Seasonal Watering Proposal 2023/2024

Goulburn River

GOULBURN BROKEN CATCHMENT MANAGEMENT AUTHORITY

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Photo: the lower Goulburn River at Shepparton North exhibiting high river bank vegetation cover post flooding (Photo by GBCMA).

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Executive Summary

This proposal is for the use of water in the Goulburn River to maximise environmental outcomes in 2023/24. The Goulburn River, its floodplain and wetland habitats support intact river red gum forests, and numerous threatened species such as Murray cod, Trout cod, Macquarie perch and Eastern great egret. The region also contains many important cultural heritage sites, provides water for agriculture and urban centres, and supports a variety of recreational activities such as fishing, boating and camping.

The millennium drought led to terrestrial vegetation encroachment on the low and mid banks of the lower Goulburn River, and a reduction of appropriate flood tolerant plants. Since the end of the drought (2010), environmental condition has improved with the commencement of environmental water deliveries in 2011. This water has improved the cover and abundance of flood tolerant species with very positive responses in condition and cover. Monitoring since 2014 has shown a reduction in mean grass cover, and an increase in mean total cover of water dependent species (Webb et al, 2017).

Environmental water delivery has also led to improved understanding of Golden perch spawning cues, increased fish spawning in the Goulburn River, and an increased understanding of large scale fish movement in the Murray River and tributaries. Improved abundance of Murray River rainbowfish in the lower Goulburn River in 2016/17 is thought to be in response to improved littoral bank vegetation which this species uses for spawning (Webb et al, 2017). Other river health improvements believed to have resulted from delivery of environmental water since 2011 include a positive effect on food resources used by fish and other aquatic biota (Webb et al, 2017).

Since 2017 consumptive water delivery (Inter valley transfers (IVT)) has resulted in unseasonal high summer flows, two to three times higher than environmental flow recommendations. These high flows have eroded some of the improvements in river health noted above.

Volumes of IVT delivery have increased over the years peaking at around 380 GL in 2018/19. A formal monitoring program has been undertaken in the lower Goulburn River since 2018/19 to monitor bank vegetation and condition changes (i.e. erosion) resulting from IVT deliveries. Monitoring has shown increased erosion rates, loss of vegetation on the lower bank below the IVT delivery level and reductions in recruitment of Murray cod.

Since September 2019 the Victorian Minister for Water has introduced interim operating rules directing how GMW and MDBA deliver IVT. This has resulted in lower flows over the summer and autumn period. IVT was delivered as a series of pulses interspersed with average flows around 1,300 ML/day for the 2019/2020 and 2020/2021 summer. Monitoring of the flow regime in these periods showed reduced erosion compared to years with constant high flows but impacts of notching were still higher than average due to higher flows and lack of vegetation. Some patchy vegetation recovery occurred on benches and bars in these years.

La Nina conditions across the southern hemisphere led to higher than average rainfall across the Murray Darling Basin in 2021/2022. Although there was no flooding in the Upper Murray or Goulburn Rivers, large inflows led to full Murray River storages and numerous spills with unregulated flow conditions continuing into February 2022. Large monsoonal rainfall events led to flooding in the Northern Basin with the Menindee Lakes filling, and high inflows from the Darling and Murrumbidgee Rivers.

The combined high Murray River flows and high inflows from northern tributaries (Darling and Murrumbidgee Rivers) led to minimal IVT delivery over summer and autumn. This has given the Goulburn River a chance to enjoy a more natural flow regime with lower flows at the recommended environmental flow levels (below 1,000 ML/day). The reduced IVT demand has meant baseflows were primarily delivered within the environmental flow recommendations using environmental water. The lower flows led to some good vegetation recovery on the lower banks with patches of littoral vegetation in areas not seen since December 2016.

The winter and spring of 2022 was unusually wet with large scale flooding over most of the Goulburn River floodplain resulting from two day rainfall totals exceeding 200mm on October 13 and 14. Flooding on the

Yea River and Goulburn River at Seymour reached the highest level on gauged record, with the second highest gauged flood levels measured on the Goulburn River at Murchison and Shepparton.

From the end of August flows at McCoys Bridge remained above 9,000 ML/day until the first week of December, with a peak flow rate of 115,000 ML/day on 20th October. A peak flow of greater than 150,000 ML/day was recorded at Murchison on 15th October. The duration of flows above baseflow levels has reset lower bank vegetation with most of the vegetation impacted. However, given the presence of water tolerant littoral and lower bank vegetation, recovery is expected to be rapid.

Although lower summer flows in 2020/21 and 2021/22 saw growth of appropriate water tolerant vegetation, greater recovery of the vegetation and lower bank condition is still required following the damage caused by three consecutive years of unseasonal (summer/IVT) inundation and the re-set resulting from long duration natural flooding in spring 2022. Thus, the CMA are proposing to focus environmental water use in 2023/2024 on maximising vegetation recovery of the lowest metre of the bank (equating to flow rates of 700 – 2,000 ML/day). Without the presence of vegetation to stabilise the lower bank, notching and erosional process with mass failure will continue to occur.

High flows inundating wetlands in the Darling, Murrumbidgee and Murray Rivers has led to a good breeding and recruitment with a large cohort of Golden and Silver perch migrating up the Murray River. An autumn fresh delivered in March/April 2022 was designed to attract these fish into the Goulburn River. As the Goulburn River is reliant on migration of these species to maintain populations, attracting these fish will be a priority for 2024.

Although environmental watering has been shown to improve the ecological condition of the lower Goulburn River, further improvements in condition are limited by the ability to only provide in channel watering events that do not engage the floodplain and wetlands. Operational constraints mean environmental water can only influence half of the riverbank and a handful of low-lying wetlands. Although there has been limited scientific monitoring, observations have shown large ecological benefit from flooding in spring 2022. For example, there has been improved floodplain and riparian vegetation, increased instream habitat complexity and widespread connection of the river and floodplain wetlands. In addition to addressing negative impacts of unseasonal flow, progression of the constraints management strategy for the Goulburn River (as per the Basin Plan) is imperative to maximise the potential benefits of environmental water use in the river.

This proposal considers annual environmental water management under a range of possible climate and corresponding water resource availability scenarios for 2023/24 ranging from extremely dry to wet. Given antecedent conditions and watering actions achieved in 2022/2023, prioritisation of the environmental watering actions for 2023/24 have been based around the following principles;

1. Maintain or re-establish lower bank vegetation.
2. Protect the bank and aquatic biota by minimising erosion and mass failure of the lower bank, managing water quality and re-introduce sediments/seed.
3. Achieve fish outcomes – improve Murray and Trout cod populations, cue Golden and Silver perch spawning and attraction into the river.
4. Maximise platypus breeding success by providing nesting cues
5. Maximise ecological outcomes by using tributary flows as much as possible to meet environmental watering objectives, and especially during the spring period
6. Increasing habitat by connecting low lying floodplain features in the mid Goulburn .

Due to high volumes of Environmental water available he priority watering actions that could be met are the same under each climate/water resource scenario as outlined in the table below:

Summary of potential environmental watering actions provided under each water resource scenario

Priority	Compliance point; Eildon, Murchison, McCoys	Potential environmental watering actions	Rationale	Scenario 1 – Extreme dry (99% PoE)	Scenario 2 – Dry (90% PoE)	Scenario 4 – Average (50% PoE)	Scenario 5 – Wet (10% PoE)
1	Murchison McCoys	Provide a year round low flow 600 – 1,000 ML/day in reach four and five for habitat diversity and sustaining the system		Y	Y	Y	Y
2	Eildon	Provide a year round variable low flow of 400-2,000 ML/day to reach 1.		Y	Y	Y	Y
3a	Murchison McCoys	Provide a 2023 winter fresh to reach 4-5 of (>7,300 ML for 4-5 days) up to 9,500 ML/day in July - August for channel forming, and platypus nesting cues. Aim to use a natural fresh and provide most of the event from rainfall runoff with minimal releases from Lake Eildon.	Aim will be to deliver later in winter i.e. July/August for platypus cues and aligning with Reach 1. Timing of delivery will depend on Eildon maintenance works. Maintenance is currently planned to start in late May	Y	Y	Y	Y
3b	Eildon	Provide a winter fresh to reach 1 of >8,000 ML/d (or as high as possible) for 5-10 days between late July and late August to connect low lying wetlands and provide a nesting cue for platypus.	Likely to coincide with the reach 4 and 5 fresh, depending on time of delivery and required release volume from Lake Eildon. Otherwise, this will be delivered as a separate winter fresh that can be re-harvested in Waranga Basin or passed through the lower Goulburn River.	Y	Y	Y	Y
4a	Murchison McCoys	Provide a spring fresh (>7,300 ML for 7 days) up to 10,500 ML/day in September - October to prime the system for lower bank vegetation establishment and maintenance. Aim to use a natural fresh and provide most of the event from rainfall runoff with minimal releases from Lake Eildon.		Y	Y	Y	Y
4b	Eildon	Provide a spring fresh to reach 1 (as high as possible, but not exceeding the winter fresh discharge) for 5-10 days between September and November	This fresh will be delivered as part of the reach 4 and 5 event. If there are sufficient unregulated flows and Eildon releases are small then a separate event will occur at least 1- 3 weeks after the fresh for reaches 4 and 5.	Y	Y	Y	Y
5	Murchison McCoys	Provide a year round standing order for freshes up to 6,000 ML/day from Goulburn Weir to maintain water quality, protect the banks and provide natural variability	This will be used to slow recession flows	Y	Y	Y	Y
6	Murchison McCoys	Provide an autumn fresh (>5,700 ML for 2-5 days) between March and May 2024 for lower bank vegetation reinvigoration and maintenance and/or fish migration outcomes.		Y	Y	Y	Y

		NOTE: this fresh will only be delivered depending on flow and vegetation condition over the summer period					
7	Eildon	Provide up to three freshes in reach 1 of >5,000 ML/d for 5-10 days between May and November to mimic natural flow variability and connect wetlands.	These will be in addition to the reach 4 and 5 winter and spring freshes	Y	Y	Y	Y
8	Eildon Murchison McCoys	Provide (carryover) for baseflow of 1000 ML/day in July to September (23/24)		Y	Y	Not needed	Not needed
9	Murchison McCoys	Provide higher baseflows or freshes up to 6,000 ML/day between May and November to pass Reach 1 freshes or mimic natural variability through the length of the Goulburn River.	This flow will be delivered to provide variability between freshes	Y	Y	Y	Y
10a	Murchison McCoys	Provide 2024 winter fresh >7,300 ML/day or as high as possible in May - August for channel forming, and platypus nesting cues. Aim to use a natural fresh and provide most of the event from rainfall runoff with minimal releases from Lake Eildon.		Y	Y	Y	Y
10b	Eildon	Provide a winter 2024 fresh of >8,000 ML/day (or as high as possible) for 7 days in Reach 1 to connect low lying wetlands, and provide nesting cues and food for platypus		Y	Y	Y	Y
11^	Murchison McCoys	Provide a late spring fresh (>6,600 ML for 1 day) between October and December for native fish spawning *NOTE: this fresh will only be delivered if flows will not damage littoral vegetation*		Y	Y	Y	Y

+ the autumn fresh will only be delivered if IVT pulses under the operating plan haven't met water requirements or flows have exceeded 2000ML/day for more than 20 days

^ to limit littoral vegetation damage this fresh will only be delivered if following the spring fresh there is 6-8 weeks of baseflows of around 1000 ML/day or flow have not been less than 2000ML/day for more than a week.

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Glossary and acronyms

AEP – annual exceedance probability. The likelihood of occurrence of a flood of a given size or occurring in any one year

Bankfull - carrying capacity of the stream before spilling out onto adjacent land

Baseflow - low flows sufficient to maintain fish passage, water quality, and pool and riffle habitats

Goulburn Broken Catchment Management Authority (GBCMA) -statutory authority established to manage regional and catchment planning, waterways, floodplains, salinity and water quality

Channel - that part of a river where water flows and includes the bed and banks, taken to mean the whole of the depression in which the water flows before it rises sufficiently to spill over onto adjacent lands as flood water

Commonwealth Environmental Water Office (CEWO) - (part of the Department of the Environment) holds and manages the water entitlements purchased through the Restoring the Balance water recovery program

Department of Energy, Environment and Climate Action (DEECA) – Victorian government department responsible for protecting the environment, responding to climate change and supporting sustainable population growth

DO - dissolved oxygen

Environmental flow regime - the timing, frequency, duration and magnitude of flows for the environment

Environmental flow study - a scientific study of the flow requirements of a particular basin's river and wetlands systems used to inform decisions on the management and allocation of water resources

Environmental water entitlement - an entitlement to water to achieve environmental objectives in waterways (could be an environmental entitlement, environmental bulk entitlement, water share, Section 51 license or supply agreement)

Flow component - components of a river system's flow regime that can be described by timing, seasonality, frequency and duration (for example, cease to flow and overbank flows)

Flow regime - pattern of seasonal flow variations in any one year, usually consisting of periods of low flow during summer-autumn then high flows during winter-spring

Freshes - flows that produce a substantial rise in river height for a short period, but do not overtop the riverbank.

Geomorphology (fluvial) - the physical interaction of flowing water and the natural channels of rivers including erosion and sedimentation

Gigalitre (GL) - one billion (1,000,000,000) litres

GMW – Goulburn-Murray Rural Water Corporation, trading as Goulburn-Murray Water

High flows - high flow within channel capacity.

High reliability entitlement - legally recognised, secure entitlement to a defined share of water, as governed by the reserve policy

Instream - refers to that area of a waterway below the surface of the water

Inter Valley Transfers (IVT) - means bulk transfers of water from the Goulburn water supply system to supply water users in the Murray water supply system

Low reliability entitlement - legally recognised, secure entitlement to a defined share of water, as governed by the reserve policy (full allocations are expected only in some years)

Macroinvertebrates - aquatic invertebrates whose body length usually exceeds 1 mm (included insects, crustacean, aquatic worms and aquatic snails)

Macrophytes - an aquatic plant that grows in or near water and is emergent, submergent, or floating

Megalitre (ML) - one million (1,000,000) litres

MDBA – Murray Darling Basin Authority

Overbank flow - flows that overtop the banks and spill onto the floodplain

Passing flow - water released out of storages to operate river and distribution systems (to deliver water to end users), provide for riparian rights and maintain environmental values and other community benefits

Planktonic algae - floating microscopic plants that are an important food source for aquatic fauna

Pool - a significantly deeper area in the river bed

Reach - a length of stream that is reasonably uniform with respect to geomorphology, flow and ecology

RWS – Regional Waterway Strategy

Riffle - a section of the river with fast and turbulent flow over a pebble bed with protruding rocks

Riparian vegetation - vegetation growing on the water line, up the bank or along the very top of the bank. It is the vegetation which has the most direct effect on instream biota.

Seasonal allocation - the volume of water allocated to a water share in a given season, expressed as a percentage of total entitlement volume

Slackwater habitat – an area in the river channel where water depth is less than 0.5 m and velocity is less than 0.05 m/s

The Living Murray (TLM) - an intergovernmental program, which holds an average of 500,000 ML of environmental water per year, for use at six icon sites along the River Murray

Unregulated entitlement - an entitlement to water declared during periods of unregulated flow in a river system, that is, flows that are unable to be captured in storages

Victorian Environmental Flow Monitoring and Assessment Program (VEFMAP) – assesses the effectiveness of environmental flows in delivering ecological outcomes

Victorian Environmental Water Holder (VEWH) - an independent statutory body responsible for holding and managing Victorian environmental water entitlements and allocations (Victorian Water Holdings)

Water entitlement - the right to a volume of water that can (usually) be stored in reservoirs and taken and used under specific conditions

Water Holdings - environmental water entitlements held by the Victorian Environmental Water Holder

Waterway manager - agency responsible for the environmental management of waterways (includes catchment management authorities and Melbourne Water)

Waterways - can include rivers, wetlands, creeks, floodplains and estuaries

Introduction

This seasonal watering proposal outlines the Goulburn Broken Catchment Management Authority's priorities for the use of water in the Goulburn River in 2023/24, as required under section 192A of the *Water Act 1989*.

The purpose of this Goulburn River Seasonal Watering Proposal is to:

- identify the environmental water requirements of the Goulburn River in 2023/24 under a range of climate and consumptive water delivery scenarios; and
- inform the development of environmental water priorities in the VEWH's Seasonal Watering Plan.

The proposal is informed by current ecological conditions, scientific studies and reports that identify the flow regimes required to meet the ecological objectives of the Goulburn River.

Priority reaches and measuring points

There have been several environmental flow studies of the Goulburn River with each dividing the river into representative reaches. Flow recommendations, compliance points and monitoring are based on these reach delineations. The reaches are as follows:

1. Lake Eildon to Yea River (85 km)
2. Yea River to Sunday Creek (Seymour) (45 km)
3. Sunday Creek (Seymour) to Goulburn Weir (65 km)
4. Goulburn Weir to Loch Gary (110 km)
5. Loch Gary to the Murray River (125 km)

These reaches are detailed in Cottingham et al (2007) and (2014) and are shown in Figure 1.

In spring, summer and autumn irrigation and consumptive water releases from Lake Eildon means there is less opportunity to release water for the environment to reaches one, two and three. However, opportunities still exist for environmental water releases to support and enhance ecological values in this part of the river at this time of year, as well as over winter during the non-irrigation season. Additionally, diversion of consumptive/irrigation water from Goulburn Weir to the irrigation districts provides an improved opportunity for environmental water to be passed through the weir and delivered to reaches 4 and 5 to support a more natural flow regime. Flow delivered to reaches four and five throughout the year can also benefit reaches one, two and three depending on how much of these deliveries require Lake Eildon releases versus tributary inflows.

The key measurement points for environmental flows are at Eildon for reach one, Trawool for reach two, Seymour for reach three, Murchison and Shepparton for reach four and McCoys Bridge for reach five.

Water sources

Water available to meet environmental needs in the Goulburn River are listed in

Table 1 and include:

- minimum passing flows and a Water Quality Reserve established in the Bulk Entitlement (Eildon – Goulburn Weir) Conversion Order 1995 and subsequent amendments;
- environmental entitlements held by the VEWH, the CEWH and the MDBA; and
- unregulated flows (not listed).

Water holders can trade or transfer water from one catchment to another. Consequently, the volumes listed below are strictly entitlement volumes, but total volume available in the Goulburn River could be greater or less depending on state priorities and those in the southern Murray Darling Basin. Such water sharing arrangements are negotiated with water holders throughout the year.

Inter-Valley Transfers (from the Goulburn system to the Murray system) (IVT) usually provide flows in summer and autumn that can be used to meet baseflows and reduces the need to deploy water from environmental entitlements. However, due to increased demand for IVT and consequent ecological impacts, the Minister for Water announced revised trade rules along with revise interim operating and trade rules in Juner 2022. These operating rules set limit the rates that consumptive water (IVT and environmental water) can be delivered throughout the year. The rules outline maximum flows and require minimum low flow periods, with average baseflows of 1,100 ML per day over summer and autumn for six to eight weeks at a time, between three short higher volume releases, called 'pulses'. These pulses will last around 14 days in total, peaking for a few days at up to 3,000 ML per day before slowly returning to 1,100 ML per day. These rules set maximum levels of IVT that the MDBA can call out each month. In addition there are also specific rules related to delivery of environmental water above these rates. There are certain conditions that may mean these volumes are not delivered and actual monthly flow may exceed these volumes if environmental or unregulated flows occur. The rules set three pulses of 3,000 ML/day to meet the default volumes over summer and autumn. The full report and can be found on the Victorian water Register via this link.

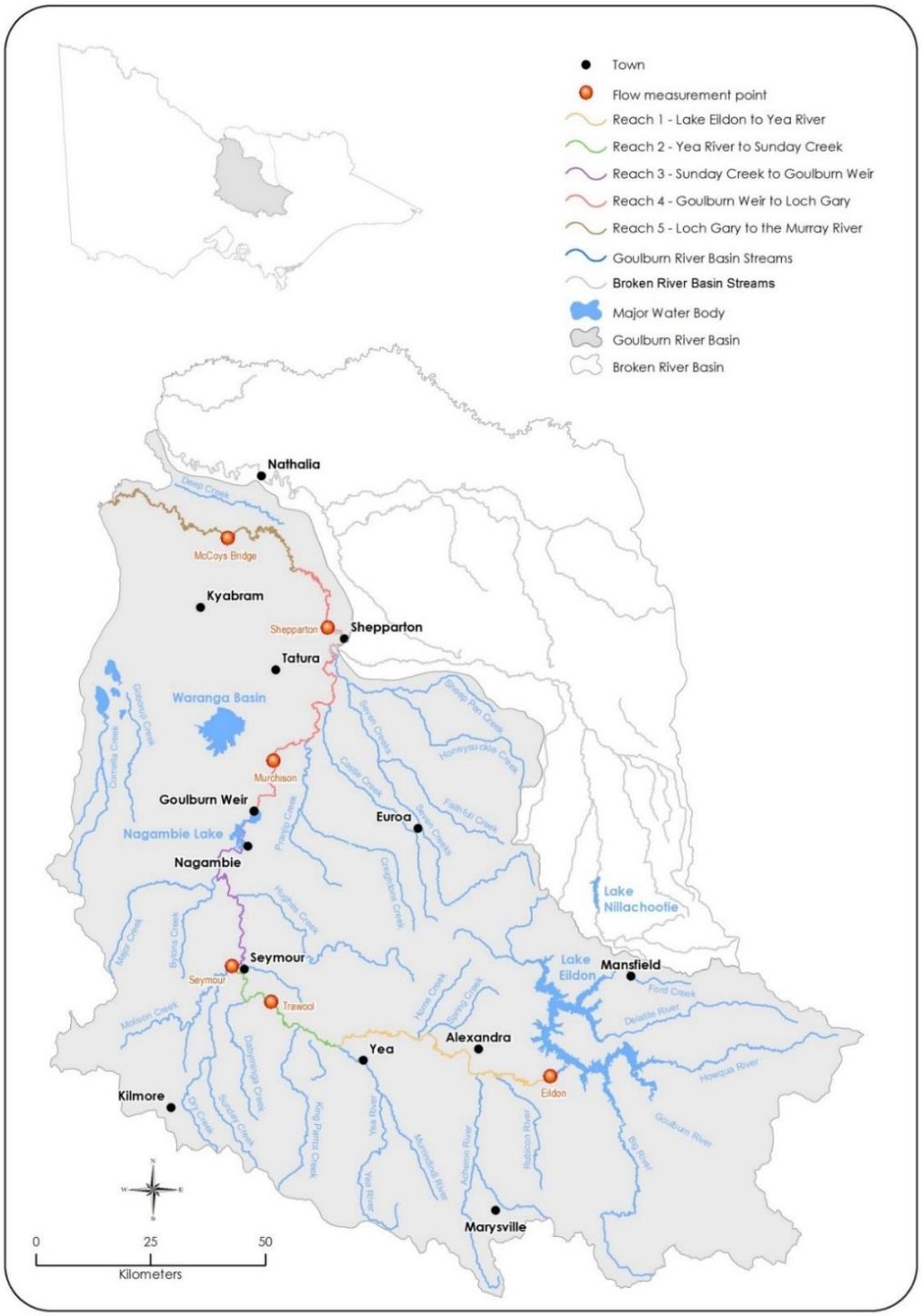


Figure 1: Goulburn River catchment

Table 1: Bulk entitlements and environmental water available for use in the Goulburn River

Environmental Water	Responsible Agency	Description	Conditions
Bulk Entitlement (Eildon – Goulburn Weir) Conversion Order 1995			
Minimum flow	GMW	Minimum flow of 120 ML/day at Eildon Pondage Weir	
Minimum flow	GMW	Minimum average weekly flow of 250 ML/day at Goulburn Weir	Daily rate to be no less than 200 ML/day[1]
Minimum flow	GMW	Minimum average monthly flow of 350 ML/day from November to June (inclusive) at McCoys Bridge	Daily rate to be no less than 300 ML/day[1]
Minimum flow	GMW	Minimum average monthly flow of 400 ML/day from July to October (inclusive) at McCoys Bridge	Daily rate to be no less than 350 ML/day[1]
Goulburn Water Quality Allowance	GMW and VEWH*	30 GL per year	Maintenance of water quality
Additional passing flow below Eildon Pondage Weir	GMW	Minimum passing flows at Eildon Pondage Weir increased to 250 ML/day	Inflows to Lake Eildon for previous 24 months must reach a specified volume[1]
Additional Passing Flow below Eildon Pondage Weir	VEWH	Up to 80 GL in November to provide up to 16,000 ML/day peak flow for one day	Inflows to Lake Eildon from previous 12 and 24 months must reach specified volumes and VEWH confirms the need for a release[1]
Environmental Water Entitlements			
Goulburn System NVIRP Stage 1	VEWH	35,781.3 ML HRWS One third of water savings created in the Goulburn system resulting from modernisation works completed as Stage 1 of the Northern Victorian Irrigation Renewal Project (NVIRP)	Volume based on works implemented and water losses saved in previous year's climate
Goulburn River Environmental Entitlement	VEWH	7,417 ML HRWS 1A 3,140 ML LRWS 1A 1,434 ML HRWS 1B (used in Loddon) This water is generally used in Goulburn catchment wetlands, however, is also available to the river	
Environmental Entitlement (Goulburn-System – The Living Murray) 2007	MDBA	39,625 ML high reliability entitlement 156,980 ML low reliability entitlement 5,559 Water Shares	Water allocated to this entitlement must be used for the Living Murray 'icon sites'. However, this water can provide environmental benefits in the Goulburn River on route to the Murray River
Commonwealth Environmental Water Holdings+	CEWH	317,557 ML Goulburn high reliability water share 42,467 ML Goulburn low reliability water share (as at 28 February 2021)	Water use is subject to agreement with the CEWH

1 Minimum flows in the Goulburn Bulk Entitlement can be reduced under drought conditions and banked for later use.

* The VEWH has delegated their role in the management of the Goulburn Water Quality Allowance to the GBCMA

+ CEWH may have the opportunity to trade additional environmental water allocations from the Murray to meet Goulburn demands

Table 2: Assumed maximum allowable monthly volumes of IVT to be delivered under the Trade Rule Operating Plan and rules

Month	Goulburn IVT volume (ML)
July	0
August	0
September	14,000
October	25,000
November	19,000
December	38,000
January	29,000
February	30,000
March	38,000
April	16,000
May	5,000
June	5,000
TOTALS	**219,000**

Engagement

There are two main audiences for engagement in the development of this proposal. The primary audience are the agencies involved in delivering the proposed flows. This includes Goulburn-Murray Water, the Victorian and Commonwealth Environmental Water Holders and the Murray-Darling Basin Authority (river operators and the Living Murray program).

The VEWH will use this proposal as the basis for developing their Seasonal Watering Plan. Water allocated is to be delivered in accordance with the plan and the plan is used to seek agreement from other water holders for the use of their water. Routine communication (videoconference, phone, email) will report on deployment of water under the plan.

The CEWO may allocate water to the Seasonal Watering Plan which is based on this proposal. Environmental water releases from the Goulburn River also assist in achieving further benefits at downstream environmental sites. Routine communication will be via the VEWH.

GMW is the key water delivery agency for this plan. When the final proposal for 2023/24 is agreed, communications with GMW will continue to manage environmental water orders and releases and informing GMW and their customers of the intended purpose.

MDBA (river operators) is responsible for calling out Inter-Valley Transfers. IVT orders are placed with GMW. However, regular communications (phone, email) throughout the year with the CMA will be aimed at delivering IVT in line with the 2020 draft operating rules and GMW's 2023/24 operating plan. As the operating plan is still in a draft state and not protected in legislative instruments there will be ongoing communication on implementation and review, operating rules and trade rules may impact on the delivery of IVT into 2023/24.

A Goulburn and Broken Operational Advisory Group was formally established by the VEWH in 2016 and is comprised of representatives from the VEWH, Goulburn-Murray Water, CEWO, Taungurung Land and Waters Council, MDBA and GBCMA. This group aims to provide a regular and coordinated forum to discuss the environmental water resource management planning and delivery in the Goulburn River and discuss how this impacts system scale coordination of consumptive and other environmental water.

The secondary audience of this proposal are those potentially affected by, or interested in, environmental flows but not directly involved in planning and delivery. This includes Parks Victoria, water users along the river, local government, Victorian Fisheries Authority, environment groups and the general public. The communication objective for these groups is to provide information about the decision to provide environmental flows and what it is trying to achieve. These communications are generally through media articles, emails, and potentially through presentations to special interest groups and direct engagement.

To assist with engaging the community, the GBCMA established a Goulburn Environmental Water Advisory Group in 2012. The aim of the group is for community members and interest groups to provide feedback to the CMA on river health trends observed by landholders and river users and provide advice on planning environmental water use. The group comprises community members and representatives from key agency partners. Indigenous groups (Yorta Yorta Nation Aboriginal Corporation and Taungurung Land and Waters Council) have a seat in the group and are starting to attend the meetings on a regular basis. At times, limited resources have restricted their involvement and when this happens, they are consulted through separate meetings or discussions.

Table 3 outlines the consultation process the CMA has undertaken during the development of this Seasonal Water Proposal.

Table 3: Engagement undertaken in development of the Seasonal Watering Proposal 2023/24

Who	Engaged on 2023/24 SWP	Engagement method	IAP2 level of engagement	Engagement purpose
Community groups and Environment groups	Goulburn Valley Environment Group	GEWAG meeting on the 24/2/2023	Involve	Seek feedback on environmental water priorities for 2023/24 Incorporate feedback and observations on river condition into the SWP
Program Partners (Government Agencies)	Goulburn Murray Water VEWH CEWO Parks Victoria MDBA/TLM	GEWAG meeting on the 24/2/2023 Direct engagement Meeting with VEWH on 10 November 2022 to discuss the proposed updated watering actions for reach 1-3.	Collaborate	Seek input to development of proposal and ensure partners understand any issues in environmental water planning and provide feedback on any constraints to delivery
Recreational users and Local businesses	Trellys fishing and hunting Local ecotourism operator	GEWAG meeting on the 24/2/2023 Direct engagement	Involve Involve	Seek feedback on environmental water priorities for 2023/24 and observations of the river. Seek feedback on social and recreational use of the river
Landholders	Goulburn Environmental Water Advisory Group (GEWAG)	GEWAG meeting on the 24/2/2023	Involve	Seek feedback on e-flow priorities for 2023/24 Incorporate feedback and observations on river condition into the SWP
Traditional owners	Yorta Yorta	GEWAG meeting on the 24/2/2023 Direct engagement for contribution to the SWP – 18 January 2023	Involve	Seek feedback on e-flow priorities for 2023/24 Incorporate feedback and observations on river condition and objectives into the SWP
	Taungurung	Meeting with TLWC on 10 November 2022 to discuss proposed updated watering actions for reach 1-3. Confirmation of support from Baan Ganalina on 11 January 2023. Direct engagement for contribution to the SWP-Met 22 February 2023	Involve	Confirm that new flow recommendations for reaches 1-3 are supported by the Taungurung Water Knowledge Group and did not require further amendment. Seek feedback on e-flow priorities for 2023/24 Incorporate feedback and observations on river condition and objectives into the SWP
Technical experts	Scientific leads from the CEWO Monitoring, Evaluation and Research Program – Goulburn River G-M trade rule review Scientific Advisory panel	Direct engagement through various sources – FLOW MER annual workshop 17/2/2023.	Collaborate	Seeking advice from scientists on their observations from monitoring and adapting plans/objectives to these results Fish, Vegetation, Macroinvertebrates, Bank Condition

Aboriginal cultural values and uses of waterways

Taungurung Land and Waters Council and Yorta Yorta Nation Aboriginal Corporation kindly provided their values for inclusion in Table 4 which also highlights shared benefits from environmental water deliveries. Based on discussions at meetings with TO groups, the GB CMA has interpreted how the watering actions align with these values and will seek endorsement of the Seasonal Watering Proposal and this section.

Yorta Yorta representatives were present at the Goulburn River Environmental Water Advisory group meeting held on the 24 February 2022 and contributed to the development of the potential watering actions in this proposal. Wording in Table 4 was provided by Yorta Yorta in 2022.

The proposed watering actions and overall environmental watering objectives and management plans were discussed with the Taungurung water knowledge group, Baan Ganalina (Guardians of Water) on the 9th and 10th.

Table 4: Traditional Owner values provided in 2021 and alignment with potential watering actions

Values				
River/Wetland	**Traditional owner Group**	**Cultural NRM strategy (emerging) alignment**	**Outcomes**	**Alignment with potential watering action**
Waring **(Mid Goulburn River, reach 1-3)**	Taungurung	Healing Country	Supporting the health of cultural values and landscapes - protecting intangible cultural heritage and valued species, traditional food and medicine plants	Reach 1-3 baseflows and freshes will have positive outcomes for Improving the health of Waring including connecting wetlands that support valued species, at appropriate times.
			Actively fulfilling Caring for Country responsibilities - investigating on more natural water regimes to degraded significant sites, rehabilitation of native habitat conditions	The updated watering actions will help reinstate a more natural water regime that better reflects the size, timing and variability of natural inflows to this part of the river.

River/Wetland	Traditional owner Group	Values	Alignment with potential watering action
Kaiela **(Lower Goulburn River, reach 4-5)**	Yorta Yorta	Environmental flows on the Lower Goulburn River are critical for culturally important species both flora and fauna. Flows encouraging spawning activity, recession flows to alleviate slumping of culturally important sites such as middens & scar trees and flows with a focus on reviving riparian vegetation are important in sustaining culturally valued food, fibre, and medicine.	All watering actions proposed for Reaches 4 and 5 align with the values of the Yorta Yorta peoples as they are designed to improve the ecological health of the Kaiela. The standing order for recession flows will help to prevent mass failure and the freshes will bring in sediment and seeds to rebuild the banks to protect culturally important sites. Watering actions have been developed using results from monitoring which has shown lower bank vegetation and health/abundance of aquatic animals has improved by delivery of environmental water in previous years that has been delivered in consistently with the actions in this proposal.

Social, recreational and economic values and uses of waterways

The Goulburn River has significant social values associated with passive recreation, fishing and boating, and economics. These revolve around enjoying the natural environment and are enhanced by improvements in river health achieved with targeted environmental flows. The use of environmental water also improves water quality in the river which has a direct benefit for human consumption, stock and domestic and irrigation uses.

Table 5: Social, recreational and economic shared benefits of environmental water in 2023/24

Goulburn River reach	Shared benefit	Beneficiary	Description
All	Economic	Consumptive water users – GMW irrigators and diverters, Goulburn Valley Water (GVW) customers.	Environmental flows improve water quality, reduce blackwater risk and dilute blackwater, which reduces water treatment costs for GVW and operational risk. Higher flows/water levels improve water access to some pumps, reduce pumping costs and water quality risks for water users.
All	Recreational Amenity	Broader community Local residents, visitors, anglers, game hunters, kayakers and canoers.	Environmental water improves vegetation and water quality and consequently provides an attractive area for campers, hikers, and walkers to enjoy. Environmental water improves the local environment, increases species richness in the riparian area and retains natural assets that can be enjoyed by everyone, encouraging community conservation and outdoor activities.
All	Recreational Economic	Broader community Anglers	Using environmental water to provide fish passage and habitat, and delivering freshes to encourage fish migration and spawning, enhances native fish populations for recreational benefit. The benefits are extended to other waterways in the entire southern connected Murray Darling Basin. The delivery of freshes are timed to minimise impact to regional communities and businesses (e.g. annual Cod opening or Easter).

OFFICIAL

Seasonal Review

Long term flow history

In 2010/11 the first Goulburn River flood occurred in more than 15 years. Since then, the climate has got progressively drier with 2011/12 and 2012/13 drier than average, 2013/14 and 2014/15 very dry, and 2015/16 one of the driest on record in the Goulburn catchment. However, 2016/17 was a very wet year with above average rainfall for most months between May and October (MDBA weekly report, 7 December 2016). Inflows in the Goulburn catchment were very high and tracked in the above average to wet scenarios, with at least three distinct overbank flows during winter and spring. From 2016-2021, the climate again started to dry with inflows slowly receding, before record flooding occurred in 2022. Mean daily flow at McCoys Bridge since 2012 is shown in Figure 2.

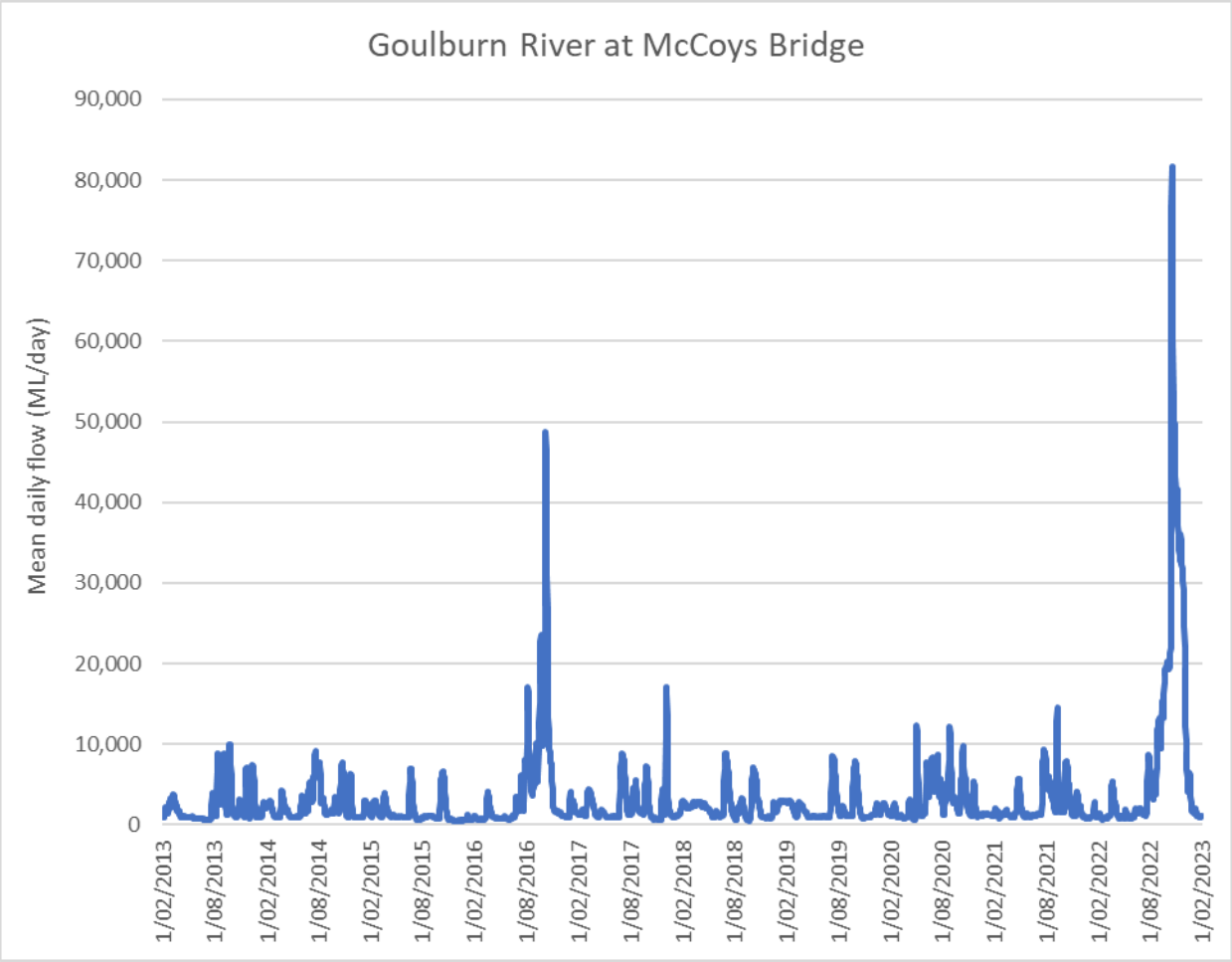
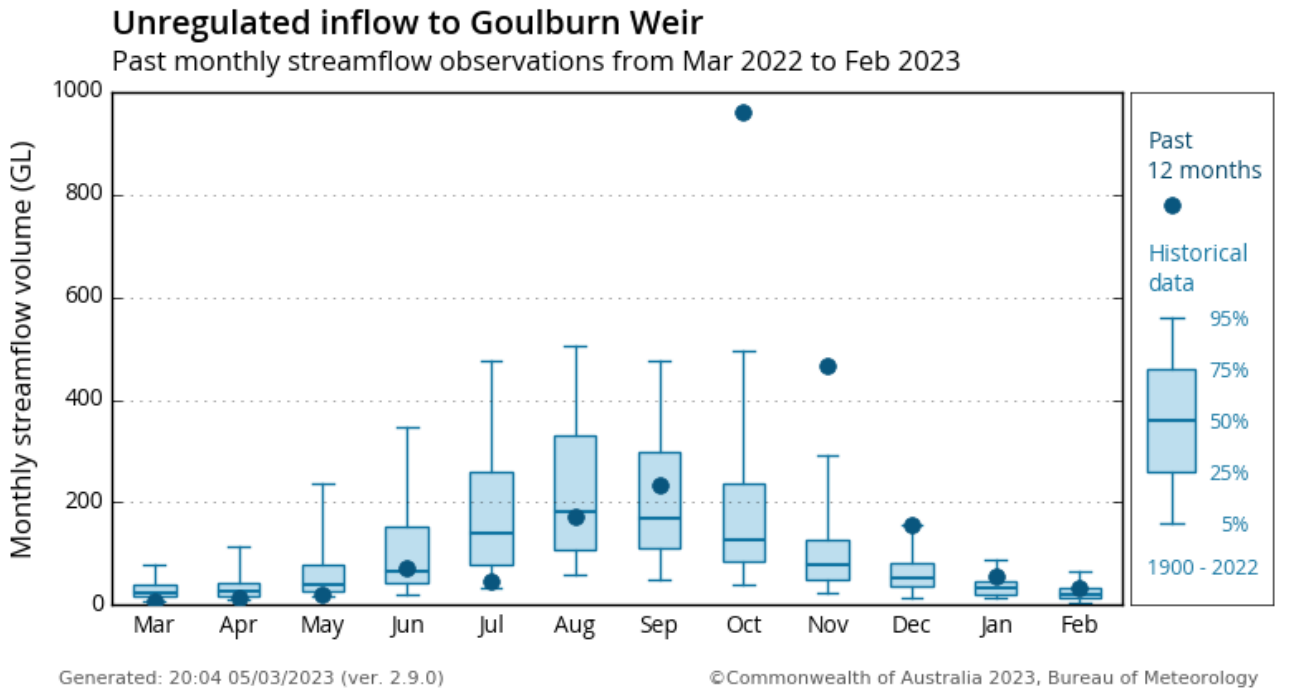


Figure 2: Ten years of flow at McCoys Bridge

Monthly flows generated in the past 12 months from rainfall runoff into the Goulburn River storages (Lake Eildon and Goulburn Weir) are compared to long term historical data in Figure 3. The charts show that rainfall runoff in spring and summer 2022/23 were for the most part, well above historical inflows, while winter was lower than historical averages at Goulburn Weir, but generally higher at Lake Eildon. Overall, inflows to Goulburn River storages in 2022/23 were above average for 6 months at Goulburn Weir and 10 months at Lake Eildon.



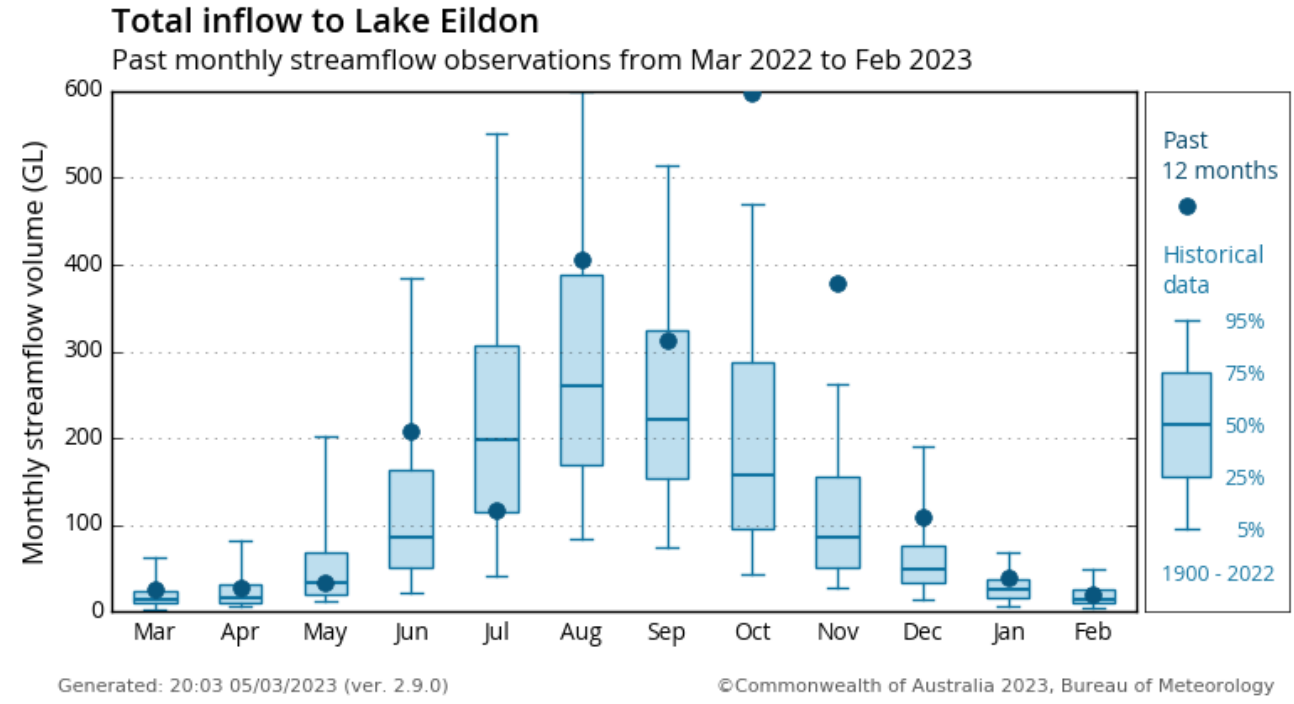


Figure 3: 2022/23 inflows to Lake Eildon and Goulburn Weir compared to historical inflows (Seasonal Streamflow Forecasts: Water Information: Bureau of Meteorology (bom.gov.au))

2022/23 flow review

Mid Goulburn

The CMA has been working with Taungurung Land and Waters Council to improve our understanding of the ecological/biocultural values and hydrological requirements of the mid Goulburn River. This has focussed on the numerous off-channel habitats, such as anabranches, lagoons and backwaters that connect to the river at varying flow heights. These areas provide a different type of habitat to the main river channel, supporting threatened fish and platypus, as well as being culturally significant to Taungurung people.

At times these sites drain unnaturally reducing aquatic habitat availability. The sites drain due to low river flows; e.g. environmental water deliveries at baseflows of 400 ML/d, or when irrigation demand is very low/absent. Therefore, the CMA investigated what flow rate is required to maintain these off-channel areas. An example of the types of sites investigated is shown in Figure 4.

Figure 4: Examples of off channel habitats that were assessed in the mid Goulburn River

In May 2022, Goulburn Broken CMA conducted a flow trial in the mid Goulburn River to identify how channel and off-channel habitat conditions changed in response to increasing releases from Lake Eildon. Observations of available habitat were assessed every three days at sites that were accessible for the following flow rates (at Eildon):

- 400 ML/d
- 1,000 ML/d
- 2,000 ML/d
- 3,000 ML/d
- 4,000 ML/d
- 5,000 ML/d and on the drawdown when flows had returned to 400 ML/d.

The lower Goulburn River winter fresh in July 2022 provided an opportunity for monitoring to be undertaken at Lake Eildon releases of approximately 8,000 ML/day (Figure 5). There were 21 sites assessed between Lake Eildon and Seymour, including both river channel (8) and off-channel habitats (13). The observations provided new information on the hydrology/habitat relationships in the river and consequently existing environmental watering actions for the mid Goulburn (reach 1-3) were internally reviewed. The assessment was based on the scientific evidence that informed the mid Goulburn River FLOWS study (Cottingham et al. 2014).

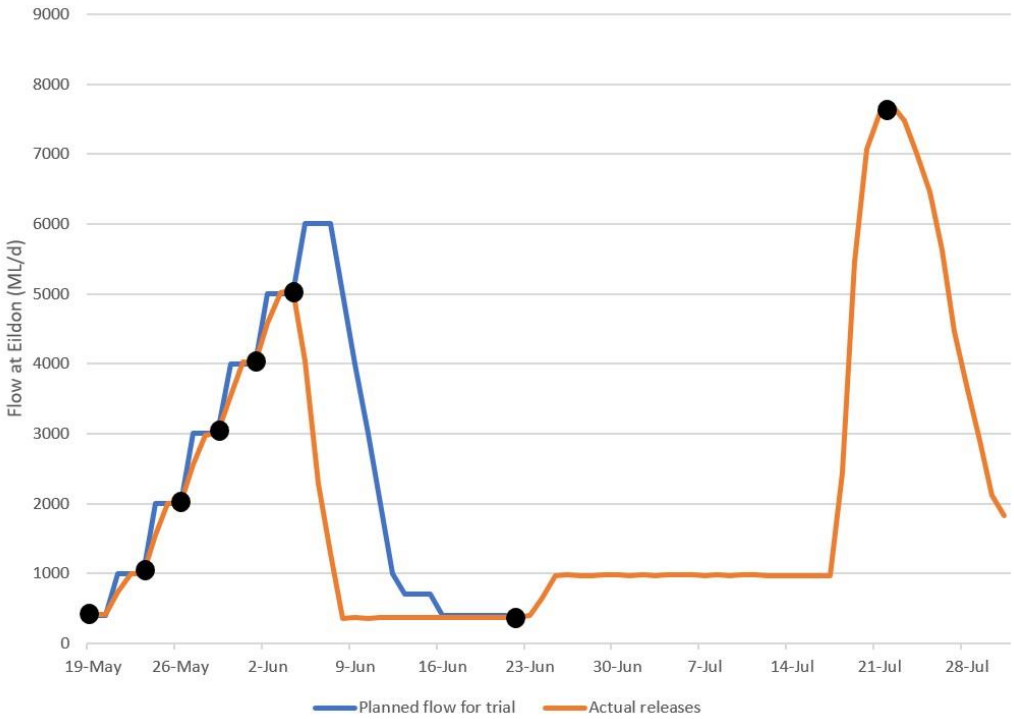


Figure 5: Periods of monitoring during the 2022 mid Goulburn River winter fresh and flow trial (black dots)

Updated watering actions were developed and an ecological justification report drafted to document how and why the watering actions should change. This report has been reviewed by Taungurung Land and Waters Council, the Taungurung water knowledge group (Baan Ganalina), the VEWH and a panel of scientists, and has informed the watering actions proposed for reach 1-3 in the 2023/24 Seasonal Watering Proposal. A member of Baan Ganalina provided the following response in relation to the updated watering actions:

> *"These flow recommendations will help support Waring (Goulburn River), which is such an important part of Taungurung identity. It's good to see how GBCMA have used peer reviewed articles to show the effects on important animals like platypus, and shared this knowledge. The river is a work in progress, but together with GBCMA we will continue to seek ways to heal Country despite the harm it has suffered. Baan Ganalina hope to see the proposed higher winter flows, and look forward to taking an ongoing role in monitoring their effects."*
>
> Corrie Leatham, member of *Baan Ganalina*

Following the winter fresh, wet conditions over winter and into spring saw Lake Eildon come close to capacity and GMW commenced airspace releases in early September. High, widespread rainfall in October 2022 resulted in flow over the Lake Eildon spillway occurring for the first time since the early 1990s, at up to 36,000 ML/day (Figure 6). Combined with high tributary inflows, the Goulburn River at Trawool reached approximately 80,000 ML/day. The mid Goulburn experienced widespread flooding that impacted natural, agricultural and urban areas. Releases from Lake Eildon were temporarily reduced in late October to enable the movement of farm stock to drier ground. Releases then remained high until the start of December when more typical river operations resumed (Figure 7).

Figure 6: Lake Eildon spillway at 38,000 ML/day (15 October 2022)

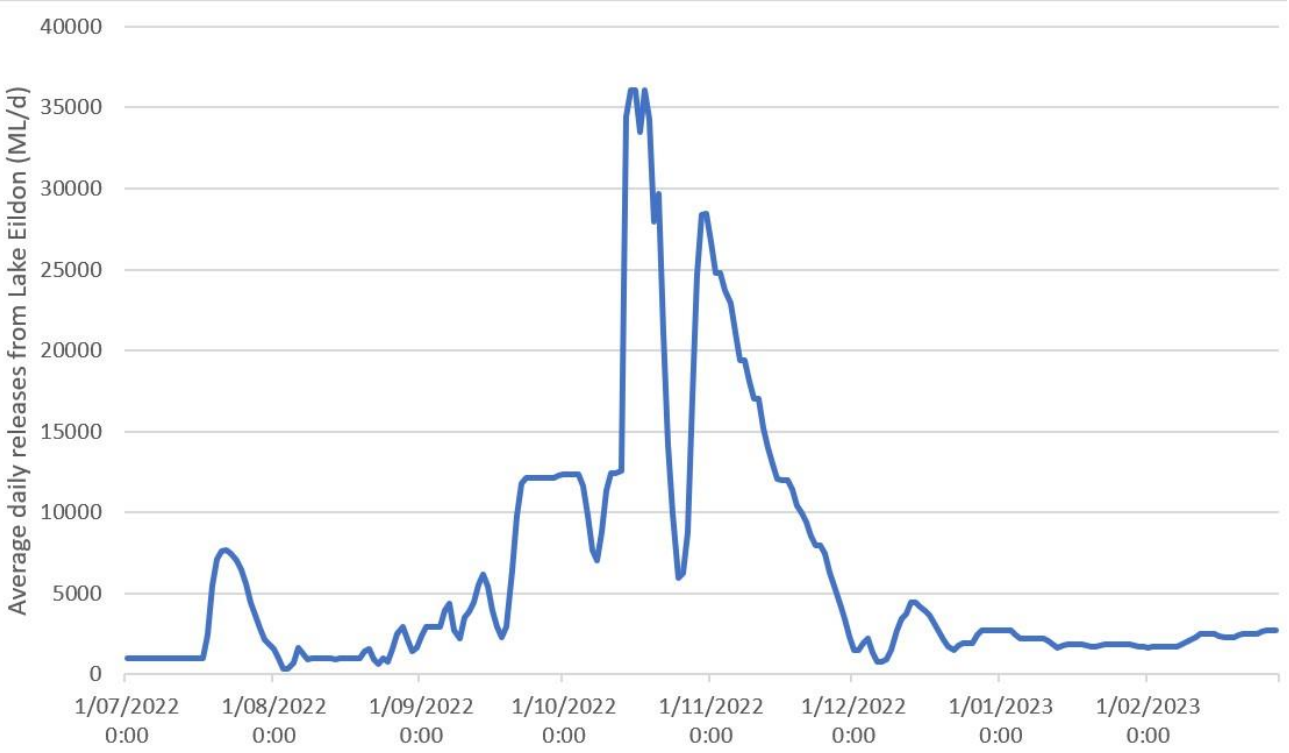


Figure 7: Flow at Lake Eildon

Lower Goulburn

Unregulated flows and floods dominated 2022/23 and consequently there was limited use of environmental water.

Prior to unregulated flows, the delivery of a winter fresh occurred in July, predominately using water released from Lake Eildon. The peak flow rates of the fresh were approximately 8,900 ML/day at Murchison (on 24th July) and 8,700 ML/day at McCoys Bridge on 28th July. Following the winter fresh variable baseflows were delivered using tributary flows to reach flow targets downstream of Goulburn Weir. The flows were planned to not exceed 3,000 ML/day (operational limits). However, by mid August baseflows were reduced to 900 ML/day due to widespread rainfall and rising river levels in the Goulburn and Murray Rivers.

From the end of August flows at Murchison and McCoys Bridge remained above 9,000 ML/day and exceeded 25,000 ML/day for all of October with widespread flooding from mid to the end of October. A peak mean daily flow rate of 150,000 ML/day was measured on 15th October at Murchison and a peak mean daily flow rate of 115,000 ML/day was recorded at McCoys Bride on 20th October. The Yea River (~1:200 AEP) and Goulburn River at Seymour (~1:75 AEP) reached the highest level on gauged record, and the second highest gauged flood levels were measured on the Goulburn River at Murchison (~1:150 AEP) and Shepparton (~1:100 AEP). Downstream of Shepparton numerous levees breached on the right bank of the river (east) and there was extensive floodplain inundation. Volumes of water were estimated to be three to four times greater than previous floods at Shepparton and duration longer than the 1974 flood.

In December, river levels dropped by five metres in a week and flows dropped below 9,000 ML/day in the first week of December for the first time since late August. When river levels dropped there was minor slumping and notching observed along some banks. The duration of flows above baseflow levels has reset lower bank vegetation with most of the vegetation impacted. However, given the presence of water tolerant littoral and lower bank vegetation recovery is expected to be rapid with additional seed delivered from flood waters.

Following floodplain inundation and the slow recession leading into summer, water quality reserve water was used from early December to provide refuge habitat from potential hypoxic blackwater in the lower Goulburn River. Water was delivered through irrigation outfalls to provide discrete refuge and from early January 2023, was transferred from water quality reserve to environmental water. The use of environmental water for this purpose is considered delivery of baseflows and included in the total order for Goulburn River baseflows. A maximum of 100 ML/day can be delivered through irrigation outfalls.

A standing order was placed in June 2022 to slow the recession of flows from Goulburn Weir and thereby manage bank slumping and stranding biota from rapidly dropping river levels. In December GMW was able to slow the rate of fall for the recession from flood flows from 6,000ML/day at Murchison in line with recommended rates. However subsequent rainfall led to another unregulated release that due to drier conditions in the lower Goulburn and irrigation demand meant that GMW could not slow the recession with operational water. High river Murray flows meant that environmental water could also not be used leading to rates of fall in excess of 0.5m/day seen at Murchison.

Due to full storages and high mid Goulburn flows, a spill from Goulburn Weir with flow up to 2300ML/day occurred on the 3 Jan 2022. GMW used environmental water to slow the recession flow down from the level of 2200ML/day back to baseflows.

The wet winter/spring resulted in very limited demand for IVT water in summer/autumn 2023. The spring floods took a long time to recede, and flows did not return to recommended environmental flow rates (1,000 ML/day) until mid January 2023. The floods and slow recession may see a resetting of various components of the system. It is hopeful the lower banks have sufficient, appropriate water tolerant vegetation for regrowth from rhizomes or seed present prior to flooding. Consequently, the CMA are proposing to continue focusing environmental water use in 2023/24 on vegetation recovery of the lowest metre of the bank (i.e. flow rates of 700 – 2,000 ML/day).

An autumn fresh was proposed for delivery in March/April 2023 and is designed to attract Golden and Silver perch into the river.

Due to unique environmental conditions following major flooding, delivery of the 2023 fresh will not occur. This year the scientists have advised that the fresh is not required as the ecological outcomes targeted for vegetation, fish and instream condition have already been met this year and delivery of the fresh may lead to adverse outcomes, in particular movement of large numbers of Carp into the Goulburn River.

- Significant flooding with high flows right through to summer mean that soil moisture is likely still enough and vegetation will not need extra water this year. Observations from CMA staff, photographs and discussions with scientists have confirmed there is no ecological need for the fresh for Vegetation outcomes this year.
- There are limited benefits for native fish delivering the fresh this year, native fish dispersal and movement will have occurred with the flooding and the fresh will not provide significant feeding or life cycle benefits.
- Latest scientific evidence is that there are large numbers of Carp moving through the Murray and limited numbers of native fish. Fishways are being closed in Gunbower and planned to be closed in the Murray river to prevent movement of carp.
    - Monitoring of the Gunbower fishways have captured 4 tonnes of Carp and only two native Golden Perch
    - In the week ending 21 Feb at the Torrumbarry fish ladder 800Kg of carp was captured vs 20kg of Native fish
- Delivering the fresh has the potential to have adverse ecological and social impacts of attracting large volumes of carp into the Goulburn.
- Significant flooding with high flow velocities right through to summer have met the scouring and geomorphological process objectives for this year. The Autumn fresh is not needed for these processes.

Figure 8 displays a hydrograph at McCoys Bridge showing watering events for the season.

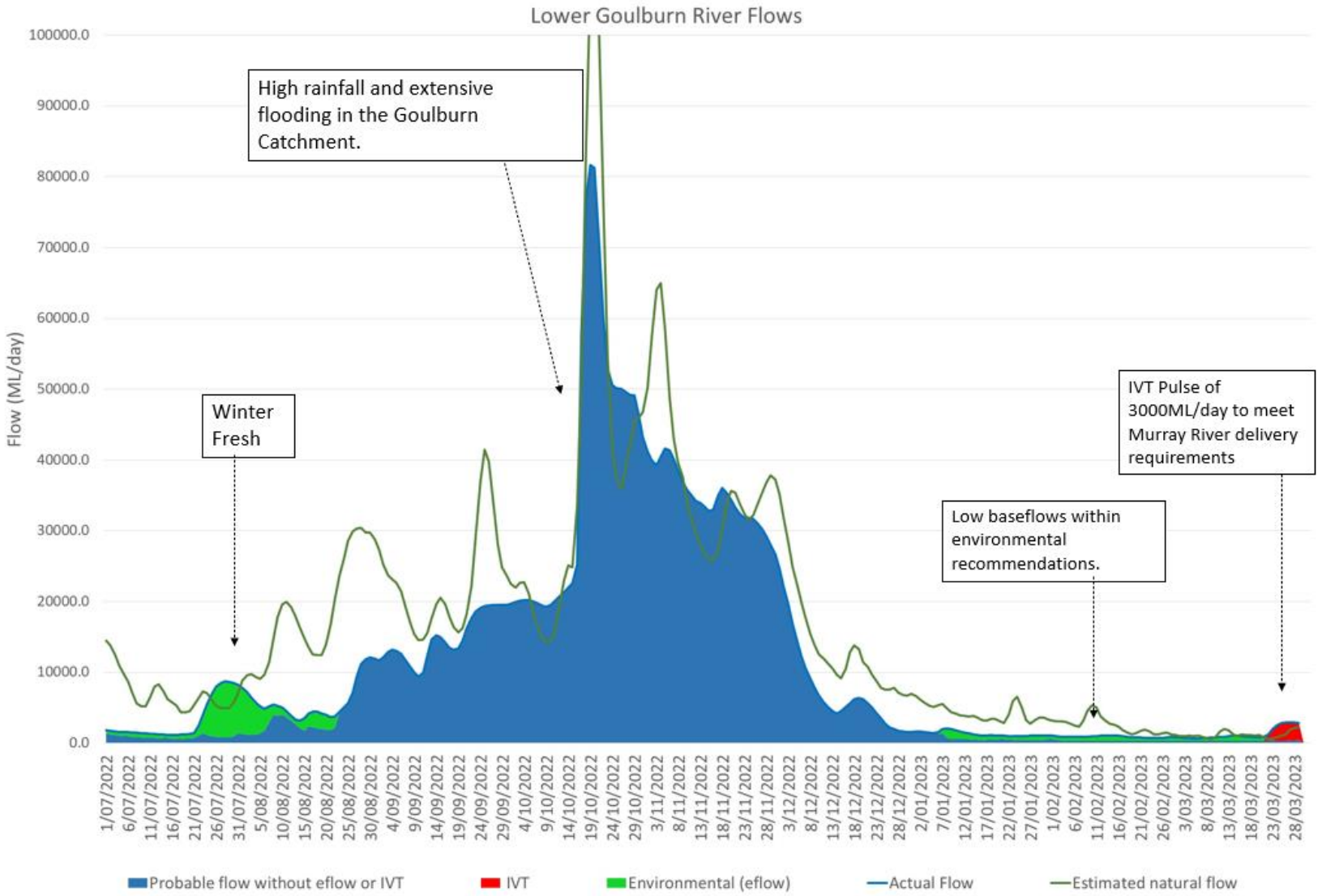


Figure 8: Flow and source of water at Goulburn River, McCoys Bridge

Current ecological conditions

Mid Goulburn River

Without a formal monitoring program in the mid Goulburn River the following ecological conditions are based on observations and monitoring by GBCMA staff.

The floods have had both positive and negative ecological impacts on this section of the river. There has been an increase in the amount of instream large woody debris providing habitat and hydraulic diversity to all three reaches. Large woody debris provide a hard substrate for fungi and algae to form and provide protection from predators for fish, turtles and frogs and are spawning sites for some species. There has been noticeable movement of sediment and gravel throughout reaches one and two creating new bars and benches, some of which are already being stabilised with emergent macrophytes (e.g. *Persicaria*). The instream macrophytes that were present prior to the flooding have persisted and are regrowing; these contain vegetation such as *Myriophyllum*.

Negative impacts from the floods include a prolific number of carp that will have impacts on water quality, increased competition for resources with native fish, and direct impacts to invertebrates and aquatic plants. The presence of the critically endangered Flat Headed Galaxias in at least one of the connected floodplain wetlands of the mid Goulburn River make carp management important. Intense hot spots of erosion are also evident in channel and in some off channel environments. Assessment for management options of this erosion is underway.

Photopoint monitoring commenced in June 2017 at eight sites in reach one to monitor the extent of baseflow coverage. This has been extended to include consideration of wetland connection and revision of the baseflow recommendation to consider wetland connectivity and higher flows.

A joint assessment between GB CMA, The Platypus Conservancy and Taungurung community members in 2022 confirmed use by platypus of the mid Goulburn off channel habitats for feeding and refuge. Several important sites were also identified in the project for suitable platypus breeding. Additionally, a citizen science based platypus monitoring project commenced in the mid Goulburn River in August 2019. This project is led by The Platypus Conservancy and involves residents logging platypus sightings on a phone application or website. Results show that good platypus numbers have been observed by the community in the mid Goulburn and can be found on the Australian Platypus Monitoring Network (APMN) website (https://platypusnetwork.org.au/findings). A number of sub-adult rakali were observed by a Goulburn EWAG community member in recent years. The same community member reported in February 2023 that adult platypus sightings have reduced since the flood.

Lower Goulburn

There are two ecological monitoring programs in the lower Goulburn River; one monitoring against environmental flow objectives and one monitoring for impacts of implementing the Goulburn to Murray trade rule. Both programs are discussed here.

The Commonwealth Environmental Water Office (CEWO) has been monitoring environmental flow deliveries since 2014/15. Details of the program and historic reports can be found on the CEWO website. The draft annual report containing results from monitoring in 2021/22 has not yet been released. However, the key recommendations from draft 2021/22 report are provided below.

- Prioritise at least one spring fresh each year. Depending on ecological endpoints (i.e. vegetation or fish spawning), the timing and duration may differ.
- When there is enough environmental water, deliver a winter fresh to help deliver seed and sediment to the banks for improved establishment of vegetation
- Optimise carbon production through the use of winter and summer baseflows and small freshes, and spring and autumn moderate flows
- Continue to progress operational solutions for managing risk from high IVTs
- Continue to investigate the option of delivering overbank flows.

Monitoring for the 2022/23 year has been severely hampered by floods. Spring monitoring did not occur due to floodwater restricting access to sites. As a consequence of flooding and perceived public liability risk, Parks Victoria has closed access to the lower Goulburn National Park to the public since October 2022, hence no CEWO monitoring has been carried out in 2022/23.

IVT monitoring 2022/23

As part of the review of the Goulburn-Murray Trade rule, the Victorian government has funded a monitoring program to specifically investigate issues arising from prolonged, unseasonal IVT deliveries and investigate ecological responses to the new operating rules and plans. A Scientific Advisory Panel (SAP) has been convened to oversee development of the monitoring program to address key research questions.

Due to the restricted river access due to flooding and a relatively wet summer, there has been minimal IVT delivered throughout the summer and autumn of 2022/23. Consequently, there has been very limited opportunity to monitor the ecological responses to the proposed flow regime of IVT delivery under the new rules.

Shared benefits 2023/24

The shared benefits associated with delivery of water for the environment outlined in this Seasonal Watering Proposal are listed in Table 6.

Table 6: Shared Benefits from environmental water delivery along the Goulburn River in 2023/24

Shared benefit	Beneficiary	Shared benefits
Cultural	Yorta Yorta Traditional Owners	During consultation with Yorta Yorta, specific cultural shared benefits were not identified from environmental water deliveries in the Goulburn River. However, environmental water deliveries align with their values of caring for country.
Cultural	Taungurung Traditional Owners	Improved health of Waring including the support of valued species and delivery of more natural flows to priority off-channel areas.
Amenity	General community, adjacent landholders, visitors	Minimum low flows retained (aesthetically pleasing) flowing habitat for most of the year. Recession flows
Recreation	Local residents, visitors, anglers, game hunters, kayakers and canoers.	Enviro water delivered at lower baseflow have improved recreational activities with access to more sandbars etc. Feedback from the community – Boss's dog blog has been positive.
Economic	Consumptive water users – GMW irrigators and diverters, Goulburn Valley Water (GVW) customers.	Environmental water deliveries have continued to promote good water quality for local irrigators and D&S use.
Health/Amenity	Goulburn Valley Water (GVW) customers in Shepparton, Mooroopna	Ewater was deliberately delivered at highest baseflow (1,000ML/day) to dilute and flush blackwater from the Broken and Seven Cks to improve water quality and reduce taste/odour issues.

Photo point monitoring

Photo point monitoring has been undertaken along the lower Goulburn River since 2012. This monitoring has been more formalised since 2013/14, with ten sites between Goulburn Weir and Yambuna. The following is a snapshot of a number of sites over the years, concentrating mostly on changes to the riparian vegetation and any evident erosion.

February 2015

February 2016

February 2017

February 2018

March 2019

February 2020

February 2021

February 2022

February 2023

December 2022

February 2023

Figure 9: Goulburn River at Medland Road, Bunbartha

February 2015

February 2016

February 2017

February 2018 (note higher water level)

March 2019

February 2020

February 2021

February 2022

February 2023

December 2022

February 2023

Figure 10: Goulburn River at Carters Road, Arcadia

Flow components delivered

Due to large scale flooding in the Goulburn River, very little environmental water was used in 2022/23. Two flow components were delivered; a winter fresh along the length of the river (targeting the lower Goulburn) and variable baseflows in both the mid and lower river.

An autumn fresh was not delivered in March/April due to unique environmental conditions following major flooding. This year the scientists advised that the fresh wasn't required as the ecological outcomes targeted for vegetation, fish and instream condition had already been met this year and delivery of the fresh may lead to adverse outcomes, in particular movement of large numbers of Carp into the Goulburn River and damage to late littoral vegetation germination.

The winter fresh was aiming to use tributary inflows to reach the peak flow rate, however due to dry conditions in July, the main water source was Lake Eildon (with releases peaking at 7,700 ML/day). The maximum flow rate at Murchison, Shepparton and McCoys Bridge was approximately 8,900 ML/day, 9,200 ML/day and 8,700 ML/day respectively. There was minor (i.e. 200-300 ML/day) tributary contributions in the lower Goulburn from Seven Creeks and the Broken River.

Unregulated flows led to spring freshes substantially larger than what is possible through environmental water deliveries. Record rainfall and river flows resulted in low demand for IVT delivery and environmental water was used to meet watering actions over summer and autumn.

The Water Quality Reserve was used in the lower Goulburn River in January 2023 due to concerns for potential for hypoxic conditions as the floodplain drained any intense rainfall during the hot summer months. This was also used due to high, unregulated flows in the Murray River restricting the use of environmental water in the Goulburn River due to government policy being that environmental water is not to inundate private land without prior landholder consent.

Baseflows in 2021/22 were within environmental flow recommendations for the first time since 2015/16. However, in 2022/23 flow rates did not consistently reach below 1,000 ML/day until mid January.

Table 7 details each watering action that was delivered and the source of water used.

Key observations and learnings

- In extremely wet years delivery of environmental water is limited and the unique conditions may mean that not all flow components are necessary (e.g. autumn fresh).
- Extensive flooding led to good ecological outcomes on the floodplain with large amounts of native wetland plants and filling of floodplain wetlands. Further highlighting the need for relaxing constraints to maximise outcomes with environmental water
- Mid Goulburn baseflow trial (reach 1 and 2 observations)– A flow range of 1,000-2,000 ML/d provides improvements to instream habitat (compared to 400 ML/d) including improved depth over riffles and inundation of instream structures including valuable macrophyte (aquatic plant) beds. At 2,000 ML/d, the water level reaches the littoral zone, making this important habitat zone available to aquatic organisms. Flows of at least 5,000 ML/d are needed to provide functional aquatic habitat within connected wetlands. As flow increases from 5,000 ML/d to 8,000 ML/d the extent and depth of off-channel habitat increases, with additional habitat features inundated and made available for aquatic biota e.g. large woody debris, vegetated benches and banks.
- Known constraints in other downstream systems and uncertainty of unknown 3rd party impacts along with the Victorian government position of no unapproved environmental water onto private land impacts our ability to deliver environmental water even withing Goulburn River operational levels (e.g. Torrumbarry constraint on recession flow)

Table 7: Flow components delivered in 2022/23

Priority Watering Action	Comment
Provide a year-round baseflow of 500 – 1,000 ML/day in reaches 4 and 5 for habit diversity and sustaining the system	Met all year. Flows were above baseflow recommendations for most of the year due to high rainfall run off.
Provide 2022 winter fresh >7,300 ML/day or as high as possible in May - August for channel forming, and platypus nesting cues. Aim to use a natural fresh and provide most of the event from rainfall runoff with minimal releases from Lake Eildon. In the case of low Eildon releases provide a small winter fresh of 5,000 ML/day for 2 days in Reach 1 to provide nesting cues for platypus	Delivered
Provide an early spring fresh (>7,300 ML for 7 days) up to 10,500 ML/day in September and October to prime the system for lower bank vegetation establishment and maintenance.	Natural flows provided an overbank event in October
Provide an autumn fresh (>5,700 ML for 2 days) between March and May for lower bank vegetation establishment and maintenance NOTE: this fresh will only be delivered if various triggers are met over the summer period	This was not delivered as soil moisture and bank vegetation is in good condition post floods, and to minimise the potential risk of encouraging carp movement into the Goulburn River.
Provide higher winter/spring baseflows and freshes of up to 6,000 ML/day in the mid Goulburn River to trial connection to wetlands and reflect natural flow levels between June and October	Delivered in May 2022 and as part of the winter fresh in July 2022.
Provide a variable baseflow of 400-2,000 ML/day in the mid Goulburn River when required	Provided by CEWH and VEWH water when the river was regulated.
Provide a standing order for slower recession to unregulated flows/releases from Goulburn Weir to prevent damage to the lower bank for 3,000ML/day and below in Summer /Autumn and 6,000 ML/day and below in Winter/Spring	Generally not able to be delivered due to constraints with high Murray River flows. A small recession flow was delivered in January 2024
Provide a standing order for higher baseflows or freshes up to 6,000 ML/day between May and October to mimic natural variability through the length of the Goulburn River	Not needed
Provide (carryover) for baseflow of 500-540 ML/day in July to September (21/22) for fish and macroinvertebrate habitat	Not needed
Provide 2023 winter fresh >7,300 ML/day or as high as possible in May - August for channel forming and platypus nesting cues. Aim to use a natural fresh and provide the majority of the event from rainfall runoff and minimal releases from Lake Eildon. In the case of low Eildon releases provide a small winter fresh of 5,000 ML/day for 2 days in Reach 1 to provide nesting cues for Platypus	Planned to be delivered
Provide a late spring fresh (>6,600 ML for 1 days) between October and December for native fish spawning	Not needed. Natural flows provided an over bank event in October and bankfull flows in November

Environmental objectives and scope of environmental watering

The Goulburn River Environmental Water Management Plan was completed in 2015 by the Goulburn Broken CMA (2015) and provides an overview of the long term environmental water management objectives. The following table lists these environmental objectives for the Goulburn River (GBCMA 2015).

Table 8: Environmental objectives for the Goulburn River

Ecological value	Long term ecological objective
Native fish	Increase the abundance, spatial distribution and size class diversity of key native fish species (i.e. Macquarie perch, Murray cod, Trout cod, Golden and Silver perch)
Native vegetation	Increase the abundance and richness of aquatic and flood dependant native species (i.e. instream and lower bank)
Macroinvertebrates	Increase macroinvertebrate biomass and diversity
Geomorphology	Protect and promote natural channel form and dynamics (e.g. sediment diversity, rates of sediment transport and bank erosion rates) Increase instream physical habitat diversity (e.g. shallow and deep water habitats)
Stream metabolism	Provide sufficient rates of instream primary production and respiration to support native fish and macroinvertebrate communities
Water Quality	Minimise risk of hypoxic blackwater after natural events.
Platypus*	Maximise self sustaining populations of Platypus
Turtles*	Maximise self sustaining populations of Turtles

*New objectives identified through community consultation in the 2020 flows study

A number of environmental flows studies have been undertaken for the Goulburn River. These are all listed in the references and include:

- Environmental Flow Recommendations for the Goulburn River below Lake Eildon (Cottingham et al 2003)
- Evaluation of Summer Inter-Valley Water Transfers from the Goulburn River (Cottingham et al 2007)
- Objectives for flow freshes in the lower Goulburn River 2010/11 (Cottingham et al 2010)
- Mid Goulburn River FLOWS study (Cottingham et al 2014a)
- Kaiela (Lower Goulburn River) Environmental flows study (University of Melbourne, 2020)

In 2018, some environmental flows objectives were reviewed as part of an investigation into IVT potential in the lower Goulburn River (Cottingham et al, 2018). This resulted in some new flow objectives and flow recommendations. Although not a new flow recommendation, the report advises that flow rates of 500 ML/day or less result in fine sediments settling out and smothering the bed. The report also suggests maintaining bench habitat by inundating three in five years to a depth of half a metre for two to four days, preferably when water can come from unregulated flows (Cottingham et al, 2018). Cottingham et al (2018) also refined vegetation objectives to focus on maintaining fringing and aquatic vegetation and encouraging bench and bar vegetation diversity. Fish objectives remained largely the same as previous flows studies but were refined to focus on maintaining a diversity of hydraulic habitats and providing flow cues for spawning and migration with specific flow recommendations.

The Kaiela River (lower Goulburn) flows study (University of Melbourne, 2020) developed flow recommendations using a slightly different method to the standard Victorian government method. The adopted method used a 'designer' flow approach and recognises that the Goulburn River is highly regulated and is no longer compatible with the 'natural flow paradigm' approach. The designer approach uses input from scientists and the community to develop ecological objectives

and then links ecological response models to flow components to determine flow recommendations required to achieve the agreed objectives. Further detail regarding this new method can be found in the Kaiela (lower Goulburn) flows study (University of Melbourne, 2020). The process has changed some of the high priority objectives in the lower Goulburn River, and now includes flow recommendations for floodplain inundation. After prioritising year round baseflows, the delivery of an overbank or high flow event was the second highest priority for the Goulburn River community and scientists. Flow recommendations for this include the delivery of flows ranging from 10,500 ML/day to 30,000 ML/day. However, the feasibility of delivering the overbank flow recommendations whilst avoiding damage to public and private assets is an issue that requires negotiation and policy change. Accordingly, environmental water will not be used to provide overbank flow recommendations in 2023/24. Delivering overbank flows is critical to improve the health of the entire Goulburn River and its floodplain and until government policy permits using environmental water to deliver overbank flows, the full potential of water recovery will not be realised and ecological outcomes required for the Goulburn River and the Basin Plan may not be met.

While extensive floodplain inundation is presently unviable, there is potential to deliver flows that link very low lying wetlands and anabranches of the floodplain in reaches four and five. Vietz (2017) undertook an investigation into inundation of floodplain wetlands and anabranches using existing hydraulic models and made assumptions regarding model extrapolation, discharge-elevation relationships and lidar data quality and comparison to Australian Height Datum. Despite these, and other assumptions, some follow up field work has validated some of the results from the investigations. The results show with flows up to 13,000 ML/day, approximately 10 additional wetland areas can be inundated, and connected to the river channel, at the most downstream section of the river i.e. Wyuna to the Murray River confluence. The average wetland size is around three hectares. If the current freshes in the Goulburn River have a slightly larger peak flow rate, additional ecological benefits would be achieved. However, there are currently constraints of delivering flows above 9,500 ML/day.

Most flow objectives are derived from the various studies described above, however consultation also occurs with ecologists and geomorphologists from the CEWO Monitoring, Evaluation and Research Program (MER) program to incorporate the most recent learnings into operational water delivery. This adaptive management has resulted in some new flow objectives such as the previously delivered “attractant flow” (2017) that aims to move juvenile fish upstream in the Murray River and into tributaries such as the Goulburn River. This type of adaptive management will continue.

There is less opportunity to manage water in reaches one to three for environmental purposes due to their location immediately downstream of Lake Eildon and irrigation releases occurring over spring to autumn. However, opportunities still exist for environmental water releases to support and enhance ecological values in this part of the river at this time of year, as well as over winter during the non-irrigation season. This includes having baseflow targets that optimise functional instream habitat in the event that Lake Eildon releases suddenly reduce in late spring or early summer e.g. maintaining inundation over valuable aquatic plant beds to avoid drying and reducing their vigour. It also includes, where operationally possible, restoring a more natural flow pattern by providing multiple fresh events over autumn to spring enabling the connection of off-channel wetlands and anabranches that support significant ecological and cultural values. Therefore, each reach of the Goulburn River is considered a priority for environmental water management where the opportunity is available. Detailed flow objectives for reach one to five are shown in Appendix One.

An option to deliver environmental flows using unregulated tributary flow is an approach the CMA is aiming to achieve in spring 2023. Using unregulated flows to achieve ecological objectives provides greater benefit than dam releases by using natural ecosystem cues such as water pressure and chemistry which may encourage greater population response and delivering higher levels of

sediment to assist with seed germination on the riverbanks (although further research into this is required). The CMA will work closely with GMW to deliver water in a manner that uses as much tributary flow as possible. GMW will advise all customers that there is the potential for flows up to 9,500 ML/day and notice may be short and only up to 2 days prior via text or email. This will provide the opportunity to pass flow events through the Goulburn Weir and the potential to deliver freshes using tributary flow rather than Eildon releases.

When describing flow priorities for the lower Goulburn (reaches 4-5), the zonation of the riverbank vegetation displayed in Figure 11 is used when defining the objectives in terms of vegetation outcomes.

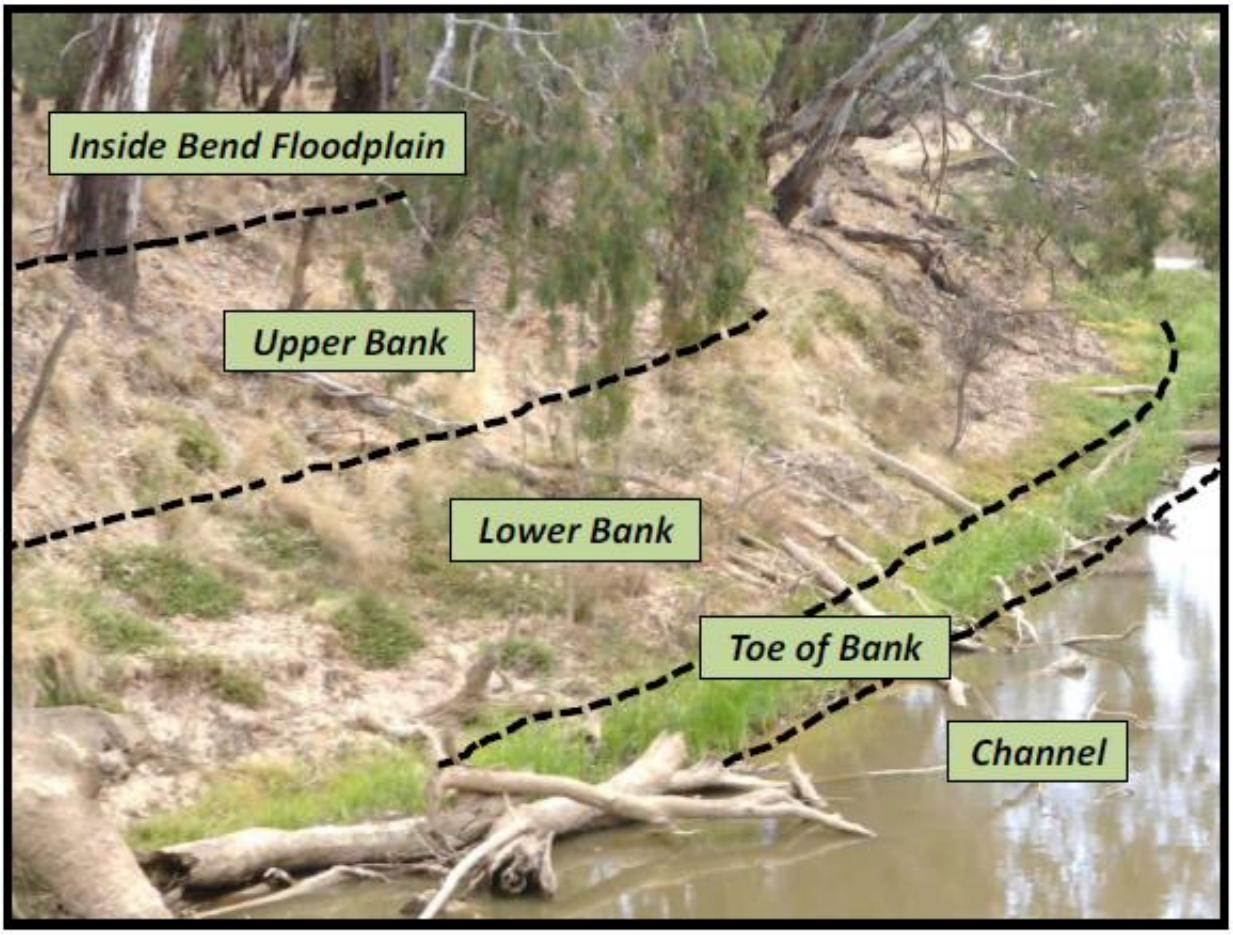


Figure 11: Illustration of bank differentiation for vegetation objectives. Toe of bank relates to flows between 750-1,100 ML/day and lower bank for flows up to 7,500 ML/day (Roberts 2018)

Table 9: Environmental flow components for reaches 1-3

Flow component	Magnitude	Duration	Timing	Frequency
Variable baseflow	400-2,000 ML/d Variability pattern within channel bed to be informed by natural inflow pattern and operational practicalities.	N/A	All year	Every year
Winter fresh	>8,000 ML/d	5-10 days Single flow rate held less than 7 days.	Late July-late August But 1-3 weeks after any lower Goulburn tributary dominated freshes	Once per year
Spring fresh	As high as possible but not exceeding the winter fresh magnitude	5-10 days Single flow rate held less than 7 days.	September -November But 1-3 weeks after any lower Goulburn tributary dominated freshes	Once per year
Natural cue freshes	>5,000 ML/d Aim to reflect natural inflow cues	5-10 days	May-November But 1-3 weeks after any lower Goulburn tributary dominated freshes	3 events per year

NB: a delivery constraint of 9,500 ML/d exists at Molesworth.

Each of these flow components will support the full suite of Goulburn River environmental objectives outlined above (with the exception of the water quality objective which is lower Goulburn specific).

Table 10: Environmental objectives and flow components for reaches 4 and 5

Flow Component	Magnitude	Duration	Timing	Frequency	Environmental flow constraints or trade offs	Relevant objectives and key considerations	Discussion
Year round Baseflow (Providing habit diversity and sustaining the system)	During summer and autumn, preferred flows are between 500 – 1,000 ML/d (or unregulated) During summer and autumn, ensure variability in flow regime (CV > 0.2) (e.g. mean of 750 and standard deviation of 150 ML/d) During winter and spring, ensure flow greater than 500 ML/d	N/A	All year	Every Year	Cod season at start of December and importance of lower base flows for the two weeks prior to provide dry banks for anglers Baseflows > 1,000 ML/d at a constant rate for a duration of longer than 7 days may lead to notching and mass failure (slumping) • Flows with low variability (CV < 0.2) between 1,000 ML/d – 2500 ML/d cause the largest notching impacts - critical zone • Flows above 2500 ML/d also have potential for notching Higher rate of fall may pose a risk to bank stability through slumping (keep rate of fall <0.15m per day and rise <0.38m per day) Flows > 1,000ML/day for greater than 10 days will lead to damage/loss of littoral vegetation Flows > 1,750 ML/d may cause damage littoral vegetation Flows from Sep - Jan that are higher than the flows delivered in late winter challenge platypus by flooding nesting burrows	**All Fish** – Baseflow for fish passage, at least 40cm and habitat diversity (provided at 500ML/day). **Instream Productivity (to support Macroinvertebrates)** - Water depth < 2-3 m for best irradiation of benthic surfaces across substantial part of cross-section. Max of 2,000 ML/day above which slack areas are lost (this will decrease viable areas for biofilm growth) **Macroinvertebrates (to support fish, turtles and platypus)** – Flows engage with littoral vegetation to provide edge habitat. Ensure higher flows do not destroy instream vegetation **Littoral Vegetation –** Regular but small fluctuations will increase the width of the zone of littoral vegetation, improving habitat outcomes for fish and macroinvertebrates. **Mid bank Vegetation-** Occasional higher summer baseflows provide wetting mid bank elevations and maintaining vegetation, however sustained heightened baseflows causing severe inundation would negatively impact vegetation **Bank Stability –** Lower, but variable, baseflows are protective against bank notching. **Turtles –** No direct effects; affected through benefits of baseflows for macroinvertebrates as a food source **Social –** flows greater than 1,000 ML/d inundate high-level sand bars and limit access for camping and fishing (particularly important during holidays and through to Jan 25, with consideration during the Easter holidays)	Lower limit in place to ensure depth for fish and platypus passage (500 ML/d provides a depth of 30 – 40 cm). Upper limit to protect bank stability (slumping and notching), bank vegetation and social needs While habitat diversity is primarily determined by channel complexity, variable flows will improve habitat diversity by engaging different parts of the channel at different discharges, including slack water and slow velocity and deep pools. (Refer to hydraulic cross sections showing 500 and 1,000 ML/d) High summer flows identified as an issue for platypus burrows may become more likely under climate change scenarios, with decreased probabilities of high winter flow events being delivered. Note that the 'or natural' clause here is to allow flows to exceed 1,000 ML/d if there is a natural event outside the control of operations.

Flow Component	Magnitude	Duration	Timing	Frequency	Environmental flow constraints or trade offs	Relevant objectives and key considerations	Discussion
Winter-Spring variable baseflow (Ensure habitat diversity)	>500 ML/d - natural Variability required – mimic natural variability by passing freshes and larger events from tributaries		Winter and spring	Every year	Water availability and seasonal conditions may play a role here. Carryover of sufficient water to ensure that water is available to capitalise on rainfall runoff events in early season for flow variability. Water for spring fresh is higher priority.	**All Fish** – Baseflow for fish passage, at least 40cm and habitat diversity **Macroinvertebrates** – Flows engage with littoral vegetation to provide edge habitat. **Littoral Vegetation –** Regular fluctuations will increase the width of the zone of littoral vegetation, improving habitat outcomes for fish and macroinvertebrates. However, littoral vegetation is dormant in winter. **Mid bank Vegetation-** Higher winter baseflows appropriate to season support wetting of mid bank soils and vegetation maintenance **Instream Habitat Complexity –** Movement of sediment through the system and maintenance of deep pools by passing natural flow events and through the incorporation of tributary inflows	Using a bottom-up method to determine flow requirements the minimum recommendation has therefore been set at 500 ML/d for habitat provision. However, we know from the natural regime, that winter flows would be significantly higher than summer baseflows. The role these flows play may well be a knowledge gap, especially given monitoring tends to focus on other seasons. The passing of tributary flows ensures that winter flows do have some variability and larger magnitudes. This recommendation will need further data and investigation to support. It is anticipated that the 2a overbank/high bank full event and passing of tributary flows will provide the required variability in average and wet years. In dry years with little rainfall runoff variability will be much less.
Baseflow	No greater than 1,000 ML/day	5 – 6 weeks	Late spring/ summer			**Littoral vegetation -** maintain for more than one season a littoral fringe of emergent or amphibious plants **Macroinvertebrates and fish –** provide habitat for macroinvertebrates and small bodied fish. **Provides bank stability**	This flow recommendation has arisen from high irrigation demand immediately following a spring fresh. By keeping flows at a low flow rate, plant germination can proceed. From Roberts (2018)
Baseflow/freshes	1,000 – 5,000 ML/day		Spring / summer/ autumn			Maintain a zone with viable (patchy but persistent) perennial herbs or graminoids on mid to lower riverbank	Maximum continuous duration for P. prostrata is 50 days; maximum continuous duration for A. denticulata is 70 days Shorter duration of inundation is acceptable, but a longer duration is risky From Cottingham (2018)

Flow Component	Magnitude	Duration	Timing	Frequency	Environmental flow constraints or trade offs	Relevant objectives and key considerations	Discussion
Early Spring fresh (Priming the system)	(Provide if 2a not achievable or if 2a occurred early in winter allowing a second pulse) Range 5,000 ML/d to 10,500 ML/d >5,000 ML/d provide some benefit for bank vegetation >7,300 ML/d to mobilize bed sediments and scour fine sediment	7 days at peak	At least one annually in early spring	Yearly	Higher rate of fall may pose a risk to bank stability through slumping (keep rate of fall less than 20% change in flow from the previous day with lower variations expected to have decreased impact on banks)) Depending on the season the overbank or high flows will be provided in addition to or may replace the early spring fresh. No repeat event (as described in #5 below) within 8 weeks between events, as flows in this time period will negatively impact vegetation germination and establishment Monitoring of vegetation establishment may be advisable	**All Fish** – Provides cues for movement through the system allowing dispersal **Macroinvertebrates** – High flows scour fine sediments from interstitial spaces, improving habitat **Littoral/Bank Vegetation –** High flows increase moisture in bank soils and provide a source of propagules, driving germination/establishment of new plants and growth of existing ones **Instream Habitat Complexity –** Freshes transport fine sediments, helping to maintain within-channel habitat features	At least one should be provided per year preferably using tributary flows from rainfall runoff Current operational constraints require the shaping of flows and it will only be possible to achieve ~9,000 – 9,500 ML/d
Winter High Flows	5,000 – 7,000 ML/day	Up to 14 days	Winter/spring	Yearly		Provide cues for spawning and migration for flood specialist native fish Maintain macroinvertebrate habitat (e.g. snags) by mobilising fine sediments and biofilms, replenishing slackwater habitats	Cottingham (2018)
Late Spring fresh (to cue fish spawning)	>7,500 ML/d for high chance of spawning >5,600 ML/d for any benefit	2 days at peak	Ideally Nov or at latest Dec Water temperature > 19°C	Yearly	If this event occurs within 8 weeks of the early spring fresh there is likely to be a negative impact on vegetation, particularly where vegetation is not well established. Delivery of this event should be judged based on the relative antecedent condition of bank vegetation and periodic fish, and weighed against the alternative of recruiting periodic fish from the Murray (see Autumn fresh) Rates of rise and fall important for equilibrium fish (keep less than 10% per day) with higher rates disturbing nesting Sep to Dec, especially Nov and Dec Cod season at start of December and importance of lower base flows for the two weeks prior to provide dry banks for anglers. Noted previously in winter baseflows but a late Spring fresh could also impact opening	**Periodic Fish** – Provides cues for adult golden perch in the Goulburn to move downstream and spawn. Water temperatures must be over 19 °C **Macroinvertebrates** – High flows scour old biofilms from hard substrates, resetting them and improving food resources **Instream Habitat Complexity –** Freshes transport fine sediments, helping to maintain within-channel habitat features	The relative priority of this event may be greater if it has not been delivered for several years

Flow Component	Magnitude	Duration	Timing	Frequency	Environmental flow constraints or trade offs	Relevant objectives and key considerations	Discussion
Freshes			Summer / autumn		Flows should not exceed 1,000 ML/day for more than 10 consecutive days, with a minimum of 6 weeks between pulses	Maintain, for more than one season, a littoral fringe of emergent or amphibious plants. Recommended Provision of habitat for macroinvertebrates and small bodied fish. Provide bank stability	Roberts (2018) adapted to the recent flows study recommendations relating to vegetation.
Autumn fresh (flow variability and ecosystem maintenance)	>5,700 ML/d to reset surfaces	1 – 2 days at peak for vegetation and scouring 7 days at peak for migration of fish (noting that trade off with vegetation for longer event)	During the growing season	Yearly	Higher rate of fall may pose a risk to bank stability through slumping (keep rate of fall <20% change per day)	**All Fish** – Provides cues for movement through the system allowing dispersal. Autumn flows delivered while Murray River flows are relatively low can promote the migration of juvenile golden and silver perch into the Kaiela. **Macroinvertebrates** – High flows scour old biofilms from hard substrates, resetting them and improving food resources **Mid-Bank Vegetation –** If summer flows have been consistently low, high flows in autumn can reinvigorate drying vegetation on the bank, providing some growth before the weather cools and vegetation strops growing **Instream Habitat Complexity –** Freshes transport fine sediments, helping to maintain complexity.	
Overbank or high flows (channel forming event)	Opportunistic event – aim to provide as high as possible an event by utilising or re-creating natural events. Where overbank not possible, still provide as large an event as possible for channel maintenance and forming. >30,000 ML/d allow significant area of floodplain vegetation to be inundated	Areas on the lower floodplain will fill instantaneously. 5 days at peak to fill larger wetlands (base this on opportunity to piggyback).	Ideally late winter to spring or as naturally induced Not during summer to minimize black water events.	As often as possible given natural flow events. Aim for an event >10,500 or as high as possible each year (rainfall runoff or release) >20,000 7 in 10 years or as per natural rainfall runoff >30,000	Higher rate of fall may pose a risk to bank stability through slumping (keep rate of fall <20% change per day) Flows greater than 40,000 ML/d begin to inundate private properties with adverse social outcomes Late spring and summer high flows exceeding the high winter flows can have an adverse impact on platypus juveniles, increasing risks of flooding burrows. Important to monitor spring flows in relation to winter flows Late spring flows greater than 22,000 ML/D will have an impact on turtle nesting and juveniles	**Opportunistic Fish** – Provides connectivity to off-channel habitats with greater food resources **Periodic/Equilibrium Fish** – Provides cues for movement through the system allowing dispersal **Instream Productivity** – Return flows bring organic matter from the floodplain and off-channel habitats into the river channel, driving production and respiration **Macroinvertebrates** – Benefit from higher instream productivity as a food source **Littoral/Bank Vegetation –** Return flows bring large amounts of sediments and propagules into the river channel system rebuilding vegetation habitat **Floodplain Vegetation –** Semi-regular inundation of floodplain vegetation is necessary for plant condition and as part of reproductive cycle **Instream Habitat Complexity –** These are 'channel forming' events that create in-	There are currently operational constraints that limit the ability to deliver overbank flows and the achievement of this recommendation. There is also a delivery constraint of 9,500 ML/d release from Lake Eildon. Delivering this event is therefore opportunistic based on high tributary flows and is only likely to be possible in wetter years (requiring GMW not to divert tributary inflows to Waranga Basin). These tributary inflows also play an important role in transporting sediment/propagules. Note that climate change will alter the frequency of these natural events. This is an area that requires further investigation to consider how to sustain the objectives that require these overbank / high flow events

Flow Component	Magnitude	Duration	Timing	Frequency	Environmental flow constraints or trade offs	Relevant objectives and key considerations	Discussion
	>20,000 ML/d inundates floodplain near Loch Garry >10,500 ML/d starts to inundate low lying floodrunners and anabranches			Natural frequency.		channel complexity by scouring bed sediments to recreate pools and deposit those sediments onto higher levels to create bars and benches that provide variable level niches, providing dynamic habitat complexity **Turtles –** Inundation of off-channel habitats creates superior nesting habitat for adults **Platypus** – Inundation of off-channel habitats creates superior feeding habitat (especially beneficial in late autumn-winter to support reproductive success)	and look at possible alternatives for managing the floodplain. As noted, these are opportunistic flow events. These flows would be generated naturally in the upper and mid Goulburn River and flow past the Waranga Basin offtake and through the Goulburn Weir. Contributions from tributaries may help increase these flow events. Cultural burns conducted in coordination with Yorta Yorta representatives floodplain inundation can help maximize benefits to native plants such as cumbungi (*typha ss.*), common reed (*Phragmites australis*),old man weed (*Centripeda cunninghamii*) and basket weaving grasses.

Priority watering actions 2023/24

This proposal considers environmental water management under a range of possible climate scenarios from extremely dry to wet. Given antecedent conditions the environmental watering actions in the following tables for 2023/24 have been based around the following principles:

1. Maintain (or re-establish) lower bank vegetation in the lower Goulburn.
2. Protect the bank and aquatic biota by minimising erosion and mass failure of the lower bank, managing water quality and reintroduce sediments/seed.
3. Achieve fish outcomes – improve Murray and Trout cod populations, cue Golden and Silver perch spawning and attraction into the river.
4. Maximise platypus breeding success by providing nesting cues
5. Maximise ecological outcomes by using tributary flows as much as possible to meet environmental watering objectives, and especially during the spring period.
6. Increasing habitat by connecting low lying floodplain features in the mid Goulburn.

Table 11: Potential priority watering actions for reaches 1 to 3

Target reach: Reach 1	**Reach 1-3 is a priority to receive environmental water as it provides habitat that is unique within the Goulburn River including large beds of native aquatic plants (e.g. *Vallisneria*) and a diversity of off-channel environments including flowing anabranches, lentic backwaters and lagoons. Reach 1-3 supports a large population of threatened platypus and other threatened species such as flat-headed galaxias and broad shelled turtle. Compliance point: Gauge 405204 Goulburn River downstream of Lake Eildon**		
Potential watering action	Year round baseflows (400 -2,000ML/day)	Winter and Spring Fresh (2 events of >8000ML/day)	Natural cue freshes
Climate/operational scenario variations	The volume of water used will vary based on climatic and operational scenarios and whether Goulburn Weir spills. The assumptions for planning are:	Depending if delivery of the lower Goulburn winter and spring fresh relies on Eildon releases:	The volume of water used will vary with operational scenarios and whether Goulburn Weir spills. The assumptions are:
Triggers	Will occur when GMW is not releasing from Lake Eildon for downstream demands.	Natural inflow cues where possible but likely to align with the winter and spring freshes for the Lower Goulburn. If the winter and spring freshes are not delivered from Lake Eildon during the lower Goulburn fresh events (due to wet conditions) then release the target flow rate in reach one when operationally possible and 1-3 weeks after the lower Goulburn tributary dominated freshes to allow for sediment consolidation on the lower Goulburn banks.	Natural inflow cues where possible. Can include piggy-backing onto irrigation/consumptive releases to gain water efficiencies.
Expected watering effects	Scouring fine sediments from gravels and riffles. Riffle habitat maintenance for fish and macroinvertebrates. Maintenance of aquatic macrophyte beds that provide habitat for macroinvertebrates and fish. Improved food resources and foraging habitat for platypus and turtles.	As per baseflows, plus: Maintain physical instream features e.g scour holes. Provide natural seasonality to support macroinvertebrate lifecycles. Connect low lying off-channel habitats enabling organic matter exchange, providing access to temperature refuge and supporting lentic (still water) specialists Provide cues for platypus nesting higher in the bank. Optimise foraging conditions for platypus and turtles.	As per the winter/sprin freshes. As per baseflows, plus: Maintain physical instream features e.g scour holes. Provide natural seasonality to support macroinvertebrate lifecycles. Connect low lying off-channel habitats enabling organic matter exchange, providing access to temperature refuge and supporting lentic (still water) specialists. Optimise foraging conditions for platypus and turtles.
Environmental objectives	All objectives (with the exception of water quality)	All objectives (with the exception of water quality)	All objectives (with the exception of water quality)
Application of potential watering action	Provide a variable baseflow of 400-2000 ML/day in reach one all year under all climate scenarios. The baseflow delivery rate given is dependent on seasonal conditions. A flow range of 1,000-2,000 ML/d will be targeted most of the time, with flows of 400-1,000 ML/d allowed when ecologically desirable	Deliver the fresh up to a peak flow of 9,500 ML/day (>8,000 ML for 7 days). The aim is to deliver two events > 8000ML/day in Reach 1 over Winter and spring under all climate scenarios.	Provide up to three freshes >5,000 ML/d for 5 – 10 days in May – November in Reach 1 to mimic natural variability

Rationale for delivery in 2023-24	Post flooding field observations suggest most macrophyte beds remain present but their condition has been impacted by the very high flood flows. There was evidence of plants beginning to grow in early 2023. Providing optimum baseflow conditions for species like *Vallisneria* will help in the recovery of these plants beds and improve their resilience to other pressures such as grazing. It's a win-win for ewater use and ecological outcomes - in drier scenarios when there is less environmental water its less likely for the Goulburn Weir to spill and there will be no use of ewater as the water will be reharvested in Waranga and still available	The winter fresh provides cues for platypus to build nests higher in the bank to avoid inundation of juveniles when they are most susceptible to drowning i.e. November to February. These higher magnitude freshes are a priority every year to maximise the period of time off-channel habitats are accessible for native biota.	Freshes are a priority every year to maximise the period of time off-channel habitats are accessible for native biota. Due to interactions with operations and Eildon releases for consumptive and ewater actions in the Lower Goulburn its anticipated that these three events could potentially occur in - May/June - August/September in between the winter and spring freshes - November (may be consistent with the Lower Goulburn spawning fresh)

Table 12: Potential priority watering actions for reaches 4 and 5 in 2023/24

Target reach: Reach 4 and 5	**Reaches 4 and 5 are a priority for environmental watering Compliance point: Gauge 405200 Murchison and Gauge 405232 McCoys Bridge**		
Potential watering action	Year round baseflow	Early spring fresh in September/October	Provide a winter fresh
Expected watering effects	• Provide slow, shallow habitat required for the recruitment of larvae/ juvenile fish and habitat for adult small-bodied fish • Provide deep-water habitat for large-bodied fish • Provide habitat and food for turtles • Submerge snags and littoral vegetation to provide habitat for fish and waterbugs and a substrate for biofilms to grow • Maintain habitat for aquatic vegetation and water the root zone of low- bank vegetation • Vary flow within a specified range to encourage planktonic production (for food), disrupt biofilms and maintain water quality • Low variable flows enable vegetation to establish to protect against notching and bank erosion	• Provide connectivity to off channel habitats and through the river for fish dispersal and greater food resources Improve macroinvertebrate habitat by scouring fine sediments. • Provide cues for fish movement and dispersal • Provide organic matter and carbon (e.g. leaf litter) to the channel • Increase moisture in bank soils and provide a source of propagules driving establishment of new plants and growth of existing ones. • Remove terrestrial vegetation, scour and transport fine sediments to maintain pools and bring in sediments to maintain instream complexity	• Provide connectivity to off channel habitats and through the river for fish dispersal and greater food resources • Trigger lamprey migration in South Australia if delivered to the Lower Lakes during July and/or August. • Channel forming events scour bed sediments to maintain and maintain pools and change in-channel complexity • Provide cues for platypus to nest higher up the bank so they are not impacted by the spring fresh. • Provide organic matter and carbon (e.g. leaf litter) to the channel • Tributary and high flows are a source of sediment and propagules driving establishment of new plants. • Remove terrestrial vegetation and trigger the recruitment of semi-aquatic vegetation • Improve macroinvertebrate habitat by scouring fine sediments, improving habitat area and food availability
Environmental objectives	All Fish Turtles Instream Productivity Littoral and Mid Bank Vegetation Macroinvertebrates Geomorphology and Bank Stability	All Fish Instream productivity Littoral/Bank Vegetation Macroinvertebrates Geomorphology - Instream Habitat Complexity	Opportunistic and Periodic/Equilibrium Fish Geomorphology Instream Habitat Complexity Platypus Instream Productivity Littoral/Bank Vegetation Macroinvertebrates
Application of potential watering action	Provide a variable baseflow of 600 - 800 ML/day in reach four and 600 - 1000 ML/day in reach five all year under all climate scenarios. The baseflow delivery rate given is dependent on seasonal conditions.	Deliver the fresh up to a peak flow of 10,500 ML/day (>7,300 ML for 7 days) in September and October. The magnitude of the fresh will be dependent on the proportion of natural flow and only exceed 9,500 ML/day if it is from natural flows. The spring fresh is the highest priority of freshes and will be delivered under all climate scenarios.	In all scenarios provide a winter fresh > >9000 ML/day or as to reach 4-5 of (>7,300 ML for 4-5 days) up to 9,500 ML/day (or high as possible) between May - August. Aim to use a natural fresh and provide most of the event from rainfall runoff and minimal releases from Lake Eildon
Rationale for 2023-24	Baseflows are the highest priority and critical environmental watering action and required year round. With the higher volumes of water available baseflows will target 800 ML/day at Murchison and around 1000 ML/day at McCoys Bridge. Higher flows will provide more habitat and boost primary productivity.	Monitoring has shown the spring fresh provides the greatest overall ecological benefits of all the freshes. GMW has changed notification timing for irrigators and there is now potential to pass natural flow events from the mid Goulburn through Goulburn Weir. As a result, the aim will be to deliver the spring fresh using contributions from tributary flow as much as possible rather than release from Eildon.	The winter fresh is important to provide cues for platypus so they nest further up the bank and their nests will not be impacted by the spring fresh. With water availability high under all but the extreme dry scenario it is planned to do a full magnitude fresh.

Target reach: Reach 4 and 5	Reaches 4 and 5 are a priority for environmental watering Compliance point: Gauge 405200 Murchison and Gauge 405232 McCoys Bridge	
Potential watering action	**Maintain water quality and protect the banks from erosion**	**Mimic natural variability through the length of the Goulburn River**
Expected watering effects	• Minimise the risk of bank erosion associated with mass failure from rapid drops in river levels • Minimise the risk of hypoxic blackwater after natural events • Reduce the risk of poor water quality harming aquatic biota	• Transport and deposit seed, plant propagules and sediment on the riverbank • Provide organic matter and carbon (e.g. leaf litter) to the channel
Environmental objectives	Geomorphology Vegetation Water Quality	Instream Productivity Vegetation
Application of potential watering action	Although these are two separate watering actions with different objectives they will have the same application. A standing order will be placed with GMW to deliver a fresh up to 6,000 ML/day to: 1) slow the recession of any unregulated flow/releases from Goulburn Weir. 2) maintain water quality 3) pass mid Goulburn tributary flow through to the lower Goulburn in late autumn to spring. The magnitude and duration of these events will vary depending on seasonal conditions, in line with operational constraints, rates of rise and fall and ecological implications the following maximum peak of freshes and starting points for recession flows will be use. Due to operational constraints, it may be difficult to deliver flows about 3,000 ML/day in summer/autumn. When required environmental water will be used to slow the recession of a spill or release from Goulburn Weir to protect the lower banks. In the event of a water quality issue, most likely hypoxic blackwater, a fresh will be delivered to protect the instream aquatic biota. Between the winter and early spring freshes aim to pass tributary flow in the mid Goulburn through to the lower Goulburn. When tributary induced flows in reach 3 are above 4,000 ML/d pass flows on top of baseflows into in reaches four and five between May and October	
Rationale for 2023-24	These watering actions require rapid responses to natural flows arising from rain events (often of a high intensity), e.g. hypoxic black water, spills from Goulburn Weir, or rapid short duration freshes from mid Goulburn tributaries. For these events there is often not enough time to arrange all approvals for use of environmental water to reduce the rate of fall and prevent slumping, respond to water quality events or pass natural mid Goulburn freshes to the lower Goulburn. There are no rates of rise and fall set for releases in GMW's operations or rules and unregulated spills can drop from 5,000 to 1,000 ML/day in 24 hours. Therefore, environmental water is used to slow the recession of unregulated flows downstream of Goulburn Weir to reduce bank slumping and stranding of biota. A standing order will exist for the whole season to slow the recession from 6,000ML/day to protect the damaged lower band from slumping (it is likely in summer/autumn recession orders may only be delivered from 3,000ML/day due to operational constraints. This watering event is heavily dependent on climatic conditions and in this highly modified system will be delivered as a managed variable baseflow and designed fresh that passes a proportion of the tributary flows that occur in the mid Goulburn. The following assumptions for the application of the watering action (in terms of water needed) for each climate scenario are as follows: • Extreme Dry and Dry – not needed • Below Average – one event for winter/spring • Average – one event for summer/autumn and one event for winter/spring • Wet - two events for summer/autumn and two events for winter/spring	

Target reach: Reach 4 and 5	Reaches 4 and 5 are a priority Compliance point: Gauge 405200 Murchison and Gauge 405232 Mc Coys Bridge	
Potential watering action	**Provide an autumn fresh**	**Provide a late spring fresh for fish spawning**
Expected watering effects	• Cue fish to move through the system allowing dispersal. Attract Golden and Silver perch to migrate into the Goulburn • Reinvigorate drying vegetation on the banks and provide some growth before the weather cools • Flush fine sediment and scour old biofilm from hard substrates to allow new biofilm growth and to improve food and habitat for macroinvertebrates • Scour and remove fine sediments to maintain instream habitat complexity	• Stimulate spawning of Golden and Silver perch • Scour bed sediments to maintain pools and change in-channel complexity for improved habitat • Improve waterbug habitat and food availability by scouring fine sediments and biofilms from hard substrates
Environmental objectives	Fish Macroinvertebrates Littoral/Bank Vegetation Instream Habitat Complexity	Periodic Fish Geomorphology Waterbugs
Application of potential watering action	Provide an autumn fresh (>5,700 ML for 2 -5days) between March and May. When aiming to attract fish the duration of the fresh will be extended. Planned for all climate scenarios but delivery of the fresh will be dependent on low flow over the summer period and the number and magnitude of IVT pulses which may provide the fresh.	In October to December provide a short duration fresh >6,600ML/day for 2 days and >1,500ML/day for around 14 days. A fresh in November will target Golden perch whereas a fresh in December will target Silver perch but will likely trigger some Golden perch spawning as well. To limit littoral vegetation damage this fresh will only be delivered if following the spring fresh there is 6-8 weeks of baseflows of around 1,000 ML/day or flow have not been less than 2,000ML/day for more than a week
Rationale for 2023-24	An autumn fresh is now recommended annually in the latest flow recommendations. With sufficient environmental water to deliver this fresh, it will be delivered if flow over summer is appropriate. An autumn fresh would target existing vegetation maintenance and encourage germination of new seed on the lower banks and benches. The fresh will also assist to improve water quality, and to achieve some macroinvertebrate objectives including resuspension of fine sediment from macroinvertebrate habitats and consequent increase in biofilm availability. To reduce the potential for damage from the fresh due to the banks being primed for failure from IVT delivery. The fresh should not be in the same area of bank targeted by IVT delivery over spring/summer and be of a higher magnitude. Depending on IVT delivery over the year a higher magnitude autumn fresh may help to repair/reset some of the erosional damage caused.	This is a high priority for 2023 due to the large abundance of carp following the spring 2022 floods. To assist native fish populations a late spring fresh is likely to be delivered. However, if conditions are average or wet with high natural flows over winter and spring (with likely bankfull or overbank events) then the event may not be delivered. The duration and magnitude of the event will be dependent on seasonal conditions and consideration of implications for vegetation and erosion will be required.

Scenario Planning and Prioritisation

Climatic outlook for 2023/24

The long term climate outlook for environmental water planning is difficult to determine. Consequently, the CMA uses allocation outlook scenarios provided by Goulburn-Murray Water to assist in scenario planning. shows the outlook (based on historic river flows and inflows) into storages that has been used as a basis for this Seasonal Watering Proposal.

With good inflows in 2022/23 and allocations reaching 100% early in the season there are reserves in the Goulburn system that will provide for an opening allocation under all inflow conditions. There is also a large volume of environmental water carryover that will aid in delivering early season watering priorities.

Table 13: Goulburn system outlook for 2023/24 seasonal determination of high reliability shares

Inflow Conditions	3 July 2023	15 August 2023	16 October 2023	15 February 2024
Wet	100%	100%	100%	100%
Above average	100%	100%	100%	100%
Average	92%	100%	100%	100%
Below average	85%	100%	100%	100%
Dry	79%	95%	100%	100%
Very dry	77%	88%	100%	100%
Extreme Dry	75%	80%	87%	97%

Source: GMW, 15 February 2023

The scenario planning for 2023/24 under the different inflow scenarios is outlined in Table 14 . It builds on details included in the previous section on seasonal watering priorities. Given the high carryover volume from 2022/23 and high early season allocations, all watering priorities are the same for every inflow scenario except the extreme dry inflow scenario.

Table 14: Scenario planning summary

Reaches 1, 4 and 5	Scenario 1 Extreme dry 99% POE	Scenario 2 Dry 90% POE	Scenario 3 Below average 70% POE	Scenario 4 Average 50% POE	Scenario 4 Wet 10% POE
Expected river conditions	No unregulated flow Blackwater could be an issue over the warmer months	One or two small, short duration freshes in winter/spring (perhaps up to 5,000 ML/day) and reasonable baseflows for half a month Blackwater could be an issue over the warmer months	One or two freshes (3,000 to 20,000 ML/day) and reasonable baseflows for a few months.	One to three freshes (up to 20,000 ML /day) Good baseflows for most of the year (would be reduced during irrigation season), perhaps two to three months baseflow provided by unregulated Blackwater could be an issue over the warmer months	Three to five freshes (including overbank flows) Unregulated flow to provide the majority of flow over winter and spring
	Bulk entitlement minimums will be delivered 400 ML/day at McCoys from July – October 350 ML/day at McCoys from November – June 250ML/day d/s Lake Eildon to June 2023 (high inflow trigger) then 120ML/day				
Expected water allocations	97% HRWS allocation	100% HRWS allocation	100% HRWS allocation	100% HRWS Storage management likely with a chance of Eildon spilling	100% HRWS Eildon dam will spill/storage releases
Expected water availability from water holders *	CEWH – 308 GL TLM – 44 GL VEWH – 24 GL	CEWH –318 GL TLM – 45 GL VEWH – 25 GL	CEWH –318 GL TLM – 45 GL VEWH – 25 GL	CEWH –318 GL TLM – 45 GL VEWH – 25 GL	CEWH –318 GL TLM – 45 GL VEWH – 25 GL
Forecast carryover from 22/23	CEWH, TLM and VEWH combined 366 GL	CEWH, TLM and VEWH combined 366 GL	CEWH, TLM and VEWH combined 366 GL	CEWH, TLM and VEWH combined 366 GL	CEWH, TLM and VEWH combined 366 GL
Total water available from water holders	742 GL	754 GL	754 GL	754 GL	754 GL

Reaches 1, 4 and 5	Scenario 1 Extreme dry 99% POE	Scenario 2 Dry 90% POE	Scenario 3 Below average 70% POE	Scenario 4 Average 50% POE	Scenario 4 Wet 10% POE
Demands	50 GL has been set aside for deliveries to the Broken Creek and Lower Goulburn Wetlands from CEWH/VEWH Goulburn entitlement in every scenario				
Assumed IVT available	400 GL+	400 GL+	400 GL+	400 GL+	400 GL+
Assumed IVT water deliveries to support Goulburn River environmental outcomes	It assumed that the default monthly volumes of IVT delivered for the year. These volumes are assumed to meet nearly all of the baseflow volume requirements for the year	It assumed that the default monthly volumes of IVT delivered for the year. These volumes are assumed to meet nearly all of the baseflow volume requirements for the year	It assumed that the default monthly volumes of IVT delivered for the year. These volumes are assumed to meet nearly all of the baseflow volume requirements for the year	It assumed that the default monthly volumes of IVT delivered for the year. These volumes are assumed to meet all of the baseflow volume requirements for the year. However it's likely that in this scenario not all IVT will be delivered but unregulated flows would cover baseflow needs.	It assumed that the default monthly volumes of IVT are delivered for the year. These volumes are assumed to meet all of the baseflow volume requirements for the year. However it's likely that in this scenario not all IVT will be delivered but unregulated flows would cover baseflow needs.
Environmental objectives	In addition to the environmental objectives 1. Maintain or re-establish lower bank vegetation in the lower Goulburn. 2. Protect the bank and aquatic biota by minimising erosion and mass failure of the lower bank, managing water quality and re-introduce sediments/seed. 3. Achieve fish outcomes – improve Murray and Trout cod populations, cue Golden and Silver perch spawning and attraction into the river. 4. Maximise platypus breeding success by providing nesting cues 5. Maximise ecological outcomes by using tributary flows as much as possible to meet environmental watering objectives, and especially during the spring period. 6. Increasing habitat by connecting low lying floodplain features in the mid Goulburn.				
Priority watering actions	Lower Broken Creek environmental water requirements. (50GL)				
1	Provide a year round baseflow of 600 - 1000 ML/day in reach four and five for habitat diversity and sustaining the system (41GL) – primarily provided by IVT	Provide a year round baseflow of 600 - 1000 ML/day in reach four and five for habitat diversity and sustaining the system (37GL) – primarily provided by IVT	Provide a year round baseflow of 600 - 1000 ML/day in reach four and five for habitat diversity and sustaining the system (48GL) – primarily provided by IVT	Provide a year round baseflow of 600 - 1000 ML/day in reach four and five for habitat diversity and sustaining the system (48GL) – primarily provided by IVT or unregulated flow	Provide a year round baseflow of 600 - 1000 ML/day in reach four and five for habitat diversity and sustaining the system (48GL) – primarily provided by IVT or unregulated flow

Reaches 1, 4 and 5	Scenario 1 Extreme dry 99% POE	Scenario 2 Dry 90% POE	Scenario 3 Below average 70% POE	Scenario 4 Average 50% POE	Scenario 4 Wet 10% POE
2	Provide a year round variable baseflow of 400-2,000 ML/day to reach 1. Assume all use re-captured and not spilt, loss allowance. (50 GL)	Provide a year round variable baseflow of 400-2,000 ML/day to reach 1. Assume all use re-captured and not spilt, loss allowance. (50 GL)	Provide a year round variable baseflow of 400-2,000 ML/day to reach 1. Assume a small volume spilt. (50 GL)	Provide a year round variable baseflow of 400-2,000 ML/day to reach 1. (75 GL)	Provide a year round variable baseflow of 400-2,000 ML/day to reach 1. (100 GL)
3a	Provide 2023 winter fresh to reach 4-5 of (>7,300 ML for 4-5 days) up to 9,500 ML/day in July - August for channel forming, and platypus nesting cues. (95GL)	Provide 2023 winter fresh to reach 4-5 of (>7,300 ML for 4-5 days) up to 9,500 ML/day in July - August for channel forming, and platypus nesting cues. Aim to use a natural fresh and provide most of the event from rainfall runoff with minimal releases from Lake Eildon. (95GL)	Provide 2023 winter fresh to reach 4-5 of (>7,300 ML for 4-5 days) up to 9,500 ML/day in July- August for channel forming, and platypus nesting cues. Aim to use a natural fresh and provide most of the event from rainfall runoff with minimal releases from Lake Eildon. (50GL)	Provide 2023 winter fresh to reach 4-5 of (>7,300 ML for 4-5 days) up to 9,500 ML/day in July- August for channel forming, and platypus nesting cues. Aim to use a natural fresh and provide most of the event from rainfall runoff with minimal releases from Lake Eildon. Some unregulated flow will contribute to the event. (50GL)	Provide 2023 winter fresh to reach 4-5 of (>7,300 ML for 4-5 days) up to 9,500 ML/day in July- August for channel forming, and platypus nesting cues. In this scenario its likely that unregulated flow will contribute significantly to, or exceed the event magnitude. (0GL)
3b	Provide a winter fresh to reach 1 of >8,000 ML/d (or as high as possible) for 5-10 days between late July and late August to connect low lying wetlands and provide a nesting cue for platypus. Likely to coincide with the reach 4 and 5 fresh, depending on delivery timing and required volume released from Lake Eildon. Otherwise, this will be delivered as a separate winter fresh that can be re-harvested in Waranga Basin or passed through the lower Goulburn River	Provide a winter fresh to reach 1 of >8,000 ML/d (or as high as possible) for 5-10 days between late July and late August to connect low lying wetlands and provide a nesting cue for platypus. Likely to coincide with the reach 4 and 5 fresh, depending on delivery timing and required volume released from Lake Eildon. Otherwise, this will be delivered as a separate winter fresh that can be re-harvested in Waranga Basin or passed through the lower Goulburn River	Provide a winter fresh to reach 1 of >8,000 ML/d (or as high as possible) for 5-10 days between late July and late August to connect low lying wetlands and provide a nesting cue for platypus. Likely to coincide with the reach 4 and 5 fresh, depending on delivery timing and required volume released from Lake Eildon. Otherwise, this will be delivered as a separate winter fresh that can be re-harvested in Waranga Basin or passed through the lower Goulburn River (0GL)	Provide a winter fresh to reach 1 of >8,000 ML/d (or as high as possible) for 5-10 days between late July and late August to connect low lying wetlands and provide a nesting cue for platypus. Likely to be delivered as a separate winter fresh from reach 4 and 5, and can be re-harvested in Waranga Basin or passed through the lower Goulburn River (0GL)	Provide a winter fresh to reach 1 of >8,000 ML/d (or as high as possible) for 5-10 days between late July and late August to connect low lying wetlands and provide a nesting cue for platypus. Likely to be delivered as a separate winter fresh from reach 4 and 5, and spilt or passed through the lower Goulburn River. (34GL)

Reaches 1, 4 and 5	Scenario 1 Extreme dry 99% POE	Scenario 2 Dry 90% POE	Scenario 3 Below average 70% POE	Scenario 4 Average 50% POE	Scenario 4 Wet 10% POE
	(0GL)	(0GL)			
4a	Provide an early spring fresh to reach 4-5 (>7,300 ML for 7 days) up to 10,500 ML/day in September and October to prime the system for lower bank vegetation establishment and maintenance. (145GL)	Provide an early spring fresh to reach 4-5 (>7,300 ML for 7 days) up to 10,500 ML/day in September and October to prime the system for lower bank vegetation establishment and maintenance. (145GL)	Provide an early spring fresh to reach 4-5 (>7,300 ML for 7 days) up to 10,500 ML/day in September and October to prime the system for lower bank vegetation establishment and maintenance. Aim to use a natural fresh and provide the majority of the event from rainfall runoff and minimal releases from Lake Eildon. Assume one quarter from natural flow. (102GL)	Provide an early spring fresh to reach 4-5 (>7,300 ML for 7 days) up to 10,500 ML/day in September and October to prime the system for lower bank vegetation establishment and maintenance. Aim to use a natural fresh and provide the majority of the event from rainfall runoff and minimal releases from Lake Eildon. Assume one quarter from natural flow. (102GL)	Provide an early spring fresh to reach 4-5 (>7,300 ML for 7 days) up to 10,500 ML/day in September and October to prime the system for lower bank vegetation establishment and maintenance. It is assumed that the spring fresh will be met using environmental water to extend a natural fresh and natural flows will provide half of the flow. (73GL)
4b	Provide a spring fresh to reach 1 (as high as possible, but not exceeding the winter fresh discharge) for 5-10 days between September and November This fresh will be delivered as part of the reach 4 and 5 event so no extra water reqired. (0GL)	Provide a spring fresh to reach 1 (as high as possible, but not exceeding the winter fresh discharge) for 5-10 days between September and November This fresh will be delivered as part of the reach 4 and 5 event, but if there are sufficient unregulated flows and Eildon releases are small then a separate event will occur. This could potentially coincide with the reach 4-5 late spring fresh.	Provide a spring fresh to reach 1 (as high as possible, but not exceeding the winter fresh discharge) for 5-10 days between September and November This fresh will be delivered as part of the reach 4 and 5 event but if there are sufficient unregulated flows and Eildon releases are small then a separate event will occur. This could potentially coincide with the reach 4-5 late spring fresh. Any delivery covered by 4a water use allowance.	Provide a spring fresh to reach 1 (as high as possible, but not exceeding the winter fresh discharge) for 5-10 days between September and November This fresh will be delivered as part of the reach 4 and 5 event but if there are sufficient unregulated flows and Eildon releases are small then a separate event will occur. This could potentially coincide with the reach 4-5 late spring fresh. Any delivery covered by 4a water use allowance.	Provide a spring fresh to reach 1 (as high as possible, but not exceeding the winter fresh discharge) for 5-10 days between September and November This fresh will be delivered as part of the reach 4 and 5 event but if there are sufficient unregulated flows and Eildon releases are small then a separate event will occur. This could potentially coincide with the reach 4-5 late spring fresh. Any delivery covered by 4a water use allowance.

Reaches 1, 4 and 5	Scenario 1 Extreme dry 99% POE	Scenario 2 Dry 90% POE	Scenario 3 Below average 70% POE	Scenario 4 Average 50% POE	Scenario 4 Wet 10% POE
		Assumed any extra water is re-harvested and not lost. (0GL)	(0GL)	(0GL)	(0GL)
5	Provide a year round standing order for freshes up to 6,000ML/day from Goulburn Weir to maintain water quality, protect the banks, provide natural variability. (0 GL)	Provide a year round standing order for freshes up to 6,000ML/day from Goulburn Weir to maintain water quality, protect the banks, provide natural variability. (0 GL)	Provide a year round standing order for freshes up to 6,000ML/day from Goulburn Weir to maintain water quality, protect the banks, provide natural variability. (25 GL)	Provide a year round standing order for freshes up to 6,000ML/day from Goulburn Weir to maintain water quality, protect the banks, provide natural variability. (25 GL)	Provide a year round standing order for freshes up to 6,000ML/day from Goulburn Weir to maintain water quality, protect the banks, provide natural variability. (30 GL)
6	Provide an autumn fresh (>5,700 ML for 2-5 days) between March and May for lower bank vegetation reinvigoration and maintenance and/or fish migration outcomes. *NOTE: this fresh will only be delivered depending on flow and vegetation condition over the summer period* (30GL)	Provide an autumn fresh (>5,700 ML for 2-5 days) between March and May for lower bank vegetation reinvigoration and maintenance and/or fish migration outcomes. *NOTE: this fresh will only be delivered depending on flow and vegetation condition over the summer period* (30GL)	Provide an autumn fresh (>5,700 ML for 2-5 days) between March and May for lower bank vegetation reinvigoration and maintenance and/or fish migration outcomes. *NOTE: this fresh will only be delivered depending on flow and vegetation condition over the summer period* (60GL)	Provide an autumn fresh (>5,700 ML for 2-5 days) between March and May for lower bank vegetation reinvigoration and maintenance and/or fish migration outcomes. *NOTE: this fresh will only be delivered depending on flow and vegetation condition over the summer period* (60GL)	Provide an autumn fresh (>5,700 ML for 2-5 days) between March and May for lower bank vegetation reinvigoration and maintenance and/or fish migration outcomes. *NOTE: this fresh will only be delivered depending on flow and vegetation condition over the summer period* (60GL)

Reaches 1, 4 and 5	Scenario 1 Extreme dry 99% POE	Scenario 2 Dry 90% POE	Scenario 3 Below average 70% POE	Scenario 4 Average 50% POE	Scenario 4 Wet 10% POE
7	Provide a standing order in reach 1 for up to three freshes >5,000 ML/d for 5 – 10 days in May – November to mimic natural variability (0 GL)	Provide a standing order in reach 1 for up to three freshes >5,000 ML/d for 5 – 10 days in May – November to mimic natural variability (0 GL)	Provide a standing order in reach 1 for up to three freshes >5,000 ML/d for 5 – 10 days in May – November to mimic natural variability (0GL)	Provide a standing order in reach 1 for up to three freshes >5,000 ML/d for 5 – 10 days in May – November to mimic natural variability (0GL)	Provide a standing order in reach 1 for up to three freshes >5,000 ML/d for 5 – 10 days in May – November to mimic natural variability (0GL)
8	Provide (carryover) for baseflow of 1000 ML/day in July to September (23/24) for fish and macroinvertebrate habitat (50GL)	Provide (carryover) for baseflow of 1000 ML/day in July to September (23/24) for fish and macroinvertebrate habitat (50GL)			
9	Provide higher baseflows or freshes up to 6,000 ML/day between May and November in reach 4 & 5 to pass Reach 1 freshes or mimic natural variability through the length of the Goulburn River (30 GL) No events expected	Provide higher baseflows or freshes up to 6,000 ML/day between May and November in reach 4 & 5 to pass Reach 1 freshes or mimic natural variability through the length of the Goulburn River (20 GL) No events expected	Provide higher baseflows or freshes up to 6,000 ML/day between May and November in reach 4 & 5 to pass Reach 1 freshes or mimic natural variability through the length of the Goulburn River (50 GL)	Provide higher baseflows or freshes up to 6,000 ML/day between May and November in reach 4 & 5 to pass Reach 1 freshes or mimic natural variability through the length of the Goulburn River (50 GL)	Provide higher baseflows or freshes up to 6,000 ML/day between May and November in reach 4 & 5 to pass Reach 1 freshes or mimic natural variability through the length of the Goulburn River (15 GL)
10a	Provide a 2024 winter fresh >7,300 ML/day or as high as possible in May - August for channel forming, and platypus nesting cues. Aim to use a natural fresh and provide most of the event from rainfall runoff with minimal releases from Lake Eildon. (85GL)	Provide a 2024 winter fresh >7,300 ML/day or as high as possible in May - August for channel forming, and platypus nesting cues. Aim to use a natural fresh and provide most of the event from rainfall runoff with minimal releases from Lake Eildon. (85GL)	Provide a 2024 winter fresh >7,300 ML/day or as high as possible in May – August for channel forming, and platypus nesting cues. Aim to use a natural fresh and provide most of the event from rainfall runoff with minimal releases from Lake Eildon. (85GL)	Provide a 2024 winter fresh >7,300 ML/day or as high as possible in May - August for channel forming, and platypus nesting cues. Aim to use a natural fresh and provide most of the event from rainfall runoff with minimal releases from Lake Eildon. (95GL)	Provide a 2024 winter fresh >7,300 ML/day or as high as possible in May - August for channel forming, and platypus nesting cues. Aim to use a natural fresh and provide most of the event from rainfall runoff with minimal releases from Lake Eildon. (95GL)
10b	Provide a winter 2024 fresh of >8,000 ML/day (or as high as possible) Reach 1	Provide a winter 2024 fresh of >8,000 ML/day (or as high as possible) Reach 1	Provide a winter 2024 fresh of >8,000 ML/day (or as high as possible) Reach 1	Provide a winter 2024 fresh of >8,000 ML/day (or as high as possible) Reach 1	Provide a winter 2024 fresh of >8,000 ML/day (or as high as possible) Reach 1

Reaches 1, 4 and 5	Scenario 1 Extreme dry 99% POE	Scenario 2 Dry 90% POE	Scenario 3 Below average 70% POE	Scenario 4 Average 50% POE	Scenario 4 Wet 10% POE
11	Provide a late spring fresh (>6,600 ML for 1 days) between October and December for native fish spawning NOTE: this fresh will only be delivered if there is 8 weeks of baseflows of around 1000 ML/day or Lower bank vegetation has not been inundated for less than a week (50GL)	Provide a late spring fresh (>6,600 ML for 1 days) between October and December for native fish spawning NOTE: this fresh will only be delivered if there is 8 weeks of baseflows of around 1000 ML/day or Lower bank vegetation has not been inundated for less than a week (50GL)	Provide a late spring fresh (>6,600 ML for 1 days) between October and December for native fish spawning NOTE: this fresh will only be delivered if there is 8 weeks of baseflows of around 1000 ML/day or Lower bank vegetation has not been inundated for less than a week (50GL)	Provide a late spring fresh (>6,600 ML for 1 days) between October and December for native fish spawning NOTE: this fresh will only be delivered if there is 8 weeks of baseflows of around 1000 ML/day or Lower bank vegetation has not been inundated for less than a week (50GL)	Provide a late spring fresh (>6,600 ML for 1 days) between October and December for native fish spawning NOTE: this fresh will only be delivered if there is 8 weeks of baseflows of around 1000 ML/day or Lower bank vegetation has not been inundated for less than a week (50GL)
Volume required	576 GL	562 GL	520 GL	555 GL	555 GL
Tier 2 actions					
	N/A	N/A	N/A	N/A	N/A

+ Based on conversations with GMW

* CEWH may have the opportunity to trade additional environmental water allocations from the Murray to meet Goulburn demands

Delivery Constraints

IVT deliveries can have a benefit of meeting environmental watering priorities in the Goulburn River if the demand coincides with environmental demands. However, it can also lead to elevated flows that conflict with lower Goulburn River environmental watering priorities and objectives. The aim of environmental water to deliver baseflows up to approximately 1,000 ML/day throughout summer may be constrained, and not achievable due to high demand for IVT water in 2023/24. This presents a delivery constraint to being able to achieve two objectives:

1. Use of environmental water in the Goulburn River, as IVT water takes precedence.
2. Achieving ecological outcomes from environmental water delivery, and increasing the risk to bank stability and vegetation resilience and native fish populations.

The current Goulburn-Murray Trade rule review and operating rules for the Goulburn River aimed at protecting the ecology of the lower Goulburn River further increase this constraint as environmental water use is constrained for 6 months of the year. Further, high volumes of IVT likely to be carried over from 2022/23 may limit the ability to deliver environmental water over winter and spring if IVT carryover reduction is given precedence. This is unclear in the current rules and plans.

Implementation arrangements

Metering and flow monitoring arrangements for the Goulburn River are documented in the *Northern Victorian Environmental Metering Program* (VEWH 2018).

Draft operating arrangements exist for the Goulburn River. Operational arrangements at regulating structures and delivery of consumptive water within the catchment and downstream can constrain the ability to meet flow recommendations (GBCMA, 2015). Capacity constraints at Goulburn Weir are also possible, and GMW consult with GBCMA when such circumstances occur.

Environmental water delivery is primarily constrained by the risk of flooding adjacent land and assets. The Bureau of Meteorology minor flood levels at each flow measurement point along the Goulburn River are as follows:

- 3 metres (14,500 ML/day) at Eildon (reach 1)
- 4 metres (21,700 ML/day) at Trawool (reach 2)
- 4 metres (24,800 ML/day) at Seymour (reach 3)
- 9 metres (33,100 ML/day) at Murchison (reach 4)
- 9 metres (28,300 ML/day) at McCoys Bridge (reach 5)

However, constraints to delivery of environmental flows are known at lower flows than these. The following limitations and reasoning have been identified:

- during the irrigation season flows greater than 3,000 ML/day impact on some diverter's access to pumps and landholder notification of any flows above this flow is required approximately three weeks prior to delivery. This 3,000 ML/day limit also extends to the delivery of IVT water.
- releases from Lake Eildon are typically limited to 9,500ML/day to avoid inundation of private land in the vicinity of Molesworth.
- managed releases from Goulburn Weir are limited to 10,000 ML/day by GMW due to the unknown impact of inundating land downstream.

Costs

Relevant headworks costs for environmental entitlements are met by the environmental water entitlement holders. There are no water delivery costs.

Notice and time required

A minimum notice period of one to two days, and preferably four days, is required for environmental water orders from Goulburn system storages. Releases from Lake Eildon take approximately two and a half days to reach Goulburn Weir. Releases from Goulburn Weir take three to four days to reach Shepparton, and approximately six to seven days to reach McCoys Bridge from Goulburn Weir. However, this can be influenced by existing conditions in the river channel and seasonal conditions. If flows are being harvested at Goulburn Weir into Waranga Basin, releases can be made from Goulburn Weir to the lower Goulburn River by reducing harvesting, hence saving travel time from Lake Eildon.

When flows above 3,000 ML/day are being targeted, notification to landholders adjoining the Goulburn River is required up to three weeks in advance during irrigation periods. GMW have improved their knowledge of impacted diverters and moved from letters to email and text notifications for events.

For the winter and early spring (up until the proposed spring fresh in September/October) GMW will advise all customers that there is the potential for flows up to 9,500 ML/day and notice may be short and only up to 2 days prior. This will provide the opportunity to pass flow events through the Goulburn Weir and the potential to deliver freshes using tributary flow rather than Eildon releases.

Confounding factors

The main confounding factor is the inability to inundate the floodplain to meet ecological and community outcomes. This is being addressed under the Victorian Constraints Measures Program.

Increasing Knowledge

Monitoring

River flows and water quality are currently monitored through the North East Monitoring Partnership and often assist in environmental flow management. Sites of flow monitoring on the Goulburn River are Lake Eildon, Killingworth (water level only), Trawool, Seymour, Goulburn Weir, Murchison, Shepparton, Loch Garry (level only) and McCoys Bridge.

Water quality monitoring includes continuous (i.e. 15 minute intervals) and non-continuous monitoring. Continuous data collection has been occurring since 2009 (primarily in response to drought) and non-continuous monitoring (monthly) has been occurring for more than ten years. Table 15 lists the sites, frequency and parameters that are used for environmental flow monitoring. This monitoring is used frequently (sometimes daily) in short term environmental flow management to assist decision making, especially for minimising the risk of dissolved oxygen sags and potential fish deaths or other water quality issues.

Table 15: Monitoring sites used in environmental flow management

Site	Parameter
Continuous monitoring	
Goulburn River @ McCoys Bridge	Dissolved oxygen, electrical conductivity, temperature, level
Goulburn River @ Shepparton Golf Club	Dissolved oxygen, temperature
Goulburn River @ Trawool	Turbidity, electrical conductivity, temperature, level, dissolved oxygen
Seven Creeks @ Galls Gap Road	Dissolved oxygen, temperature
Non-continuous monitoring	
Goulburn River @ McCoys Bridge	TP, TN, dissolved organic carbon
Goulburn River @ Shepparton	Suspended solids, turbidity, TP, TN
Goulburn River @ Murchison	Dissolved oxygen, temperature, turbidity, electrical conductivity, suspended solids, TP, TN
Goulburn River @ Trawool	Dissolved oxygen, temperature, turbidity, electrical conductivity, suspended solids, TP, TN
Goulburn River @ Eildon	Dissolved oxygen, temperature, turbidity, electrical conductivity, suspended solids, TP, TN

Knowledge gaps and limitations

As delivery and monitoring of environmental water continues we are increasing our knowledge and understanding of ecosystem responses. However, with the increased knowledge comes new knowledge gaps. Below are some key knowledge gaps of ecosystem response to flow management in the Goulburn River (this list is by no means exhaustive):

- What is the influence of flow rate on water depths and velocity in high value macrophyte beds and riffle habitats across reaches 1-3, to inform flow recommendations?
- How do flows influence macroinvertebrate food sources within aquatic macrophyte beds and how are these being used by platypus relative to riffle habitats in upper reaches?

- What fish community exists in reaches 1 and 2 and how can environmental water be best delivered to support this community?
- How many years can Murray River Rainbow fish tolerate unseasonal, prolonged summer/autumn flows before local extinction?
- Understanding of native fish, particularly Silver and Golden perch movement and life history requirements through the entire southern connected basin requires more research.
- How often should golden/silver perch spawning flows be targeted as a high priority in the Goulburn River, without having impact on the population structure of these fish within the Goulburn and broader southern connected basin?
- What habitat requirements do large bodied native fish require in the juvenile stage?
- What are the ecological processes and productive value of instream benches following inundation?
- What are the areas and types of habitats (wetlands, bars, benches, anabranches) connected by current environmental flows and what are the benefits of connecting the different habitat types?

Knowledge gaps also exist with regard to the integration of Traditional Ecological Knowledge to improve the alignment of environmental watering with Traditional Owner biocultural values. It will be necessary to continue to work closely with Traditional Owners, and facilitate Traditional Owner led assessments of biocultural values to identify cultural priorities for watering such as support for food and medicinal plant species, or protection of culturally significant aquatic fauna. Investigation is also necessary to determine how best to facilitate ongoing involvement of Traditional Owners in order to identify and adequately consider indicators of these tangible biocultural values in e-water planning, as well as better respond to intangible values such as the maintenance of connection to Country and the expression of cultural obligations to heal Country.

Risk Management

The risks associated with the proposed water delivery in the Goulburn system are listed in Table 16 . Risks were primarily identified at the VEWH risk workshop held via an online meeting in February 2022. Associated risks and risk ratings are the same for each season, except for winter. Mitigation strategies that will be employed to address the identified risks are detailed in Table 16 along with lead agencies.

The key management activities with immediate outcomes include:

- management of flood risk associated with delivering freshes by considering potential runoff in deciding when to commence releases or whether to cease releases prematurely;
- to keep key stakeholders advised of release plans and outcomes of releases.

The risk of flooding arises from catchment runoff adding flow on top of environmental releases. The key issue is the unpredictability of the amount of rainfall and runoff. At Shepparton, flooding occurs at approximately 18,000 ML/day, although inundation of some assets (such as irrigation pumps) occurs at much lower flows (anecdotally as low as 3,000 ML/day). Managing the risk of flooding is a balance in determining spare capacity in the river to carry runoff and the potential reduction/suspension of environmental releases required when rainfall is forecast. The highest flow (due to capacity constraints) that can be provided from Lake Eildon is 9,000 to 10,000 ML/day under dry conditions and assumes no irrigation water supply demand. This leaves 8,000 to 9,000 ML/day of spare river capacity in the lower Goulburn to carry runoff on a dry catchment. Under wet conditions, lower flow releases would be needed to manage the likely higher runoff. However, following a rainfall runoff event short duration releases of 9,000 ML/day could be added to the recession to achieve higher flow rates or extended duration when little or no rainfall is forecast in the seven day outlook. The higher the flow rate (due to runoff), the more likely the flow release would be reduced or ceased, making provision of the environmental or water supply flow erratic and potentially unreliable.

Naturally high rainfall and floods have resulted in hypoxic blackwater in parts of the Goulburn River and Murray River in recent years. The Water Quality Reserve can be used to manage hypoxic water at GMW's discretion and at short notice, but there are specific conditions attached to its use, including that it cannot be replenished within a season.

Another key risk in the lower Goulburn River is the management of water from Lake Eildon to consumptive and environmental users downstream. This can provide ecological benefits to the river and reduce the volume of environmental water required, however if large volumes of consumptive water are required at times contradictory to the environmental flow recommendations for the Goulburn River, this can pose a significant risk to achieving the ecological outcomes intended with the Goulburn environmental water. The implications of (and direct damage caused) by delivery of consumptive water over summer and autumn has been recognised by the Victorian Government and at the time of writing proposed new trading and operational rules for delivery of traded water through Inter Valley transfers have been released Goulburn to Murray trade rule review | Engage Victoria. The actual rules arising from the review are currently not finalised but the operating rules proposed under the preferred option in the Regulatory Impact Statement (RIS) has the potential to prevent several watering actions proposed in this plan from being delivered. In particular there are large risks that the late spring fresh and Autumn fresh cannot be delivered. This is identified as an extreme risk and still has a high residual risk following mitigation actions.

Table 16: VEWH risk assessment for 2023/24 watering proposals – risks medium or higher –

			Pre-Mitigation Risk					Residual Risk			
Risk ID	**Risk category**	**Risk description**	**Likelihood**	**Consequence**	**Risk Rating**	**Mitigation actions**	**Lead organisn. for action**	**Likelihood**	**Consequence**	**Risk Rating**	**Risk type** Static or Dynamic
NOGB2020-01	Environment	Specified flow rates are insufficient to achieve the intended extent of wetland inundation or magnitude and duration of river flows, resulting in a failure to achieve planned environmental outcomes. Applicable for mid-Goulburn flow trials in 2023-24 (new actions), also applicable to post-flood environment. Much lower risk for Ovens.	Possible	Major	Medium	• Include contingency allowance in estimated watering requirements, based on previous event data, and consider a contingency in the duration of the event to achieve desired wetland inundation. • Monitor event (especially for deliveries to new sites or for previously untested events) and adjust flows as necessary, or terminate event if it becomes clear that insufficient water is available. • Identify and address constraints that may limit the flow rates for environmental deliveries.	CMA CMA CMA/GMW	Possible	Minor	Low	Static
NOGB2020-02	Reputational	Specified flow rates are insufficient to achieve the intended extent of wetland inundation or magnitude and duration of river flows, resulting in a failure to achieve planned environmental outcomes and loss of community support.	Possible	Major	Medium	• Communications on the environmental benefits of watering actions. • Monitor event (especially for deliveries to new sites or for previously untested events) and adjust flows as necessary, or terminate event if it becomes clear that insufficient water is available. • Communicate the need for complimentary measures to optimise the benefits of environmental watering actions.	CMA	Unlikely	Minor	Low	Static
NOGB2020-11	Environment	High downstream demands may lead to flows that exceed local environmental requirements and targets (including rates of river rise and fall), leading to negative environmental outcomes, including negating previous environmental improvements. Recent monitoring and assessment is confirming consequences in Goulb and Lwr Bkn - high water avail. in 22-23 increases likelihood	Almost certain	Major	Extreme	- Monitor the effectiveness of adopted seasonal flow limits for river systems, with annual negotiation and management of release plans and reviews during the season as required. - Monitor impacts of new trade limits and revised operating rules and review as necessary - Coordination of downstream e-water demands with regard for upstream impacts to balance impacts and benefits - modify or delay delivery of prioity environmental watering actions to reduce potential of environmental water adding to negative ecological outcomes	VEWH and DELWP DELWP/GBCMA VEWH/SCBEWC	Possible	Moderate	Medium	Dynamic
NOGB2020-12	Legal	Environmental releases, either on their own or potentially in combination with unexpected tributary inflows, cause unauthorised inundation of private land, resulting in impacts on landowner activities and assets. *Note that 2022 floods have caused erosion or damage to the river banks which may result in Environmental releases (at previously acceptable flow rates) causing unauthorised inundation of private land, resulting in impacts on landowner activities and assets.*	Possible	Major	Medium	• Ensure currency of any landholder agreements for inundation of private land. • Release plans designed to avoid exceeding operational thresholds or unauthorised flooding. • Monitor events and adjust releases to avoid overbank flows. This may include limiting deliveries to daylight hours only, where feasible and consistent with watering requirements. • Monitor forecast rainfall and tributary inflows and adjust releases to avoid overbank flows. • Monitor deliveries to new locations to build an understanding of flow patterns and inundation thresholds and adjust releases accordingly. - Investigations post flood to determine commence to flow of major erosion in the Mid Goulburn (and other systems as required) - Seek advice from storage operator of any known changes in bank levels and commence to flow levels	CMA CMA GMW/MDBA GMW/MDBA CMA CMA Storage operator	Unlikely	Moderate	Low	Static
NOGB2020-13	Reputational	Public land and/or access routes into public land areas may be inundated by delivery of environmental water, leading to potential impacts on recreational opportunities for park users (e.g. access to boat ramps, fishing spots, firewood collection etc.). **Applies to lower Goulburn - rated for this site - no access roads impacted, but sandbars and beaches could be.**	Almost certain	Moderate	High	• Watering proposals to identify potential impacts. communication of planned events, access closures, alternative recreational opportunities and alternative access routes	CMA Land Manager	Almost certain	Minor	Medium	Static
NOGB2020-20	Environment	Environmental water deliveries may generate or mobilise BGA blooms, with adverse water quality and/or health impacts (including to people, livestock and pets), resulting in cessation of releases and environmental impacts.	Possible	Major	Medium	• Consider likelihood of initiating BGA blooms in event planning and amend as required to manage risk, including investigation alternate delivery paths - e.g. lower outlets/offtakes, or non-delivery (e.g. as per 2022 for lower Broken creek) • Land managers or water corporation implement a risk-based monitoring program during environmental watering events, and where issues are identified, activate BGA response processes. **Notes: Parks Victoria are currently writing a BGA risk management plan for Northern Victoria Region that considers the potential risk of environmental water events. This plan will outline proactive and reactive monitoring and management responsibilities that Parks Victoria commits to as a Local Waterway Manager for BGA. Adequate BGA resourcing is being considering as part of this plan.* • Regional monitoring and advice on BGA status.	CMA / GMW Land Manager GMW GMW	Unlikely	Minor	Low	Static

			Pre-Mitigation Risk					Residual Risk			
Risk ID	**Risk category**	**Risk description**	**Likelihood**	**Consequence**	**Risk Rating**	**Mitigation actions**	**Lead organisn. for action**	**Likelihood**	**Consequence**	**Risk Rating**	**Risk type** Static or Dynamic
NOGB2020-21	Reputational	Environmental water management activities may conflict with or not complement water based recreational objectives, leading to loss of community support for activities. Highest risk at Goulburn River (for river/creek sites) - rated accordingly.	Almost certain	Moderate	High	• Communicate benefits of environmental water management to the broader community and engage with recreational user peak bodies. • Engage with local recreational user groups to inform them of environmental water management activities and the underlying rationale. • Adjust events or actions to reduce/avoid impact where practical without reducing environmental outcomes. • Communicate alternate recreational opportunities. • Enhance community understanding of water system operations and entitlement frameworks (water literacy).	VEWH CMA CMA Land Manager VEWH	Possible	Minor	Low	Static
NOGB2020-24	Legal	Failure to recognise cultural heritage issues at a site targeted for watering may result in necessary permits and approvals not being obtained, leading to prosecution and fines.	Possible	Moderate	Medium	• Undertake desktop reviews and site assessments with archaeologists, traditional owners and land managers, to identify approval needs and contingency measures. • Obtain any necessary formal approvals/permits and implement required actions. - Seek necessary resources to undertake approvals and assessments	CMA	Unlikely	Minor	Low	Dynamic
NOGB2020-26	Reputational	Inability to demonstrate outcomes achieved through environmental watering activities may lead to a loss of public/political support for activities	Possible	Major	Medium	• Rationalise and refocus current monitoring programs (e.g. Wetmap) to better identifying outcomes. • Seek additional funds to address gaps in monitoring programs and knowledge. • Communicate the benefits of environmental watering and monitoring results (Note: It may not be possible/affordable to address all monitoring gaps, so this risk may still be rated as medium after mitigation actions.) *Residual risk for 2023-24 reflects recent high flows experience - some community nervousness, general acceptance of ewater benefits*	DELWP VEWH CMA	Possible	Minor	Low	Static
NOGB2020-27	Environment	Environmental deliveries improve conditions for non-native species (e.g. carp, invasive species, feral horses) and over-abundant native species (e.g. kangaroos, Red Gum encroachment) leading to adverse environmental impacts. Particular issue in Goulburn River (risks of carp migration into system has impacted flows proceeding - likely to happen regardless), but applicable to all river systems.	Likely	Moderate	Medium	• Study/understand life history of species and develop high level management strategies. • Develop and implement site specific management strategies aimed at eradication/control of existing populations (e.g. carp management strategy, willow removal program, water-lily spraying program, feral animal programs). - Implement pest reduction efforts prior to delivery of water, to ensure increases in populations remain within "tolerable" levels, e.g. consider adjusting timing and magnitude of flows, and check in with fish ecologists *(Note: This risk is still rated as **medium** after mitigation actions. Still the case for 2023-24 - ecologist advice has recently prevented autumn fresh in Goulburn systems)*	DELWP CMA/Land Manager	Likely	Moderate	Medium	Static
NOGB2020-28	Environment	Environmental watering actions trigger non-targeted environmental responses (e.g. bird breeding) causing unintended consequences (or lost opportunities) for other environmental values. Can't think of likely examples for rivers/creeks: Risk only relevant to wetlands sites - residual risk rating to be assessed at Delivery Plan phase.	Likely	Moderate	Medium	• Undertake monitoring and communicate these issues as they arise and apply adaptive management and review of delivery plans. • Consider including contingency allowance in delivery plan water volumes to complete breeding events.	CMA	Possible	Minor	Low	Dynamic
NOGB2020-32	Reputational	Sections of the community perceives (incorrectly) that high river flows are due to environmental releases in dry conditions, leading to a loss of support for watering activities.	Possible	Moderate	Medium	• Communications to inform the community on the drivers/reasons for high flows in river systems, especially under dry scenarios *- residual risk based on 23-24 conditions*	System operator & CMA	Unlikely	Minor	Low	Dynamic
NOGB2020-34	Reputational	Under dry conditions, community expectations of the extent of environmental watering that can be achieved are not met, leading to a loss of support for environmental watering actions. Note - e-water deliveries may be constrained in 22-23 due to high consumptive avail.	Possible	Moderate	Medium	• Communications to inform the community on the limits of environmental water holdings and the extent of actions possible under dry conditions. *Note that public concern in this regard may be heightened as a result of the Menindee 2019 fish death events.* *- residual risk based on 23-24 conditions*	CMA	Unlikely	Minor	Low	Dynamic
NOGB2021-41	Safety	Negative community sentiment in relation to government decisions/actions creates a safety risk for staff involved in environmental watering actions **This is state wide risk, but may not apply in all systems - the risk rating will reflect local risk levels*	Possible	Moderate	Medium	- ensure staff are alerted to warnings about violent members of public - Strategic Communication of benefits of e-water and concern over safety to wider public (with co-ordination between partners) - ensure safe operational procedures for staff are followed	All	Unlikely	Minor	Low	Static

			Pre-Mitigation Risk					Residual Risk			
Risk ID	**Risk category**	**Risk description**	**Likelihood**	**Consequence**	**Risk Rating**	**Mitigation actions**	**Lead organisn. for action**	**Likelihood**	**Consequence**	**Risk Rating**	**Risk type** Static or Dynamic
NOGO2022-44	Environment	High operational and consumptive water demands lead to reduced access for environmental deliveries, with the result that target flows/volumes cannot be achieved, impacting on environmental outcomes Note: Consumptive water en route may achieve some outcomes in Goulb, but limiting e-water from the Goulburn has d/s implications for environmental outcomes at downstream Victorian sites in the Murray system, as well as the Murray River and Lower Lakes	Likely	Moderate	Medium	• Event planning will seek to avoid peak demand periods, and events will be monitored and adjusted as necessary. - Ensure SCBEWC multi-site planning includes operational demands in its planning for downstream sites • System operators to provide longer term forecasts for future consumptive demands as an input to planning watering proposals • Develop longer term agreements on river capacity access for environmental deliveries, with interim processes for capacity sharing at bulk level *- residual risk based on 23-24 conditions*	CMA and GMW VEWH GMW/MDBA VEWH	Possible	Minor	Low	Dynamic

Approval

I, Chris Cumming, the authorised representative of the agency shown below, approve the Seasonal Watering Proposal for the Goulburn River 2023-24.

SIGNED FOR AND ON BEHALF OF Goulburn Broken Catchment Management Authority

Signature of authorised representative

Name of authorised representative

Chris Cumming (CEO)

Date: 6 April 2023

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Appendix 1:Historic & current ecological objectives for the Goulburn River for reaches one to five

Flow Component	Ecological Value	Ecological Objectives	Functional Watering Objectives	Season	Flow (ML/day)					Report
					Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	
Baseflow	Macroinvertebrates Vegetation Native fish	Wet and maintain riffles for macroinvertebrates and small bodied fish, maintain wetted perimeter and aquatic vegetation	• scour fine sediment from gravel bed and riffle substrate • maintain existing beds of in channel vegetation	All	Minimum of 400 or natural	Minimum of 500 or natural	Minimum of 800 or natural	N/A	N/A	2014
Baseflow	Native fish	Provide suitable in channel habitat for all life stages.	Provide slow shallow habitat required for larvae/juvenile recruitment and adult habitat for small bodied fish	All	N/A	N/A	N/A	400	540	2007
			Provide deep water habitat for large bodied fish (depth of 2m)	All	N/A	N/A	N/A	800	800	2018 (Cottingham et al)
Baseflow	Macroinvertebrates	Provide food and habitat for macroinvertebrates including suitable water quality	Entrainment of litter packs available as food/habitat source for macroinvertebrates	All	N/A	N/A	N/A	540	770	2007
Baseflow	Macroinvertebrates	Provide habitat and food source for macroinvertebrates by submerging snag habitat within the euphotic zone	• provide conditions suitable for aquatic vegetation • provide slackwater habitat favourable for planktonic production (food source) for macroinvertebrates	All	N/A	N/A	N/A	830	940	2007

Flow Component	Ecological Value	Ecological Objectives	Functional Watering Objectives	Season	Flow (ML/day)					Report
					Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	
			• entrain litter packs as food source for macroinvertebrates • maintain water quality suitable for macroinvertebrates							
			• provision of conditions suitable for establishment of aquatic vegetation (for macroinvertebrate habitat) • provide slackwater habitat favourable for planktonic production (food source) for macroinvertebrates	Summer (30 – 40 days)	N/A	N/A	N/A	1,500	NA	2007
Baseflow	Littoral vegetation	Maintain, for more than one season, a littoral fringe of emergent or amphibious plants	Provision of habitat for macroinvertebrates and small bodied fish. Provide bank stability	Late spring/summer	N/A	N/A	N/A	Flows should not exceed 1,000 ML/day for 5-6 weeks	Flows should not exceed 1,000 ML/day for 5-6 weeks	2018 (Roberts)
Baseflow/ fresh	Geomorphology	Maintain pool depth especially from unseasonal events that fill pools but do not flush them	Maintenance of water quality suitable for macroinvertebrates	Summer < 90 days	N/A	N/A	N/A	856 – 6,590 (variable flow rates based on length of delivery time)	1096 – 6,060 (variable flow rates based on length of delivery time)	2007
Baseflow/fresh	Lower to mid vegetation	Maintain a zone with viable (patchy but persistent) perennial herbs or		Spring/summer/ autumn				Maximum continuous duration for P. prostrata is 50 days; maximum continuous duration for A. denticulata is 70 days		2018 (Cottingham et al)

Flow Component	Ecological Value	Ecological Objectives	Functional Watering Objectives	Season	Flow (ML/day)					Report
					Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	
		graminoids on mid to lower river bank						Shorter duration of inundation is acceptable, but a longer duration is risky		
Freshes	Littoral vegetation	Maintain, for more than one season, a littoral fringe of emergent or amphibious plants. Recommended frequency is every 1 in 2-4 years	Provision of habitat for macroinvertebrates and small bodied fish. Provide bank stability	Summer autumn	N/A	N/A	N/A	Flows should not exceed 1,000 ML/day for more than 20 consecutive days, with a minimum of 7 days between pulses	Flows should not exceed 1,000 ML/day for more than 20 consecutive days, with a minimum of 7 days between pulses	2018 (Roberts)
Fresh	In channel habitat Macroinvertebrate	Scour fine sediments from riffle surfaces to maintain invertebrate habitat Maintain habitat for macrophytes	• macroinvertebrates provide food source for fish • mobilise sediments	Winter Spring	Min 900 1 day					2014
Fresh	Macroinvertebrates Native fish	Sloughing filamentous algae and refreshing biofilms Maintain areas of riffle habitat	Increase flow variability to more closely mimic natural hydrological regime	Summer Autumn Winter Spring	Min 2,500 5-7 days 2 per year	Min 2,500-3,500 5-7 days 2 per year	Min 2,500-3,500 5-7 days 2 per year			2014
Fresh	Native fish	Provide flows to promote large bodied endangered species colonisation	Promote Macquarie perch spawning	Spring			0.5m increase in stage height over one week			2014

Flow Component	Ecological Value	Ecological Objectives	Functional Watering Objectives	Season	Flow (ML/day)					Report
					Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	
Fresh	Native fish	Provide cues for spawning and migration for flood specialist native fish	Maintain macroinvertebrate habitat (e.g. snags) by mobilising fine sediments and biofilms, replenishing slackwater habitat	Winter Spring				5,000 – 7,000 Up to 14 days (winter/ spring)	5,000 – 7,000 Up to 14 days (winter/ spring)	2018 (Cottingham et al)
Fresh	Native fish	Initiate spawning, pre-spawning migrations and recruitment of native fish	Maintain aquatic macrophytes, macroinvertebrate and fish habitat (e.g. snags) by mobilising fine sediments, replenishing slackwater habitat	Summer	NA	NA	NA	2-4 days (summer/ autumn)	2-4 days (summer/ autumn)	2010
Fresh	Riparian vegetation	Remove terrestrial vegetation and re-establish amphibious vegetation	Provide carbon (e.g. leaf litter) to the channel, inundate bench habitats to encourage germination	Winter Spring Summer/ Autumn				6,600 ML/day 14 days (winter/ spring) 2-4 days summer/ autumn 1 – 4 events	6,600 ML/day 14 days (winter/ spring) 2-4 days summer/ autumn 1 – 4 events	2010
Bankfull	Geomorphology	Maintain channel form and key habitats (including in channel benches)		Winter Spring	7,000-9,000 2 days					2014
Bankfull	Geomorphology / habitat diversity Native Fish Riparian vegetation Macroinvertebrates	Maintain bed diversity Provide flows to increase native fish recruitment and colonisation Provide periodic regeneration	• overturn bed substrate • maintain channel form and key habitats • maintain riffle habitat for macroinvertebrates	Winter Spring	11,000 1-4 days	11,000 1-4 days	12,000 – 13,000 2 days			2014

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Flow Component	Ecological Value	Ecological Objectives	Functional Watering Objectives	Season	Flow (ML/day)					Report
					Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	
		opportunities for native riparian species Retain natural seasonality for macroinvertebrate life stages	• maintain or increase connection to warmer water • maintain channel connectivity to tributaries							
Bankfull	Geomorphology Native fish Native vegetation	Maintain bed diversity Provide periodic opportunities for regeneration of riparian and floodplain species and improve in channel carbon availability Retain natural seasonality to ensure synchronicity of life cycle of macroinvertebrates	• overturn of bed substrate • scour sediments from base of pools to maintain quantity and quality of habitat • maintain channel and inlet for connectivity to main channel with floodplain and wetlands • promote colonisation by large bodied endangered species provision of lateral connectivity for habitat and production	Spring and Autumn			14,000 1-4 days			2014
Overbank	Geomorphology Native fish Riparian vegetation Macroinvertebrates	Maintain channel form Maintain connectivity to floodplain and wetlands Provide floodplain connection for	• maintain diversity among low lying wetlands • promote colonisation by large bodied endangered species	Winter Spring	15,000 - 20,000 1-4 days	15,000 – 20,000 1-4 days	15,000 - 20,000 1-4 days			2014

Flow Component	Ecological Value	Ecological Objectives	Functional Watering Objectives	Season	Flow (ML/day)					Report
					Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	
		exchange of organic matter Provide periodic regeneration opportunities for native floodplain wetland plants	• overturn of bed material and maintain benches • improve in channel carbon availability • provide lateral connectivity as habitat and recruitment areas for native fish							
Overbank	Floodplain and wetland vegetation	Increase the extent and diversity of flood dependent vegetation communities	• provide habitat for wetland specialist fish • exchange of food and organic material between the floodplain and channel • increase breeding and feeding opportunities for native fish, waterbirds and amphibians	Winter Spring				25,000 5+ days 2-3 events in a year 7-10 event years in10	NA	2011
Overbank	Floodplain and wetland vegetation higher in the landscape	Increase the extent and diversity of flood dependent vegetation communities	• provide habitat for wetland specialist fish • exchange of food and organic material between the floodplain and channel • increase breeding and feeding opportunities for native fish,	Winter Spring				40,000 4+ day 1-2 events in a year 4-6 event years in 10	NA	2011

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Flow Component	Ecological Value	Ecological Objectives	Functional Watering Objectives	Season	Flow (ML/day)					Report
					Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	
			waterbirds and amphibians							
Rate of flow rise	Native fish and macroinvertebrates	Reduce displacement of macroinvertebrates and small/juvenile fish		All year	Max rate 2.0 (i.e. 2 times previous days flow) for flows from 1,000-5,000 ML/d 2.7 times previous days flow for flows above 5,000 ML/d	NA	NA	Max rate of 0.38/0.38/ 1.20/0.80 metres river height in summer/ autumn/ winter/ spring	NA	2014 2007
Rate of flow fall	Geomorphology, native fish and macroinvertebrates	Reduce bank slumping/erosion and stranding of macroinvertebrates and small/juvenile fish		All year	Max rate 0.8 of previous days flow	NA	NA	Max rate of 0.15/0.15/ 0.78/0.72 metres river height in summer/ autumn/ winter/ spring	NA	2014 2007
Cease to flow	Wetland vegetation	Maintain appropriate vegetation in low lying connected wetlands		Summer Autumn Winter				150 days with flows below cease to flow levels on an annual or biennial frequency	150 days with flows below cease to flow levels on an annual or biennial frequency	2018