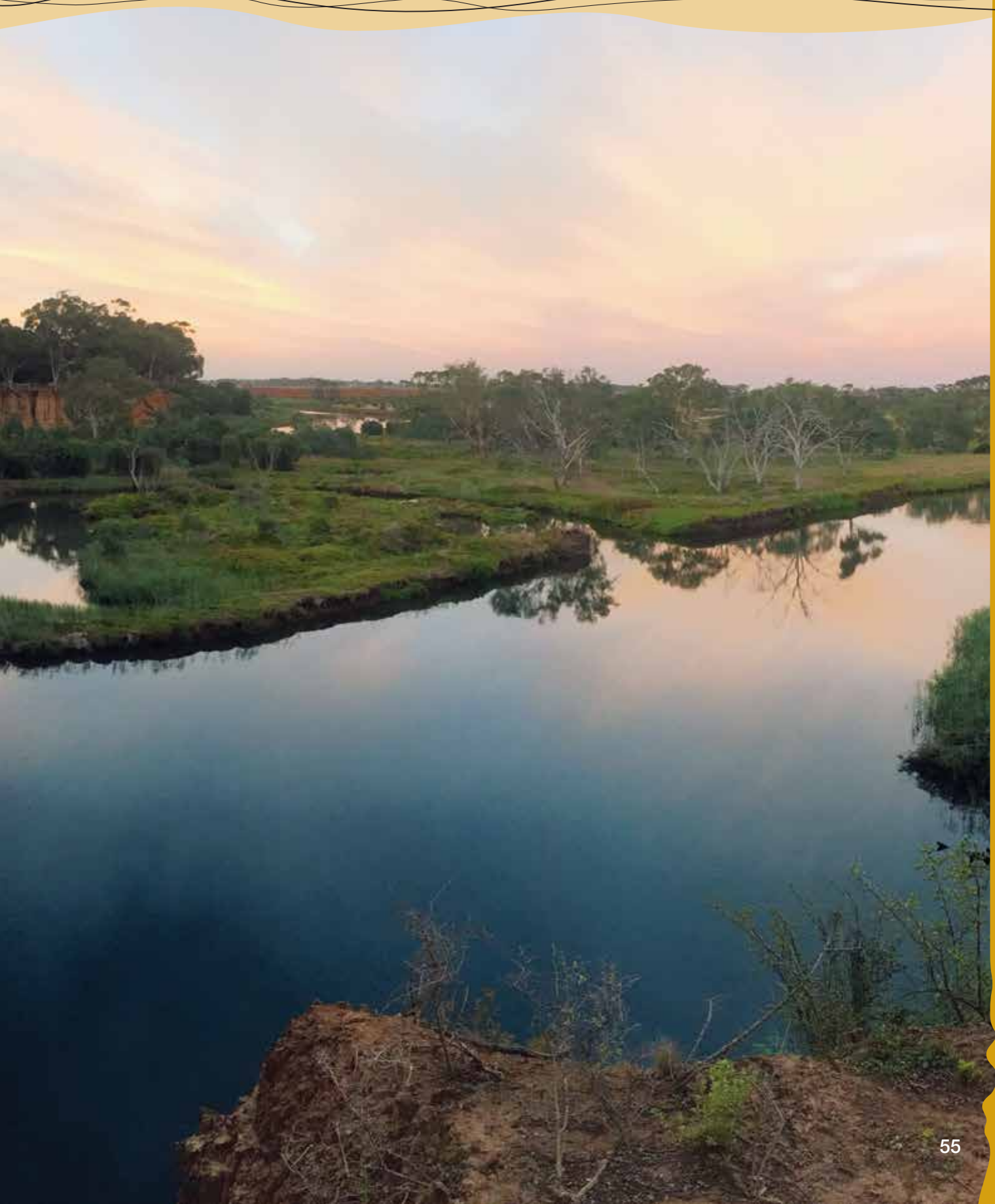
Section 3

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

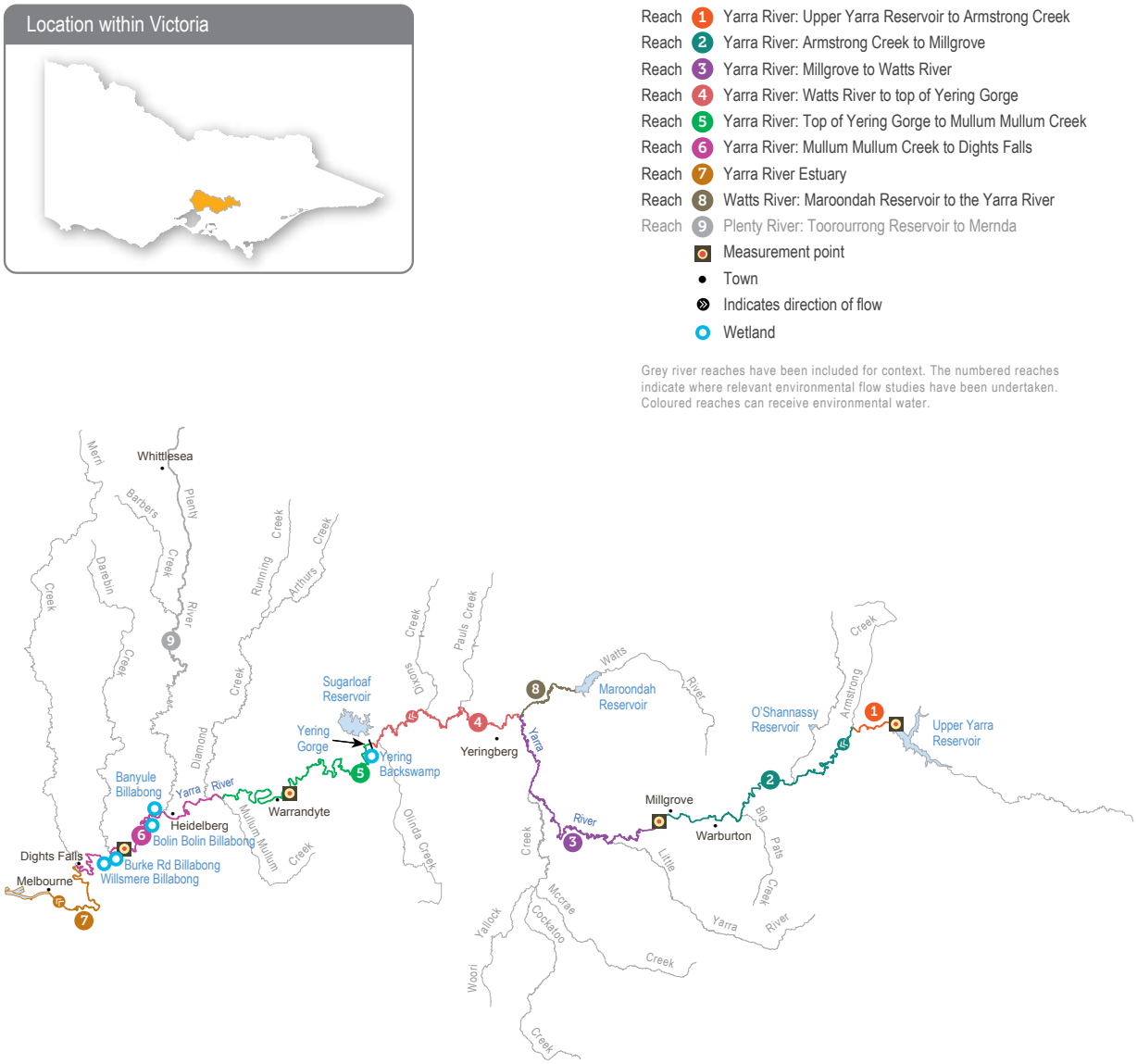
System overview

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

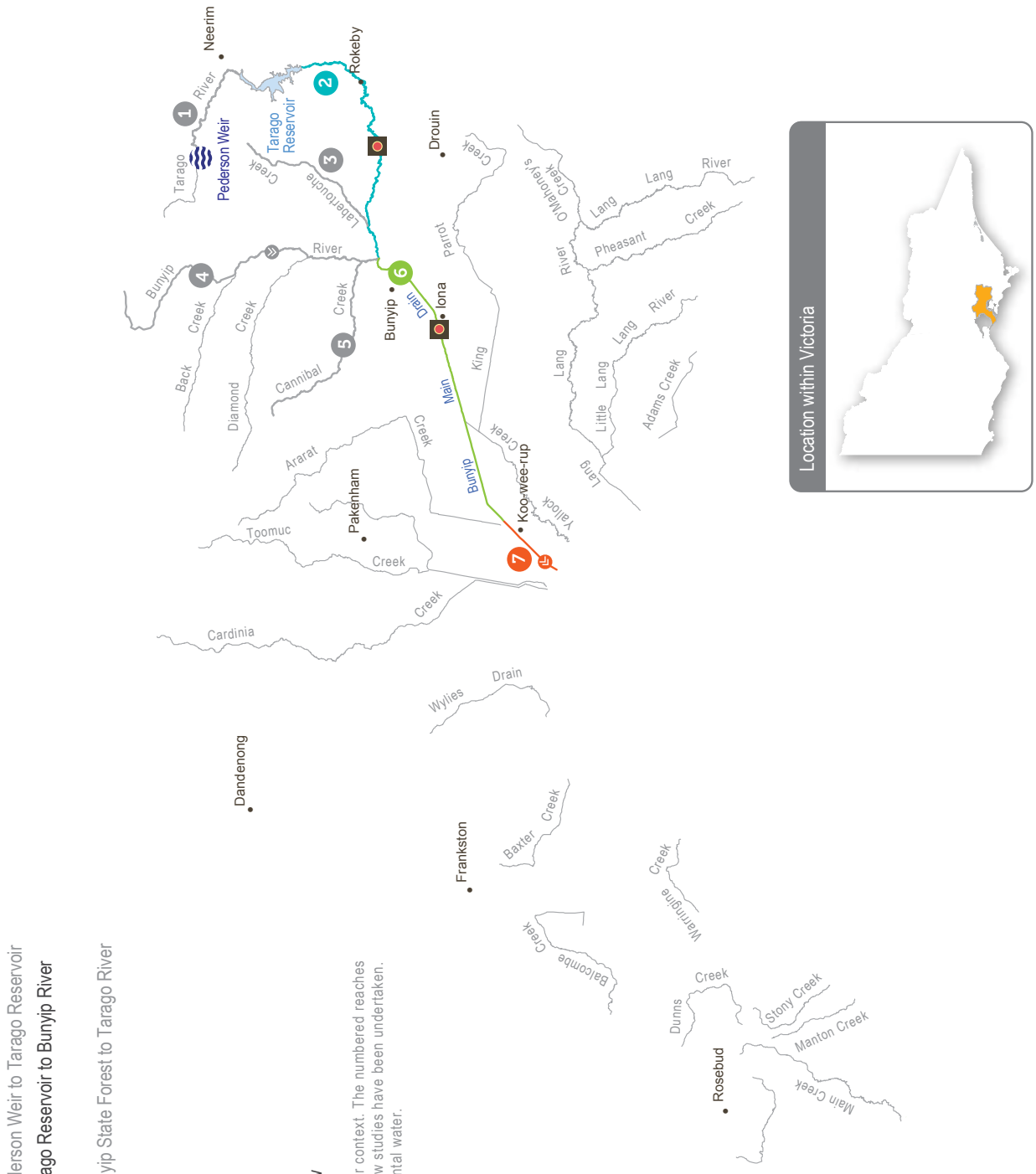
System overview

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).

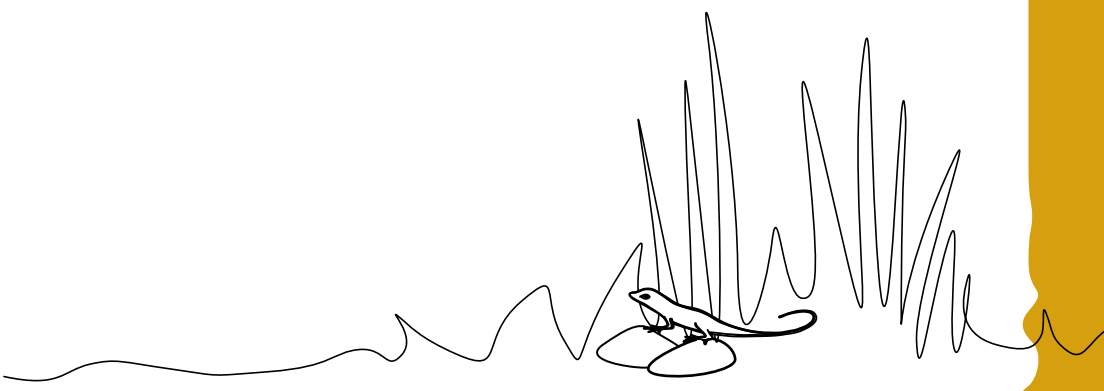
Engagement

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

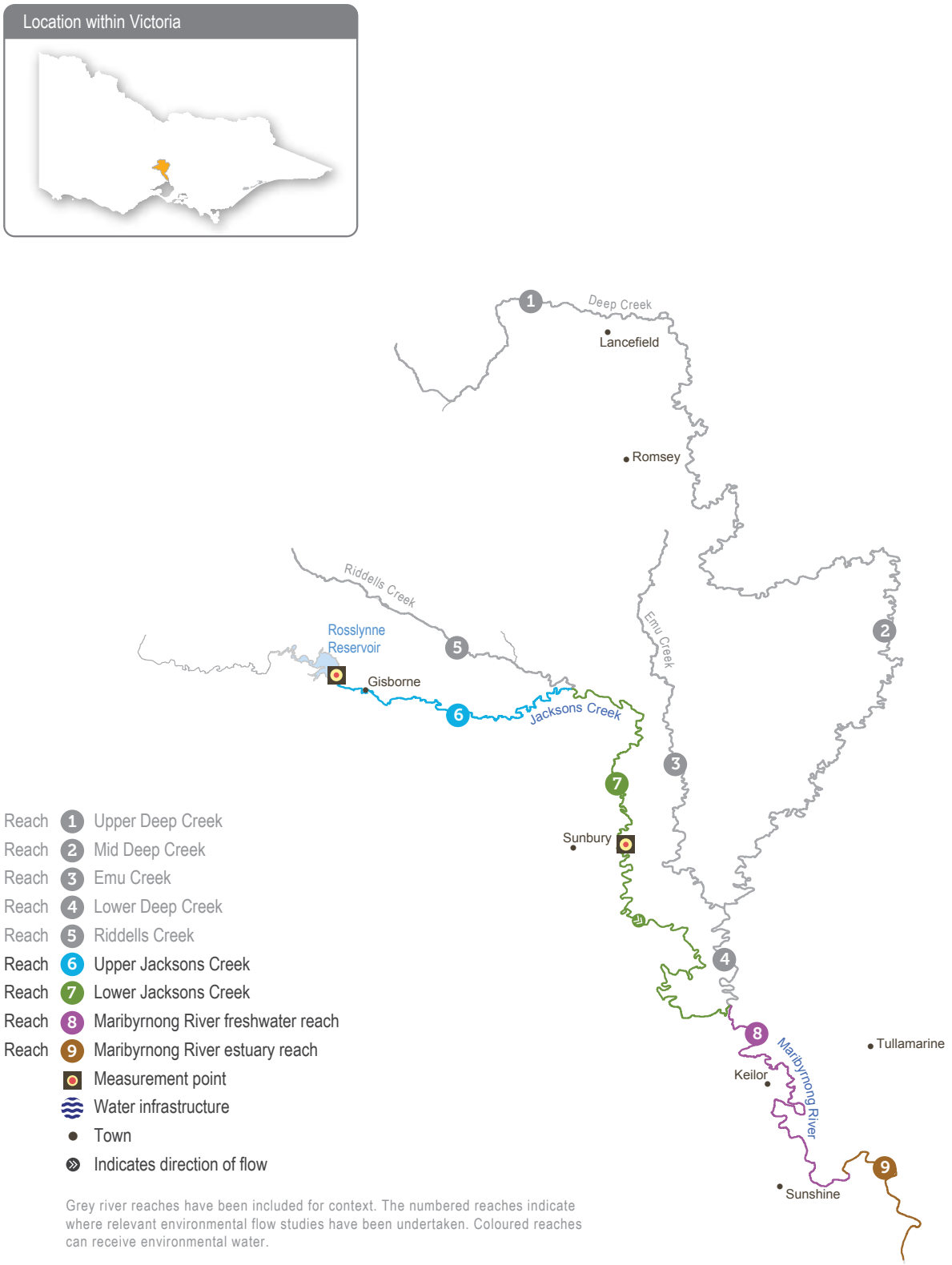
	Maintain or rehabilitate in-stream vegetation and reduce invasive terrestrial plants from encroaching into the riparian zone
	Maintain and increase feeding and breeding habitat for native fish Protect and increase populations of native, small-bodied fish by providing flows for them to move upstream and 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

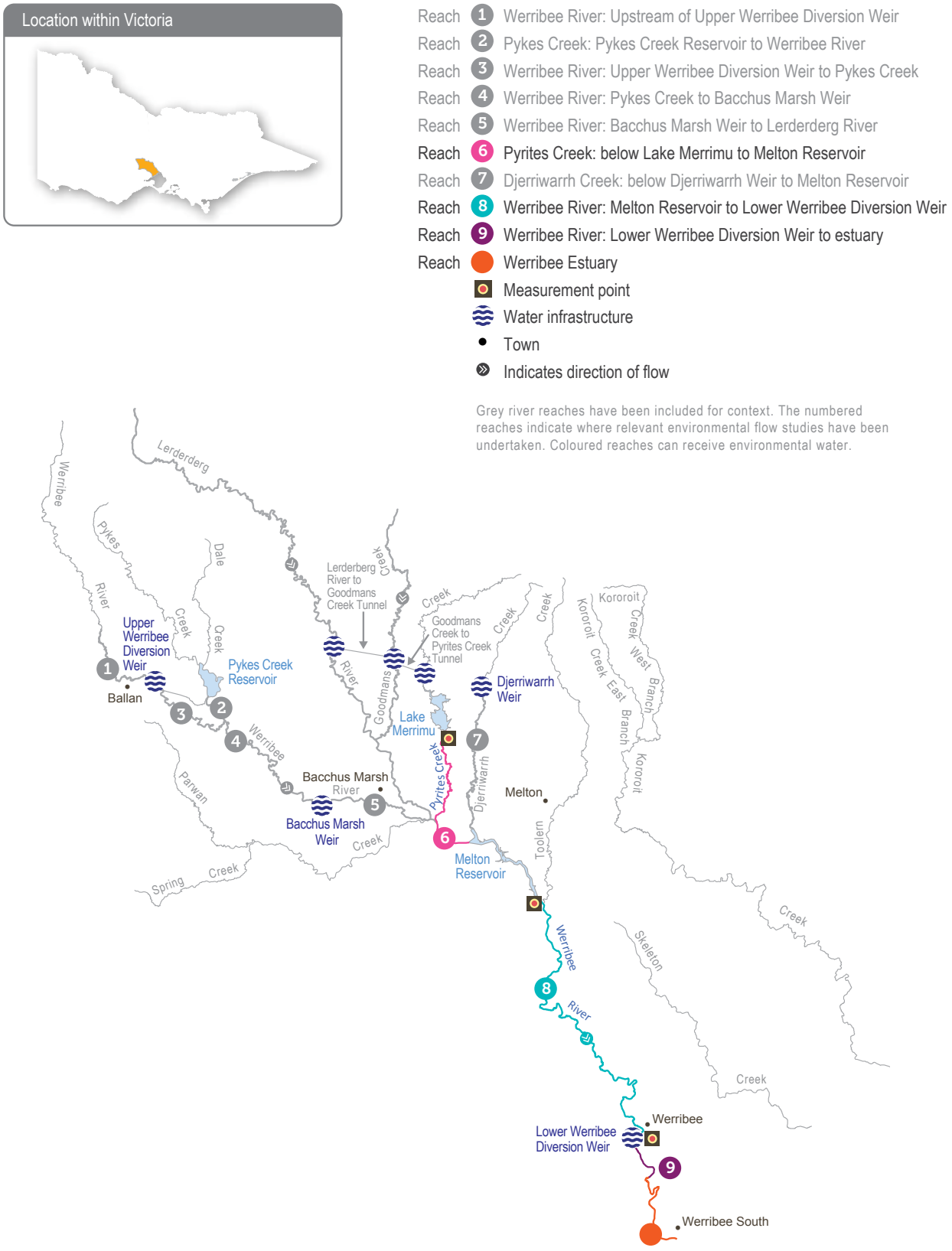
	Maintain the cover of in-stream, riverside and estuary plants
	Protect and increase populations of native fish by improving pool habitat and stimulating fish including black bream and galaxiids to migrate and spawn
	Maintain populations of frogs by providing suitable habitat
	Maintain populations of 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.

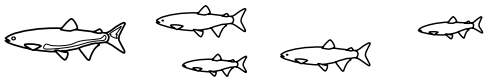
Under average or wet conditions, Melton Reservoir is likely to spill, meaning releases from upstream will spill through the reservoir and provide a small increase in unregulated flow to the lower Werribee River. More water for the environment is needed under average and wet conditions due to the inability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

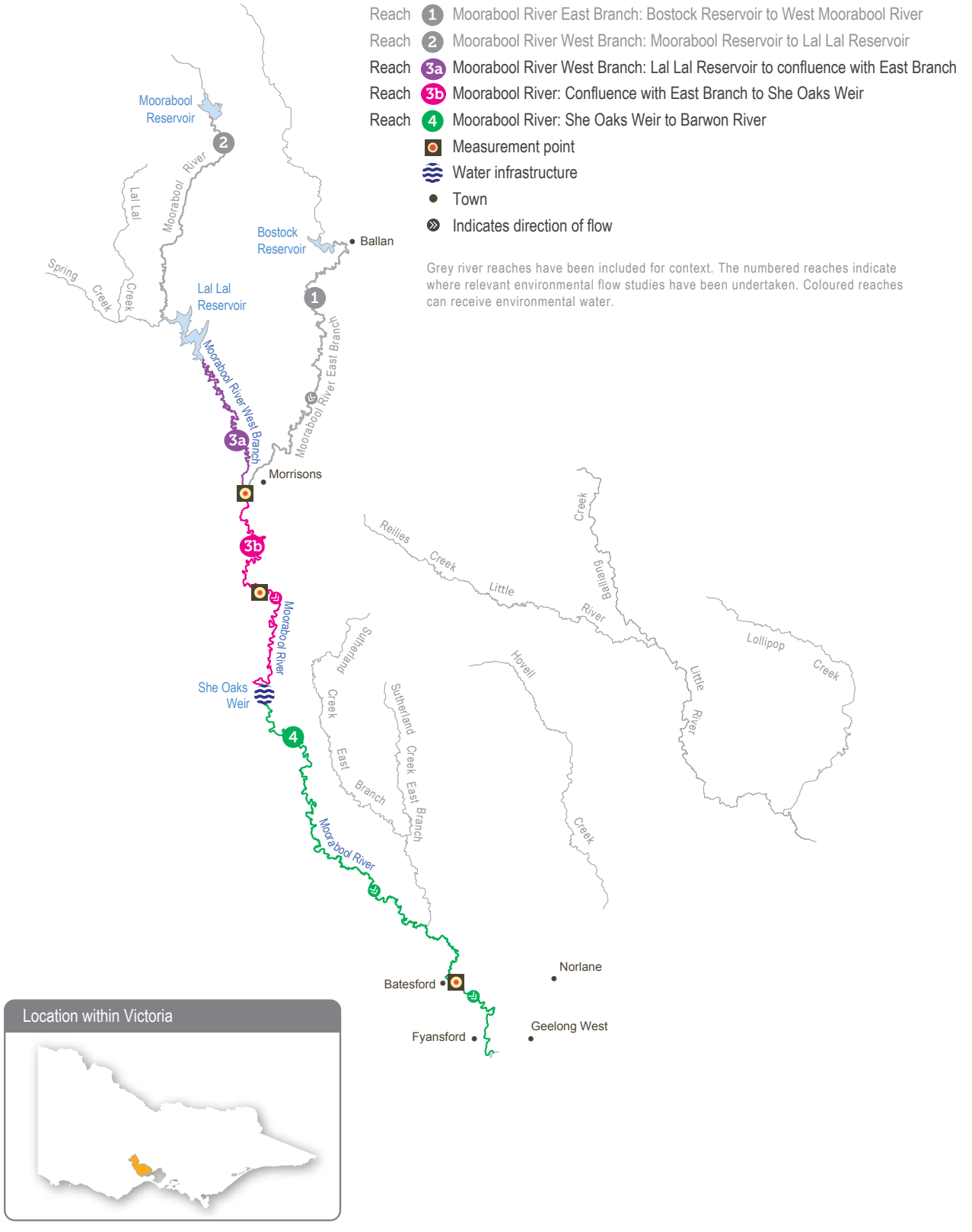
Monitoring as part of the Victorian Environmental Flows Monitoring and Assessment Program (VEFMAP) indicates that in-stream and fringing vegetation along the Moorabool River has benefited from flow management and that freshes have been sufficient to eradicate many exotic species.

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.

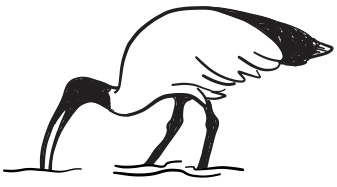
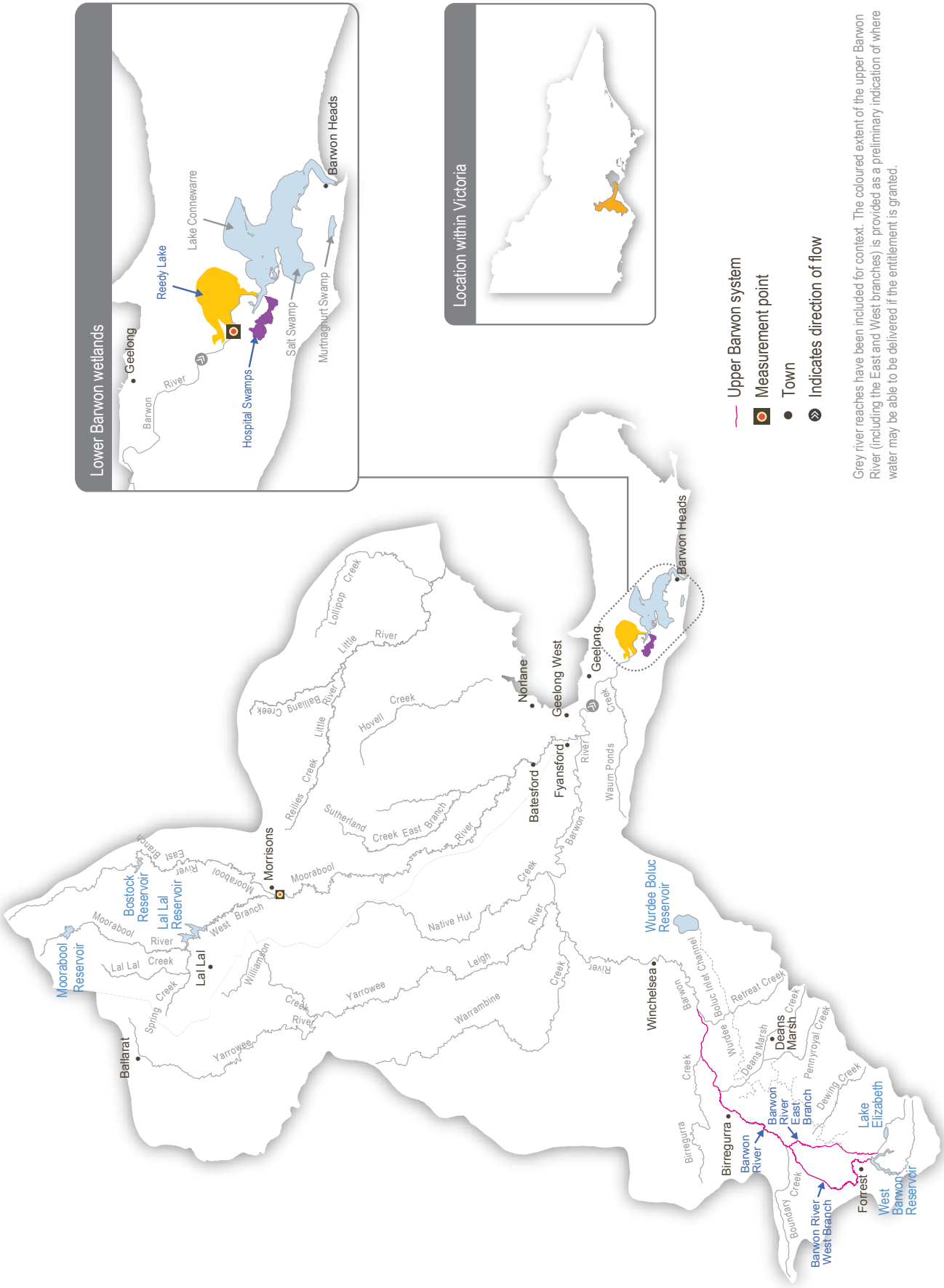


Figure 3.7.1 The Barwon system



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
Hospital Swamps	
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