



Upper Barwon River Seasonal Watering Proposal 2022-23

FINAL April 2022



*healthy and productive lands and waters
cared for by thriving communities*

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Acknowledgement of Country

The Corangamite Catchment Management Authority (Corangamite CMA) wishes to acknowledge the Eastern Maar and Wadawurrung, the Traditional Owners of the land of the Barwon River. We pay our respects to their Elders past, present and emerging. We commit to continuing to work with all Traditional Owners to ensure their knowledge and culture is included and valued in Corangamite CMA planning and delivery.

Executive Summary

This Seasonal Watering Proposal (SWP) outlines Corangamite Catchment Management Authority's proposed priorities for the use of environmental water from the West Barwon Reservoir within the Upper Barwon River system in 2022-23, as required under section 192A of the *Water Act 1989*. The Victorian Environmental Water Holder (VEWH) will use the SWP to inform the development of the Seasonal Watering Plan 2022-23.

The Barwon River rises in the Otway Ranges and flows close to the townships of Forrest, Birregurra, Winchelsea and Inverleigh, before flowing through Geelong and the Lower Barwon Wetlands, joining the coast at Barwon Heads. The current environmental water entitlement held in the West Barwon Reservoir can only provide environmental water to the Upper Barwon east branch, the Upper Barwon west branch, with diminishing effect to reaches downstream in the main Barwon River channel.

The Upper Barwon River system is facing environmental challenges due to a lack of environmental flow, largely due to the ongoing impact of the West Barwon Reservoir, and insufficient environmental entitlement. There are other contributing factors including land use change, physical constrictions, a drying climate and groundwater extraction by a range of users. Two key issues have been raised by the Upper Barwon Surface Water Advisory Group (UBSWAG) for acknowledgement in preparing previous proposals.

1. Potential impacts of historical Barwon Downs ground water extraction – Barwon Water has acknowledged potential impacts to the flows in the upper reaches and committed to monitoring to confirm impact, and remediation if required.
2. The river appears to have been disappearing to ground in the mid-Barwon between Winchelsea and Inverleigh gauges; the cause is unknown, but it is likely the water is going underground.

This SWP has been developed in consultation with the UBSWAG. The Traditional Owners of the Upper Barwon, the Eastern Maar Aboriginal Corporation (EMAC) were consulted on the elements of the document relating to Eastern Maar Country only. The upper reaches of the Barwon fall within EMAC Country and as such, these reaches tend to benefit the most from environmental releases. The Wadawurrung Traditional Owner Aboriginal Corporation (WTOAC) were engaged on the elements of the document relating to Wadawurrung Country, starting below Winchelsea township and culminating at Barwon Heads, via the Lower Barwon Wetlands.

The environmental watering objective for the Upper Barwon, developed by UBSWAG in 2017, is:

'To improve the Barwon River's flow-dependent ecological values and services through the provision of environmental water. The delivery of environmental water will also provide for social and cultural values for future generations.'

In line with this objective, Corangamite CMA proposes to use the entitlement of approximately 1,000ML/yr of water (on average) in 2022-23 for ecological outcomes and to realise shared benefits wherever possible, without compromising those ecological outcomes.

The experience gained from previous releases has informed delivery planning in subsequent years, including 2022-23. Weed constrictions continue to pose a significant problem for environmental flows in both branches of the Upper Barwon. In 2021/22 the Upper Barwon system experienced higher than average rainfall, and there were limited opportunities to release environmental water down the east

branch due to willow removal works by Barwon Water. However, water has been released down the west branch through the drier months to assist with the river's base flow.

The Upper Barwon, Yarrowee and Leigh rivers FLOWS study update (Alluvium, 2021) recommends that an additional 44GL/year of water is required to return the Barwon system to within 75% of the natural flow regime and allow for the provision of all environmental flow recommendations. This includes 29GL for the Upper Barwon section (excluding the Yarrowee-Leigh). An additional 2.34GL/year is required just to meet dry period low and dry period fresh recommendations for the Upper Barwon. The current allocation of approximately 1GL/year is drastically insufficient to meet the river's health requirements, even when just considering the reaches that are immediately downstream of where the entitlement is held.

As the entitlement cannot meet all flow recommendations for the Upper Barwon east and west branches, watering actions have been prioritised, as summarised in Table 1 below.

Table 1. A summary of the priority watering actions for 2022-23

| Environmental allocation: ~1,000ML/year | Is this in line with the FLOWS study update? |
|---|--|
| Priority 1: Upper Barwon east branch low flows of 0.5-5 ML/day between December – May | Yes. The recommendation is 0.5 ML/d but a higher volume may be required to achieve the recommendation in the reach. |
| Priority 2: 2 x 9ML/day freshes in the Upper Barwon east branch over two days between December – May | No, the FLOWS study recommends 35ML/day, however the current flow constrictions don't allow this. |
| Where water is available: | |
| Priority 3: Upper Barwon west branch low flows of 3 to 30ML/day between December – May | Yes |
| Priority 4: Upper Barwon east branch low flow of 9ML/day (or natural if available) between June-November | No, the FLOWS study recommends 10ML/day, however the current flow constrictions don't allow this. |
| Priority 5: 5 x ~20-30 ML/day freshes in the Upper Barwon west branch over 6 days, between December-May | No, the FLOWS study recommends 100ML/day, however the flow constrictions and the current entitlement do not allow this. |
| Priority 6: Maintain Upper Barwon west branch low flow of 20-30ML/day between June-November | No, the FLOWS study recommends 100ML/day or natural, however the flow constrictions current entitlement do not support this. |

1. Introduction

The SWP outlines Corangamite CMA 's proposed priorities for the use of environmental water in the Upper Barwon River system in 2022-23, as required under section 192A of the *Water Act 1989* and outlined in the Central Sustainable Water Strategy (Department of Environment, Land, Water and Planning, 2006). The VEWH will use the SWP to inform the development of the Seasonal Watering Plan 2022-23 (the Plan). The Plan will outline the full scope of state-wide priorities for use of the Water Holdings.

To support the issues of chokes reducing water flows due to willows and glyceria in the Upper Barwon River, Corangamite CMA has identified the Upper Barwon integrated project as a priority within the newly formed Barwon Flagship. Over the next 30 years, starting with the river's upper reaches, the Upper Barwon project aims to improve riparian quality to support the river's overall health, provide downstream benefits and improve delivery of the environmental entitlement.

1.1 System Overview

The Barwon River rises in the Otway Ranges and flows close to the townships of Forrest, Birregurra, Winchelsea and Inverleigh before flowing through Geelong and the Lower Barwon wetlands, joining the coast at Barwon Heads. The Leigh River, a major tributary, rises near Ballarat and joins the Barwon River at Inverleigh. Two other tributaries, Birregurra and Boundary Creeks, flow into the Barwon from the western part of the catchment. The Barwon River flows through both Eastern Maar Country and Wadawurrung Country. For Wadawurrung people it is known as *Parwan (magpie)* in language and *forming Rivers of the Barwon*. Barre Warre Yulluk as a living and integrated entity: the rivers, creeks and wetlands and the landscapes through which they flow. Flowing from the uplands to the sea, supporting and bringing life to the region. It carries great Cultural significance for both Traditional Owner groups.

The Barwon River is a major water supply for greater Geelong and the smaller urban centres; and farm water supply for the region. The system is significantly altered due to on-stream reservoirs, extensive farm dam storages, and many diversion licenses. Inter-basin transfers can potentially occur from Lake Colac (via the Lough Calvert drainage scheme) and Lake Corangamite (via the Woody Yaloak drainage scheme) into the Barwon River. Parts of the landscape zone near the headwaters of the Barwon River and several of its tributaries include the Otway Ranges. Parts of both the Great Otway National Park and Otway Forest Park are in the catchment.

The Upper Barwon is facing environmental challenges due to a lack of environmental flow, largely due to the ongoing impact of the West Barwon Reservoir, and insufficient environmental entitlement. There is a range of other contributing factors including land use change, physical constrictions, a drying climate and groundwater extraction by a range of users. Two key issues have been raised by the UBSWAG for acknowledgement in preparing previous proposals.

1. Potential impacts of historical Barwon Downs ground water extraction – Barwon Water has acknowledged potential impacts to the flows in the upper reaches and committed to monitoring to confirm impact, and remediation if required.
2. The river appears to have been disappearing to ground in the mid-Barwon between Winchelsea and Inverleigh gauges; the cause is unknown, but it is likely the water is going underground.

1.2 Environmental Entitlement

The Upper Barwon Environmental Entitlement was established in 2018 to provide water for the environment in the Upper Barwon River system in Victoria. The Victorian Environmental Water Holder (VEWH) is entitled to a 2,000ML share of storage capacity in the West Barwon Reservoir, and 3.8% of inflows. This results in approximately 1,000ML per year specific to the West Barwon Reservoir.

The Upper Barwon, Yarrowee and Leigh rivers FLOWS study update (Alluvium, 2021) was undertaken to identify the flow requirements of freshwater reaches of these river systems. It replaces an earlier study. The new study divides the Barwon River downstream of the West Barwon Reservoir into seven reaches above the confluence with the Leigh River, based on geomorphology, hydrology, system operation and natural values, as outlined below in Figure 1. The current entitlement in the West Barwon Reservoir can provide environmental water directly to two reaches: the Upper Barwon east branch and the Upper Barwon west branch. The entitlement has a diminishing impact on reaches in the main Barwon channel past the confluence of the Upper Barwon east and west branches. It should be noted that although the West Barwon Reservoir is situated on the Upper Barwon west branch, water can be released down the Upper Barwon east branch (through a diversion tunnel) as well as to the Upper Barwon west branch.

The 2021 FLOWS study update recommends that an additional 44GL/year of water is required to return the Barwon system to within 75% of the natural flow regime and allow for the provision of all environmental flow recommendations. This includes 29GL down the Upper Barwon section (excluding the Yarrowee-Leigh). An additional 2.34GL/year is required just to meet dry period low and dry period fresh recommendations down the Upper Barwon. The current allocation of approximately 1GL/year is drastically insufficient to meet the river's health requirements, even when just considering the reaches that are immediately downstream of where the entitlement is held.

Passing flows are an important source of water for the Upper Barwon River and where opportunity exists, the environmental entitlement will be used to enhance these flows. Passing flow rules for the Upper Barwon are outlined in Table 2. Barwon Water must provide an instantaneous flow below the diversion weirs of the lesser of the minimum passing flow as specified in Table 2 and the natural flow.

Table 2. Passing flow rules for the Upper Barwon

| Minimum Passing Flows, April to December (inclusive) | | |
|---|---|--|
| System storage volume is less than 40,000ML | | System storage volume is greater than 40,000ML |
| West Barwon River | 4 | 5 |
| East Barwon River | 1 | 5 except during September |

| Minimum Passing Flows, January to March (inclusive) | | |
|--|---|--------------------------------|
| System storage volume is less than | | System storage is greater than |
| for January - 26,100ML | | for January - 26,100ML |
| for February - 22,900ML | | for February - 22,900ML |
| for March - 20,900ML | | for March - 20,900ML |
| West Barwon River | 4 | 4 |
| East Barwon River | 1 | Pass natural Flow |

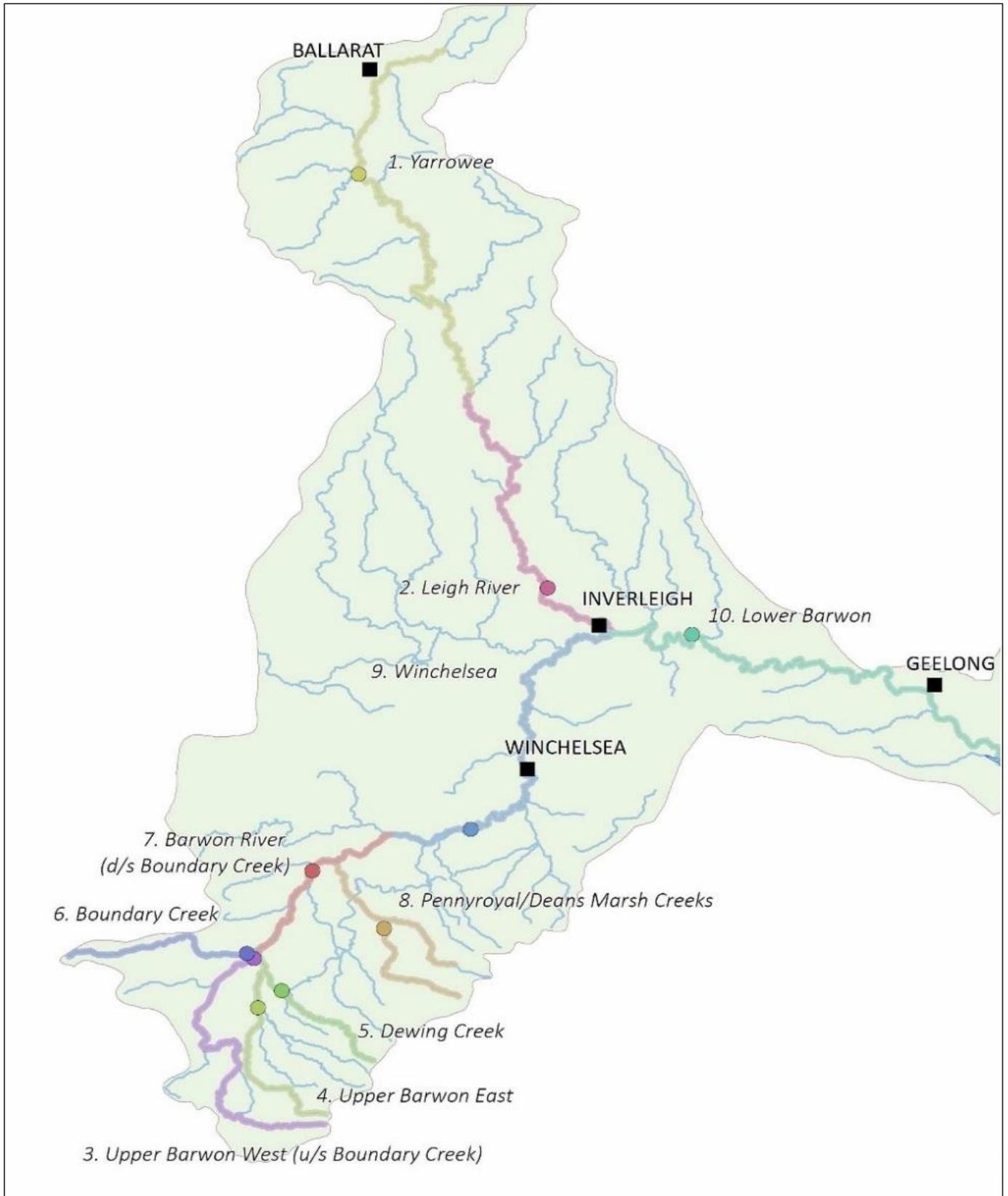


Figure 1. The Upper Barwon River System showing adopted study reaches and locations

The FLOWS study update (Alluvium, 2021) states that effective delivery of environmental water to achieve flow objectives in relevant reaches will only be possible through an integrated program of

complementary actions and environmental water delivery. Importantly, these complementary actions must include management of flow limiting infrastructure and choking weed infestations in the upper reaches, as captured in Figure 2 below. Flow limitations have been experienced down both the east and west branches. These issues are further outlined below in *Section: 7 Delivery Constraints* and *Section 8 Confounding Factors*.



Figure 2. A typical section of the Upper Barwon east branch constrained by willows

2. Engagement

Corangamite CMA has engaged with the UBSWAG during the development of this plan. The UBSWAG was established by Corangamite CMA in 2017 to support the development of SWPs. The group also supports other important scientific studies relating to flows in the river. UBSWAG is a passionate and dedicated group of individuals, community groups and government representatives with a broad combination of skills including technical knowledge, historical information and an understanding of government policy and community values. In 2018, UBSWAG played a key role in determining the ecological values, objectives, threats, and opportunities for the Upper Barwon River to inform the new Upper Barwon-Yarrowee Leigh FLOWS study update (Alluvium, 2021). The group also has a key role in informing the watering priorities in the SWP each year.

Together with the UBSWAG, Corangamite CMA engage with Traditional Owners through EMAC and WTOAC on activities relating to the management of environmental water in the Barwon River on Eastern Maar and Wadawurrung Country, including this SWP. WTOAC collaborated on the technical panel of the FLOWS study update 2021, a state first. The partnership that Corangamite CMA has with WTOAC has led to the recognition of the cultural values of rivers on Wadawurrung Country and the concern Wadawurrung have for their Yulluk and Parwan and ongoing role in caring for them. The Corangamite CMA has received a Letter of Support from WTOAC (Appendix 6) for this Seasonal Watering Proposal 2022-23. The UBSWAG is notified of all environmental flow releases throughout the year, and Corangamite CMA also works with stakeholders individually on specific issues related to the management of environmental water as they arise.

In 2020, EMAC acquired Registered Aboriginal Party (RAP) status. Corangamite CMA reached out to EMAC to incorporate their views and priorities into the management of environmental water in the upper reaches of the Barwon River; and met on Country in February 2022 to discuss this SWP.

Traditional Owner and community knowledge and input has added significant value to this document and planned watering actions, in particular:

- Feedback and advice on the landscape characteristics of the reaches and any other localised considerations or observations relating to the rivers
- The realities and feasibility of water delivery volumes and timing
- Anecdotal observation and accounts of environmental watering
- New and emerging shared benefits because of the watering.

In line with the Victorian Government best practice for public participation guidelines, Table 3 below defines the level of participation, timing and method of engagement with stakeholders during the development of the SWP. The International Association for Public Participation (IAP2, 2018) spectrum of public participation is designed to assist with the selection of the level of participation that defines the public's role in any community engagement program and can be found in Appendix 3.

Table 3. Stakeholder engagement for the Upper Barwon River SWP 2022-23

| Who | Stakeholders | IAP2 level | Engagement method | Engagement purpose |
|--|--|------------|---|--|
| Community groups and environment groups | <ul style="list-style-type: none"> • Friends of the Barwon • Land and Water Resources Otway Catchment (LAWROC) • Geelong Field Naturalists Club • Otway Agroforestry Network • Winchelsea Landcare Group • Upper Barwon Landcare Network • Environment Victoria | Involve | <p>Representation on UBSWAG</p> <ul style="list-style-type: none"> • Meeting to discuss and seek input to draft proposal • Review of draft proposal and opportunity to provide formal feedback. • Response to stakeholders on how their feedback influenced the SWP and why. <p>Direct engagement (one-on-one).</p> <p>Attendance at community forums.</p> | <ul style="list-style-type: none"> • Seek user input to the development of the proposal. • Review previous environmental watering actions and seek feedback on any outcomes and capture observations. • Provide an opportunity for individuals, agencies and groups to contribute to the proposed watering actions and intended outcomes. • Identify opportunities to achieve shared benefits. • Assist in increasing awareness and understanding of the purpose and objectives of the environmental watering program |
| Government agencies | <ul style="list-style-type: none"> • Department of Environment, Land, Water and Planning (Water & Catchments) • Barwon Water • Southern Rural Water • VEWH | Involve | <p>Representation on UBSWAG</p> <ul style="list-style-type: none"> • Meeting to discuss and seek input to draft proposal • Review of draft proposal and opportunity to provide formal feedback. • Response to stakeholder on how their feedback influenced the SWP and why. • Partnership meetings with links or relevance to seasonal water proposal development. <p>Direct engagement (one-on-one) (UBSWAG).</p> <p>Attendance at community forums.</p> | <ul style="list-style-type: none"> • Identify opportunities to achieve shared benefits. • Assist in increasing awareness and understanding of the purpose and objectives of the environmental watering program |
| Landholders /farmers & recreational users | <ul style="list-style-type: none"> • Individual owners and users | Involve | <p>Membership of UBSWAG</p> <ul style="list-style-type: none"> • Meeting to discuss and seek input on draft proposal • Review of draft proposal and opportunity to provide formal feedback. | <ul style="list-style-type: none"> • Assist in increasing awareness and understanding of the purpose and objectives of the environmental watering program |

| Who | Stakeholders | IAP2 level | Engagement method | Engagement purpose |
|---------------------------|---|------------|---|-----------------------------|
| | | | <ul style="list-style-type: none"> Response to stakeholder on how their feedback influenced the SWP and why. <p>Direct engagement (one-on-one).</p> <p>Attendance at community forums.</p> | for the Upper Barwon River. |
| Traditional Owners | Wadawurrung Traditional Owners Aboriginal Corporation (WTOAC) | Involve | <ul style="list-style-type: none"> Directly engaged on the applicable cultural aspects within the 2022-23 SWP draft. Invited to attend community forums. Meeting to discuss and seek input to draft proposal. Review of relevant sections of draft proposal and opportunity to provide formal feedback. Partnering to create the FLOWS study update (Alluvium, 2021), which underpins the SWP. | |
| | Eastern Maar Aboriginal Corporation (EMAC) | Involve | <ul style="list-style-type: none"> Invited to participate via letter early December 2021 (NB: involvement sought via email as recommended). Directly consulted on the applicable cultural aspects within the 2022-23 SWP draft. Invited to attend community forums. Meeting to discuss and seek input on draft proposal. Review of relevant sections of draft proposal and opportunity to provide formal feedback. Partnering to create the FLOWS study update (Alluvium, 2021), which underpins the SWP. | |
| Local Government | Colac Otway Shire Council | Consult | <p>Representation on UBSWAG</p> <ul style="list-style-type: none"> Meeting to discuss and seek input to draft proposal Review of draft proposal and opportunity to provide formal feedback. Response to stakeholder on how their feedback influenced the SWP and why. <p>Direct engagement (one-on-one).</p> <p>Attendance at community forums.</p> | |

2.1 Notable feedback

The Upper Barwon Seasonal Watering Proposal 2022-23 was presented and distributed to the UBSWAG and other community and agency members in March 2022. Individuals had two weeks to provide feedback to Corangamite CMA.

A letter of support for the seasonal watering proposal was received from Wadawurrung Traditional Owners Aboriginal Corporation. This can be found in Appendix 6.

A member of the UBSWAG suggested it would be beneficial to increase the 1000 ML annual allocation due to the West Barwon Reservoir being at capacity and for environmental water releases to be increased towards the end of March 2022. The Corangamite CMA responded that the full 2000 ML allocation is available due to the wet year experienced and that higher volumes of environmental releases will be commencing late-March 2022. Detail of the comments received, and Corangamite CMA responses can be found in the Upper Barwon SWP 2022-23 Comments Register.

Detail of the comments received (other than letters of support) and Corangamite CMA responses are provided to the UBSWAG. Other individuals or organisations can contact the Corangamite CMA at info@ccma.vic.gov.au to request a copy of the Upper Barwon SWP 2022-23 Comments Register.

3. Values and uses of waterways

The primary purpose of the environmental water entitlement is to achieve environmental outcomes. However, the delivery of environmental water is likely to provide other benefits that depend on the condition of our waterways, such as supporting social and cultural values. Shared benefits are the many recreational, social, economic and Aboriginal cultural benefits that occur because of environmental watering, such as fishing, boating, bird watching, community events and supporting Traditional Owner values and events. Opportunities for shared benefits are incorporated into planning and watering decisions if they do not compromise environmental outcomes.

Corangamite CMA is flexible in its delivery approach and aspires to realise shared benefits that arise from the delivery and use of the water, where possible.

The Upper Barwon system is split into the east and west branches and the east branch is prioritised over the west branch. Due to the willow removal works over the 2021-22 summer limiting releases in the east branch, the west branch was prioritised over the east, providing improved aesthetic and well-being benefits associated with this reach and the reaches downstream.

As part of the management of the Upper Barwon Environmental Entitlement 2018, Corangamite CMA consults with stakeholders to ensure that consideration is given to social, cultural and economic matters relevant to water management for the Upper Barwon. Figure 3 illustrates the shared benefit of waterway amenity on the Upper Barwon.



Figure 3. Red gums on the Upper Barwon (CCMA, 2017)

3.1 Aboriginal cultural values and uses of waterways

The Barwon River has important social, cultural and economic values. Both Eastern Maar and Wadawurrung Traditional Owners have a strong connection and place a high cultural value on the Barwon River. Many Eastern Maar and Wadawurrung people in the region have a connection and a long history with the river. The Barwon River forms an integral part of Wadawurrungs' Barre Warre Yulluk. Yulluk (great river) that runs from the Barre (mountains) to the Warre (ocean), and their stories tell of these connections. Their waterways were like their highways, they were how they moved around country. Their people gathered, made important decisions, camped, gathered food, caught eels and other fish and waterbirds to eat.

The reaches of the Barwon River that can be most influenced by water delivered from the West Barwon Reservoir sit in Eastern Maar Country, upstream of Winchelsea. In February 2020, EMAC received RAP status over a large portion of land in south-west Victoria, which includes the Barwon River upstream of Winchelsea. This status recognises Eastern Maar as the primary guardians, keepers and knowledge holders for the management and protection of Aboriginal cultural heritage within the determined area. EMAC's (2015) Country Plan (*Meerreengeeye ngakeepoorryeeyt*) identifies healthy country and sustainable use of natural resources as a goal. While cultural values have not yet been formally defined with the Eastern Maar there are opportunities within relevant reaches for actively managed shared benefits in the future.

Wadawurrung Traditional Owners through WTOAC released their *Paleert Tjaara Dja – let's make Country good together 2020-2030 – Wadawurrung Country Plan in 2020* (WTOAC, 2020). *Yulluk* – waterways, rivers, estuaries and wetlands, along with warre (sea country) are important values identified in the plan to be looked after. Engagement is ongoing, and meetings are held regularly with the Wadawurrung to help progress future projects and work together to expand on the opportunities for shared benefits.

The following Wadawurrung cultural values and recommendations are applicable across all sites within Wadawurrung Country, including the Barwon River south of Winchelsea:

- Maintaining watering requirements for healthy, thriving, culturally significant species is crucial
- Protection of totem species is priority
- Recognition of confluences as places of meeting, ceremony and trade
- Identifying Clan boundaries with confluences
- Maintain deep/permanent waterholes and refuge pools
- Maintain access to culturally important sites – story places, ceremonial places
- Protection of all Wadawurrung cultural heritage
- Use of appropriate Wadawurrung language for places of cultural importance on Wadawurrung Country
- Increased opportunities for Wadawurrung Traditional Owners to be involved in monitoring and evaluation activities on Wadawurrung Country

- Increased opportunities for Wadawurrung Traditional Owners in all communications of environmental water releases and activities on Wadawurrung Country

Increasing opportunities for Wadawurrung Traditional Owners to build knowledge of the use of interventions in the *yulluk* such as reservoirs and dam storage and how they harm the river and affect cultural flows. Corangamite CMA continues to work with Eastern Maar and Wadawurrung Traditional Owners to support their values and uses of the Upper Barwon River, and to refine our understanding of how environmental watering can support their needs and wants and strengthen self-determination and access to cultural flows.

Due to resource constraints, the Eastern Maar have agreed to write a Letter of Support regarding future environmental water releases.

Key Wadawurrung cultural objectives and values as identified in Upper Barwon Yarrowee and Leigh River FLOWS study update (Alluvium, 2021) are found below in Table 4.

Table 4. Traditional Owner values and uses

| River | Traditional Owner group | Category | Objectives & opportunities | Values & uses | How will this opportunity be considered environmental watering in 2021-22? |
|---------------------------------|--|--------------------------------|---|---|--|
| Mid - Barwon (below Winchelsea) | Wadawurrung Traditional Owner Aboriginal Corporation (WTOAC) | Culturally significant species | Maintain or improve abundance, breeding and recruitment of <i>Wad-dirring/ Perridak</i> (platypus). | Meat and pelt. | Environmental watering will aim to provide pool habitat and connectivity between reaches where possible. |
| | | | Maintain or improve abundance of <i>Buniya</i> (Eels). | Meat, important food source sometimes smoked. | Where possible, environmental watering aims to provide for pools, habitat and food sources, as well as providing water over riffles to allow eels to migrate. |
| | | | Maintain or improve abundance of <i>Turrapurt</i> (Native trout <i>galaxias</i> spp.) | Meat | Where possible environmental watering aims to provide for pools, habitat and food sources, provide water over riffles to allow fish to move between pools and breed, feed and find new habitats. |
| | | | Maintain or improve abundance of <i>Ware-rap</i> (Blackfish). | Meat | |
| | | | Maintain or improve abundance of <i>Polango/ Warn gare</i> (Water ribbons <i>Triglochin procera</i>). | Plant food, finger shaped tubers are crisp and sweet. Cooked in ground oven. | Environmental watering aims to maintain adequate depth of water in channel where possible. |
| | | | Maintain or improve condition, extent and abundance of <i>Tark</i> (common reed <i>Phragmites australis</i>), <i>Toolim</i> (Pale Rush <i>Juncus pallidus</i>), and <i>Bal-yan</i> (Cumbungi <i>Typha latifolia</i>) | <i>Tark</i> : Weapon-stems used for spear shafts for fishing. Reed cut while still green to make necklaces, weaving-bags and baskets; also a food plant. <i>Toolim</i> : Weaving baskets. <i>Bal-yan</i> : Fluff used to pack wounds under paperbark bandage. | Where possible, environmental watering aims to maintain adequate depth of water to limit terrestrial encroachment into aquatic habitats. This will also support growth on terraces, channel edge and lower bank. |

| River | Traditional Owner group | Category | Objectives & opportunities | Values & uses | How will this opportunity be considered environmental watering in 2021-22? |
|-------|-------------------------|-------------------|--|---|---|
| | | | Maintain or improve abundance of <i>Biyal</i> (River red gum <i>Eucalyptus camaldulensis</i>) | Bark removed for canoe, shelter and tools, <i>Tarnuk</i> (bowl); nectar drink; medicinal – gum or sap was used for burns to shrink or seal them, the sap is high in tannin. Leaves for steam baths. | |
| | | | Maintain or improve abundance of <i>Larrap</i> (Manna gum <i>Eucalyptus viminalis</i>) and <i>Kokibainang</i> (swamp wallaby grass <i>Amphibromus reservatus</i>). | <i>Larrap</i> : Timber used for making club-shields called Malka. Sap-sucking lerp bug gathered each season. Young leaves were fed onto fire near patient. Poultice of well-chewed leaves applied for back ache. Quail flocks attracted to Manna. <i>Kokibainang</i> : Leaves split, dried out and re-constituted in running water. Fibres twisted into rope to make long nets for game hunting. | Environmental watering cannot consider this in 2021-22 due to various constraints such as an insufficient entitlement. |
| | | Physical features | Deep pools | The presence of deep pools has cultural significance. | Environmental watering will supplement in filling and ensuring connectivity to pools where possible. |
| | | | Confluences | High cultural value due to historical use of site as a meeting place for three different Clans. | Where possible, environmental watering will aim to supplement adequate depth of water for connectivity. |
| | | Events | Holding cultural events on the Upper Barwon | Celebration of culture, family events, fishing days, cultural festivals. | Due to a limited entitlement, fresh events to support events are not possible on Wadawurrung country due to its lack of proximity to the release point. |

3.2 Social, recreational and economic values and uses of waterways

The adjacent land use of the Upper Barwon River is dominated by grazing for livestock (beef, sheep and dairy) and forestry, and is significant in terms of economic value. There is limited public access to river frontage, therefore social and recreational values and uses of the Upper Barwon are also limited. Recreational use tends to be informal and often on private land in the form of swimming and fishing. There are some public areas through towns such as Forrest, Birregurra and Winchelsea where people may gain access to frontage for camping, swimming, walking, running, fishing or events. For example, this review of the Forrest trail run was posted online: “*Conveniently located in the middle of the Otway’s, the areas surrounding are stunning.*” Claude Castro, google review (Figure 4).



Figure 4. Forrest Trail Run (Photo: Kobus de Wet).

Corangamite CMA commissioned the Geelong Values study, which examined the social and economic benefits provided by the Barwon and Moorabool Rivers to the community of Geelong, and the importance of river flows for supporting and protecting these values (RCMG, 2021). The study found that improved river flows can help protect water quality, maintain water levels and reduce the risk of algal blooms in the lower Barwon River through Geelong. The benefits of the river through Geelong are largely driven by land use surrounding the river, for example, recreation; and on an annual basis, the river and surrounding areas are visited approximately 500,000 times for recreation.

The Upper Barwon Eel Investigation project was driven by community questions. Corangamite CMA and Barwon Water collaborated with Arthur Rylah Institute (ARI) to answer these questions. The report detailed which native fish were caught during the field work and concluded that there is a lack of understanding of eel migration in the Upper Barwon system. The report has been released to the community and uploaded to Corangamite CMA’s Knowledge Base.

Corangamite CMA enquired of Colac Otway Shire Council to determine if there are events that can be supported through delivery of environmental water. Colac Otway Shire Council advised that they are unaware of any events that will be impacted by or benefit from increased flows. Opportunities to

support social, recreational and economic values are incorporated into planning and watering decisions if they do not compromise environmental outcomes.

While access in some parts of the river is limited, environmental water supports a range of informal activities such as swimming, camping, bird watching and fishing. Native fish species such as the River Blackfish are supported through environmental water flows (Figure 5).



Figure 5. River Blackfish (*Gadopsis marmoratus*) found in the Upper Barwon (Photo: ARI 2019).

Table 5 presents the potential social, recreational and economic benefits for the 2022-23 water year.

Table 5. Social, recreational, and economic shared benefits for the Upper Barwon River for 2022-23

| Waterway | Beneficiary | Connection to the river | Values / uses / objectives / opportunities | How have these benefits been considered? |
|--------------------|---|---|---|--|
| Upper Barwon River | Recreation: fishing | Recreational fishing is important for social and recreational purposes. Recreational fishers have an interest in maintaining a healthy system. | A healthy fish population is important as it provides opportunities for recreational fishing. | Environmental watering supports a healthy system. Low flow watering supports connectivity throughout the reaches and allows fish to move. Fresh events aid in maintaining and expanding migratory fish populations as they trigger migration and support their life cycle. |
| Upper Barwon River | Recreation: water based e.g. canoeing, swimming | Water based recreational activities are important for social and recreational purposes. Those who engage with the natural environment are likely to support the idea of maintaining a healthy system. | Adequate water quality, depth and connectivity are important for those who engage in recreational water activities. | Environmental watering where possible supports a healthy, flowing and connected system with increased depth to create more opportunities for people engaging in recreational water activities. |
| Upper Barwon River | Economic: stock and domestic use | The Upper Barwon River predominantly flows through private property which is sometimes used for farming purposes. Landholders have an interest in maintaining a healthy system. | Adequate water quality, depth and connectivity are important to ensure use as a water supply catchment. | Where possible, environmental watering supports a healthy, flowing and connected system with increased depth and water quality to ensure economic values are retained. |

4. Seasonal review 2021-22

4.1 Climate

The Barwon South-west region has a temperate climate with mild to warm summers and cold winters. Summer average maximum temperatures are around 22 to 24°C near the coast and in elevated areas, and 25 to 27°C inland. Winter average maximum temperatures are around 12 to 14°C. Rainfall occurs mostly in winter and spring and is generally the result of rain-bearing weather systems coming from the west (DELWP, 2015).

2021 was the coolest year since 2012, but still the 19th warmest year on record with the national mean temperature at 0.56°C warmer than the 1961-1990 average. Rainfall was above average for eastern Victoria, however parts of western Victoria were below average. La Niña remained through summer 2020-21, returning to neutral during March, before becoming established again in November 2021. A negative Indian Ocean Dipole in winter and spring fuelled above average winter/spring rainfall in parts of southern Australia (BOM, 2022).

Rainfall in the Upper Barwon was above average in 2021 (Figure 6), with nine months of the year being wetter than average (2000-2019) and three months being drier, including March which was significantly below average (Figure 6). In 2022, rainfall was above average in January and March (Figure 6).

The West Barwon Reservoir was spilling due to unusually wet conditions over Winter/Spring. The spilling reservoir produced very high flow volumes passing through the west branch, which caused road flooding. This was exacerbated due to numerous weed chokepoints throughout the Upper Barwon system. Corangamite CMA was not releasing environmental water during this time.

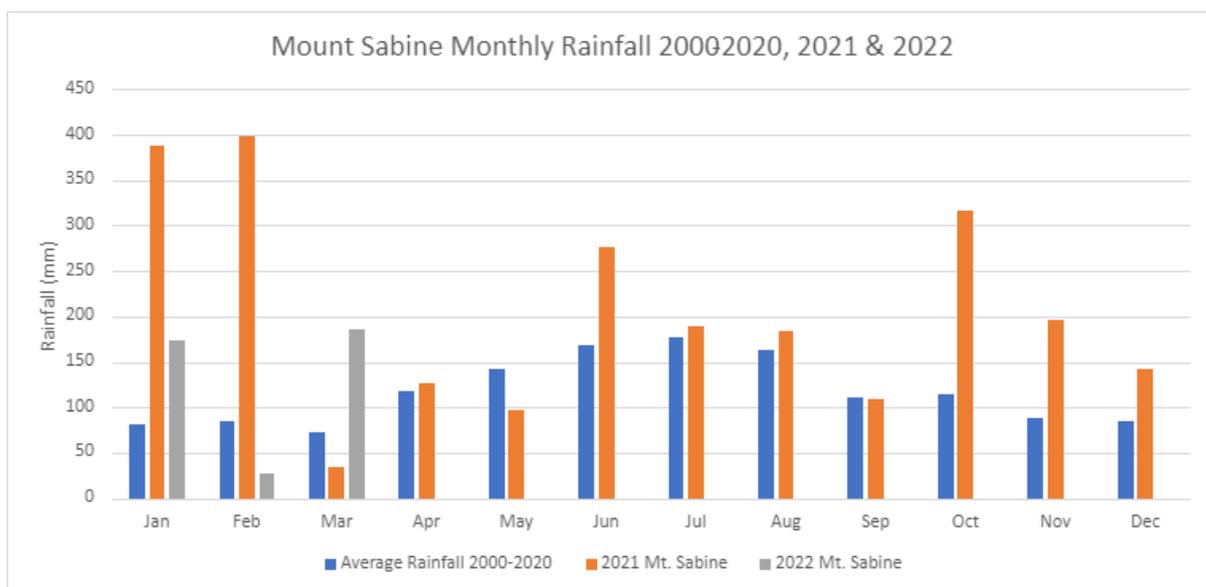


Figure 6. A comparison of monthly average rainfall (2000-2020) at Mount Sabine with 2021 and 2022 monthly rainfall

4.2 Environmental water delivery 2021-22

The FLOWS Update (Alluvium, 2021) details priorities and flow recommendations for the east and west branches of the Upper Barwon River. The east branch has priority over west branch. Corangamite CMA does not release environmental water during Flood Watches and only releases small volumes compared to natural events. If a natural flooding event occurs, the relative contribution of the environmental releases is minimal. This applies to both the east and west branches.

East branch

The East Barwon @ U/S River King Creek Junction gauge tops out at approximately 35ML/day and went offline in early December 2021. The East Barwon River @ Flume gauge can be used as an alternative gauge to monitor flows, but tops out at approximately 100ML/day, resulting in unverified data. To gain an understanding of whether the east branch flow recommendations were achieved, Corangamite CMA graphed both the East Barwon @ U/S River King Creek Junction gauge data and the East Barwon River @ Flume gauge data, and removed all unverified data points, as denoted Figure 8.

Over the wet period, the east branch experienced high natural flows, especially in July, October and November, achieving approximately 50% of low flow recommendations for that period if the flume gauge data is considered (Figure 8). It is possible that a wet period fresh was met, however this cannot be confirmed as the flow recommendation is higher than the range of the available gauges, and the range was exceeded during the period.

Given our understanding of the degree of channel constriction along the Upper Barwon east branch and associated risk of flooding, the dry period freshes planned were reduced from the recommended 35ML/day to 9ML/day. However, due to the Barwon Water willow removal occurring December 2021-April 2022, Corangamite CMA was unable to release any environmental water down the east branch over the dry period. Three partial freshes (<35ML/day for 2 days) were achieved naturally in January and March. Dry period low flows (0.5ML/day) were achieved naturally (Figure 8).

West branch

Over the wet period, high rainfall in August-November allowed for some good natural flows, but overall the base flow was still well short of the low flow recommendation for this period (100ML/day) (Figure 9). Wet period freshes, and even bankfull freshes, may have been achieved naturally with a spilling reservoir, however because the west branch gauge cannot read flow rates greater than approximately 75ML/d, this cannot be assessed. As a result of the Corangamite CMA being unable to make environmental releases down the east branch, delivery was focused on the west branch, with releases of 6ML/day dry period low flows from mid-December 2021 until mid-January. Flows were suspended due to a BOM Storm Warning and recommenced after three days. Dry period low flows were increased to 6-20ML/d for variability during February-March. The 6ML/day did not achieve the dry period low flow recommendations, but the combined natural flow and environmental water releases will have benefited the river. Due to the West Barwon Reservoir spilling from mid-March 2022 the releases of 8-11 ML/day dry period low flows were ceased and recommenced early-April 2022.

Corangamite CMA will not attempt to release a dry period fresh (100ML/day for six days each) until weed choke points have been removed in the west branch, as localised flooding would occur. The limited volume of the current environmental entitlement would also not allow for delivery of this flow component under the current order of priorities. The planned removal of weeds and improvements of river health are planned to continue over time with funding through the Barwon Flagship. Larger volumes of environmental water down the west branch in future years will also be dependent on recovering more water for the environment, as outlined in the DRAFT Central and Gippsland Region Sustainable Water Strategy.

Ricketts Marsh

The Ricketts Marsh gauge is downstream from the east and west branches. Comparing Ricketts Marsh natural flows to Winchelsea natural flows shows that the Upper Barwon received high volumes of water in 2021. Winchelsea flows were constantly higher than Ricketts Marsh, this is expected in a naturally wet year as the Winchelsea gauge is downstream from the Ricketts Marsh gauge (Figure 7), and river flows build, with surface run off and tributaries entering, moving downstream in a natural system.

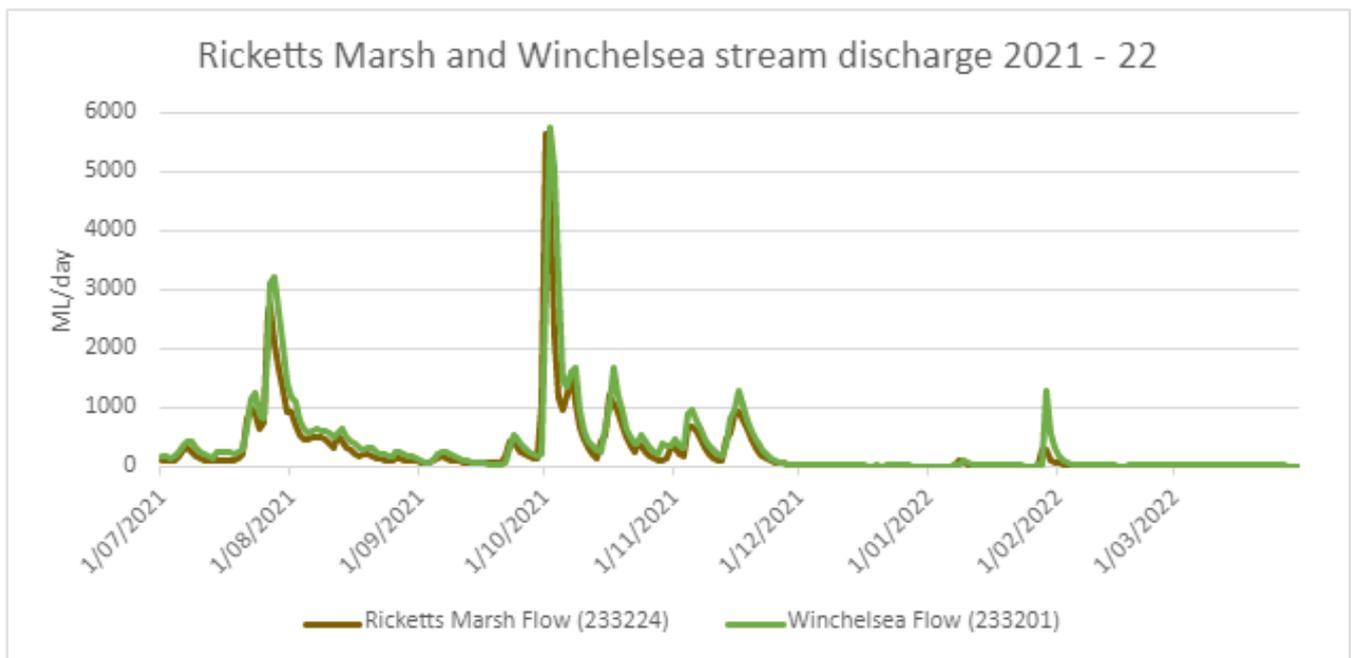


Figure 7. Daily average stream flow at Ricketts Marsh and Winchelsea, 2021-22

Due to higher-than-average rainfall during the winter months, Ricketts Marsh natural flow achieved all of the wet period fresh flow recommendations (Figure 10). Dry period fresh recommendations were not achieved, noting that natural flows also peaked in this time at 300ML/day for 2 days.

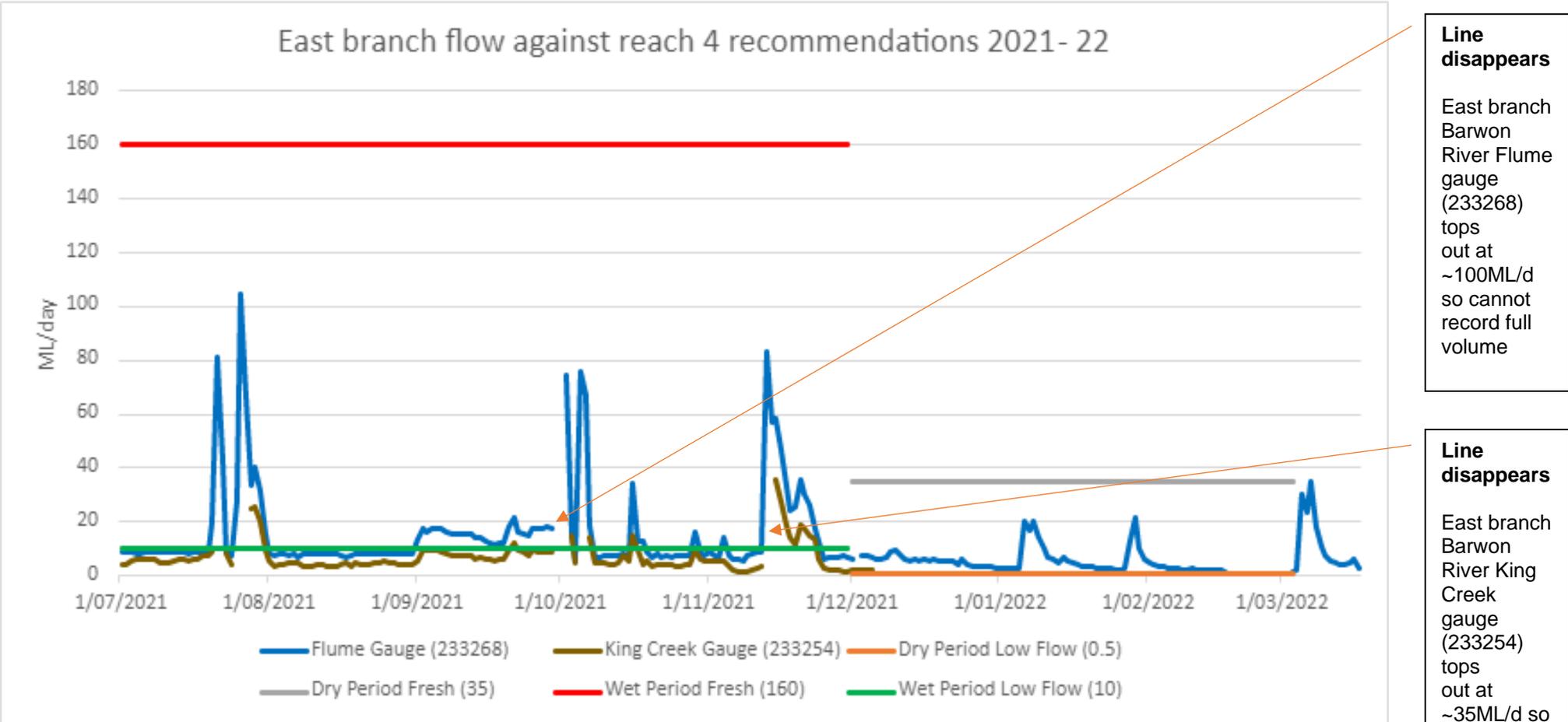


Figure 8. East branch flow against reach 4 flow recommendations achieved 2021-22. Note, no environmental water releases occurred.

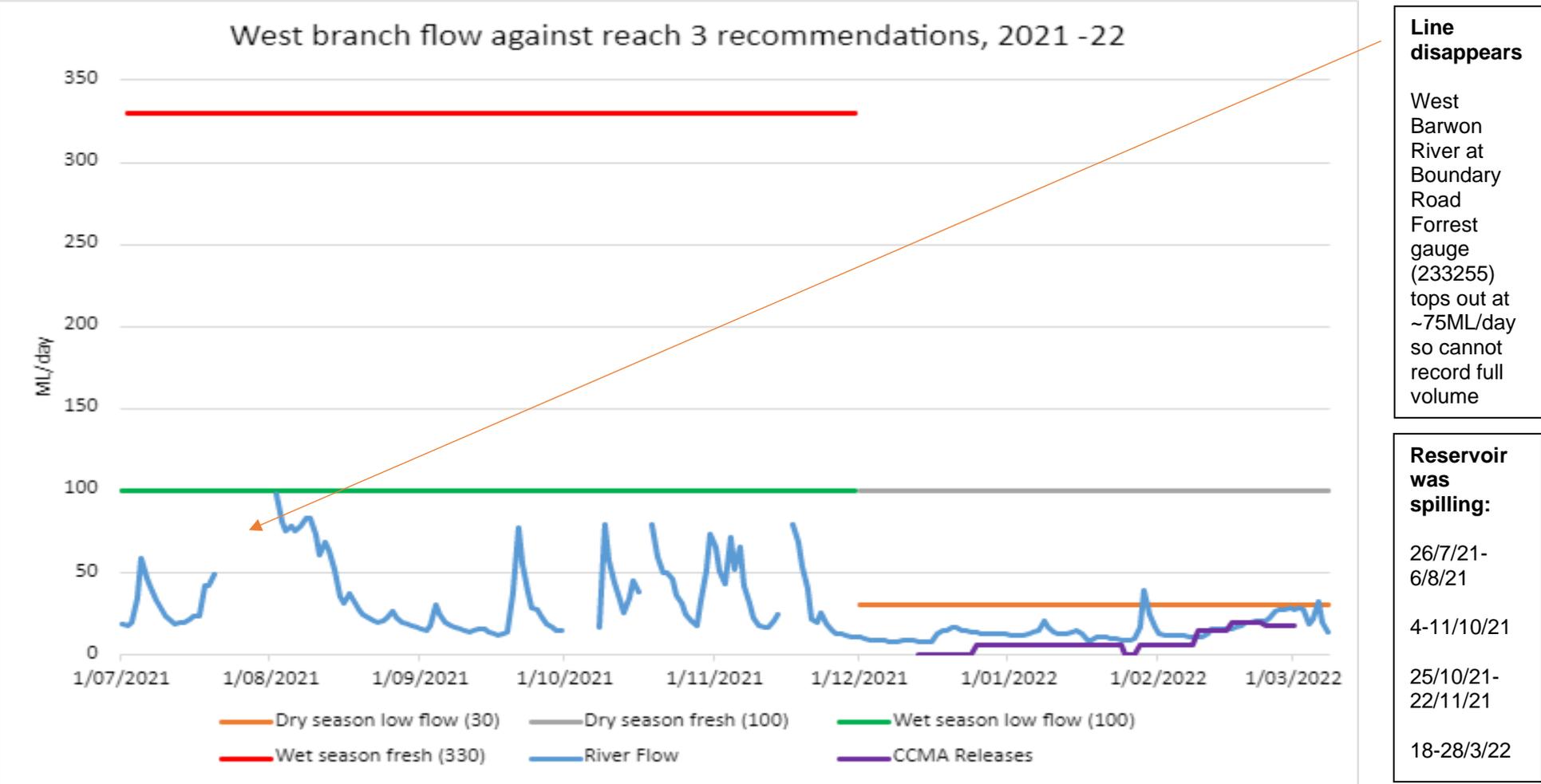


Figure 9. West branch flow against reach 3 flow recommendations in 2021-22

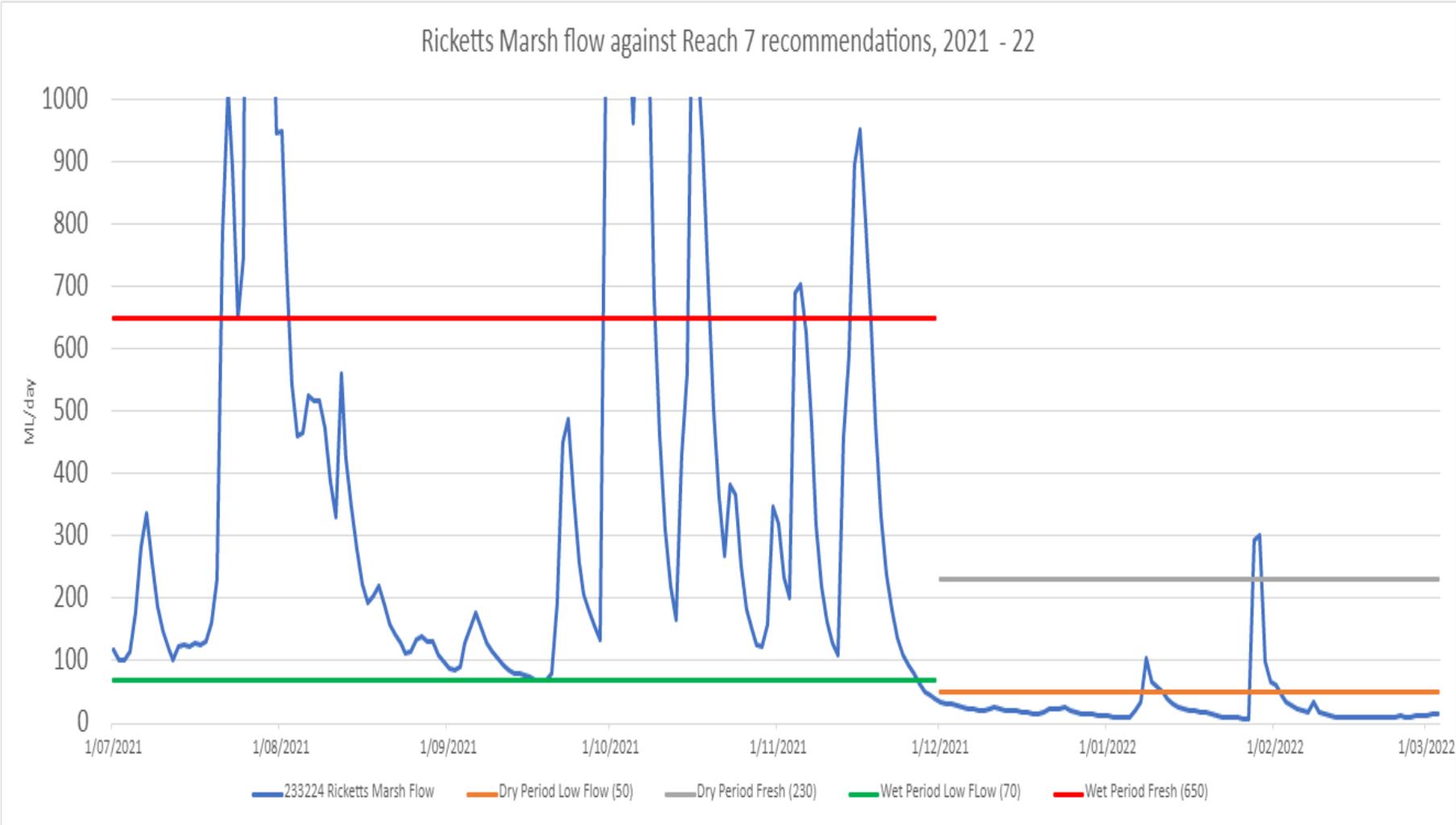


Figure 10. Daily average stream flow at Ricketts Marsh against reach 7 flow recommendations achieved 2021-22

The 2021-22 Environmental Water release program and its compliance at Ricketts Marsh is outlined below in **Error! Reference source not found..**

Table 6. Environmental water program 2021-22

| Flow priorities | Rate | Duration | Total | Achieved? | How? |
|---|---------------------|----------|--------|---|---|
| Priority 1: East Branch dry period Low Flow (Dec – May) | 0.5-5ML/day | 181 days | 90.5ML | Not able to release water down the east branch due to Barwon Water willow removal works but mostly achieved naturally | Achieved due to natural flows |
| Priority 2: 1st fresh East Branch dry period Fresh | 9ML/day + ramp days | 2 days | 50ML | Not able to release water down the east branch due to Barwon Water willow removal works | Achieved due to natural flows |
| Priority 2: 2nd fresh East Branch dry period Fresh | 9ML/day + ramp days | 2 days | 50ML | Not able to release water down the east branch due to Barwon Water willow removal works | Achieved due to natural flows |
| Priority 3: West Branch dry period Low Flow (Dec – May) | 2-4ML/day | 181 days | 362ML | Not able to release water down the west branch in March/April due to West Barwon Reservoir spilling | Partially achieved through environmental releases and natural flows |

4.3 Hydrological achievement

Water monitoring gauges can be used to assess whether releases from the West Barwon Reservoir are meeting environmental flow recommendations downstream; and they are used to monitor compliance and inform planning and delivery. Historically, monitoring of flow compliance for environmental watering on the east branch was assessed via flow rate data provided by Barwon Water immediately downstream of the Upper Barwon east branch release point. In 2020, the East Barwon River @ U/S King Creek Junction gauge was installed on the east branch. This gauge is offline at the time of writing but should be reinstated in Spring 2022. Corangamite CMA is retrospectively using Barwon River data from East Barwon River @ Flume gauge located downstream of Barwon Water's diversion channel, in its place. This is used to help assess flow delivery against recommendations in the east branch, however it is situated at the start of the watered reach, rather than further down like the East Barwon River @ U/S King Creek Junction gauge. Flow compliance in the west branch is assessed using the West Barwon River @ Boundary Road Forrest gauge and reach 7 will continue to be monitored through the Barwon River @ Rickett's Marsh gauge, just downstream of Birregurra.

Although no environmental water was delivered over the wet period (June to November) during the 2021-2022 water year, in the east branch, a wet winter and spring, particularly July, October and November, ensured that wet period recommendations were partially met naturally. In the west branch, wet period low flows were partially met naturally. Compliance below the confluence of the east and west branches at Ricketts Marsh was achieved naturally for some of the wet period freshes and winter baseflow were also met. A downpour in January resulted in some small peaks that exceeded the low flow recommendation and met the recommended fresh peak on one occasion. Flow compliance for the current and previous years as measured at gauging points available is summarised in Table 9 (reach 7 - Ricketts Marsh) and Table 7 (reach 4 – East Barwon River at Flume) below.

Table 9 shows that over the past decade, the summer low flows and freshes have not been met at Ricketts Marsh. Small winter freshes often occur naturally, with the natural flows fulfilling all of the winter fresh flow recommendations and winter base flow 99% of the time.

It should be noted that compliance for 2009-10 to 2017-18 was assessed against flow recommendations for reach 1: Upper Barwon River from the old FLOWS study (Lloyd, 2006), and during this time there was no environmental entitlement. The last four years have been assessed against the new flow recommendations for reach 7: Barwon River downstream of Boundary Creek from the FLOWS study update (Alluvium, 2021).

Table 7 outlines a check point for reach 4: Upper Barwon east, using data the new East Barwon @ U/S River King Creek Junction gauge and the East Barwon River @ Flume gauge data. Dry period flow components were naturally achieved, and wet period low flow components were achieved 50% of the time in 2021-22 for Upper Barwon east. However, the year is not over and there is still a small window of opportunity for wet period freshes be completely fulfilled in 2022.

Table 8 introduces a check point for reach 3: Upper Barwon west branch, using data from the West Barwon River at Boundary Road Forrest gauge (233255). Natural flows allowed partial wet period low flows to be achieved, and wet period freshes may have been achieved but due to the gauge topping out at 75ML/day it is not possible to assess. Dry period low flows were not achieved, and dry period freshes may have been achieved but it is not possible to assess.

Table 7. Hydrological achievement of flows 2021-22 at the east branch (East Barwon River at U/S King Creek/ East Barwon River at Flume gauge)

| Reach | Flow component (FLOWS, 2021) | | | | Hydrological achievement of flow components |
|--------------------------|------------------------------|-------|-------|-------|--|
| | | 19-20 | 20-21 | 21-22 | Ecological outcomes/observations relating to the achievement of PWA in 2021-22 |
| Upper Barwon east branch | Dry period low flow 0.5ML/d | EO | EO | OU | Flow achieved by passing/natural flow. |
| | Dry period fresh 35ML/d | | OU | X | The East Barwon River Flume gauge shows that while some reduced volume fresh events have occurred naturally, peaks levels did not meet the recommendation of 35ML/d. |
| | Wet period low flow 10ML/d | | OU | OU | Achieved approximately 50% of the time naturally. |
| | Wet period fresh 160ML/d | | OU | X | It is not possible to assess this component because the gauge tops out ~100ML/d (Flume gauge) and did exceed the gauge range during the 2021-22 year for the required period. It is possible that 1 fresh was met. |
| | Bankfull 800ML/d | | | X | It is not possible to assess this component because the gauge tops out ~100ML/d (Flume gauge) and did exceed the gauge range during the 2021-22 year for the required period. |
| | | | | | |

| | |
|---|--|
| | No significant part of the flow component achieved |
| | Flow component partially achieved |
| | Flow component has been completely achieved, i.e. complete duration, frequency and volume was achieved |
| E | Managed environmental water release |
| O | Consumptive water en route/other managed flow (including passing flows) |
| U | Unregulated (natural) |
| X | Unknown at this stage |

Table 8. Hydrological achievement of flows 2021-22 at the west branch (West Barwon River at Boundary Road Forrest)

| Reach | Flow component (FLOWS, 2021) | | Hydrological achievement of flow components |
|--------------------------|------------------------------|-------|--|
| Upper Barwon west branch | | 21-22 | Ecological outcomes/observations relating to the achievement of PWA in 2021-22 |
| | Dry period low flow 30ML/d | | Did not achieve. Low flow releases of 6-20 ML/d for most of the dry period occurred since mid-December. Releases have been increased for the remainder of the dry period. |
| | Dry period fresh 100ML/d | X | It is not possible to assess this component because the gauge tops out ~75ML/d (Flume gauge) and did exceed the gauge range during the 2021-22 year for the required period. |
| | Wet period low flow 100ML/d | X | It is likely to have been partially met through natural flow but cannot be assessed due to gauge topping out at 75ML/d. |
| | Wet period fresh 330ML/d | X | It is not possible to assess this component because the gauge tops out ~75ML/d (Flume gauge) and did exceed the gauge range during the 2021-22 year for the required period. |
| | Bankfull 2100ML/d | X | It is not possible to assess this component because the gauge tops out ~75ML/d (Flume gauge) and did exceed the gauge range during the 2021-22 year for the required period. |

| | |
|---|--|
| | No significant part of the flow component achieved |
| | Flow component partially achieved |
| | Flow component has been completely achieved, i.e. complete duration, frequency and volume was achieved |
| E | Managed environmental water release |
| O | Consumptive water en route/other managed flow (including passing flows) |
| U | Unregulated (natural) |
| X | Unknown at this stage |

Table 9. Hydrological achievement of flow compliance over time at Ricketts Marsh (Conns Lane, Birregurra): 2009-2022

| Flow Component (Lloyd, 2006) for reach 1: Upper Barwon River | Hydrological achievement of flow components over time 2009/10 to 2018/22 | | | | | | | | | Flow component (FLOWS, 2021) for reach 7: Barwon River d/s of Boundary Creek. | 18-19 | 19-20 | 20-21 | 21-22 | Ecological outcomes/observations relating to the achievement of PWA in 2021-22 |
|--|--|---------|---------|---------|---------|---------|---------|---------|---------|---|-------|-------|-------|-------|---|
| | 2009-10 | 2010-11 | 2011-12 | 2012-13 | 2013-14 | 2014-15 | 2015-16 | 2016-17 | 2017-18 | | | | | | |
| Summer low flow | | | | | | | | | | Dry period low flow 50ML/d | E | E | EO | UO | Summer low flow supplemented, approx. 25% compliance since Dec 1 (as of 3/3/2022). |
| Summer low flow freshes | | | | | | | | | | Dry period fresh 230ML/d | E | U | UO | UO | One event (Jan 2022) partially met naturally, volume exceeded recommendation (peak of 300ML/d for 2 days), however three days short for full fresh. |
| Winter baseflow | | | | | | | | | | Wet period low flow 70ML/d | U | U | UO | UO | Winter low flow was met for the majority of the wet period. |
| Winter small high flow fresh | | | | | | | | | | Wet period fresh 650ML/d | U | U | UO | UO | Five events (natural), all above recommended volume and two longer than recommended. |
| Large high flow fresh | | | | | | | | | | Bankfull 3000ML/d | | U | UO | UO | Early October for one day, with a flow of 5,675ML/d., well over the recommended 3,000ML/d and would have achieved ecological outcomes. |

| | |
|--|--|
| | No significant part of the flow component achieved |
| | Flow component partially achieved |
| | Flow component has been completely achieved, i.e. complete duration, frequency and volume was achieved |

| | |
|---|---|
| E | Managed environmental water release |
| O | Consumptive water en route/other managed flow (including passing flows) |
| U | Unregulated (natural) |
| X | Unknown at this stage |

4.4 Key ecological observations

There was one direct formal monitoring of the Upper Barwon River undertaken over the 2021-22 year: the Upper Barwon Eel Investigation, project managed by Corangamite CMA and Barwon Water and conducted by ARI. This investigation was designed to collect baseline data on short-finned eel and other native fish populations in the West Barwon Reservoir. Findings included that improved fish passage past the West Barwon Reservoir would increase opportunities for short-finned eel and migratory fish species, however there are many fish passage barriers in the catchment which are considered higher priority.

Associated studies where information can be extrapolated to infer possible outcomes associated with environmental water deliveries such as the VEFMAP program are outlined below. Corangamite CMA will continue to seek funding from investment sources for direct and relevant ecological monitoring for environmental water outcomes.

In 2020, Stage 6 of the Victorian Environmental Flows Monitoring and Evaluation Program (VEFMAP) led by the Arthur Rylah Institute (Tonkin et al., 2020), identified some of the patterns associated with fish responses to environmental flows across Victoria. Stage 6 is now complete, and Stage 7 will also look at how changing spring flow pulses and baseflow recommendations may affect fish retention and survival. Stage 7 will also focus on current knowledge gaps that are conceptual in the flow recommendations but untested, such as wetland connectivity, aquatic vegetation interactions and downstream eel migration. Stage 6 of VEFMAP identified some of the emerging patterns from environmental watering in Victoria (Table 10). The VEFMAP program does not cover all systems comprehensively in the state where environmental water is delivered. Representative systems are chosen for monitoring and assessment, with assumptions then made about similar systems such as the Upper Barwon. This information has been included and its relevance to the Upper Barwon River is addressed in Table 10.

Incidental observations are recorded where possible and the following provides a summary of community observations and reports.

Community sightings of platypus at the Meadow and at Platypus Point were confirmed (and video recorded) this summer. These sites, approximately 1km apart, are within the Barwon River and Golf Course precinct. Crayfish holes are again on the river flat. White faced Herons have nested, and raised chicks as have Kookaburras, Spotted Pardalote and Plovers, and there have been several sightings of Sacred Kingfisher. It has been a great season for birds. Other bird sightings around town include Currawong, Grey Goshawk (white variant), Superb Fairy Wren, Eastern spinebill, New Holland Honeyeater, Grey Shrike Thrush, Silvereye, Red Browed Finch, Yellow Thornbill, Brown Thornbill, Restless Flycatcher, Yellow tailed black cockatoo, Gang Gang, Rufous Whistler, Golden Whistler, and of course Magpie (Personal Comms. Lachlan Gordon).

In December 2021, Winchelsea Land and Rivercare group and the Victorian Fisheries Authority released 30,000 Estuary Perch into the Barwon River between Winchelsea and Birregurra (Personal Comms. Jim Lidgerwood).

Table 10. Identified emerging patterns in environmental watering in Victoria and their relation to the Upper Barwon

| ARI observations | Upper Barwon consideration |
|---|--|
| Given that high discharge rates in early spring increase the number of galaxiids in rivers, spring environmental flow releases are not expected to provide detectable benefits at the population scale within rivers when a large natural flow pulse has already occurred during spring. These environmental flow releases are best used in years with relatively low spring discharge (e.g. Werribee River in 2017). | This is not relevant to Upper Barwon system as there is insufficient entitlement to provide spring releases. |
| To provide conditions for upstream dispersal, instream habitat and survival of galaxiids and Tupong, maintain recent base flow targets that have been shown to provide enough depth for the upstream migration and sustain suitable water quality for galaxiids and Tupong. | Dry season base flow in the east branch is the priority watering action, given fish dispersal is not blocked by the reservoir wall. |
| Consider prioritising summer or early autumn freshes to provide connectivity for large-bodied species or, during high recruitment years (e.g. years with high spring flows for galaxiids), to enhance the upstream dispersal of juvenile diadromous fishes. However, sufficient base flows are considered a priority. | Summer or early autumn freshes are already prioritised according to the FLOWS study; however, flow constrictions and the limited nature of the entitlement mean that fresh releases will have limited effect on juvenile diadromous fishes in the middle to lower reaches. |
| Environmental base flows and fresh releases will not benefit upstream dispersal of diadromous fishes in rivers where barriers (natural or artificial) prevent their movement. | See comments above. This is also noted in the FLOWS study. Corangamite CMA has a program of prioritised fish barrier removal throughout the Barwon-Moorabool system. |

4.5 Shared benefit review

This section should be read in conjunction with Section 3.1 which outlines how stakeholders' values are considered wherever possible in the environmental delivery of water. Table 11 provides more detail where benefits are general in nature and linked to the overall watering activities, and of specific outcomes achieved in 2021-22 water year, where they exist. Corangamite CMA is flexible in its delivery approach and aspires to achieve shared benefit opportunities that arise from the delivery and use of environmental water. Wherever possible, Corangamite CMA times releases to coincide with long weekends and school holidays.

As the environmental entitlement is small, the increased flow down the upper reaches of the Barwon River is small and mainly experienced through private farming property direct access to the river. However, one community member stated that the river at Birregurra was quite extensively used for swimming in January and February, this is most likely due to high natural flows in the system. Further specific shared benefits were not reported however assumptions can be made that active and passive recreation benefits would occur downstream through the provision of water in the river, such as recreational fishing and walking.

It should be noted that due to COVID-19 restrictions, community events and gatherings were unable to occur or quite limited and this may have reduced the extent of shared benefits during

2021-22. Alternatively, downstream of private property recreation such as fishing, kayaking or bushwalking may have become more popular on the river during this time as people attempted to get outdoors locally in the midst of a pandemic, due to limited travel options. Many images can be found on social media when searching 'Barwon River', of people participating in recreation during the 2021-22 year, again potentially due to locals staying close to home when travel was limited.

Table 11. Shared benefits review

| Beneficiary | Review of benefits / outcomes |
|--|---|
| Traditional Owners | <p>Traditional Owner wellbeing is closely tied to healthy Country. Environmental flows that support and improve the health of the Upper Barwon River may therefore benefit Traditional Owners. Values include maintaining healthy, thriving, culturally significant species.</p> <p>Several of the cultural values and objectives as outlined in Table 4 for the Wadawurrung were supported in the 2020-21 watering year as a result of natural rainfall and the release of environmental flow, however it should be noted that the ability of the current releases to influence values on Wadawurrung Country is limited due to the small volume of the entitlement. These values include maintaining and improving the abundance of culturally significant species such as <i>Wad-durring/Perridak</i> (Platypus), <i>Bunya</i> (Eels), <i>Turrput</i> (native trout <i>galaxias spp</i>, <i>Ware-rap</i> (Blackfish), <i>Polango Warngare</i> (water ribbons <i>Triglochis procera</i>, <i>Tark</i> (common reed <i>Phragmites australis</i>, <i>Toolim</i> (Pale Rush <i>Juncus pallidus</i>), <i>Bal-yan</i> (Cumbungi <i>Typha latifolia</i>) and maintaining deep pools and confluences.</p> |
| Landholders | <p>Low flow releases and freshes that are delivered throughout the dry period will have contributed to prevent declines in water quality, potentially improving quality of supply for landholders who use the water for stock and domestic purposes. Environmental water may have assisted with maintaining a level of flow that mitigates invasive terrestrial vegetation intruding into the channel, which would cause constrictions and impact negatively on landholders' property as it could potentially cause flooding.</p> |
| Recreational users/environment groups/local businesses | <p>The dry period low flow released throughout summer and autumn in the west branch would have had a subtle freshening impact which may have improved water quality and connectivity. This may have benefited passive recreation for those participating in swimming, kayaking, bushwalking, camping or fishing. It was reported that the section of the river that flows through Birregurra was a popular swimming spot over summer. A member of community reported multiple platypus and crayfish hole sightings, serving aesthetic and intrinsic benefits.</p> |

5. Environmental objectives and scope of environmental watering

The Upper Barwon Surface Water Advisory Group (UBSWAG) was established by Corangamite CMA to provide feedback on surface water management planning in the Upper Barwon River to achieve environmental outcomes. The primary responsibilities of the group are to actively participate in and contribute to discussions about surface water; provide advice on environmental water related research; and be a conduit for community feedback. In 2017, the UBSWAG endorsed the following environmental watering objective:

“To improve the Barwon River’s flow-dependent ecological values and services through the provision of environmental water. The delivery of environmental water will also provide for social and cultural values for future generations.” (UBSWAG endorsed long-term watering objective for the Upper Barwon, 2017).

Consistent with this objective, the purpose of the Upper Barwon Environmental Entitlement is to reduce the adverse impacts caused by the lack of adequate flows downstream of the West Barwon Reservoir storage in reaches 3, 4, 7, 9 and 10 as identified in the Upper Barwon, Yarrowee and Leigh Rivers FLOWS Study Update (Alluvium, 2021).

5.1 Water delivery objectives

The FLOWS study update (Alluvium, 2021) highlights that the volume of water in the environmental entitlement is insufficient to meet all the recommended flow components identified (Figure 11) and sets prioritised targets for water recovery to maintain and improve flow-dependent ecological values into the future.

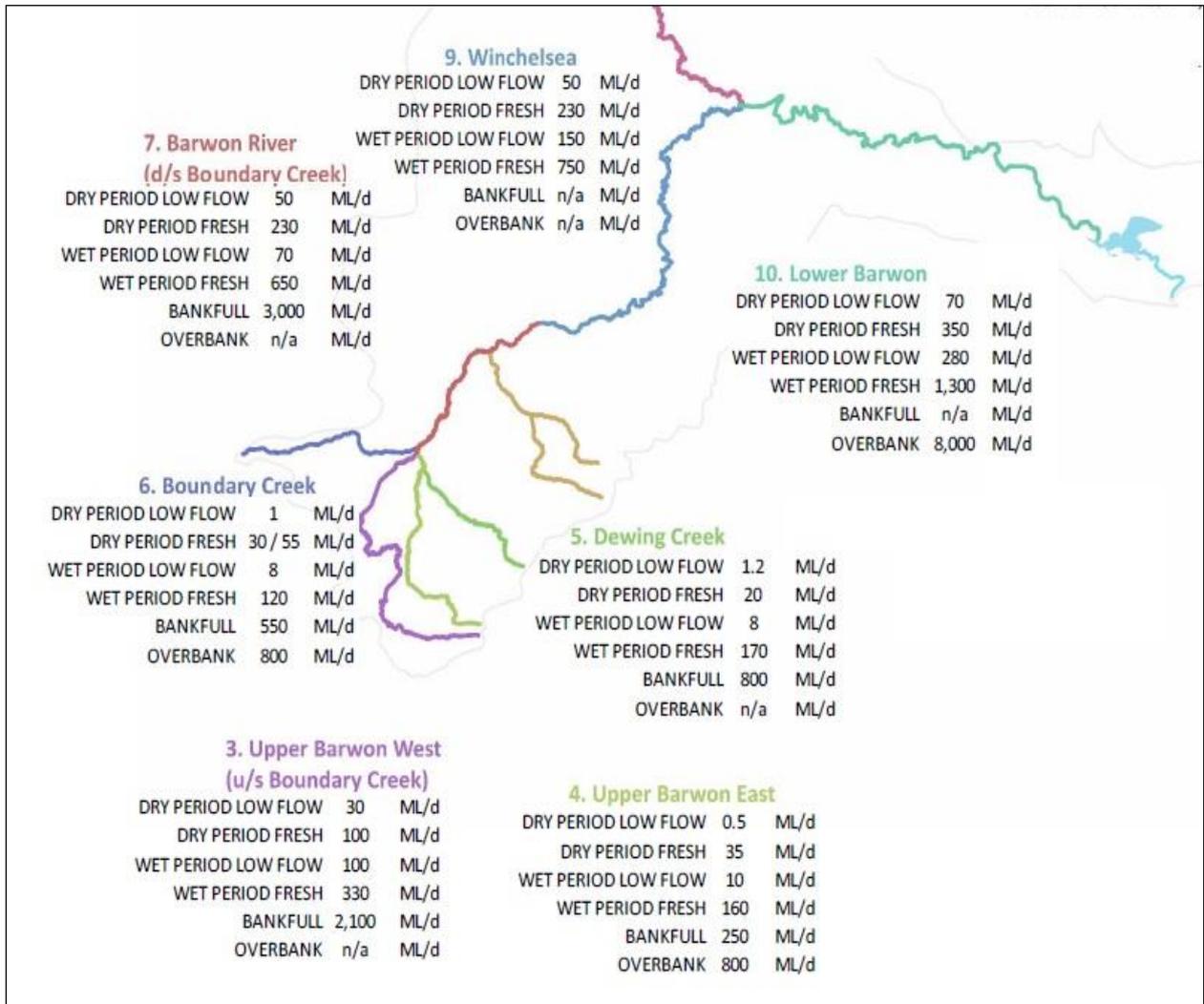


Figure 11. Flow recommendations for the Barwon River

Table 12 presents an overview of the reaches of the Barwon River that can be influenced by the entitlement. The priority of each reach is also presented.

Table 12. Environmental watering priorities and the Upper Barwon entitlement beneficiaries

| Reach No. | Reach Name | Priority | Ability of entitlement to influence |
|-----------|--|---|-------------------------------------|
| 3 | Upper Barwon west (u/s Boundary Creek) | Moderate (as a means to get more water for reaches 9 and 10). | High |
| 4 | Upper Barwon east | High | High |
| 7 | Barwon River (d/s Boundary Creek) | Medium (not assigned a priority in the FLOWS study). | Medium |
| 9 | Winchelsea | Highest | Minor |

The current environmental entitlement falls well short of the volume required to meet recommended flow components for all branches, and the physical location of the entitlement only allows provision of environmental water to the Upper Barwon east and west branches, and to a lesser extent the reaches immediately downstream, with diminishing effect. Water can reach the township of Winchelsea, however the river is prone to drying out, particularly downstream of Winchelsea before the Leigh River enters the system.

With the limited entitlement, Corangamite CMA will deliver the water available down the Upper Barwon east as a priority, then down the Upper Barwon west in order to deliver water through to priority reaches 7 and 9 located downstream. Delivery peaks will be modified to prevent flooding due to channel constricting weed infestations. Delivery of this water will assist in supporting the environmental objectives defined in the FLOWS study update (Alluvium, 2021) as follows:

- Maintain or improve abundance, breeding and recruitment of migratory fish
- Maintain or improve abundance, breeding and recruitment of resident non-migratory fish
- Maintain or improve abundance, breeding and recruitment of macroinvertebrates as a food source for fish, frog and platypus populations
- Maintain or improve abundance, breeding and recruitment of growling grass frog
- Improve condition and extent of growling grass frog
- Maintain or improve, abundance, condition and extent of platypus
- Maintain or improve condition, extent and diversity of in-stream, emergent, riparian and floodplain vegetation.

Delivery of environmental water also helps to improve and maintain good water quality and channel form.

Helping to guide the prioritisation of environmental watering, key cultural objectives identified by the Wadawurrung for the reaches of the Barwon River that flow through Country downstream of Winchelsea can be found in section 3.1 *Aboriginal cultural values and uses of waterways*.

5.2 Flow recommendations and potential watering actions

The FLOWS study update (Alluvium, 2021) recommends a flow regime for the Upper Barwon River, consisting of a number of flow components to be delivered at specific flow rates and frequencies. These are the basis for the potential watering actions in any given year, which is limited by the size of the environmental entitlement itself.

Potential watering actions produce an 'expected watering effect' in the river that will help to achieve an environmental objective. The 'expected watering effects' relate to physical, chemical, biological or behavioural responses to specific components of the watering regime. Environmental objectives, such as *'Maintain or improve abundance, breeding and recruitment of migratory fish'*, are measurable outcomes that are not solely linked to environmental watering and are often achieved through a range of complementary management activities, such as instream and riparian improvements (See Section 8 Confounding Factors).

Flow prioritisation is an important part of flow delivery planning for the Upper Barwon River due to the limited amount of water available within the entitlement and to ensure the water is used for the greatest environmental benefit. The FLOWS study update (Alluvium, 2021) was developed to determine the volume, priority and ecological objectives for flow components in the Barwon River under different climatic scenarios. It prioritises flows in the following order, with flows in the east branch prioritised over the west:

1. provision of dry season low flows
2. provision of dry season freshes
3. provision of wet season freshes
4. provision of wet season low flow.

Whilst the FLOWS study update (Alluvium, 2021) recommends delivering all the Upper Barwon east branch flow recommendations before putting water down the west, these priorities are a trade-off, particularly considering the flow volume limitations of the Upper Barwon east branch preventing delivery of wet period freshes, bank full and overbank recommendations; the exception being the ability to supplement wet period low flow. On balance, provision of water down both upper branches in the dry period is prioritised as the only practicable option.

The potential watering actions for the coming water year are detailed in Table 13. The table reflects the potential watering actions in order from highest to lowest priority. It is expected that with an average year forecast the limited entitlement and with assistance from rainfall events, there will only be enough water for priorities 1 to 4. Priority 4 may occur if the West Barwon Reservoir continues to fill with rainfall. If climate conditions change as the water year progresses, flow planning may be amended to reflect revised water availability. Refer to Appendix 5 for more detail.

Table 13. Potential watering actions for 2022-23

| Potential watering action | Priority 1: Dry period low flow (Dec-May 0.5-5ML/d) – east branch/ reach 4 | | | | |
|--|--|-----------------------|------------------------|-----------------------------|------------------------|
| Expected watering effects | <ul style="list-style-type: none"> • Provide minimum velocity to maintain mixing in pool • Provide water in pools for habitat and food sources • Provide pool habitat • Maintain adequate depth of permanent water in channel • Maintain adequate depth of permanent water in stream channel to limit terrestrial encroachment into aquatic habitats • Maintain a shallow water table with low salinity throughout the year | | | | |
| Environmental objectives | <ul style="list-style-type: none"> • Reduce prolonged stratified conditions in pools and promote adequate levels of water quality to allow fish and macroinvertebrate populations to persist • Maintain abundance of resident freshwater fish, including galaxias, smelt, big-headed gudgeon and Yarra pygmy perch. • Maintain abundance of platypus • Maintain or improve condition and extent of instream vegetation to provide structural habitat for macroinvertebrates and various fish species. • Maintain or improve condition, extent, and diversity of emergent macrophyte vegetation to provide structural habitat and channel/lower bank stability to low and moderate flows. • Maintain or improve condition and extent of floodplain vegetation as part of endangered EVCs. | | | | |
| Application of potential watering action in 2022-23 | | Magnitude (ML) | Duration (days) | Frequency (per year) | Timing (months) |
| | Dry | 0.5-5 | Continuous | Continuous | Dec to May |
| | Average | 0.5-5 | Continuous | Continuous | Dec to May |
| | Wet | 0.5-5 | Continuous | Continuous | Dec to May |
| Rationale for proposed application in 2022-23 | <p>This flow is required for the survival of high value species; to provide essential habitat for aquatic fauna; and to provide moisture to instream and emergent macrophyte vegetation. The water entitlement must be delivered down the Upper Barwon east or Upper Barwon west branches, and the Upper Barwon east branch has been identified as the higher priority. Dry period low flow is the highest flow priority. A flow release range up to 5ML/d has been proposed to achieve the average in-reach recommendation of 0.5ML/day.</p> | | | | |

| | | | | | |
|--|--|-----------------------|------------------------|-----------------------------|------------------------|
| Potential watering action | Priority 2: Dry period freshes (Dec-May modified from 35ML/d to 9ML/d for 2 days) – east branch/ reach 4 | | | | |
| Expected watering effects | <ul style="list-style-type: none"> • Provide water over riffles to allow fish to move between pools to breed, feed and find new habitats • Submerge and clean woody debris and hard surfaces to provide breeding substrate • Sustain macroinvertebrate communities during the dry period • Provide longitudinal connectivity between reaches • Provide a mosaic of spatially and temporally differentially wetted areas within stream channel, on benches and on lower banks • Support growth on terraces, channel edge and lower bank • Provide minimum velocity to establish mixing and flushing of pools • Scour sediment from base of pools to maintain pool and to use bed sediments to scour algae from riffles • Mobilise sediment from base of pools | | | | |
| Environmental objectives | <ul style="list-style-type: none"> • Maintain abundance of resident freshwater fish, including galaxias, smelt, big-headed gudgeon and Yarra pygmy perch. • Improve breeding and recruitment of resident freshwater fish including River blackfish. • Maintain abundance of macroinvertebrates as a food source for fish, frog and platypus populations. • Improve condition and extent of platypus. • Maintain or improve condition, extent, and diversity of emergent macrophyte vegetation to provide structural habitat and channel/lower bank stability to low and moderate flows. • Maintain or improve condition, extent, and diversity of riparian vegetation as part of endangered Ecological Vegetation Class (EVC). • Reduce prolonged stratified conditions in pools and promote adequate levels of water quality to allow fish and macroinvertebrate populations to persist. • Improve and maintain abundance and condition of pools, large wood and riffles to provide structural habitat for macroinvertebrates and various fish species. • S. Maintain channel capacity, shape and form to support flora and fauna values and objectives. | | | | |
| Application of potential watering action in 2022-23 | | Magnitude (ML) | Duration (days) | Frequency (per year) | Timing (months) |
| | Dry | 9 | 2 | 2 | Dec to May |
| | Average | 9 | 2 | 2 | Dec to May |
| | Wet | 9 | 2 | 3 | Dec to May |
| Rationale for proposed application in 2022-23 | <p>These freshes provide flushes that assist in maintaining adequate water quality and the opportunities for migration of fish and other fauna. Without these freshes, there is the potential for regional extinction and many species will not be able to move to new habitats and reproduce. The flows recommendation states peak fresh volume of 35ML/d however flow constrictions in the Upper Barwon branch will only allow delivery of considerably less than 35ML/d to prevent localised flooding. Peak fresh volumes will be modified based on delivery experience gained from the previous water years and 'real time' local knowledge around constriction impacts and management. In the 2019/2020 water year 9ML/d passed down the east branch within the channel, however 15ML/d did not. Watering action will be released at 9ML/d to avoid flooding.</p> | | | | |

| | | | | | |
|--|--|----------------|-----------------|----------------------|-----------------|
| Potential watering action | Priority 3: Dry period low flow (Dec-May 3 to 30ML/d, as water availability permits) – west branch/ reach 3 | | | | |
| Expected watering effects | <ul style="list-style-type: none"> • Provide minimum velocity to maintain mixing in pool • Provide water in pools for habitat and food sources • Provide pool habitat • Maintain adequate depth of permanent water in channel • Maintain adequate depth of permanent water in stream channel to limit terrestrial encroachment into aquatic habitats • Maintain a shallow water table with low salinity groundwater throughout the year • Provide minimum velocity to maintain mixing in pool | | | | |
| Environmental objectives | <ul style="list-style-type: none"> • Reduce prolonged stratified conditions in pools and promote adequate levels of water quality to allow fish and macroinvertebrate populations to persist • Maintain abundance of migratory fish including short-finned eels, Australian grayling, and tupong. • Maintain abundance of resident freshwater fish, including galaxias, smelt, big-headed gudgeon and Yarra pygmy perch. • Maintain or improve condition and extent of instream vegetation to provide structural habitat for macroinvertebrates and various fish species. • Maintain or improve condition, extent, and diversity of emergent macrophyte vegetation to provide structural habitat and channel/lower bank stability to low and moderate flows. • Maintain or improve condition and extent of floodplain vegetation as part of endangered EVCs. • Reduce prolonged stratified conditions in pools and promote adequate levels of water quality to allow fish and macroinvertebrate populations to persist. | | | | |
| Application of potential watering action in 2022-23 | | Magnitude (ML) | Duration (days) | Frequency (per year) | Timing (months) |
| | Dry | 3 to 30 ML/d | Continuous | Continuous | Dec to May |
| | Average | 3 to 30 ML/d | Continuous | Continuous | Dec to May |
| | Wet | 3 to 30 ML/d | Continuous | Continuous | Dec to May |
| Rationale for proposed application in 2022-23 | <p>Low flows are required for the survival of high value species, to provide essential habitat for aquatic fauna and to provide moisture to instream and emergent macrophyte vegetation. While the next priority in the FLOWS study is wet period freshes, such freshes cannot be delivered down the Upper Barwon east branch due to flow constrictions. It has therefore been decided that delivering dry period low flow down the Upper Barwon west branch should be the next priority. The flows recommendations state 30ML/d however it is likely to be delivered at a much lower rate of up to 30ML/d due to the small entitlement. The combined flow down the Upper Barwon east will help deliver more of this top priority component to the higher priority Winchelsea reach downstream.</p> | | | | |

| | | | | | |
|--|---|-----------------------|------------------------|-----------------------------|------------------------|
| Potential watering action | Priority 4: Wet period low flow (June-Nov modified from 10ML/d to 9ML/d, as water availability permits) – east branch/ reach 4 | | | | |
| Expected watering effects | <ul style="list-style-type: none"> • Mobilise sediment from base of pools for sustained duration • Provide water in pools for habitat and food sources • Provide pool habitat • Maintain adequate depth of permanent water in the channel, with natural seasonal drawdown to promote recruitment • Maintain adequate depth of permanent water in stream channel to limit terrestrial encroachment into aquatic habitats • Maintain a shallow water table with low salinity groundwater throughout the year • Provide minimum velocity to maintain mixing in pool | | | | |
| Environmental objectives | <ul style="list-style-type: none"> • Maintain channel capacity, shape and form to support flora and fauna values and objectives. • Maintain abundance of migratory fish including short-finned eels, Australian grayling and tupoong. • Maintain abundance of resident freshwater fish, including galaxias, smelt, big-headed gudgeon and Yarra Pygmy perch. • Maintain abundance of platypus. Maintain or improve condition and extent of instream vegetation to provide structural habitat for macroinvertebrates and various fish species. • Maintain or improve condition, extent and diversity of emergent macrophyte vegetation to provide structural habitat and channel/lower bank stability to low and moderate flows. • Maintain or improve condition and extent of floodplain vegetation as part of endangered EVCs. • Reduce prolonged stratified conditions in pools and promote adequate levels of water quality to allow fish and macroinvertebrate populations to persist. | | | | |
| Application of potential watering action in 2022-23 | | Magnitude (ML) | Duration (days) | Frequency (per year) | Timing (months) |
| | Dry | 9 | Continuous | Continuous | June to Nov |
| | Average | 9 | Continuous | Continuous | June to Nov |
| | Wet | 9 | Continuous | Continuous | June to Nov |
| Rationale for proposed application in 2022-23 | As mentioned above, low flows are required for the survival of high value species, to provide essential habitat for aquatic fauna and to provide moisture to instream and emergent macrophyte vegetation. The water entitlement must be delivered down the Upper Barwon east or Upper Barwon west branches, and the Upper Barwon east branch has been identified as the higher priority. A flow variability could be achieved as variability is important for native species. The flows recommendations state 10ML/d however the watering action will be reduced to 9ML/d to avoid flooding. | | | | |

| | | | | | |
|--|---|-----------------------|------------------------|-----------------------------|------------------------|
| Potential watering action | Priority 5: Dry period fresh (Dec-May modified from 100ML/d to 20-30ML/d for 6 days x5) – west branch/ reach 3 | | | | |
| Expected watering effects | <ul style="list-style-type: none"> • Provide water over riffles to allow fish to migrate upstream from estuary • Provide water over riffles to allow fish to move between pools to breed, feed and find new habitats • Submerge and clean woody debris and hard surfaces to provide breeding substrate • Sustain macroinvertebrate communities during the dry period • Provide longitudinal connectivity between reaches • Provide a mosaic of spatially and temporally differentially wetted areas within stream channel, on benches and on lower banks • Support growth on terraces, channel edge and lower bank • Provide minimum velocity to establish mixing and flushing of pools • Scour sediment from base of pools to maintain pool and to use bed sediments to scour algae from riffles • Mobilise sediment from base of pools | | | | |
| Environmental objectives | <ul style="list-style-type: none"> • Maintain abundance of migratory fish including short-finned eels, Australian grayling, and tupong. • Maintain abundance of resident freshwater fish, including galaxias, smelt, big-headed gudgeon and Yarra pygmy perch. • Improve breeding and recruitment of resident freshwater fish including River blackfish. • Maintain abundance of macroinvertebrates as a food source for fish, frog and platypus populations. • Improve condition and extent of platypus. • Maintain or improve condition, extent, and diversity of emergent macrophyte vegetation to provide structural habitat and channel/lower bank stability to low and moderate flows. • Maintain or improve condition, extent, and diversity of riparian vegetation as part of endangered Ecological Vegetation Class (EVC). • Reduce prolonged stratified conditions in pools and promote adequate levels of water quality to allow fish and macroinvertebrate populations to persist. • Improve and maintain abundance and condition of pools, large wood and riffles to provide structural habitat for macroinvertebrates and various fish species. • Maintain channel capacity, shape and form to support flora and fauna values and objectives. | | | | |
| Application of potential watering action in 2022-23 | | Magnitude (ML) | Duration (days) | Frequency (per year) | Timing (months) |
| | Dry | 20-30 | 6 | 5 | Dec to May |
| | Average | 20-30 | 6 | 5 | Dec to May |
| | Wet | 20-30 | 8 | 6 | Dec to May |
| Rationale for proposed application in 2022-23 | <p>As above, after all the flow components that can be physically delivered down the Upper Barwon east have been achieved, the next priority is to target a dry period fresh down the Upper Barwon west branch following a dry period low flow. These freshes provide flushes that assist in maintaining adequate water quality and the opportunities for migration of fish and other fauna. Without these freshes, there is the potential for regional extinction and many species will not be able to move to new habitats and reproduce. The flows recommendations state 100ML/d however the watering action will be reduced to 20-30ML/d due to current restrictions. As weed choke points are removed release volumes will be increased from 20ML/d.</p> | | | | |

| | | | | | |
|--|--|-----------------------|------------------------|-----------------------------|------------------------|
| Potential watering action | Priority 6: Wet period low flow (June-Nov modified from 100ML/d to 20-30ML/d) – west branch/ reach 3 | | | | |
| Expected watering effects | <ul style="list-style-type: none"> • Mobilise sediment from base of pools for sustained duration • Provide water in pools for habitat and food sources • Provide pool habitat • Maintain adequate depth of permanent water in the channel, with natural seasonal drawdown to promote recruitment • Maintain adequate depth of permanent water in stream channel to limit terrestrial encroachment into aquatic habitats • Maintain a shallow water table with low salinity groundwater throughout the year • Provide minimum velocity to maintain mixing in pool | | | | |
| Environmental objectives | <ul style="list-style-type: none"> • Maintain channel capacity, shape and form to support flora and fauna values and objectives. • Maintain abundance of migratory fish including short-finned eels, Australian grayling and tupong. • Maintain abundance of resident freshwater fish, including galaxias, smelt, big-headed gudgeon and Yarra Pygmy perch. • Maintain abundance of platypus. Maintain or improve condition and extent of instream vegetation to provide structural habitat for macroinvertebrates and various fish species. • Maintain or improve condition, extent and diversity of emergent macrophyte vegetation to provide structural habitat and channel/lower bank stability to low and moderate flows. • Maintain or improve condition and extent of floodplain vegetation as part of endangered EVCs. • Reduce prolonged stratified conditions in pools and promote adequate levels of water quality to allow fish and macroinvertebrate populations to persist. | | | | |
| Application of potential watering action in 2022-23 | | Magnitude (ML) | Duration (days) | Frequency (per year) | Timing (months) |
| | Dry | 20-30 | Continuous | Continuous | June to Nov |
| | Average | 20-30 | Continuous | Continuous | June to Nov |
| | Wet | 20-30 | Continuous | Continuous | June to Nov |
| Rationale for proposed application in 2022-23 | As mentioned above, these flows play an important role in channel shape and form over long time scales. Failure to provide these flows over long periods of time may result in reduction of available habitat due to deposition of material in pools and other changes in channel form. While the next flow component priority after dry period freshes is wet period freshes, these are undeliverable at anywhere near the recommended volume of 100ML/d, with the current restrictions. Wet period low flow is therefore the next priority and can be achieved in a modified form if the water is available, at approximately 20-30ML/d. | | | | |

6. Scenario Planning

6.1 Outlook for 2022-23

The Barwon South West region has a temperate climate, with mild to warm summers and cold winters. Summer average maximum temperatures are around 22-24°C near the coast and in elevated areas, and 25-27°C inland. Winter average maximum temperatures are around 12-14°C. Rainfall occurs mostly in winter and spring and is generally the result of rain-bearing weather systems coming from the west (DELWP, 2015). Regarding long term climate projection (DELWP & CSIRO, 2019), based on a medium (RCP4.5) emissions scenario, annual rainfall totals are likely to decline by 25% by the end of the decade, with the greatest drying to occur in spring. As warming continues, more heat extremes will occur.

Australia's temperature and rainfall variability are influenced by global warming caused by human activities, with the nation's climate warming by around 1.44 °C since 1910 (BOM, 2021). In 2022, the BOM (2022) predicts February to April 2022 is likely to be wetter than average for much of Australia and eastern Victoria, but makes no prediction for south west Victoria. Whilst the outlook may indicate wetter than average conditions, the southern part of Australia is in its drier season, therefore even if rainfall is above average it is not likely to be enough to relieve long-term rainfall deficits. Minimum temperatures for January to March are likely to be warmer than median in Victoria. The second year of La Niña in the Pacific Ocean and the positive Southern Annular Mode (SAM) are likely the influence these climate outlooks.

On balance it is thought that an average or wet year of rainfall is likely for the upcoming water year.

Given this year's average/wet conditions and the relative unpredictability of what this means locally, the FLOWS study update (Alluvium, 2021) recommendations for the Upper Barwon will be in line with an 'average year' and prioritised based on the available entitlement. In a year of potential unknowns regarding rainfall, a priority-based regime would attempt to avoid multiple loss of fauna and flora. Regular monitoring of water levels and discharge through DELWP's Water Measurement Information System (WMIS) and field observations will be important to determine the best time to release and in what volume. Even in wetter years, monitoring is important to determine how rainfall is delivering flows to meet our objectives.

In the event of flooding, environmental flows will not be delivered. In the event of average or high flow in the catchment, the flow planning would be reassessed against the recommendations to determine a new priority for flow releases.

6.2 Scenario planning

Planning for this year's environmental watering has been tailored to average rainfall conditions (see Section 4.1) but may be adapted if conditions change. The average year scenario has been highlighted in Table 14, which outlines how achievement of priorities may change under a range of resource availability and climate scenarios. In the driest scenarios, the priority is to avoid critical losses or catastrophic events, while in wetter years the priority is to maximise recruitment, build resilience and maintain geomorphic processes. The ecological objectives of environmental

watering under different climates are developed through consideration of impacts from four different seasonal outcomes, ranging through drought, dry, average and wet.

The analysis of hydrological compliance over recent years (Section 4), shows typically a shortage of water availability especially over the dry months. Depending on climatic conditions it is expected that all the available entitlement will be delivered or held in drought reserve (500ML) over this dry period, which means wet period flows are reliant on rainfall events. There will be an increased capacity to meet a larger number of priority flow components in wetter years as more elements will be met by naturally occurring flows. Because the current entitlement only secures a fraction of the river's water requirements, the achievement of environmental flow components is largely dependent on the prevailing climate during the 2022-23 water year.

Table 14. Planning of environmental watering under different climate scenarios

| UPPER BARWON | Drought | Dry | Average (predicted) | Wet |
|--|--|---|---|--|
| Expected availability of environmental water | <p>Assumptions.</p> <ul style="list-style-type: none"> Starting volume 2000ML No inflows. <p>Less the reserve, which would still be planned to be carried over in the first year of drought, that leaves 1500ML to use.</p> | <p>Assumptions.</p> <ul style="list-style-type: none"> Starting volume 2000ML 500ML of inflows <p>Less the reserve, that leaves 2000ML to use.</p> | <p>Assumptions.</p> <ul style="list-style-type: none"> Starting volume 2000ML 1000ML of inflows <p>Less the reserve, that leaves 2500ML to use.</p> | <p>Assumptions.</p> <ul style="list-style-type: none"> Starting volume 2000ML 1500ML of inflows <p>Less the reserve, that leaves 3000ML to use.</p> |
| Expected river conditions (including unregulated water, consumptive water, etc.) | <p>Disconnected pools in some parts of the system. Cease to flow events.</p> <p>Disconnected refuge habitat pools.</p> <p>Deteriorating water quality.</p> <p>No passing flows over summer.</p> | <p>Disconnected pools in some parts during first half of the year. Cease to flow events.</p> <p>Disconnected refuge habitat pools</p> <p>Little to no passing flows over summer.</p> | <p>Some passing flows (~50%) over summer, high peaks in winter months. Good connectivity especially in winter and spring.</p> | <p>Full passing flows being released. Good connectivity year-round. Possibility of a spilling reservoir.</p> |
| Logic for scenario | <p>Going into a first year of drought conditions, essentially no inflows (noting that you need more than one year of no inflows to declare a drought) with a full entitlement, normal environmental water delivery will still be possible. The limitation would be the entitlement rather than the drought conditions.</p> <p>Carryover of 500ML will still be possible.</p> | <p>The logic here is the same as for the drought scenario, but it is assumed that some inflows will be received and that conditions will be slightly less dry, allowing less water to be used to achieve watering actions in the east branch.</p> | <p>Under this scenario, flow compliance in the east branch can be maintained with lower releases again, due to a wetter system and passing flows. It is assumed that passing flows will also contribute to west branch flows.</p> | <p>The logic here is the same as for the average scenario, but <i>greater</i> benefits can be provided to the upper west branch and lower reaches due to greater volume of water available for delivery and the likelihood of east branch flow components being met naturally.</p> |

| UPPER BARWON | Drought | Dry | Average (predicted) | Wet |
|---|--|--|---|--|
| Tier 1a Potential watering actions: expected to be delivered in 2021-22 | <ul style="list-style-type: none"> • Priority 1 – East branch dry period low flow 0.5-5 (may need up to 5 ML/day release to achieve 0.5 ML/d in channel). • Priority 2- East branch dry period freshes x 2 - 9 ML/d (constraints allow <15 ML/day) ML/day for 2 days • Priority 3- West branch dry period low flow up to 3 ML/day (modified volume) | <ul style="list-style-type: none"> • Priority 1 – East branch dry period low flow 0.5-5 (may need 2.5 ML/day release to achieve 0.5 ML/d in channel) - 6 months at ~2.5 ML/d • Priority 2- East branch dry period freshes x 2 - 9 ML/d (constraints allow <15 ML/day) ML/day for 2 days. • Priority 3- West branch dry period low flow up to 8 ML/day (modified volume) | <ul style="list-style-type: none"> • Priority 1 – East branch dry period low flow 0.5-5 (may need 1.5 ML/day release to achieve 0.5 ML/d in channel) • Priority 2- East branch dry period freshes x 2 - 9 ML/d (constraints allow <15 ML/day) ML/day for 2 days. • Priority 3- West branch dry period low flow up to 12 ML/day (modified volume) | <ul style="list-style-type: none"> • Priority 1 – East branch dry period low flow 0.5-5 (release 0 ML/day)- achieved naturally • Priority 2- East branch dry period freshes x 3 - 9 ML/d (15) – achieved naturally. • Priority 3- West branch dry period low flow up to 16.5 ML/day (modified volume). Including passing flow would reach the constriction limit of ~20ML/d. |
| Tier 1a environmental water demand | 1464 ML | 1947 ML | 2513 ML | 2986 ML |

| UPPER BARWON | Drought | Dry | Average (predicted) | Wet |
|--|--|---|--|---|
| Tier 1b Potential watering actions: delivery is reliant on additional water/resources becoming available in 2021-22 | <ul style="list-style-type: none"> • Priority 3- West branch dry period low flow topped up to 20 ML/day (modified volume) • Priority 4- East branch wet period low flow 9 ML/day (modified volume) • Priority 5- West branch dry period fresh (modified volume) 20 ML/day for 6 days x 5 • Priority 6- West branch wet period low flow 20 ML/d (modified volume) | <ul style="list-style-type: none"> • Priority 3- West branch dry period low flow topped up to 20 ML/day (modified volume) • Priority 4- East branch wet period low flow 9 ML/day (modified volume) • Priority 5- West branch dry period fresh (modified volume) 20 ML/day for 6 days x 5 • Priority 6- West branch wet period low flow 20-30 ML/d (modified volume) | <ul style="list-style-type: none"> • Priority 3- West branch dry period low flow topped up to 20 ML/day (modified volume) • Priority 4- East branch wet period low flow 9 ML/day (modified volume) • Priority 5- West branch dry period fresh (modified volume) 20 ML/day for 6 days x 5 • Priority 6- West branch wet period low flow 20 ML/d (modified volume) | <ul style="list-style-type: none"> • Priority 4- East branch wet period low flow 9 ML/day (modified volume) • Priority 5- West branch dry period fresh (modified volume) 20 ML/day for 8 days x 6 • Priority 6- West branch wet period low flow 20 ML/d (modified volume) |
| Tier 1b environmental water demand | 7602 ML | 6697 ML | 4305 ML | 2896 ML |
| Potential environmental watering – tier 2 | NA (current physical constraints do not allow for tier 2 watering actions) | NA (current physical constraints do not allow for tier 2 watering actions) | NA (current physical constraints do not allow for tier 2 watering actions) | NA (current physical constraints do not allow for tier 2 watering actions) |
| Tier 2 environmental water demand | NA | NA | NA | NA |
| Priority carry over requirement | 500ML | 500ML | 500ML | 500ML |
| Beyond Tier 1 and 2 Water Demands: A water recovery target of 28.6GL/yr. from the West Barwon Reservoir would return the Barwon River environmental flows to within 70% of the natural flow regime. | | | | |
| *Water required to deliver all Tier 1a and Tier 1b demands at the volumes currently permitted by the infrastructure and channel constraints. It includes low flow year-round, and compromised summer freshes down both the east and west Upper Branches. | | | | |
| **Partial – partially achieved flows study magnitude recommendations | | | | |

7. Delivery constraints

7.1 Temporary constraints

Future remediation by Barwon Water of the downstream reach of the east branch, downstream of the Wurdee Boluc offtake, is currently in early concept design phase (Brigid Creasey, Personal Comms.). Barwon Water plan to commence removal of these willows and construct rock chutes over the 2023/24 summer. Wurdee Boluc channel may be utilised to divert the natural flows and transfer environmental flows around the impacted reach during construction. This would need to be worked out during the construction planning.

Although there are few potential temporary constraints that inhibit delivery, risks are identified prior to and reviewed throughout the year. Potential risks associated with climate events, such as fire, flood and heatwaves may negatively impact the water quality and availability. There is no indication that this year will be dry, however given the climate unpredictability, temporary constraints may be revealed throughout the 2022-23 year (outlined below in Table 15).

Table 15. Potential temporary constraints to environmental water delivery

| Potential temporary constraint | Impact on watering | Action |
|---|---|---|
| Weed removal works | Potential impact on low flow and fresh delivery | Corangamite CMA Estuaries & Environmental Water team to remain in close contact with the Land & Catchment Health team and Barwon Water to determine if any works are likely to impact environmental water delivery options. |
| Systematic landscape-scale in-channel weed infestations | Interrupt environmental water passing further downstream and spot works associated | Corangamite CMA conducting works at one site to deal with specific weed infestation, potentially results in reduced volumes of environmental water to facilitate works. |
| Blue-green algal bloom in storage reservoir | Interruption to environmental watering, may result in delays. | Water delivery schedule will be revised. |
| Fire in the catchment or adjacent to the river. | Interruption to environmental watering, depending on scale of fire will determine significance. | Water delivery discontinued if it is considered that there will be detrimental effects, such as water quality issues to the river or further downstream. |
| Flood warnings | Interruption to environmental watering. | In the event of a flood watch or flood warning issued by the Bureau of Meteorology, all environmental releases will be stopped. |

7.2 Systemic constraints

7.2.1 Flow constriction and diversion points

The FLOWS study update (Alluvium, 2021) highlights that many complementary actions will be required to realise the full effectiveness of the environmental entitlement, in particular to release 'fresh' events. For example, the dry period fresh flow peak for the east branch has been reduced from 35ML/day to 9ML/day. The need for modification of planned flow releases has been demonstrated in the previous watering years in both branches where despite the flow rate being significantly reduced

each season, some flooding was still experienced. The flooding appeared to be caused by in-channel flow constrictions such as choking Willows and Glyceria, and to a lesser extent, old channel diversions to restricting infrastructure points. See section 8.1 and 8.2 for more information.

7.2.2 Allocation

The FLOWS study update (Alluvium, 2021) recommends a water recovery target of 28.6GL for the Barwon River to get back to 70% of natural flow and meet ecological requirements. Therefore, the current allocation is significantly insufficient to meet the river's health requirements.

The Upper Barwon Environmental Entitlement 2018 allows for a 2,000ML share of the total storage capacity of the West Barwon Reservoir and allows for storage of 3.8% of the flow into the reservoir, up to the 2,000ML. Modelling has shown that this will typically be about 1,000ML of water each year, but theoretically up to 2,000ML or more could be available if a portion of the stored allocation was used and the 2,000ML storage allocation refilled. Corangamite CMA will however aim to always keep approximately 500ML in storage in case of drought.

The Government released the consultation draft Central and Gippsland Sustainable Water Strategy in late 2021. Once finalised and released this document will be a significant strategy for the Upper Barwon as Sustainable Water Strategies enable long term water resource planning for Victoria's water resources and can be a vehicle for recovering more water for the environment. Sustainable water strategies identify and manage threats to the supply and the quality of a region's water resources and identify ways to improve waterway health.

The consultation draft Central and Gippsland Sustainable Water Strategy had two proposed directions for the Barwon River:

- 1) Proposed direction 12-8, *'an additional environmental entitlement of 3,836 megalitres per annum for the Barwon River within five years and;*
- 2) Proposed direction 12-9, *'an additional environmental entitlement of 6,500 megalitres per annum for the Barwon River within ten years.'*

7.2.3 Barwon Water delivery infrastructure limitations

As operators of the West Barwon Reservoir, Barwon Water reports that the maximum release capacity from the reservoir is 320ML/day, with 140ML/d down the Upper Barwon east branch. This is not a systematic constraint at this point in time, due to channel capacity limitations further downstream. To improve Barwon Water's ability to deliver a range of environmental releases, Barwon Water and Corangamite CMA are liaising to determine a preferred dimension upgrade to the environmental weir in the next 5-10 years, so that the weir can handle the highest and lowest volumes of environmental releases expected. This will also need to take into account the Central and Gippsland Sustainable Water Strategy proposed directions.

8. Confounding factors

Flow alteration is one of many factors that affect the environmental condition of the Upper Barwon and many environmental watering objectives will not be fully achieved unless other impacts are adequately addressed. In the Upper Barwon system, there are multiple confounding factors that impact negatively on the river's health that cannot be mitigated by the entitlement alone. Confounding factors can be resolved between agencies and other stakeholders.

The Upper Barwon project is a newly established integrated catchment management project under the Barwon Flagship that will work with many stakeholders to address flow restrictions through riparian management as part of a long-term program.

8.1 Flow Constrictions

Following review of the environmental flow requirements for the Upper Barwon, Yarrowee and Leigh Rivers (Alluvium, 2021), release of the first environmental flows caused some inundation of private properties. This flooding was caused by in-channel flow constrictions from invasive species such as Willow and Glyceria and historic channel diversions and infrastructure. These flow constrictions prevent optimal delivery of the entitlement through the east and west branches of the river and have forced Corangamite CMA to reduce the volumes of all flow components in these branches to avoid flooding.

In response to inundation around the Birregurra-Forrest Road in 2021 because of the Barwon West Reservoir spilling, a modelling exercise was completed to determine what impact targeted removal of instream Glyceria and Willows would have (Alluvium, 2021a). The report showed Glyceria removal hotspots in the affected 2.6km stretch of the Barwon west branch near the Birregurra-Forrest Road. Removal works will be completed in autumn 2022. On the east branch, Barwon Water removed 3.4km of willows during the summer of 2021-22 to improve water transfer for the supply system.

8.2 Riparian Rehabilitation

Healthy land supports healthy waterways. Water quality, bank stability and habitat can decline due to a lack of adequate riparian vegetation surrounding the river channel. As many parts of the Barwon River run through agricultural properties, there is degraded riparian zones that negatively impact on the river's health. In order to mitigate these impacts, Corangamite CMA works directly with landholders to fence off the riparian zone to keep stock away from the waterway and replant and revitalise native vegetation. Riparian restoration is a significant component of the Upper Barwon Project but landholders are unwilling to undertake riparian management but would like to see removal of willows (Behaviour Works Australia, 2021; Angus Donaldson pers comms). The Corangamite CMA is currently designing a trial for riparian management that will involve interested landholders.

8.3 Fish Barriers

In the Upper Barwon system, there are several barriers to fish passage. This includes weirs, dams and obsolete structures that limit fish migration. To mitigate these impacts, removal or modification will be required. Along with other agencies, Corangamite CMA will seek to remediate these barriers where funding and resources are available.

9. Increasing knowledge

Increasing our knowledge and addressing priority knowledge gaps is an important part of managing risks associated with environmental water delivery. Corangamite CMA regularly reviews knowledge needs to enable the organisation to plan for and deliver environmental water in an adaptive and effective manner.

Recent studies undertaken for the Upper Barwon River that have supported environmental water delivery include:

- **Upper Barwon Eel Investigation** (ARI, 2021).

This study collected baseline data on short-finned eel and various fish populations in the West Barwon Reservoir. Initial results indicate a total of 349 individual fish comprising two native (Common Galaxias (*Galaxias maculatus*) and Flat-headed Gudgeon (*Philypnodon grandiceps*)) and two exotic fish species were collected. However, preliminary results indicate that there were no short-finned eels present during the three-day survey period. The absence of the short-finned eels may reflect the possibility that the 2021 spring reservoir spilling may have disrupted migration of adult eels from the reservoir to downstream reaches as indicated in recent studies conducted by ARI.

- **Riparian land management in the Upper Barwon** (BehaviourWorks Australia, 2021).

This project commenced in February 2021 with a survey of landholders in the Upper Barwon exploring opinions, practices and experiences in relation to riparian land management. Part 2 (to be completed in 2022) involves implementation and evaluation of innovative options for riparian management based on recommendations from the landholder survey.

- **Geelong Values: Analysis of the social and economic values dependent on a flowing Barwon River (through Geelong) and lower Moorabool River** (RMCG, 2021).

This study was commissioned by the Corangamite CMA to examine the social and economic benefits the Barwon and Moorabool Rivers provide to the community of Geelong, and the importance of river flows for supporting and protecting these values. It is intended the results of this study will be used to guide future water recovery decisions for the Barwon and Moorabool Rivers.

- **West Barwon Flood Response** (Alluvium, 2021a).

Due to the West Barwon Reservoir spilling in 2021, Alluvium were commissioned by the Corangamite CMA to review the conditions at the site, identify constrictions, potential options of improved flow and risks from potential management intervention. The report recommended that removing glyceria infestations and two willow blockages would alleviate flooding risk.

- **Upper Barwon Restoration** (Alluvium, 2020).

This study was commissioned by the Corangamite CMA to undertake a scoping study for the restoration of the Upper Barwon channels (east and west branches). The report highlights that there are approximately 50 sites that have potential to constrict the flow in the Barwon River.

- **Strategic analysis of Waterwatch data** (Alluvium, 2020a)

This work has looked back over Waterwatch data sets available on the Moorabool to see how useful they might be to assess the effectiveness of environmental water delivery before and after a flow event, and over many years of delivery. It also assessed which Waterwatch parameters were most responsive to e-flows and how data collection could be adapted in the future to better inform the achievement of environmental water objectives.

- **Stage 6 of the Victorian Environmental Flows Monitoring and Evaluation Program (VEFMAP)**

Tonkin et al. (2020) identified some of the patterns associated with fish responses to environmental flows across Victoria. Stage 6 is now complete, and Stage 7 will also look at how changing spring flow pulses and baseflow recommendations may affect fish retention and survival. See section 4.2 for further information about the findings for stage 6.

- **Prioritising barriers to upstream fish passage** (Marsden et al., 2016)

The objective of this project was to assess and identify all potential barriers to fish passage and low flows in the Barwon and Moorabool River basins.

Out of the total 97 potential barriers in the Barwon and Moorabool basins, 56% were identified as barriers to fish migration. In the Top 25 barriers prioritised, second equal were the three Buckley Falls barriers on the Barwon River in Geelong. The three barriers are estimated to cost approximately \$1 million to remove. Corangamite CMA has prioritised fish barriers which will significantly increase the habitat available to migratory fish.

In addition to this important information, greater monitoring within the system, analysis of existing data and mapping of significant water users may assist in developing more effective strategies to deliver environmental water and in demonstrating outcomes to the community. Most studies listed above are available online in the Corangamite CMA Knowledge Base.

Below are important projects for the entire Barwon River system:

- **The Barwon Flagship prioritising the Upper Barwon project**

The Barwon Flagship Project has just recently commenced. As a Flagship project under Water for Victoria it is a long-term integrated waterway health project that will focus on different priorities over time. Initially the Upper Barwon is the first priority with the aim of improving waterway health by addressing chokes and riparian management that will enhance environmental water delivery and outcomes. The geographical area of interest for the project is the priority reaches of the Upper Barwon River's east branch and west branch as well as Dewing Creek.

The Flagship includes:

- **Analysis of the social and economic values dependent on a flowing Barwon River through Geelong and lower Moorabool River**

Corangamite CMA continues to work to build the case for more water in the Barwon River through projects such as the 'Analysis of the social and economic values

dependent on a flowing Barwon River through Geelong and lower Moorabool River', finalised in November 2021.

- **'Riparian land management in the Upper Barwon**

An additional benefit of environmental releases includes coinciding releases with riparian and in-stream weed removal works as the likelihood of weed re-establishing is reduced. Larger environmental flow releases will benefit the entire river system.

- **Central and Gippsland Regions Sustainable Water Strategy (SWS)**

Corangamite CMA was also engaged in the DELWP-led project of preparing the new Central and Gippsland Regions Sustainable Water Strategy and sharing the draft SWS with the Upper Barwon Surface Water Advisory Group (UBSWAG). The SWS is an important document for increasing the environmental water entitlement in the Upper Barwon.

9.1 Knowledge gaps

Table 16 below outlines knowledge gaps in the Upper Barwon River. The initial projects were prioritised by Corangamite CMA and project status has been provided. Please note the proposed projects have not been committed to by the Corangamite CMA or external funding providers. This list represents potential projects that could improve knowledge for managers and the community. The Corangamite CMA will continue to seek opportunities for investment in these priority projects to enhance the management for waterway health outcomes.

Table 16. Knowledge Gaps, Responsible Authority and Status

| <i>Knowledge gaps and project recommendation</i> | <i>Responsible authority</i> | <i>Status</i> |
|--|-------------------------------------|----------------------|
| <p>Identifying Traditional Owner values</p> <p>Acquiring greater knowledge of indigenous heritage values in the area is a key priority for the Corangamite CMA. Creating opportunities to enable Wadawurrung and Eastern Maar Traditional Owners to create and re-create linkages with the river system will bring about a more precise knowledge base for delivery of environmental water and realise significant shared benefits for Eastern Maar and Wadawurrung Traditional Owners and the wider community.</p> | CCMA | <i>Proposed</i> |
| <p>Fish monitoring in the Upper Barwon system</p> <p>There is currently no monitoring on the Upper Barwon River to assess progress towards environmental objectives being targeted by the</p> | CCMA | <i>Proposed</i> |

| | | |
|--|------------------------------------|--------------------|
| <p>Upper Barwon Environmental Entitlement deliveries.</p> <p>Proposed Barwon River Flagship monitoring includes fish monitoring as it is a major knowledge gap in the system, despite the Barwon River having 44 species of fish (including native protected species) and the local community being highly interested. Monitoring could be undertaken to track presence and abundance in the context of current environmental releases, following an expected increase in the annual volume of the environmental entitlement and post remediation of choke points throughout the system over the life of the Flagship. This would progress towards the fish objectives outlined in the FLOWS study. Engagement with the Eastern Maar Traditional Owners would be beneficial to ascertain culturally significant species.</p> | | |
| <p>Rivers of the Barwon (Barre Warre Yulluk) Action Plan</p> <p>Is the Government's response to the Ministerial Advisory Committee (MAC). The Action Plan lays out steps to protect the catchment and ensure its assets can be enjoyed by future generations. It recognises these waterways and their landscapes as unique, interconnected living entities and the Traditional Owners as the 'voice of the living entities'.</p> | DEWLP | <i>In progress</i> |
| <p>Alluvium Upper Barwon Restoration report</p> <p>A scoping study for the restoration of the Upper Barwon channels (east and west branches), to investigate physical and hydrological condition, identify constraints, develop a potential program of work to address these constraints, identify knowledge and data gaps and outline the next steps to resolve these constraints.</p> | Corangamite CMA | <i>Completed</i> |
| <p>Downstream migration of adult silver eels</p> <p>This project aims to investigate the effect of river discharge, including environmental flows, on the downstream spawning migrations of adult eels in the Barwon-Moorabool river system. This information is needed to validate and support refinement and implementation of environmental flows to assist the management and conservation of eel populations.</p> | Corangamite CMA, Barwon Water, ARI | <i>Proposed</i> |

| | | |
|--|--|---------------------------|
| <p>Riparian land management in the Upper Barwon</p> <p>This project commenced in February 2021 with a survey of landholders in the Upper Barwon exploring opinions, practices and experiences in relation to riparian land management. Part 2 (to be completed in 2022) involves implementation and evaluation of innovative options for riparian management based on recommendations from the landholder survey.</p> | <p>Corangamite CMA, DELWP</p> | <p><i>In progress</i></p> |
| <p>Great Australian Platypus Search</p> <p>The aim of this citizen science program conducted in Spring 2021 is to identify the eDNA in our waterways from not only platypus but also other vertebrates including fish, turtles and rakali. When available the report findings will build on eDNA data evidence gathered by the Upper Barwon Landcare Network in association with Friends of the Barwon and Geelong Landcare Network in 2018, 2019 and 2020.</p> | <p>Odonata, DELWP</p> | <p><i>In progress</i></p> |
| <p>National Waterbug Blitz</p> <p>The aim of this citizen science program is to help evaluate the benefit of e-water regimes on waterbug communities in the Upper Barwon.</p> | <p>Corangamite CMA</p> | <p><i>In-progress</i></p> |
| <p>Deakin University Riparian Buffer Study – Riparian Restoration</p> <p>A PhD project focusing on the effects of willow removal and the physical characteristics of riparian restoration on water quality, microclimate, and morphology.</p> | <p>Barwon Water, Deakin University and WaterRA</p> | <p><i>In progress</i></p> |
| <p>Deakin University Riparian Buffer Study – Costs and Benefits of Riparian Buffers</p> <p>A Masters project to develop a tool for calculating the costs and benefits of riparian buffers for stakeholders.</p> | <p>Barwon Water, Deakin University</p> | <p><i>In progress</i></p> |
| <p>Deakin University Riparian Buffer Study – Leaf Decomposition</p> <p>An Honours project investigating leaf decomposition rates and processes between streams.</p> | <p>Barwon Water, Deakin University</p> | <p><i>In progress</i></p> |

Gauging

Up until a year ago, there was insufficient water gauging on the Upper Barwon River to adequately assess how releases from the West Barwon Reservoir move down through the river system. In January 2021, the East Barwon @ U/S River King Creek Junction gauge was installed on the east branch near Forrest, however it can only record low flow events approximately <34ML/day. The gauge

is offline at the time of writing but should be reinstated in the spring. Corangamite CMA is retrospectively using East Barwon River @ Flume gauge data, which is more useful for reporting as opposed to flow management as it is not telemetered, however the East Barwon River @ Flume gauge can record up to approximately 100ML/day, which allows the Corangamite CMA to analyse flow data more accurately. The new West Barwon River @ Boundary Road near Forrest gauge was also installed by Barwon Water on the west branch which became available in February 2021, but can only record low flow events approximately <75ML/day. So there is a knowledge gap on both branches relating to flows above the maximum limit of the new gauges. This gap prevents assessment of flow compliance at higher flow rates, particularly on the west branch where an alternative data set is unavailable.

Corangamite CMA worked collaboratively with Barwon Water during the design phase to ensure the new gauges do not create any barriers to fish migration.

Cold water pollution

In 2020, a question was raised by the community about cold water pollution risks in relation to environmental releases from West Barwon Reservoir. Corangamite CMA has sought expert advice, and this has included a statement that a much greater risk to environmental values is posed by a lack of water.

The risks are outlined below:

- There are only two offtake points in the West Barwon Reservoir and water needs to be one metre above the offtakes to use it; there are situations where releases can be taken from up to 12m deep.
- Corangamite CMA and Barwon Water are aware of the risks to biota because of cold or anoxic releases and have formalised a requirement that environmental flows will always be released from the highest possible point in the reservoir for this reason.
- The river branches are monitored upstream and downstream of the reservoir, but the data sets are limited. A review of the limited data set indicates that within one day, there is likely to be 3.5-4.5-degree difference between water that has not been stored in the reservoir and water that is released.

To address the potential risks the Corangamite CMA has:

- Worked with Barwon Water to undertake a monitoring program that will result in a larger, more accurate data set that considers seasonal variation and aspect. Monitoring is ongoing and the final report will be provided to the UBSWAG and the general community once completed.
- Used this to obtain expert advice on the significance of any temperature variation to downstream ecosystems.

Once the full data set and analysis has been completed in 2022, the results will be shared with the community.

10. Risk management

A risk assessment has been undertaken for the 2022-23 season, with members from Barwon Water, the VEWH, and the Corangamite CMA present.

This assessment identifies the risks associated with delivering water for the priority actions. Mitigation actions to reduce risks have been identified and should be undertaken as part of the release plan.

An overview of the risk assessment and management for the current plan with potential risk mitigation measures and associated residual risk assessment is outlined below in Table 17.

Table 17. Risk assessment and management

| Risk ID | Risk category | Risk description | Likelihood | Conseq | Risk Rating | Mitigation actions | Lead organisn. for action | Risk type Static/Dynamic |
|----------------------|-------------------|---|------------|--------|-------------|--|--|--------------------------|
| CEB A202 0-22 | Legal | Heavy rainfall following environmental deliveries may lead to unintended inundation of private land in the upper Barwon River, resulting in impacts on landowner activities and assets. | Possible | Minor | Low | <ul style="list-style-type: none"> • Undertake detailed monitoring of water levels and adjust delivery plans based on seasonal conditions and forecasts. • Ongoing communication of delivery plans to landholders. • Limiting maximum delivery rates to reduce risk of flooding • Undertake regular communications between CMA and Barwon Water to identify local risks (using operator knowledge) and manage releases accordingly • Reassess acceptable flow limits following willow/constraints removal program | CCMA CCMA CCMA/BW CCMA/BW CCMA | Static |
| CEB A202 -23 | Cultural Heritage | Inability to engage with Eastern Maar during planning may lead to a failure to address T.O. values or damage to heritage/artifacts and may impact on values or heritage <i>Note: There may also be some reputational risks if Eastern Maar can't be engaged in environmental water processes</i> | Possible | Minor | Low | <ul style="list-style-type: none"> • Continue efforts to seek to establish meaningful partnership arrangements with Eastern Maar people, leading to ongoing inclusion of T.O. values into watering proposals • Continue to partner and share knowledge with T.O.s to build capacity to actively engage in water related issues | CCMA | Static |

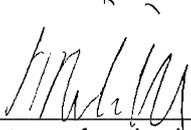
| Risk ID | Risk category | Risk description | Likelihood | Conseq | Risk Rating | Mitigation actions | Lead organism. for action | Risk type Static/ Dynamic |
|----------------------|---------------|---|------------|----------|-------------|---|---------------------------|---------------------------|
| CEB A202 0-24 | Reputational | Implementing watering actions for new sites supplied from West Barwon Reservoir may not be successful due to lack of information on flow behaviour and constraints with the result that environmental benefits are not achieved. | Possible | Moderate | Medium | <ul style="list-style-type: none"> • Review and assess potential risk issues for water delivery actions and develop specific mitigation actions. • Continue to support community and stakeholder information and engagement processes. • Continue to implement upper Barwon restoration project to restore channel capacity for environmental water delivery • Expand flow monitoring capability where possible | CCMA | Static |
| CEB A202 0-25 | Reputational | Community concerns related to establishment and implementation of Barwon Water groundwater remediation plan may be extended (incorrectly) to Barwon River environmental release plans, leading to a loss of public/political support for activities | Unlikely | Moderate | Low | <ul style="list-style-type: none"> • Engage with key objectors to address information gaps and concerns. | CCMA | Dynamic |

| Risk ID | Risk category | Risk description | Likelihood | Conseq | Risk Rating | Mitigation actions | Lead organism. for action | Risk type Static/ Dynamic |
|----------------------|---------------|--|------------|----------|-------------|---|---------------------------|---------------------------|
| CEB A202 0-26 | Reputational | The availability of environmental entitlements creates a community expectation (which can't be met) that regular "natural" cease to flow events in the mid-Barwon and low flows/BGA issues in the lower Barwon will no longer occur. | Unlikely | Moderate | Low | <ul style="list-style-type: none"> • Continue to engage with the local community to build understanding of the limitations on the available environmental water entitlements and the processes for identifying and prioritising environmental watering actions. • Engagement in the redevelopment of the SWS to address environmental water needs. • Consider accessing additional water through trade | CCMA CCMA VEWH | Dynamic |
| CEB A202 0-27 | Environment | Environmental releases do not achieve planned/specified flow targets due to releases being diverted by other users before reaching delivery site. | Likely | Minor | Low | <ul style="list-style-type: none"> • Ensure licensing authority is aware of planned events and alert it to the need to manage compliance by all users. • Work with SRW to improve diversions compliance management options and shepherding of environmental flows through the system. | CCMA | Static |

11. Approval and endorsement

I, John Riddiford, the authorised representative of the agency shown below, approve the Seasonal Watering Proposal for the Upper Barwon River system 2021-22.

SIGNED FOR AND ON BEHALF OF Corangamite Catchment Management Authority



Signature of authorised representative

John Riddiford

Name of authorised representative

Date

Appendix 1. Abbreviations

| | |
|--------|---|
| ARI | Arthur Rylah Institute |
| BOM | Bureau of Meteorology |
| CCMA | Corangamite Catchment Management Authority |
| DELWP | Department of Environment Land Water and Planning |
| EMAC | Eastern Maar Aboriginal Corporation |
| EVC | Ecological Vegetation Class |
| LAWROC | Land and Water Resources Otway Catchment |
| GL | Gigalitre |
| MAC | Ministerial Advisory Committee |
| ML | Megalitre |
| RAP | Registered Aboriginal Party |
| SRW | Southern Rural Water |
| SWP | Seasonal Watering Proposal |
| UBSWAG | Upper Barwon Surface Water Advisory Group |
| VEWH | Victorian Environmental Water Holder |
| VEFMAP | Victorian Environmental Flows Monitoring and Assessment Program |
| WMIS | DELWP's Water Measurement Information System |
| WTOAC | Wadawurrung Traditional Owners Aboriginal Corporation |

Appendix 2. References

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Appendix 3. IAP2 spectrum of public participation

| INCREASING IMPACT ON THE DECISION  | | | | | |
|--|--|--|---|---|--|
| | INFORM | CONSULT | INVOLVE | COLLABORATE | EMPOWER |
| PUBLIC PARTICIPATION GOAL | To provide the public with balanced and objective information to assist them in understanding the problem, alternatives, opportunities and/or solutions. | To obtain public feedback on analysis, alternatives and/or decisions. | To work directly with the public throughout the process to ensure that public concerns and aspirations are consistently understood and considered. | To partner with the public in each aspect of the decision including the development of alternatives and the identification of the preferred solution. | To place final decision making in the hands of the public. |
| PROMISE TO THE PUBLIC | We will keep you informed. | We will keep you informed, listen to and acknowledge concerns and aspirations, and provide feedback on how public input influenced the decision. | We will work with you to ensure that your concerns and aspirations are directly reflected in the alternatives developed and provide feedback on how public input influenced the decision. | We will look to you for advice and innovation in formulating solutions and incorporate your advice and recommendations into the decisions to the maximum extent possible. | We will implement what you decide. |

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IAP2 spectrum of public participation

Appendix 4. VEHW Risk matrix

VEWH risk rating matrix

| Likelihood | Consequence | | | | |
|----------------|-------------|--------|----------|---------|---------|
| | Negligible | Minor | Moderate | Major | Extreme |
| Almost certain | Low | Medium | High | Extreme | Extreme |
| Likely | Low | Medium | High | Extreme | Extreme |
| Possible | Low | Medium | Medium | High | Extreme |
| Unlikely | Low | Low | Medium | High | Extreme |
| Rare | Low | Low | Low | Medium | High |

VEWH risk likelihood legend

| Rating | | Description | Probability |
|----------------|---|--|-------------|
| Rare | 1 | Event may occur only in exceptional circumstances | 0-5% |
| Unlikely | 2 | The event could occur at some time | 5-20% |
| Possible | 3 | The event might occur | 20-50% |
| Likely | 4 | The event will probably occur in most circumstances | 50-80% |
| Almost certain | 5 | The event is expected to occur in most circumstances | 80-100% |

VEWH risk consequence matrix

| Rating | | Environment | Business Costs | People | | Political/ Reputational | Legal | Service Delivery |
|-----------------|---|--|--|--|---|--|---|---|
| | | | | Safety and Well-being | People and Culture | | | |
| Negligible Harm | 1 | No material effect on the environment, contained locally within a single site/ area. Environment affected for days | Cost impact of up to 2.5% of allocated operational budgets (including capital budget); OR a cost impact of up to \$2.5m | On-site first aid treatment only | Staff disgruntlement | Minimal adverse local attention (1 day only) | Non-compliance with legislation, identified internally and resulting in internal acknowledgement and process review. | Insignificant impact to the partnership's capability in providing its services - no inconvenience to customers/ stakeholders |
| Minor Harm | 2 | Limited effect on the environment, restricted to a single township or locality. Environment affected for weeks. | Cost impact between 5%-10% of allocated operational budgets (including capital budget); OR a cost impact of up to \$5m | Minor injuries/illness requiring medical attention | Complaints, passively upset, and uncooperative | Adverse localised public attention on a single issue over a short period. (up to 1 week) | Non-compliance with legislation or breach of duty of care, identified externally and either (1) resolved without prosecution or civil action, or (2) resulting in prosecution or civil action involving low level of resourcing required to defend, exposure to low level remedies or damages, and low-level risk of negative precedent | Minimal short-term temporary impact to the partnership's capability in providing its services - customers/ stakeholders slightly inconvenienced |
| Moderate Harm | 3 | Moderate effect on the environment, impacting on a municipality or multiple localities. Environment affected for months. | Cost impact >10% of allocated operational budgets (including capital budget); OR a cost impact of up to \$10m | Significant injury/illness requiring inpatient hospitalisation | Low morale, disengagement, increased absenteeism and workplace conflict | Adverse localised negative public attention on a single issue over a sustained period (up to 2 months) | Non-compliance with legislation or breach of duty of care resulting in prosecution of, or civil action, with one of high level of resourcing required to defend; exposure to high level remedies or | Significant impact to the partnership's capability in providing its services - customers/ stakeholders inconvenienced |

| | | | | | | | | |
|--------------|---|--|---------------------------------|--|---|---|---|--|
| | | | | | | | damages or high-level risk of negative precedent. | |
| Major Harm | 4 | Major effect on the environment, impacting on a region or multiple municipalities. Environment affected for 1-3 years. | Cost impact between \$10m-\$50m | Extensive and/or permanent injury/ illness | Major morale issues, high absenteeism and resignations of key staff | Serious adverse public attention on more than one issue over a prolonged period (up to 2 years) | Non-compliance with legislation or breach of duty of care resulting in prosecution of or civil action (with <i>all</i> high level of resourcing required to defend, exposure to high level remedies or damages, and high-level risk of negative precedent); or public enquiry | Continuing difficulties in the partnership's capability in servicing customers/stakeholders over a protracted period |
| Extreme Harm | 5 | Very serious effect on the environment, impacting on the state or multiple regions. Environment affected for >3 years | Cost impact of over \$50m | Death or permanent disability/ illness | Partnership wide morale issues, mass resignations and absenteeism | Very serious public outcry over a prolonged period (greater than 2 years), or leading to a formal inquiry, serious investigation of another major political event | Non-compliance with legislation or breach of duty of care resulting in prosecution of or civil action (leading to imprisonment of an officer and/or uninsured compensation payments). | Long term detrimental effect on the partnership's capability in providing services to customers/ stakeholders |

Appendix 5. Hydraulic criteria for flow objectives in the Upper Barwon, Yarrowee and Leigh Rivers, arranged by value (Alluvium, 2021)

| Value | Objective | Reaches | Function | Period | Component | Criteria |
|---------------------|--|-------------|---|-------------|---|---------------------------|
| ABORIGINAL CULTURAL | | | | | | |
| Mammals | Maintain or improve abundance, breeding and recruitment of Waddirring/ Perridak (platypus) | 1, 2, 9, 10 | Provide pool habitat | Dry | Low flow | AM1 See other fauna (PL1) |
| | | 1, 2, 9, 10 | Provide longitudinal connectivity between reaches | Wet | Fresh | AM2 See other fauna (PL2) |
| Fish | Maintain or improve abundance of Buniya (eels) | 1, 2, 9, 10 | Provide water in pools for habitat and food sources | Dry | Low flow | AF1 See fish (MF1) |
| | | 1, 2, 9, 10 | Provide water over riffles to allow fish to migrate upstream from estuary | Dry | Fresh | AF2 See fish (MF2) |
| | Maintain or improve abundance of Turrpurt (native trout <i>galaxias spp.</i>) | 1, 2, 9, 10 | Provide water in pools for habitat and food sources | Dry | Low flow | AF3 See fish (RF1) |
| | | 1, 2, 9, 10 | Provide water over riffles to allow fish to move between pools to breed, feed and find new habitats | Dry | Fresh | AF4 See fish (RF2) |
| | | 1, 2, 9, 10 | Provide prolonged seasonal inundation of vegetation beds and instream benches as habitat to stimulate invertebrate hatching and fish breeding | Wet | Fresh | AF5 See fish (RF4) |
| | | | Maintain or improve abundance of Ware-rap (blackfish) | 1, 2, 9, 10 | Submerge and clean woody debris and hard surfaces to provide breeding substrate | Dry |
| Vegetation | Maintain or improve abundance of Polango/Warngare (water ribbons <i>Triglochin procera</i>) | 1, 2, 9, 10 | Maintain adequate depth of permanent water in the channel, with natural seasonal drawdown to promote recruitment | Dry | Low flow | AV1 See vegetation (IV1) |
| | Maintain or improve condition, extent, and | 1, 2, 9, 10 | Maintain adequate depth of permanent water in stream channel | Dry | Low flow | AV2 See vegetation (EV1) |

| | | | | | | | |
|---------------|--|-------------|--|---------|----------|-----|--------------------------------|
| | abundance of Tark (common reed <i>Phragmites australis</i>), Toolim (pale rush <i>Juncus pallidus</i>), and Bal-yan (cumbungi <i>Typha latifolia</i>) | | to limit terrestrial encroachment into aquatic habitats | | | | |
| | | | Provide a mosaic of spatially and temporally differentially wetted areas within stream channel, on benches, and on lower banks | Dry | Fresh | AV3 | See vegetation (EV2) |
| | | | Support growth on terraces, channel edge, and lower bank | Dry | Fresh | AV4 | See vegetation (EV3) |
| | | | Provide a mosaic of spatially and temporally differentially wetted areas within stream channel, on benches, and on lower banks | Wet | Fresh | AV5 | See vegetation (EV4) |
| | Maintain or improve abundance of Biyal (river red gum <i>Eucalyptus camaldulensis</i>) | 2, 10 | Support growth on terraces, channel edge, and lower bank | Dry | Fresh | AV6 | See vegetation (RV1) |
| | | | Support growth on terraces, channel edge, and lower bank | Wet | Fresh | AV7 | See vegetation (RV2) |
| | | | Support growth in the channel and upper bank, disturb riparian zone and channel to open recruitment niches for riparian plants | Anytime | Bankfull | AV8 | See vegetation (RV3) |
| | Maintain or improve abundance of Larrap (manna gum <i>Eucalyptus viminalis</i>) and Kokibainang (swamp wallaby grass <i>Amphibromus recurvatus</i>). | 2, 9, 10 | Inundate floodplain, provide moisture and fill floodplain depressions and billabongs to support the growth of seasonal and emergent wetland vegetation | Anytime | Overbank | AV9 | See vegetation (FV3) |
| Geomorphology | Deep pools | 1, 2, 8, 10 | Scour sediment from base of pools to maintain pool and to use bed sediments to scour algae from riffles | Dry | Fresh | AG1 | See supporting functions (GE1) |
| | | | Scour sediment from base of pools to maintain pool and to use bed sediments to scour algae from riffles | Wet | Fresh | AG2 | See supporting functions (GE2) |
| | | | Mobilise sediment from base of pools | Dry | Fresh | AG3 | See supporting functions (GE3) |
| | | | Mobilise sediment from base of pools for a sustained duration | Wet | Low flow | AG4 | See supporting functions (GE4) |
| | Confluences of Barwon and Leigh rivers, and | 1, 2, 10 | Maintain adequate depth of permanent water in the channel | Dry | Low flow | AG5 | Flow between pools |

| Yarrowee River and Cargerie Creek | | | | | | | |
|-----------------------------------|--|-------------------------|---|-----|----------|-----|--|
| FISH | | | | | | | |
| Migratory fish | Maintain abundance of migratory fish including short-finned eels, Australian grayling, and tupong | 1, 2, 3, 7, 9, 10 | Provide water in pools for habitat and food sources | Dry | Low flow | MF1 | 600 mm water depth in pools |
| | | | Provide water over riffles to allow fish to migrate upstream from estuary | Dry | Fresh | MF2 | 500 mm water depth over riffles |
| | | | Provide water over riffles to allow longitudinal connectivity and for fish to move between pools | Wet | Fresh | MF3 | 500 mm water depth over riffles |
| | Improve breeding and recruitment of migratory fish including broad-finned galaxias and common Jollytail | All reaches | Provide connectivity to allow fish to migrate downstream to breed | Wet | Fresh | MF4 | 300 mm water depth over riffles |
| Resident freshwater fish | Maintain abundance of resident freshwater fish, including galaxias, smelt, big-headed gudgeon, and Yarra pygmy perch | All reaches | Provide water in pools for habitat and food sources | Dry | Low flow | RF1 | 250 mm water depth in pools |
| | | | Provide water over riffles to allow fish to move between pools to breed, feed and find new habitats | Dry | Fresh | RF2 | 300 mm water depth over riffles |
| | Improve breeding and recruitment of resident freshwater fish including blackfish | 1, 2, 3, 4, 6, 7, 9, 10 | Submerge and clean woody debris and hard surfaces to provide breeding substrate | Dry | Fresh | RF3 | 500 mm water depth over some instream benches and vegetation beds or meet criteria GE2 |
| | Improve breeding and recruitment of resident freshwater fish, including galaxias, smelt, big-headed gudgeon, and Yarra pygmy perch | All reaches | Provide prolonged seasonal inundation of vegetation beds and instream benches as habitat to stimulate invertebrate hatching and fish breeding | Wet | Fresh | RF4 | 500 mm water depth over some instream benches and vegetation beds |
| OTHER FAUNA | | | | | | | |
| Macro-invertebrates | Maintain abundance of macroinvertebrates as a | All reaches | Sustain macroinvertebrate communities during the dry period | Dry | Fresh | MA1 | Inundation of benches |

| | | | | | | | |
|---------------------|--|-------------------------|--|-----|----------|-----|--|
| | food source for fish, frog and platypus populations | All reaches | Create and extend aquatic habitats for macroinvertebrates | Wet | Fresh | MA2 | Extend wetted area |
| | Improve breeding and recruitment of macroinvertebrates as a food source for fish, frog and platypus populations | All reaches | Allow growth and reproduction of macroinvertebrate communities | Wet | Fresh | MA3 | Scour sediment and disturb biofilm, see objective S2 (GE1 and GE2) |
| Growling grass frog | Maintain abundance of growling grass frog | 1, 2, 6, 9, 10 | Provide pool habitat | Dry | Low flow | GF1 | Flow between pools |
| | Improve breeding and recruitment of growling grass frog | 1, 2, 6, 9, 10 | Allow growth and reproduction of macroinvertebrate communities | Wet | Fresh | GF2 | Scour sediment and disturb biofilm, see objective S2 (GE1 and GE2) |
| | Improve condition and extent of growling grass frog | 1, 2, 6, 9, 10 | Provide longitudinal connectivity between reaches | Wet | Fresh | GF3 | 300 mm water depth over riffles |
| Platypus | Maintain abundance of platypus | 1, 2, 3, 4, 7, 8, 9, 10 | Provide pool habitat | Dry | Low flow | PL1 | Flow between pools |
| | Improve condition and extent of platypus | 1, 2, 3, 4, 7, 8, 9, 10 | Provide longitudinal connectivity between reaches | Dry | Fresh | PL2 | 200 mm water depth over riffles |
| VEGETATION | | | | | | | |
| Instream | Maintain or improve condition and extent of instream vegetation to provide structural habitat for macroinvertebrates and various fish species | All reaches | Maintain adequate depth of permanent water in the channel, with natural seasonal drawdown to promote recruitment | Dry | Low flow | IV1 | 400 mm water depth in pools |
| Emergent macrophyte | Maintain or improve condition, extent, and diversity of emergent macrophyte vegetation to provide structural habitat and channel/lower bank stability to low and moderate flows. | All reaches | Maintain adequate depth of permanent water in stream channel to limit terrestrial encroachment into aquatic habitats | Dry | Low flow | EV1 | 400 mm water depth in pools |
| | | All reaches | Provide a mosaic of spatially and temporally differentially wetted areas within stream channel, on benches, and on lower banks | Dry | Fresh | EV2 | Water level rise from low flow level of 100-200 mm |
| | | All reaches | Support growth on terraces, channel edge, and lower bank | Dry | Fresh | EV3 | Inundate channel terraces and lower bank |
| | | All reaches | Provide a mosaic of spatially and temporally differentially wetted areas within stream channel, on benches, and on lower banks | Wet | Fresh | EV4 | Water level rise from low flow level of 100-200 mm |

| | | | | | | | |
|----------------------|---|--------------------------------------|--|---------|----------|---|--|
| Riparian | Maintain or improve condition, extent, and diversity of riparian vegetation as part of endangered EVCs | All reaches | Support growth on terraces, channel edge, and lower bank | Dry | Fresh | RV1 | Inundate lower bank and channel terraces |
| | | All reaches | Support growth on terraces, channel edge, and lower bank | Wet | Fresh | RV2 | Inundate lower bank and channel terraces |
| | | 1, 3, 4, 5, 6, 7, 8 | Support growth in the channel and upper bank, disturb riparian zone and channel to open recruitment niches for riparian plants | Anytime | Bankfull | RV3 | Inundate all channel |
| Floodplain | Maintain or improve condition and extent of floodplain vegetation as part of endangered EVCs | 5 | Groundwater interactions with floodplain features supports flow-dependent species | Dry | Low flow | FV1 | 400 mm water depth in pools |
| | | 3, 4, 6, 8 | Maintain a shallow water table with low salinity groundwater throughout the year | Dry | Low flow | FV2 | 400 mm water depth in pools |
| | | 2, 4, 6, 8, 10 | Inundate floodplain, provide moisture and fill floodplain depressions and billabongs to support the growth of seasonal and emergent wetland vegetation | Anytime | Overbank | FV3 | Water flows to floodplain |
| SUPPORTING FUNCTIONS | | | | | | | |
| Water quality | Reduce prolonged stratified conditions in pools and promote adequate levels of water quality to allow fish and macroinvertebrate populations to persist | All reaches | Provide minimum velocity to maintain mixing in pool | Dry | Low flow | WQ1 | Minimum velocity in pools of 0.1m/s |
| | | All reaches | Provide minimum velocity to establish mixing and flushing of pools | Dry | Fresh | WQ2 | Minimum velocity in pools of 0.3m/s |
| Geomorphology | Improve and maintain abundance and condition of pools, large wood and riffles to provide structural habitat for macroinvertebrates and various fish species | All reaches | Scour sediment from base of pools to maintain pool and to use bed sediments to scour algae from riffles | Dry | Fresh | GE1 | Shear stress in pool exceeds 1N/m ² for sand bed streams and 0.1N/m ² for silt bed streams |
| | | All reaches | Scour sediment from base of pools to maintain pool and to use bed sediments to scour algae from riffles | Wet | Fresh | GE2 | Shear stress in pool exceeds 1N/m ² for sand bed streams and 0.1N/m ² for silt bed streams |
| | Maintain channel capacity, All shape and form to support reaches | Mobilise sediment from base of pools | Dry | Fresh | GE3 | Shear stress in pool exceeds 1N/m ² for sand bed streams and | |

| | | | | | | |
|--|-------------|---|---------|----------|-----|--|
| flora and fauna values and objectives | | | | | | 0.1N/m ² for silt bed streams |
| | All reaches | Mobilise sediment from base of pools for a sustained duration | Wet | Low flow | GE4 | Shear stress in pool exceeds 1N/m ² for sand bed streams and 0.1N/m ² for silt bed streams |
| | All reaches | Maintain volume and size of transported sediments | Wet | Fresh | GE5 | Inundate high channel benches |
| | All reaches | Maintain volume and size of transported sediments | Anytime | Bankfull | GE6 | 'Effective discharge' (around 1.5 yr ARI event) |
| Improve and maintain level of floodplain connectivity to support instream and riparian flora and fauna | All reaches | Connect the channel and floodplain to promote sediment deposition, carbon exchange, and organic matter supply | Anytime | Overbank | GE7 | Water flows to floodplain |

Appendix 6. WTOAC Letter of Support



Wadawurrung
Traditional Owners
Aboriginal Corporation

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e reception@wadawurrung.org.au
w wadawurrung.org.au

17th February 2022

Attn: Hayley Vinden (via email)

RE: Upper Barwon River Seasonal Watering Proposal

Dear Hayley,

Wadawurrung Traditional Owners Aboriginal Corporation (WTOAC) is a Registered Aboriginal Party (RAP) under the Aboriginal Heritage Act 2006 (Vic) and was established in 1998. WTOAC is governed by a Board of Directors of Wadawurrung Traditional Owners. Each director represents a family group of the Wadawurrung People.

The role of the Corporation is to protect and advance the aspirations of Wadawurrung People by managing their cultural heritage rights and interests while providing a representative voice for Traditional Owners in relation to the management of Wadawurrung Country.

I am pleased to advise that Wadawurrung Traditional Owners Aboriginal Corporation support the Catchment Management Authority's Seasonal Watering Proposal and the potential watering actions 2022-23.

Yours sincerely,

Paul Davis
CEO
Ph: 0417 593 000
E: paul@wadawurrung.org.au