Moorabool Yulluk (Moorabool River), by the VEWH

Section 3

Central region

3.1 Central region overview

The systems in the central region that can receive water from the VEWH's environmental entitlements are the Yarra and Tarago in the east and the Werribee, Moorabool and Barwon (upper Barwon River and lower Barwon wetlands) in the west. The VEWH doesn't hold an environmental entitlement in the Maribyrnong system, but in some years the VEWH purchases available allocation to allow environmental watering in selected reaches of the Maribyrnong system.

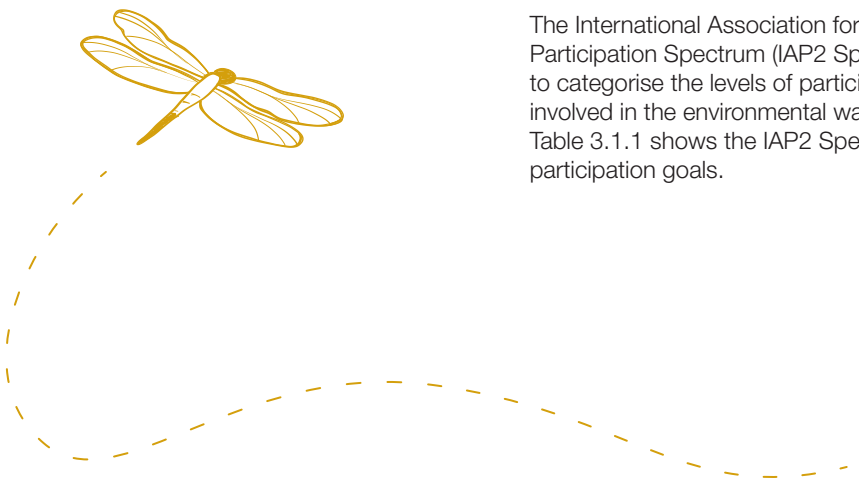
Environmental values, recent conditions, environmental watering objectives and planned actions for each system in the central region are presented in the system sections that follow.

Traditional Owners in the central region

Traditional Owners in the central region continue to have a deep connection to the region's rivers, wetlands and floodplains.

The Bunurong Land Council Aboriginal Corporation, Eastern Maar Aboriginal Corporation, Wadawurrung Traditional Owners Aboriginal Corporation and Wurundjeri Woi wurrung Cultural Heritage Aboriginal Corporation are the Registered Aboriginal Parties for the areas incorporating waterways covered by this section of the seasonal watering plan.

Gunaikurnai Land and Waters Aboriginal Corporation is also a Registered Aboriginal Party within the geographic area, but the Gunaikurnai waterways managed with water for the environment are covered under the Gippsland region section of the seasonal watering plan.



Engagement

Seasonal watering proposals are informed by community, stakeholder and program partner engagement, as well as longer-term regional catchment strategies, regional waterway strategies, relevant technical studies (such as environmental flows studies and environmental water management plans). Program partners and other stakeholders help identify environmental watering priorities and opportunities for the coming year. The strategies and technical reports collectively describe a range of environmental, cultural, economic, social and Traditional Owner perspectives and longer-term integrated catchment and waterway management objectives that influence environmental watering actions and priorities.

The VEWH and its program partners also consider Aboriginal cultural, social and recreational values and uses of waterways when planning for environmental watering activities. Through engagement with community representatives, waterway managers aim to determine how community benefits from environmental flows can be provided while optimising environmental priorities for the year ahead. Aboriginal cultural, social and recreational values and uses are considered for each system in the following system sections.

The International Association for Public Participation's Public Participation Spectrum (IAP2 Spectrum) has been used to categorise the levels of participation of stakeholders involved in the environmental watering planning process. Table 3.1.1 shows the IAP2 Spectrum categories and participation goals.

Table 3.1.1 International Association for Public Participation's Public Participation Spectrum categories and participation goals[1]

IAP2 level	Engagement goal
Inform	Provide balanced and objective information to assist understanding, alternatives, opportunities and/or solutions
Consult	Obtain feedback on analysis, alternatives and/or decisions
Involve	Work directly throughout a process to ensure that concerns and aspirations are consistently understood and considered
Collaborate	Partner in each aspect of the decision including the development of alternatives and the identification of the preferred solution
Empower	Place final decision-making in the hands of the stakeholder

1 The VEWH has the permission of the International Association for Public Participation to reproduce the IAP2 Spectrum.

Table 3.1.2 shows the partners, stakeholder organisations and individuals with which Melbourne Water and Corangamite CMA engaged when preparing the Moorabool, Barwon (upper Barwon River and lower Barwon wetlands), Yarra, Tarago, Maribyrnong and Werribee systems' seasonal watering proposals. This includes engagement conducted as part of developing the seasonal watering proposals as well as engagement during the preparation of key foundational documents that directly informed the proposals. VEWH staff were also consulted for operational information as part of the development of all annual seasonal watering proposals by CMAs.

The table also shows the level of engagement between Melbourne Water and Corangamite CMA and stakeholders of the environmental watering program in the central region based on Melbourne Water and Corangamite CMA's interpretation of the IAP2 Spectrum.

The level of engagement differs between organisations and between systems, depending on the availability, capacity or interest of stakeholders to participate, roles and responsibilities of organisations in managing a site or system, and the potential interaction of proposed watering with other activities on the waterway. For example, a landholder on a waterway may only wish to be informed of what's planned, while another may wish to participate in the planning. A government agency may collaborate in planning where it has a land management responsibility for a site, but only need to be informed for another site where it does not affect its responsibilities.

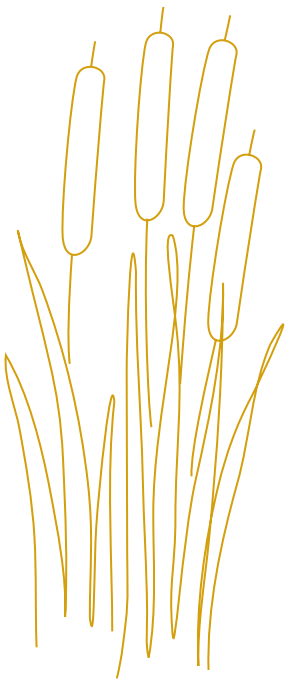


Table 3.1.2 Partners and stakeholders engaged by Corangamite Catchment Management Authority in developing seasonal watering proposals for the Moorabool system, upper Barwon River and lower Barwon wetlands and other key foundation documents that have directly informed the proposals (grouped in alphabetical order)

	Moorabool system	Upper Barwon River	Lower Barwon wetlands
Community groups and environment groups	**IAP2 level: Involve** • Corangamite Waterwatch and Corangamite EstuaryWatch • Geelong Landcare Network • People for A Living Moorabool	**IAP2 level: Involve** • Environment Victoria • Friends of the Barwon • Geelong Field Naturalists Club • Land and Water Resources Otway Catchment • Otway Agroforestry Network Ltd • Upper Barwon Landcare Network • Winchelsea Land and Rivercare group	**IAP2 level: Involve** • Corangamite Waterwatch and Corangamite EstuaryWatch • Geelong Environment Council Inc. • Geelong Field Naturalists Club
Government agencies	**IAP2 level: Collaborate** • Barwon Water • Central Highlands Water • Department of Environment, Land, Water and Planning • Parks Victoria • Southern Rural Water	**IAP2 level: Collaborate** • Barwon Water • Department of Environment, Land, Water and Planning • Southern Rural Water	**IAP2 level: Collaborate** • Barwon Water • City of Greater Geelong • Department of Environment, Land, Water and Planning • Parks Victoria • Southern Rural Water • Victorian Fisheries Authority
	IAP2 level: Consult • Golden Plains Shire Council • Moorabool Shire Council	**IAP2 level: Consult** • Colac Otway Shire Council	
Landholders/farmers	**IAP2 level: Involve** • Landholders on the Moorabool Stakeholder Advisory Committee	**IAP2 level: Involve** • Landholders on the Upper Barwon Surface Water Advisory Group	**IAP2 level: Involve** • Landholders on the Lower Barwon Community Advisory Committee
Local businesses	**IAP2 level: Involve** • Adelaide Brighton Cement		**IAP2 level: Involve** • Commercial eel fishers
Recreational users			**IAP2 level: Involve** • Association of Geelong and District Angling Clubs Inc. and VRFish • Field and Game Australia (Geelong Branch) • Geelong Gun and Rod Association Inc.
Traditional Owners	**IAP2 level: Collaborate** • Wadawurrung Traditional Owners Aboriginal Corporation	**IAP2 level: Consult** • Wadawurrung Traditional Owners Aboriginal Corporation	**IAP2 level: Collaborate** • Wadawurrung Traditional Owners Aboriginal Corporation
		IAP2 level: Inform • Eastern Maar Aboriginal Corporation	

Table 3.1.3 Partners and stakeholders engaged by Melbourne Water in developing seasonal watering proposals for the Yarra, Tarago, Maribyrnong and Werribee systems and other key foundation documents that have directly informed the proposals (grouped in alphabetical order)

	Yarra system	Tarago system	Maribyrnong system	Werribee system
Community groups and environment groups	**IAP2 level: Inform** • Collingwood Children's Farm • Environment Victoria • Friends of Yarra Flats Park • Friends of Yarran Dheran Nature Reserve • Independent community members • Native Fish Australia • Waterwatch coordinators • Yarra Riverkeeper	**IAP2 level: Inform** • Cannibal Creek Water Monitoring Group • Environment Victoria • Friends of Mt Cannibal Flora and Fauna Reserve • Friends of Robin Hood Reserve • Independent community members • Native Fish Australia • Waterwatch Coordinators	**IAP2 level: Inform** • Environment Victoria • Friends of Holden Flora Reserve • Friends of the Maribyrnong Valley Inc. • Independent community members • Jacksons Creek EcoNetwork • Native Fish Australia • Waterwatch Coordinators	**IAP2 level: Inform** • Ecolinc • Environment Victoria • Friends of Toolern Creek Reserve • Friends of Werribee Gorge & Long Forest Mallee Inc. • Independent community members • Moorabool Environment Group/ Platypus Alliance - Bacchus Marsh • Native Fish Australia • NatureWest • Pinkerton Landcare and Environment Group • Waterwatch Coordinators • Werribee Riverkeeper • Western Region Environment Centre

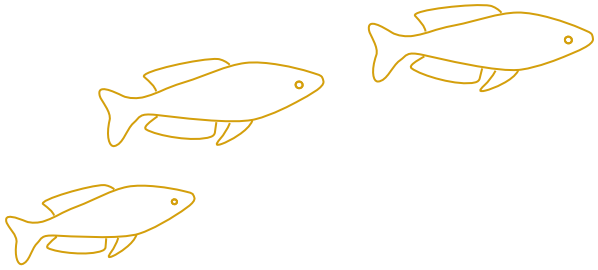


Table 3.1.3 Partners and stakeholders engaged by Melbourne Water in developing seasonal watering proposals for the Yarra, Tarago, Maribyrnong and Werribee systems and other key foundation documents that have directly informed the proposals (grouped in alphabetical order) *(continued)*

	Yarra system	Tarago system	Maribyrnong system	Werribee system
Government agencies	**IAP2 level: Collaborate** • Department of Environment, Land, Water and Planning • Melbourne Water (Service Delivery)	**IAP2 level: Collaborate** • Department of Environment, Land, Water and Planning • Melbourne Water (Service Delivery) • Southern Rural Water	**IAP2 level: Collaborate** • Department of Environment, Land, Water and Planning • Melbourne Water (Service Delivery) • Southern Rural Water • Western Water	**IAP2 level: Collaborate** • Department of Environment, Land, Water and Planning • Melbourne Water (Service Delivery) • Southern Rural Water • Western Water
	IAP2 level: Inform • Aboriginal Victoria • Banyule City Council • City of Boroondara • Commissioner for Environmental Sustainability Victoria • Environment Protection Authority Victoria • Manningham City Council • Nillumbik Shire Council • Parks Victoria • Port Phillip and Westernport CMA • Victorian Fisheries Authority • Yarra City Council • Yarra Ranges Shire Council	**IAP2 level: Inform** • Aboriginal Victoria • Baw Baw Shire Council • Cardinia Shire Council • Commissioner for Environmental Sustainability Victoria • Environment Protection Authority Victoria • Parks Victoria • Port Phillip and Westernport CMA • Victorian Fisheries Authority	**IAP2 level: Inform** • Aboriginal Victoria • Commissioner for Environmental Sustainability Victoria • Environment Protection Authority Victoria • Hume City Council • Maribyrnong City Council • Moonee Valley City Council • Parks Victoria • Port Phillip and Westernport CMA • Victorian Fisheries Authority • Victoria Police	**IAP2 level: Inform** • Aboriginal Victoria • Commissioner for Environmental Sustainability Victoria • Environment Protection Authority Victoria • Melton City Council • Parks Victoria • Port Phillip and Westernport CMA • Wyndham City Council • Victorian Fisheries Authority
Landholders/ farmers	**IAP2 level: Inform** • Individual landholders • Licensed diverters	**IAP2 level: Inform** • Individual landholders	**IAP2 level: Inform** • Licensed diverters from the Maribyrnong River at Keilor	**IAP2 level: Inform** • Individual landholders • Zoos Victoria
Local businesses	**IAP2 level: Inform** • Melbourne Adventure Hub • Warburton Holiday Park • Warrior Spirit Adventures	**IAP2 level: Inform** • Glen Cromie Reserve	**IAP2 level: Inform** • Atlas Ecology Pty Ltd • Blackbird Cruises	**IAP2 level: Inform** • Camp Sunnystones • Habitat Creations

Table 3.1.3 Partners and stakeholders engaged by Melbourne Water in developing seasonal watering proposals for the Yarra, Tarago, Maribyrnong and Werribee systems and other key foundation documents that have directly informed the proposals (grouped in alphabetical order) *(continued)*

	Yarra system	Tarago system	Maribyrnong system	Werribee system
Recreational users	**IAP2 level: Inform** • Paddle Victoria • Patterson Lakes Canoe Club • VRFish • Whitehorse Canoe Club Inc.	**IAP2 level: Inform** • Local anglers • VRFish	**IAP2 level: Inform** • VRFish	**IAP2 level: Inform** • VRFish • Werribee & District Anglers Club
Technical experts	**IAP2 level: Consult** • Aquatic Pollution Prevention Partnership • Arthur Rylah Institute (Department of Environment, Land, Water and Planning) • Australian Platypus Conservancy • Cesar Australia • Melbourne Water subject matter experts • Research collaborators at Melbourne University	**IAP2 level: Consult** • Aquatic Pollution Prevention Partnership • Arthur Rylah Institute (Department of Environment, Land, Water and Planning) • Australian Platypus Conservancy • Cesar Australia • Melbourne Water subject matter experts • Research collaborators at Melbourne University	**IAP2 level: Consult** • Aquatic Pollution Prevention Partnership • Arthur Rylah Institute (Department of Environment, Land, Water and Planning) • Australian Platypus Conservancy • Cesar Australia • Melbourne Water subject matter experts • Research collaborators at Melbourne University	**IAP2 level: Consult** • Aquatic Pollution Prevention Partnership • Arthur Rylah Institute (Department of Environment, Land, Water and Planning) • Australian Platypus Conservancy • Cesar Australia • Melbourne Water subject matter experts • Research collaborators at Melbourne University
Traditional Owners	**IAP2 level: Collaborate** • Wurundjeri Woi wurrung Cultural Heritage Aboriginal Corporation **IAP2 level: Consult** • Boon Wurrung Foundation • Bunurong Land Council Aboriginal Corporation	**IAP2 level: Consult** • Boon Wurrung Foundation • Bunurong Land Council Aboriginal Corporation • Wurundjeri Woi wurrung Cultural Heritage Aboriginal Corporation	**IAP2 level: Consult** • Boon Wurrung Foundation • Bunurong Land Council Aboriginal Corporation • Wurundjeri Woi wurrung Cultural Heritage Aboriginal Corporation	**IAP2 level: Consult** • Boon Wurrung Foundation • Bunurong Land Council Aboriginal Corporation • Wadawurrung Traditional Owners Aboriginal Corporation • Wurundjeri Woi wurrung Cultural Heritage Aboriginal Corporation

Integrated catchment management

Altered water regimes are one of many threats to the health of Victoria's waterways. To be effective, environmental flows need to be part of an integrated approach to catchment management. Many of the environmental objectives from water for the environment in the central region will not be fully met without simultaneously addressing issues such as barriers to fish movement, poor water quality, reduced contribution of groundwater to surface water flows, loss of stream bank vegetation and invasive species.

Victorian and Australian government agencies, Traditional Owner groups, community groups and private landholders collectively implement a wide range of programs that aim to protect and improve the environmental condition and function of land, soils and waterways throughout Victoria's catchments.

Examples of waterway managers' on-ground works programs and complementary projects that are likely to support environmental watering outcomes in the central region include:

- ongoing investigations into the surface water and groundwater interactions in *Moorabool Yulluk* (Moorabool River) and their continued partnership with the Batesford Quarry operators to allow water from the quarry to be discharged to the river (an important contribution to flow)
- a landscape-scale approach to improve the management of billabongs along *Birrarung* (Yarra River) to help meet cultural, ecological and liveability objectives
- works to protect and enhance streambanks along priority reaches including willow removal, revegetation and fencing to exclude stock
- the development of the *Central and Gippsland Region Sustainable Water Strategy*, to provide higher security and reliability of the supply of water for the environment for all flow-stressed systems in the central region including to achieve long-term outcomes.

For more information about integrated catchment management programs in the central region, refer to the Corangamite CMA and Melbourne Water regional catchment strategies and regional waterway strategies.

Risk management

During the development of the seasonal watering proposals for the Yarra, Tarago, Maribyrnong, Werribee, Moorabool and Barwon systems, environmental watering program partners assessed risks associated with potential environmental watering actions for 2021-22 and identified appropriate mitigating strategies. Risks and mitigating actions are continually assessed by program partners throughout the year (see subsection 1.3.6).

Seasonal outlook 2021-22

Rainfall across the central region can vary from the eastern to the western systems. In 2020-21, the Yarra and Tarago systems had above-average rainfall. Natural events met many planned environmental watering actions in both of these systems in 2020-21, and strong allocations of water for the environment and carryover will enable a large proportion of potential watering actions to be delivered in 2021-22. The other systems in the central region had average or above-average rainfall in 2020-21, but inflows to system storages were variable. Low inflows to Rosslynne Reservoir meant there was no opportunity for the VEWH to purchase water for environmental use in the Maribyrnong system. In the Werribee system, Pykes Creek and Melton reservoirs filled and spilled, but Merrimu Reservoir remained below 50 percent capacity throughout 2020-21. Lal Lal Reservoir filled and spilled in spring 2020-21, which provided important flow and allocations of water for the environment in the Moorabool system. Upper Barwon Reservoir only reached 70 percent capacity in 2020-21, but it was sufficient to deliver the full allocation of water for the environment for the year in the Barwon River.

The Bureau of Meteorology has forecast slightly above-average rainfall across the central region in autumn and winter 2021, but La Niña conditions have weakened, which may lead to drier conditions later in 2021-22. Large carryover volumes and secure water allocations will allow a wide range of watering actions to be delivered in the Yarra, Tarago and Werribee systems under all climate scenarios, to build on 2020-21 outcomes to improve environmental condition and ecosystem resilience. In contrast, the Maribyrnong system remains relatively dry, and Rosslynne Reservoir will need significant inflows during winter and spring 2021 to create an opportunity to purchase and use water for environmental flows. Environmental watering options in the Moorabool and Barwon systems in 2021-22 will be more heavily influenced by local climatic conditions than the Melbourne Water systems, due to their smaller and more variable environmental allocations. Larger flows to improve environmental condition will only be delivered in *Moorabool Yulluk* (Moorabool River) and the upper Barwon River under average and wet climate scenarios. Flows will be delivered at the lower end of their recommended range in *Moorabool Yulluk* (Moorabool River) and the upper Barwon River under drought and dry climate scenarios, to maintain refuge habitats and limit any decline in environmental condition. Environmental watering in the lower Barwon wetlands is not affected by annual allocations of water for the environment, and the proposed fill in winter/spring and partial draw down in summer/autumn should be possible under all climate scenarios.

3.2 Yarra system

Waterway manager – Melbourne Water

Storage manager – Melbourne Water

Environmental water holder – Victorian Environmental Water Holder

Did you know...?

Birrarung (Yarra River) is central to the Dreaming of the Wurundjeri Woi wurrung people.

In 2017 the Victorian Government recognised *Birrarung* (Yarra River) as one living integrated entity in the *Yarra River Protection Act (Wilip gin Birrarung murron) 2017*. It was the first piece of legislation in Australia to confer such rights to a river and associated lands, to be co-titled in a Traditional Owner language and to incorporate a traditional language in the preamble.

The Act recognises the Woi wurrung people as Traditional Owners of *Birrarung* (Yarra River).

Top: Birrarung (Yarra River) at Heidelberg, by Melbourne Water
Above: Ducks at Annulus Billabong, by Andrew Lees

The Yarra system includes *Birrarung* (Yarra River), the Plenty River and Yarra billabongs.

System overview

Birrarung (Yarra River) flows west from the Yarra Ranges above 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 (Figure 3.2.1). Over time, *Birrarung* (Yarra River) below Warrandyte has been straightened, widened and cleared of natural debris as Melbourne has developed.

Up to 400,000 ML per year (long-term average diversion limit) can be harvested from the Yarra system for consumptive use in Melbourne and surrounding areas. The Upper Yarra, O'Shannassy and Maroondah reservoirs harvest water from headwater tributaries, and a pump station at Yering is used to divert water from *Birrarung* (Yarra River) to Sugarloaf Reservoir.

Flow in the upper reaches of *Birrarung* (Yarra River) is influenced by tributaries (such as Armstrong Creek, McMahons Creek, Starvation Creek, Woori Yallock Creek, Watts River and Little Yarra River). Urbanised tributaries (such as Olinda Creek, Mullum Mullum Creek, Diamond Creek, Plenty River and Merri Creek) provide additional water to the middle and lower reaches of *Birrarung* (Yarra River).

Environmental flows can be released from the Upper Yarra, Maroondah and O'Shannassy reservoirs to support ecological processes and environmental outcomes in downstream river reaches and wetlands. The priority environmental flow reaches in *Birrarung* (Yarra River) are reaches 2 and 5, shown in Figure 3.2.1. Water for the environment that is delivered to reaches 2 and 5 will help meet flow targets in downstream reaches.

Plenty River rises from the slopes of Mt Disappointment in the Great Dividing Range about 50 km north of Melbourne. It flows downstream through rural and semi-rural areas and Plenty Gorge before joining *Birrarung* (Yarra River) near Viewbank, east of Banyule Flats Reserve. Yan Yean Reservoir is located off the waterway, north of Plenty Gorge, and it receives flows from Toorourrong Reservoir via a channel. The Plenty River has not received managed environmental flows before, but there may be opportunities to deliver water for the environment from Yan Yean Reservoir from 2021-22 onwards.

Environmental values

The upper reaches of *Birrarung* (Yarra River) (reaches 1-3) provide habitat for a range of native fish species including river blackfish, mountain galaxias and common galaxias, and have good-quality streamside and aquatic vegetation. Middle and lower reaches of *Birrarung* (Yarra River) (reaches 4-6) flow through forested gorges, cleared floodplains and some highly-urbanised areas, and support several populations of native fish including Australian grayling, river blackfish, Macquarie perch and tupong. Macquarie perch were introduced to *Birrarung* (Yarra River) last century, and the population is now considered one of the largest and most important in Victoria.

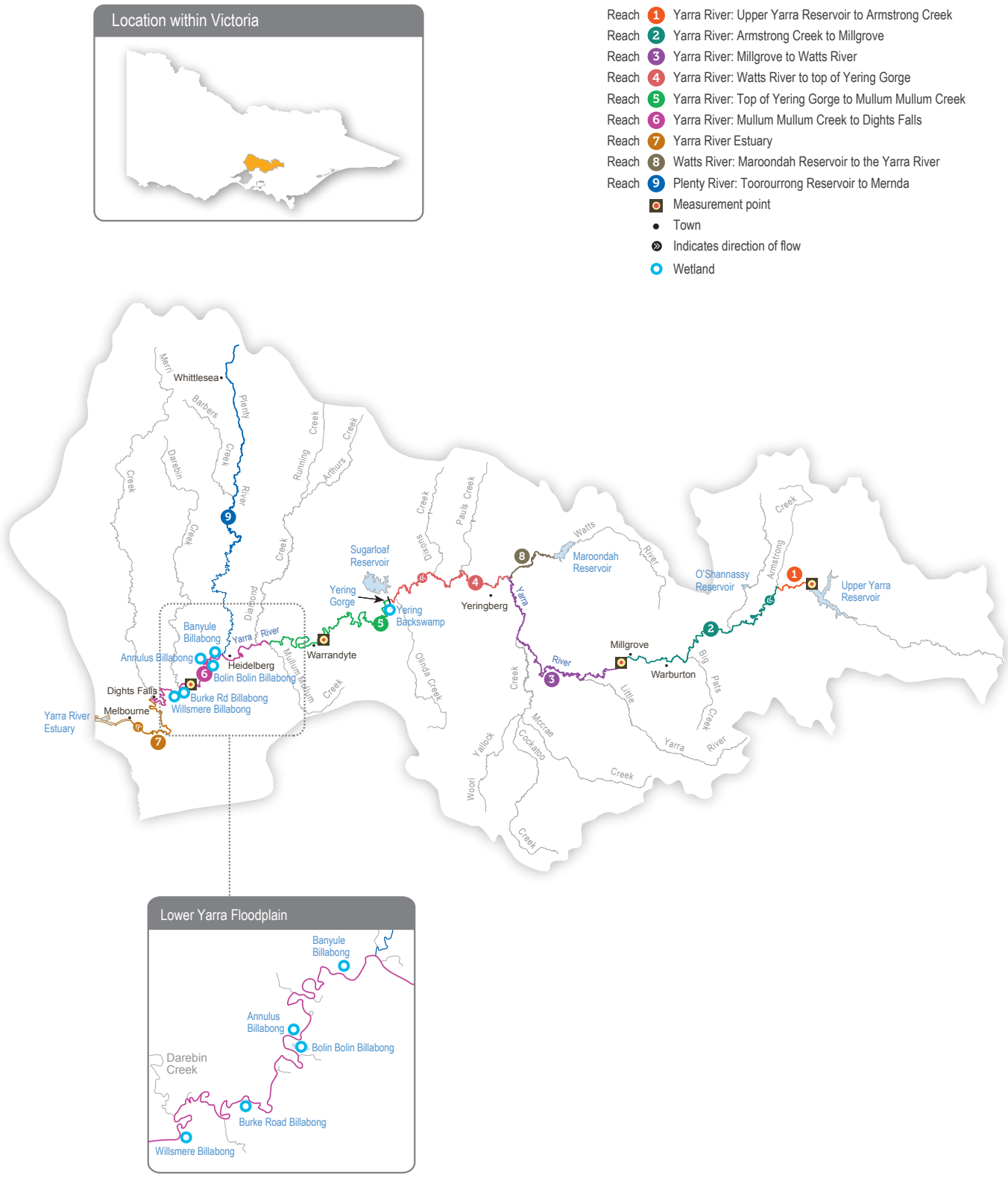
The Plenty River (reach 9) provides habitat for waterbugs and native fish species (such as common galaxias). Platypus have been detected in the Plenty River in the past, but none have been recorded in recent surveys.

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

Environmental watering objectives in *Birrarung* (Yarra River), the Plenty River and Yarra billabongs

	Protect and increase populations of native fish including threatened species (such as the Australian grayling, Macquarie perch and river blackfish)
	Maintain the population of frogs, particularly on the mid-*Birrarung* (Yarra River) floodplain
	Maintain the form of the river channel Scour silt from riffles and clean cobbles
	Maintain the population of resident platypus
	Increase and maintain native streamside and aquatic vegetation on the riverbank and in the channels Increase and maintain the growth of threatened wetland plant species to rehabilitate shallow marsh, deep marsh and freshwater meadows on the floodplain and billabongs
	Maintain and increase the abundance and diversity of waterbugs to support aquatic food webs
	Improve water quality in river pools, ensuring adequate oxygen concentration in the water to support fish, crustaceans and waterbugs

Figure 3.2.1 The Yarra system



Traditional Owner cultural values and uses

Wurundjeri Woi wurrung Cultural Heritage Aboriginal Corporation and Melbourne Water are working towards an overarching partnership that will frame the relations and obligation between the two organisations. The intent is to embed Wurundjeri Woi wurrung as active partners in the planning, delivery, and monitoring of all works associated with *Birrarung* (Yarra River).

Melbourne Water has also made initial contact with Bunurong Land Council Aboriginal Corporation and Boon Wurrung Foundation to discuss environmental watering in the Yarra system.

Increasing the involvement of Traditional Owners in environmental water planning and management, and ultimately providing opportunities to progress towards self-determination within and beyond the environmental watering program, is a core commitment of the VEWH and its agency partners. This is reinforced by a range of legislation and policy commitments (for example the *Water Act 1989*, the Victorian Aboriginal Affairs Framework, *Water for Victoria* (2016)) and, in some cases, agreements under the *Traditional Owner Settlement Act 2010*. Where Traditional Owners are more deeply involved in the planning and/or delivery of environmental flows for a particular site, their contribution is acknowledged in Table 3.2.1 with an icon. The use of this icon is not intended to indicate that these activities are meeting all the needs of Traditional Owners but is incorporated in the spirit of valuing that contribution, and indicating progress towards this objective.

Watering planned and/or delivered in partnership with Traditional Owners to support cultural values and uses

There are a large number of places of tangible and intangible cultural significance for the Wurundjeri Woi wurrung people on the lower *Birrarung* (Yarra River) floodplain. Where possible, Melbourne Water and the Wurundjeri Woi wurrung Cultural Heritage Aboriginal Corporation will work together to link water for the environment with cultural outcomes for Wurundjeri Woi wurrung.

A recent example is a vegetation monitoring and water quality monitoring project at the billabongs with the Wurundjeri Woi wurrung Cultural Heritage Aboriginal Corporation's Narrap Team, The University of Melbourne and Melbourne Water. The group has been out monitoring the vegetation watering outcomes and held an on-Country knowledge-sharing day to discuss learnings. Monitoring is underway at Annulus Billabong following a delivery of water for the environment in 2020-21, and similar work will likely be undertaken in 2021-22.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 3.2.1, Melbourne Water considered how environmental flows could support values and uses including:

- water-based recreation (such as kayaking, canoeing, fishing and swimming)
- riverside recreation and amenity (such as walking, running, cycling, camping and birdwatching)
- community events and tourism (such as the Moomba Festival and the Inflatable Regatta)
- socio-economic benefits (such as diverters for irrigation, domestic and stock uses, and Melbourne's water supply).

Recent conditions

Rainfall in the *Birrarung* (Yarra River) catchment in 2020-21 was above the long-term average, and tributary inflows significantly contributed to flow in *Birrarung* (Yarra River) and the Plenty River throughout the year. O'Shannassy Reservoir was offline for most of the year for maintenance, so most flow from the O'Shannassy River catchment passed directly into *Birrarung* (Yarra River). Maintenance work at Upper Yarra Reservoir required operational releases to *Birrarung* (Yarra River) during September and October 2020. These operational releases replaced the need for environmental flows that were planned during that time. The operational releases were adjusted where possible to align with environmental flow needs, and they largely met the expected watering effects.

In *Birrarung* (Yarra River), natural rain events combined with the larger-than-normal inflows from the O'Shannassy River and operational releases from Upper Yarra Reservoir achieved most of the planned watering actions for 2020-21. As a result, only a small portion of available water for the environment was used in 2020-21, and there is a large carryover volume for 2021-22. Water for the environment was released in conjunction with a natural fresh in May 2021 to support Australian grayling migration and spawning. In the Plenty River, natural rain events achieved most of the high-priority planned watering actions. An opportunity to supplement winter/spring low flows with water for the environment could not occur, due to poor water quality and valve delivery constraints at Yan Yean Reservoir.

Yering Backswamp has received water for the environment annually since 2013. Wet conditions in early May 2020 primed the site for a series of top-ups using water for the environment in late May, June and July. Wet conditions in August maintained water levels, which helped support water-dependant vegetation and aquatic animals. The wetland was allowed to gradually dry out by December, in accordance with the site's management plan. Annulus Billabong last filled in 2011 by an overbank flow from *Birrarung* (Yarra River), and it held water until 2012. Water for the environment was delivered to the site for the first time from October to December 2020 to support the growth of threatened wetland plant species and provide habitat for frogs, waterbugs and eels. This delivery was undertaken safely and successfully during a COVID-19 lockdown period, providing great recreational opportunities for many local visitors. Bolin Bolin was filled in 2017 with a combination of overbank flows and environmental watering. Drying at the site since has resulted in the return of terrestrial and exotic plant species. Overbank flows in August 2020 partially filled Bolin Bolin wetland, and further watering is planned in 2021-222 to improve vegetation outcomes.

Monitoring is showing that upgrades to the Dights Falls fish ladder in November/December 2020 are allowing more native fish to move between the *Birrarung* (Yarra River) estuary and the freshwater reaches. At Yering Backswamp, Melbourne Water has initiated a monitoring program to understand how bat species use the site as water levels vary. Monitoring by Melbourne Water, the Wurundjeri Woi wurrung Cultural Heritage Aboriginal Corporation's Narrap team and citizen scientists indicated that the new watering actions at Annulus Billabong supported at least four frog species.

Scope of environmental watering

Table 3.2.1 describes the potential environmental watering actions in 2020-21, their expected watering effects (that is, the intended physical or biological effects of the watering action) and the longer-term environmental objective(s) they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological effects.

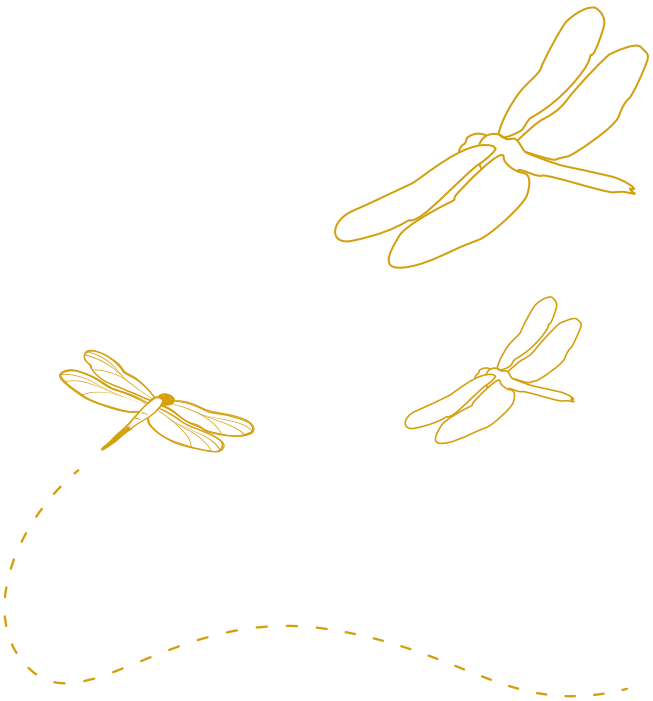


Table 3.2.1 Potential environmental watering actions, expected watering effects and associated environmental objectives for *Birrarung* (Yarra River), the Plenty River and Yarra billabongs

Potential environmental watering action	Expected watering effects	Environmental objectives
***Birrarung* (Yarra River)** **The highest-priority reaches for *Birrarung* (Yarra River) are reaches 2 (upper *Birrarung*) and 5 (lower *Birrarung*); water delivered to these reaches generally benefits other reaches**		
Winter/spring low flow (June to November) Reach 2: 200 ML/day Reach 5: 350 ML/day	• Physically mix pools to minimise the risk of stratification and low oxygen • Maintain access to habitats for fish, waterbugs and platypus • Wet bank vegetation to promote growth	
Winter/spring fresh(es) (one to two freshes for three to seven days during June to November) Reach 2: 700 ML/day Reach 5: 2,500 ML/day	• Scour sediment and biofilm from gravel in riffles to improve spawning opportunities for Macquarie perch • Wet native streamside vegetation on the banks of the river to promote growth • Provide cues for upstream migration of juvenile migratory fish (e.g. Australian grayling and tupong)	
Spring high flow (one high flow for 14 days in September) Reach 2: 700 ML/day Reach 5: 2,500 ML/day	• Scour sediment and biofilm from gravel in riffles • Provide prolonged wetting to favour flood-tolerant native vegetation in the streamside zone • Provide cues for upstream migration of juvenile migratory fish (e.g. Australian grayling and tupong) • Trigger spawning of Macquarie perch	
Summer/autumn low flow (December to May) Reach 2: 80 ML/day Reach 5: 200 ML/day	• Physically mix pools to minimise the risk of stratification and low oxygen • Maintain access to habitats for fish, waterbugs and platypus	
Summer/autumn fresh(es) (one to three freshes for two to four days during December to May) Reach 2: 350 ML/day Reach 5: 750 ML/day	• Flush pools to prevent a decline in water quality • Scour sediment and biofilm from gravel in riffles and pools to maintain habitat quality for fish and waterbugs • Provide opportunities for the localised movement of fish and platypus • Wet the banks of the river to maintain flood-tolerant vegetation on the banks	

Table 3.2.1 Potential environmental watering actions, expected watering effects and associated environmental objectives for *Birrarung* (Yarra River), the Plenty River and Yarra billabongs *(continued)*

Potential environmental watering action	Expected watering effects	Environmental objectives
Autumn high flow (one high flow for seven to 14 days during April to May) Reach 2: 560 ML/day Reach 5: 1,300 ML/day	• Cue the migration of Australian grayling • Scour sediment and biofilm from gravel in riffles and pools to maintain habitat quality for fish and waterbugs	
Plenty River		
Winter/spring low flow (20 ML/day during June to November)	• Physically mix pools to minimise the risk of stratification and low oxygen • Maintain access to habitats for fish and waterbugs • Wet bank vegetation to promote growth	
Winter/spring freshes (four freshes of 70 ML/day for three days during June to November)	• Scour sediment and biofilm from gravel in riffles • Provide access to habitats for fish and waterbugs • Wet native streamside vegetation on the banks of the river to promote growth	
Summer/autumn low flow (10 ML/day from December to May)	• Physically mix pools to minimise the risk of stratification and low oxygen • Maintain access to habitats for fish and waterbugs	
Summer/autumn freshes (four freshes of 55 ML/day for two days)	• Flush pools to prevent a decline in water quality • Scour sediment and biofilm from gravel in riffles and pools to maintain habitat quality for fish and waterbugs • Provide opportunities for the localised movement of fish • Wet the banks of the river to maintain flood-tolerant vegetation on the banks	
Yarra billabongs		
Annulus Billabong (partially fill in winter/spring) 	• Wet the wetland bed for up to three months to support the growth of threatened wetland plant species to rehabilitate shallow marsh, deep marsh and freshwater meadows • Provide habitat for frogs, waterbugs and eels	
Bolin Bolin (partially fill in winter/spring) 	• Wet the deepest part of the wetland to about 100-150 cm to provide habitat for frogs, waterbugs and eels • Wet the remaining area of the wetland to about 50-100 cm to support the growth of threatened wetland plant species and encourage the regeneration of spreading aquatic herbs	
Yering Backswamp (complete fill in autumn/ winter/spring)	• Wet the deepest parts of the wetland to about 80 cm to provide habitat for fish, frogs and waterbugs • Wet remaining areas of the wetland to about 40-60 cm to support the growth of threatened wetland plant species and encourage the regeneration of spreading aquatic herbs	

Scenario planning

Table 3.2.2 outlines the potential environmental watering and expected water use under a range of planning scenarios. Drought planning scenarios are not considered in the four Melbourne Water systems as the potential watering actions are the same as the dry climate scenario.

In the Yarra system, current scenario planning is considered only under dry, average and wet climate scenarios. A combination of the highly reliable environmental allocation (17,000 ML each year), and high carryover volume from 2020-21 will provide sufficient supply for most required watering actions in 2021-22, and there is no need to significantly restrict watering actions in very dry or drought conditions.

Environmental flow planning in *Birrarung* (Yarra River) primarily focuses on providing sufficient low flow throughout the year to maintain habitat for aquatic life and on providing high flows at critical times to support the migration and breeding requirements of native fish. Summer/autumn low flows and freshes, an autumn high flow, a spring high flow and winter/spring low flows and freshes are needed to achieve these outcomes under all climate scenarios, but the extent to which these flows are likely to be met by natural tributary inflows varies between dry, average and wet scenarios. Water for the environment will be used to fill the main deficits under each scenario, where possible.

It is anticipated that summer/autumn low flows and winter/spring freshes are likely to be met through a combination of natural flows and environmental flows in average and wet climate scenarios. The higher-than-normal carryover volume from 2020-21 will potentially allow autumn and spring high flows to be delivered in *Birrarung* (Yarra River) under all climate scenarios in 2021-22. The autumn high flow is a priority because it was not delivered in 2017-18 or 2018-19, and it is needed in most years to support Australian grayling breeding. A spring high flow is recommended under all climate scenarios as it has only been met twice since 2017-18, and it is generally required at least once every two years to support Macquarie perch breeding and the upstream migration of Australian grayling and tupong.

The highest-priority potential watering actions for the Plenty River are winter/spring low flows, summer/autumn low flows and freshes under all climate scenarios to maintain water quality and aquatic habitat for native plants and animals. Winter/spring freshes are planned under average and wet climate scenarios, and they will likely be met through a combination of environmental flows and natural flows. Environmental watering in the Plenty River in 2021-22 will be implemented as a trial, to help waterway managers understand the operational and safety requirements for the system and to better understand the river's response to water for the environment.

Watering at Yering Backswamp, Bolin Bolin Billabong and Annulus Billabong is considered a high priority under all scenarios in 2021-22, because having some billabongs inundated across the landscape provides refuge habitat for rare and threatened species. There are numerous billabongs throughout the *Birrarung* (Yarra River) catchment that are drier than natural, due to river regulation and modifications to natural flow paths. Melbourne Water has finalised a landscape-scale approach to watering floodplain billabongs that will consider the ecosystem services provided by different billabongs and how many billabongs need to be watered at any given time to support regionally important plant and animal populations.

A minimum of 12,000 ML carryover into 2022-23 is required (in addition to the 17,000 ML annual entitlement) to deliver the highest-priority flows if average conditions continue into the following year.

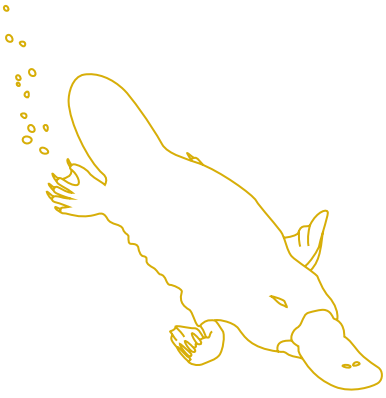


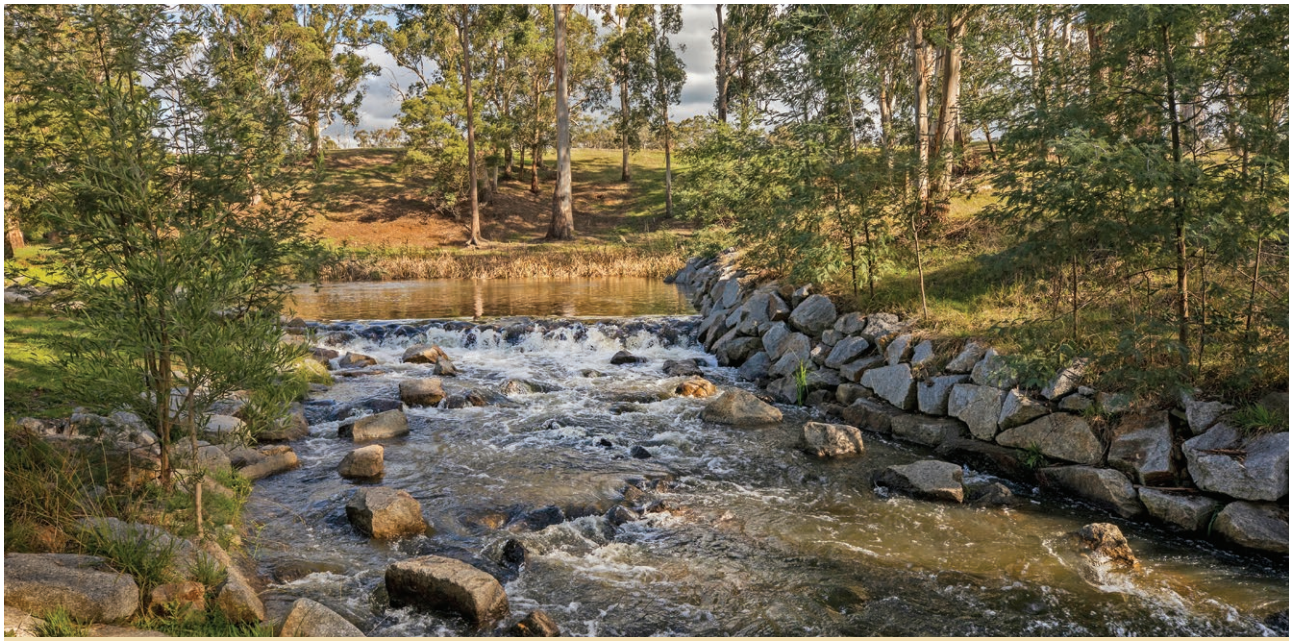
Table 3.2.2 Potential environmental watering for *Birrarung* (Yarra River), the Plenty River and Yarra billabongs under a range of planning scenarios

Planning scenario	Dry	Average	Wet
Expected river conditions	• Low streamflow year-round • Lack of unregulated freshes and high flow • Passing flows are not likely to meet the minimum environmental flow recommendations • Potential poor water quality, particularly in summer • Pools may stratify • Plenty River may experience cease-to-flow events	• Minimum passing-flow recommendations are likely to be met • Natural flow may provide some freshes, but its duration and/or magnitude will likely be less than recommended environmental flow • Potentially poor water quality, particularly in summer • Pools may stratify • Small reservoirs may spill • Overbank flow is not likely	• Passing flow recommendations are likely to be met • High, natural flow will occur, most likely in winter/spring • Major spills from reservoirs may occur • Some natural wetting of billabongs may occur
Predicted supply of water for the environment	• 48, 000 ML		
***Birrarung* (Yarra River) (targeting reach 2 and 5)**			
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**		
	• Winter/spring low flow • Spring high flow (one high flow) • Summer/autumn low flow • Summer/autumn freshes (three freshes) • Autumn high flow (one high flow) • Targeted billabong watering (Annulus, Bolin Bolin, Yering)	• Winter/spring low flow • Spring high flow (one high flow) • Summer/autumn low flow • Summer/autumn freshes (three freshes) • Autumn high flow (one high flow) • Targeted billabong watering (Annulus, Bolin Bolin, Yering)	• Winter/spring low flow • Winter/spring freshes (two freshes) • Spring high flow (one high flow) • Summer/autumn low flow • Summer/autumn freshes (three freshes) • Autumn high flow (one high flow) • Targeted billabong watering (Annulus, Bolin Bolin, Yering)
	Tier 1b (supply deficit)		
	• Winter/spring freshes (two freshes)	• Winter/spring freshes (two freshes)	• N/A
Potential environmental watering – tier 2 (additional priorities)	• N/A		

Table 3.2.2 Potential environmental watering for *Birrarung* (Yarra River), the Plenty River and Yarra billabongs under a range of planning scenarios *(continued)*

Planning scenario	Dry	Average	Wet
Plenty River (targeting reach 9)			
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**		
	• Winter/spring low flow • Summer/autumn low flow • Summer/autumn freshes (four freshes)	• Winter/spring low flow • Winter/spring freshes (four freshes) • Summer/autumn low flow • Summer/autumn freshes (four freshes)	• Winter/spring low flow • Winter/spring freshes (four freshes) • Summer/autumn low flow • Summer/autumn freshes (four freshes)
	Tier 1b (supply deficit)		
	• Winter/spring freshes (four freshes)	• N/A	
Potential environmental watering – tier 2 (additional priorities)	• N/A		
Possible volume of water for the environment required to achieve objectives	• 37,100 ML (tier 1a) • 14,000 ML (tier 1b)	• 36,000 ML (tier 1a) • 10,000 ML (tier 1b)	• 32,700 ML (tier 1a)
Priority carryover requirements	• 12,000 ML		

3.3 Tarago system



Waterway manager – Melbourne Water

Storage manager – Melbourne Water

Environmental water holder – Victorian Environmental Water Holder

Did you know...?

Short-finned eels migrate from Victorian rivers all the way to the Coral Sea to spawn: this can be up to 5,000 km and take over a year! Melbourne Water is working with scientists at the Arthur Rylah Institute to monitor how short-finned eels and other migratory species respond to environmental flows in the Tarago River.

Top: Tarago River, by Melbourne Water
Above: Mountain galaxias, by Melbourne Water

System overview

The Tarago River rises in the Tarago State Forest and flows into the Tarago Reservoir at Neerim (Figure 3.3.1). The reservoir harvests inflows from all upstream tributaries to supply towns on the Mornington Peninsula and around the Western Port area. Water is released from the reservoir to supply downstream irrigators. Below the reservoir, the Tarago River flows close to the town of Rokeby before meeting the Bunyip River at Longwarry North. From there, the Bunyip River flows through a modified, straightened channel — Bunyip Main Drain — that discharges into Western Port. The Bunyip Main Drain supplies many irrigators in the catchment.

Water available under the Tarago environmental entitlement is stored in and released from Tarago Reservoir. This water is primarily used to meet environmental objectives in reach 2, which is between the reservoir and the confluence of the Tarago and Bunyip rivers, as Figure 3.3.1 shows. Water for the environment that is delivered to reach 2 also supports environmental flow recommendations in reach 6 (Bunyip Main Drain).

Year-round passing flows in the Bunyip and Tarago rivers are stipulated under both the environmental entitlement and Melbourne Water's bulk entitlement. These passing flows are generally sufficient to meet the minimum low-flow requirements in summer/autumn, but are much less than the recommended minimum flows in winter/spring; and they do not provide any of the freshes or higher flows that are needed throughout the year to support environmental outcomes.

Water releases to meet irrigation demands create variable flow patterns in the Tarago and Bunyip rivers throughout the year. The magnitude and timing of these releases can influence environmental outcomes, and Melbourne Water continues to work with Southern Rural Water to optimise the shared value derived from irrigation releases.

Environmental values

The Tarago system contains several significant and threatened native plant and animal species including Australian grayling, long pink-bells, tree geebung and swamp bush-pea. The upper catchment (reach 2) has healthy streamside vegetation and diverse in-stream habitat that supports platypus and native fish including river blackfish and mountain galaxias. The lower catchment (reach 6) has been highly modified, but still contains patches of remnant vegetation and healthy populations of Australian grayling and platypus.

Environmental watering objectives in the Tarago River

	Increase populations of native fish including threatened species (such as the Australian grayling)
	Maintain channel form and structure
	Increase platypus populations
	Increase native streamside and aquatic plant communities on the riverbank and in the channel
	Increase the diversity and biomass of waterbugs, to support aquatic foodwebs
	Improve water quality in river pools, ensuring adequate oxygen concentration in the water to support fish, crustaceans and waterbugs

Traditional Owner cultural values and uses

Melbourne Water has made initial contact with Boon Wurrung Foundation, Bunurong Land Council Aboriginal Corporation and Wurundjeri Woi wurrung Cultural Heritage Aboriginal Corporation to discuss environmental watering in the Tarago/Bunyip system.

Bunurong Land Council Aboriginal Corporation has expressed a desire to be more involved in environmental flows planning and management in the Tarago system.

Wurundjeri Woi wurrung Cultural Heritage Aboriginal Corporation is interested in undertaking a program of work to determine cultural values and uses in the Tarago system using their preferred method.

There are more opportunities for Melbourne Water and the VEWH to work with the Traditional Owner groups to identify and integrate cultural values and their flow requirements into the environmental watering program on an ongoing basis.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 3.3.1, Melbourne Water considered how environmental flows could support values and uses including:

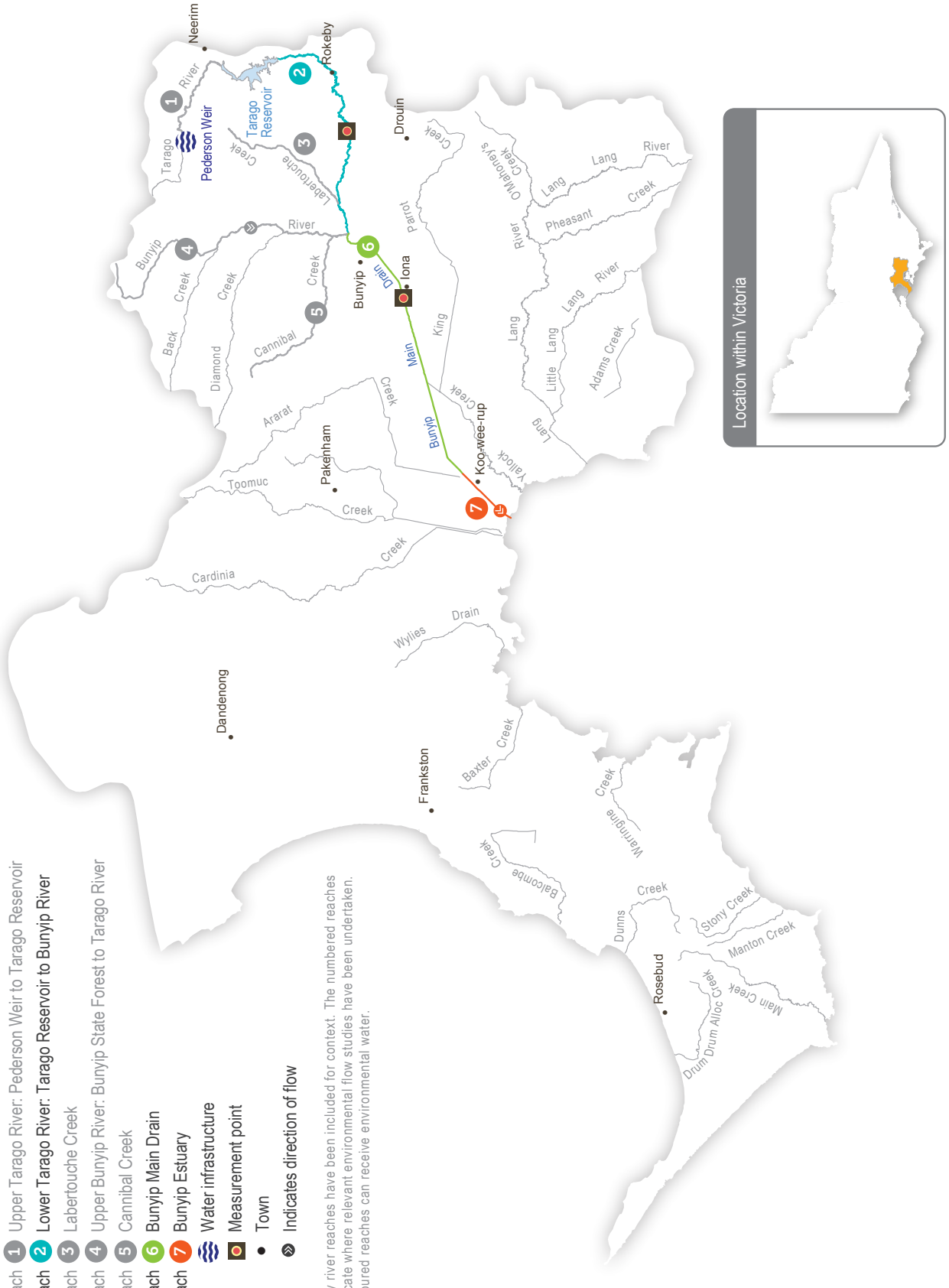
- riverside recreation and amenity (such as day visitors, short- and long-term visitors and camping)
- socio-economic benefits (such as irrigators and stock and domestic users)

If the timing or management of planned environmental flows may be modified to align with a community benefit, this is acknowledged in Table 3.3.1 with the following icon.

	Watering planned to support peaks in visitation (e.g. camping or other public activities on long weekends or school holidays)

Melbourne Water may time the release of a summer fresh in the Tarago River to coincide with long weekends in January or March 2020, so visitors and long-term residents of the Glen Crombie Caravan Park can enjoy the additional flows in the river.

Figure 3.3.1 The Tarago system



Recent conditions

The Tarago River catchment received above-average rainfall in winter and spring 2020, which delivered significant inflows into the storage. Tarago Reservoir filled and spilled in October 2020, January 2021 and April 2021. The Tarago environmental entitlement received its full allocation — 3,000 ML share of storage — in July 2020, and use throughout the year was replenished by frequent inflows. Opportunistic use of water held under the Tarago Reservoir airspace agreement contributed significantly to planned environmental watering actions. Rainfall also contributed to flows in the Tarago and Bunyip rivers downstream of the reservoir.

Natural inflows and storage spills maintained the recommended low flows in the Tarago River throughout much of 2020-21, and they also delivered five winter/spring freshes and three summer/autumn freshes. Water for the environment was used to deliver an additional winter/spring fresh in September 2020 and one summer/autumn fresh in January 2021.

Water for the environment was managed in line with an average climate scenario throughout 2020-21. All planned potential watering actions were met. Melbourne Water delivered a winter/spring high flow in September using environmental water held under the airspace agreement. This temporary arrangement between the VEWH, the storage manager and other entitlement holders allows the VEWH to save its share of inflows in spare reservoir capacity if its share of storage is full. This can help reserve enough environmental water to provide for some of the higher flow requirements that VEWH would otherwise not have sufficient water for.

The high flow improved water quality downstream of the reservoir and provided opportunities for the upstream migration of juvenile native fish species including Australian grayling, common galaxias and tupong. It is the first time since 2012-13 that water for the environment has been used to deliver a winter/spring high flow in the Tarago River.

Water for the environment was used to deliver a summer/autumn fresh at the end of January to flush sediment and organic material from the river bed. The fresh coincided with a public holiday, which improved conditions for riverside campers and other visitors. An autumn high flow may be delivered using water for the environment in May 2021 to cue Australian grayling to spawn.

Between 1,500 and 2,000 ML of water for the environment will be carried over in the Tarago system to help meet critical priorities in 2021-22 including summer and autumn freshes and an autumn high flow.

Scope of environmental watering

Table 3.3.1 describes the potential environmental watering actions in 2020-21, their expected watering effects (that is, the intended physical or biological effects of the watering action) and the longer-term environmental objective(s) they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological effects.

Table 3.3.1 Potential environmental watering actions, expected watering effects and associated environmental objectives for the Tarago River

Potential environmental watering action	Expected watering effects	Environmental objectives
Winter/spring low flow (75 ML/day [or natural] during June to November)	• Prevent the encroachment of terrestrial vegetation in the channel • Wet the banks to promote streamside vegetation growth • Maintain an adequate depth through riffles to allow access to habitats for fish and platypus • Maintain water quality through an increased low flow to flush the system and wet additional habitat for fish and macroinvertebrates	
Winter/spring fresh(es) (one to two freshes with a peak of 100-200 ML/day for two days during June to September)	• Flush sediment and scour biofilm from stream substrate and large woody debris to maintain habitat for macroinvertebrates and fish including river blackfish • Create extra depth to allow greater fish movement between pools and reaches • Cue the downstream migration of species such as eel and tupong • Wet the banks and low benches to maintain the fringing aquatic vegetation	

Table 3.3.1 Potential environmental watering actions, expected watering effects and associated environmental objectives for the Tarago River *(continued)*

Potential environmental watering action	Expected watering effects	Environmental objectives
Spring high flows (two to three high flows with a peak of 200-300 ML/day for two days in a seven-to-10-day duration during September to October)	• Form and maintain scour holes around large wood • Prevent the encroachment of terrestrial vegetation into the channel • Cue the upstream migration of juvenile diadromous fish (e.g. Australian grayling) from the sea or estuary into the river • Wet the higher benches to maintain the fringing aquatic vegetation and ensure vertical zonation of the fringing vegetation • Encourage female platypus to select a nesting burrow higher up the bank, to reduce the risk of higher flow later in the year flooding the burrow when juveniles are present	
Summer/autumn low flows (20 ML/day [or natural] during December to May)	• Maintain an adequate depth through riffles to support waterbugs and allow access to habitats for fish and platypus • Maintain adequate foraging habitat for fish and platypus • Maintain water quality and increase oxygen in pools	
Summer/autumn fresh(es) (one to five freshes of 75 ML/day for two days during December to May) 	• Flush fine silt from hard substrates and around large woody debris to maintain habitat for native fish in low-flow periods • Allow the localised movement of native fish • Prevent terrestrial vegetation growth on sandbars • Maintain water quality by aeration in times of low flow	
Autumn high flow (one high flow with a peak of 100 ML/day for two days in a minimum seven-day duration during April to May)	• Form and maintain scour holes around large wood • Cue the downstream migration and spawning for diadromous fish (e.g. Australian grayling) • Assist the dispersal of juvenile platypus	

Scenario planning

Table 3.3.2 outlines the potential environmental watering and expected water use under a range of planning scenarios. Drought planning scenarios are not considered in the four Melbourne Water systems as the potential watering actions are the same as the dry scenario.

Winter, spring, summer and autumn freshes and low flows are considered high priorities under all climatic conditions, to maintain the quality and quantity of habitat for native fish and platypus and to provide specific cues for them to breed and migrate. Under average and wet climate scenarios, it is expected that most of these watering actions will be met with natural flows, but water for the environment will likely be needed to help achieve them under a dry climate scenario.

Australian grayling rely on autumn high flows to cue migration and spawning at least two out of every three years. The recommended autumn high flow was fully achieved in 2019-20 and partially achieved in 2018-19 and 2020-21, and it is therefore a high priority to deliver in 2021-22. There is unlikely to be enough water for the environment to deliver a full autumn high flow under a dry or average climate scenario, but a partial high flow is still expected to cue some fish to move and successfully spawn.

Under average and wet climate scenarios, a spring high flow may be delivered to support the migration of native fish. This flow is required for the successful recruitment of some species and is recommended to be delivered in most years where possible. It was delivered in 2020-21, but only sporadically in the prior decade: before last year, it had not been achieved using environmental flows since 2012-13. The flow may be delivered naturally or with a combination of natural flow and water for the environment under average and wet climate scenarios. However, there is unlikely to be enough water for the environment to deliver this event under a dry climate scenario.

Carrying over 1,000 ML of water into 2022-23 will be a high priority under all climate scenarios, to ensure there is sufficient water to deliver summer and autumn freshes in the following year.

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

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

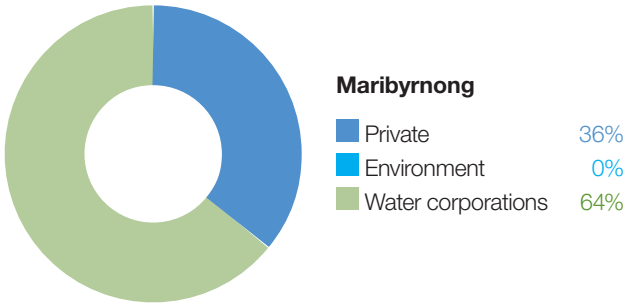
Planning scenario	Dry	Average	Wet
Expected river conditions	• Low streamflow • Some reduction to passing flow • Irrigation releases likely	• Average streamflow • Partial freshes naturally provided	• Above-average streamflow • Partial or full freshes naturally provided • Irrigation releases unlikely
Predicted supply of water for the environment	• 2,000-2,500 ML	• 2,500-3,500 ML	• 3,800-5,000 ML
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**		
	• Winter/spring low flow • Summer/autumn low flow • Summer/autumn freshes (three freshes) • Autumn high flow (one high flow, partially achieved)	• Winter/spring low flow • Spring high flow (one high flow, partially achieved) • Summer/autumn low flow • Summer/autumn freshes (five freshes) • Autumn high flow (one high flow, partially achieved)	• Winter/spring low flow • Winter/spring freshes (two freshes) • Spring high flow (one high flow) • Summer/autumn low flow • Summer/autumn freshes (five freshes) • Autumn high flow (one high flow)
	Tier 1b (supply deficit)		
	• Spring high flow (one high flow, partially achieved) • Winter/spring freshes (two freshes)	• Tier 1a spring high flow fully achieved • Winter/spring freshes (two freshes)	• N/A
Potential environmental watering – tier 2 (additional priorities)	• N/A		
Possible volume of water for the environment required to achieve objectives	• 1,000-1,500 ML (tier 1a) • 1,000-1,200 ML (tier 1b)	• 2,000-3,000 ML (tier 1a) • 1,500-1,800 ML (tier 1b)	• 0-3,500 ML (tier 1a)
Priority carryover requirements	• 1,000 ML		

3.4 Maribyrnong system

Waterway manager – Melbourne Water

Storage manager – Southern Rural Water

Environmental water holder – Not Applicable



Proportion of water entitlements in the Maribyrnong basin held by private users, water corporations and holders of water for the environment on 30 June 2020.

Did you know...?

The Maribyrnong River is known to the Wurundjeri Woi wurrung as *Mirrangbamurn*.

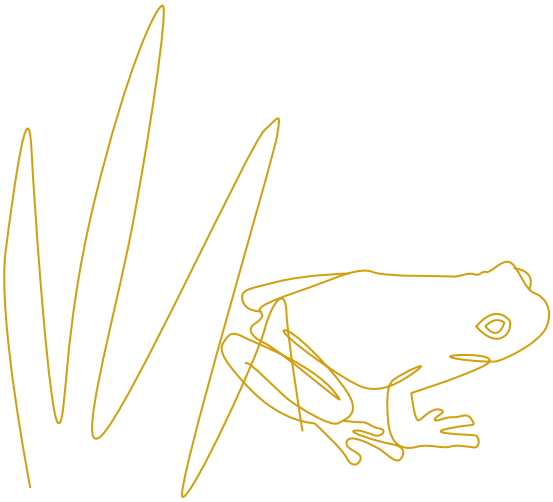
Top: Mirrangbamurn (Maribyrnong River), by Melbourne Water
Above: Platypus, by Paul Carracher

System overview

The Maribyrnong catchment is located to the north-west of Melbourne. The main waterways in the catchment are Jacksons Creek, which flows south-east from Mount Macedon, and Deep Creek, which flows south from Lancefield (Figure 3.4.1). These two tributaries join at Keilor North to form *Mirrangbamurn* (Maribyrnong River), which flows south to join *Birrarung* (Yarra River) at Yarraville, before flowing into Port Phillip Bay.

Rosslynne Reservoir is in the upper reaches of Jacksons Creek near Gisborne and is the only major storage in the Maribyrnong catchment. The reservoir has a release capacity of 20 ML per day, which significantly constrains the environmental outcomes that can be achieved in the Maribyrnong system. Water for the environment is primarily used to support environmental outcomes in Jacksons Creek between Rosslynne Reservoir and the confluence with Deep Creek (that is, the environmental flow reaches 6 and 7 shown in Figure 3.4.1). These two reaches are described as upper and lower Jacksons Creek respectively.

The VEWH does not hold an environmental entitlement in the Maribyrnong system, and it relies on opportunistic, temporary trade to meet demands. Melbourne Water and the VEWH work with local diversion licence holders to purchase unused water when it is available to support environmental outcomes. This arrangement is negotiated each year, and it only occurs with the agreement of all parties involved.



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 abundant food for a significant platypus population in several reaches in the Maribyrnong system.

Environmental watering objectives in the Maribyrnong system

	Protect and increase populations of native small-bodied fish
	Maintain platypus population
	Maintain and improve the condition, abundance, diversity and structure of in-stream and streamside vegetation
	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 oxygen concentrations

Traditional Owner cultural values and uses

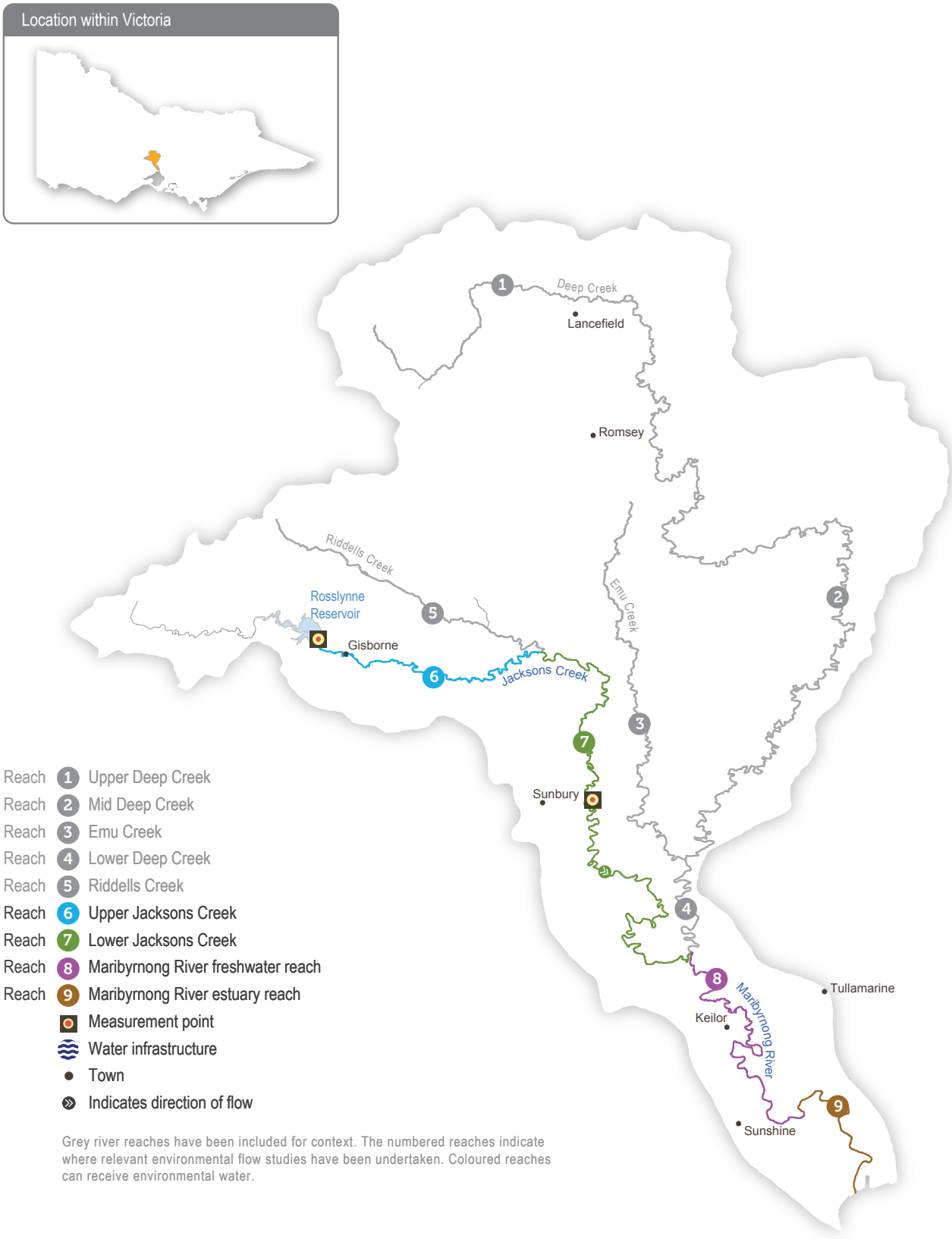
Melbourne Water has made initial contact with the Boon Wurrung Foundation, Bunurong Land Council Aboriginal Corporation and Wurundjeri Woi wurrung Cultural Heritage Aboriginal Corporation to discuss environmental watering in the Maribyrnong system.

There are more opportunities for Melbourne Water and the VEWH to work with the Traditional Owner groups to identify and better integrate cultural values and their flow requirements into the environmental watering program on an ongoing basis.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 3.4.1, Melbourne Water considered how environmental flows could support social values such as community connection and amenity, by planning flows that will maintain healthy habitat and improve water quality.

Figure 3.4.1 The Maribyrnong system



Recent conditions

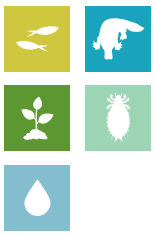
The Maribyrnong catchment had above-average rainfall during winter and spring 2020, leading to high soil moisture and above-average tributary inflows downstream of Rosslynne Reservoir. Conditions remained near-average for the remainder of the year, but inflows to Rosslynne Reservoir were well-below average during 2020-21, and the storage remained below 30 percent capacity. The VEWH did not purchase allocation from licence holders due to low water availability in the Maribyrnong system, meaning no water for the environment was available for use in 2020-21.

The wetter-than-average conditions in the catchment below Rosslynne Reservoir meant winter/spring low flows in reach 7 were partially met by tributary inflows. Local rainfall runoff and passing flows (delivered by Southern Rural Water's bulk entitlement) met most of the summer and autumn low-flow watering actions recommended for reaches 6 and 7 and two summer/autumn freshes in reach 7. These flows maintained water quality and suitable habitat and food resources for native fish, platypus and waterbugs, despite the lack of environmental water.

Scope of environmental watering

Table 3.4.1 describes the potential environmental watering actions in 2021-22, their expected watering effects (that is, the intended physical or biological effects of the watering action) and the longer-term environmental objectives they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological effects.

Table 3.4.1 Potential environmental watering actions, expected watering effects and associated environmental objectives for the Maribyrnong system

Potential environmental watering action	Expected watering effects	Environmental objectives
Winter/spring low flow (40 ML/day during June to November)	• Wet the in-stream vegetation and streamside benches to support the growth of native plants and to limit encroachment by terrestrial plant species • Prevent fine sediment settling and smothering waterbug habitat • Provide passage for small-bodied native fish and platypus between habitats	
Summer/autumn low flow (6 ML/day during December to May)	• Maintain waterbug habitat by providing suitable depth over riffles, maintaining pools and inundating large woody debris • Provide passage for small-bodied native fish and platypus between habitats	
Summer/autumn freshes (two to three freshes of 40 ML/day for seven days during December to May)	• Flush pools to maintain water quality • Prevent fine sediment settling and smothering waterbug habitat • Wet the in-stream vegetation and streamside benches to support the growth of native streamside plants and to limit encroachment by terrestrial plant species • Provide passage for small-bodied native fish and platypus between habitats	

Scenario planning

Table 3.4.2 outlines the potential environmental watering and expected water use under a range of planning scenarios. Drought planning scenarios are not considered in the four Melbourne Water systems as the potential watering actions are the same as the dry scenario.

There is no environmental entitlement in the Maribyrnong system, so environmental watering actions can only occur in 2021-22 if other entitlement holders have water they don't require and are willing to sell to the VEWH. Any water that the VEWH can purchase will be used to help meet recommended targets for winter/spring low flows and summer/autumn low flows where needed, to maintain adequate habitat and dispersal opportunities for small-bodied native fish and platypus and to deliver summer/autumn freshes to prevent adverse water-quality outcomes. Proposed flows will primarily target reach 7, but they will provide similar outcomes in reach 6 en route.

Adequate low flows and summer/autumn freshes are a high priority under all climate scenarios. They are likely to be met by a combination of natural runoff, higher passing flows and a larger groundwater contribution under average and wet climate scenarios. They are less likely to be achieved under a dry climate scenario, but low inflows to Rosslynne Reservoir will likely limit opportunities to purchase water for environmental use. Any water that is available for environmental use under a dry climate scenario will be used to supplement summer/autumn low flows for a short period or provide summer/autumn freshes to prevent drying in critical habitats or poor water quality.

The VEWH is unable to carry over water in the Maribyrnong system to support multi-year planning.

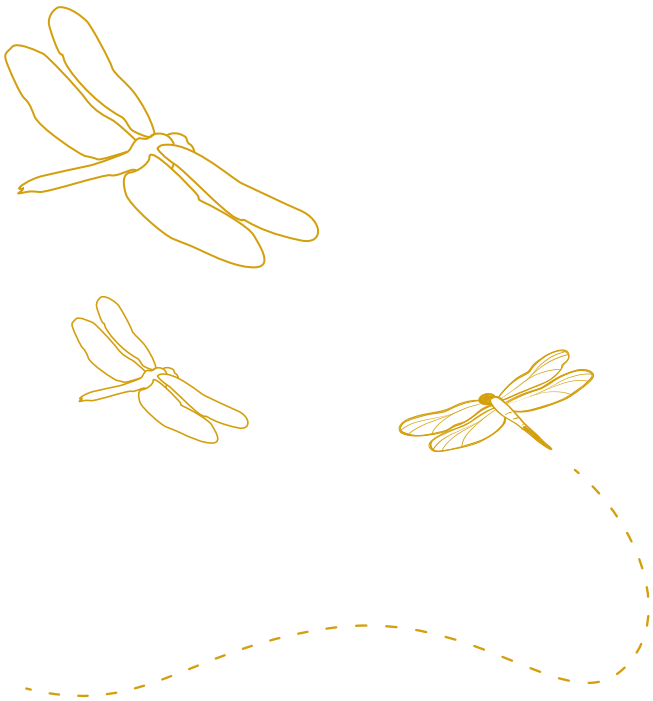
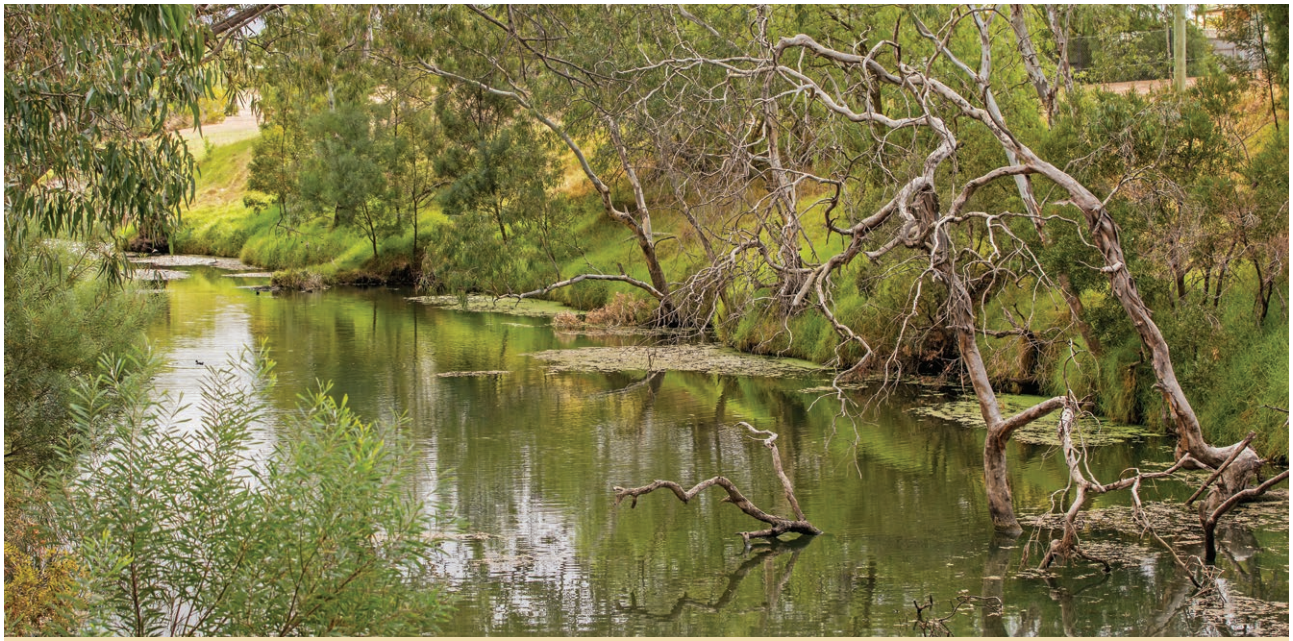


Table 3.4.2 Potential environmental watering for the Maribyrnong system under a range of planning scenarios

Planning scenario	Dry	Average	Wet
Expected river conditions	• Low volumes of unregulated flows • Passing flows may meet some low-flow objectives • Some baseflow from groundwater contributions in lower Jacksons Creek	• Unregulated flows meet some objectives • Passing flows may meet several low-flow objectives • Groundwater contributions provide baseflow in lower Jacksons Creek	• Unregulated flows meet most objectives • Passing flows may meet most low-flow objectives • Groundwater contributions provide baseflow in lower Jacksons Creek
Predicted supply of water for the environment	• There is no environmental entitlement in the Maribyrnong system. Water will need to be purchased from willing sellers to support tier 1b watering actions.		
Maribyrnong system (targeting reaches 6 and 7)			
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**		
	• N/A		
	Tier 1b (supply deficit)		
	• Winter/spring low flow • Summer/autumn low flow • Summer/autumn freshes (two freshes)	• Winter/spring low flow • Summer/autumn low flow • Summer/autumn freshes (two freshes)	• Winter/spring low flow • Summer/autumn low flow • Summer/autumn freshes (three freshes)
Possible volume of water for the environment required to achieve objectives	• 300 ML (tier 1b)	• 300 ML (tier 1b)	• 300 ML (tier 1b)

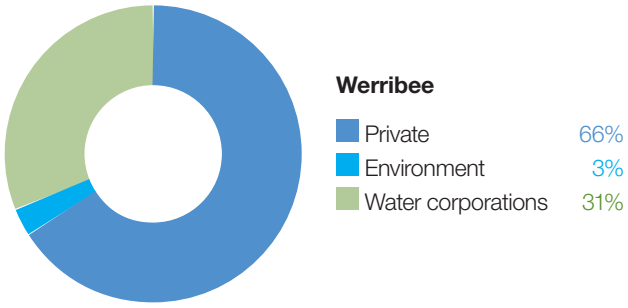
3.5 Werribee system



Waterway manager – Melbourne Water

Storage manager – Southern Rural Water

Environmental water holder – Victorian Environmental Water Holder



Proportion of water entitlements in the Werribee basin held by private users, water corporations and holders of water for the environment on 30 June 2020.

Did you know...?

The Werribee River is known to Wadawurrung people as *Wirribi Yaluk*, which means 'wide river with big red gums'.

Top: Wirribi Yaluk (Werribee River), by Melbourne Water
Above: Pyrites Creek, by Melbourne Water

System overview

Wirribi Yaluk (Werribee River) flows south-east from the Wombat State Forest near Ballan, through the Werribee Gorge to Bacchus Marsh and then into Port Phillip Bay at Werribee (Figure 3.5.1). 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 four reaches in the Werribee system that can receive water for the environment are Pyrites Creek between Lake Merrimu and Melton Reservoir (reach 6), *Wirribi Yaluk* (Werribee River) between Melton Reservoir and the Werribee Diversion Weir (reach 8), *Wirribi Yaluk* (Werribee River) between the Werribee Diversion Weir and Werribee Park Tourism Precinct (reach 9) and the Werribee River estuary below the Werribee Park Tourism Precinct.

Environmental watering that targets environmental objectives in reach 9 and the estuary is delivered from Melton Reservoir and therefore also benefits reach 8. Water for the environment released from Lake Merrimu is re- harvested in Melton Reservoir, where it can be held and released at an appropriate time to achieve environmental objectives in lower *Wirribi Yaluk* (Werribee River).

Environmental values

The Werribee system supports a range of native fish including Australian grayling, river blackfish, flathead gudgeon, short-finned eel, tupong, Australian smelt, several species of galaxiids, and a large population of black bream in the estuary. Several species of frogs, a diverse waterbug community and platypus inhabit the upper and 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, and it provides nursery habitat for juvenile freshwater fish species and estuarine species (such as black bream).

Environmental watering objectives in the Werribee system

	Protect and increase populations of native freshwater fish species including galaxiids and Australian grayling Protect and increase populations of black bream in the estuary
	Maintain native frog populations
	Maintain channel beds and pool habitats Maintain clean substrate surfaces to support biological processes
	Maintain the platypus population
	Maintain the health and increase the cover of in-stream, streamside and estuary plants Limit the spread of terrestrial plants, and promote the recruitment of native water-dependent plant species on the banks and benches of waterways
	Maintain and enhance the population of waterbugs, to break down dead organic matter and support the river's food chain
	Maintain oxygen and salinity levels in pools

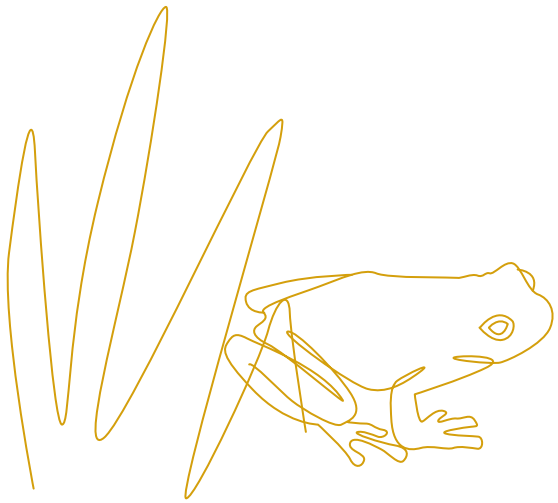
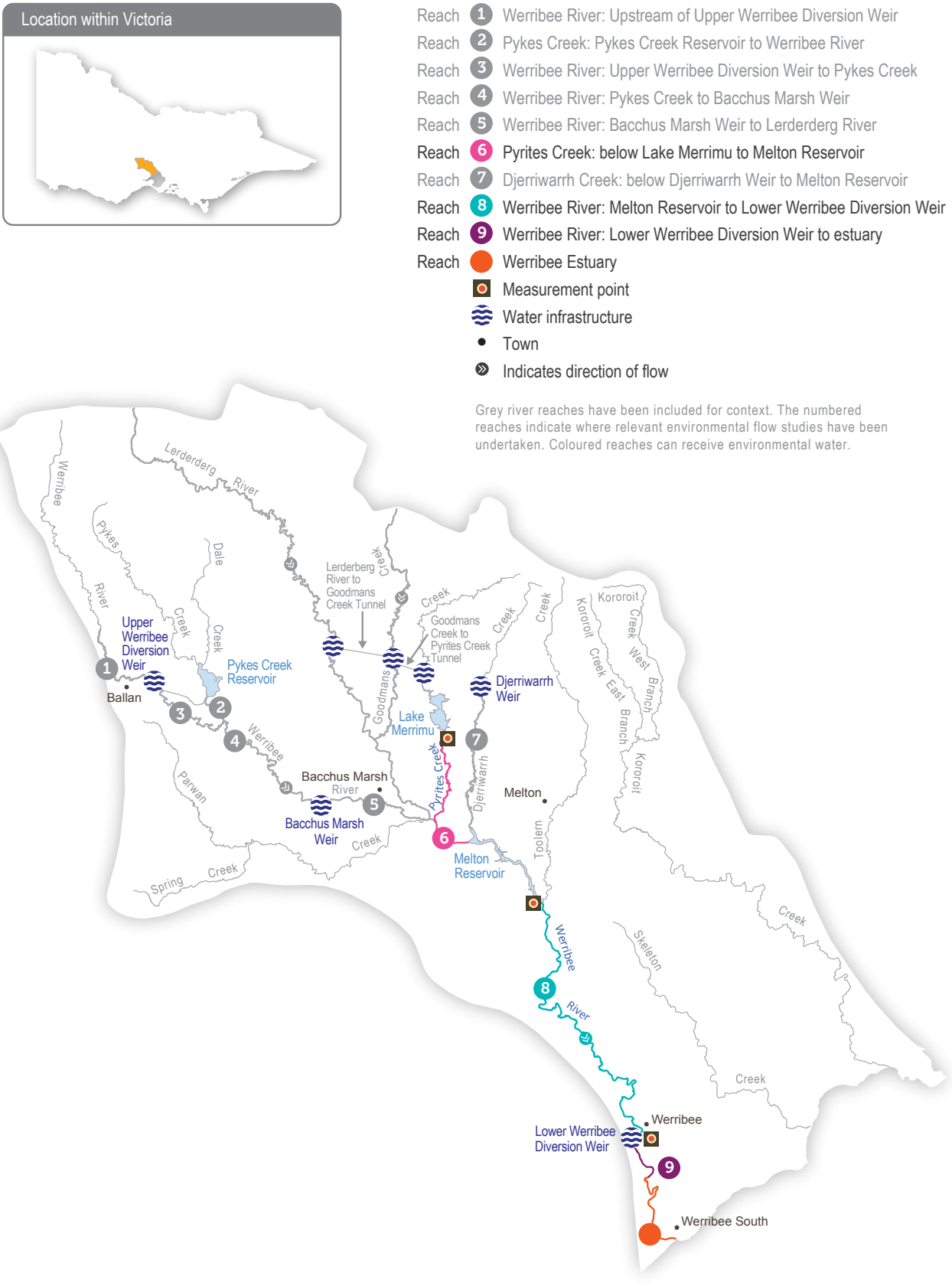


Figure 3.5.1 The Werribee system



Traditional Owner cultural values and uses

Melbourne Water has made initial contact with the Wadawurrung Traditional Owners Aboriginal Corporation and Wurundjeri Woi wurrung Cultural Heritage Aboriginal Corporation to discuss environmental watering in the Werribee system.

There are more opportunities for Melbourne Water and the VEWH to work with the Traditional Owner groups to identify and better integrate cultural values and their flow requirements into the environmental watering program on an ongoing basis.

The Wadawurrung Traditional Owners Aboriginal Corporation has reviewed the environmental values for the Werribee system and has identified the following values that also have cultural significance to Wadawurrung Traditional Owners.

Reach	Extent	Key environmental values with cultural significance to the Wadawurrung
8	*Wirribi Yaluk* (Werribee River)	
9	*Wirribi Yaluk* (Werribee River) between Wyndham Vale and Bluestone Ford	
Estuary	Werribee River downstream of Bluestone Ford	

Social, recreational and economic values and uses

In planning the potential watering actions in Table 3.5.1, Melbourne Water considered how environmental flows could support values and uses including:

- water-based recreation (such as canoeing, fishing, kayaking and swimming)
- riverside recreation and amenity (such as picnicking)
- community events and tourism (such as Werribee Zoo).

Recent conditions

The Werribee system catchment experienced wetter-than-average conditions in autumn 2020 and throughout 2020-21. High rainfall in autumn 2020 caused Pykes Creek Reservoir and Melton Reservoir to fill and spill, and both storages spilled on several occasions throughout late spring and summer 2020-21. Allocations against high-reliability water shares in Melton Reservoir reached 100 percent by December 2020, and low-reliability water shares reached 80 percent by March 2021. In contrast, Lake Merrimu had below-average inflows and contributed only a small volume to the environmental entitlement in 2020-21.

Pyrites Creek did not have any significant natural high-flow events in 2020-21. Water for the environment was used to deliver a spring fresh, a spring/summer high flow and maintain low flows to the end of December. These flows enabled connections between habitat pools for native fish, frogs and waterbugs. The flows supported the recruitment and growth of native vegetation within the creek and on the banks, and it flushed sediment from pools along the length of the reach. Most of the water delivered during the high flow in September and the fresh in December was re-harvested at Melton Reservoir and used to deliver watering actions in lower *Wirribi Yaluk* (Werribee River).

Spills from Melton Reservoir provided some large natural flows through reaches 8 and 9 and the Werribee River estuary during spring and summer. Water for the environment was used to deliver a partial spring/summer high flow in September to support the upstream migration of native fish from the estuary. Small environmental flows were delivered during summer and autumn to freshen the lower reaches and flush algal blooms that developed near the Werribee Zoo. The storage manager's increased passing flows below the Werribee Diversion Weir met the low-flow watering actions during late summer, autumn and winter.

Water for the environment was managed in the Werribee system in accord with an average climate scenario in 2020-21. Most planned watering actions were fully met. The spring high flow in Pyrites Creek and winter/spring fresh in the lower *Wirribi Yaluk* (Werribee River) were only partially delivered due to capacity constraints at reservoir outlets, but the expected watering effects and environmental objectives for these flows were likely met.

Delivering a partial winter/spring fresh in 2021-22 under dry and average conditions and a full winter/spring fresh under wet conditions will remain a high priority, to support black bream recruitment following a fish death event in early 2020 linked to low oxygen and an excess influx of nutrients in stormwater.

Scope of environmental watering

Table 3.5.1 describes the potential environmental watering actions in 2021-22, their expected watering effects (that is, the intended physical or biological effects of the watering action) and the longer-term environmental objectives they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological effects.

Table 3.5.1 Potential environmental watering actions, expected watering effects and associated environmental objectives for the Werribee system

Potential environmental watering action	Expected watering effects	Environmental objectives
Pyrites Creek (reach 6)		
Winter/spring/summer low flow (two ML/day [or natural] during June to December)	• Maintain access to food and habitat for waterbugs, native fish and frogs • Increase the growth and recruitment of in-stream vegetation	
Spring fresh(es) (one to four freshes of 40 ML/day for two days during September to October)	• Drown terrestrial plant species that encroach into the waterway • Increase the growth and recruitment of streamside and in-stream vegetation • Transport carbon to drive aquatic food webs • Scour silt, biofilms and algae from substrates to maintain the quality and quantity of food and habitat for waterbugs • Improve water quality and the quantity of food and habitat for waterbugs, frogs and native fish • Wet depressions adjacent to the stream that frogs can use for breeding	
Spring/summer high flow(s) (one to three high flows of 130 ML/day for two days during September to December)	• Maintain access to food and habitat for waterbugs, native fish and frogs • Increase the growth and recruitment of in-stream vegetation	
Lower Werribee River (reaches 8, 9 and estuary)		
Winter/spring low flow (up to 80 ML/day during June to November)	• Provide flow to allow fish to move upstream past natural and artificial barriers • Facilitate the downstream movement of diadromous fish to the estuary • Drown terrestrial plant species and support the growth and recruitment of water-dependent streamside vegetation • Maintain permanent pools and increase the extent of habitat for waterbugs, fish, platypus and frogs • Maintain flow through pool habitats to allow mixing or suppression/dilution of saline groundwater	
Winter/spring fresh(es) (one to four freshes of 250-350 ML/day for three days during June to October)	• Support the growth and recruitment of water-dependent streamside vegetation • Flush silt and scour biofilms and algae from substrates on the stream bed and maintain pools and channel dimensions • Provide movement cues and enough flow for fish to move upstream past natural and artificial barriers • Maintain water quality and quantity of food and habitat for waterbugs and platypus • Wet depressions adjacent to the stream that frogs can use for breeding	
Summer/autumn low flow (10 ML/day during December to May)	• Increase the growth and recruitment of in-stream and water-dependent streamside vegetation • Maintain access to habitat and improve water quality for native fish, frogs, platypus and waterbugs • Maintain flow through pool habitats to allow mixing or suppression/dilution of saline groundwater intrusion	

Table 3.5.1 Potential environmental watering actions, expected watering effects and associated environmental objectives for the Werribee system *(continued)*

Potential environmental watering action	Expected watering effects	Environmental objectives
Summer/autumn fresh(es) (one to five freshes of 80 ML/day for two days during November to May)	• Increase the growth and recruitment of water-dependent streamside vegetation • Flush silt and scour biofilms and algae from substrates on the stream bed and maintain pools and channel dimensions • Maintain access to habitat and improve water quality for native fish, frogs and platypus • Provide enough flow for native fish to move downstream past natural or artificial barriers • Maintain the quality of water within pools by dispersing azolla and blue-green algae blooms	

Scenario planning

Table 3.5.2 outlines the potential environmental watering and expected water use under a range of planning scenarios. Drought planning scenarios are not considered in the four Melbourne Water systems as the potential watering actions are the same as the dry scenario.

The Pyrites Creek catchment downstream of Merrimu Reservoir relies on passing flows, operational releases and environmental flows for virtually all of its flow. The highest-priority potential watering actions for Pyrites Creek under all scenarios are spring freshes, spring/summer high flows and winter/spring/summer low flows. These flows will maintain connected aquatic habitats from winter to summer, maintain streamside and in-stream vegetation zones and periodically wet channel margins that can support frog breeding. Fish and other aquatic animals will retreat to permanent pools that are maintained by groundwater in summer and autumn.

The lower *Wirribi Yaluk* (Werribee River) is also heavily reliant on passing flows, operational deliveries and environmental flows to provide low flows and freshes, but unregulated spills from Melton Reservoir, downstream tributary inflows and local runoff including stormwater from Werribee provide larger flows, especially in wet years. The highest-priority watering actions for lower *Wirribi Yaluk* (Werribee River) under all scenarios are summer/autumn freshes and winter/spring freshes. Passing flows and operational deliveries for irrigation customers are expected to meet most low-flow requirements in lower *Wirribi Yaluk* (Werribee River) but managed environmental flows are important to control water quality and disperse small algae blooms and provide regular opportunities for fish and platypus to move throughout lower *Wirribi Yaluk* (Werribee River). These flows will also support streamside and aquatic vegetation.

The number of freshes delivered to Pyrites Creek and lower *Wirribi Yaluk* (Werribee River), as well as the magnitude of the winter/spring fresh in lower *Wirribi Yaluk* (Werribee River) will vary between dry, average and wet scenarios, depending on water availability. Water for the environment may be used to supplement summer/autumn low flows in lower *Wirribi Yaluk* (Werribee River) under a wet scenario, but more water for the environment would need to be secured to deliver these flows under dry and average climate scenarios.

A minimum of 600 ML is planned to be carried over into 2022-23. Maintaining sufficient carryover in both Lake Merrimu and Melton Reservoir will be prioritised over the delivery of tier 1b potential watering actions, to ensure high-priority flows can be delivered to Pyrites Creek (reach 6) and lower *Wirribi Yaluk* (Werribee River) in 2022-23.

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

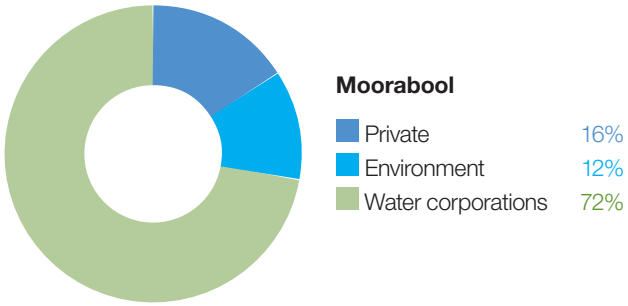
Planning scenario	Dry	Average	Wet
Expected river conditions	• Minor natural flow below Melton Reservoir • Minimal passing flows to reach 6, possible transfers during summer • Some consumptive releases out of storage into reach 8 in summer/autumn	• Unregulated spills in winter/spring from Melton Reservoir into reaches 8 and 9 and the estuary; most low flow in reach 6 met by passing flow • Consumptive releases out of storage into reach 8 in summer/autumn	• Unregulated spills in winter/spring from Melton Reservoir into reaches 8 and 9 and the estuary; all low flow in reach 6 provided • Consumptive releases out of storage into reach 8 in summer/autumn
Predicted supply of water for the environment	• 1,805 ML	• 2,141 ML	• 2,641 ML
Pyrites Creek (targeting reach 6)			
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**		
	• Winter/spring/summer low flow • Spring freshes (three freshes) • Summer high flow (one high flow)	• Winter/spring/summer low flow • Spring freshes (four freshes) • Summer high flows (three high flows)	• Winter/spring/summer low flow • Spring freshes (four freshes) • Summer high flows (three high flows)
Werribee River (targeting reach 9 and estuary)			
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**		
	• Winter/spring fresh (one fresh, partially achieved) • Summer/autumn freshes (three freshes)	• Winter/spring fresh (one fresh, partially achieved) • Summer/autumn freshes (five freshes)	• Winter/spring low flow • Winter/spring freshes (two freshes) • Summer/autumn low flow (one month) • Summer/autumn freshes (five freshes)
	Tier 1b (supply deficit)		
	• Tier 1a winter/spring fresh at increased magnitude • Summer/autumn low flow	• Tier 1a winter/spring fresh at increased magnitude • Summer/autumn low flow	• Summer/autumn low flow at increased duration
Possible volume of water for the environment required to achieve objectives	• 1,060 ML (tier 1a) • 1,580 ML (tier 1b)	• 1,250 ML (tier 1a) • 1,580 ML (tier 1b)	• 1,880 ML (tier 1a) • 900 ML (tier 1b)
Priority carryover requirements	• 600-800 ML		

3.6 Moorabool system

Waterway manager – Corangamite Catchment Management Authority

Storage manager – Central Highlands Water

Environmental water holder – Victorian Environmental Water Holder



Proportion of water entitlements in the Moorabool basin held by private users, water corporations and holders of water for the environment on 30 June 2020.

Did you know...?

Moorabool Yulluk (Moorabool River) is on the traditional lands of the Wadawurrung people who have had an ongoing connection with the river for thousands of years. 'Moorabool' means 'monster' in the language of the Wadawurrung. It's the local name of the stone curlew, a bird that used to be common by the river and which is renowned for its night-time, eerie, high-pitched wailing. Wadawurrung parents would use the stone curlew's frightening call to warn their children away from the river. "Moorabool, Moorabool (monster, monster)", they would tell the children to make sure they didn't stray close to the dangers of the river in the dark.

Top: Moorabool Yulluk (Moorabool River) at She Oaks, by Corangamite CMA
Right: Moorabool Yulluk (Moorabool River) in-stream vegetation, by Corangamite CMA

System overview

Moorabool Yulluk (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 (Figure 3.6.1). *Moorabool Yulluk* (Moorabool River) is a highly regulated catchment with major storages that include Lal Lal, Moorabool and Bostock reservoirs.

The lower section of *Moorabool Yulluk* (Moorabool River) between She Oaks and Batesford has nine private diversion weirs that are significant barriers to fish. These barriers have increased the extent of slow-flowing habitat and reduced habitat diversity. The Moorabool system is a water supply catchment for Barwon Water and Central Highlands Water. Releases from Lal Lal Reservoir for urban water supply contribute to environmental outcomes in reach 3a and 3b (above Barwon Water's diversion point at She Oaks) and allow more efficient delivery of water for the environment to reach 4. Barwon Water and Corangamite CMA coordinate to make releases in tandem, where possible, to optimise these benefits.

Water allocated to the *Moorabool Yulluk* (Moorabool River) environmental entitlement is stored in Lal Lal Reservoir. The entitlement includes passing flows that are a significant component of annual streamflows and help maintain low flows 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 can have the most benefit. Water use is limited by both inflows to the reservoir and by a use cap specified in the entitlement. Environmental flows may also provide some benefits to flow-dependent values in the reach between She Oaks Weir and the confluence with the Barwon River.

Environmental values

Moorabool Yulluk (Moorabool River) is a highly flow-stressed system, but it does retain significant environmental values. The 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 also contains extensive areas of endangered remnant vegetation including streambank shrubland and streamside woodland ecological vegetation communities. Platypus, rakali (water rats) and a range of waterbugs are also present. *Moorabool Yulluk* (Moorabool River) flows into the Barwon River, connecting it to the Ramsar-listed lower Barwon wetlands.

Environmental watering objectives in *Moorabool Yulluk* (Moorabool River)

	Improve and increase the distribution, abundance and diversity of migratory species (tupong, short-finned eel, common galaxias, spotted galaxias, short-headed lamprey and Australian grayling) Maintain and increase the distribution, abundance and diversity of non-migratory species (flat-headed gudgeon, Australian smelt, southern pygmy perch and river blackfish)
	Maintain channel form and processes Maintain physical habitat diversity
	Maintain and improve a self-sustaining breeding population of platypus and support the dispersal of juveniles and the movement of adults
	Maintain in-stream macrophyte communities Maintain streamside vegetation communities and promote recruitment
	Maintain the abundance and diversity of waterbug communities
	Maintain water quality Prevent hypoxic blackwater events

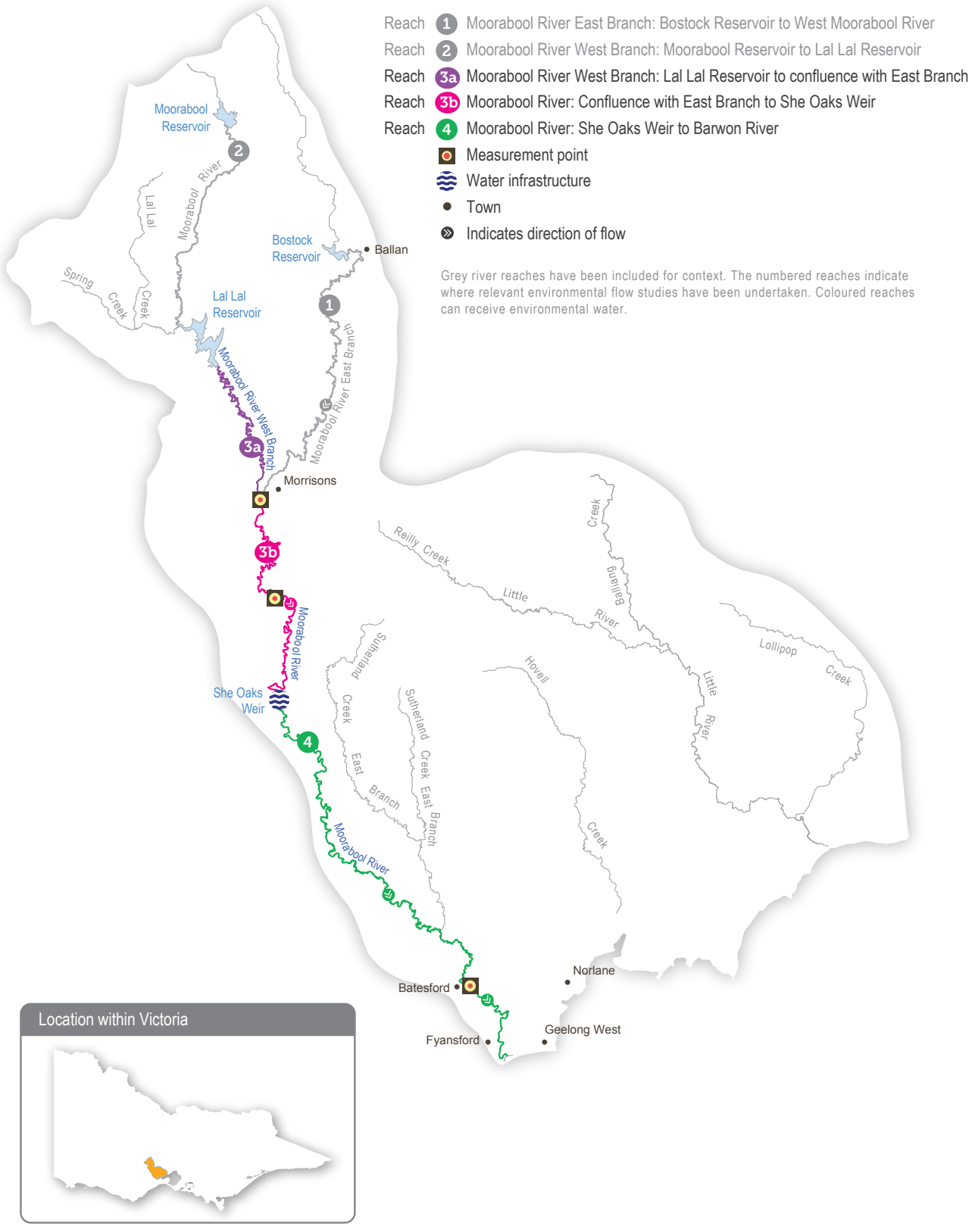
Traditional Owner cultural values and uses

The Wadawurrung are the Traditional Owners of the land of *Moorabool Yulluk* (Moorabool River) and parts of the Barwon, Leigh and Yarrowee rivers.

Wadawurrung Traditional Owners have a strong connection to the river and place high cultural value on *Moorabool Yulluk*. They are a key partner in advocating for additional water recovery to help support environmental outcomes and cultural water objectives.

In 2020, the Wadawurrung Traditional Owners released *Paleert Tjaara Dja – Let's make Country good together 2020 – 2030 Wadawurrung Country Plan*. Waterways, rivers, estuaries and wetlands – *Yulluk* – are identified as key values to look after.

Figure 3.6.1 The Moorabool system



In 2019, the Wadawurrung partnered with Corangamite CMA to complete an environmental flows study for the upper Barwon, Yarrowee and Leigh rivers. Environmental flows studies are essential technical references for river managers, which identify the types of flows needed to support environmental and cultural values in a river system. The cultural values identified in the flows study apply to all waterways within Wadawurrung Country, including *Moorabool Yulluk* (Moorabool River). The values include:

- significant aquatic species such as *Buniya* (eels), *Ware-up* (river blackfish), *Tark* (common reed) and *Bal-yun* (cumbungi) which are traditional food, materials or medicinal sources
- waterway confluences and deep pools, which are places for meeting, ceremonies and trade and mark clan boundaries.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 3.6.1, Corangamite CMA considered how environmental flows could support values and uses including:

- water-based recreation (such as camping, fishing, kayaking and swimming)
- riverside recreation and amenity (such as birdwatching, bushwalking, camping, picnicking and lookouts)
- community events and tourism
- socio-economic benefits (such as domestic stock users).

If the timing or management of planned environmental flows may be modified to align with a community benefit, this is acknowledged in Table 3.6.1 with the following icon.

Watering planned to support peaks in visitation (e.g. camping or other public activities on long weeks or school holidays)

Summer/autumn freshes provide a freshening flow in *Moorabool Yulluk* (Moorabool River) and are planned to coincide with school holidays and public holidays where possible. These flows improve opportunities for riverside and water-based recreation, in particular camping and fishing.

Recent conditions

Rainfall in the Moorabool system catchment was close to the long-term average throughout most of 2020-21, but above average in late winter to early spring and during summer. Lal Lal Reservoir filled and spilled in early October 2020, when each entitlement holders total share of reservoir capacity was reached.

Water for the environment was used to help meet target low flow in early winter, but natural catchment inflows dominated flow patterns through late winter and spring. The natural spill at Lal Lal Reservoir in October 2020 delivered a peak flow of 1,040 ML per day at Morrison's gauge, which was sufficient to connect low-lying parts of the floodplain, support channel-forming geomorphological processes and provide migration triggers for native fish. Total monthly rainfall over January 2021 contributed significantly to catchment inflows, delivering a natural fresh of 50 ML per day earlier in the month and again in early February. These and other associated rain events helped meet many of the recommended summer/autumn freshes. Summer/autumn low-flow targets were largely met with a combination of passing flows and operational water transfers, with limited amounts of water for the environment used to make up deficits only where required.

Environmental watering in the Moorabool system was managed according to an average climate scenario throughout 2020-21, and all planned watering actions were met. About 2,100 ML was delivered in 2020-21, which ensures water availability of about the same volume or more could be delivered next year depending on catchment conditions and inflows.

Scope of environmental watering

Table 3.6.1 describes the potential environmental watering actions in 2021-22, their expected watering effects (that is, the intended physical or biological effects of the watering action) and the longer-term environmental objectives they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological effects.

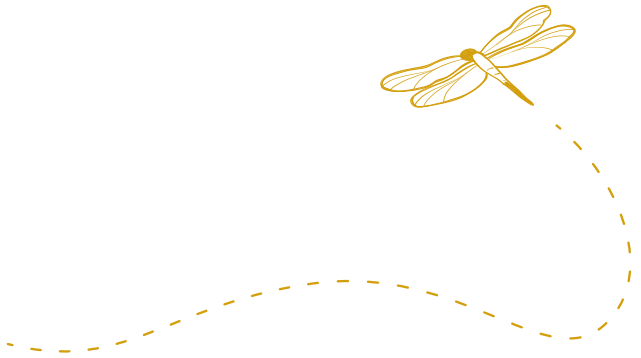


Table 3.6.1 Potential environmental watering actions, expected watering effects and associated environmental objectives for *Moorabool Yulluk* (Moorabool River)

Potential environmental watering action	Expected watering effects	Environmental objectives
Winter/spring low flow (10-60 ML/day continuous from June to November)	• Maintain in-stream vegetation • Maintain connectivity and allow fish movement through the reach • Reduce intrusion by terrestrial vegetation into the stream bed	
Winter/spring fresh(es) (one to three freshes of 80-162 ML/day for five days during June to November)	• Maintain pool and riffle habitats and provide connectivity to support fish and platypus movement through the reach • Trigger downstream spawning migration of tupong (May-August) and upstream migration of juvenile *Turrpurt* (galaxias), tupong, *Buniya* (short-finned eel) and Australian grayling (September-November) • Provide flow variability to maintain species diversity of the fringing vegetation and promote the growth and recruitment of streamside vegetation • Flush silt, scour pools and remove biofilms from hard substrates and the stream bed to maintain waterbug communities and transport organic matter to prevent blackwater events	
Summer/autumn low flow (5-10 ML/day continuous from December to May)	• Maintain pool and riffle habitat for fish, waterbugs platypus and submerged aquatic vegetation • Maintain water quality for biota by reducing periods of low oxygen, high temperature and high electrical conductivity	
Summer/autumn fresh(es) (one to three freshes of 30-60 ML/day for three to five days from December to May) 	• Trigger downstream spawning migration of adult *Buniya* (short-finned eel) (January-February), tupong (May-August), Australian grayling (April-May) and short-headed lamprey • Maintain pool and riffle habitat and the condition of streamside vegetation, and promote recruitment • Allow fish and platypus to move through the reach to access habitat • Flush silt and scour biofilms and algae from the stream bed and substrates to improve habitat quality for waterbugs • Maintain water quality for biota by reducing periods of low oxygen, high water temperature and salinity	

Scenario planning

Table 3.6.2 outlines the potential environmental watering and expected water use under a range of planning scenarios.

Moorabool Yulluk (Moorabool River) requires continuous low flows throughout the year and periodic freshes under all climate scenarios except drought to achieve the intended environmental outcomes. Under drought and dry climate scenarios, the main objective is to provide sufficient habitat to maintain existing populations of native fish and platypus, and therefore flows can be delivered at the lower end of their recommended size range and frequency. However, flows generally need to be larger under average and wet climate scenarios to help grow populations of native fish and platypus and to improve the condition of in-stream and streamside vegetation.

Under average and wet climate scenarios, most of the recommended flows are expected to be provided through a combination of natural flows, passing flows, operational releases and deliveries of water for the environment. Continuous low flows, at least one winter/spring fresh and one summer/autumn fresh are likely to be delivered at the lower end of their recommended ranges under a dry climate scenario. These flows should be sufficient to maintain existing populations of native fish and platypus and to maintain the condition of aquatic and streamside vegetation. Delivering a 60 ML per day fresh for five days in autumn will be a high priority under average and wet climate scenarios, and they will be delivered where possible under a dry scenario to trigger Australian grayling migration and spawning. These autumn high flows are required two out of every three years to maintain and grow Australian grayling populations. They occurred in the Moorabool system in 2018-19 and 2019-20, and delivering them in 2021-22 will help the populations recover from past dry periods and provide a buffer in case there is a return to drier conditions in 2022-23.

Under a drought scenario, there will be less contribution from natural events and the expected volume of water for the environment available will not be sufficient to deliver all of the required flows to maintain the condition of existing environmental values. The highest environmental watering priority under a drought scenario will be to maintain connecting flows for as long as possible during summer and autumn, because this is when the system is at the greatest risk of drying up or having poor water quality. If it is not possible to maintain continuous flow, water for the environment available will be used to deliver freshes to periodically top up refuge pools and prevent adverse water-quality events. Even with these proposed watering actions, some decline in environmental condition and the size of plant and animal populations is expected under a drought scenario.

Although environmental watering in *Moorabool Yulluk* (Moorabool River) primarily targets outcomes in reaches 3a and 3b, deliveries will be planned where possible to also provide benefits in reach 4.

Carryover of 1,000 ML has been identified to ensure there is sufficient water to deliver low flows in summer and autumn in 2022-23 if there is another drought.

Table 3.6.2 Potential environmental watering for *Moorabool Yulluk* (Moorabool River) under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Little to no rainfall with no inflow to Lal Lal Reservoir • Regular periods of no flow	• Below-average rainfall and inflow into Lal Lal reservoir • Periods of no flow or very low flow in some reaches	• Continuous flow with low flow over summer and high peaks in winter months	• Continuous flow year-round • Bankfull flow persistent throughout winter • Overbank conditions in some parts during spring/autumn
Predicted supply of water for the environment[1]	• 3,800 ML	• 4,600 ML	• 5,600 ML	• 7,600 ML
Potential environmental watering – tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**			
	• Summer/autumn low flow	• Winter/spring low flow • Winter/spring fresh (one fresh) • Summer/autumn low flow • Summer/autumn fresh (one fresh)	• Winter/spring low flow • Winter/spring fresh (one fresh) • Summer/autumn low flow • Summer/autumn freshes (three freshes)	• Winter/spring low flow • Winter/spring freshes (two freshes) • Summer/autumn low flow • Summer/autumn freshes (three freshes)
	Tier 1b (supply deficit)			
	• Winter/spring low flow • Winter/spring freshes (two freshes) • Summer/autumn fresh (one fresh)	• Winter/spring low flow • Winter/spring fresh (one fresh)	• Winter/spring freshes (two freshes)	• Winter/spring fresh (one fresh)
Potential environmental watering – tier 2 (additional priorities)	• As per tier 1, but at a higher magnitude	• As per tier 1, but at a higher magnitude	• As per tier 1, but at a higher magnitude	• As per tier 1, but at a higher magnitude
Possible volume of water for the environment required to achieve objectives	• 250 ML (tier 1a) • 3,373 ML (tier 1b) • 10,420 ML (tier 2)	• 2,500 ML (tier 1a) • 565 ML (tier 1b) • 10,690 ML (tier 2)	• 2,500 ML (tier 1a) • 1,130 ML (tier 1b) • 11,160 ML (tier 2)	• 2,085 ML (tier 1a) • 2,650 ML (tier 1b) • 11,160 ML (tier 2)
Priority carryover requirements	• Up to 1,000 ML			

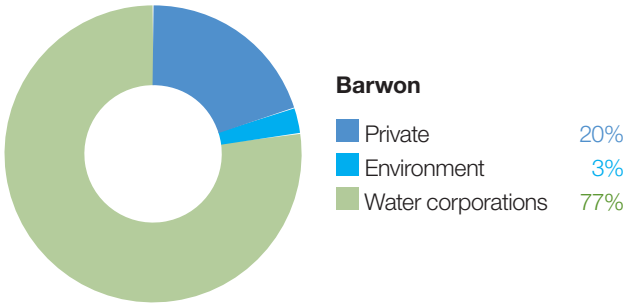
1 The expected availability of water for the environment is the estimated volume of water that may be held in the VEWH's share of storage capacity in Lal Lal Reservoir during 2021-22 under drought, dry, average and wet scenarios. The *Moorabool River Environmental Entitlement 2010* allows the use of up to 7,500 ML of water in any consecutive three-year period including the current year, so the volume of water available to be delivered may be less than the total expected water availability.

3.7 Barwon system

Waterway manager – Corangamite Catchment Management Authority

Storage manager – Barwon Water

Environmental water holder – Victorian Environmental Water Holder



Proportion of water entitlements in the Barwon basin held by private users, water corporations and holders of water for the environment on 30 June 2020.

The volume attributed to the environment in the Barwon system does not include water that is available to the lower Barwon wetlands because there is no limitation on the volume of water that can be supplied to the wetlands from the Barwon River.

Did you know...?

Environmental flows are small in the upper Barwon River but they are essential to enhance and maintain habitat, improve water quality and increase feeding opportunities for our iconic platypus species. Citizen scientists were at the river learning spotting skills with the Australian Platypus Conservancy. They learnt how to use the Australian Platypus Monitoring Network's app and were diligent enough to spy two platypuses! The Upper Barwon Landcare Network also caught a glimpse of a couple of these critters when undertaking riverside vegetation restoration work. Platypus have also been detected, using DNA sampling techniques, in the upper Barwon River near Birregurra recently.

Top: Upper Barwon River, by the VEWH
Right: Reedy Lake coastal saltmarsh, by Corangamite CMA

The Barwon system includes the upper Barwon River and lower Barwon wetlands.

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 (Figure 3.7.1). The Leigh River and *Moorabool Yulluk* (Moorabool River) 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 flow into the Barwon River above Winchelsea. The main storages in the Barwon River catchments are the West Barwon and Wurdee Boluc reservoirs.

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 flows in the upper Barwon River and manage water levels in Reedy Lake and Hospital Swamps, which connect to the lower Barwon River.

3.7.1 Upper Barwon River

System overview

Flows in the upper Barwon River are regulated by the operation of the West Barwon Reservoir. Water can be released directly from the reservoir into the west branch, or into the east branch via a diversion tunnel. The junction of the two branches is near Boundary Creek. Downstream of the reservoir, operational water can be diverted into the Wurdee Boluc inlet channel, a 57-km, concrete-lined channel that transfers water to Wurdee Boluc Reservoir.

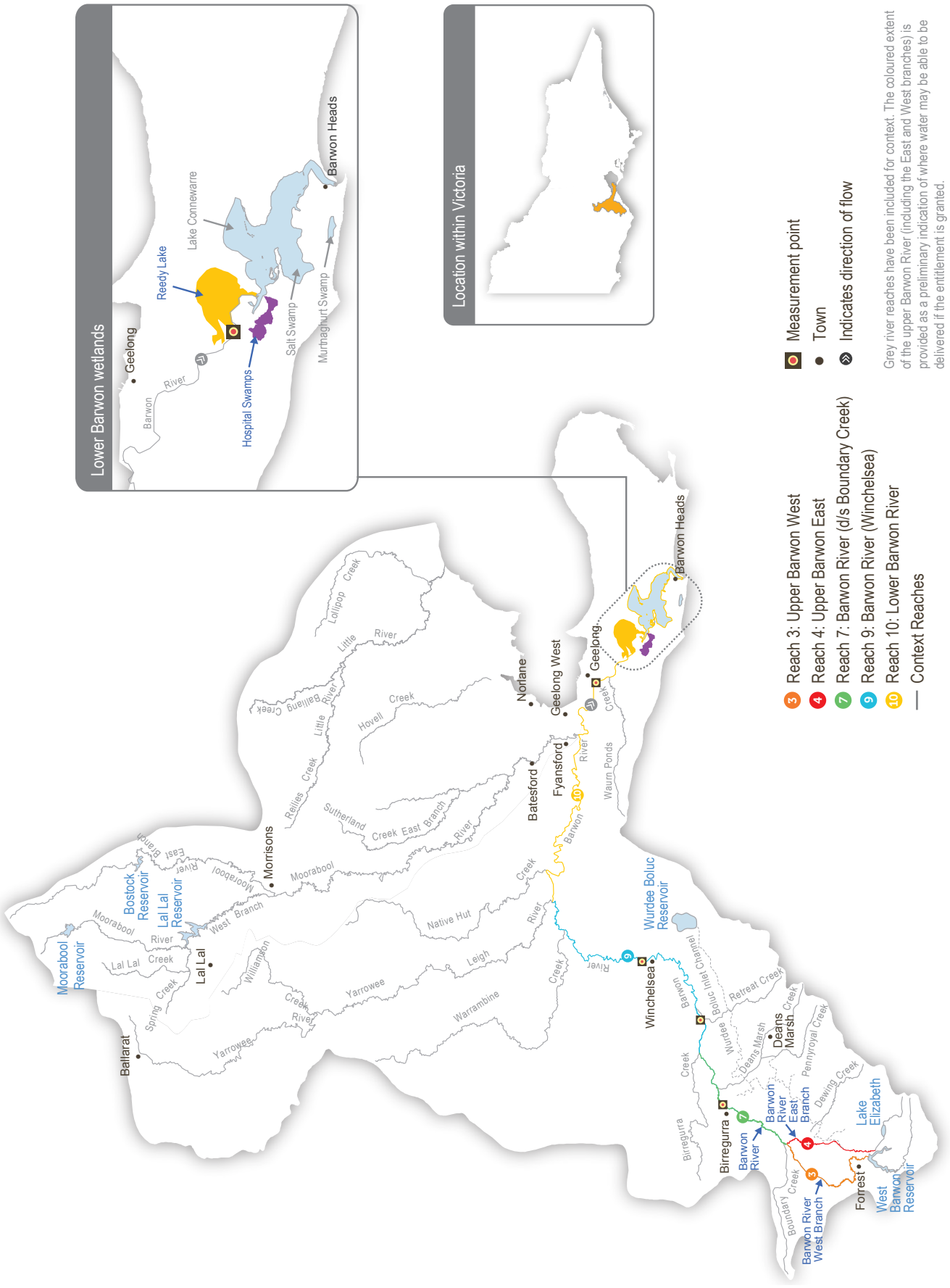
Barwon Water releases passing flows in the order of 1-5 ML per day in both the upper east and west branch from the West Barwon Reservoir. These releases may increase to 15 ML per day in September in a wet year. Flood spills from the reservoir and natural inflows from unregulated and partly regulated tributaries add to the passing flows.

The *Upper Barwon River Environmental Entitlement 2018* enables water to be made available for the environment from the West Barwon Reservoir. The entitlement provides an average of 1,000 ML per year and up to 2,000 ML of the total storage capacity at full supply. Water for the environment was first delivered to the upper Barwon in 2018-19. The current entitlement provides only enough water to meet the highest ecological objectives in the upper Barwon east branch (reach 4) and the upper Barwon west branch (reach 3) under particular climatic conditions.

Environmental values

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

Figure 3.7.1 The Barwon system



Environmental watering objectives in the upper Barwon River

	Maintain the abundance, and improve the breeding and recruitment of migratory fish species including short-finned eels, Australian grayling, tupong, broad-finned galaxias and common galaxias Maintain the abundance, and improve the breeding and recruitment of resident freshwater fish including several species of galaxias, Australian smelt, big-headed gudgeon, Yarra pygmy perch, southern pygmy perch and river blackfish
	Maintain the abundance and improve the condition and extent of platypus populations
	Improve the condition and extent of in-stream vegetation, to provide structural habitat for waterbugs and various fish species Improve the condition, extent and diversity of emergent macrophyte vegetation and streamside vegetation to provide structural habitat and stabilise the channel and lower banks
	Increase the abundance and improve the breeding and recruitment of waterbugs as a food source for fish, frog and platypus populations
	Maintain water quality for native fish, waterbugs, aquatic vegetation and other water-dependent animals

Traditional Owner cultural values and uses

The reaches of the Barwon River that can be most influenced by water delivered from the West Barwon Reservoir sit in Eastern Maar Country. In February 2020, the Eastern Maar Aboriginal Corporation received Registered Aboriginal Party status under the *Aboriginal Heritage Act 2006* over a large portion of land in south-west Victoria including the Barwon River upstream of Winchelsea. The Eastern Maar Aboriginal Corporation was invited to be involved in the development of Corangamite CMA's seasonal watering proposal, as good opportunities exist within these reaches to support Eastern Maar values and aspirations associated with the waterway.

The Corangamite CMA is working with Wadawurrung Traditional Owners to understand opportunities to provide for cultural values and uses and other aspirations for management of water for the environment in the Barwon River downstream of Winchelsea.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 3.7.1, Corangamite CMA considered how environmental flows could support values and uses including:

- water-based recreation (such as canoeing, fishing, kayaking and swimming)
- riverside recreation and amenity (such as birdwatching, camping and walking)
- socio-economic benefits (such as domestic and stock uses).

Recent conditions

Rainfall in the Barwon River catchment in 2020-21 was slightly above the long-term average. Wet conditions from August to October contributed high inflows to catchment storages, but West Barwon Reservoir did not fill beyond 70 percent capacity. Allocations against the environmental entitlement increased from 536 ML in July 2020 to 1,000 ML in October 2020.

Operational releases and passing flows maintained low flows in the upper Barwon River throughout most of the year. High-rainfall events delivered several natural high-flow events during winter and spring 2020 and two natural freshes in January 2021. These high flows and freshes provided opportunities for fish and platypus to migrate and likely improved the condition of native vegetation and in-stream habitats. Water for the environment was used to supplement low flows in the west branch of the upper Barwon River as needed, to achieve recommended flow targets during summer and autumn.

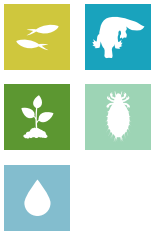
Water for the environment in the upper Barwon River was managed in line with an average climate scenario during 2020-21, and all planned watering actions were achieved.

A lack of flow data from key locations has limited the assessment of previous environmental flow releases in the upper Barwon River. A new streamflow gauge was installed on the east branch (near King Creek junction) in 2020, and data from that site will support future environmental flow management.

Scope of environmental watering

Table 3.7.1 describes the potential environmental watering actions in 2021-22, their expected watering effects (that is, the intended physical or biological effects of the watering action) and the longer-term environmental objectives they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological effects.

Table 3.7.1 Potential environmental watering actions, expected watering effects and associated environmental objectives for the upper Barwon River

Potential environmental watering action	Expected watering effects	Environmental objectives
Winter/spring low flow (10-50 ML/day or natural) (June to November) (east and west branch)	• Maintain connectivity and an adequate water depth in the channel/pools to support fish and platypus foraging and breeding habitat • Maintain an adequate depth of permanent water in the channel to promote the recruitment of aquatic and streamside plants and to limit the encroachment of terrestrial species • Provide sufficient flow velocity, to mix pools	
Summer/autumn low flow (0.5-5 ML/day from December to May, east branch) Summer/autumn low flow (30 ML/day or natural from December to May, west branch)	• Maintain an adequate depth of permanent water in the channel/pools to provide habitat to support resident and migratory fish, platypus and waterbugs • Reduce encroachment by terrestrial plants into the aquatic zone • Provide minimum velocity to mix and flush pools	
Summer/autumn freshes (two to three freshes of 9-35 ML/day for two days from December to May, east branch) Summer/autumn freshes (five to six freshes of 50 ML/day for six days from December to May, west branch)	• Provide longitudinal connectivity with water over riffles to allow fish to migrate upstream and fish and platypus to move between pools to breed, feed and find new habitats • Submerge woody debris and clean hard surfaces to provide breeding substrate for resident freshwater fish • Mobilise sediment and scour algae to maintain waterbug communities in the dry period by flushing organic matter into the channel to provide food after inundating benches for platypus • Provide a mosaic of wetted areas to improve emergent and streamside vegetation on terraces, the channel edge and lower bank • Provide minimum velocity to mix and flush pools	

Scenario planning

Table 3.7.2 outlines the potential environmental watering and expected water use under a range of planning scenarios.

The upper Barwon environmental entitlement can only support a small proportion of the environmental flow recommendations for the upper Barwon River. Under drought and dry climate scenarios, water for the environment available will be used to maintain a continuous flow in the east branch of the Barwon River for as long as possible in summer and autumn. The east branch is prioritised over the west branch because it has higher environmental values and a smaller channel capacity, so even relatively small flows have the potential to deliver significant environmental outcomes.

The increased volume of water for the environment available under average and wet climate scenarios will be shared between the east and west branches and will be used to supplement natural events. In the east branch, the priority will be to deliver summer/autumn low flows as well as freshes. The summer/autumn freshes will help to improve water quality and provide opportunities for fish and platypus to disperse throughout the system to breed and take advantage of increased food and habitat under wet and average climatic conditions. Any remaining water for the environment under an average or wet climate scenario will be used to supplement summer/autumn low flows in the west branch and contribute to flows further downstream.

The tier 1a and 1b watering actions described should help to maintain current environmental values and conditions in the upper Barwon River. However, a larger environmental entitlement and complementary works that address non-flow-related impacts in the catchment (such as constrictions) will be needed to significantly improve environmental conditions.

It is intended to carry over up to 500 ML at the end of 2021-22, to ensure the highest-priority flows can be achieved under any scenario in the following year.

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 six months • Disconnected pools	• No flow at Ricketts Marsh for four months • Cease-to-flow events	• Low flow at Ricketts Marsh for two months • Low summer flow, high peaks in winter	• High flow throughout winter with very high peaks; constant steady summer flow
Predicted supply of water for the environment	• 500 ML	• 800 ML	• 1,000 ML	• 2,000 ML
East branch				
Potential environmental watering - tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**			
	• Summer/autumn low flow	• Summer/autumn low flow	• Summer/autumn low flow • Summer/autumn freshes (two freshes)	• Summer/autumn low flow • Summer/autumn freshes (three freshes)
	Tier 1b (supply deficit)			
	• Winter/spring low flow • Summer/autumn low flow • Summer/autumn freshes (two freshes)	• Winter/spring low flow • Summer/autumn low flow • Summer/autumn freshes (two freshes)	• Winter/spring low flow	• Winter/spring low flow
West branch				
Potential environmental watering - tier 1 (high priorities)	**Tier 1a (can be achieved with predicted supply)**			
	• N/A		• Summer/autumn low flow	• Summer/autumn low flow
	Tier 1b (supply deficit)			
	• Winter/spring low flow • Summer/autumn low flow • Summer/autumn freshes (five freshes)	• Winter/spring low flow • Summer/autumn low flow • Summer/autumn freshes (five freshes)	• Winter/spring low flow • Summer/autumn low flow • Summer/autumn freshes (five freshes)	• Winter/spring low flow • Summer/autumn low flow • Summer/autumn freshes (five freshes)
Potential environmental watering – tier 2 (additional priorities)	• N/A			
Possible volume of water for the environment required to achieve objectives	• 250 ML (tier 1a) • 17,008 ML (tier 1b)	• 300 ML (tier 1a) • 16,547 ML (tier 1b)	• 500 ML (tier 1a) • 14,057 ML (tier 1b)	• 1,500 ML (tier 1a) • 12,337 ML (tier 1b)
Priority carryover requirements	• Up to 500 ML			

3.7.2 Lower Barwon wetlands

System overview

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. The system has long been of a place of high significance to the Wadawurrung Traditional Owners. *Paleert Tjaara Dja – Let's make Country good together 2020 – 2030 Wadawurrung Country Plan* acknowledges the special place the system has in their Dreaming: '*The chain of ponds from the Barwon River to Reedy Lake, Hospital Lake, Lake Connewarre and Estuary Bay is connected through water and our Connewarre (Black Swan) Dreaming*'.

Water for the environment can be used to manage water levels in Reedy Lake and Hospital Swamps, which connect to the Barwon River. 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 the natural wetting of the wetlands.

Environmental values

Reedy Lake and Hospital Swamps form part of the internationally recognised Port Phillip Bay (Western Shoreline) and Bellarine Peninsula Ramsar site, which is used by many thousands of migratory birds from around the world. The wetlands support 47 known threatened plant and animal 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 naturally a partly ephemeral system, but river regulation meant the lake was permanently wetted from the 1970s until 2016. This long-term wetting resulted in a decline in biodiversity. The full water levels reduced the extent and diversity of vegetation communities including coastal saltmarsh, and reduced the availability of shallow wading habitat which in turn has resulted in lower waterbird diversity.

In 2016-17, Corangamite CMA and the VEWH implemented a four-year watering regime trial at Reedy Lake to reinstate a more natural wetting and drying cycle. The 2019-20 water year was the final year of the trial — three years of partial drying and one year completely full — and a review of the recommended regime was completed in 2020. The review's recommendations have informed the 2021-22 watering actions and future directions.

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

Environmental watering objectives in the lower Barwon wetlands

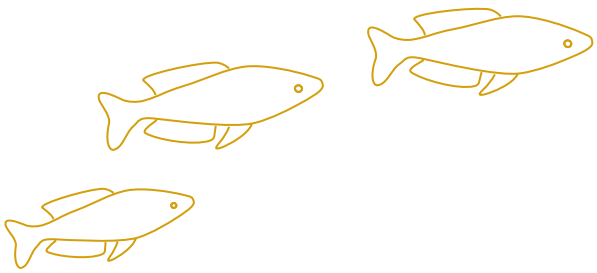
	Provide habitat for fish breeding and growth and improved conditions for migration and dispersal, when wetlands are connected to the Barwon River Reduce carp populations
	Provide varying water levels and conditions to promote soil salinisation, to support the persistence and growth of threatened salt-dependent ecological vegetation communities Improve soil health and enable the weathering of heavy metals in vegetation-covered fringing soils
	Increase the diversity of ecological vegetation communities in the wetlands and increase the recruitment of aquatic vegetation Increase the growth and extent of coastal saltmarsh, herbfields and lignum shrubland ecological vegetation communities Retard the colonisation of tall reed in low-lying areas and increase open water habitat
	Provide suitable feeding and breeding habitat for waterbirds including mud flats and shallow water for wading birds, flooded vegetation and wetland fringes Maintain waterbird breeding events
	Maintain and improve the waterbug population and its biomass
	Maintain nutrient cycling and improve lake productivity Provide flushing inflow to remove accumulated salts Maintain surface water and groundwater interactions

Traditional Owner cultural values and uses

Corangamite CMA worked with Wadawurrung Traditional Owners during the development of environmental watering plans for the lower Barwon wetlands, as part of an ongoing conversation to ensure Wadawurrung knowledge and culture is incorporated into decision-making, and that watering requirements for culturally significant species are maintained.

The Wadawurrung have identified cultural values which apply to all waterways within Wadawurrung Country. Values that have been identified in the lower Barwon wetlands include:

- culturally significant wetland species such as *Porronggitj* (brolga), *Toolim* (black duck), *Kunuwarra* (black swan), *Buniya* (eel), *Tark* (common reed) and *Bal-yan* (bull rush)
- recognition of wetlands as meeting, ceremony and trade places
- maintaining water holes and refuge pools
- maintaining access to culturally important story places and ceremonial places
- protection of artefact sites
- use of appropriate Wadawurrung language for places of cultural importance
- increased opportunities for the Wadawurrung to be involved in monitoring and evaluation activities
- including the Wadawurrung in all communication around releases of water for the environment and other wetland-related activities.



Social, recreational and economic values and uses

In planning the potential watering actions in Table 3.7.3, Corangamite CMA consulted widely with stakeholders to ensure it considered social, cultural and economic matters relevant to water management in the lower Barwon wetlands. Opportunities for social, recreational and economic values and uses are incorporated into planning and watering decisions if they do not compromise environmental outcomes. Expert advice (such as a flow ecology study and the 2020 Lower Barwon Review) emphasised that the entire recommended watering regime — filling the wetlands and allowing water levels to draw down at the right times — must be implemented to improve biodiversity and protect the long-term health of the wetlands, so it may not be possible to meet some community expectations at all times (such as keeping the wetlands permanently full). However, Corangamite CMA plans to ensure management of water levels in the wetlands can meet ecological requirements and also support a range of values and uses where possible including:

- water-based recreation (such as boating, duck hunting and fishing)
- riverside recreation and amenity (such as birdwatching and spending time outdoors)
- community events and tourism (such as community events and Traditional Owner events)
- socio-economic benefits (such as commercial fishing).

Corangamite CMA works with its community advisory group and stakeholders and seeks to balance these interests where possible, while maintaining the overall health of the wetlands to help sustain these activities into the future.

Recent conditions

Rainfall across the lower Barwon River catchment in 2020-21 was mostly above the long-term average. High-flow events in the Barwon River during spring and summer provided natural inflows to Reedy Lake and Hospital Swamps.

The Corangamite CMA had planned to draw down water levels in Reedy Lake from early summer 2020-21, to provide the recommended drying cycle and associated effects to maintain the character of the wetland as per the Lower Barwon Review, but the drawdown was delayed by the natural inflows and an associated bird breeding event. A partial drawdown commenced in February 2021, once the breeding birds had fledged their chicks. The planned drawdown at Hospital Swamps was also delayed by natural inflows from the Barwon River and stormwater inflows from a neighbouring development site.

The late drawdown in both wetlands meant the target low water level of 0.3 m AHD could not be met in Reedy Lake, and it was achieved much later than planned in Hospital Swamps. The incomplete and delayed drawdowns reduced the quantity of shallow foraging habitat for wading waterbirds and limited growing conditions for coastal salt marsh vegetation. The wetter-than-average conditions in 2020-21 are a natural year-to-year variation, and they are not expected to compromise the long-term environmental objectives for the site provided the lakes can draw down in coming years.

Scope of environmental watering

Table 3.7.3 describes the potential environmental watering actions in 2021-22, their expected watering effects (that is, the intended physical or biological effects of the watering action) and the longer-term environmental objectives they support. Each environmental objective relies on one or more potential environmental watering actions and their associated physical or biological effects.

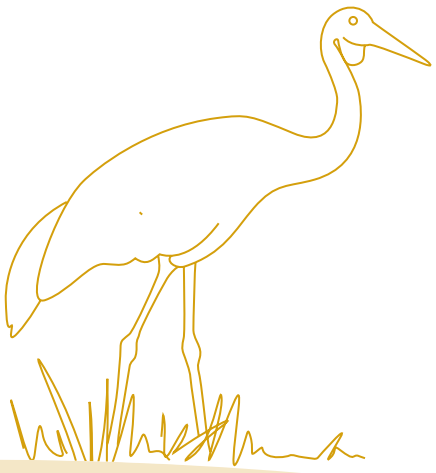
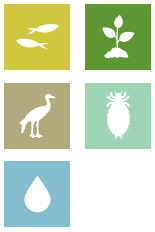


Table 3.7.3 Potential environmental watering actions, expected watering effects and associated environmental objectives for the lower Barwon wetlands

Potential environmental watering action	Expected watering effects	Environmental objectives
Reedy Lake		
Autumn/winter/spring fill (April/early May to November) (targeting 0.8m AHD)	• Maintain a mosaic of water depths and resources across the wetland to support waterbird breeding events • Inundate fringing wetland vegetation to provide foraging habitat for waterbirds • Maintain a sufficient depth of water around wetland vegetation to provide fish breeding habitat • Temporarily inundate the outer edges of the wetland to initiate growth and recruitment of diverse vegetation communities while permanently inundating the inner wetland vegetation communities • Allow fish to move between the river, lake and estuary • Stimulate waterbug communities to breed for waterbird feeding • Dilute soil and surface water salts and initiate the decomposition of organic matter	
Summer/autumn drawdown (December to April/early May, top-up or drawdown as required) (targeting 0.3m AHD)	• Lower the water level by natural evaporation and assisted drawdown (if required and as informed by waterbird monitoring) to dry out wetland fringing vegetation, to reduce potential waterlogging of saltmarsh communities to support germination • Expose mudflats and margins to provide feeding habitat for wading/migratory waterbirds and frogs • Manage reed colonisation of low-lying areas by allowing drying and saline groundwater intrusion to reduce growth • Support a drying phase for vegetation communities that require drying to grow and recruit • Reduce water levels to restrict carp movement and access to habitat • Allow vegetation to decay and soils to oxidise and release nutrients, to improve lake productivity and maintain biogeochemical processes • Enable surface water/groundwater interaction by allowing saline groundwater to discharge to the wetland bed	
Hospital Swamps		

Autumn/winter/spring fill (May to November) (targeting 0.5m AHD)	• Maintain a mosaic of water depths and resources across the wetland and inundate various vegetation communities and create nesting, breeding and feeding opportunities for waterbirds, fish and waterbugs
	• Increase water levels to trigger fish spawning and waterbird breeding:
	  • high water levels will allow fish to access the wetland from the river
	  • more freshwater will dilute the salt in the soil and dilute surface water over the winter
	• Inundate the outer edges and margins to initiate the growth and maintain the condition of important wetland vegetation communities
		

Potential environmental watering action	Expected watering effects	Environmental objectives
Summer/autumn drawdown (December to April) (by natural evaporation and assisted drawdown, if required) (targeting 0.1-0.3m AHD)	• Lower the water level by natural evaporation and assisted drawdown (if required and as informed by waterbird monitoring if available) to dry out the wetland fringing vegetation and expose mudflats and margins to support feeding by wading/migratory waterbirds and frogs • Manage reed colonisation in low-lying areas by allowing drying and saline groundwater intrusion to reduce growth • Support a drying phase for vegetation communities that require drying to grow and recruit • Reduce water levels to restrict carp movement and access to habitat • Allow vegetation to decay and soils to oxidise and release nutrients, to improve lake productivity and maintain biogeochemical processes • Enable surface water/groundwater interaction by allowing saline groundwater to discharge to the wetland bed	

Scenario planning

Table 3.7.4 outlines the potential environmental watering and expected water use under a range of planning scenarios.

An independent review of the lower Barwon wetlands watering trial from 2016-17 to 2019-20 was completed in 2020. The review confirmed that the current wetting and drying regimes for Reedy Lake and Hospital Swamps are appropriate, but it recommended that the timing of planned drawdowns should be adaptively managed to avoid disturbing any significant waterbird breeding at either site.

The 2012 FLOWS study for the lower Barwon wetlands and the 2020 Lower Barwon Review recommend a four-year watering cycle: filling the wetlands in autumn/winter/spring every year and having low water levels during summer in three out of four years to facilitate partial drying. Water levels in both wetlands remained high throughout 2019-20, and the planned drying event in 2020-21 was only partly implemented, to avoid disturbing a waterbird breeding event. Drying the wetlands out in summer 2021-22 is a high priority under all climate scenarios, to achieve the recommended water regime. The planned summer/autumn drawdown will be delayed if there is significant waterbird breeding. It is also acknowledged that the planned wetland drying may be difficult to implement under a wet climate scenario, especially if there are multiple high-flow events in the Barwon River during summer and autumn.

Table 3.7.4 Potential environmental watering for the lower Barwon wetlands under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Limited to no inflow from the Barwon River in winter/ spring • Dry conditions over summer will dry the wetlands	• Some natural inflow from the Barwon River in winter/ spring • Dry conditions over summer will assist in the drying of the wetlands	• Some natural inflow from the Barwon River in winter/ spring • Conditions over summer may assist the drying of the wetland water levels	• Overbank flow from the Barwon River is likely to fill the wetlands • Stormwater inflow and local rain/runoff will provide regular top-ups • Extensive drying of the wetlands is unlikely
Reedy Lake				
Potential environmental watering	• Autumn/winter/ spring fill • Summer/autumn drawdown	• Autumn/winter/ spring fill • Summer/autumn drawdown	• Autumn/winter/ spring fill • Summer/autumn drawdown	• Autumn/winter/ spring fill • Summer/autumn drawdown
Hospital Swamps				
Potential environmental watering	• Autumn/winter/ spring fill • Summer/autumn drawdown	• Autumn/winter/ spring fill • Summer/autumn drawdown	• Autumn/winter/ spring fill • Summer/autumn drawdown	• Autumn/winter/ spring fill • Summer/autumn drawdown