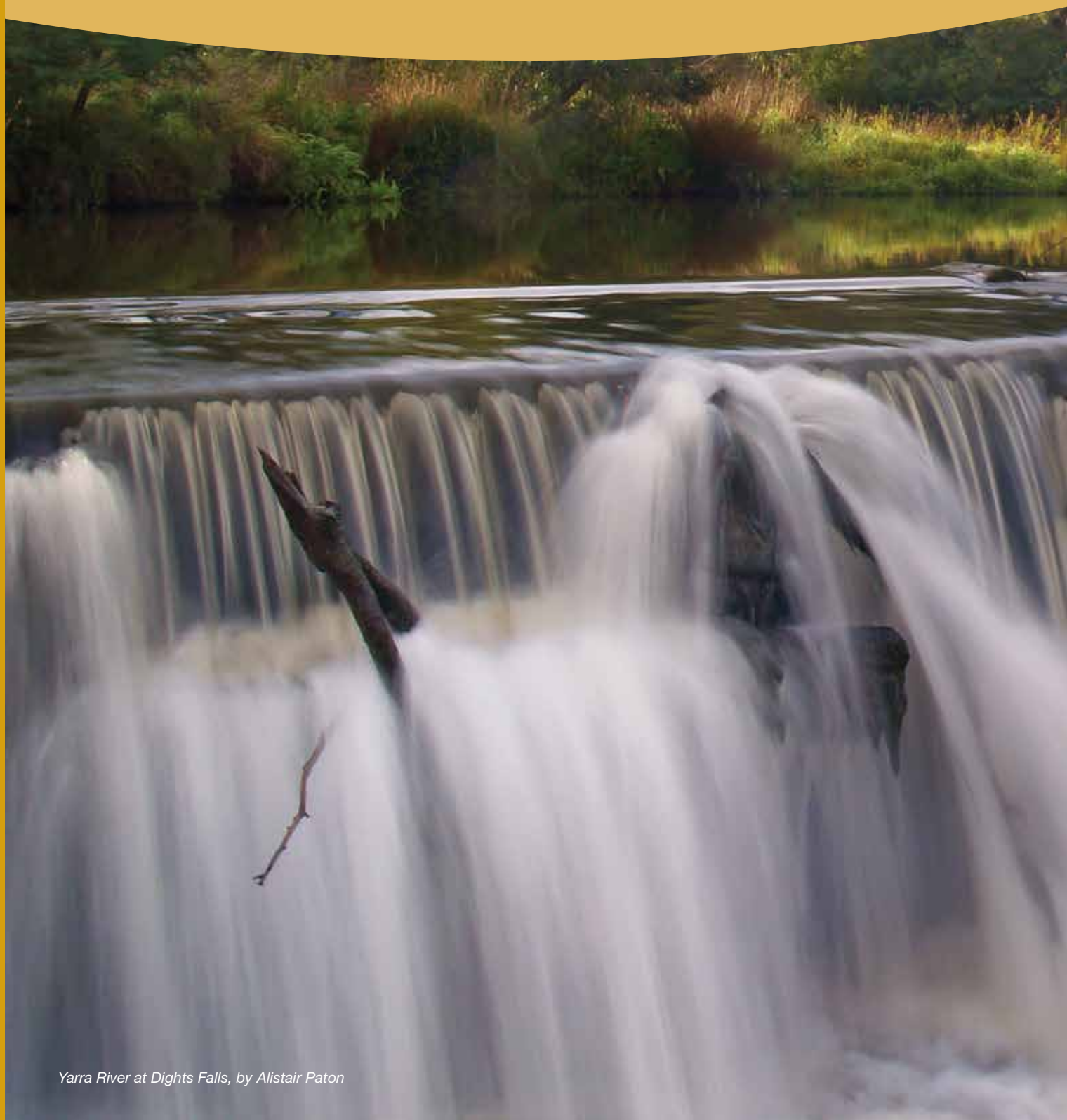
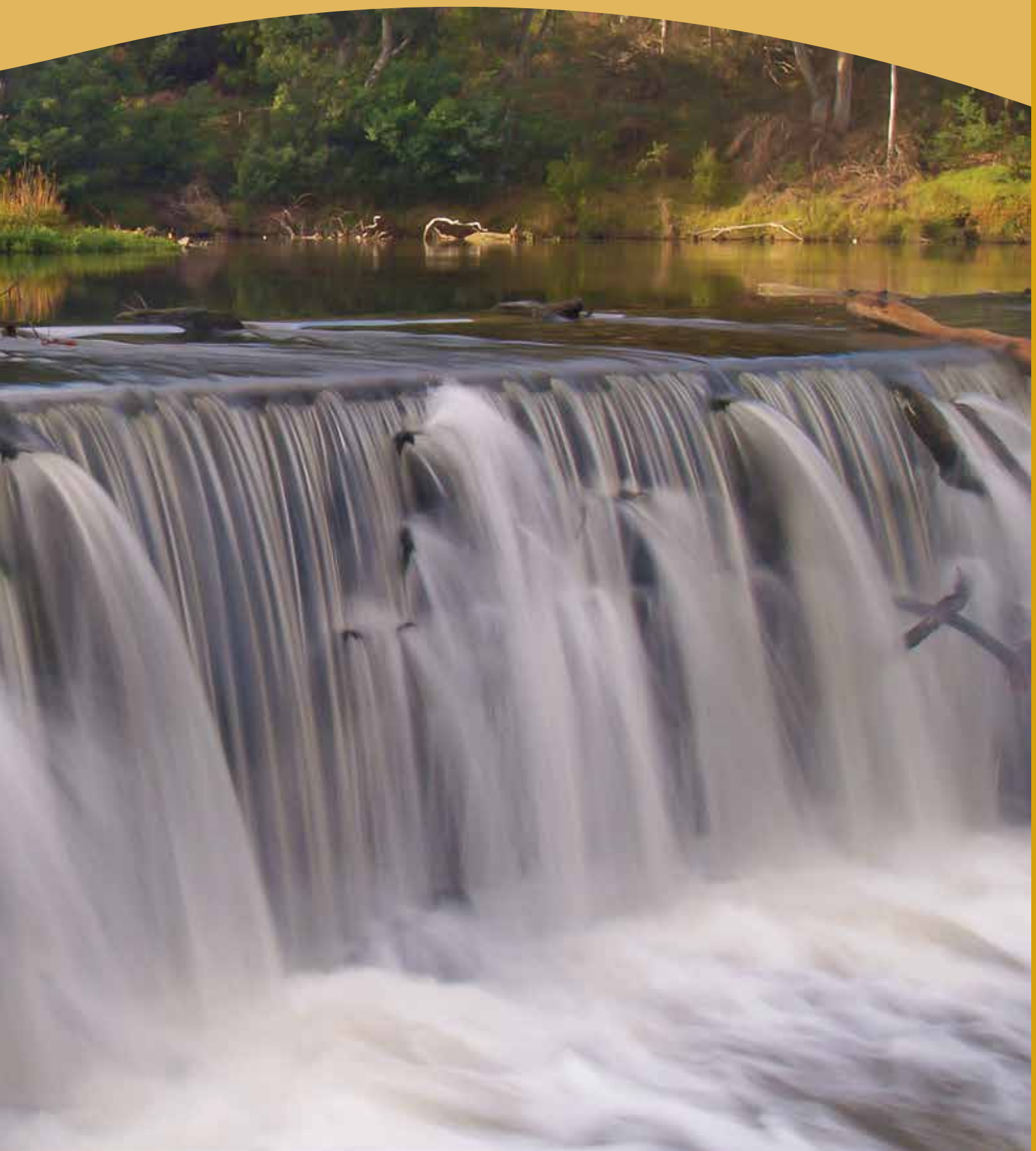


Yarra River at Dights Falls, by Alistair Paton

Section 3

Central region



3.1 Central region overview

There are six systems in the central region that can receive managed environmental flows: the Yarra and Tarago in the east and the Werribee, Maribyrnong, Moorabool and Barwon (upper Barwon River and lower Barwon wetlands) in the west.

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 have a deep connection to the region's rivers, wetlands and floodplains.

The Bunurong Land Council Aboriginal Corporation, Eastern Maar Aboriginal Corporation, Wathaurung Aboriginal Corporation (trading as Wadawurrung) 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 to 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 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.

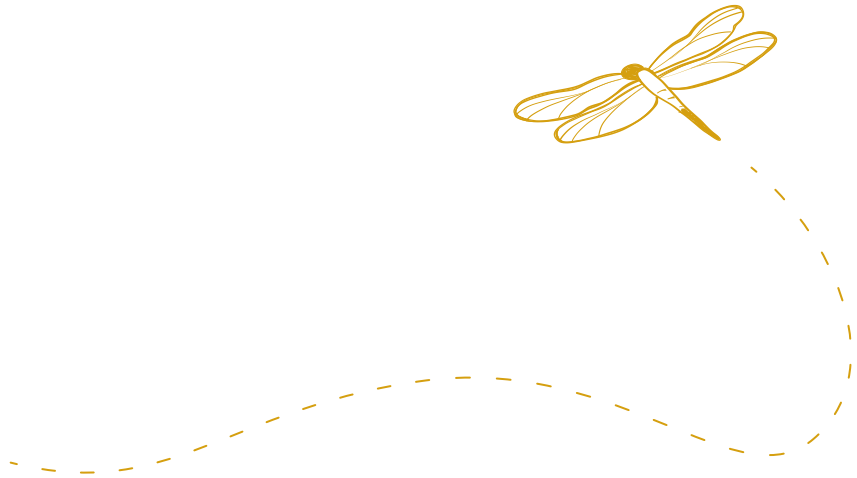


Table 3.1.1 International Association for Public Participation's Public Participation Spectrum categories and participation goals[1]

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.

Tables 3.1.2 and 3.1.3 show the partners, stakeholder organisations and individuals that Melbourne Water and Corangamite CMA engaged with when preparing 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 and Melbourne Water.

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's 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, the roles and responsibilities of organisations in managing a site or system, and 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.

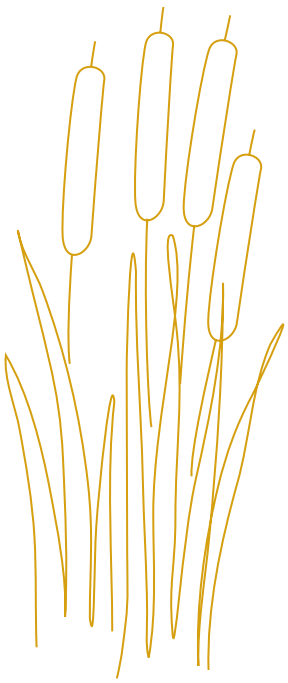


Table 3.1.2 Partners and stakeholders engaged by Corangamite CMA in developing seasonal watering proposals for the Moorabool, upper Barwon and lower Barwon wetlands systems and other key foundation documents that have directly informed the proposals

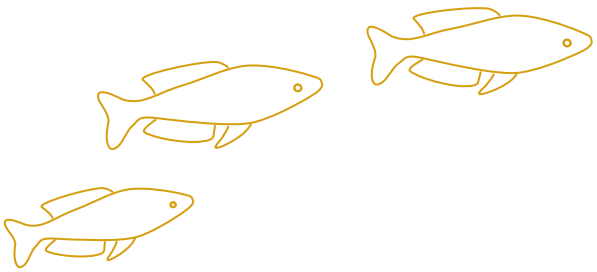
	Moorabool	Upper Barwon River	Lower Barwon wetlands
Community groups and environment groups	**IAP2 level: Consult** • Australian Platypus Conservancy • Geelong Landcare Network • Local community groups • Moorabool Stakeholder Advisory Committee • People for a Living Moorabool	**IAP2 level: Involve** • Upper Barwon Surface Water Advisory Group	**IAP2 level: Involve** • Community members on the Lower Barwon Community Advisory Committee • Members of the Lower Barwon Review Project Advisory Group
		IAP2 level: Consult • Land and Water Resources Otway Catchment	**IAP2 level: Consult** • Environment Victoria • Geelong Environment Council • Geelong Field Naturalists Club
Government agencies	**IAP2 level: Collaborate** • Barwon Water • Central Highlands Water • Department of Environment, Land, Water and Planning - Water and Catchments • Southern Rural Water • Parks Victoria	**IAP2 level: Collaborate** • Barwon Water • Department of Environment, Land, Water and Planning Water and Catchments • Southern Rural Water	**IAP2 level: Collaborate** • Barwon Water • Department of Environment, Land, Water and Planning • Parks Victoria • Southern Rural Water
		IAP2 level: Consult • Colac Otway Shire Council	**IAP2 level: Consult** • Greater Geelong City Council • Victorian Fisheries Authority
Landholders/ farmers	**IAP2 level: Consult** • Landholders on the Moorabool Stakeholder Advisory Committee	**IAP2 level: Consult** • Landholders on the Upper Barwon Surface Water Advisory Group	**IAP2 level: Consult** • Landholders • Farmers
Local businesses			**IAP2 level: Consult** • Commercial eel fishers
Recreational users	**IAP2 level: Consult** • Recreational users on the Moorabool Stakeholder Advisory Committee	**IAP2 level: Consult** • Recreational users on the Upper Barwon Surface Water Advisory Group	**IAP2 level: Consult** • Geelong Field and Game • Geelong Gun and Rod Association • VR Fish
Technical experts			**IAP2 level: Involve** • Lower Barwon Review 2020 Expert Review Panel
Traditional Owners	**IAP2 level: Consult** • Wathaurung Aboriginal Corporation	**IAP2 level: Involve** • Eastern Maar Aboriginal Corporation • Wathaurung Aboriginal Corporation	**IAP2 level: Involve** • Wathaurung 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

	Yarra system	Tarago system	Maribyrnong River	Werribee River
Community groups and environment groups	**IAP2 level: Inform** • Environment Victoria • Native Fish Australia • Yarra Riverkeeper	**IAP2 level: Inform** • Friends of Robin Hood Reserve • Waterwatch co-ordinators	**IAP2 level: Inform** • Friends of Holden Flora Reserve • Friends of the Maribyrnong Valley Inc. • Jacksons Creek Eco-network	**IAP2 level: Inform** • Werribee Riverkeeper
Government agencies	**IAP2 level: Collaborate** • Banyule City Council • Boroondara City Council • Department of Environment, Land, Water and Planning | Water and Catchments • Manningham City Council • Melbourne Water Service Delivery • Parks Victoria	**IAP2 level: Collaborate** • Department of Environment, Land, Water and Planning | Water and Catchments • Melbourne Water Service Delivery • Parks Victoria • Southern Rural Water	**IAP2 level: Collaborate** • Department of Environment, Land, Water and Planning | Water and Catchments • Southern Rural Water • Western Water	**IAP2 level: Collaborate** • Department of Environment, Land, Water and Planning | Water and Catchments • Southern Rural Water • Western Water
	IAP2 level: Inform • Environment Protection Authority • Port Phillip and Westernport Catchment Management Authority • Nillumbik City Council • Yarra Ranges Shire Council	**IAP2 level: Inform** • Baw Baw Shire Council • Cardinia Shire Council • Environment Protection Authority • Port Phillip and Westernport Catchment Management Authority	**IAP2 level: Inform** • Environment Protection Authority • Port Phillip and Westernport Catchment Management Authority	**IAP2 level: Inform** • Environment Protection Authority • Parks Victoria (land manager) • Port Phillip and Westernport Catchment Management Authority • Wyndham City Council
Landholders/ farmers	**IAP2 level: Inform** • Individual landholders • Licensed diverters	**IAP2 level: Inform** • Individual landholders	**IAP2 level: Inform** • Licenced diverters from the Maribyrnong River at Keilor	**IAP2 level: Inform** • Zoos Victoria
Local businesses	**IAP2 level: Inform** • Warburton Holiday Park	**IAP2 level: Inform** • Glen Cromie Caravan Park		
Recreational users	**IAP2 level: Inform** • Paddle Victoria • VRFish • Whitehorse Canoe Club	**IAP2 level: Inform** • Local Anglers • VRFish		**IAP2 level: Inform** • Werribee Anglers Club

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 *(continued)*

	Yarra system	Tarago system	Maribyrnong River	Werribee River
Technical experts	**IAP2 level: Involve** • Melbourne University – research collaborators • Monash University	**IAP2 level: Involve** • Melbourne University – research collaborators • Monash University	**IAP2 level: Involve** • Melbourne University – research collaborators • Monash University	**IAP2 level: Involve** • Melbourne University – research collaborators • Monash University
	IAP2 level: Inform • Arthur Rylah Institute (Department of Environment, Land, Water and Planning)	**IAP2 level: Inform** • Arthur Rylah Institute (Department of Environment, Land, Water and Planning)	**IAP2 level: Inform** • Arthur Rylah Institute (Department of Environment, Land, Water and Planning)	**IAP2 level: Inform** • Arthur Rylah Institute (Department of Environment, Land, Water and Planning)
Traditional Owners	**IAP2 level: Collaborate** • 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 • 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 • Wathaurung Aboriginal Corporation
	IAP2 level: Consult • Boon Wurrung Foundation • Bunurong Land Council Aboriginal Corporation			



How have Traditional Owners' values and uses of waterways been considered?

In recognition of the cultural importance of water, caring for Country and their long-standing traditional ecological knowledge, Traditional Owners are increasingly working with waterway managers to plan for and deliver environmental flows. Examples in the central region in 2020–21 include:

- ongoing work by Wadawurrung (Wathaurung Aboriginal Corporation) and Corangamite CMA to share knowledge of cultural values and environmental water planning. Wadawurrung have shared knowledge of significant sites (such as refuge pools and river confluences traditionally used as meeting places for clans) and animals with cultural value including platypus, eels and blackfish, and they have recommended how these can be supported by environmental flows. Corangamite CMA has incorporated this into its environmental water planning and management of environmental flows in collaboration with Wadawurrung
- ongoing work with the Wurundjeri Woi-Wurrung Cultural Heritage Aboriginal Corporation and Melbourne Water to implement initiatives under the *Yarra River Strategic Plan*, in particular the restoration of billabongs on the lower Yarra floodplain. Wurundjeri Woi-Wurrung people and the Narrap ranger team are helping identify the cultural and environmental values of the billabongs, supporting environmental water planning and management and monitoring outcomes of environmental water deliveries at the billabongs.

Where the involvement of Traditional Owners in planning and delivering water for the environment has explicitly identified environmental flows supporting cultural outcomes, these are identified in the system sections.

How have economic, recreational and social values and uses of waterways been considered?

Environmental outcomes provide some direct economic, recreational, social benefits to communities. Waterway managers, in consultation with communities, have identified numerous opportunities to support these community benefits including activities such as tourism, fishing, birdwatching, boating and hunting. Examples of these opportunities in the central region include:

- enhancing major events (such as Moomba and the Inflatable Regatta) through summer and autumn flows that improve water quality in the Yarra River
- supporting recreational fishing in the Barwon River by allowing species including river blackfish and short-finned eel to move between pools to breed, feed and find new habitats.

Summaries of the social, recreational and economic values considered are provided for each system. Where the timing or management of planned environmental flows may be modified to align with a community benefit, this is identified alongside the potential watering actions.

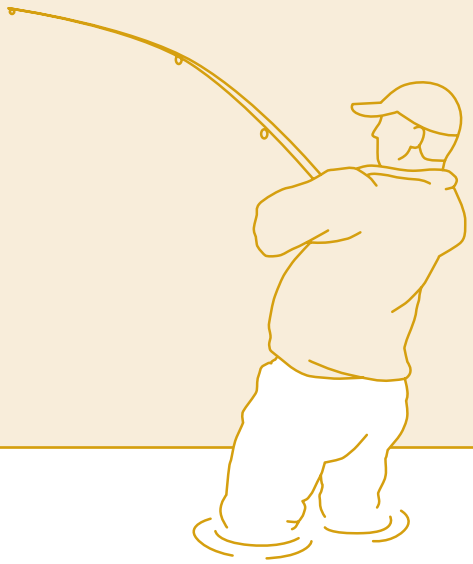
Community benefits from environmental watering

Healthy rivers and wetlands support vibrant and healthy communities. By improving the health of rivers, wetlands and floodplains, environmental flows also provide benefits to communities.

The VEWH and its program partners consider Aboriginal cultural values and uses and 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 optimised with environmental priorities for the year ahead.

Healthy waterways provide community benefits (such as providing nice places to walk, picnic or fish recreationally, and sustaining Healthy Country for Aboriginal communities). Community benefits can sometimes be enhanced by modifying environmental flows (such as timing a flow to support a community rowing or fishing event), provided the environmental objective is not compromised.

The VEWH and its partners seek to deliver these benefits throughout the water year, though opportunities can depend on the weather, climate or environmental conditions, water availability and the way the system is being operated to deliver water for other purposes.



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 for water for the environment in the central region will not be fully met without simultaneously addressing issues such as barriers to fish movement, limited volumes of environmental entitlement, poor water quality, reduced contribution of groundwater to surface water flows and 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 complementary programs that are likely to support environmental watering outcomes in the central region include:

- Corangamite CMA's ongoing investigations into the surface water and groundwater interactions in the 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)
- the review of the effectiveness of recent wetting and drying regimes at Reedy Lake and recommended future directions for water management at Reedy Lake and Hospital Swamps
- Melbourne Water's performance review and rectification works for the Dights Falls fishway on the Yarra River, which will allow native fish to move upstream under a wider range of flows
- Corangamite CMA's scoping of channel restoration in the upper Barwon River, investigating options to remediate constriction points along the upper Barwon River to improve environmental water deliveries from the West Barwon Reservoir
- continued works by Corangamite CMA and Melbourne Water to protect and enhance streambanks along priority reaches in the catchments including willow removal, revegetation and fencing to exclude stock
- Melbourne Water's landscape-scale approach to improve the management of billabongs along the Yarra River to help meet cultural, ecological and liveability objectives.

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 2020–21 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 2020–21

Rainfall in 2019–20 was highly variable both within and between seasons across the central region's systems. The Yarra catchment experienced above-average conditions with natural inflows achieving many planned watering actions including low flows and freshes. Lal Lal Reservoir in the Moorabool system filled in spring 2019, and Pykes Creek Reservoir and Melton Reservoir in the Werribee system both filled and spilled. In contrast, inflows to Rosslynne Reservoir were well-below average, which meant the VEWH was unable to purchase any water to support environmental flows in the Maribyrnong system.

The Bureau of Meteorology is predicting above-average rainfall across the central region for the first three months of the 2020–21 water year, which could increase storage levels and produce some larger flow events that cannot be delivered through managed environmental flows. These conditions may allow the VEWH, Melbourne Water and Corangamite CMA to deliver watering actions that are only planned under average or wet scenarios and aim to improve rather than just maintain environmental values in the region's waterways. This may include delivering flows over winter/spring of increased magnitude or duration, such as in the Moorabool system to provide a cue for fish (like the adult tupong) to migrate downstream to spawn.

If the central region experiences relatively dry conditions throughout 2020–21, water for the environment will mostly be used to deliver minimum low flows and freshes to maintain habitat and water quality and prevent significant decline in populations of aquatic plants and animals.

3.2 Yarra system

Waterway manager – Melbourne Water

Storage manager – Melbourne Water

Environmental water holder – Victorian Environmental Water Holder

Did you know...?

The Yarra River is known to Wurundjeri Woi-Wurrung people as *Birrarung*.

Top: Lower Yarra River, by Melbourne Water
Above: Platypus by the Yarra, by Doug Gimesy

System overview

The 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. Over time, the lower 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 River 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 the Yarra River to Sugarloaf Reservoir.

Flow in the upper reaches of the 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 the 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 the 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 the 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 2020–21 onwards.

Environmental values

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

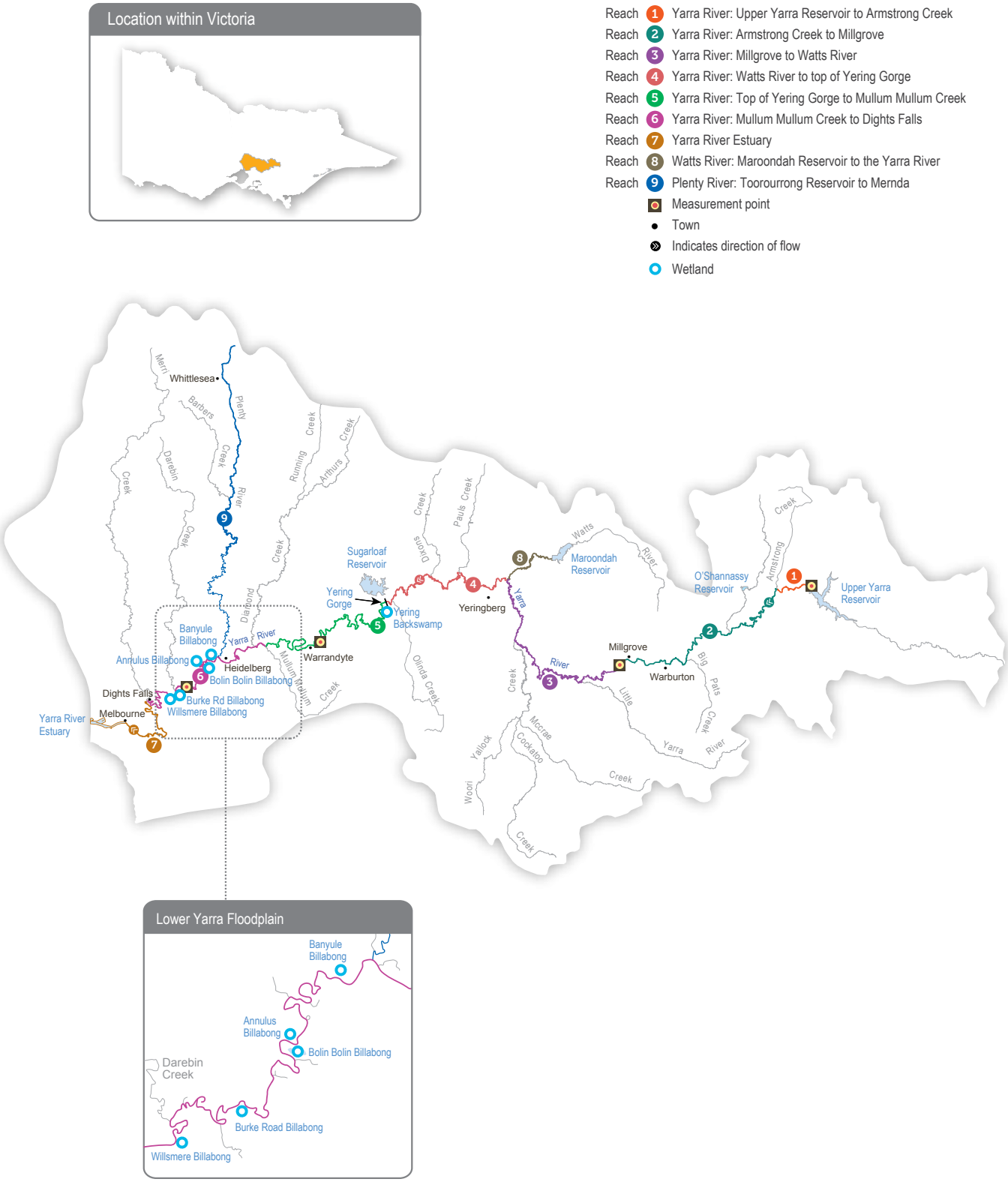
The Plenty River (reach 9) provides habitat for waterbug populations and native fish species (such as common galaxias and river blackfish). Platypus have been detected in the Plenty River in the past, but none have been recorded in recent surveys.

Billabongs are an important feature of the 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 the Yarra River.

Environmental watering objectives in the Yarra River, 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-Yarra floodplain
	Maintain the form of the river channel Scour silt from riffles and clean cobbles
	Maintain the population of resident platypus
	Increase, strengthen and maintain native streamside and aquatic vegetation on the riverbank and in the channels Increase, strengthen and maintain the growth of threatened wetland plant species to rehabilitate shallow marsh, deep marsh and freshwater meadows on the floodplain and billabongs
	Protect and increase communities of waterbugs, which break down dead organic matter and support the river's food chain
	Improve water quality in river pools, ensuring adequate oxygen concentration in the water to support fish, crustaceans and waterbugs

Figure 3.2.1 The Yarra system



Traditional Owner cultural values and uses

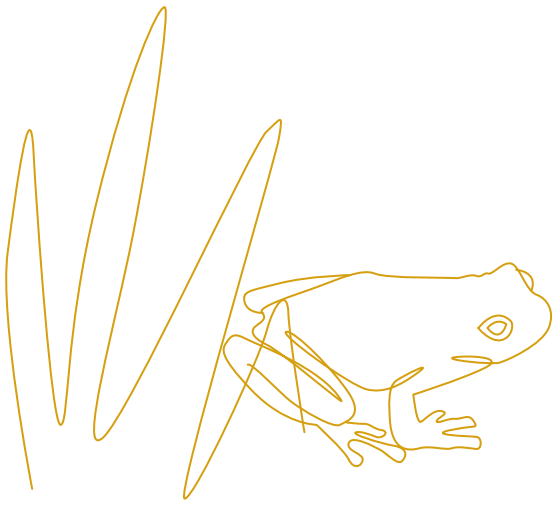
Wurundjeri Woi-Wurrung Cultural Heritage Aboriginal Corporation and Melbourne Water are working towards an integrated approach that includes Wurundjeri as active participants in the planning, delivery, and monitoring of all works on the lower Yarra floodplain. Melbourne Water has also made initial contact with Bunurong Land Council Aboriginal Corporation and Boon Wurrung Foundation to discuss environmental watering in the Yarra system.

Waterway managers are seeking opportunities to increase the involvement of Traditional Owners in environmental water planning and management. 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.

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

In November 2019 Wurundjeri Woi-Wurrung Cultural Heritage Aboriginal Corporation completed the Bulleen-Banyule Flats Cultural Values Study, which details places of Traditional Owner tangible and intangible significance. Melbourne Water has supported this project by attending on-Country visits with Elders and hope to link this study and the identified potential cultural benefits with environmental watering.

Wurundjeri Woi-Wurrung Cultural Heritage Aboriginal Corporation's *Narrap* team undertakes on-ground activities, such as water quality and frog monitoring, through the cultural water program at billabong sites along the lower Yarra floodplain. Monitoring is underway at Banyule Billabong following a delivery of water for the environment in 2019–20 and similar work will likely be undertaken at Annulus Billabong in 2020–21.



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 2019–20 in the Yarra catchment was above the long-term average, and tributary inflows significantly contributed to flow in the Yarra and Plenty rivers throughout the year. O'Shannassy Reservoir was offline for most of the year for maintenance, so most flow in the O'Shannassy River passed directly into the Yarra River.

Natural rainfall events, combined with the larger-than-normal inflows from the O'Shannassy River, achieved most of the high-priority planned watering actions for 2019–20, and some lower-priority watering actions (such as winter/spring freshes) provided important flow variability. One of the highest-priority planned watering actions for the Yarra River was an autumn high flow to support the migration and spawning of Australian grayling. The planned environmental flow release in April 2020 coincided with a natural rain event, which reduced the volume of environmental water needed to achieve the target flow.

In September 2019, water for the environment was used to partially fill Banyule Billabong on the lower Yarra floodplain near Heidelberg for the first time since 2016–17. Monitoring by Melbourne Water indicated that the watering action drowned some of the terrestrial plants that had colonised the bed of the wetland in recent years and stimulated growth of some native wetland plant species. Water for the environment was used to fill Yering Backswamp in May 2020, to maintain water-dependent vegetation and aquatic animals.

Scope of environmental watering

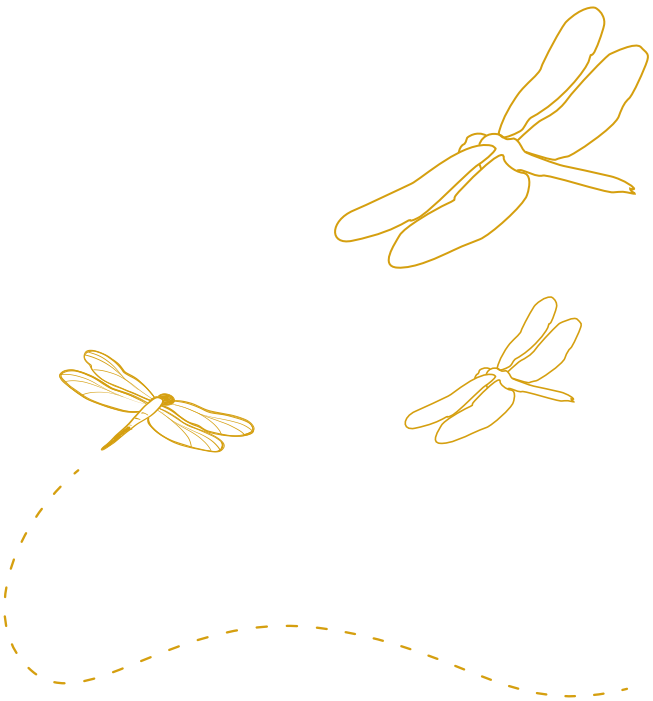
Table 3.2.1 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect of the watering action) and the longer-term environmental objectives they support. Each environmental objective relies on one or more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

Table 3.2.1 Potential environmental watering actions and objectives for the Yarra River, Plenty River and Yarra billabongs

Potential environmental watering action	Functional watering objectives	Environmental objectives
Yarra River		
Summer/autumn low flow (80–200 ML/day during December to May)	• Physically mix pools to minimise the risk of stratification and low oxygen • Maintain access to habitats for fish, waterbugs and platypus	
Winter/spring low flow (200–350 ML/day during June to November)	• 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	
Summer/autumn fresh (one to three freshes of 350–750 ML/day for two to four days during December to May)	• 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 localised movement of fish and platypus • Wet the banks of the river to maintain flood-tolerant vegetation on the banks	
Autumn high flow (one fresh of 560–1,300 ML/day for seven to 14 days during April to May)	• Cue the migration of Australian grayling • Scour sediment and biofilm from gravel in riffles and pools to maintain habitat quality for fish and waterbugs	
Winter/spring fresh (one to two freshes of 700–2,500 ML/day for three to seven days during June to November)	• 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 of 700–2,500 ML/day for 14 days in September)	• 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) • Promote spawning of Macquarie perch	

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

Potential environmental watering action	Functional watering objectives	Environmental objectives
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	
Billabong watering		
Annulus Billabong (partial fill in winter/spring) 	• Prime wetland for a fill • 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	
Yering Backswamp (partial or complete fill in autumn and 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 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.

Environmental flow planning in the Yarra River primarily focuses on providing sufficient low flow throughout the year to maintain habitat for aquatic life and providing high flows at critical times to support the migration and breeding requirements of native fish. The extent to which the required flows are met by natural tributary inflows varies between dry, average and wet scenarios. Water for the environment is used to fill the main shortfalls under each scenario, where possible.

The highest priorities for watering in the Yarra River are summer/autumn low flows and freshes, an autumn high flow, a spring high flow and winter/spring low flows and freshes. Summer/autumn low flows are not identified as a planned watering action under a wet scenario, as it is anticipated they would be met by natural flows.

The summer/autumn low flows and freshes help maintain water quality and improve aquatic habitats. A higher-than-normal carryover volume from 2019–20 will potentially allow an autumn high flow and a spring high flow to be delivered in 2020–21 under all scenarios. The autumn high flow is a priority because it was not delivered in 2017–18 or 2018–19 and is needed in most years to support Australian grayling breeding. Spring high flows trigger Australian grayling migration back up the system and scour sediments in the mid-reaches, to improve spawning habitat for Macquarie perch.

The potential watering actions for the Plenty River are winter/spring low flows and freshes. This is the first time that environmental flows are planned to be delivered in the Plenty River. Flows are planned 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 and Annulus Billabong is considered a high priority under all scenarios in 2020–21. There are numerous billabongs throughout the Yarra catchment that are drier than natural, due to river regulation and modifications to natural flow paths. Melbourne Water is currently developing 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. This is the first year that Annulus Billabong is planned to receive water for the environment. Water levels will be monitored at Annulus Billabong to inform future management of the site and the broader billabong assessment.

The environmental entitlement for the Yarra system is highly secure, and it is expected that the volume of water available for use in 2020–21 will be sufficient to deliver all the potential watering actions under the average and wet scenarios. Lower tributary inflows under a dry scenario means that larger volumes of environmental water will likely be needed to deliver potential watering actions in a dry year. The expected volume of available water should be sufficient to deliver all of the potential watering actions under a dry scenario except for winter/spring freshes in the Yarra River.

A critical carryover volume of 3,000 ML has been identified to provide sufficient water to deliver high-priority actions (summer/autumn low flows and freshes, an autumn high flow and targeted billabong watering) in 2021–22.

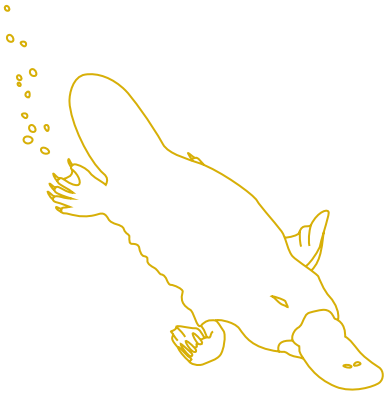


Table 3.2.2 Potential environmental watering for the Yarra River, Plenty River and Yarra billabongs under a range of planning scenarios

Planning scenario	Dry	Average	Wet
Expected river conditions	• Low streamflows year round • Lack of unregulated freshes and high flows • Passing flows are not likely to meet the minimum environmental flow recommendations • 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 flows • Potentially poor water quality, particularly in summer • Pools may stratify • Small reservoirs may spill • Overbank flows are 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
Expected availability of water for the environment	• 43,000 ML		
Potential environmental watering – tier 1a (high priorities)	• Summer/autumn low flows • One to three summer/autumn freshes • One autumn high flow • One spring high flow • Fill or partial fill of Yering Backswamp and Annulus Billabong • Winter/spring low flows • Winter/spring low flows (Plenty River) • Four winter/spring freshes (Plenty River)	• Summer/autumn low flows • One to three summer/autumn freshes • One autumn high flow • One spring high flow • Fill or partial fill of Yering Backswamp and Annulus Billabong • Winter/spring low flows • One to two winter/spring freshes • Winter/spring low flows (Plenty River) • Four winter/spring freshes (Plenty River)	• One to three summer/autumn freshes • One autumn high flow • One spring high flow • Fill or partial fill of Yering Backswamp and Annulus Billabong • Winter/spring low flows • One to two winter/spring freshes • Winter/spring low flows (Plenty River) • Four winter/spring freshes (Plenty River)
Potential environmental watering – tier 1b (high priorities with shortfall)	• One to two winter/spring freshes	• N/A	• N/A
Potential environmental watering – tier 2 (additional priorities)	• N/A	• N/A	• N/A
Possible volume of environmental water required to achieve objectives	• 40,000 ML (tier 1a) • 7,500 ML (tier 1b)	• 38,000 ML (tier 1a)	• 29,000 ML (tier 1a)
Priority carryover requirements	• 3,000 ML		

3.3 Tarago system

Waterway manager – Melbourne Water

Storage manager – Melbourne Water

Environmental water holder – Victorian Environmental Water Holder

Did you know...?

Diadromous fish spend some of their life in freshwater and some in saltwater. Scientists tagged over 150 diadromous fish in the Tarago River in March 2020, and they will now be able to track how the Australian grayling, short-finned eels, tupong and common galaxia move in response to environmental flows in real time.

Top: Tarago River fish ladder, by Melbourne Water
Above: Australasian darter dries its wings at Bunyip Main Drain, by Melbourne Water

System overview

The Tarago River rises in the Tarago State Forest and flows into the Tarago Reservoir at Neerim. The reservoir harvests inflows from all upstream tributaries to supply towns on the Mornington Peninsula and around the Western Port area, and it is also used to manage flows for downstream irrigators. Below the reservoir, the 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 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 it 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

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.

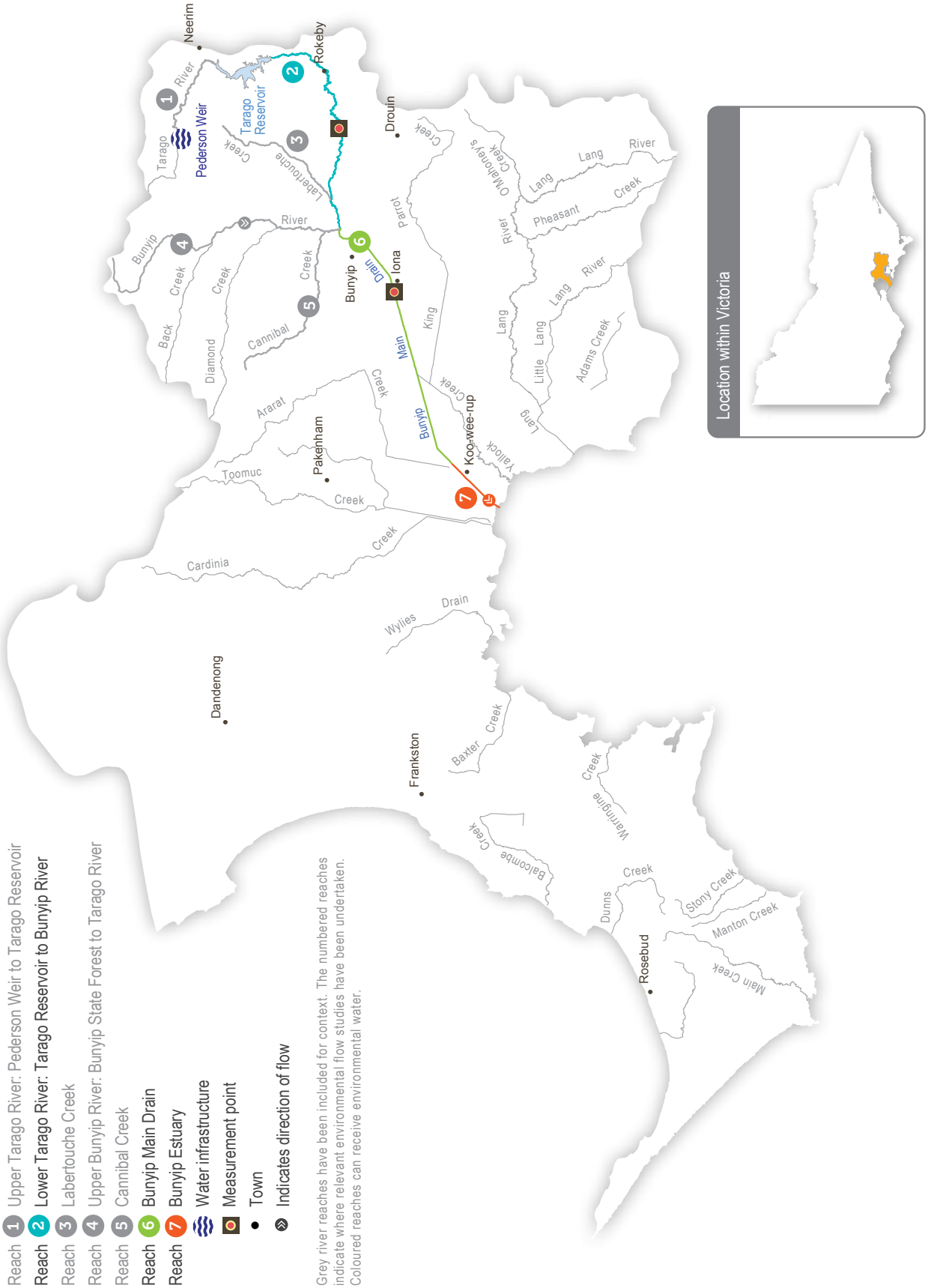
Social, recreational and economic values and uses

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 an 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 a summer fresh in the Tarago River to occur on the long weekends in January or March 2020, so visitors and long-term residents of the Glen Crombie Caravan Park alongside the river can enjoy the additional flows in the river.

Figure 3.3.1 The Tarago system



Recent conditions

The Tarago River catchment received below-average rainfall in winter 2019 but above-average rainfall in spring 2019 and summer 2020. Most of the rain fell downstream of the Tarago Reservoir, so although it provided natural flow in the river it did not translate to significant inflows into the storage.

Winter/spring high flows, winter/spring freshes, spring high flow and autumn high flow requirements and most of the recommended summer/autumn freshes were met from natural flows. Summer/autumn freshes were the highest-priority potential watering actions for all scenarios in 2019–20; they play a critical role in providing habitat for native fish species (such as short-finned eels and common galaxias) and maintaining water quality throughout the system.

A volume of 1,000 ML of water for the environment will be carried over to help meet critical priorities in 2020–21.

Scope of environmental watering

Table 3.3.1 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect 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 functions.

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

Potential environmental watering action	Functional watering objectives	Environmental objectives
Summer/autumn fresh (one to five freshes of 75 ML/day for two days during December to May)	• Scour sediment from holes 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 fresh 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 spawning for diadromous fish (e.g. Australian grayling) • Allow the downstream movement of Australian grayling • Assist the dispersal of juvenile platypus	
Spring high flow (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 (such as Australian grayling) from the sea or estuary into the river • Wet higher benches to maintain the fringing aquatic vegetation and ensure vertical zonation of the fringing vegetation • Provide a cue for platypus to select nesting burrows above high water level	
Winter/spring fresh (one to two freshes with a peak of 100–200 ML/day for two days during June to September)	• Prevent sediment build-up and remove biofilm from large woody debris to maintain habitat for macroinvertebrates and fish including river blackfish • Maintain access to habitats by ensuring sufficient depth through riffles to allow fish movement between pools and reaches • Cue the downstream migration of species such as eel and tupong • Wet the banks, wetting the lower benches to maintain the fringing aquatic vegetation	
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 increased low flows to flush the system and wet additional habitat for fish and macroinvertebrates • Maintain foraging habitat for platypus	

Scenario planning

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

Summer and autumn freshes are considered high priority under all climatic conditions. These freshes aim to top up pool habitats and improve water quality, which helps to maintain the quality and quantity of available habitat for fish, macroinvertebrates and platypus. Freshes temporarily increase river depth in riffles and run habitats between pools, allowing native fish to move within and between reaches. Freshes also wet sand bars and lower sections of the riverbank, which helps to prevent the encroachment and growth of unwanted terrestrial species in the waterway.

An autumn high flow is needed to cue Australian grayling to spawn. As this is a short-lived species, the autumn high flow should be delivered in at least two out of every three years. In average and wet years, this increases to an annual requirement. The autumn high flow was partially achieved in 2018–19 and fully achieved in 2019–20. Hence, full delivery of an autumn high flow is a tier 2 priority for 2020–21, although a partial autumn high flow using a lesser volume of water may be delivered under dry and average conditions.

Under average and wet scenarios, a spring high flow may be delivered to support the migration of native fish. This flow has not been achieved with environmental flows since 2012–13, and although reach 6 has received some natural spring high flows, reach 2 has not. The spring high flow will encourage movement and cue the upstream migration of juvenile native fish species including Australian grayling, common galaxias and tupong.

The spring high event is a higher priority than the winter/spring freshes, because previous monitoring has shown it triggers more fish to move.

A carryover volume of 700–1,000 ML is required to support high-priority actions (such as summer/autumn freshes) in 2021–22.

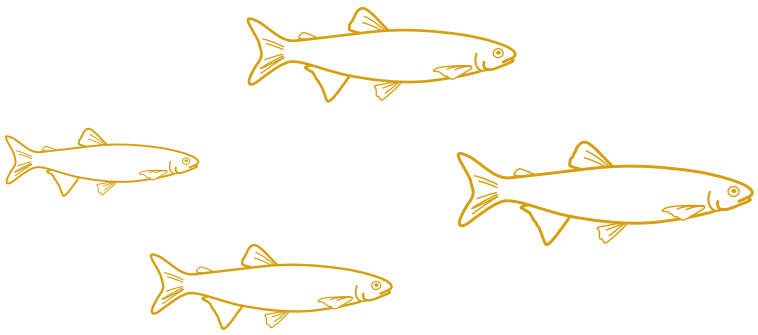


Table 3.3.2 Potential environmental watering for the Tarago River under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Very low streamflow • Very low inflows • Reduced passing flows • Irrigation releases likely	• Low streamflow • Some reduction to passing flows • Irrigation releases likely	• Average streamflows • Partial freshes naturally provided	• Above-average streamflows • Partial or full freshes naturally provided • Irrigation releases unlikely
Expected availability of water for the environment	• 1,700 ML	• 2,000–2,500 ML	• 2,500–3,500 ML	• 3,800–5,000 ML
Potential environmental watering – tier 1a (high priorities)	• One to three summer/autumn freshes	• One to three summer/autumn freshes • One autumn high flow (partial achievement)	• One to five summer/autumn freshes • One autumn high flow (partial achievement) • Winter/spring high flow (partial achievement)	• One to five summer/autumn freshes • One autumn high flow • Winter/spring high flow • One to two winter/spring freshes
Potential environmental watering – tier 1b (high priorities with shortfall)	• Winter/spring high flow (partial achievement) • One autumn high (partial achievement)	• Winter/spring high flow (partial achievement) • One to two winter/spring freshes	• Winter/spring high flow • One to two winter/spring freshes	• N/A
Potential environmental watering – tier 2 (additional priorities)	• One autumn high flow • One to two winter/spring high flow • One to two winter/spring freshes	• One autumn high flow • One to two winter/spring high flows	• One autumn high flow	• N/A
Possible volume of environmental water required to achieve objectives[1]	• 1,000 ML (tier 1a) • 1,000 ML (tier 1b) • 800 ML (tier 2)	• 1,000–1,500 ML (tier 1a) • 1,000–1,200 ML (tier 1b) • 400 ML (tier 2)	• 2,000–3,000 ML (tier 1a) • 1,500–1,800 ML (tier 1b) • 3,000 ML (tier 2)	• 0–3,000 ML (tier 1a) • N/A (tier 1b) • N/A(tier 2)
Priority carryover requirements	• 700–1,000 ML			

[1] Environmental water requirements for tier 2 actions are additional to tier 1 requirements.

3.4 Maribyrnong system

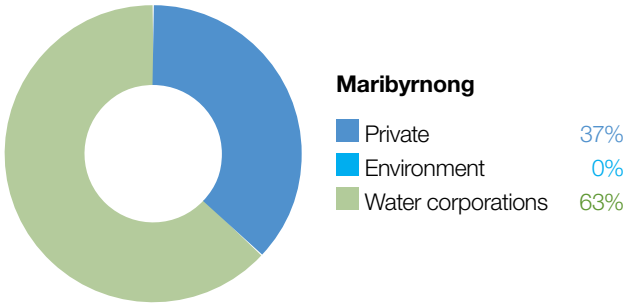
Waterway manager – Melbourne Water

Storage manager – Southern Rural Water

Environmental water holder – No entitlement held in this system

Did you know...?

The Maribyrnong River is the second major river in metropolitan Melbourne, after the Yarra. It runs for 160 km from its source on the slopes of Mount Macedon to Port Phillip Bay, where it meets the sea.



Proportion of water entitlements in the Maribyrnong basin held by private users, water corporations or environmental water holders at 30 June 2019.

Top: Maribyrnong River walk, by Melbourne Water
Above: Maribyrnong vegetation, by Melbourne Water

System overview

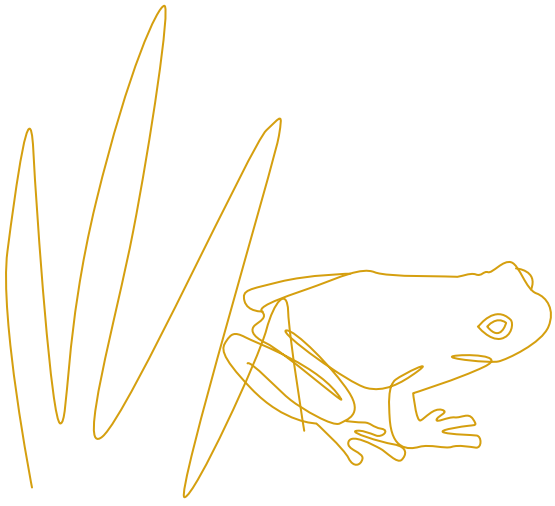
The Maribyrnong catchment is located to the north-west of Melbourne. The main waterways in the catchment are Jacksons Creek, which flows south-east from Mount Macedon, and Deep Creek, which flows south from Lancefield. These two tributaries join at Keilor North to form the Maribyrnong River, which flows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

Rosslynne Reservoir is in the upper reaches of Jacksons Creek near Gisborne, and it 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, 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 channel morphology
- Maintain platypus population
- Maintain and improve the condition, abundance, diversity and structure of instream 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

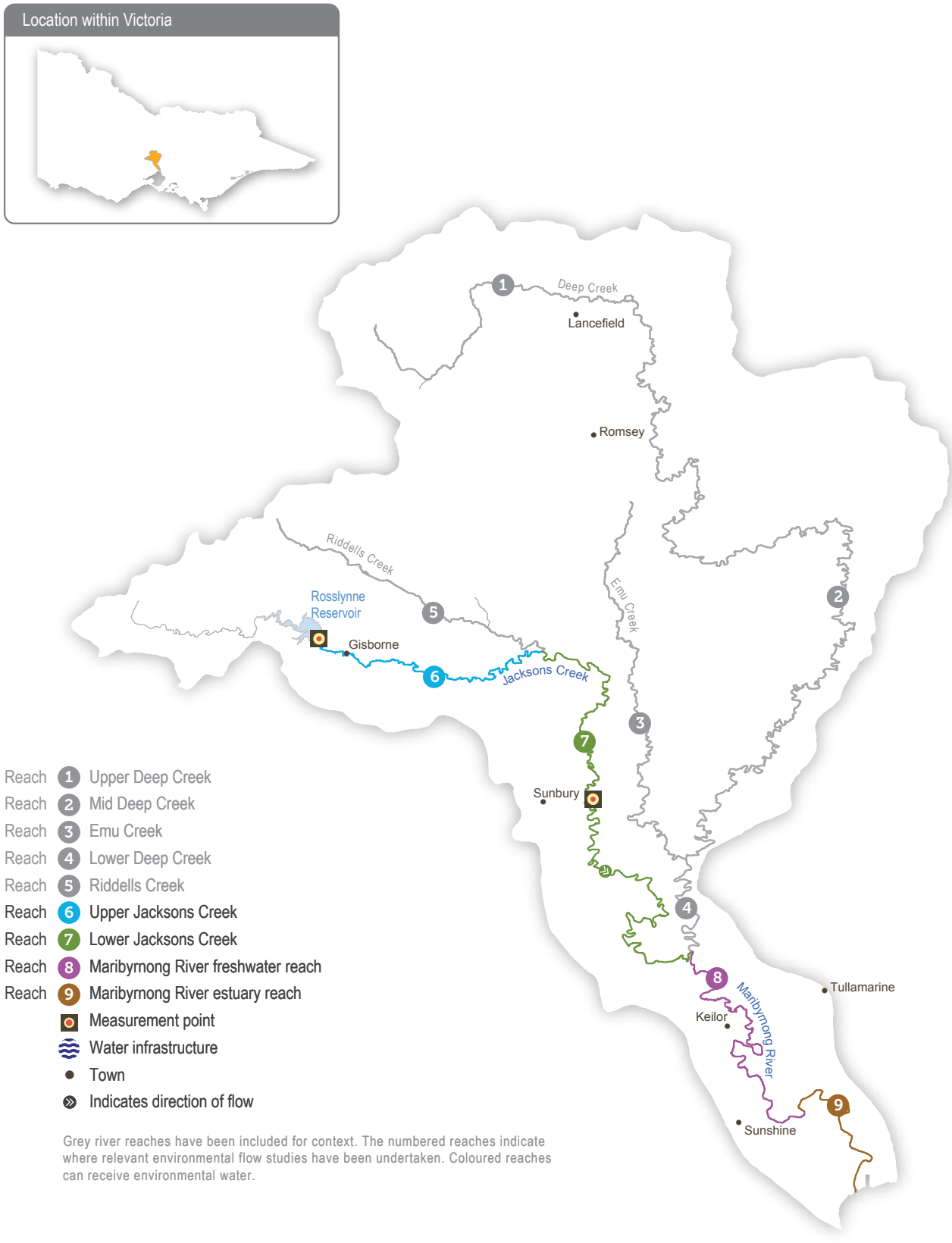
Traditional Owner cultural values and uses

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

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). This includes repeating the outcomes of watering in 2019–20, where releases into the upper reaches of the Maribyrnong helped maintain healthy habitat and improve water quality.

Figure 3.4.1 The Maribyrnong system



Recent conditions

The Maribyrnong catchment has experienced below-average rainfall since the summer of 2016–17, and inflows to Rosslynne Reservoir in 2019–20 continued to track well-below average. The VEWH did not purchase allocation from licence holders in 2019–20, due to low water availability in the Maribyrnong system.

The dry conditions meant that winter/spring low-flow, winter/spring and summer/autumn freshes were not achieved in 2019–20. Summer/autumn low flows were achieved in reach 6, but only partially achieved in reach 7 (below Riddles Creek) by passing flows delivered under Southern Rural Water's bulk entitlement. These flows prevented poor water quality conditions and maintained suitable habitat and food resources for small-bodied native fish, waterbugs and platypus.

Scope of environmental watering

Table 3.4.1 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect 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 functions.

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

Potential environmental watering action	Functional watering objectives	Environmental objectives
Summer/autumn low flow (four to six 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 fresh (one to five freshes of 20–40 ML/day for up to seven days during December to May)	• Flush pools to maintain water quality • Scour substrates to remove fine sediment • 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	
Winter/spring low flow (20–40 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 • Scour substrates to remove fine sediment • 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.

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

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

If more water is made available in 2020–21, the priority will be to deliver additional freshes year-round and increase the duration and magnitude of low flows during winter and spring.

If Rosslynne Reservoir receives limited inflows in winter and spring 2020, there will be little if any opportunity to purchase water to support environmental flows in the Maribyrnong system during 2020–21. The VEWH is unable to carry over any water in the Maribyrnong system to support multi-year planning.

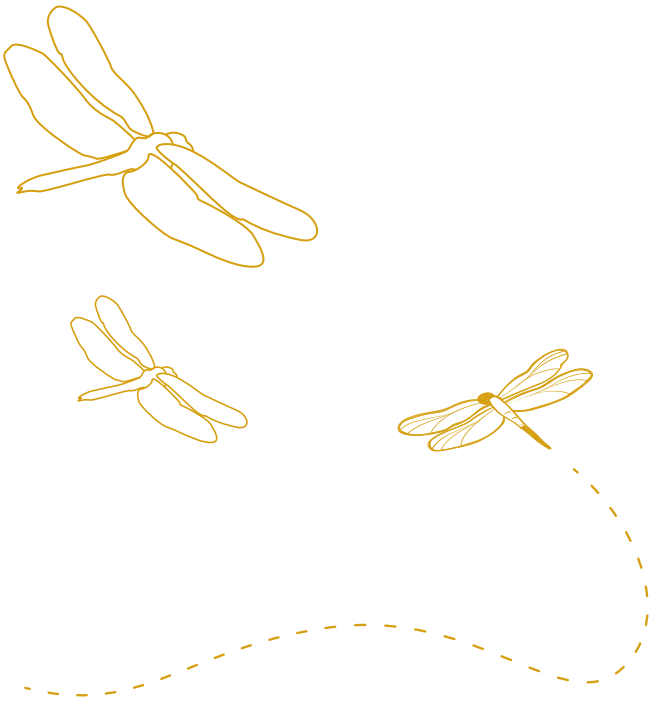


Table 3.4.2 Potential environmental watering for the Maribyrnong system under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Unregulated flows unlikely • Passing flows ceased • Some baseflow from groundwater contributions in lower Jacksons Creek	• 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
Potential environmental watering – tier 1a (high priorities)	• Due to a lack of formal environmental entitlement, the Maribyrnong system will not receive an environmental allocation in 2020–21 and therefore no tier 1a watering actions have been identified. Water will need to be purchased from willing sellers to support tier 1b or tier 2 watering actions			
Potential environmental watering – tier 1b (high priorities with shortfall)	• Summer/autumn low flows • Two summer/ autumn freshes	• Three summer/ autumn freshes	• Three summer/ autumn freshes • Winter/spring low flows (up to 14 days)	• Two summer/ autumn freshes • Winter/spring low flows (up to 21 days)
Potential environmental watering – tier 2 (additional priorities)	• Two summer/ autumn freshes	• Two summer/ autumn freshes	• Two summer/ autumn freshes • Increased duration winter/spring low flows	• Two summer/ autumn freshes • Increased duration winter/spring low flows
Possible volume of environmental water required to achieve objectives[1]	• 300 ML (tier 1b) • 200 ML (tier 2)	• 300 ML (tier 1b) • 200 ML (tier 2)	• 600 ML (tier 1b) • 200 ML (tier 2)	• 600 ML (tier 1b) • 200 ML (tier 2)

[1] Environmental water requirements for tier 2 actions are additional to tier 1 requirements.

3.5 Werribee system

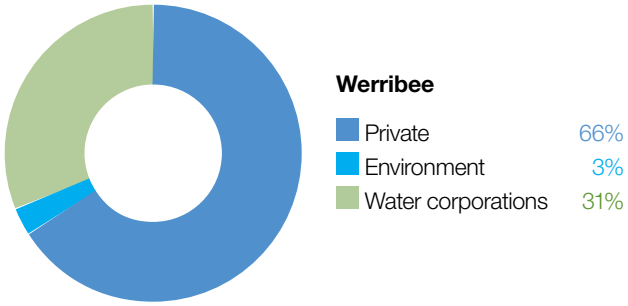
Waterway manager – Melbourne Water

Storage manager – Southern Rural Water

Environmental water holder – Victorian Environmental Water Holder

Did you know...?

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



Proportion of water entitlements in the Werribee basin held by private users, water corporations or environmental water holders at 30 June 2019.

Top: Werribee River walk, by Melbourne Water
Above: Werribee River pool waterbirds, by Melbourne Water

System overview

The 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. 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), the Werribee River between Melton Reservoir and the Werribee Diversion Weir (reach 8), the Werribee River between the Werribee Diversion Weir and Werribee Park Tourism Precinct (reach 9) and the Werribee estuary below the Werribee Park Tourism Precinct (the estuary).

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 the lower Werribee River.

Environmental values

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

Environmental watering objectives in the Werribee system

	Protect and increase populations of native freshwater fish species including galaxiids 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

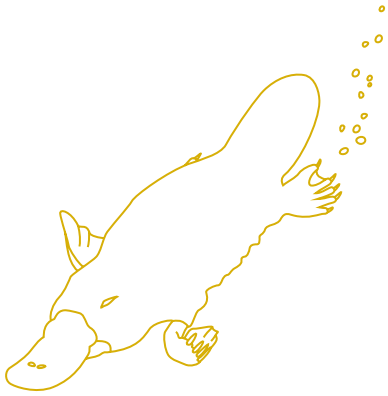
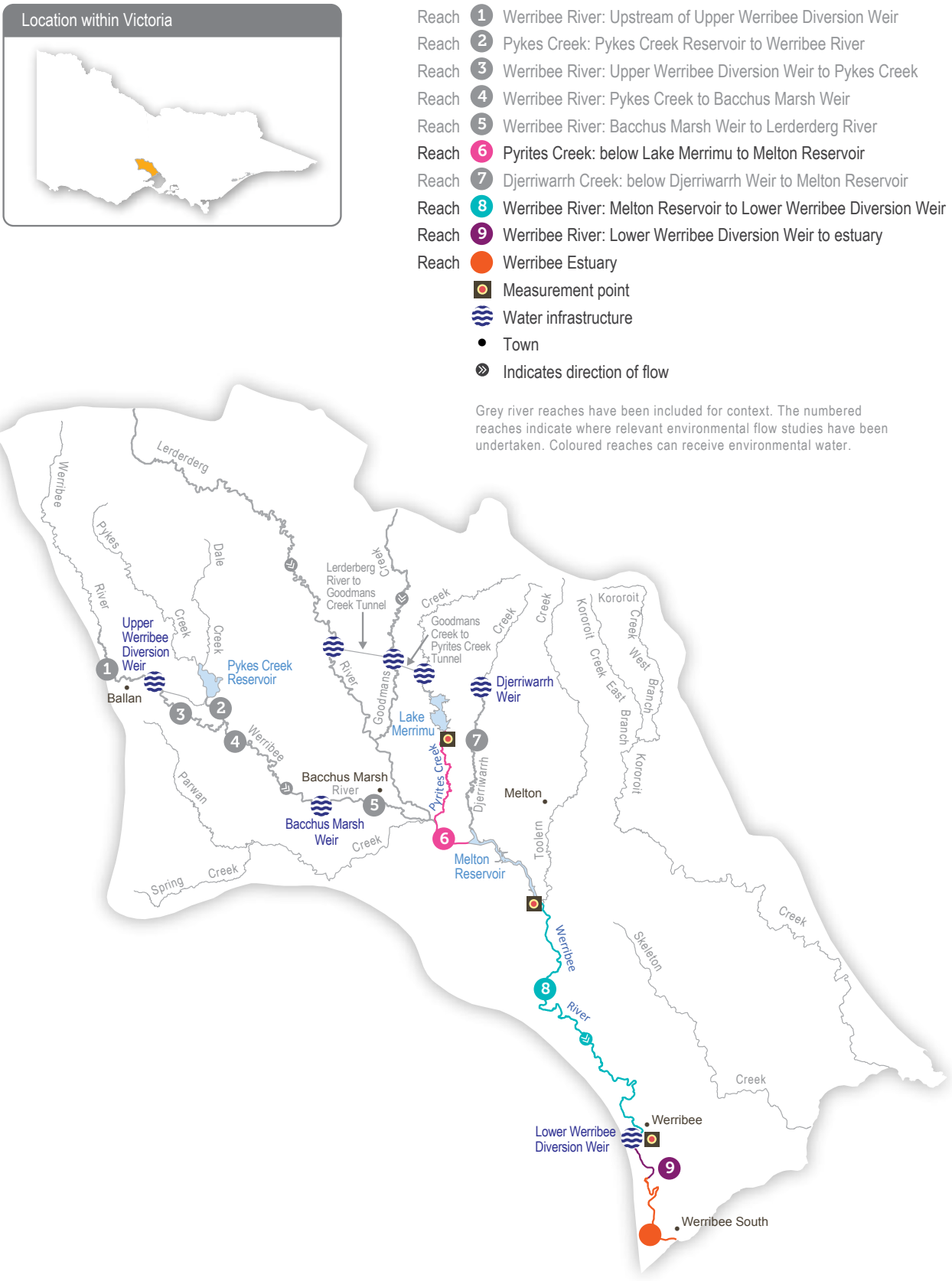


Figure 3.5.1 The Werribee system



Traditional Owner cultural values and uses

Melbourne Water has made initial contact with Wathaurung Aboriginal Corporation (Wadawurrung) and Wurundjeri Woi-Wurrung Cultural Heritage Aboriginal Corporation, to discuss environmental watering in the Werribee system.

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 fishing)
- riverside recreation and amenity (such as improved water quality for communities)
- tourism (such as Werribee Zoo).

Recent conditions

Total rainfall in the Werribee system during 2019–20 was close to the long-term annual average, but rainfall was not evenly distributed across all reaches or storages. Pykes Creek Reservoir and Melton Reservoir both spilled in winter and spring 2019, which delivered large flows to the lower Werribee River. Inflows to Lake Merrimu remained low throughout the year, and environmental flows provided some flow in Pyrites Creek in spring 2019. By early March 2020, holders of high-reliability water shares in the Werribee system had received 100 percent allocations, and holders of low-reliability water shares had received 60 percent allocations. Small volumes of inflows into Lake Merrimu were attributed to the environmental entitlement throughout 2019–20.

Most of the potential watering actions for the lower Werribee River were delivered in 2019–20. Natural events provided regular freshes throughout the year, and water for the environment was used to deliver additional summer freshes and some low flows in June 2020. One of the summer freshes was used to flush an algal bloom that developed in the lower Werribee River during early summer. Low flows during autumn and winter were achieved by passing flows delivered by the storage manager.

In Pyrites Creek, water for the environment was used to deliver low flows and two spring freshes. These flows connected habitat pools for frogs, waterbugs and native fish, flushed sediment from pools and supported the recruitment and growth of native vegetation in the stream and along the margins of the banks. About one-third of flow in Pyrites Creek seeps into groundwater reserves or evaporates, but all flow that reached Melton Reservoir was re-harvested for later use.

Scope of environmental watering

Table 3.5.1 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect 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 functions.

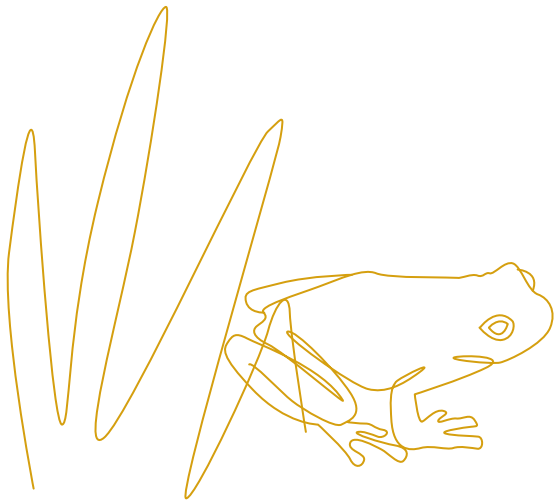


Table 3.5.1 Potential environmental watering actions and objectives for the Werribee system

Potential environmental watering action	Functional watering objectives	Environmental objectives
Pyrites Creek (reach 6)		
Spring fresh (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 • Scour silt, biofilms and algae from substrates to maintain the quality and quantity of food and habitat for waterbugs • Wet depressions adjacent to the stream that frogs can use for breeding	
Spring/summer high flow (one to three high flows of 130 ML/day for two days during September to December)	• 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 • Wet depressions adjacent to the stream that frogs can use for breeding	
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	
Lower Werribee River (reaches 8, 9 and estuary)		
Summer/autumn fresh (one to five freshes of 80 ML/day for two days during November to May)	• 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 • 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 and quantity of food and habitat for waterbugs	
Winter/spring fresh (one to two freshes of 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 flows 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 (six ML/day during December to May)	• Maintain the growth and recruitment of in-stream vegetation • Support the growth and recruitment of water-dependent streamside vegetation • Maintain water quality and food in pool habitats for native fish • Maintain access to habitat 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 and objectives for the Werribee system *(continued)*

Potential environmental watering action	Functional watering objectives	Environmental objectives
Increased winter/spring low flow (up to 80 ML/day or natural during June to November)	• Provide flows to allow fish to move upstream past natural and artificial barriers • 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, platypus and frogs • Maintain flow through pool habitats to allow mixing or suppression/dilution of saline groundwater	

Scenario planning

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

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 highest-priority watering actions for the lower 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 the lower Werribee River, but managed environmental flows are important to control water quality and provide regular opportunities for fish and platypus to move throughout the lower Werribee River and to support streamside and aquatic vegetation.

The number of freshes delivered to both Pyrites Creek and the lower 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 the lower Werribee River under a wet scenario, but more environmental water would need to be secured to deliver these flows under dry or average scenarios. A minimum of 980 ML is planned to be carried over into 2021–22 to ensure high-priority flows can be delivered to Pyrites Creek (reach 6) and the lower Werribee River, if environmental water allocations are low.

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	• No 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 flows in reach 6 met by passing flows • 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 flows in reach 6 provided • Consumptive releases out of storage into reach 8 in summer/autumn
Expected availability of water for the environment[1]	• 2,154 ML	• 2,789 ML	• 3,039 ML
Potential environmental watering – tier 1a (high priorities)	• Three spring freshes (reach 6) • One spring/summer high flow (reach 6) • Winter/spring/summer low flows (reach 6) • Three summer/autumn freshes lower Werribee River • One winter/spring fresh lower Werribee River	• Four spring freshes (reach 6) • Three spring/summer high flows (reach 6) • Winter/spring/summer low flows (reach 6) • Five summer/autumn freshes lower Werribee River • One winter/spring fresh lower Werribee River	• Four spring freshes (reach 6) • Three spring/summer high flows (reach 6) • Winter/spring/summer low flows (reach 6) • Five summer/autumn freshes lower Werribee River • Two winter/spring freshes lower Werribee River • Summer/autumn low flows lower Werribee River
Potential environmental watering – tier 1b (high priorities with shortfall)	• Summer/autumn low flows lower Werribee River • Additional winter/spring fresh lower Werribee River	• Summer/autumn low flows lower Werribee River • Additional winter/spring fresh lower Werribee River	• Increased duration summer/autumn low flows lower Werribee River
Potential environmental watering – tier 2 (additional priorities)	• Increased winter/spring low flows lower Werribee River	• Increased winter/spring low flows lower Werribee River	• Increased winter/spring low flows lower Werribee River
Possible volume of environmental water required to achieve objectives[2]	• 930 ML (tier 1a) • 1,580 ML (tier 1b) • 10,000 ML (tier 2)	• 1,250 ML (tier 1a) • 1,580 ML (tier 1b) • 10,000 ML (tier 2)	• 1,880 ML (tier 1a) • 900 ML (tier 1b) • 10,000 ML (tier 2)
Priority carryover requirements	• 980 to 1,060 ML[3]		

[1] Includes water shares held by Melbourne Water that may be transferred to the VEWH for use in the Werribee system.

[2] Environmental water requirements for tier 2 actions are additional to tier 1 requirements.

[3] A minimum volume of 200 ML is required to be carried over in Lake Merrimu to meet demands in Pyrites Creek.

3.6 Moorabool system

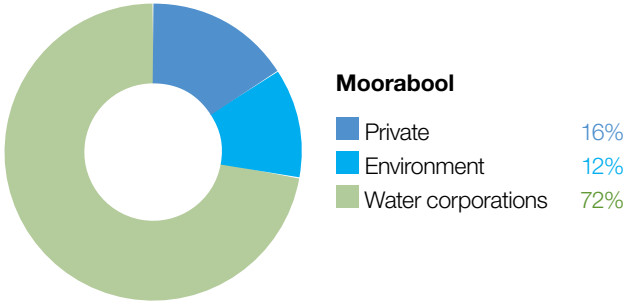
Waterway manager – Corangamite Catchment Management Authority

Storage manager – Central Highlands Water

Environmental water holder – Victorian Environmental Water Holder

Did you know...?

The 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. Of a nighttime, the stone curlew is renowned for its eerie, high-pitched wailing. The parents in the Wadawurrung communities 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.



Proportion of water entitlements in the Moorabool basin held by private users, water corporations or environmental water holders at 30 June 2019.

Top: At Moorabool River, by Corangamite CMA
Above: Moorabool River streamside vegetation, by Sarah Martin

System overview

The Moorabool River is a tributary of the Barwon River. It flows south from the Central Highlands between Ballarat and Ballan to join the Barwon River at Fyansford just north of Geelong. The Moorabool River is a highly regulated catchment with major storages that include Lal Lal, Moorabool and Bostock reservoirs.

The lower section of the 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 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 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 inflow 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.

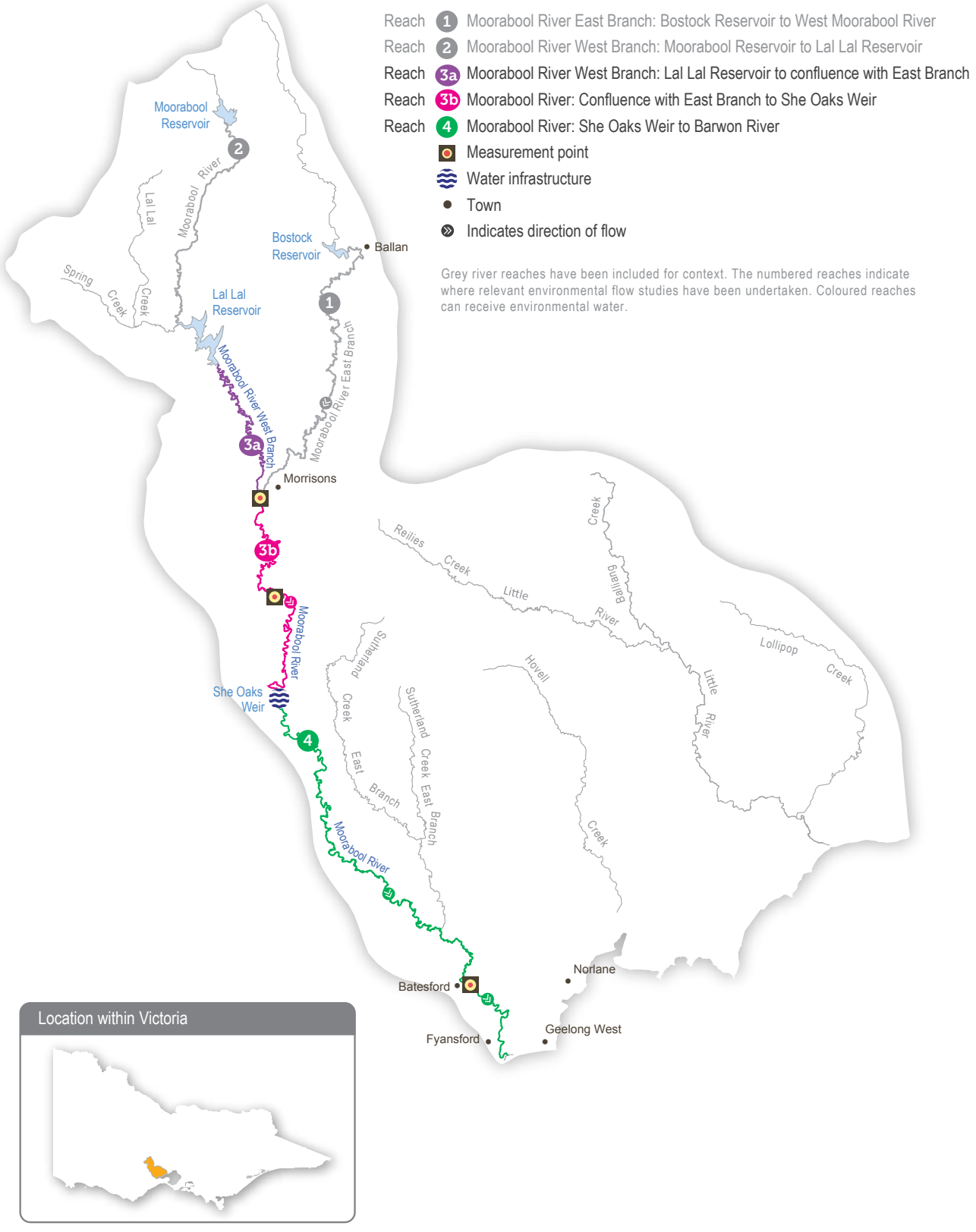
Environmental values

The 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. The Moorabool River flows into the Barwon River, connecting it to the Ramsar-listed lower Barwon wetlands.

Environmental watering objectives in the 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

Figure 3.6.1 The Moorabool system



Traditional Owner cultural values and uses

The Wadawurrung are Traditional Owners of the land of the Moorabool River and parts of the Barwon, Leigh and Yarrowee rivers. Eastern Marr Aboriginal Corporation also have Country within areas of the Barwon River.

During 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 are applicable to all waterways within Wadawurrung Country, including the 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.

Potential watering actions for the Moorabool River that support these values are identified in Table 3.6.1 using the icon below.

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

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 kayaking, canoeing, fishing and swimming)
- riverside recreation and amenity (such as birdwatching, walking, camping, picnicking and using parks and lookouts)
- socio-economic benefits (such as diverters for irrigation, domestic and stock uses, and Geelong's water supply).

Recent conditions

Total rainfall in the Moorabool catchment in 2019–20 was slightly below the long-term average, but there was significant variation between and within seasons. Winter 2019 was wetter than average, and Lal Lal Reservoir filled to 99 percent capacity in November 2019. The second half of spring and the first half of summer were drier than average, but February through to April 2020 saw a return to wetter-than-average conditions.

The wet winter provided some minor and moderate peaks in discharge in July and August 2019 as inflows continued to run off the catchment. As such, the recommended minimum low flows for winter and spring were met by natural inflows in 2019–20. Water for the environment was used to deliver freshes in August and October 2019, maintain low flows in reaches 3a and 3b throughout summer and autumn and to deliver targeted freshes throughout the system in summer and autumn.

The Moorabool River near Batesford (reach 4) stopped flowing in January 2020. This part of the river is directly connected to the underlying groundwater table and often ceases to flow in summer. As a result, low flow releases from Lal Lal Reservoir in January were increased from five ML per day to 10 ML per day over a week to extend flow into reach 4. Water for the environment was also used to deliver freshes in late summer and autumn 2020 to cue the downstream migration of native fish, support platypus dispersal, flush the system and water the fringing vegetation.

Scope of environmental watering

Table 3.6.1 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect 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 functions.

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

Potential environmental watering action	Functional watering objectives	Environmental objectives
Summer/autumn low flow (five ML/day continuous during December to May)	• Maintain pool and riffle habitats for fish, waterbugs, platypus and submerged aquatic vegetation • Maintain water quality for biota during summer/autumn by reducing periods of low oxygen, high temperature and high electrical conductivity	
Winter/spring low flow (10–60 ML/day continuous during June to November)	• Maintain connectivity and allow fish movement through the reach • Reduce intrusion by terrestrial vegetation into the stream bed	
Autumn fresh (one fresh of 60 ML/day for five days during April to May)	• Provide a cue for the downstream migration and spawning of Australian grayling • Allow fish and platypus to move through the reach to access habitat • Maintain the condition of streamside vegetation • Flush silt and scour biofilms and algae from streambed and substrates to improve habitat quality for waterbugs	
Summer fresh (one fresh of 60 ML/day for five days during January to February)	• Provide a cue for downstream spawning and migration of short-finned eel • Allow fish and platypus to move through the reach to access habitat • Maintain the condition of streamside vegetation • Flush silt, scour pools and remove biofilms from hard substrates • Maintain water quality for biota by reducing periods of low oxygen, high water temperature and salinity	
Spring fresh (one or two freshes of 80–162 ML/day for five days during September to November)	• Trigger the upstream migration of juvenile galaxias, tupong, short-finned eel and Australian grayling • Provide connectivity to support fish and platypus movement and maintain access to habitat • Scour biofilms and algae from the streambed and transport organic matter • Promote the growth and recruitment of streamside vegetation	
Winter fresh (one fresh of 80–162 ML/day for five days during May to August)	• Trigger the downstream spawning migration of tupong • Allow fish and platypus to move through the reach and maintain access to habitat • Scour biofilms and algae from the streambed to maintain waterbug communities and transport organic matter to prevent blackwater events • Promote the growth and recruitment of streamside vegetation	
Summer/autumn fresh (one fresh of 30 ML/day for five days during February to March)[1]	• Maintain water quality for biota by reducing periods of low oxygen, high water temperature and salinity	

[1] This event is trigger-based, to be delivered if water quality deteriorates to an extent that is harmful to aquatic life.

Scenario planning

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

The highest environmental flow priority under all scenarios in the Moorabool River in 2020–21 will be to provide continuous low flows during summer and autumn to maintain habitat for fish, waterbugs, platypus and aquatic vegetation, to allow fish and platypus to disperse and to protect water quality. Maintaining continuous low flows in winter and spring is also a high priority when these flows are not met naturally. Spring freshes are a high priority under dry, average and wet scenarios to cue the upstream migration of juvenile galaxias, tupong, short-finned eel and Australian grayling.

Summer and autumn freshes are important under drought and dry scenarios, to help mitigate against extreme water quality conditions that may threaten fish and other aquatic animals in refuge pools. Autumn and winter freshes may be delivered under average and wet conditions to cue tupong and Australian grayling to migrate and spawn. Freshes at any time of year will help transport nutrients through the system and scour biofilms and algae from the streambed and other hard surfaces.

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

Critical carryover of 1,000 ML has been identified to allow delivery of trigger-based freshes in 2021–22, if there is low allocation.

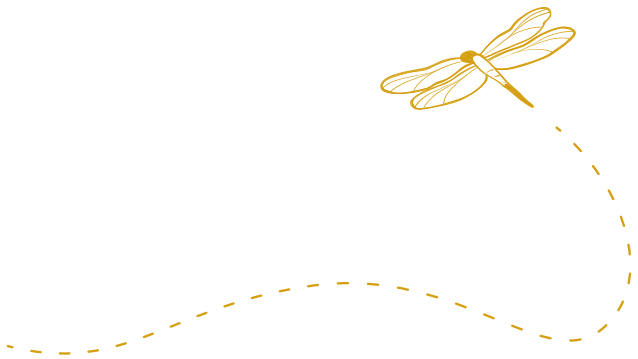


Table 3.6.2 Potential environmental watering for the Moorabool River under a range of planning scenarios

Planning scenario	Drought	Dry	Average	Wet
Expected river conditions	• Regular periods of no flow in some reaches	• 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 flows persistent throughout winter • Overbank conditions in some parts during spring/autumn
Expected availability of water for the environment[1]	• 3,900 ML	• 4,700 ML	• 5,700 ML	• 7,700 ML
Potential environmental watering – tier 1a (high priorities)	• Summer/autumn fresh (trigger based) • Summer/autumn low flows • Winter/spring low flows • Autumn fresh	• Summer/autumn fresh (trigger based) • Summer/autumn low flows • Winter/spring low flows • Autumn fresh • Summer fresh	• Summer/autumn low flows • Winter/spring low flows • Autumn fresh • Summer fresh • Spring fresh	• Summer/autumn low flows • Winter/spring low flows • Autumn fresh • Summer fresh • Spring fresh • Winter fresh • Spring fresh • Summer fresh
Potential environmental watering – tier 1b (high priorities with shortfall)	• Summer fresh • Spring fresh • Winter fresh • Spring fresh • Summer fresh	• Spring fresh • Winter fresh • Spring fresh • Summer fresh	• Winter fresh • Spring fresh • Summer fresh	
Potential environmental watering – tier 2 (additional priorities)	• As per tier 1, but at higher peak flows	• As per tier 1, but at higher peak flows	• As per tier 1, but at higher peak flows	• As per tier 1, but at higher peak flows
Possible volume of environmental water required to achieve objectives[2]	• 2,318 ML (tier 1a) • 4,860 ML (tier 1b) • 6,600 (tier 2)	• 2,508 ML (tier 1a) • 4,433 ML (tier 1b) • 6,600 (tier 2)	• 2,461 ML (tier 1a) • 3,735 ML (tier 1b) • 6,600 (tier 2)	• 1,682 ML (tier 1a) • 6,600 (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 2020–21 under drought, dry, average and wet scenarios. *The Moorabool River Environmental Entitlement 2010* entitles the VEWH to up to 7,500 ML of water from the VEWH's share of storage capacity 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.

[2] Environmental water requirements for tier 2 actions are additional to tier 1 requirements.

3.7 Barwon system

Waterway manager – Corangamite Catchment Management Authority

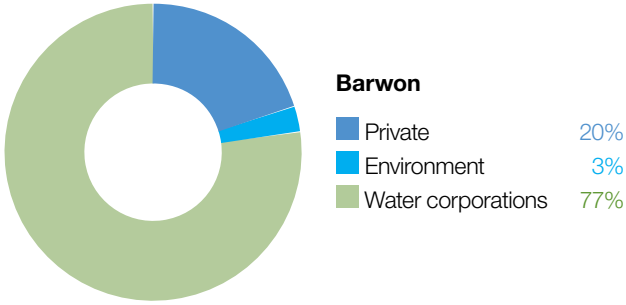
Storage manager – Barwon Water

Environmental water holder – Victorian Environmental Water Holder

Did you know...?

The Barwon River is known to the Wadawurrung people as *Barra Warre yulluk* which means 'from the mountains to the sea.'

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.



Proportion of water entitlements in the Barwon basin held by private users, water corporations or environmental water holders at 30 June 2019.

Top: Upper Barwon River, by Corangamite CMA
Above: Upper Barwon River revegetation site at Birregurra, by Sarah Martin

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. The Leigh and Moorabool rivers are major tributaries, joining the Barwon River at Inverleigh and Fyansford respectively. Other tributaries including Birregurra, Boundary, Callahan, Dewing, Matthews, Pennyroyal, Deans Marsh and Gosling creeks 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 upstream of Forrest. Water can be released directly from the reservoir into the west branch, or into the east branch via a diversion channel. The junction of the two branches is near Boundary Creek. Upstream of Birregurra, water can be diverted into the Wurdee Boluc inlet channel, a 57 km, concrete-lined channel that transfers water to Wurdee Boluc Reservoir.

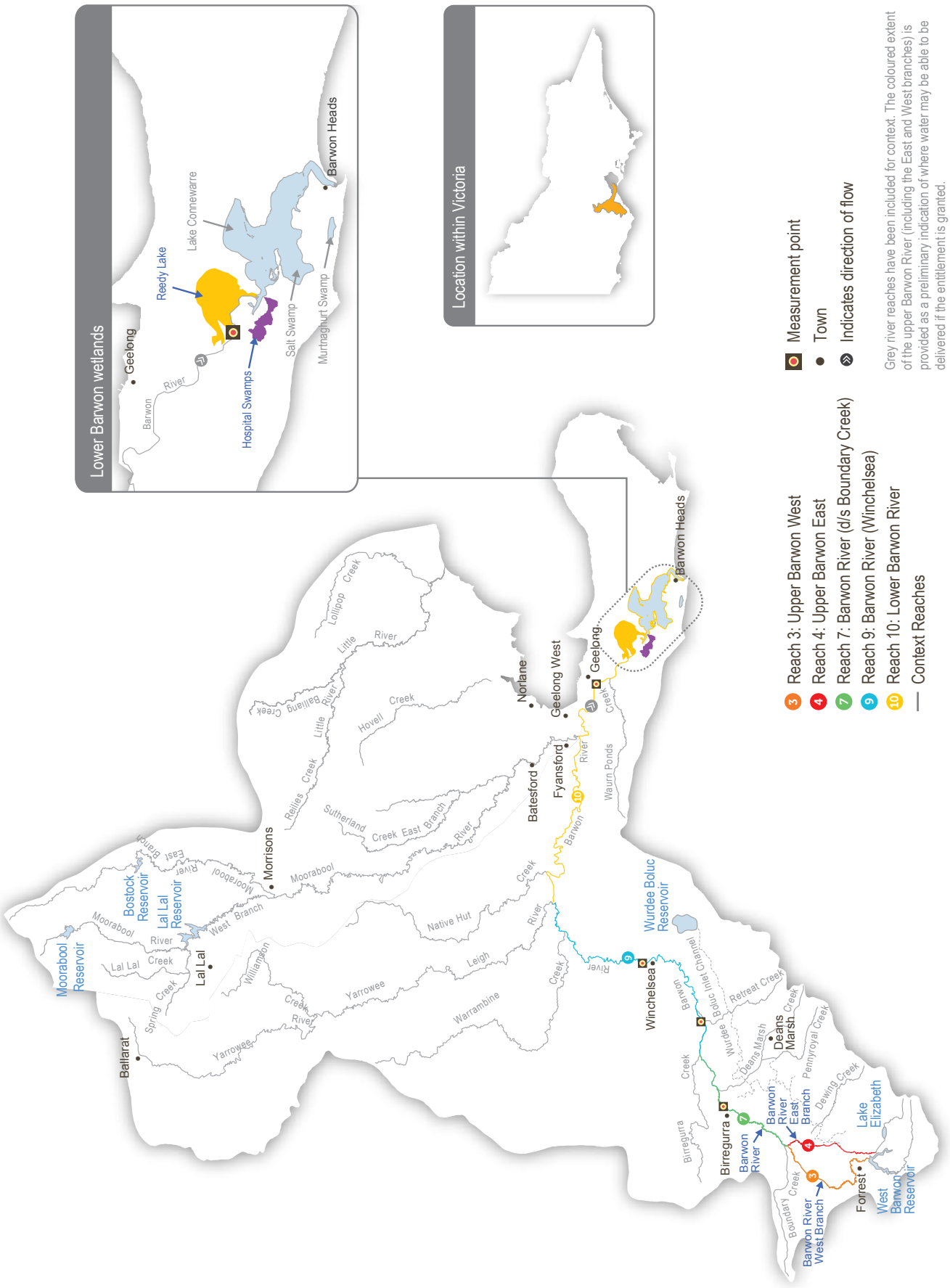
Barwon Water releases passing flows in the order of 1–5 ML per day in both the upper east and west branch (and up to 15 ML per day in September during a wet year) from the West Barwon Reservoir. Flood spills from the reservoir and natural inflows from unregulated and partly regulated tributaries add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

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: these 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 and 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 and southern pygmy perch and river blackfish

Maintain the abundance and improve the condition and extent of platypus populations

Improve the condition and extent of instream 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 Corangamite CMA is working with Eastern Maar and Wadawurrung Traditional Owners to understand opportunities to provide for both groups' respective cultural values and uses and other aspirations for environmental water management throughout the Barwon system.

The reaches of the Barwon River that can be most influenced by water delivered from the West Barwon Reservoir sit in Eastern Maar Country. Good opportunities exist within these reaches for actively managed shared benefits in the future.

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 bird watching, walking, camping, picnicking and using parks and lookouts)
- socio-economic benefits (such as diverters for irrigation, domestic and stock uses).

Recent conditions

Total rainfall in the Barwon River catchment was slightly below average during 2019–20 but varied within and between seasons. Significant rain in July and August 2019 filled the West Barwon Reservoir from 26 percent capacity to 60 percent capacity, and rainfall between January and May 2020 was above the long-term average.

Natural inflows maintained an average flow of 50 to70 ML per day at Winchelsea throughout winter and spring 2019 and delivered several high-flow events and freshes including a peak flow of 3,560 ML per day at Winchelsea in mid-July 2019. Water for the environment was used to maintain minimum low-flow targets (up to five ML per day) in the east branch of the upper Barwon River during summer, to maintain water quality and instream habitat for native fish and platypus and to maintain aquatic vegetation. Small freshes up to 15 ML per day were delivered in January and March 2020 to allow fish and other aquatic animals to disperse and maintain vegetation higher up the banks. The recommended fresh of 35 ML per day cannot currently be delivered due to channel constraints.

Scope of environmental watering

Table 3.7.1 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect 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 functions.

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

Potential environmental watering action	Functional watering objectives	Environmental objectives
Summer/autumn low flow (continuous 0.5–30 ML/day during December to May)	• Maintain an adequate depth of permanent water in the channel/pools to support resident fish, platypus and waterbugs • Promote the recruitment of native aquatic vegetation • Reduce encroachment by terrestrial plants into aquatic zone • Provide minimum velocity to maintain mixing in pools	
Summer/autumn freshes (two freshes of nine to 35 ML/day for two days during December to May: east branch only)	• Provide longitudinal connectivity with water over riffles to allow fish to move between pools to breed, feed and find new habitats • Submerge woody debris and clean hard surfaces to provide breeding substrate • Maintain waterbug communities in the dry period by flushing organic matter into the channel to provide food after inundating benches • Maintain emergent and streamside vegetation on terraces, the channel edge and lower bank • Provide minimum velocity to mix and flush pools	
Winter/spring low flow (continuous 10–50 ML/day or natural during April to November)	• Maintain 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 minimum velocity, to mix 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. The highest-priority potential watering actions under all scenarios are summer/autumn low flows and freshes. The size of these events is likely to be less than recommended in the latest environmental flows study, due to system constraints and expected water availability.

Watering actions in the east branch of the Barwon River will be prioritised, because it has higher environmental values than the west branch and because relatively small flows in the east branch have the potential to deliver significant environmental outcomes. Some low flows may be delivered down the west branch under dry, average or wet scenarios to help meet target flow objectives further downstream.

An additional 18,000 ML of water for the environment is required to achieve the remaining potential watering actions (tier 1b) in the upper Barwon River. The tier 1a watering actions described here should help to maintain current environmental values and conditions in the upper Barwon River, but larger environmental entitlements and complementary works that address non-flow-related impacts in the catchment will be needed to significantly improve environmental conditions.

It is intended to carry over up to 500 ML at the end of 2020–21 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
Expected availability of water for the environment	• 1,000 ML	• 1,300 ML	• 1,500 ML	• 2,500 ML
Potential environmental watering – tier 1a (high priorities)	• Summer/autumn low flow (east branch) • Two summer / autumn freshes (east branch, reduced volumes)	• Summer/autumn low flow (east branch) • Two summer / autumn freshes (east branch, reduced volumes) • Summer/autumn low flow (west branch, reduced volume)	• Summer/autumn low flow (east branch) • Two summer / autumn freshes (east branch, reduced volumes) • Summer/autumn low flow (west branch, reduced volume)	• Summer/autumn low flow (east branch) • Two summer / autumn freshes (east branch, reduced volumes) • Summer/autumn low flow (west branch, reduced volume)
Potential environmental watering – tier 1b (high priorities with shortfall)	• Summer/autumn low flow (west branch) • Winter/spring low flow (east branch) • Summer/autumn fresh (west branch, reduced volume) • Winter/spring low flow (west branch)	• Summer/autumn low flow (west branch) • Winter/spring low flow (east branch) • Summer/autumn fresh (west branch, reduced volume) • Winter/spring low flow (west branch, reduced volume)	• Summer/autumn low flow (west branch) • Winter/spring low flow (east branch) • Summer/autumn fresh (west branch, reduced volume) • Winter/spring low flow (west branch, reduced volume)	• Summer/autumn low flow (west branch) • Winter/spring low flow (east branch) • Summer/autumn fresh (west branch, reduced volume) • Winter/spring low flow (west branch)
Potential environmental watering – tier 2 (additional priorities)	• There are no tier 2 watering demands because additional watering actions cannot be delivered within the existing infrastructure and flow constrictions			
Possible volume of environmental water required to achieve objectives	• 250 ML (tier 1a) • 18,200 ML (tier 1b)	• 800 ML (tier 1a) • 17,900 ML (tier 1b)	• 1,000 ML (tier 1a) • 17,700 ML (tier 1b)	• 2,000 ML (tier 1a) • 16,700 ML (tier 1b)
Priority carryover requirements	• Up to 250 ML	• 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. 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 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 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 they 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 is currently underway. The recommendations from the review will inform the 2020–21 watering actions and determine future directions. The lower Barwon wetlands section of the seasonal watering plan will be updated by September 2020 to reflect the review's recommendations.

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 fringe soils

Increase the diversity of ecological vegetation communities in the wetlands and improve the recruitment of aquatic vegetation

Increase the growth and extent of coastal saltmarsh, herbfields and lignum shrubland ecological vegetation communities

Reduce tall reed extent and increase open water habitat

Maintain and improve the waterbug population and its biomass

Maintain nutrient cycling and improve lake productivity

Provide flushing inflows to remove accumulated salts

Maintain surface water and groundwater interactions

Provide suitable feeding and breeding habitat for waterbirds, including mud flats and shallow water for wading birds, flooded vegetation and wetland fringes

Maintain and increase waterbird breeding events

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.

As part of this partnership, the Wadawurrung have identified cultural values which are applicable 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 access to culturally important story places and ceremonial places
- protection of artefact sites.

Social, recreational and economic values and uses

In planning the potential watering actions in Table 3.7.3, Corangamite CMA considered how environmental flows could support values and uses including:

- water-based recreation (such as fishing and duck hunting)
- riverside recreation and amenity (such as birdwatching and spending time outdoors)
- socio-economic benefits (such as commercial fishing).

Recent conditions

Rainfall across the lower Barwon River catchment in 2019–20 was close to the long-term average. High rainfall in winter 2019 and in late summer to autumn 2020 contributed high flows in the river and delivered water to Reedy Lake and Hospital Swamps.

Water levels in Reedy Lake varied between 0.6 m and 1.0 m AHD throughout 2019–20. This followed three successive years of managed partial drying, where the lake was filled in winter and then allowed to draw down during summer and autumn. Monitoring at Reedy Lake over the last four years indicates the drying regime has improved the diversity of vegetation, increased species richness of brackish aquatic herbland plants and increased the abundance of waterbirds including Australasian bitterns and magpie geese.

In 2019–20, Hospital Swamps was filled in winter and then drawn down to 0.3 m AHD over summer.

Scope of environmental watering

Table 3.7.3 describes the potential environmental watering actions in 2020–21, their functional watering objectives (that is, the intended physical or biological effect 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 functions.

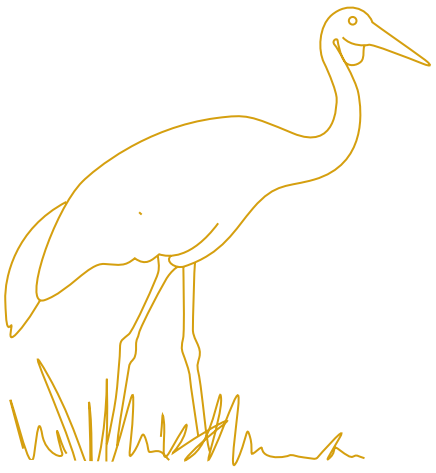
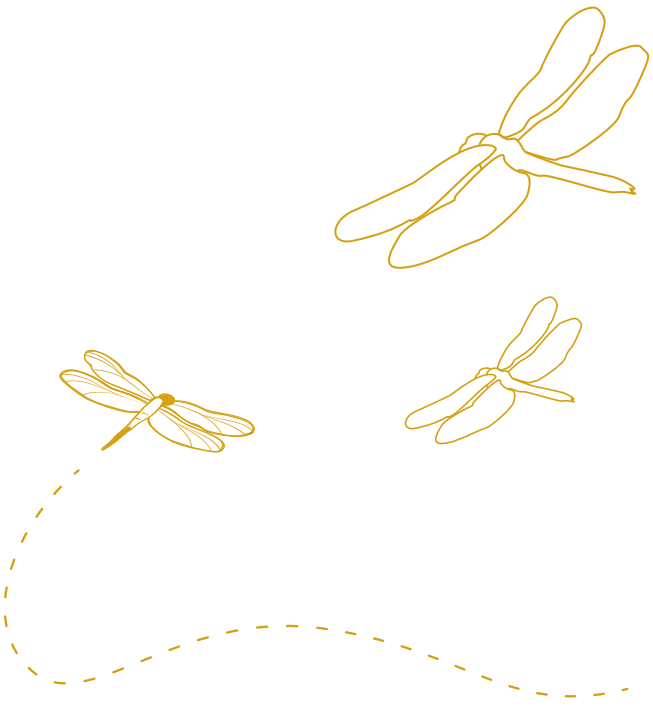


Table 3.7.3 Potential environmental watering actions and objectives for the lower Barwon wetlands[1]

Potential environmental watering action	Functional watering objectives	Environmental objectives
Reedy Lake		
Winter/spring fill (July to September) *The inlet to Reedy Lake will be opened to allow high flows in the Barwon River to flow into the wetland*	• Maintain the water level to 0.8 m AHD (allowing for natural fluctuations) • Maintain waterbird breeding events • Wet the vegetation at the wetland margins to provide feeding habitat for waterbirds • Maintain fish breeding and recruitment opportunities • Allow fish to move between the river, lake and estuary	
Hospital Swamps		
Winter/spring fill (July to September) *Hospital Swamps will be connected to the Barwon River for at least six weeks by keeping the inlet and outlet open*	• Maintain the water level at 0.5 m AHD (allowing for natural fluctuations) • Create habitat to support waterbug and fish populations • Improve fish and waterbird breeding • Allow fish to access the wetland from the river • Dilute salt in the soil and surface water over winter • Promote and sustain the growth of important wetland vegetation communities	

[1] The table only includes potential watering actions for July–September 2020. Potential watering actions for the rest of the year will be based on the independent review of the lower Barwon wetlands watering trial 2016–17 to 2019–20.



Scenario planning

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

The environmental watering regime for Reedy Lake and Hospital Swamps will be informed by the outcomes of an independent review of the lower Barwon wetlands watering trial 2016–17 to 2019–20, which is due to be completed early in 2020–21.

After the independent review of the lower Barwon wetlands watering trial is complete, Corangamite CMA will consult with the Lower Barwon Community Advisory Committee to determine the recommended watering regime for both wetlands from October 2020 to June 2021. Any future management of Reedy Lake and Hospital Swamps is expected to include a winter filling phase under all scenarios and so that watering action has been included in the table. This section of the seasonal watering plan will be formally varied before October 2020 to describe the potential watering actions that may be delivered for the rest of the 2020–21 water year. Variations to the seasonal watering plan will be published on the VEWH website (www.vewh.vic.gov.au) before the planned watering actions are delivered.

Table 3.7.4 Potential environmental watering for the lower Barwon wetlands under a range of planning scenarios[1]

Planning scenario	Dry	Average	Wet
Expected river conditions	• Some natural inflows from the Barwon River in winter/spring • Dry conditions over summer will assist in the drying of the wetlands	• Some natural inflows from the Barwon River in winter/spring • Conditions over summer may assist drying of the wetland water levels	• Overbank flows are likely to wet the wetlands as a result of higher river flows, stormwater inflows and local rain/run-off • Extensive drying of the wetlands is unlikely
Reedy Lake	• Winter/spring fill	• Winter/spring fill	• Winter/spring fill
Hospital Swamps	• Winter/spring fill	• Winter/spring fill	• Winter/spring fill

[1] The table only includes potential watering actions for July–September 2020. Potential watering actions for the rest of the year will be based on the independent review of the lower Barwon wetlands watering trial 2016–17 to 2019–20.