,000 ML carryover • 15,000 ML VEWH • 279,000 ML CEWH • 39,000 ML Living Murray • 358,000 ML total	• 25,000 ML carryover • 15,000 ML VEWH • 279,000 ML CEWH • 39,000 ML Living Murray • 358,000 ML total
Potential environmental watering – tier 1 (high priorities)[1]	• 1 Year-round low flows • 2 Spring fresh (partial) • 3a Increased year-round low flows (partial) • 3b Winter/spring variable low flows • 8 Provide a baseflow in reach 1 from May–September	• 1 Year-round low flows • 2 Spring fresh • 3a Increased year-round low flows (partial) • 3b Winter/spring variable low flows • 4 Autumn fresh (partial) • 8 Provide a baseflow in reach 1 from May–September	• 1 Year-round low flows • 2 Spring fresh • 3a Increased year-round low flows • 3b Winter/spring variable low flows • 4 Autumn fresh • Recession flow management • 8 Provide a baseflow in reach 1 from May–September	• 1 Year-round low flows • 3a Increased year-round low flows • 3b Winter/spring variable low flows • 4 Autumn fresh • 5 Winter fresh • Recession flow management • 8 Provide a baseflow in reach 1 from May–September
Potential environmental watering – tier 2 (additional priorities)[1]	• 2 Spring fresh (full) • 3 Increased year-round low flows (full) • 4 Autumn fresh • 5 Winter fresh • Recession flow management	• 3 Increased year-round low flows (full) • 4 Autumn fresh (full) • 5 Winter fresh • Recession flow management	• 5 Winter fresh	
Possible volume of water for the environment required to achieve objectives[2]	• 137,000 ML (tier 1) • 368,000 ML (tier 2)	• 280,000 ML (tier 1) • 249,000 ML (tier 2)	• 319,000 ML (tier 1) • 142,000 ML (tier 2)	• 344,000 ML (tier 1) • 0 ML (tier 2)
Critical carryover into 2019–20	• 0 ML	• 23,000 ML	• 0 ML	• 0 ML

[1] *The number preceding each potential environmental watering action align to the numbering in Table 5.4.2 above.*
[2] *Water for the environment requirements for tier 2 actions are additional to tier 1 requirements.*

Risk management

Environmental watering program partners have considered and assessed risks and identified mitigating strategies relating to environmental flows in 2018–19. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

5.4.2 Goulburn wetlands

Of some 2,000 natural wetlands in the Goulburn Broken area, only three in the Goulburn catchment (Reedy Swamp, Gaynor Swamp and Doctors Swamp) have been able to receive environmental water, through infrastructure connections to the river. Recent works to connect Loch Garry to the irrigation system will mean that it will also be possible to deliver water for the environment to Loch Garry from 2018–19, subject to the agreement of landowners. Loch Garry is a paleo channel (a remnant course) of the Goulburn River and the only wetland in the catchment that can receive water for the environment that has objectives for fish.

The Goulburn wetlands have been, and continue to be, places of significance for Traditional Owners and their Nations. The Registered Aboriginal Party (RAP) in the region is the Yorta Yorta Nation Aboriginal Corporation.

Environmental values

Many natural wetlands across the Goulburn catchment including Reedy Swamp, Loch Garry, Gaynor Swamp and Doctors Swamp are formally recognised for their conservation significance. The Goulburn wetlands support a variety of plant communities ranging from swamps dominated by river red gums to cane grass wetlands.

Reedy Swamp contains a mosaic of vegetation types including tall marsh, floodway pond herbland and rushy riverine swamp. It is an important drought refuge and nesting site for colonial waterbirds and an important stopover feeding site for migratory birds (such as sharp-tailed and marsh sandpipers).

Doctors Swamp is considered one of the most-intact red gum swamps in Victoria, supporting over 80 wetland plants.

Gaynor Swamp is a cane grass wetland situated on paleosaline soils, and it can sometimes receive saline water from Lake Cooper during times of flood. When wet, Gaynor Swamp supports thousands of waterbirds including brolga and intermediate egrets. As Gaynor Swamp has a higher salt concentration than other wetlands in the region, it attracts a different suite of feeding waterbirds as it draws down. One of the most-significant species that feed on exposed mudflats at Gaynor Swamp is the red-necked avocet.

Loch Garry supports large areas of deep, open water fringed by giant rush and dominated by tall marsh. It is an important site for waterbird feeding and roosting, and it is a drought refuge for eastern great egrets, musk ducks, nankeen night herons and royal spoonbills. Monitoring in 2012 recorded these four threatened waterbird species at Loch Garry.

Social and economic values

Visitor activities enjoyed at the Goulburn wetlands include birdwatching, picnicking, camping and walking. Duck hunting is allowed at Doctors Swamp and Gaynor Swamp, which are state game reserves, and at Loch Garry, which is a wildlife reserve.

Environmental watering objectives in the Goulburn wetlands

	Maintain and improve the range of native plant life including river red gum and grassy wetland species
	Provide feeding and breeding habitat for waterbirds including migratory and colonial nesting waterbirds
	Provide habitat for frog breeding
	Provide refuge in deep holes for large and small native fish

System overview

Gaynor Swamp, Reedy Swamp, Loch Garry and Doctors Swamp wetlands can all receive water for the environment via irrigation supply infrastructure in the Shepparton and Central Goulburn irrigation districts. The volume delivered at any one time depends on the available capacity in the irrigation supply network, and it may also be negotiated with adjacent landholders.

Reedy Swamp is naturally inundated when flow in the Goulburn River exceeds about 20,000 ML per day. Doctors Swamp can only receive water for the environment if the Cattanach Canal is running at 2,500 ML per day and there is available capacity after irrigation demand and operational requirements are met.

A structure to facilitate the delivery of water for the environment to Gaynor Swamp was constructed in February 2018, and the wetland received water for the environment for the first time in April 2018.

The newly constructed infrastructure connecting Loch Garry to the irrigation system will allow up to 20 ML per day of water for the environment to be delivered to Loch Garry. Loch Garry does not have a delivery share, so water for the environment can only be delivered when there is spare capacity to carry water in the channel.

Recent conditions

Natural inflows from high rainfall in the Goulburn catchment during December 2017 inundated all Goulburn wetlands, triggering the germination and reproduction of some wetland plants and providing habitat for waterbirds. Wetlands to the west of the Goulburn Broken catchment including Doctors Swamp and Gaynor Swamp received the highest rainfall, and Doctors Swamp filled.

Sloanes froglet, musk duck, hardheads and plumed whistling duck were recorded at Doctors Swamp following the natural filling. Fringed marshwort was prolific in the wetland, and billy-buttons grew around the fringes.

Gaynor Swamp was the only wetland to receive water for the environment in 2017–18. It received water for the environment in autumn 2018 for the first time, after drying from the heavy summer rainfall. The remaining wetlands have been inundated several times in the last few years and were therefore left to draw down naturally after the December event.

Scope of environmental watering

Table 5.4.4 shows potential environmental watering actions and their environmental objectives.

Table 5.4.4 Potential environmental watering actions and objectives for the Goulburn wetlands

Potential environmental watering	Environmental objectives
Doctors Swamp (fill in spring)	Maintain the diversity of wetland vegetation including cane grass Provide waterbird breeding and feeding habitat
Gaynor Swamp (fill in winter/spring)	Maintain the diversity of wetland vegetation including cane grass Provide waterbird breeding and feeding habitat
Loch Garry (fill in spring)	Increase the diversity of native wetland vegetation Maintain habitat for waterbird breeding Provide refuge pools for native fish
Reedy Swamp (fill in spring)	Increase the diversity of native wetland vegetation Maintain habitat for water breeding (particularly royal spoonbills and ibis)

Scenario planning

Table 5.4.5 outlines potential environmental watering and expected water use under a range of planning scenarios.

Goulburn Broken CMA has planned wetland watering to maintain a range of habitat types to support waterbirds and other water-dependant animals in the region at any point in time.

Maintaining a natural cycle of flooding and drying is important for the health of the wetlands. If Reedy Swamp remains dry over the winter of 2018, it will have reached its optimum drying period, and it will need watering in spring 2018.

Due to the natural flooding of Doctors Swamp (which remained wet until autumn 2018) and water for the environment delivered to Gaynor Swamp in autumn 2018, drying will be promoted at these wetlands. However, if significant target species (such as brolga) are found to be breeding before the wetland dries (or because of additional natural inflows), a spring/summer top-up may be necessary. If there are no natural inflows, Doctors Swamp and Gaynor Swamp will receive water for the environment in autumn 2019, to increase vegetation diversity and waterbird habitat.

Deliveries of water for the environment to Loch Garry cannot be guaranteed in 2018–19 because the agreement of landholders still needs to be negotiated.

Doctors Swamp on the regulator side, by Goulburn Broken CMA

Table 5.4.5 Potential environmental watering for the Goulburn wetlands under a range of planning scenarios

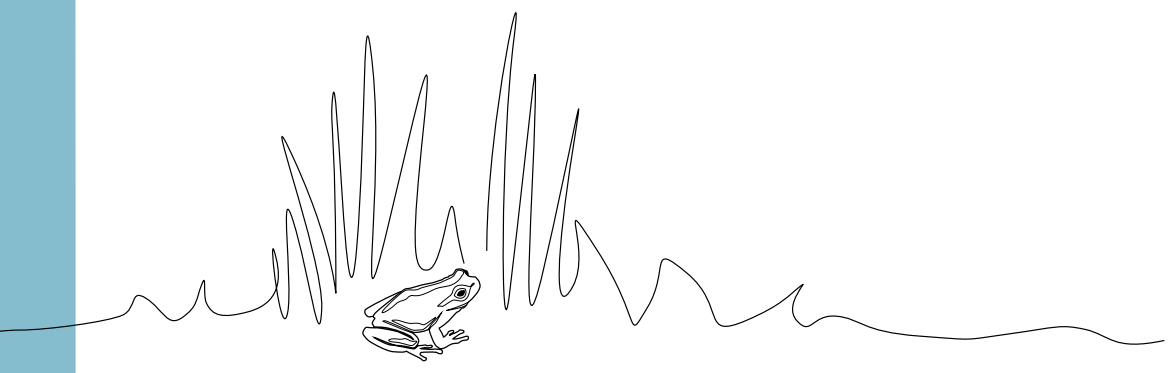
Planning scenario[1]	Drought	Dry	Average	Wet
Expected catchment conditions	• Catchment run-off and unregulated flows into the wetlands are highly unlikely	• Catchment run-off and unregulated flows into the wetlands are unlikely	• Some catchment run-off and unregulated flows into some of the wetlands are likely, particularly in winter/spring	• Catchment run-off and unregulated flows into the wetlands may significantly contribute to water levels in the wetlands, particularly in winter/spring
Potential environmental watering – tier 1 (high priorities)	• Reedy Swamp	• Reedy Swamp	• Reedy Swamp	• Reedy Swamp
Potential environmental watering – tier 2 (additional priorities)	• Gaynor Swamp • Doctors Swamp • Loch Garry	• Gaynor Swamp • Doctors Swamp • Loch Garry	• Gaynor Swamp • Doctors Swamp • Loch Garry	• N/A
Possible volume of water for the environment required to achieve objectives[2]	• 500 ML (tier 1) • 1,500 ML (tier 2)	• 500 ML (tier 1) • 1,500 ML (tier 2)	• 500 ML (tier 1) • 750 ML (tier 2)	• 250 ML (tier 1)
Priority carryover requirements	• 2,000 ML	• 2,000 ML	• 1,250 ML	• 550 ML

[1] *If any of the wetlands support significant waterbird breeding events in spring/summer, deliveries of water for the environment may be considered to support bird habitat until fledging.*

[2] *Water for the environment requirements for tier 2 actions are additional to tier 1 requirements.*

Risk management

Environmental watering program partners have considered and assessed risks and identified mitigating strategies relating to environmental flows in 2018–19. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).



5.5 Broken system

Waterway manager – Goulburn Broken Catchment Management Authority

Storage manager – Goulburn-Murray Water

Environmental water holders – Victorian Environmental Water Holder, Commonwealth Environmental Water Holder

The Broken system (including the Broken River, upper Broken Creek, lower Broken Creek and wetlands) supports threatened plant and animal species including six native fish species of Victorian and national conservation significance. The system also supports a range of habitats for waterbirds, especially cane grass wetlands that brolga rely on for feeding and breeding. The lower Broken Creek forms part of the irrigation network and receives water from the Murray and Goulburn systems.

Engagement

Table 5.5.1 shows the partners and stakeholder organisations with which the Goulburn Broken CMA engaged when preparing the Broken system seasonal watering proposal.

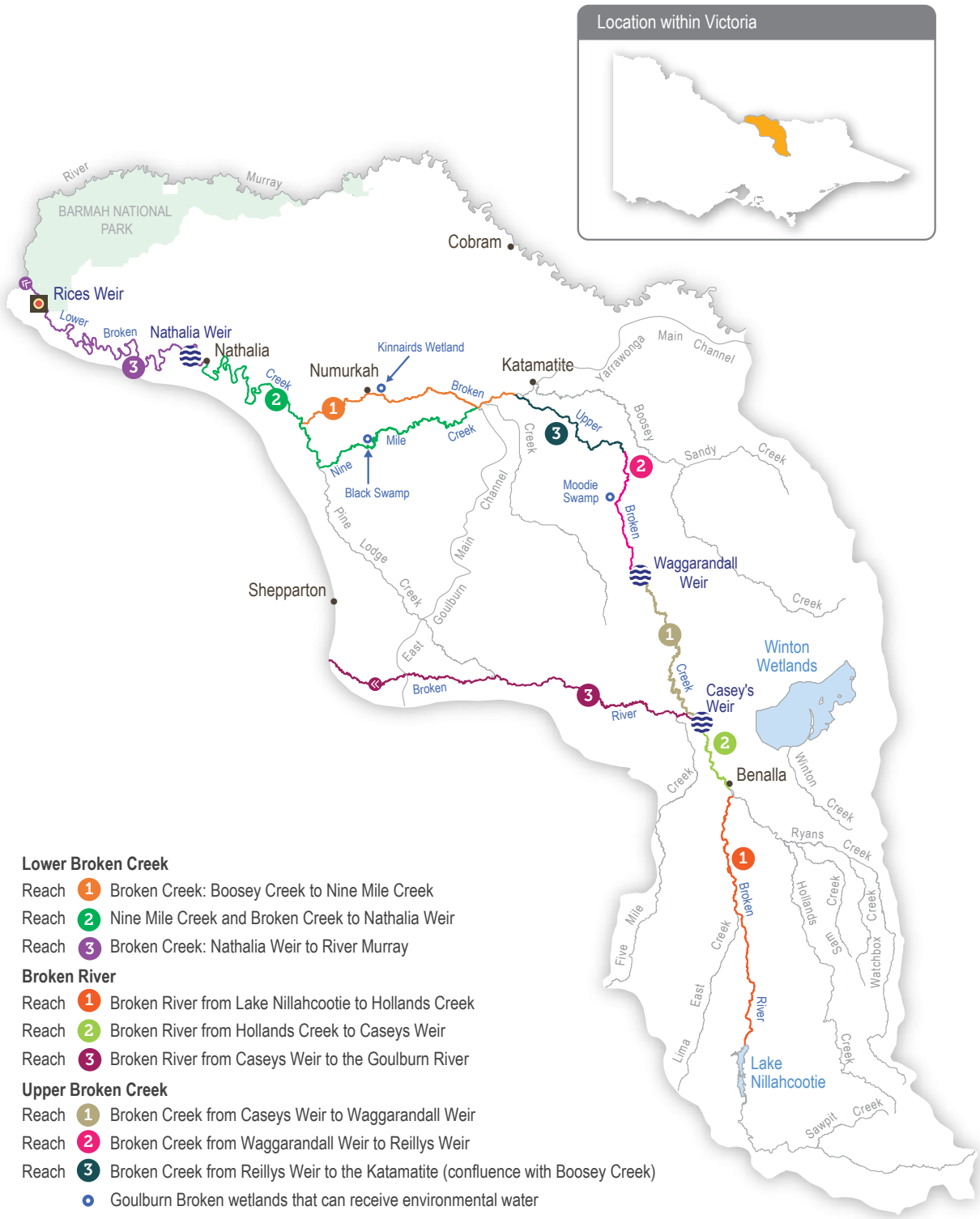
Seasonal watering proposals are informed by longer-term plans such as regional catchment strategies, regional waterway strategies and environmental water management plans and other studies. These plans incorporate a range of environmental, cultural, social and economic perspectives and longer term integrated catchment and waterway management objectives. For further details, refer to the *Goulburn Broken Regional Catchment Strategy* and *Goulburn Broken Waterway Strategy*.

Table 5.5.1 Partners and stakeholders engaged in developing the Broken system seasonal watering proposal

Partner and stakeholder engagement
• Broken Environmental Water Advisory Group (comprising community members)
• Commonwealth Environmental Water Office
• Goulburn Broken Catchment Wetland Advisory Group (with representation of Goulburn Valley Landcare, Field & Game Australia, Moira Shire, Greater Shepparton City Council, Turtles Australia, Parks Victoria, Trellys Fishing and Hunting and Kinnairds Wetland Advisory Committee)
• Goulburn-Murray Water
• Murray–Darling Basin Authority (River Murray Water)
• Parks Victoria
• Taungurung Clans Aboriginal Corporation
• Victorian Environmental Water Holder
• Yorta Yorta Nation Aboriginal Corporation

Flood marks on trees in Broken Creek, by Keith Ward, Goulburn Broken CMA

Figure 5.5.1 The Broken system



Lower Broken Creek

Reach 1 Broken Creek: Boosey Creek to Nine Mile Creek
Reach 2 Nine Mile Creek and Broken Creek to Nathalia Weir
Reach 3 Broken Creek: Nathalia Weir to River Murray

Broken River

Reach 1 Broken River from Lake Nillahcootie to Hollands Creek
Reach 2 Broken River from Hollands Creek to Caseys Weir
Reach 3 Broken River from Caseys Weir to the Goulburn River

Upper Broken Creek

Reach 1 Broken Creek from Caseys Weir to Waggarandall Weir
Reach 2 Broken Creek from Waggarandall Weir to Reillys Weir
Reach 3 Broken Creek from Reillys Weir to the Katamatite (confluence with Boosey Creek)

Goulburn Broken wetlands that can receive environmental water
Measurement point
Water infrastructure
Town
Indicates direction of flow

Grey river reaches have been included for context. The numbered reaches indicate where relevant environmental flow studies have been undertaken. Coloured reaches can receive environmental water.

5.5.1 Broken River and upper Broken Creek

The Broken River is a tributary of the Goulburn River, rising in the Wellington–Tolmie highlands and flowing north-west to Benalla and then west for a total distance of 190 km before it joins the Goulburn River near Shepparton. Lake Nillahcootie is the main storage on the Broken River. It is about 36 km upstream of Benalla and diverts water from the river to support irrigated agriculture. The main tributaries of the Broken River are Hollands Creek, Ryans Creek and Lima East Creek.

The upper Broken Creek is defined as the 89 km stretch of creek from Broken River (at Caseys Weir) to the Boosey Creek confluence near Katamatite. The creek is located on a flat, riverine plain and has naturally low run-off from its local catchment. It receives flood flows from the Broken River, although the frequency of these floods has been reduced by earthworks and road construction.

The Broken River and upper Broken Creek continue to be places of importance for Traditional Owners and their Nations. The Registered Aboriginal Parties (RAPs) in the Broken catchment are the Yorta Yorta Nation Aboriginal Corporation and the Taungurung Clans Aboriginal Corporation. Representatives from both RAPs were engaged during the preparation of Broken River and upper Broken Creek seasonal watering proposals.

Environmental values

The Broken River retains one of the best examples of healthy in-stream vegetation in a lowland river in the region. A range of native submerged and emergent plant species populate the bed and margins of the river including eelgrass, common reed and water ribbons. These plants provide habitat for a range of animals including small- and large-bodied native fish species. Murray cod, Macquarie perch, golden perch, silver perch, river blackfish, mountain galaxias and Murray-Darling rainbowfish all occur in the Broken River, and the river also supports a large platypus population.

The upper Broken Creek area is dominated by unique box riparian vegetation and remnant plains grassy woodland. It supports numerous threatened species including brolga, Australasian bittern, buloke and rigid water milfoil. It contains high-quality native vegetation, much of which is set aside as a natural features reserve. The creek supports a variety of threatened animals including fish species (such as the carp gudgeon, Murray cod, golden perch and Murray-Darling rainbowfish), as well as platypus and common long-necked turtle.

Both the Broken River and upper Broken Creek are listed as on the *Directory of Important Wetlands in Australia*.

Social and economic values

The Broken River and associated wetland and floodplain habitats support a range of recreational and tourism values, and they provide opportunities for bushwalking, boating, fishing and birdwatching. The waterways are an important source of water and a delivery mechanism for some stock and domestic and irrigation customers.

Environmental watering objectives in the Broken River and upper Broken Creek systems

	Mobilise built-up sand and clay material to restore deep pools and provide habitat for aquatic animals
	Improve in-stream and riparian vegetation
	Enhance native fish populations including threatened Murray cod and golden perch by improving pool habitat and encouraging fish migration and spawning
	Maintain water quality
	Support a wide range and high biomass of waterbugs to break down dead organic matter and support the river's food web
	Maintain platypus populations and provide conditions for successful breeding

System overview

Lake Nillahcootie has a storage capacity that is about half the mean annual flow of its upstream catchment, so it fills in most years. The operation of Lake Nillachootie has modified the river's natural flow pattern; winter/spring flows are less than natural because a large proportion of inflows are harvested, while summer/autumn flows are higher than natural because water is released to meet downstream irrigation demands. These impacts are most pronounced in the reach between Lake Nillahcootie and Hollands Creek. Downstream of Hollands Creek, the river retains a largely natural flow pattern due to the contribution of tributary inflows. The catchment has been extensively cleared for agriculture including dryland (such as livestock grazing and cereal cropping) and irrigated agriculture (such as dairy, fruit and livestock).

Water is released from Lake Nillahcootie to meet downstream demand and minimum-flow requirements specified under the bulk entitlement for the Broken River system. Releases from the dam may be less than 30 ML per day as tributary inflows immediately below the dam (such as from Back Creek) can supply much of minimum-flow requirements specified in the bulk entitlement.

Upper Broken Creek has been regulated for more than a century. Before 2007, water was diverted into upper Broken Creek at Casey's Weir to meet local demand, but recent water-savings projects have reduced the demand on the creek. There are now low flows throughout the year between Caseys Weir and Waggarandall Weir. Flows downstream of Waggarandall Weir are now influenced by rainfall and catchment run-off and environmental deliveries to Moodie Swamp. These changes have reduced the amount of permanent aquatic habitat, which can be increased by deliveries of water for the environment.

Delivery of water for the environment down the Broken River is primarily constrained by the availability of water. In most cases, the water for the environment available is much less than the volume required to deliver the desired flow components. Deliveries of water for the environment in upper Broken Creek are primarily restricted by channel capacity, to avoid flooding adjacent land.

Recent conditions

Flows in the Broken River between June 2017 and March 2018 met minimum-flow requirements. High-rainfall events delivered natural freshes via tributary inflows in winter, spring and summer, with peak discharges between 300 ML per day and 4,500 ML per day in the lower reaches (reach 3). Reach 1 received less water from tributaries and therefore had fewer freshes compared with downstream reaches. A large storm in early December 2017 generated an event with a peak discharge of 1,800 ML per day from Lake Nillachootie, which was the only natural fresh in reach 1 for the year. Water for the environment was used to deliver another fresh of 300 ML per day to reach 1 in autumn 2018. It was the first time an environmental flow had been delivered in the Broken River to meet environmental objectives.

Flows in the upper Broken Creek between June 2017 and March 2018 met minimum winter/spring flow requirements most of the time, while summer/autumn minimum-flow requirements were met less than half of the time. Four small, natural freshes occurred in winter, spring and summer, with peak discharges between 20 ML per day and 40 ML per day. This would have flooded a small proportion of the floodplain in reach 2 downstream of Waggarandall Weir. In autumn 2018, deliveries of water for the environment to Moodie Swamp helped meet the minimum-flow recommendation of 5 ML per day at Waggarandall Weir.

Scope of environmental watering

Table 5.5.2 shows potential environmental watering actions and their environmental objectives.

Table 5.5.2 Potential environmental watering actions and objectives for the Broken River and upper Broken Creek system

Potential environmental watering	Environmental objectives
Summer/autumn fresh in upper Broken Creek (1 fresh of up to 50 ML/day for 10 days in December–May)	• Maintain water quality, particularly in refuge pools
Summer/autumn low flows in upper Broken Creek (up to 5 ML/day for 30–60 days in December–May)	• Maintain habitat for native fish populations and waterbugs • Maintain platypus habitat • Maintain in-stream vegetation
Winter/spring low flows in upper Broken Creek (up to 10 ML/day for 30–60 days in June–November)	• Maintain habitat for native fish populations and waterbugs • Support successful platypus breeding • Maintain in-stream vegetation
Year-round low flows in the Broken River (up to 15 ML/day for 40–100 days)	• Maintain hydraulic habitat for native fish, aquatic plants and waterbugs
Summer/autumn freshes in the Broken River (1 fresh of 400–500 ML/day for 2–5 days in December–May)	• Scour sediment around large wood and turn over bed sediments • Provide flow cues to stimulate native fish breeding and migration • Replenish biofilms and increase productivity • Maintain habitat for aquatic plants • Maintain longitudinal connectivity for native fish passage

Scenario planning

Table 5.5.3 outlines the potential environmental watering and expected water use under a range of planning scenarios.

Requirements for water for the environment for the upper Broken Creek and Broken River are greater than the volume of water for the environment expected to be available in the Broken system. Environmental flow management aims to allow catchment run-off and water system operation to meet as many flow recommendations as possible. Where possible, water from environmental entitlements will be used to meet the highest-priority flows that are not met from consumptive deliveries or natural flows.

Priority is given to upper Broken Creek watering actions in summer and autumn under all scenarios. Flow targets in upper Broken Creek are less likely to be met by catchment run-off and managed releases, and a lack of flow in the creek poses a significant risk to native fish, platypus and macroinvertebrate populations. Low flows and water-quality freshening flows are planned throughout the year.

Once the requirements of upper Broken Creek have been met, any remaining water for the environment may be used in the Broken River. Minimum baseflows are planned to be maintained if not met through irrigation releases or catchment run-off, as well as a fresh immediately downstream of Lake Nillahcootie after the end of the irrigation season, if there is little catchment run-off.

Table 5.5.3 Potential environmental watering for the Broken River and upper Broken Creek system under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• No unregulated winter and spring flows in Broken River • No unregulated flows in upper Broken Creek • Minimal volume transferred to the Goulburn River • Low and cease-to-flow events during summer/autumn below Waggarandall Weir on upper Broken Creek	• Low unregulated flows and some freshes in Broken River • No unregulated flows in the Upper Broken Creek • Up to 1,500 ML of consumptive water delivered via the Broken River in summer/autumn	• High winter and spring flows in the Broken River • Some contribution of unregulated winter and spring flows and freshes in upper Broken Creek • Up to 1,500 ML of consumptive water delivered via the Broken River in summer/autumn	
Expected availability of water for the environment[1]	• 0–267 ML	• 534 ML		
Potential environmental watering	• Summer/autumn fresh in upper Broken Creek • Summer/autumn low flows in upper Broken Creek • Winter/spring low flows in upper Broken Creek • Year-round low flows in the Broken River	• Summer/autumn fresh in upper Broken Creek • Summer/autumn low flows in upper Broken Creek • Winter/spring low flows in upper Broken Creek • Year-round low flows in the Broken River • Summer/autumn fresh in Broken River	• Summer/autumn fresh in upper Broken Creek • Summer/autumn low flows in upper Broken Creek • Winter/spring low flows in upper Broken Creek • Summer/autumn fresh in Broken River	• Summer/autumn fresh in upper Broken Creek
Possible volume of water for the environment required to achieve objectives	• 1,500–2,000 ML	• 1,090–5,500 ML	• 890–5,300 ML	• 0–1,000 ML

[1] *Water for the environment may be traded into the Broken system to increase supply, subject to trade rules.*

Risk management

Environmental watering program partners have considered and assessed risks and identified mitigating strategies relating to environmental flows in 2018–19. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

5.5.2 Lower Broken Creek

Lower Broken Creek is the section of Broken Creek that flows from the confluence with Boosey Creek near Katamatite to the River Murray near Barmah. Nine Mile Creek is an anabranch that leaves lower Broken Creek at the East Goulburn Main Channel and rejoins it downstream of Numurkah. Both waterways are collectively referred to as the lower Broken Creek.

The lower Broken and Nine Mile creeks and associated floodplain continue to be an important place for Traditional Owners and their Nations. The RAP for this system is the Yorta Yorta Nation Aboriginal Corporation, who were involved in preparing the lower Broken Creek seasonal watering proposal.

Environmental values

The lower Broken Creek and Nine Mile Creek support a diverse and abundant native fish community including the threatened Murray cod, golden perch, silver perch, unspecked hardyhead and crimson-spotted rainbowfish (also known as the Murray-Darling rainbowfish). Sections of the lower Broken and Nine Mile creeks have been reserved as state park and natural features reserve. The associated floodplain and wetland habitats support box-dominated grassy woodland communities and numerous threatened species of state and national conservation significance including river swamp wallaby-grass and the Australasian bittern.

Social and economic values

The lower Broken and Nine Mile creeks and associated floodplain and wetland habitats provide water for agriculture and urban centres and support a variety of recreational activities (such as fishing and bushwalking).

Environmental watering objectives in the lower Broken Creek

	Control excessive build-up of azolla, which is a native aquatic plant that can lower water quality in the creek when significant blooms occur
	Protect and increase populations of native fish including the threatened Murray cod, golden perch and silver perch by maintaining habitat (water level and quality), allowing fish passage and stimulating fish to migrate and spawn
	Maintain healthy water oxygen levels

System overview

The lower Broken and Nine Mile creeks have been regulated for over a century, significantly altering their flow regimes. Pre-regulation, the creeks would have mainly flowed in winter and spring and the adjacent floodplain would have received more-regular flooding from overbank flows. In summer and autumn, the creeks would have had much less flow, often contracting to isolated pools or drying out completely. The creeks now have numerous weirs and flow at a relatively constant level from mid-August until mid-May to support adjacent irrigated farming. These modifications have changed the way native animals use the creek. Previously, native fish would have moved into the creek when it was flowing and returned to the River Murray as it dried. Both creeks now provide year-round habitat for native fish, and fish passage structures allow fish to move between weir pools. Water for the environment is used to support these permanent fish habitats, by providing flows to trigger fish movement and support fish passage, control water quality or flush azolla as necessary.

The lower Broken Creek is operated separately to the upper Broken Creek and Broken River because regulated water is delivered to the lower Broken Creek from the Goulburn and Murray systems via the irrigation channel network.

Water for the environment can be provided to the lower Broken Creek from the Goulburn system through the East Goulburn Main Channel and from the Murray system through the Yarrawonga Main Channel. Water is released into the lower Broken Creek from several irrigation area regulators along the length of the lower Broken Creek. The priority river reach for environmental watering is reach 3 (from Nathalia Weir Pool to the River Murray), as it supports the best fish community and is where water quality deteriorates first in warmer months. Environmental flows that target reach 3 are expected to also deliver the desired flows in reaches 1 and 2. The measurement point for environmental flows in the lower Broken Creek is at Rices Weir.

Environmental targets can also be met by water delivered from Lake Eildon (known as inter-valley transfers) or Hume Reservoir (known as choke bypass flows) to meet downstream consumptive demands in the River Murray. These consumptive deliveries occur usually during peak irrigation demand, occurring from spring to autumn. These flows may help achieve the desired environmental objectives without the need to release environmental water.

Recent conditions

A dry winter and spring in 2017 meant there was little unregulated flow in the lower Broken Creek, so water for the environment was used to maintain target flows. A winter low flow was delivered before higher flushing flows in August and September 2017, which were delivered to break up and move azolla, which blanketed over 2 km of the creek in several locations. A combination of weir pool manipulation and physically disrupting the azolla significantly reduced the amount of azolla and prevented a further build-up. Hot weather in October 2017 caused much of the remaining azolla to shrink and die, and higher flows that were delivered to provide fish passage helped to break up the remaining blockages and flush the azolla from the system.

In response to a large rainfall event forecast in early December 2017, water levels in the Murray Valley irrigation channels were lowered by increasing outfalls into the lower Broken Creek. The outfalls increased flow in the creek above 700 ML per day for a short period.

Water for the environment was used to maintain dissolved oxygen levels in the lower Broken Creek through summer. Between January and March 2018, average daily flow past Rices Weir was reasonably steady, with a combination of environmental flow releases and Goulburn inter-valley transfer deliveries maintaining target flow rates.

A recent fish population survey in the lower Broken Creek indicates natural spawning and recruitment is occurring and that reaches with a high density of submerged wood, which provides fish habitat, have the highest abundance of native fish. Murray cod larvae were recorded in the creek for the first time, and adult golden perch were abundant. The lack of juvenile golden perch and the detection of golden perch movement in response to increases in flow and water temperature in spring support the theory that the population is primarily maintained by migration from the River Murray. Murray cod were detected moving throughout the lower Broken Creek system during late winter and spring, which highlights the benefit of delivering environmental flows outside of the irrigation season.

Scope of environmental watering

Table 5.5.4 shows potential environmental watering actions and their environmental objectives.

Table 5.5.4 Potential environmental watering actions and objectives for the lower Broken Creek

Potential environmental watering	Environmental objectives
Year-round low flows (40 ML/day)[1]	• Provide native fish passage through fish ladders
Winter/spring low flows (120 ML/day in August–November)	• Minimise azolla growth
Spring/summer/ autumn low flows (150–250 ML/day in October–May)	• Minimise azolla build-up • Maintain dissolved oxygen above 5 mg/L
Winter/spring freshes (up to 500 ML/day in August–November)	• Manage azolla blooms • Trigger fish migration
Spring/summer low flows (250 ML/day in September–December)	• Increase the availability of native fish habitat during the migration and breeding seasons

[1] *Primarily planned for the irrigation season between mid-August and mid-May, but it may be delivered year-round subject to supply constraints.*

Scenario planning

Table 5.5.5 outlines the potential environmental watering and expected water usage under a range of planning scenarios.

Due to regulation of the lower Broken and Nine Mile creeks, which creates highly modified and relatively uniform conditions, water for the environment needs in these creeks are relatively fixed from year to year and independent of annual climatic conditions.

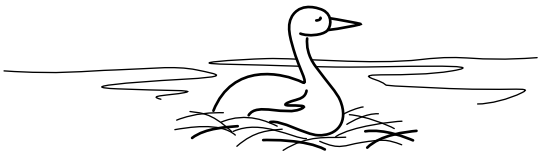
During 2018–19, environmental flows in the lower Broken Creek will be adjusted as needed to maximise the quantity of habitat and movement opportunities for native fish, maintain water quality and flush azolla through the system. The environmental flow objectives may be partly or wholly met by regulated flows to meet irrigation demand and by natural unregulated flows and therefore water for the environment will only be used to make up shortfalls. During dry conditions, water for the environment will be mainly used to provide higher flows because irrigation demand and the associated consumptive water flows are likely to meet many of the environmental low-flow requirements. During wet conditions, there will be less demand for consumptive water and therefore more water for the environment may be needed to meet the low-flow requirements.

Table 5.5.5 Potential environmental watering for the lower Broken Creek under a range of planning scenarios

Planning scenario	Drought to dry	Average	Wet
Expected river conditions	• Some unregulated flows in winter • No unregulated flows throughout the irrigation season (mid-August–May) • No diversion of unregulated River Murray flows available	• Unregulated flows in winter/spring • No unregulated flows from October–May • Diversion of unregulated River Murray flows available mid-August–October	• Unregulated flows in winter/spring • No unregulated flows from November–May • Diversion of unregulated River Murray flows available mid-August–November
Potential environmental watering	• Year-round low flows • Winter/spring low flows • Spring/summer/autumn low flows • Winter/spring freshes • Spring/summer low flows		
Possible volume of water for the environment required to achieve objectives	• 56,480 ML	• 54,470 ML	• 57,580 ML

Risk management

Environmental watering program partners have considered and assessed risks and identified mitigating strategies relating to environmental flows in 2018–19. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).



5.5.3 Broken wetlands

Of some 2,000 natural wetlands in the Goulburn Broken area, only three in the Broken catchment have infrastructure that connect them to receive environmental water: Black Swamp, Kinnairds Wetland and Moodie Swamp. Kinnairds Wetland (96 ha) and Black Swamp (16.5 ha) are red gum swamps near Numurkah. Moodie Swamp is a 180 ha cane grass wetland adjacent to Broken Creek at Waggarandall that provides excellent breeding habitat for brolga.

Wetlands in this region continue to be important places for Traditional Owners and their Nations. The Registered Aboriginal Parties (RAP) in the region are the Yorta Yorta Nation Aboriginal Corporation and the Taungurung Clans Aboriginal Corporation. Representatives from the RAPs were engaged during the preparation of the Broken wetlands seasonal watering proposal.

Environmental values

Moodie Swamp, Kinnairds Wetland and Black Swamp support a high diversity of vegetation communities ranging from river red gum-dominated swamps to cane grass wetlands. The wetlands contain state and nationally threatened vegetation communities and species including ridged water milfoil and river swamp wallaby-grass. The wetlands also provide food resources and breeding habitat for bird species of high conservation significance (such as eastern great egret, Latham's snipe, white-bellied sea eagle, Australasian bittern, brolga, spoonbill, Australasian shoveler and glossy ibis). Many of these species are listed in international agreements and conventions.

Social and economic values

The wetlands support a range of recreational activities including birdwatching, bike riding, bushwalking and camping. Moodie Swamp and Black Swamp are state game reserves managed by Parks Victoria. Kinnairds Wetland is managed by Moira Shire and Goulburn-Murray Water.

Environmental watering objectives in the Broken wetlands

	Maintain or improve the diversity of wetland vegetation Maintain populations of nationally threatened plant species (such as ridged water milfoil, slender water milfoil and river swamp wallaby-grass)
	Maintain feeding and breeding habitat for waterbirds, particularly for brolga, royal spoonbill and Australasian shoveler

System overview

The water regimes of these wetlands have been greatly influenced by their position in the landscape. The development and operation of the Shepparton, Central Goulburn and Murray Valley irrigation districts have changed the natural flow paths and the timing, frequency, volume and duration of natural flooding to these and other wetlands in the region. Existing irrigation system infrastructure enables water for the environment to be delivered to the three nominated wetlands, to restore some of the natural wetting and drying patterns. However, the lack of channel capacity share restricts the ability to deliver the required volume of water for the environment to the wetlands when it is most needed.

Recent conditions

The Broken River catchment received near-average rainfall early in the 2017–18 water year, followed by a drier-than-average summer and autumn. The main exception was a storm in early December 2017 that dropped more than three times the average December rainfall in a few days. Run-off from the storm and associated flooding delivered some inflows to Black Swamp, Kinnairds Wetland and Moodie Swamp.

Black Swamp and Kinnairds Wetland filled naturally in spring 2016, and they were not actively watered in 2017–18, to support the natural wetting and drying cycles. Periodic drying of wetlands is important to allow newly germinated wetland plants to grow and set seed following extended wet phases. The December 2017 storm delivered only small inflows to both wetlands, which lasted less than three months and which did not significantly disrupt the drying phase.

Moodie Swamp also filled in spring 2016 and received some inflows in December 2017. Water for the environment was delivered to Moodie Swamp in autumn 2018 to promote cane grass habitat, priming the wetland for brolga breeding.

Scope of environmental watering

Table 5.5.6 shows potential environmental watering actions and their environmental objectives.

Table 5.5.6 Potential environmental watering actions and objectives for the Broken wetlands

Potential environmental watering	Environmental objectives
Black Swamp (fill in spring)	• Maintain the diversity of wetland vegetation • Provide waterbird feeding and breeding habitat
Kinnairds Wetland (fill in spring)	• Maintain the diversity of wetland vegetation • Maintain populations of the nationally threatened ridged water milfoil and slender water milfoil • Provide waterbird feeding and breeding habitat
Moodie Swamp (fill in autumn)	• Maintain the diversity of wetland vegetation • Maintain populations of the nationally threatened ridged water milfoil and slender water milfoil • Provide waterbird feeding and breeding habitat, particularly for brolga

Scenario planning

Table 5.5.7 outlines potential environmental watering and expected water use under a range of planning scenarios.

Goulburn Broken CMA has undertaken landscape-scale planning for these wetlands to maintain a high diversity of habitat types in the region to support waterbirds and other water-dependent animals. Plans have been made under a range of climate scenarios to guide decision-making, but decisions to deliver water for the environment to the Broken wetlands will be based largely on their hydrological condition and observed waterbird breeding activity and on the potential impact of environmental watering on wetland vegetation communities.

Kinnairds Wetland and Black Swamp have been identified as high priorities in all planning scenarios, as neither wetland received significant volumes of water in 2017–18. Both wetlands provide important habitat for waterbirds and wetland vegetation communities including ridged water milfoil, water nymph and river swamp wallaby-grass.

Moodie Swamp received water for the environment in autumn 2018. It will hold water over winter (when brolga are breeding), then be left to draw down slowly in spring, allowing newly germinated wetland plants to grow and set seed. Water for the environment may be delivered to top-up Moodie Swamp in late summer if waterbirds are breeding.

In a typical wet scenario, all three wetlands will fill naturally in winter or spring, and only small volumes of water for the environment may be required to extend the duration or extent of natural flooding to support a significant waterbird breeding event if it occurs.

A magpie goose and yellow-billed spoonbills at Black Swamp, by Goulburn Broken CMA

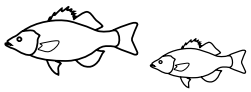
Table 5.5.7 Potential environmental watering for the Broken wetlands under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected catchment conditions	• Catchment run-off and unregulated flows into the wetlands are highly unlikely	• Catchment run-off and unregulated flows into the wetlands are unlikely	• Some catchment run-off and unregulated flows into some of the wetlands are likely, particularly in winter/spring	• Catchment run-off and unregulated flows into the wetlands may partly or wholly fill the wetlands, particularly in winter/spring
Potential environmental watering – tier 1 (high priorities)	• Black Swamp (spring) • Kinnaird Wetland (spring)	• Black Swamp (spring) • Kinnaird Wetland (spring)	• Black Swamp (spring) • Kinnaird Wetland (spring)	• Black Swamp (spring) • Kinnaird Wetland (spring)
Potential environmental watering – tier 2 (additional priorities)	• Moodie Swamp (autumn)	• Moodie Swamp (autumn)	• Moodie Swamp (autumn)	
Possible volume of water for the environment required to achieve objectives[1]	• 580 ML (tier 1) • 500 ML (tier 2)	• 580 ML (tier 1) • 500 ML (tier 2)	• 580 ML (tier 1) • 250 ML (tier 2)	• 300 ML (tier 1)

[1] *Water for the environment requirements for tier 2 actions are additional to tier 1 requirements.*

Risk management

Environmental watering program partners have considered and assessed risks and identified mitigating strategies relating to environmental flows in 2018–19. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).



5.6 Campaspe system

Waterway manager – North Central Catchment Management Authority

Storage managers – Goulburn-Murray Water, Coliban Water

Environmental water holders – Victorian Environmental Water Holder, Commonwealth Environmental Water Holder, the Murray–Darling Basin Authority (the Living Murray program)

The Campaspe catchment extends from the Great Dividing Range in the south and outfalls to the River Murray in the north, a total distance of about 150 km. The Campaspe River is the main waterway in the catchment and flows through urban, peri-urban and rural town including Kyneton, Elmore, Rochester and Echuca. The second-largest waterway is the Coliban River, which also rises in the Great Dividing Range to the west of the Campaspe River before joining it at Lake Eppalock.

The catchment supports important populations of plants and animals, particularly platypus and native fish. Platypus are a feature of both the Campaspe and Coliban rivers, and the recovery of native fish in the Campaspe River below Lake Eppalock remains a key objective.

Engagement

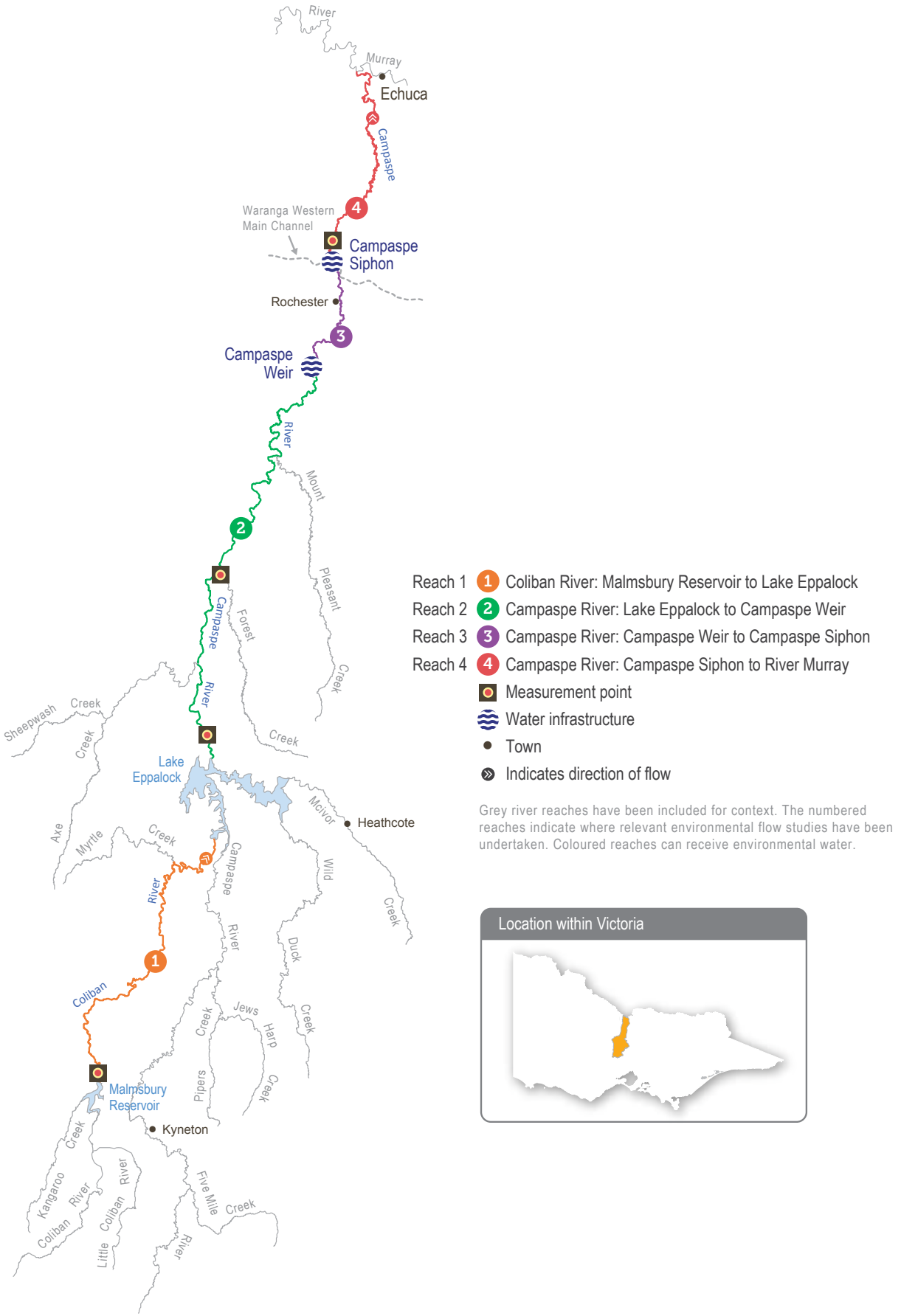
Table 5.6.1 shows the partners and stakeholder organisations the North Central CMA engaged in preparing the Campaspe system seasonal watering proposals.

Seasonal watering proposals are informed by longer-term regional catchment strategies, regional waterway strategies, environmental flow studies, water management plans and other studies. These incorporate a range of environmental, cultural, social and economic perspectives and longer-term integrated catchment and waterway management objectives. For further details, refer to the *North Central Regional Catchment Strategy* and the *North Central Waterway Strategy.*

Table 5.6.1 Partners and stakeholders engaged in developing the Campaspe system seasonal watering proposals

Partner and stakeholder engagement
• Campaspe Environmental Water Advisory Group (comprising community members, Department of Environment, Land, Water and Planning, Goulburn-Murray Water, North Central CMA, the Victorian Environmental Water Holder and the Commonwealth Environmental Water Office)
• Coliban Water
• Dja Dja Wurrung Clans Aboriginal Corporation
• Dja Dja Wurrung Traditional Owners
• Taungurung Clans Aboriginal Corporation
• Yorta Yorta Nation Aboriginal Corporation

Figure 5.6.1 The Campaspe system



5.6.1 Campaspe River

Natural inflows in the upper Campaspe River catchment are harvested into Lake Eppalock, which is located near the townships of Axedale and Heathcote. The main tributaries of the Campaspe River are the Coliban River, McIvor and Pipers creeks upstream of Lake Eppalock and Mount Pleasant, Forest and Axe creeks downstream of Lake Eppalock. Below Lake Eppalock, the major in-stream structure is the Campaspe Weir, which was built to divert water to the Campaspe Irrigation District. It is not used for water diversion now, but is a barrier to fish migration. Higher flows usually spill over the weir. The Campaspe Siphon, just downstream of Rochester, is part of the Waranga Western Channel which carries water from the Goulburn system to western Victoria. Water can be released from the Waranga Western Channel into the lower reaches of the Campaspe River, but the siphon is another barrier to fish migration at low-to-moderate flows.

The Campaspe River continues to be an important place for Traditional Owners and their Nations. The Registered Aboriginal Parties (RAPs) in the region are the Taungurung Clans Aboriginal Corporation, the Dja Dja Wurrung Clans Aboriginal Corporation and the Yorta Yorta Nation Aboriginal Corporation. Representatives from the three RAPs were engaged during the preparation of the Campaspe system seasonal watering proposal.

The Campaspe River has been identified as a priority for restoration under *Water for Victoria*. The Caring for the Campaspe project will deliver revegetation and fencing projects to protect and improve riparian land along the Campaspe River and its tributaries. Complementary water management activities such as these are needed to optimise the environmental outcomes achievable with environmental flows.

Environmental values

The Campaspe River below Lake Eppalock provides important habitat for several native fish species including Murray cod, silver perch, golden perch, Murray-Darling rainbowfish and flat-headed gudgeon. Notably the Murray-Darling rainbowfish, a listed species in Victoria and previously presumed lost from the system, has recently been recorded at many sites on the Campaspe River and is now abundant downstream of Elmore.

Maintaining flows is important for migration opportunities and dispersal of these fish species. Platypus, water rats, turtles and frogs are also present along the length of the river. The streamside vegetation zone is narrow and dominated by large, mature river red gum trees that support wildlife (such as the swift parrot and squirrel glider).

Social and economic values

The Campaspe River is an important source of water and a delivery mechanism for irrigation, industry and town water (including to Bendigo and Ballarat). Popular recreational activities along the Campaspe River include camping, boating, kayaking, fishing, swimming, bushwalking, picnicking and birdwatching. These activities draw locals and tourists alike, providing economic benefit to towns along the river.

Environmental watering objectives in the Campaspe River

	Sustain adult river red gums and provide opportunities for successful recruitment Maintain the extent and increase the diversity of riparian vegetation Maintain or increase the extent of in-stream aquatic plants
	Provide habitat to help protect and increase populations of native fish Help native fish species (such as the trout cod, river blackfish and Macquarie perch) recolonise the river
	Maintain resident platypus population by providing places to rest, breed and feed, as well as opportunities for juveniles to disperse
	Provide connection along the length of the Campaspe River and into the River Murray
	Increase the diversity and biomass of waterbugs to provide energy, break down dead organic matter and support the river's food chain
	Prevent high salinity and maintain healthy levels of oxygen in deep pools

System overview

Flows downstream of Lake Eppalock are largely influenced by releases from storage and the operation of the Campaspe Weir and the Campaspe Siphon near Rochester. The Campaspe's major tributary — the Coliban River — flows through the three Coliban Water storages — the Upper Coliban, Lauriston and Malmsbury reservoirs — before reaching Lake Eppalock. Water for the environment is held and released from Lake Eppalock, with some limited ability to regulate flows further downstream at the Campaspe Weir.

Regulation of the river has significantly reduced flows and reversed seasonal patterns, so that flows in most years are now higher during the summer and autumn irrigation season and lower in winter and spring. Lake Eppalock also captures many of the bankfull and overbank flow events that would naturally have passed through the system.

Water for the environment is released from Lake Eppalock to support aquatic plants and animals in and along the river. It can be supplemented by water for the environment delivered via the Waranga Western Channel at the Campaspe Siphon, which provides important flexibility to meeting reach 4 demands. Water for the environment is primarily used to improve the magnitude and variability of flows during the winter and spring periods. Primary flow measurement points are at Barnadown (reach 2) and downstream of the Campaspe Siphon (reach 4).

Goulburn-Murray Water transfers consumptive water from Lake Eppalock to customers in the River Murray or to downstream storages (such as Lake Victoria). These inter-valley transfers usually occur in summer/autumn and can significantly increase flows in the Campaspe River at a time when flows would naturally be low. These high flows may reduce the amount of suitable habitat for juvenile fish, which rely on protected, shallow areas of water near the edge of the river channel. They can also drown streamside vegetation. Storage managers and the CMA have been working cooperatively to enhance the positive effects and limit any negative effects these transfers may have on native plants and animals. For example, inter-valley transfers have been released in a pattern to support native fish migration from the River Murray into reach 4 of the Campaspe River, without affecting delivery to downstream users.

Recent conditions

Rainfall and climate conditions in the region were largely drier and hotter than the long-term average throughout 2017–18. There were few unregulated flows from tributaries, and Lake Eppalock did not spill. The dry conditions led to high consumptive water demand in the Murray and Goulburn systems. Large volumes of inter-valley transfers were delivered from the Campaspe system to meet these demands, and despite the dry season flows in the Campaspe River was equivalent to wet-to-very-wet conditions in summer/autumn. For much of summer, flows in the Campaspe River were close to an order of magnitude greater than recommended for environmental purposes. Managers worked with ecologists to provide advice to storage managers to minimise risks to environmental values throughout this period.

The Campaspe River received several planned environmental flows events in 2017–18. Flows were provided with a combination of passing flows, consumptive water delivery and managed releases of water for the environment. Winter low flows were delivered between July and November 2017, with small, unregulated tributary flows providing additional variation. Two freshes were delivered during spring to trigger fish movement and spawning and to improve vegetation condition and the water quality and productivity of the aquatic ecosystem. The first fresh in early September 2017 reached 1,200 ML per day for two days. The second fresh was delivered as two consecutive peaks (of 1,400 ML per day for two days and 1,600 ML per day for two days) to encourage golden perch spawning. The summer inter-valley transfers were shaped to attract juvenile golden and silver perch from the River Murray into the Campaspe system. This event builds on the success of a similar event in the previous year.

Monitoring of native fish and vegetation continued in the Campaspe River in 2017–18. Highlights include the first-detected Murray cod larvae since regular monitoring began and the detection of silver perch at more than half of the sites surveyed in reaches 3 and 4. Monitoring showed continued recovery of the vegetation after the Millennium Drought and bank-scouring floods of 2010-11, and five Victorian rare or threatened species including the small scurf-pea were detected.

Scope of environmental watering

Table 5.6.2 shows potential environmental watering actions and their environmental objectives.

Table 5.6 2 Potential environmental watering actions and objectives for the Campaspe River

Potential environmental watering	Environmental objectives
Summer/autumn low flows (10–50 ML/day in December–May)	• Provide permanent connectivity to maintain water quality, particularly dissolved oxygen and salinity levels
Winter/spring low flows (50–200 ML/day in June–November)	• Maintain connectivity of pool refuges for fish and improved habitat for water bugs • Maintain connectivity to prevent a decline in water quality
Winter/spring freshes (2 events at 1,000–1,800 ML/day for up to 7 days each in June–November)	• Stimulate fish movement, allow movement to downstream reaches and provide spawning triggers • Water riparian vegetation • Maintain habitat for waterbugs • Support platypus habitat and breeding opportunities including triggers for burrow selection • Flush organics from bank and benches to reduce the risk of blackwater events in summer
Summer/autumn freshes (up to 3 freshes of 50–200 ML/day for up to 3 days each in December–May)	• Provide longitudinal connectivity for fish in periods of low flow • Maintain habitat for waterbugs • Maintain water quality

Scenario planning

Table 5.6.3 outlines the potential environmental watering and expected water usage under a range of planning scenarios.

Planning for the use of water for the environment in the 2018–19 season is based on three identified management scenarios. Each scenario is based on expected operational river flows from Goulburn-Murray Water, unregulated flows from rainfall events and water for the environment available in the Campaspe River system.

The three scenarios have been developed in line with the historic inflow records for the Campaspe River and are the critical decision points for delivery of water for the environment. These decisions are based on the likely volume of water available and the critical-flow components required in a season. The intention of the scenario planning approach is to build the flexibility required to adjust to seasonal circumstances as they unfold throughout the year, to achieve the planned ecological objectives for 2018–19.

If additional water becomes available during the year, the number and size of events can be increased. This would provide improved conditions for plants and animals, which helps strengthen populations while conditions are good. Carryover into 2019–20 is not a priority this year, with allocation available on 1 July 2019 from a very high-reliability component of the environmental entitlement, which will meet minimum critical demands.

Table 5.6.3 Potential environmental watering for the Campaspe River under a range of planning scenarios

Planning scenario	Drought	Dry	Average to wet
Expected river conditions	• Few or no unregulated flows • High consumptive water deliveries • No passing flows in winter • No spills from storage	• Some unregulated flows • Some consumptive water deliveries • Increased passing flows • Some unregulated flows from storage spill	• Frequent unregulated flows • Moderate summer consumptive water deliveries in reach 2 and low deliveries in reaches 3 and 4 in summer • Increased passing flows • Significant spills from storage
Expected availability of water for the environment	• 20,652 ML VEWH • 6,594 ML CEWH • 126 ML Living Murray • 6,000 ML carryover • 33,372 ML total	• 20,652 ML VEWH • 6,594 ML CEWH • 126 ML Living Murray • 3,000 ML carryover • 30,372 ML total	• 20,652 ML VEWH • 6,594 ML CEWH • 126 ML Living Murray • 0 ML carryover • 27,372 ML total
Potential environmental watering – tier 1 (high priorities)	• Summer/autumn low flow • Winter/spring low flow • Winter/spring fresh (1 event) • Summer/autumn freshes (3 events) • Additional freshes may be required to avoid critical loss of species/habitat if a low-dissolved-oxygen event occurs	• Summer/autumn low flow • Winter/spring low flow • Winter/spring freshes (1 event) • Summer/autumn freshes (3 events) • Additional freshes may be required to avoid critical loss of species/habitat if a low-dissolved-oxygen event occurs	• Summer/autumn low flow • Winter/spring low flow • Winter/spring freshes (2 events) • Summer/autumn freshes (3 events) • Additional freshes may be required to avoid critical loss of species/habitat if a low-dissolved-oxygen event occurs
Potential environmental watering – tier 2 (additional priorities)	• Increased magnitude of winter/spring low flow • Winter/spring fresh (1 additional event) • Increased magnitude of summer/autumn freshes • Provide fish-attracting flows in summer	• Increased magnitude of winter/spring low flow • Winter/spring fresh (1 additional event) • Increased magnitude of winter/spring and summer/autumn freshes • Provide fish-attracting flows in summer	• Increased magnitude of winter/spring low flow • Increased magnitude of winter/spring and summer/autumn freshes • Provide fish-attracting flows in summer
Possible volume of water for the environment required to achieve objectives[1]	• 28,800 ML (tier 1) • 25,200 (tier 2)	• 30,000 ML (tier 1) • 28,800 ML (tier 2)	• 27,200 ML (tier 1) • 28,000 ML (tier 2)

[1] *Water for the environment requirements for tier 2 actions are additional to tier 1 requirements.*

Risk management

Environmental watering program partners have considered and assessed risks and identified mitigating strategies relating to environmental flows in 2018–19. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

5.6.2 Coliban River

The Coliban River is the major tributary of the Campaspe River and flows into Lake Eppalock. It is highly regulated with three storages harvesting water primarily for urban use.

The Coliban River continues to be an important place for Traditional Owners and their Nations. The Registered Aboriginal Party in the region is the Dja Dja Wurrung Clans Aboriginal Corporation who were engaged during the preparation of the Coliban seasonal watering proposal.

Environmental values

The Coliban River provides important habitat for platypus, native water rats and small-bodied native fish (such as flat-headed gudgeon and mountain galaxias). The Coliban River also contains a diverse range of waterbugs supported by stands of emergent and submergent aquatic vegetation. It is bordered by remnant patches of streambank shrubland vegetation and woodland containing river red gum, callistemon, woolly tea-tree and inland wirilda, which provide habitat for terrestrial animals.

Social and economic values

Communities in Malmsbury, Taradale, Metcalfe and the surrounding area value the Coliban River for its aesthetic and recreational features including Ellis Falls and the Cascades. Popular recreational activities in the area include camping, fishing and birdwatching. The upper Coliban storages – the Malmsbury and Lauriston reservoirs – supply urban, irrigation, stock and domestic demands in the surrounding area.

Environmental watering objectives in the Coliban system

	Increase the cover and diversity of aquatic plants Increase the cover and diversity of fringing vegetation while limiting encroachment into the middle of the channel Maintain adult riparian vegetation and provide opportunities for recruitment
	Increase the abundance and diversity of small-bodied native fish by providing flows that allow movement
	Maintain adequate diversity and biomass of waterbugs to break down dead organic matter and support the river's food chain
	Improve water quality and maintain healthy levels of dissolved oxygen in pools
	Support platypus communities by providing opportunities for successful breeding and dispersal
	Clean fine sediment from substrates to support biofilms

System overview

Flows in the Coliban River downstream of Malmsbury Reservoir are regulated by the operation of the Malmsbury, Lauriston and Upper Coliban storages. An important distinction between the Coliban River and other regulated Victorian systems is the lack of irrigation demand. Therefore, flows in the river are influenced by the passing-flow entitlement, which depends on catchment inflows, transfers of water to Lake Eppalock and major flood events in the catchment.

Reach 1 of the Coliban River below Malmsbury Reservoir to Lake Eppalock can benefit from environmental watering. The VEWH does not have any environmental entitlements in the Coliban system, but passing flows can be managed to help mitigate some risks associated with critically low summer flows including low-dissolved-oxygen levels. A small volume of Commonwealth water for the environment is held in the system, but the high cost of delivery means there is no plan to use it in 2018–19.

Recent conditions

Rainfall in the Coliban River area for the 2017–18 season has been variable although generally below average. Rainfall between August and November is essential for filling the Coliban storages. Rainfall between August and November 2017 was 165 mm, which is slightly less than the long-term average of 191 mm. For most of the year, there was little-to-no contribution of unregulated flows from catchment run-off, so flows in the Coliban River were generally well-below environmental flow recommendations. The exception was a small spill from Malmsbury Reservoir in September.

Passing flows were reduced to 4 ML per day during winter/spring to enable managers to build a reserve in the Malmsbury passing flows account that could be used to maintain continuous flows in the upper reaches over summer: otherwise, flows would stop completely. Even with the release of accumulated passing flows, the lowest reaches of the Coliban River contracted to a series of isolated pools in summer/autumn.

Scope of environmental watering

Table 5.6.4 shows potential environmental watering actions and their environmental objectives.

Table 5.6.4 Potential environmental watering actions and objectives for the Coliban system

Potential environmental watering	Environmental objectives
Pulsed summer/ autumn low flow (5–15 ML/day for up to 2 weeks in December–May as required)[1]	• Maintain water quality (including dissolved oxygen levels) and habitat for aquatic biota (including fish and platypus)
Summer/autumn low flow (1–10 ML/day in December–May)	• Maintain water quality (including dissolved oxygen levels) and habitat for aquatic animals (including fish and platypus) • Maintain aquatic and fringing vegetation • Maintain waterbug habitat
Summer/autumn freshes (2 events of up to 200 ML/day for 3 days in December–May)[1]	• Support fish and platypus movement during the summer period • Maintain aquatic and fringing vegetation • Improve water quality and waterbug habitat • Flush organics and sediment from in-stream substrates

[1] *The actual volume and duration of freshes will depend on available water resources, climatic conditions and conditions within the river.*

Scenario planning

Table 5.6.5 outlines the potential environmental watering and expected water usage under a range of planning scenarios. There is insufficient water available to meet all the requirements for water for the environment of the Coliban system and managers must prioritise actions on an annual basis.

Water availability in the Coliban system relies on withholding passing flows in winter/spring for use in the high-risk summer period when poor water quality is more likely. Providing constant low flows and short freshes can maintain habitat in the section immediately downstream of Malmsbury Reservoir.

The volume of water available varies based on inflows, storage spills and the volume of passing flows accumulated. Less water is available in dry years or following a spill from storage. Water is not likely to be available to provide summer/autumn freshes except under average conditions or when a sufficient volume has been carried over and not been lost to spill. The target flows and duration of freshes to mitigate a potentially catastrophic water-quality incident will vary depending on water availability, the severity of the conditions and incident and the amount of flow and water in the river at the time.

Coliban River at Malmsbury Common, by Imagine Photography

Table 5.6.5 Potential environmental watering for the Coliban system under a range of planning scenarios

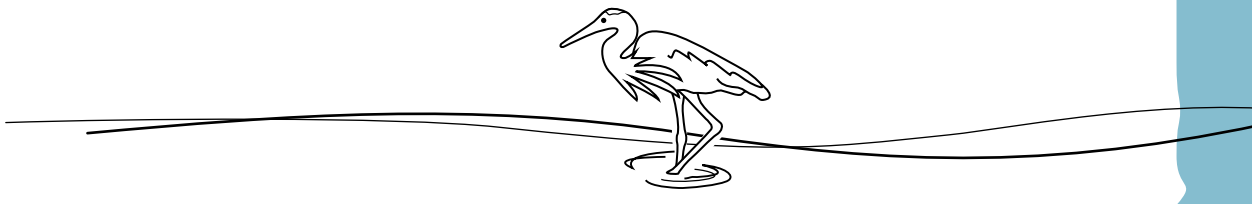
Planning scenario	Drought to dry	Average to wet
Expected river conditions	• Little or no unregulated flows	• Some unregulated river flows from tributary inflows
Expected availability of water for the environment	• Minimal passing flows and low volume to withhold for use at other times in the season	• Moderate-to-high passing flows with good volumes available but reduced ability to reserve flows due to possible storage spills • Withheld flows for use at other times in the season
Potential environmental watering – tier 1 (high priorities)	• Pulsed summer/autumn low flows • Summer/autumn low flows	• Summer/autumn low flows • Summer/autumn freshes
Potential environmental watering – tier 2 (additional priorities) [1,2]	• Increased magnitude of summer/ autumn low flows	• N/A
Possible volume of water for the environment required to achieve objectives	• 900 ML (tier 1) • 250 ML (tier 2)[2]	• 1,200 ML (tier 1)
Priority carryover requirements	• Reserve passing flows for 2019–20	

[1] *Only a priority after 2019–20 critical carryover requirements have been set aside.*

[2] *Water for the environment requirements for tier 2 actions are additional to tier 1 requirements.*

Risk management

Environmental watering program partners have considered and assessed risks and identified mitigating strategies relating to environmental flows in 2018–19. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).



5.7 Loddon system

Waterway manager – North Central Catchment Management Authority

Storage manager – Goulburn-Murray Water

Environmental water holders – Victorian Environmental Water Holder, Commonwealth Environmental Water Holder

The Loddon system contains five waterways that can receive regulated environmental flows: the Loddon River, Serpentine Creek, Tullaroop Creek, Birchs Creek and Pyramid Creek.

Engagement

Table 5.7.1 shows the partners and stakeholder organisations with which North Central CMA engaged when preparing their seasonal watering proposals.

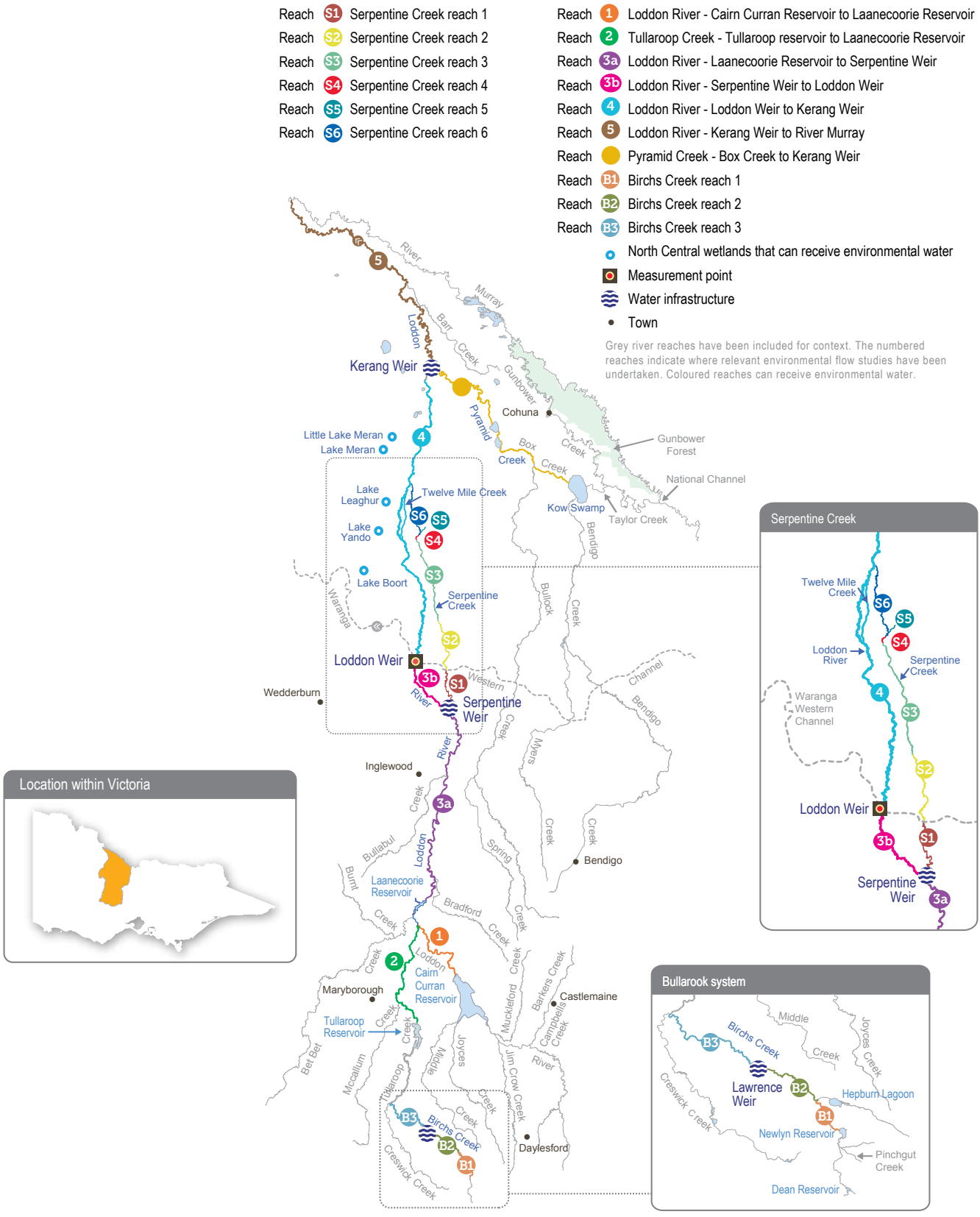
Seasonal watering proposals are informed by longer-term regional catchment strategies, regional waterway strategies, environmental flow studies, water management plans and other studies. These incorporate a range of environmental, cultural, social and economic perspectives and longer-term integrated catchment and waterway management objectives. For further details, refer to the *North Central Regional Catchment Strategy* and *North Central Waterway Strategy*.

Table 5.7.1 Partners and stakeholders engaged in developing the Loddon system seasonal watering proposal

Partner and stakeholder engagement
• Barapa Barapa Nations Traditional Owners
• Birchs Creek Environmental Water Advisory Group, Loddon Murray Wetlands Environmental Water Advisory Group and Loddon River Environmental Water Advisory Group (comprising community members and representatives of Field & Game Australia, Birdlife Australia, Game Management Authority, NCCMA's Community Consultative Committee, Gannawarra Shire Council, Swan Hill Rural City Council, Loddon Shire Council, Campaspe Shire Council, Parks Victoria, Goulburn-Murray Water, Central Highlands Water, the Victorian Environmental Water Holder)
• Commonwealth Environmental Water Office and the Victorian Environmental Water Holder
• Commonwealth Environmental Water Office
• Dja Dja Wurrung Clans Aboriginal Corporation
• Field & Game Australia
• Game Management Authority
• Goulburn-Murray Water
• Loddon Shire Council, Campaspe Shire Council
• Parks Victoria
• Victorian Environmental Water Holder
• VRFish
• Wamba Wemba Traditional Owners
• Yorta Yorta Nation Aboriginal Corporation

Sunset by the Loddon River at Kerang, by Zarleen Blakeley

Figure 5.7.1


Reach S1 Serpentine Creek reach 1
Reach S2 Serpentine Creek reach 2
Reach S3 Serpentine Creek reach 3
Reach S4 Serpentine Creek reach 4
Reach S5 Serpentine Creek reach 5
Reach S6 Serpentine Creek reach 6
Reach 1 Loddon River - Cairn Curran Reservoir to Laanecoorie Reservoir
Reach 2 Tullaroop Creek - Tullaroop reservoir to Laanecoorie Reservoir
Reach 3a Loddon River - Laanecoorie Reservoir to Serpentine Weir
Reach 3b Loddon River - Serpentine Weir to Loddon Weir
Reach 4 Loddon River - Loddon Weir to Kerang Weir
Reach 5 Loddon River - Kerang Weir to River Murray
Reach Pyramid Creek - Box Creek to Kerang Weir
Reach B1 Birchs Creek reach 1
Reach B2 Birchs Creek reach 2
Reach B3 Birchs Creek reach 3
North Central wetlands that can receive environmental water
Measurement point
Water infrastructure
Town
Grey river reaches have been included for context. The numbered reaches indicate where relevant environmental flow studies have been undertaken. Coloured reaches can receive environmental water.
Location within Victoria
Serpentine Creek
Bullarook system
Kerang Weir
Cohuna
Gunbower Forest
National Channel
Kow Swamp
Taylor Creek
Little Lake Meran
Lake Meran
Lake Leaghur
Lake Yando
Lake Boort
Twelve Mile Creek
Serpentine Creek
Loddon Weir
Serpentine Weir
Wedderburn
Inglewood
Bendigo
Laanecoorie Reservoir
Cairn Curran Reservoir
Tullaroop Reservoir
Maryborough
Castlemaine
Daylesford
Birchs Creek
Lawrence Weir
Hepburn Lagoon
Newlyn Reservoir
Pinchgut Creek
Dean Reservoir
Loddon River
Waranga Western Channel

5.7.1 Loddon River system (including Tullaroop, Serpentine and Pyramid creeks)

The Loddon River flows from the Great Dividing Range in the south to the River Murray in the north. Tullaroop Creek is the main tributary in the upper Loddon River system. The middle section of the Loddon River is characterised by many distributary streams and anabranches that carry water away from the river onto the floodplain. The lower Loddon River is joined by Pyramid Creek at Kerang, at which point the Loddon becomes part of the River Murray floodplain.

The Loddon River continues to be an important place for Traditional Owners and their Nations. The Registered Aboriginal Party (RAP) in the region is the Dja Dja Wurrung Clans Aboriginal Corporation. Representatives from Dja Dja Wurrung, Barapa Barapa and Wamba Wemba Traditional Owners were engaged during the preparation of the Loddon system seasonal watering proposals.

Environmental values

The Loddon River system supports platypus, frogs, turtles and fish. Streamside vegetation varies in condition depending on the recent water regime, the extent of clearing and historic and current land management practices. Those areas remaining relatively intact support a variety of woodland birds and other native animals. Important plant species across the system include cane grass, tangled lignum, black box and river red gum.

Although fish populations in the Loddon system are affected by the many barriers caused by weirs and reservoirs, a large range of species are still found through the catchment. Native fish are most-abundant and diverse in the upper catchment. River blackfish are found in Serpentine Creek and rare Murray-Darling rainbow fish are found in the middle sections of the Loddon River. Pyramid Creek supports large-bodied fish (such as golden perch, Murray cod and silver perch) and is an important corridor for fish migration between the Loddon and Murray systems. Engineering works to provide fish passage at the Chute, Box Creek regulator and Kerang Weir in recent years have been important in reopening these migration routes.

Social economic values

The Loddon River supplies the Loddon Valley Irrigation Area and is essential for the area's prosperity. In the highly productive irrigation areas in the lower catchment, the main land uses are dairying, pasture and irrigated horticulture. Mixed farming and cereal growing dominate the middle and upper catchment.

Storages and weir pools that form part of the irrigation network are used for recreational activities, particularly during the drier months when river levels are low. The river is an important recreational hub with locals and visitors using it for camping, hunting, waterskiing, canoeing, boating, and for walking and cycling along its banks. Murray cod and golden perch are stocked in the Loddon River and are important recreational fishing species. Bridgewater on Loddon hosts regional and national waterskiing and triathlon competitions.

Environmental watering objectives in the Loddon River system

	Maintain river red gum, tea tree and lignum and provide opportunities for new plants to germinate and grow Limit encroachment of emergent macrophytes and allow in-stream vegetation to spread to channel margins Establish and maintain a variety of vegetation types
	Protect and increase populations of native fish by providing flows for them to move upstream and downstream Maintain the water quality and the variety of aquatic habitats
	Maintain or increase the habitat available to turtles
	Create opportunities for platypus to disperse throughout the system Maintain access to foraging habitat Provide opportunities for successful breeding and recruitment
	Maintain the water quality in river pools

System overview

Three main storages are located on the Loddon River: Cairn Curran, Tullaroop and Laanecoorie reservoirs. Downstream of Laanecoorie Reservoir, river flows are regulated by the operation of the Bridgewater, Serpentine, Loddon and Kerang weirs.

Water for the environment can be delivered to the Loddon River from Cairn Curran or Tullaroop reservoirs or from the Goulburn system via the Waranga Western Channel, which intersects the Loddon River at Loddon Weir. Water is provided to Pyramid Creek through releases from Kow Swamp, which receives water diverted from the River Murray at Torrumbarry Weir. Water is diverted from the Loddon River to Serpentine Creek and to the Loddon Valley Irrigation Area to supply agriculture.

The highly regulated nature of the Loddon system provides both challenges and opportunities for effective management of water for the environment. The ability to manipulate the timing of releases at multiple locations provides opportunities to accomplish environmental outcomes at discrete locations. However, coordinating environmental flows and consumptive flows is difficult through the irrigation season, especially when irrigation demand is high. This can lead to constraints in the timing and delivery of water for the environment or higher-than-recommended flows upstream of Loddon Weir. The structures used for managing irrigation water form barriers in the waterway, restricting continuity and the ability to achieve outcomes for native fish and possibly platypus.

The highest-priority reach for environmental watering is from Loddon Weir to Kerang Weir. The reach does not carry irrigation water, and it relies heavily on environmental flows to maintain its environmental condition. Environmental flows to this reach aim to improve the condition of riparian vegetation, maintain water quality and increase the abundance of native fish. Environmental flows are delivered to the upper Loddon River, Tullaroop Creek and Serpentine Creek to maintain or increase populations of river blackfish and platypus.

Recent conditions

Rainfall patterns in the Loddon catchment varied throughout 2017–18. There was a relatively dry period in September/October 2017 and a short-lived wet period in November 2017 to January 2018. However, the late spring/early summer rain did not deliver high inflows because the rainfall was sporadic and the catchment was fairly dry. Late summer and autumn were particularly dry and environmental flows were required to maintain flows in the reaches downstream of Loddon Weir.

Most flow recommendations for summer low flows and freshes in the reaches upstream of Loddon Weir were exceeded because large volumes of irrigation water were delivered. In the priority reach, between Loddon Weir and Kerang Weir, all environmental flow components were delivered except for those which rely on unregulated flows or storages spilling.

In 2017, winter low flows and a spring fresh were delivered to Serpentine Creek for the first time. The releases helped managers understand the rate at which managed flows move through Serpentine Creek and into Pennyroyal and Bannacher creeks at the end of the system. The observations will help environmental planning in future years to support objectives for waterbirds, vegetation and native fish while limiting impacts on landholders.

Pyramid Creek and the Loddon River have benefited from actions implemented in the first three years of the North Central CMA's *Native Fish Recovery Plan – Gunbower and Lower Loddon*. Reinstatement of habitat, fish passage and an improved flow regime have significantly improved conditions for fish, particularly Murray cod and golden perch. Two environmental flows were provided to Pyramid Creek during 2017–18 to support the plan. The first was delivered in spring and involved coordinated releases through Pyramid Creek and reach 4 of the Loddon River, to attract fish from the lower Loddon and River Murray to move through Kerang Weir and the Box Creek regulator fishway at Kow Swamp. The second was delivered at the end of the irrigation season in mid-May to control the rate of drawdown in Pyramid Creek, to prevent fish becoming stranded when the irrigation system is drained. The environmental flows in Pyramid Creek could not be achieved without the cooperation and expertise of the storage manager, Goulburn-Murray Water.

Scope of environmental watering

Table 5.7.2 shows potential environmental watering actions and their environmental objectives.

Table 5.7.2 Potential environmental watering actions and objectives for the Loddon River system

Potential environmental watering	Environmental objectives
Loddon River (reach 1)	
Summer/autumn freshes (up to 4 freshes of 35–80 ML/day for 1–3 days in December–May)	• Provide a cue for fish movement so they access alternate habitats • Wash organic matter into the stream to drive the aquatic food webs • Mix and re-oxygenate pools and dilute concentrated salt • Inundate lower banks to wet the soil and promote the establishment, growth and survival of sedges and reeds
Winter/spring freshes (1–2 freshes of 400–700 ML/day for 1–5 days in July–October)	• Promote recruitment of riparian vegetation • Maintain connectivity between pools for native fish movement • Flush accumulated leaf litter from banks and low benches into the channel to drive aquatic food webs
Tullaroop Creek (reach 2)	
Summer/autumn freshes (up to 3 freshes of 30–40 ML/day for 1–3 days in December–May)	• Provide cues and passage for native fish dispersal through the system • Wash organic matter into the stream to drive aquatic food webs • Maintain water quality in pools • Inundate lower banks to wet the soil and promote the establishment, growth and survival of sedges and reeds
Winter/spring freshes (1 fresh of 200–400 ML/day for 1–5 days in July–October)	• Maintain connectivity between pools for native fish movement • Stimulate movement of Murray cod to breeding grounds • Promote the recruitment of riparian vegetation on banks and benches • Flush accumulated leaf litter from banks and low benches into the channel to drive aquatic food webs and increase ecological productivity

Table 5.7.2 Potential environmental watering actions and objectives for the Loddon River system *continued*

Potential environmental watering	Environmental objectives
Loddon River (reach 4)	
Summer/autumn freshes (up to three freshes 50–100 ML/day for 3–4 days in December–May)	• Maintain pool habitat and reduce the likelihood of low-dissolved-oxygen water
Winter/spring high flow (1 high flow of 450–750 ML/day for 6–10 days in June–November)[1]	• Provide cues for native fish movement • Flush organic matter from in-channel benches to aid carbon and nutrient cycles • Flush fine sediment and scour biofilms to replenish food supply
Summer/autumn low flows (25–50 ML/day December–May)	• Maintain connectivity between pool habitats for native fish
Winter/spring low flow (50–100 ML/day June–November)	• Maintain connectivity between pool habitats during winter to facilitate movement of native fish • Maintain water quality in pools • Maintain bank and fringing vegetation
Autumn high flow (1 high flow of 400 ML/day for 6–10 days in March–May)	• Facilitate the movement and dispersal of juvenile fish and platypus
Serpentine Creek (reach 1)[2]	
Winter/spring fresh (1 fresh of 40–150 ML/day for 2 days in June–November)	• Maintain habitat for native fish and waterbugs • Flush accumulated organic matter from benches to promote carbon cycling and prevent risk of low-dissolved-oxygen conditions during summer months
Summer/autumn freshes (up to 3 freshes of 30–40 ML/day for 1–2 days in December–May)	• Wet in-stream benches • Flush fine sediment and scour biofilms to replenish food supply • Flush organic matter from in-channel benches to aid carbon and nutrient cycles • Provide flow variability to maintain species diversity of fringing vegetation
Summer/autumn low flows (10–20 ML/day in December–May)	• Maintain connectivity between pools to connect fish habitats • Maintain water quality and prevent low-dissolved-oxygen conditions • Maintain foraging habitat for platypus • Enable the growth of in-stream aquatic vegetation
Winter/spring low flows (20–30 ML/day in June–November)	• Maintain spawning habitat and water levels for river blackfish • Maintain the vegetation fringing the bank • Inundate snags to maintain biofilms and foodweb productivity
Pyramid Creek and Loddon River (reach 5)	
Autumn/winter low flow (90–200 ML/day May–August)	• Maintain connectivity between habitats and improve water quality • Maintain the fringing vegetation on the lower banks of the channel • Provide sufficient water depth to inundate snags and maintain biofilms
Spring high flow (1 high flow of 700–900 ML/day for 10 days in September-November)	• Maintain connectivity between habitats and improve water quality • Trigger and facilitate fish movement and breeding, particularly golden perch and silver perch, to increase local populations
Autumn high flow (1 high flow of 700–900 ML/day for 10 days in March-May)	• Maintain connectivity between habitats and improve water quality • Trigger and facilitate the movement of juvenile fish • Provide recruitment opportunities for Murray cod and other native fish species

[1] *Due to potential inundation of private land, environmental flows above 450 ML/day in reach 4 will not be provided without the agreement of potentially affected landholders.*

[2] *Flows in Serpentine Creek will be allowed to continue down Pennyroyal Creek, Bannacher Creek and Nine Mile Creek with the agreement of landholders.*

Scenario planning

Table 5.7.3 outlines the potential environmental watering and expected water use under a range of planning scenarios.

Due to high regulation in the Loddon River system, the highest-priority reach between Loddon Weir and Kerang Weir relies almost entirely on environmental flows to provide its water regime; the exception is flow provided by floods and unregulated spills from storages. There are also many system constraints that limit the ability to deliver flows when lots of water is available. Due to these reasons, the planned environmental flows change little between scenarios.

Under drought to dry scenarios, low flows in the Loddon River will be released at variable rates to provide refuge for fish to survive. Small freshes in summer are essential under this scenario to maintain adequate concentrations of dissolved oxygen for fish and other aquatic animals during heatwaves.

One to three summer/autumn freshes and one high flow in spring are planned under all scenarios. A spring high flow — combining flows from the Loddon River and Pyramid Creek through Kerang Weir — is a high priority for fish migration. The release of an autumn high flow depends on increased water availability in the Loddon system under average and wet scenarios. Flows of up to 200 ML per day will be maintained in Pyramid Creek year-round (that is, including outside the irrigation season) to protect habitat for resident Murray cod.

While there is expected to be enough water available to meet the priority objectives under all scenarios, deliveries of water for the environment in the Loddon system can also be constrained by the physical capacity of the infrastructure and capacity-share rules. For example, water for the environment can only be delivered through the Waranga Western Channel when there is spare capacity after irrigation demands have been met. The VEWH and North Central CMA work with Goulburn-Murray Water to maximise environmental outcomes within system constraints. These cooperative arrangements include adjusting the timing of deliveries of water for the environment to avoid capacity constraints, and modifying the rate and timing of irrigation deliveries and transfers to support environmental outcomes.

Pyramid Creek, by North Central CMA

Table 5.7.3 Potential environmental watering for the Loddon River system under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Negligible contributions from unregulated reaches and tributaries of the Loddon River, consumptive water deliveries during the irrigation season	• Small contributions from unregulated reaches and tributaries of the Loddon River contributing to low flows, consumptive water deliveries during the irrigation season	• Unregulated flows will provide low flows and multiple freshes, most likely in winter and spring • Consumptive water deliveries during the irrigation season	• Spills from Loddon system storages will provide extended-duration high flows and overbank flows most likely in late winter to spring
Expected availability of water for the environment[1]	• Up to 21,000 ML	• Up to 24,000 ML	• Up to 25,500 ML	• Up to 26,000 ML
Loddon River (reach 1) and Tullaroop Creek (reach 2)				
Potential environmental watering	• 3 summer/autumn freshes • 1 winter fresh • Winter/spring low flows			
Loddon River (reach 4)				
Potential environmental watering – tier 1 (high priorities)	• 1–3 summer/autumn freshes • 1 winter/spring high flow • Winter/spring low flows • Summer/autumn low flows		• 3 summer/autumn freshes • 1 winter/spring high flow • Winter/spring low flows • Summer/autumn low flows • 1 autumn high flow	
Potential environmental watering – tier 2 (additional priorities)	• Increased magnitude of winter/spring and summer/autumn low flows	• Increased magnitude of summer/autumn low flows		
Serpentine Creek (reach 1)				
Potential environmental watering – tier 1 (high priorities)	• 1–3 summer/autumn freshes • 1 winter/spring fresh • Summer/autumn low flows • Winter/spring low flows			
Potential environmental watering – tier 2 (additional priorities)	• Increased magnitude of winter/spring and summer/autumn low flows			
Loddon River, Tullaroop Creek and Serpentine Creek				
Possible volume of water for the environment required to achieve objectives	• 9,000 ML (tier 1) • 6,800 ML (tier 2)[3]	• 12,400 ML (tier 1) • 3,700 ML (tier 2)[3]	• 8,300–14,400 ML	
Pyramid Creek and Loddon River (reach 5)				
Potential environmental watering – tier 1 (high priorities)	• 1 spring high flow • Autumn/winter low flows			
Potential environmental watering – tier 2 (additional priorities)	• 1 autumn high flow			
Possible volume of water for the environment required to achieve objectives	• 5,000 ML (tier 1)[2] • 6,000 ML (tier 2)[2,3]			

[1] *Does not include water available in the Goulburn and Murray systems that could be made available to support the achievement of environmental objectives in the Loddon system, subject to trading rules.*

[2] *Represents the estimated volume of water required to underwrite losses associated with the delivery of consumptive water en route through Pyramid Creek.*

[3] *Water for the environment requirements for tier 2 actions are additional to tier 1 requirements.*

Risk management

Environmental watering program partners have considered and assessed risks and identified mitigating strategies relating to environmental flows in 2018–19. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).

5.7.2 Boort wetlands

The Boort wetlands are on the floodplain west of the Loddon River, downstream of Loddon Weir. They consist of temporary and permanent freshwater lakes and swamps: Lake Boort, Lake Leaghur, Lake Yando, Little Lake Meran and Lake Meran. Together, the Boort wetlands cover over 800 ha. There are several other wetlands in the district, but they are currently not managed with water for the environmental.

The Boort wetlands are an important place for Traditional Owners and their Nations. The Registered Aboriginal Party (RAP) in the region is the Dja Dja Wurrung Clans Aboriginal Corporation. Representatives from the RAP and from Barapa Barapa and Wamba Wemba Traditional Owners were engaged during the preparation of the Boort wetlands seasonal watering proposal.

Environmental values

The Boort wetlands provide habitat for a range of plant and animal species. At Lake Yando, 12 rare plant species have been recorded including the jerry-jerry and water nymph. Bird species recorded at Lake Boort, Lake Leaghur and Lake Meran include the white-bellied sea eagle, Latham's snipe and eastern great egret. Little Lake Meran is a swampy woodland with black box trees on the highest wet margins and river red gums fringing the waterline.

Social and recreational values

The Boort wetlands provide many recreation opportunities. Lake Meran and Lake Boort are state game reserves and hunting is also allowed at Lake Yando and Lake Leaghur. The large expanse of open water at Lake Meran attracts visitors during holiday seasons and on weekends for boating, fishing and waterskiing. Lakes Yando, Boort and Leaghur contain excellent environmental values and birdwatchers and field naturalists regularly visit the lakes whether they are wet or dry.

Environmental watering objectives in the Boort wetlands

Maintain or increase the growth of river red gums and aquatic and amphibious vegetation

Rehabilitate habitat and provide breeding opportunities to maintain local and regional populations of birds, fish, frogs and turtles

System overview

The natural watering regimes of wetlands throughout the broader Loddon system have been substantially modified by the construction of levees and channels across the floodplain and by the construction and operation of reservoirs and weirs along the Loddon River. Water is delivered to the Boort wetlands through Loddon Valley Irrigation Area infrastructure.

The availability of water for the environment for the Boort wetlands is closely linked to water available for the Loddon River system. Based on seasonal outlooks at the start of the water year, there is expected to be enough water available to meet objectives under all climate scenarios in 2018–19, but the ability to deliver enough water for the environment to lakes is sometimes limited by channel-capacity constraints. The VEWH and North Central CMA work with the storage manager (Goulburn-Murray Water) to best meet environmental objectives within capacity constraints.

Recent conditions

Rainfall throughout the Loddon catchment and the Boort wetlands varied throughout 2017–18. Winter 2017 had near-average rainfall; September and October 2017 were dry; December 2017 and early January 2018 had some high rainfall; and the rest of summer and autumn were very dry. The high rainfall at the end of spring and early summer did not deliver any inflows to the Boort wetlands, and the very hot and dry conditions later in the year accelerated drying in wetlands that held water from previous years.

Lakes Boort, Leaghur and Yando and Meran were all naturally flooded in spring 2016 and water levels are now receding, allowing wetland plants an opportunity to establish. Little Lake Meran was the only lake in the Boort wetlands system to which water for the environment was delivered in 2017–18. Little Lake Meran is normally disconnected from the Loddon floodplain, except for during exceptionally high floods (such as in 2011). After flooding in 2011, river red gums germinated around the edges of the lake. Water for the environment was delivered to Little Lake Meran in May 2018 and follow-up watering is planned for winter/spring 2018, to maintain the growth of the saplings.

Scope of environmental watering

Table 5.7.4 shows potential environmental watering actions and their environmental objectives.

Table 5.7.4 Potential environmental watering actions and objectives for the Boort wetlands

Potential environmental watering	Environmental objectives
Wetland watering	
Little Lake Meran (partial fill in spring)	• Increase the growth and recruitment of river red gums • Provide feeding and breeding opportunities for waterbirds • Provide open-water and mudflat habitats to support aquatic food webs and provide habitat for waterbirds • Maintain the diversity of aquatic plant communities
Wetland drying	
Lake Boort, Lake Leaghur, Lake Meran and Lake Yando (promote natural drawdown and drying)	• These wetlands will be in a drying phase in 2018–19 • The drying will help maintain a high diversity of habitats across the landscape that can support a wide range of wetland-dependent birds and animals • Gradual drawdown at each wetland will help rehabilitate vegetation zones in and around the wetland

Scenario planning

Table 5.7.5 outlines the potential environmental watering and expected water use under a range of planning scenarios.

Little Lake Meran is the only wetland scheduled to receive water for the environment in 2018–19. River red gums that recruited in Little Lake Meran in 2011 are now mature enough to withstand a long period of inundation. The lake was partially filled in May 2018 after being dry for more than two years, and a top-up in spring 2018 will support the increased growth of river red gums on the lake. Water is planned to be provided under all climate scenarios.

All other wetlands will be allowed to draw down to a minimum level or to dry completely. This will provide a sufficient dry period to promote the growth of herbland plants and the fringing vegetation.

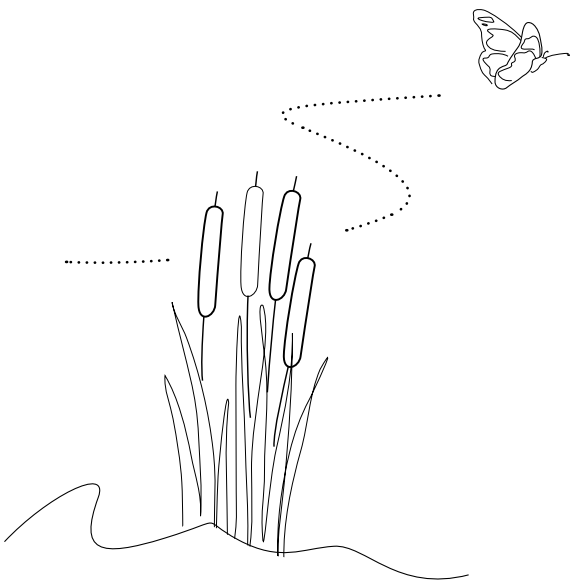
Under a wet scenario if large floods occur, most wetlands will fill from overbank flows from the Loddon River.

Table 5.7.5 Potential environmental watering for the Boort wetlands under a range of planning scenarios

Planning scenario	Dry	Average	Wet
Expected catchment conditions	• No natural inflows to wetlands	• Periods of high flows combined with localised catchment contributions expected to provide minor inflows to wetlands	• Multiple spills from Loddon system storages will provide extended durations of high flows and overbank flows which fill most wetlands
Potential environmental watering	• Little Lake Meran		
Possible volume of water for the environment required to achieve objectives	• 1,300 ML		

Risk management

Environmental watering program partners have considered and assessed risks and identified mitigating strategies relating to environmental flows in 2018–19. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).



5.7.3 Birchs Creek

Birchs Creek is a tributary of the Loddon River located in the southernmost part of the catchment. The creek rises in the ranges north-east of Ballarat and flows north-west through Newlyn and Smeaton before joining Tullaroop Creek near Clunes. The lower parts of the catchment are extensively cleared where the creek meanders through an incised basaltic valley. The creek contains a regionally significant platypus community and a vulnerable river blackfish population.

Birchs Creek is an important place for Traditional Owners and their Nations. The Registered Aboriginal Party (RAP) in the region is the Dja Dja Wurrung Clans Aboriginal Corporation. Representatives from the RAP were engaged during the preparation of the Birchs Creek seasonal watering proposal.

Environmental values

Birchs Creek supports threatened aquatic plants and its deep pools provide habitat for aquatic animals during dry periods. The creek contains native fish including regionally significant populations of river blackfish and mountain galaxias as well as flat-headed gudgeon and Australian smelt. Recent monitoring has shown that platypus are present throughout the entire creek.

The recent removal of willows along the creek is expected to lead to improvements in water quality, habitat and riparian vegetation and in-stream vegetation. This in turn will have a positive effect on macroinvertebrate and small-bodied fish populations.

Social and economic values

Birchs Creek is highly valued by nearby communities for its aesthetic appeal and the value of having water in the landscape. The creek is used for recreational fishing and passive activities (such as walking and picnicking). Water from Birchs Creek (via Newlyn Reservoir) supplies irrigated agriculture, particularly potatoes.

Environmental watering objectives in Birchs Creek

	Increase the abundance of river blackfish, mountain galaxias and other native fish and provide opportunities for movement between pool habitats
	Maintain breeding populations of platypus and provide opportunities for surplus juveniles to disperse to Creswick Creek and Tullaroop Creek
	Enhance in-stream, fringing and riparian native plant communities

System overview

Birchs Creek is part of the broader Bullarook system which contains two small storages — Newlyn Reservoir and Hepburn Lagoon — which provide water for irrigation and urban supply. The storages fill and spill during winter or spring in years with average or above-average rainfall.

Birchs Creek receives tributary inflows from Rocky Lead, Langdons, Lawrence and Tourello creeks. In the downstream reaches, Birchs Creek is highly connected to groundwater, which provides baseflows to the creek in most years.

The VEWH is allocated 100 ML in Newlyn Reservoir on 1 December each year, provided that seasonal determinations in the Bullarook system are at least 20 percent. Any unused allocation from 1 December can be carried over until 30 November of the following water year, but if Newlyn Reservoir spills from 1 July to 30 November, the volume held in carryover is lost. Any water remaining on 30 November is forfeited. When seasonal determinations are below 20 percent, the VEWH does not receive an allocation, and the system's resources are shared equitably to protect critical human and environmental needs.

Recent conditions

The Birchs Creek catchment had near-average rainfall through late winter and early spring 2017, which caused Newlyn Reservoir to fill and spill in September and October 2017. The spills delivered a peak flow of 200 ML per day at the Smeaton gauge. Summer and autumn were warmer and drier than average, and flows in Birchs Creek throughout these seasons were low.

Reservoir spills, tributary inputs and groundwater discharge contributed to meeting environmental flow objectives in Birchs Creek throughout the year, and no environmental flows were delivered in 2017–18.

Scope of environmental watering

Table 5.7.6 shows potential environmental watering actions and their environmental objectives.

Table 5.7.6 Potential environmental watering actions and objectives for Birchs Creek

Potential environmental watering	Environmental objectives
Winter/spring fresh (1 fresh of 30 ML/day for 3 days in September–November)	• Maintain and improve streamside vegetation • Scour organic matter that has accumulated in the channel • Provide habitat and refuge for small fish • Maintain connectivity between pools for fish and platypus movement
Summer/autumn freshes (up to 3 freshes of 10 ML/day for 3 days in December–May)	• Maintain water quality to minimise risks to aquatic animals associated with low dissolved oxygen and high water temperature • Maintain connectivity between refuge pools for fish movement • Maintain and improve in-stream aquatic vegetation • Maintain macroinvertebrate population

Scenario planning

In a drought scenario, seasonal determinations in the Bullarook system (which supports allocations for Birchs Creek) will be less than 20 percent on 1 December 2018. Under this scenario, the VEWH will not receive an allocation on 1 December 2018. The water that was allocated to the VEWH the previous year, on 1 December 2017, will be retained until 30 November 2018 in accordance with entitlement rules. In this case, delivery of a spring fresh using carryover is a priority to bolster the condition of the creek in the lead-up to the summer. However, entitlement rules do not permit the retention of the carryover for higher-priority flows in summer and autumn. If the VEWH does not receive an allocation on 1 December 2018, water resources in the Bullarook system will be shared, to maintain critical human and environmental needs.

Under a dry scenario, there is a fair chance that the VEWH will receive its allocation of 100 ML on 1 December 2018, but an allocation is not assured and winter/spring inflows will be required to boost seasonal determinations up to the 20 percent trigger. If water is allocated under this scenario, delivery of summer/autumn freshes in 2019 will be a high priority, to mitigate the impacts of low flows in Birchs Creek.

Under an average-to-wet scenario, high rainfall will provide high flows to Birchs Creek and recharge groundwater aquifers. Water allocated to the VEWH on 1 December 2018 may be used to provide a summer/autumn fresh in March–April 2019. However, it is more likely that there will be sufficient flows in Birchs Creek provided by groundwater discharge, and the unused water for the environment will be carried over into the following year.

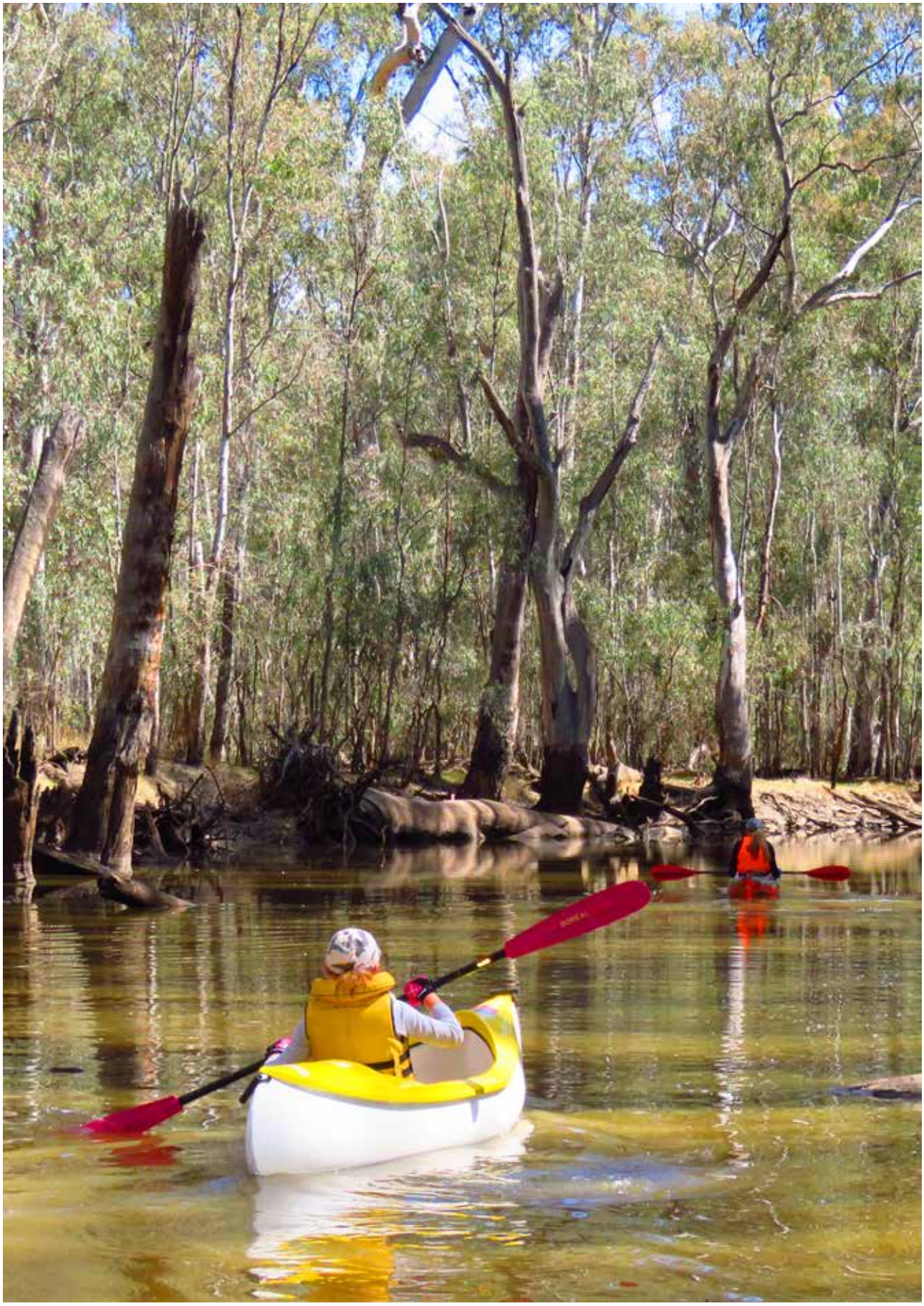
Birchs Creek at Nelson's Bridge, by North Central CMA

Table 5.7.7 Potential environmental watering for Birchs Creek under a range of planning scenarios

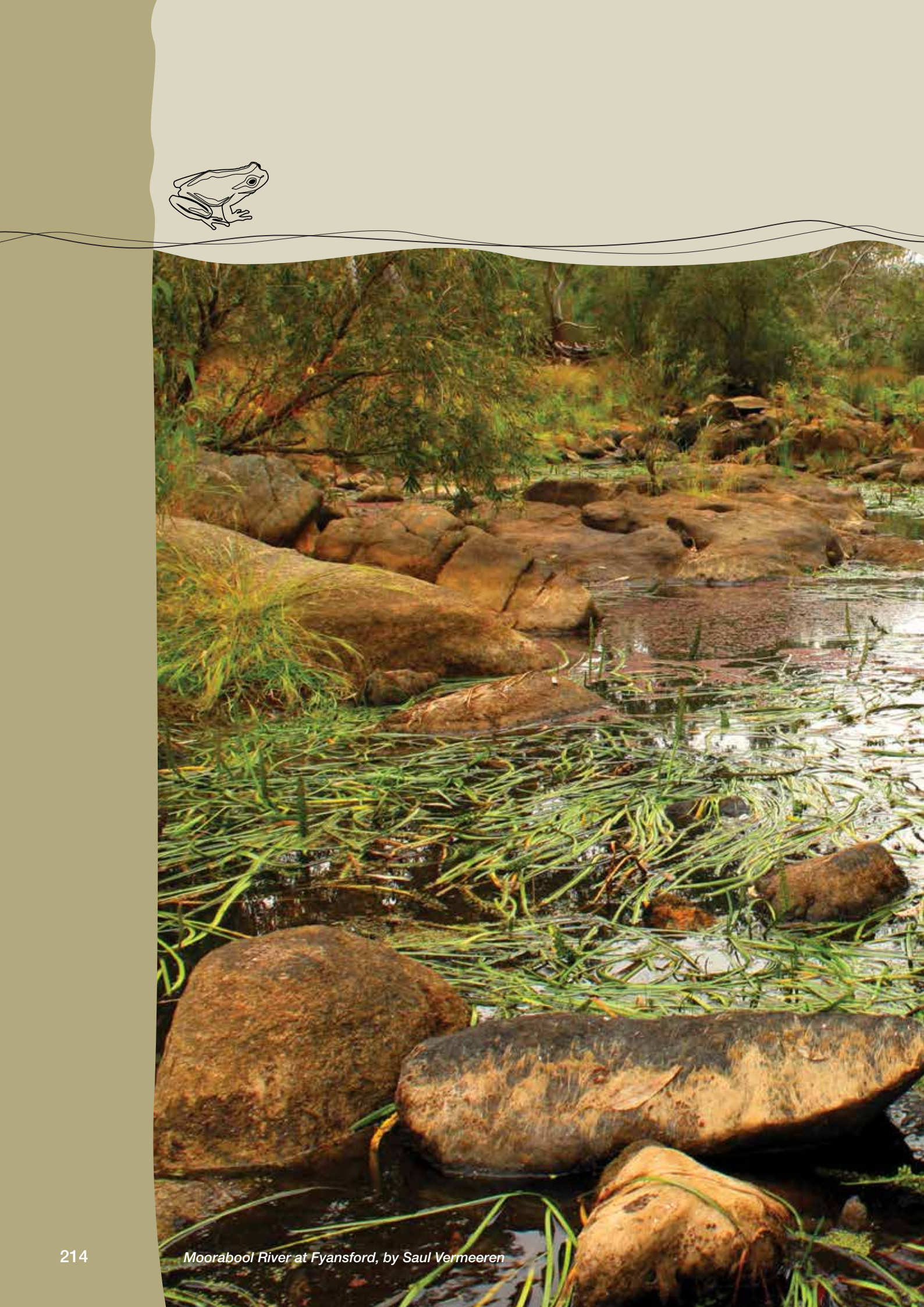
Planning scenario	Drought	Dry	Average to wet
Expected creek conditions	• Reservoir spill unlikely • Flows extremely low during winter/spring • Limited irrigation releases due to low allocations	• Reservoir spill possible • Low flows during winter/spring if no spills occur • Moderate irrigation releases	• Reservoir spills certain in winter/spring • Some unregulated flows through summer/autumn
Potential environmental watering	• 1 winter/spring fresh	• 1 winter/spring fresh • 1–3 summer/autumn freshes	• 1–3 summer/autumn freshes
Possible volume of water for the environment required to achieve objectives	• 100 ML	• 100–200 ML	• 100 ML

Risk management

Environmental watering program partners have considered and assessed risks and identified mitigating strategies relating to environmental flows in 2018–19. Risks and mitigating actions are continually reassessed by program partners throughout the water year (see section 1.3.6).



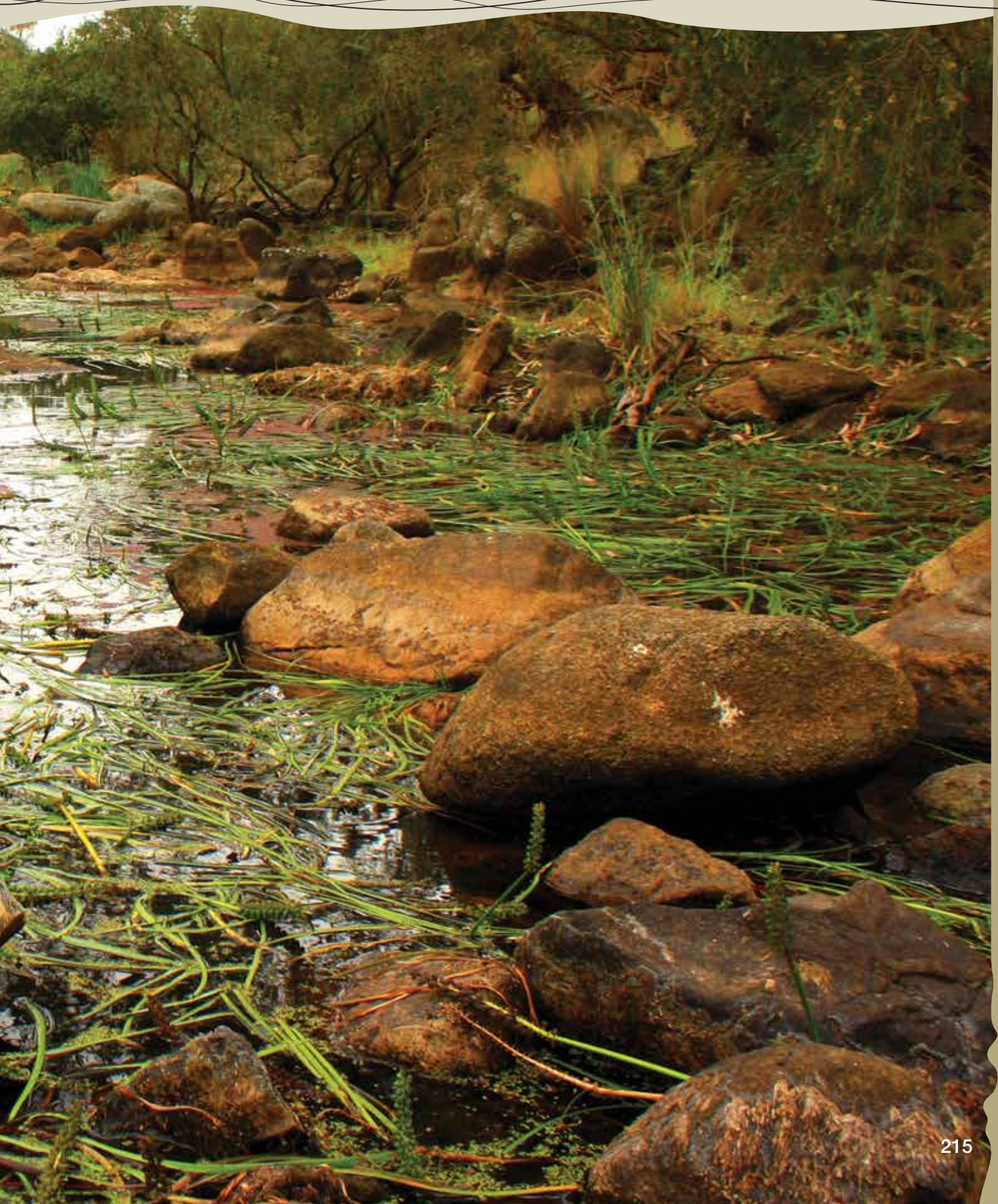
Paddling at Gunbower Creek, by Sydney Harbour Kayaks



Moorabool River at Fyansford, by Saul Vermeeren

Section 6

Further Information



6.1 Acronyms

AHD – Australian Height Datum (also see Glossary entry)

CEWH – Commonwealth Environmental Water Holder

CMA – Catchment management authority

DELWP – Department of Environment, Land, Water and Planning

MDBA – Murray–Darling Basin Authority

MDWWG – Murray Darling Wetlands Working Group

ML – Megalitre (also see glossary entry)

NRM – natural resource management

NVIRP – Northern Victoria Irrigation Renewal Project

RAP – Registered Aboriginal Party

RMIF — River Murray increased flows

VEWH – Victorian Environmental Water Holder

6.2 Glossary

Acid sulphate soils – Naturally occurring soils containing high quantities of iron sulphates. When these soils remain underwater they are stable, but if they are exposed to air, sulphuric acid is generated and can result in severe environmental impacts.

Adaptive management – An iterative decision-making process based on continuous learning that aims to reduce uncertainty over time.

Allocation (of water) – The specific volume of water allocated to water entitlements in a given water year or allocated as specified in a water resource plan.

Australian Height Datum (AHD) – Height above sea level.

Azolla – A native aquatic fern which grows in waterways in dense patches. Its presence usually indicates high levels of nutrients.

Bank erosion – The wearing-away of the banks of a stream or river (as distinct from erosion of the bed) that can occur in extensively dry conditions.

Bank slumping – A form of mass wasting in a river or stream that occurs when a coherent mass of loosely consolidated materials or rock layers moves a short distance down a slope.

Bankfull flows – Flows of sufficient size to reach the top of the riverbank, with little flow spilling onto the floodplain.

Baseflows – A relatively stable, sustained and low flow in a river, generally being its minimum natural level.

Biodiversity – The variety or abundance of plant and animal species in a particular habitat or environment.

Biofilms – Slimy films of bacteria, other microbes and organic materials that cover underwater surfaces including rocks and snags.

Biota – The animal or plant life of a particular area, habitat or geological period.

Blackwater – A natural occurrence caused by the breakdown of plant matter causing the water to discolour. The water turns black and can have very low dissolved-oxygen levels, which can stress or kill fish and other animals that breathe underwater.

Brackish water – Water that is moderately salty but not as salty as sea water. It may result from the mixing of seawater with freshwater, as in estuaries.

Carryover – Unused water of which entitlement holders are allowed to retain ownership into the following season, according to specified rules.

Catchment management authority – A statutory authority established to manage river health and regional and catchment planning and to manage waterways, floodplains, salinity and water quality.

Cease-to-flow – The period in which there is no discernible flow in a river and partial or total drying of the river channel.

Cold water pollution – A phenomena caused by cold water being released into rivers, primarily from large dams, in warmer months.

Commonwealth Environmental Water Office – An office that manages water entitlements recovered by the Australian Government through a combination of investments in water-saving infrastructure, water purchases and other water recovery programs. The entitlements are held by the Commonwealth Environmental Water Holder (CEWH).

Confluence – The point where a tributary joins a larger river (called the main stem) or where two streams meet to become the source of a river of a new name.

Consumptive water – Water owned by water corporations or private entitlement holders held in storages and actively released to meet domestic, stock, town and irrigation needs.

Diadromous fish – Fish that migrate between freshwater and saltwater.

Drawdown – Water released from a body of water (such as a reservoir) at the end of the irrigation season for dam operation and maintenance purposes.

Ecological vegetation communities – Components of a vegetation classification system, these are groups of vegetation communities based on floristic, structural and ecological features.

En route – Water that is on its way to being delivered to urban, rural and irrigation water users.

Environmental flow study – A scientific study of the flow requirements of a particular basin's river and wetland systems used to inform decisions about the management and allocation of water resources.

Environmental water - Water available for environmental purposes including entitlements held by the VEWH, passing flows and unregulated flows.

Environmental water entitlement – An entitlement to water to achieve environmental objectives in waterways. It covers an environmental entitlement, environmental bulk entitlement, water share, section 51 licence or supply agreement.

Environmental water management plan – A plan developed by a waterway manager outlining long-term environmental objectives and based on consultation with key stakeholders, local community and advisory groups to inform the seasonal watering proposal for the particular system.

Estuary – A partially enclosed body of water along the coast where freshwater from rivers and streams meets and mixes with saltwater from the sea.

Fishway – A series of pools built like steps to enable fish to travel through a waterway, dam or waterfall.

Fledging – The care of a young bird until it can fly.

Flow components – Components of a river system's flow regime that can be described by magnitude, timing, frequency and duration (for example, cease-to-flow and overbank flows).

Freshes – Small or short-duration, peak-flow events which exceed the baseflow and last for a few days.

Geomorphology – The scientific study of landforms and the processes that shape them.

Groundwater – Water held underground in the soil or in pores and crevices in rock.

Headwater – A tributary stream of a river close to or forming part of its source.

Headworks system – A system including various storage infrastructure (such as reservoirs and diversion weirs) to enable connection of multiple waterways.

Heritage rivers – Rivers listed under the *Heritage Rivers Act 1992* and parts of rivers and river catchment areas in Victoria which have significant nature conservation, recreation, scenic or cultural heritage attributes.

High-reliability entitlement – A legally recognised, secure entitlement to a defined share of water. Full allocation of a high-reliability entitlement is expected in most years.

Hydrology – The study of the properties of the water and its movement in relation to land.

Inter-valley transfers – The transfer of water between river systems to meet demands as a result of water trade between river systems.

Irrigation releases – The release of water for irrigation purposes.

Juvenile – A stage of life at which an animal or plant is not yet fully mature.

Land manager – An agency or authority responsible for conserving natural and cultural heritage on public land including parks and reserves (such as Parks Victoria and DELWP).

Low-reliability entitlement – A legally recognised, secure entitlement to a defined share of water. Full allocation of a low-reliability entitlement is expected only in some years.

Macroinvertebrates – Animals without a backbone and which can be seen with the naked eye including worms, snails, mites, bugs, beetles, dragonflies and freshwater crayfish. They are also referred to as waterbugs.

Macrophytes – Aquatic plants that are either emergent (growing out of the water, for example phragmites), submergent (growing under the water, for example ribbonweed) or floating (for example floating pond weed).

Managed release – A release of environmental water which is stored in major reservoirs and used for potential watering actions to achieve environmental outcomes.

Megalitre – One million (1,000,000) litres.

Midden – A site of cultural significance where Aboriginal people left the remains of their meals and other domestic waste.

Millennium Drought – One of the worst droughts recorded in south-east Australia since European settlement, it went from about 1995 to 2012.

Operational releases – Releases made from major storages to enable the water distribution system to operate or to make water available to consumptive water users.

Overbank flows – The portion of a flood flow that flows outside the main river channel at relatively small depths over part of or the full width of the waterway and in a direction essentially parallel with the direction of the main channel.

Passing flows – Water released from storages to operate river and distribution systems (often to help deliver water for environmental or consumptive uses) and maintain environmental values and other community benefits. The volume of passing flows is generally determined by inflows to those storages.

Permanent trade – The transfer of ownership of a water share or licence.

Potential environmental watering – Environmental flow components that have been identified for a particular system in a particular year.

Pulse – A gradual build in the flow of water, typically to replicate the most-suitable conditions for water species (such as fish to travel and spawn).

Ramsar-listed wetland – A wetland listed as internationally significant under the Convention on Wetlands signed in Ramsar, Iran in 1971.

Reach – A stretch or section of a river, generally defined in an environmental flow study.

Recruitment – The increase in plants or animals when they survive to the settlement or maturity stage.

Regional waterway strategy – An eight-year action plan prepared by a CMA for the rivers, wetlands and estuaries in its area. It provides a single regional planning document for waterways in the area.

Remnant vegetation – Patches of native trees, shrubs and grasses still remaining following disturbance.

Return flows – Any flows delivered for environmental purposes and then returned to the downstream system to be reused for other purposes. Returned flows may be captured and stored downstream for later reuse, although most commonly they remain within the waterway for in-stream reuse.

Riffle – A relatively shallow section of stream where water flows at a higher velocity with increased turbulence, causing many ripples to be formed in the water surface.

Riparian vegetation – Vegetation located in the area of land that adjoins, regularly influences or is influenced by a river.

Salt wedge – The transition zone of saltwater and freshwater environments which occurs when a freshwater river flows directly into saltwater.

Seasonal watering plan – The VEWH's annual operational document which outlines potential environmental watering across the state in the forthcoming water year.

Seasonal watering proposal – An annual proposal outlining the regional priorities for environmental water use in each water year and submitted by waterway managers to the VEWH for consideration in its seasonal watering plan.

Seasonal watering statement – A statement by the VEWH authorising a CMA to apply or use water from its environmental water entitlements consistently with the seasonal watering plan.

Shared benefits – When water is managed primarily to meet the needs of the entitlement holder, but also provides other types of benefits through decision making that deliberately targets other outcomes.

Slackwater habitat – Habitat in a body of water that has little or no flow, typically formed in areas where the current is restricted by obstructions.

Spawning – The process of species releasing eggs and sperm to reproduce.

Storage manager – Appointed by the Minister for Water to operate major water storages in a particular river basin, to deliver water to entitlement holders.

System operating water – Water managed by storage managers, held in storages and actively released to ensure the system can deliver consumptive water and water to meet other needs.

Temporary trade – Transfer of a seasonal allocation.

Terrestrial vegetation – Land-based plants.

The Living Murray program – An intergovernmental program which holds an average of 500,000 ML of environmental water a year for use at six iconic sites along the River Murray.

Trade – Water shares, allocations and take-and-use licences that can be traded in Victoria under rules the Minister for Water sets.

Translocation – The movement of living organisms from one area to another area where they are given free release.

Tributary – A smaller river or creek that flows into a larger river.

Unregulated (entitlement) – An entitlement to water declared in periods of unregulated flow in a river system (that is, flows that cannot be captured in storages).

Unregulated flows – Natural streamflows that cannot be captured in major reservoirs or storages.

Victorian Environmental Water Holder (VEWH) – An independent statutory body responsible for holding and managing Victorian environmental water entitlements and allocations.

Victorian environmental watering program – The overarching program by which all environmental watering actions are planned and delivered and in which all environmental watering partners are involved.

Water Act 1989 – The legislation that governs water entitlements and establishes the mechanisms for managing Victoria's water resources.

Water entitlement – The right to a volume of water that can (usually) be stored in reservoirs and taken and used under specific conditions.

Water trade – The process of buying, selling or exchanging water allocation or entitlements.

Water allocation – See Allocation (of water).

Water year – The same as a financial year: from 1 July to 30 June the next year.

Waterway manager – The agency or authority (such as a CMA or Melbourne Water) responsible for the environmental management of a catchment or waterway.

Waterways – Rivers, wetlands, creeks, floodplains, estuaries and other bodies of water.

6.3 Contact details

For further information about the *Seasonal Watering Plan 2018–19*, please contact the VEWH.

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For specific information about each system and details about specific seasonal watering proposals, please contact the relevant waterway manager.

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574 Main Street, Bairnsdale, Victoria 3875
PO Box 1012, Bairnsdale, Victoria 3875
(03) 5152 0600
egcma@egcma.com.au
www.egcma.com.au

Glenelg Hopkins CMA
79 French Street, Hamilton, Victoria 3300
PO Box 502, Hamilton, Victoria 3300
(03) 5571 2526
ghcma@ghcma.vic.gov.au
www.ghcma.vic.gov.au

Goulburn Broken CMA
168 Welsford Street, Shepparton, Victoria 3630
PO Box 1752, Shepparton, Victoria 3630
(03) 5822 7700
reception@gbcma.vic.gov.au
www.gbcma.vic.gov.au

Mallee CMA
DPI Complex, Corner Koorlong Avenue and Eleventh Street, Irymple, Victoria 3498
PO Box 5017, Mildura, Victoria 3502
(03) 5051 4377
reception@malleecma.com.au
www.malleecma.vic.gov.au

Melbourne Water
990 La Trobe Street, Docklands, Victoria 3008
PO Box 4342, Melbourne, Victoria 3001
131 722
enquiry@melbournewater.com.au
www.melbournewater.com.au

North Central CMA
628–634 Midland Highway, Huntly, Victoria 3551
PO Box 18, Huntly, Victoria 3551
(03) 5448 7124
info@nccma.vic.gov.au
www.nccma.vic.gov.au

North East CMA
Level 1, 104 Hovell Street, Wodonga, Victoria 3690
PO Box 616, Wodonga Victoria 3689
1300 216 513
necma@necma.vic.gov.au
www.necma.vic.gov.au

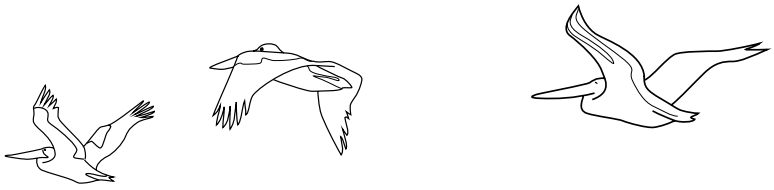
West Gippsland CMA
16 Hotham Street, Traralgon, Victoria 3844
PO Box 1374, Traralgon, Victoria 3844
1300 094 262
westgippy@wgcma.vic.gov.au
www.wgcma.vic.gov.au

Wimmera CMA
24 Darlot Street, Horsham, Victoria 3400
PO Box 479, Horsham, Victoria 3402
(03) 5382 1544
wcma@wcma.vic.gov.au
www.wcma.vic.gov.au

For specific information about the other environmental water holders in Victoria, please contact one of the following organisations.

Murray–Darling Basin Authority
Level 4, 51 Allara Street, Canberra City, ACT 2601
GPO Box 1801, Canberra City, ACT 2061
(02) 6279 0100
engagement@mdba.gov.au
www.mdba.gov.au

Commonwealth Environmental Water Office
John Gorton Building, King Edward Terrace,
Parkes, ACT 2600
GPO Box 787, Canberra, ACT 2061
02 6274 1111
ewater@environment.gov.au
www.environment.gov.au/water/cewo



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Front:

Top left: Sacred kingfisher, by John Tiddy

Top right: Maddie the platypus, by Paul Carracher with permission from The Weekly Advertiser

Bottom left: Winter fresh release from Lal Lal Reservoir to the Moorabool River, by Saul Vermeeren

Bottom right: Enjoying the sunset by the Loddon River at Kerang, by Zarleen Blakeley

Inside front:
Wallapolla East regulator, by Mallee CMA

Back:
Top left: Great egret near Broken Creek, by Keith Ward

Top right: Turtle from the Glenelg River, by Glenelg Hopkins CMA

Centre right: Lake Cullen birdwatchers, by Zarleen Blakeley

Bottom: Thomson River rafting, by West Gippsland CMA

Inside back:
Mount William Creek at Roses Gap, by John Tiddy

collaboration
integrity
commitment
initiative

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