



Seasonal Watering Proposal for the Wimmera River System 2018-19

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Wimmera CMA

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the Wimmera River System –
2018-2019*

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Wimmera Catchment
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Executive summary

A number of significant outcomes have been achieved during the 2017-2018 watering year including:

- finding the presence of platypus DNA in water samples taken below Dad and Dave Weir on the MacKenzie River providing the first reliable evidence of platypus in this reach since they were lost in the Millennium Drought. A community sighting registered on platypusSPOT has also corroborated this finding. Fish monitoring has also showed that River Blackfish have begun to recolonise this reach;
- significant increases in small-bodied native fish in the Burnt Creek, Mt William Creek and MacKenzie River in particular Southern Pygmy Perch and Obscure Galaxias;
- quantifying the socio-economic benefits provided by the Wimmera River along with a series of other regional waterways in 2016-17 (Street Ryan, 2018). It illustrated the enormous benefits the Wimmera River provides, including an annual \$4.75 million contribution to the regional economy;
- first delivery of the Commonwealth Environmental Water; and
- increased cultural knowledge and engagement through the *River Yarns project* on the Wimmera River.

Collectively we have been able to clearly demonstrate the important shared benefits that environmental water creates.

This proposal is for the use of available water in the Wimmera Catchment to maximise environmental water related outcomes in 2018-19 and build on the momentum from 2017-2018. The proposal focuses on the regulated waterways of the lower Wimmera River, Burnt Creek, MacKenzie River, Bungalally Creek and Mt William Creek. The delivery of environmental water to these waterways is intended to support the environmental assets within these waterways such as riparian vegetation, iconic Freshwater Catfish and Platypus populations, locally vulnerable Southern Pygmy Perch and River Blackfish populations and threatened species such as Glenelg Spiny Crayfish, Western Swamp Crayfish and Regent Parrot. These waterways also contain many shared benefits including important cultural heritage sites, provide water for agriculture and public open spaces and sustains a variety of recreational activities such as fishing, swimming, boating and camping.

Conditions in spring 2017 through to autumn 2018 returned to extremely dry, with the area east of the Grampians in particular receiving limited rainfall and almost no runoff. The dry conditions led to allocations for the Victorian Environmental Water Holder only reaching 81% in April 2018 and so water carried over from 2016-17 was vital for achieving outcomes in 2017-18. Environmental water releases in recent months have capitalised on the gains achieved by the floods and significant unregulated flows in winter/spring 2016. They have been particularly important in summer/autumn 2017/18 given the very dry and hot conditions experienced.

This proposal outlines the range of proposed environmental watering actions for the Wimmera River system for the 2018-19 water year. The focus for 2018-19 is to continue to pursue vegetation and fish objectives by implementing baseflows and freshes. Fish objectives are achieved by providing baseflows throughout the year as well as spring/summer freshes to stimulate native fish breeding, provide opportunities for movement and increase available habitat. Vegetation objectives are provided by implementing baseflows to maintain edge habitats and freshes to maintain existing plants, promote the establishment of new seed/plants in the growing season and maintain and encourage germination of aquatic plants. For the Wimmera River it is very important to provide baseflows throughout the year to ensure adequate water quality through keeping salinity and dissolved oxygen concentrations at acceptable levels. This in turn reduces the likelihood of fish kills, algae blooms and die back of fringing vegetation.

Environmental water will be adaptively managed as environmental conditions unfold throughout the year. Four management scenarios have been developed to cover the range of possible conditions. These scenarios and associated watering actions are outlined in Table 16.

A wide variety of shared benefits will be provided by environmental watering actions, including potential watering for cultural outcomes at The Ranch in Dimboola as well as the recreational activities the Wimmera River provides that lead to enormous positive economic and health outcomes for the region.

Table of Contents

Executive summary	4
1. Introduction	7
1.2 Purpose	7
1.3 System Overview	7
1.4 Flow Regime	8
1.5 Priority reaches and measuring points	8
1.7 Water sources	10
2. Engagement	10
3. Shared Benefits	11
3.1 Community Values	11
3.2 Aboriginal Cultural Values.....	11
4 Flow objectives and recommendations	14
5 Seasonal review	16
5.1 Climatic conditions this year and seasonal outlook.....	16
5.2 Review of 2017-18 watering, ecological observations and monitoring	17
5.3 Wimmera River summary	18
5.4 MacKenzie River summary	24
5.5 Burnt Creek summary.....	29
5.6 Bungalally Creek summary	33
5.7 Mt William Creek summary	33
6 2018-19 Priority watering actions	37
6.1 Wimmera River Reach 4 Priority Watering Actions	37
6.2 MacKenzie River Reach 3 Priority Watering Actions.....	37
6.3 MacKenzie River Reach 2 Priority Watering Actions.....	38
6.4 Upper Burnt Creek Priority Watering Actions.....	38
6.5 Lower Burnt Creek Priority Watering Actions.....	38
6.6 Bungalally Creek Priority Watering Actions	38
6.7 Upper Mt William Creek Priority Watering Actions	39
6.8 Lower Mt William Creek Priority Watering Actions	39
6.9 Dock Lake Priority Watering Actions	40

7	Scenario Planning	41
8	Delivery Constraints	43
9	Increasing Knowledge	43
10	Risk Management.....	44
11	Approval and endorsement	48
12	References	49
	Appendix 1: Media Information Regarding Environmental Water Releases	51
	Appendix 2: Environmental Flow Recommendations.....	52
	Appendix 3: Flow components that have been delivered from 2005 to 2018.	61
	Appendix 4: Priority Watering Actions	63



Burnt Creek near Zippels Road, Wonwondah North – April 2018

1. Introduction

1.1 Background

Environmental entitlements are available to be released from storages when needed and delivered to waterways to protect or enhance their environmental values and health and they also lead to a number of broader benefits as well. In the Wimmera, environmental entitlements are held by the Victorian Environmental Water Holder (VEWH) and the Commonwealth Environmental Water Holder (CEWH). The Wimmera Catchment Management Authority (Wimmera CMA) is responsible for ensuring environmental water is delivered to streams and wetlands in its region through developing and submitting seasonal watering proposals to the VEWH for consideration, and managing the delivery of environmental water in accordance with the VEWH's seasonal watering statements and agreements with the CEWH.

The VEWH prepares a statewide seasonal watering plan each water (financial) year. The plan describes the desired environmental water use for rivers and wetlands across Victoria in the coming year, based on seasonal watering proposals submitted by CMAs and Melbourne Water. The VEWH then prepares seasonal watering statements that authorise CMAs and Melbourne Water to undertake the agreed watering activities. As more environmental water becomes available during the season the VEWH may prepare additional seasonal watering statements.

In late 2017 Wimmera CMA, VEWH and CEWH developed a partnership agreement under which Wimmera CMA could use CEWH allocations in conjunction with VEWH allocations to meet environmental watering objectives.

1.2 Purpose

The purpose of the Seasonal Watering Proposal for the Wimmera System is to:

- identify the environmental water requirements of the lower Wimmera River, MacKenzie River, Burnt Creek, Mt William Creek and Bungalally Creek in the coming year under a range of climatic scenarios to protect or improve its environmental values and health;
- inform the development of environmental water priorities in the VEWH's seasonal watering plan; and
- Inform the development of CEWH plans for its portfolio management in 2018-19.

The proposal is informed by scientific studies and reports that identify the flow regimes required to meet the ecological objectives of the priority waterways. This proposal was prepared in consultation with key stakeholders and partners and has been approved by the Wimmera CMA. It is required under section 192A of the *Water Act 1989*.

1.3 System Overview

Located in western Victoria, the Wimmera River has a total catchment area of 24,011 km². Regulated waterways within the Wimmera River catchment include the lower Wimmera River, MacKenzie River, Burnt Creek, Mt William Creek and Bungalally Creek. A portion of flow in the Wimmera River also flows up the Yarriambiack Creek – a distributary creek. Refer to Figure 1 for the location of these waterways. Stretches of the Wimmera River and MacKenzie Rivers have been reserved as National Park, State Park and Natural Features Reserves. Sections of the lower Wimmera River are listed under the *Heritage Rivers Act 1992*.

These waterways support a diverse and abundant native fish community including Freshwater Catfish, River Blackfish, Southern Pygmy Perch, Australian Smelt, Flat-headed Gudgeon, Common Galaxias, Carp Gudgeon, Obscure Galaxias, Murray Cod, Golden Perch and Silver Perch. The associated floodplain habitats support largely Red Gum-dominated grassy woodland communities, and numerous threatened species of state and national conservation. The waterways and associated and floodplain habitats also contain many important cultural heritage sites, provide water for agriculture and public open spaces, and support a variety of recreational activities such as fishing and bushwalking. More detail around the Wimmera River system is available in the *Wimmera River System Environmental Water Management Plan* (Wimmera CMA, 2015).

1.4 Flow Regime

The Wimmera River, MacKenzie River, Burnt Creek, lower Mt William Creek and Bungalally Creek have been regulated for decades, significantly altering their flow regimes. Under natural conditions these waterways would have received much greater flows, particularly during winter/spring. They have been further modified due to processes like channel incision, infilling of deep pools with sediment and dryland salinity which means that releasing environmental water is vital for retaining their values. More detail around the flow regime is available in the *Wimmera River System Environmental Water Management Plan* (Wimmera CMA, 2016).

1.5 Priority reaches and measuring points

Environmental flow recommendations for waterways in the Wimmera Catchment were initially developed in 2003 and revised in 2013 to provide more relevant environmental objectives that were endorsed by a community advisory group and considered new knowledge obtained after drought and floods. These recommendations also included adaptable components based on different climatic conditions (drought, dry, average and wet). Flow recommendations for upper Mt William Creek are based on work completed in 2005 (SKM 2005). To facilitate the flow determination process the waterways were divided into reaches with similar channel morphology, flow regimes and ecological values (Figure 1). Refer to the table below for the priority waterway reaches, compliance monitoring points, flow recommendations and report references.

Table 1. Summary of waterway reaches, compliance points and flow study reference.

Waterway reach	Compliance point	Key ecological values identified	FLAWS Study
Lower Wimmera River Reach 2	Horsham 415200	Contains a self-sustaining population of Freshwater Catfish. Golden Perch and Silver Perch are also present (stocked). High quality macroinvertebrate population within well-vegetated sections. Supports abundant native fish, waterbirds, turtle, frog and rakali populations.	Alluvium 2013
Lower Wimmera River Reach 3			Alluvium 2013
Lower Wimmera River Reach 4			Alluvium 2013
Lower Burnt Creek	No current compliance point	Contains sections of valuable riparian vegetation which provides important habitat connectivity for terrestrial and aquatic species. Recent fish monitoring indicates that high value fish species are present which warrants a review of management objectives and flow recommendations.	Alluvium 2013
Upper Burnt Creek	East Wonondah 415223	Very high variety and proportion of native fish including River Blackfish, Southern Pygmy Perch, Obscure Galaxias. Key location for Southern Pygmy Perch and Obscure Galaxias breeding. Contain a regionally vulnerable Western Swamp Crayfish population. High quality macroinvertebrate population within well vegetation sections.	Alluvium 2013
Upper Mt William Creek	None applicable	Very high proportion of native fish including River Blackfish, Southern Pygmy Perch, Obscure Galaxias. Key location for breeding Southern Pygmy Perch, River Blackfish and Obscure Galaxias. Contain a regionally vulnerable Western Swamp Crayfish population (Ecology Australia, 2017b). Good quality vegetation within National park boundaries with remnant vegetation along the rest of the waterway.	SKM 2005
Lower Mt William Creek	Lake Lonsdale tail gauge 415203		Alluvium 2013
Bungalally Creek	No current compliance point	Contains sections of valuable riparian vegetation which provides important habitat connectivity for terrestrial and aquatic species.	Alluvium 2013
MacKenzie River Reach 1	No current compliance point	Regionally valuable Platypus population which has shown evidence of breeding. Very high proportion of native fish including River Blackfish, Southern Pygmy Perch and Obscure Galaxias. Contain a regionally vulnerable Glenelg Spiny Crayfish population (Ecology Australia, 2017b). Good quality vegetation within national park boundaries with remnant vegetation along the rest of the waterway. Excellent quality macroinvertebrate population.	Alluvium 2013
MacKenzie River Reach 2			
MacKenzie River Reach 3	McKenzie Creek Reserve 415251	Contains sections of valuable riparian vegetation which provides important habitat connectivity for terrestrial and aquatic species. Also contains good populations of Obscure Galaxias and Southern Pygmy Perch when it contains water.	Alluvium 2013

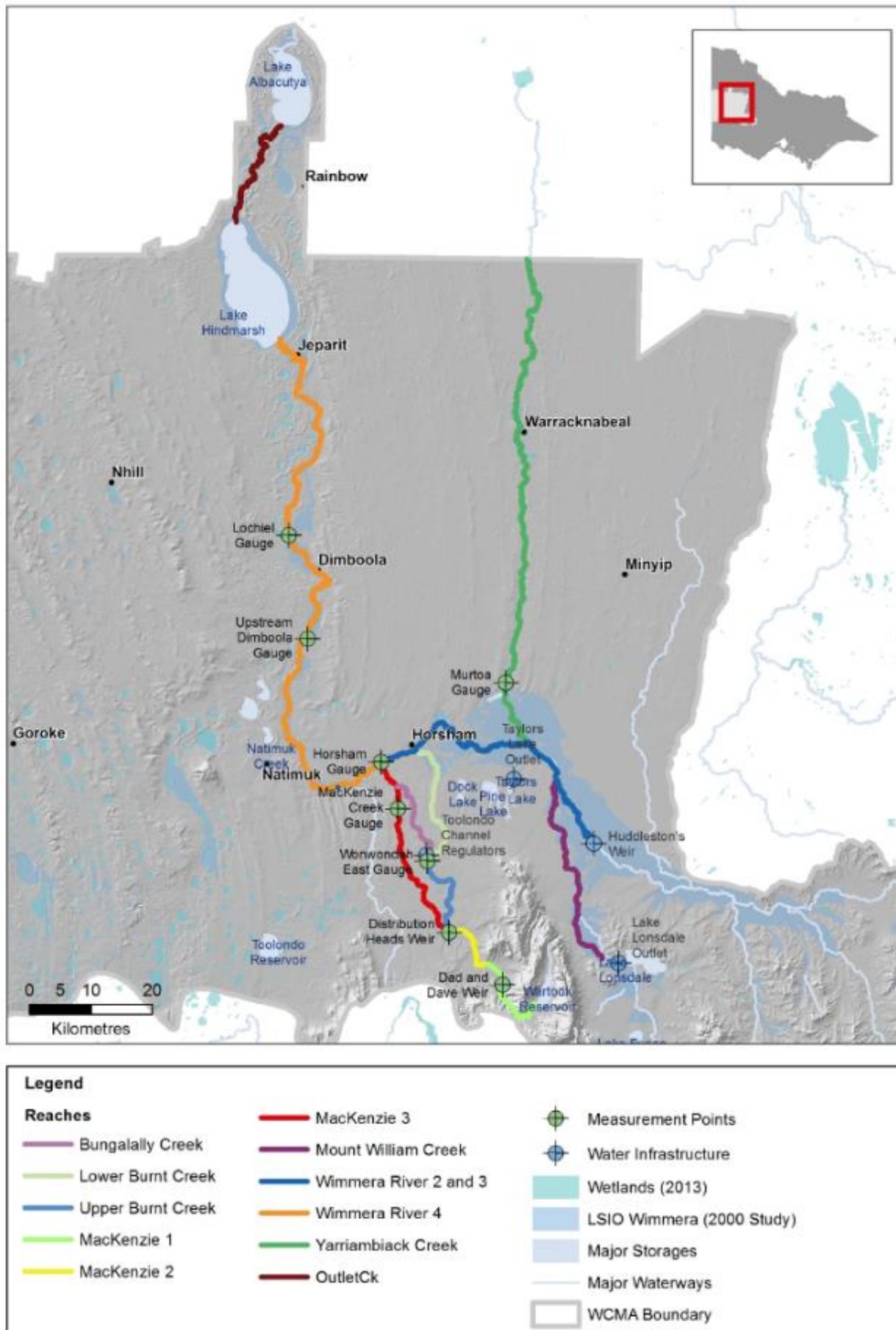


Figure 1. Wimmera system reaches, measurement points and target locations.

1.7 Water sources

Water available for use in the lower Wimmera River, MacKenzie River, Burnt Creek, Mt William Creek and Bungalally Creek include:

- regulated environmental entitlements held by the VEW and the CEWH
- unregulated flows; and
- passing flow requirements as detailed in Table 1 in Schedule 1 of the *Wimmera and Glenelg Rivers Environmental Entitlement*.

In addition to these sources there are periodic transfers between headworks storages which provide environmental benefits.

Table 2. Environmental water volumes required at compliance to deliver priority watering actions and forecast allocation for 2018/19 water year under a range of climatic scenarios.

WIMMERA REGULATED WATERWAYS Inflow Probability of Exceedance (likelihood of inflows being more than % indicated)	EXTREME DROUGHT 95%	VERY DRY 90%	DRY 75%	AVERAGE 50%	WET 20%
Environmental water required to deliver Tier 1 priority watering actions (ML) for the Wimmera System	24,295	24,450	25,675	27,970	29,445
Forecast carryover (ML) to share between the Wimmera and Glenelg Systems	35,000				
Forecast carryover (ML) for the Wimmera System	7,200				
Current forecast environmental allocation (ML) for the Wimmera and Glenelg Systems in October 2018 (not including Glenelg compensation flow)	33,067	56,396	65,725	75,053	82,760

2. Engagement

In developing this proposal, consultation with key stakeholders is summarised in Table 3. In addition to consultation listed in Table 3 the Wimmera CMA have had regular discussions with stakeholders and community members including recreational users during the implementation of water releases.

Day-to-day environmental release operations are communicated to the public via a registered SMS service. Quarterly media updates have been published in local newspapers, on the Wimmera CMA website and on social media to update the community regarding environmental releases planned and delivered, fish and vegetation survey results and water quality results. Examples of media updates developed are included in Appendix 1. Table 3 outlines consultation and engagement undertaken as part of environmental water management for the Wimmera River system.

Throughout the year the Wimmera CMA have undertaken a number of activities to engage with the community about the environmental watering program, including;

- Environmental Water Management Forum (September 2017), Wimmera CMA invited agency and community representatives to attend an information night at Sylvania Park, Drung Drung. A key feature was the launch of the findings from the socio-economic study into Wimmera waterways by Wayne Street from Street Ryan. An additional presentation was made regarding environmental water delivered and planned, recent monitoring results, current conditions and environmental water availability. Feedback was requested from all groups and agencies with an interest in environmental water in the region around the effectiveness of watering actions and other learnings;
- The Wimmera CMA held a community education event during the Horsham Fishing Competition in March 2018. Wild Action Zoo owner and TV celebrity Chris Humfrey presented a number of native animals that depend on waterways to survive. This session entertained and educated the community about the importance of environmental water releases to support our native plants and animals;
- There was the launch of *The Wimmera...a flowing fish tale* – a short film narrated by Rex Hunt and included local anglers that highlighted the great angling opportunities that the Wimmera River affords thanks to water for the environment. It has received over 11,000 views and was widely shared via social media by those in the region; and
- The development of a new page on the Wimmera CMA website enabling community members to see real-time flow and water quality data as well as updates on environmental watering activities.

Further events are planned in 2018, including a breakfast seminar series associated with World Environment Day in June.

3. Shared Benefits

3.1 Community Values

During dry years, such as much of 2017-18, environmental water releases can make up 100% of flow in some regulated waterways. Without environmental water releases there would have been greater loss of habitat as many waterways dried out completely. During dry and drought climatic conditions, environmental flows play a critical role in providing social and recreational benefits for regulated waterways. Events that have directly benefitted from environmental water releases for the Wimmera River in the past include;

- Water skiing at the Horsham and Dimboola weir pools including for the Kanamaroo Festival (Horsham) and inaugural Peter Taylor Barefoot Waterski Memorial Tournament (Dimboola);
- Rowing at Horsham and Dimboola, including the Dimboola Rowing Regatta;
- Horsham Dragon Boat Regatta;
- Horsham Triathlon; and
- The Horsham, Dimboola and Jeparit fishing competitions.

A landmark study was undertaken by Street Ryan in 2017 to quantify the socio-economic benefits provided by the Wimmera River along with a series of other regional waterways in 2016-17 (Street Ryan, 2018). It illustrated the enormous benefits the Wimmera River provided that year. Highlights include:

- \$4.75 million regional economic contribution;
- \$2.5 million mental and physical health benefits; and
- Residents who used the Wimmera River exceeded Australian Government guidelines for physical activity.

The Wimmera CMA will continue to actively support community events including the ones listed previously by consulting with local community groups around environmental water releases and where possible supporting them with environmental water releases where this aligns with environmental objectives and environmental outcomes are not compromised. The benefits for the community along the Wimmera River system since the return of regular flows in 2010 have been enormous through increased recreation opportunities and tourism as well as the sense of wellbeing that comes through seeing water in a waterway and the life it brings.





Other waterways (MacKenzie River, Burnt Creek, Mt William Creek) are valued for angling opportunities albeit not to the same degree as the Wimmera River. Dadswell's Bridge has a walking track featuring the Mt William Creek. Dock Lake is also a renowned bird watching site when it contains water.



3.2 Aboriginal Cultural Values

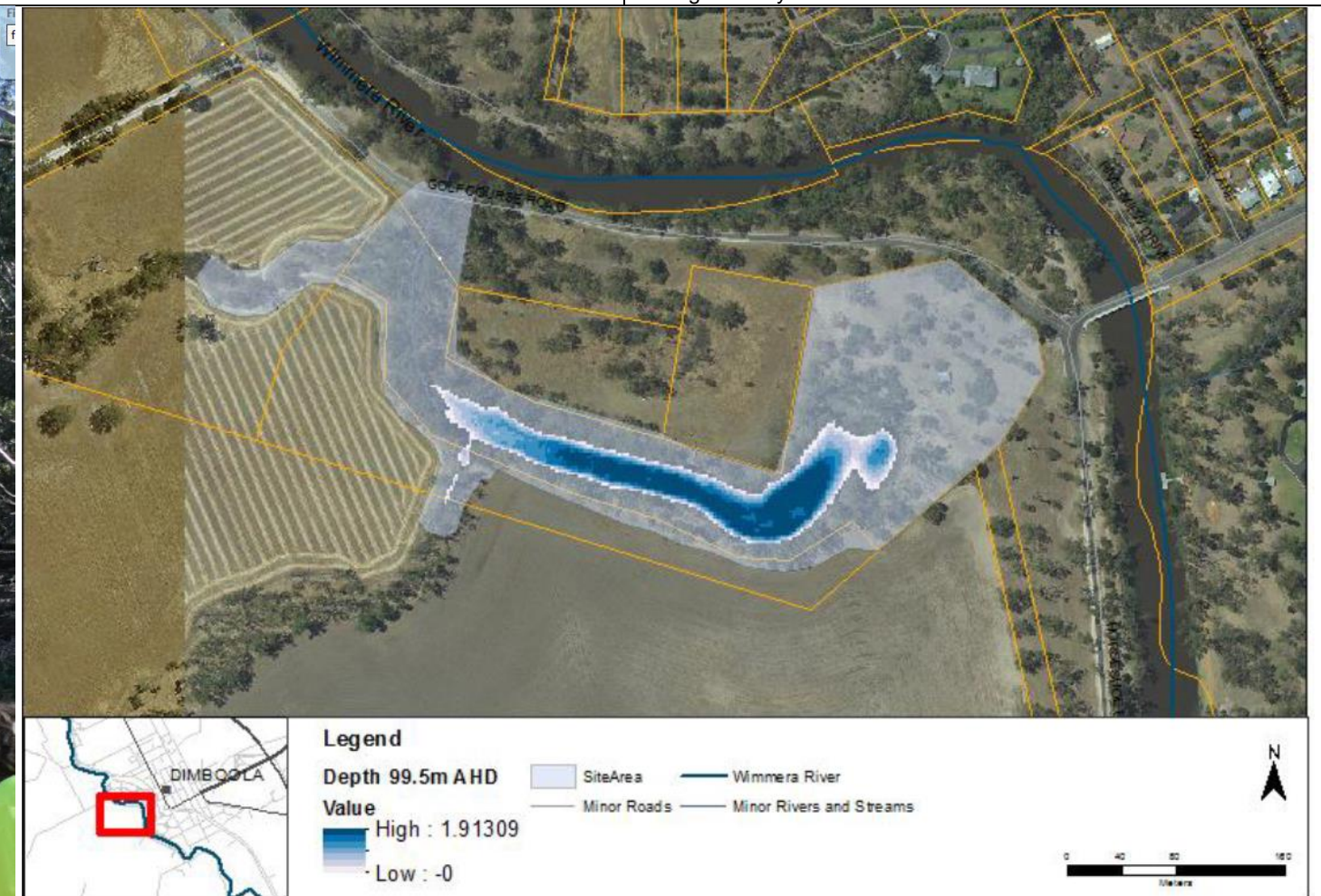
The *River Yarns* project involved members of the local indigenous community visiting sites of cultural significance along the Wimmera River from Horsham to Lake Albury in March 2017 and completing Aboriginal Waterway Assessments (AWAs). One location where AWAs were completed was The Ranch, located across the Wimmera River from Dimboola township. A key feature of this site is a billabong which is currently connected to the Wimmera River channel by a culvert managed by Hindmarsh Shire Council (Walker, 2017). The culvert is partially blocked and would only be able to receive flows when the Wimmera River is in flood.

There is a desire to restore a natural flooding regime to the billabong system and restoring indigenous plant and animal habitats, with particular attention to controlling priority weeds (BGLC, 2017) and also improve the site's amenity and suitability for gatherings and events such as earth oven and bark canoe re-creations (Ben Muir, Wimmera CMA, *pers. comm.*). The most feasible option for this would be the use of a pump to extract water from the main river channel into the billabong and an approximate volume of 12 ML would be required to fill it to a suitable level (not including seepage and evaporation losses) (Walker, 2017). Therefore should there resources and approvals be provided for a trial pumping exercise in 2018-19 it would in all likelihood involve the extraction of environmental water provided to the Wimmera River. Wetland vegetation such as Common Sneezeweed have been observed at the billabong and would benefit from a wetting/drying regime.

Table 3. Consultation undertaken regarding environmental water management for the Wimmera River System.

Who		Purpose of consultation	Form and timing of consultation	Issues identified/comments
Wimmera CMA	Wimmera CMA Board	Informing the Board regarding actions and communication approaches.	Monthly updates of EWR actions in Board reports. Approval of Seasonal Watering Proposal	Nil
 Program Partners	VEWH	Involve VEWB in development of proposal to assist with aligning document with VEWB requirements	Direct engagement and via formal advisory groups (meetings between Glenelg Hopkins CMA, GWMWater, Wimmera CMA & VEWB, throughout the year such as during Storage Manager Reference Group and Western Rivers Advisory Group).	Discussion of the likely seasonal forecast for environmental water allocation, priority watering actions for a range of environmental allocations and risk management issues.
	Glenelg Hopkins CMA	Ensuring a common approach around scenario planning		
	GWMWater	Consult with storage manager to identify operational issues with proposed releases and likely resource availability under different scenarios	Direct engagement and via formal advisory groups. The WCMA are constantly consulting with GWMWater regarding the seasonal outlook, improvements to monitoring and delivery of priority watering actions through the Storage Manager Reference Group, and directly.	It is important to receive feedback on water delivery constraints, planned maintenance and upgrades etc. to inform the proposal.
	DELWP	Communicate environmental monitoring outcomes, research project outcomes and project delivery for a number of projects.	Direct engagement (periodic phone conversations).	DELWP fund a number of projects associated with environmental water delivery and engagement in the region.
	CEWH	Discuss proposed watering actions when CEWH water becomes available.	Direct engagement. (periodic phone conversations).	Need to understand local priorities to inform portfolio management and determine outcomes of watering activities.
 Councils and Agencies	Yarriambiack Shire Council	Discuss likely flow regimes for the Wimmera River and the impact this has on the Yarriambiack Creek	Direct engagement and via formal advisory groups. Attend Yarriambiack Creek Advisory Committee meetings.	See Yarriambiack Creek Advisory Committee
	Northern Grampians Shire Council	Outline planned flow regimes for the Wimmera River and Mt William Creek	Periodic contact throughout the year and via annual environmental watering forum e.g. e-mails/phone calls around Mt William Creek flows.	The impact of environmental flows on levels in Lake Lonsdale when it contains water is an ongoing concern to the council.
	Hindmarsh Shire Council	Work with council to manage weir heights to reduce losses and to improve environmental outcomes downstream. Also to communicate proposed environmental watering actions and seasonal outlook in relation to likely environmental water allocation for 2018-19.	Periodic contact throughout the year regarding weir management and via annual environmental watering forum.	Councils are very interested in environmental water allocations available and its impact on the region's economy, tourism and the environment. Also weir management for events, maintenance works etc. is an ongoing requirement.
	Horsham Rural City Council (HRCC)			
	Fisheries Victoria	Fisheries Victoria are interested in environmental watering activities to inform fish stocking.	Periodic contact throughout the year and via annual environmental watering forum.	Share information on fish population responses
	Parks Victoria	Parks Victoria are interested in monitoring outcomes and flows relating to land they manage in the Grampians and the Wimmera Heritage River sections.	Periodic contact throughout the year and via annual environmental watering forum.	Chose not to provide feedback on proposal to manage workloads for staff.
 Environmental Groups	Yarriambiack Creek Advisory Committee	Discuss likely flow regimes for the Wimmera River and the impact this has on the Yarriambiack Creek	Direct engagement and via formal advisory groups. Attend Yarriambiack Creek Advisory Committee meetings.	The committee are interested in the role of structures (e.g. bridges, culverts) on flows along the creek.
	Friends of Bungalally Creek Group	Consult with members of the group in relation to flows for Bungalally Creek.	Direct engagement. Periodic discussions with group members and attend meetings throughout the year when requested.	Keen to see more flows along the Bungalally Creek. Flows along the creek took place in spring 2017 as a result of water levels surpassing the flood target curve for Lake Wartook
 Recreational users	Lake Lonsdale Action Group	Discuss impact of releases on storage levels with respect to recreation, water quality etc.	Direct engagement and via environmental watering forum. Regular discussions with members and attend meetings throughout the year when requested.	The Lake Lonsdale Action Group want to ensure that environmental water is supplied by a series of storages to share the impacts on water levels. Cease to flow periods coincided with peak recreation period (December – January) and low flows until well after Easter.
	Field and Game Australia	Communicate proposed environmental watering actions and seasonal outlook in relation to likely environmental water allocation for 2018/2019 next watering year.	Periodic contact throughout the year.	Infrequent discussions occur to share information.
	VRFish		Periodic contact throughout the year and via annual environmental watering forum.	Infrequent discussions occur to share information.
	Natimuk Lake Water Ski Club		Periodic contact throughout the year and via annual environmental watering forum.	Wimmera CMA worked with HRCC and the ski club to temporarily raise the water levels to allow water skiing for during the Kanamaroo Festival. Following the event environmental water was released to improve the water quality downstream.
	Dimboola Water Ski Club		Periodic contact throughout the year and via annual environmental watering forum.	Ski club has been undertaking revegetation works to reduce erosion impacts of water skiing. Management of the weir pool level as been important in allowing vegetation to establish.
	Dimboola Fishing Classic		Periodic contact throughout the year and via annual environmental watering forum.	Flows have been sufficient to enable the competition to again be a success in November 2017.
	Horsham Triathlon Committee		Periodic contact throughout the year and via annual environmental watering forum.	Flows have been sufficient to enable the triathlon to again be a success in February 2018.
	Wimmera Anglers' Association		Periodic contact throughout the year and via annual environmental watering forum.	Infrequent discussions occur to share information.
	Dimboola Rowing Club		Periodic contact throughout the year and via annual environmental watering forum.	Infrequent discussions occur to share information.
	Jeparit Anglers' Club		Periodic contact throughout the year and via annual environmental watering forum.	Flows have been sufficient to enable the competition to again be a success in April 2018.
	Hindmarsh Ski Club		Periodic contact throughout the year and via annual environmental watering forum.	Infrequent discussions occur to share information.
	Horsham Fishing Competition Committee	Work closely with the committee to develop a community education event during the fishing competition highlighting the value of healthy waterways (including flows) on water-dependent fauna.	Periodic contact throughout the year and via annual environmental watering forum.	Worked with the committee to ensure the weir pool levels were suitable for the competition and flows were released after the competition.

Who		Purpose of consultation	Form and timing of consultation	Issues identified/comments
	Canoeing Victoria	Highlight the value of the Wimmera River for potential canoeing events given the positive impact of environmental watering on water levels.	One off contact via e-mail	Will consider the river as a potential event in the upcoming calendar of events
Traditional Owners 	Barengi Gadjin Land Council	Consult with the council regarding environmental water delivery and communicate likely deliveries for next season and next watering year. Obtain information around cultural values where available.	Periodic contact throughout the year and via annual environmental watering forum.	Asked to look at proposed watering at The Ranch. Interested in water regime for Lake Hindmarsh.
Landholders/ farmers 	Wimmera community members, especially landholders	Consult with community on environmental water delivery, particularly of those from storages with high recreational value, and communicate likely deliveries for next season and next watering year. Raise community awareness regarding environmental water releases.	Media releases and advertisements have been published in local newspapers and on our web site.	Important to give the community knowledge of what environmental flows are being delivered, environmental benefits recorded and provide an opportunity for discussion and feedback.
		Periodically SMSs are sent around key changes to flows	Direct engagement via SMS	Some landholders appreciate being notified of flows being released to inform stock movement. Anglers appreciate updates around freshes given they have noted fish are more active when freshes occur.



Wotjobaluk Traditional Owners completing an Aboriginal Waterway Assessment at the Ranch, March 2017 (left) and location of Ranch and Billabong with water depths at inundation level of 99.5 AHD (right) Source: Kathryn Walker.

4 Flow objectives and recommendations

Environmental Objectives

Long-term environmental objectives that form the basis of this proposal are from the *Wimmera River Environmental Flows Study* (Alluvium, 2013). These objectives were identified by the Wimmera CMA at the time in consultation with the Wimmera CMA's Rivers and Streams Advisory Group. The study outlines the flow components that are required to affect the functions and processes that contribute to the over-arching objectives for nominated environmental assets. The *Wimmera River Environmental Flows Study* supersedes the previous information contained within the *Wimmera Bulk Entitlement Conversion – Environmental Flows Study* (SKM, 2003) that had previously been the guiding document for environmental watering in the region.

This study included revised and more relevant environmental objectives, endorsed by community advisory group members and considered new knowledge obtained after drought and floods and improved understanding of waterway ecology to provide a more rigorous and adaptable set of flow recommendations for different climatic conditions (drought, dry, average and wet).

The environmental objectives and flow components for each asset are summarised in Table 4 and outlined in detail in Appendix 2. They are consistent with the *Wimmera River Environmental Flows Study* (Alluvium 2013). The exception is the upper Mt William Creek, which have been drawn from a previous study, *Environmental Recommendations for the Mt William Creek* (SKM 2005). The *Wimmera River System Environmental Water Management Plan* (Wimmera CMA, 2015) outlines in more detail the objectives, recommendations and other matters pertaining to environmental water management (e.g. system operation) in the Wimmera.

Studies providing environmental watering recommendations have also been undertaken for the Wimmera River's terminal lakes system (Ecological Associates, 2004) and Dock Lake (Jacobs, 2015). These lakes are not targeted for regulated environmental water releases but chiefly rely on passing and or unregulated flows to provide suitable inundation to achieve ecological outcomes although regulated releases are of some value for enhancing terminal lake levels (Jacobs, 2014). Although currently there is no capacity to deliver regulated flows to Yarriambiack Creek, a small percentage of flows in the Wimmera River pass into the Yarriambiack Creek. The flow requirements of Yarriambiack Creek are met by unregulated and passing flows.

Hydrological data illustrates that environmental water availability is often less than the water needed to deliver recommended flows. It should also be noted that most of the larger flow components (e.g. bankfull and overbank) cannot be delivered through regulated releases in almost all cases (see Section 8 Constraints). Other factors (e.g. prohibitive channel losses and risks around inundation private land) also make these releases unfeasible. Overbank flow recommendations will only be provided by natural events.



**Obscure Galaxias – Mt William Ck
December 2017
(Credit: Joanne Sharley, ARI)**

Table 4. Ecological objectives and flow recommendations for Wimmera Catchment waterways.

Waterway	Flow Component	Ecological Value	Ecological Objectives	Flow (ML/day)			
				Reach 1	Reach 2	Reach 3	Reach 4
Wimmera River	Baseflow	Macroinvertebrates	Provide variable flow during low flow season for macroinvertebrates (over woody debris to increase biofilm abundance as a food source). Flush surface sediments from hard substrates for macroinvertebrates. Maintain edge habitats in deep pools and runs, and shallow water habitat availability for macroinvertebrates.	NA	10-100 ML/d		15-30 ML/d
Wimmera River	Baseflow/fresh	Native fish	Maintain self-sustaining Freshwater Catfish population in the Wimmera River. Maintain endemic fish communities (provide freshes Oct-Dec to assist spawning/nesting). Restore endemic fish community diversity and abundance by providing flow variability to maintain water quality and a diversity of habitats. Provide adequate water quality/habitat for fish refuge locations in dry periods. Provide native fish passage. Provide increased flow and variability to support fish movement and diversity of habitat.	NA	10-100 ML/d (baseflow) 35 – 400 ML/d ML (fresh)		15-30 ML/d (baseflow) 70 – 200 ML/d (fresh)
Wimmera River	Baseflow/fresh	Vegetation	Maintain submerged and emergent aquatic vegetation quality, diversity and extent for fish habitat. Maintain near permanent inundated stream channel for riparian vegetation and to prevent excessive in stream terrestrial growth. Prevent terrestrialisation of the lower banks from invasive <i>phragmites</i> .	NA	10-100 ML/d (baseflow) 35 – 400 ML/d ML (fresh)		15-30 ML/d (baseflow) 70 – 200 ML/d (fresh)
MacKenzie River	Baseflow/freshes	Platypus	Sustain a platypus population and facilitate its dispersal into the Wimmera River. Provide flow variability to maintain diversity of habitat.	2-27 ML/d baseflow 5-130 ML/d fresh		10 ML/d baseflow 35-190 ML/d fresh	NA
MacKenzie River	Baseflow/freshes	Vegetation	Protect and restore riparian and floodplain EVCs. Maintain edge habitats in deeper pools and runs, and shallow water habitat availability. Maintain submerged and emergent aquatic vegetation quality, diversity and extent for fish habitat. Inundate riparian vegetation to maintain condition and facilitate recruitment.. Maintain permanent inundation of stream channel to prevent excessive in stream terrestrial species growth.	2-27 ML/d baseflow 5-130 ML/d fresh		10 ML/d baseflow 35-190 ML/d fresh	NA
MacKenzie River	Baseflow/freshes/bankfull/overbank	Macroinvertebrates	Maintain edge habitats in deeper pools and shallow water habitat availability for macroinvertebrates. Provide variable flow (freshes) during low flow season for macroinvertebrates (over wood debris to increase biofilm abundance as a food source). Flush surface sediments from hard substrates to support macroinvertebrates. Entrain organic debris in the channel to support macroinvertebrates.	2-27 ML/d baseflow 5-130 ML/d fresh, 500-900 ML/d bankfull and overbank		10 ML/d baseflow 35-190 ML/d freshes 500-1,000 ML/d bankfull and overbank flows	NA
MacKenzie River	Bankfull/overbank	Geomorphology	Maintain the structural integrity of the channel. Maintains floodplain geomorphic features.	500-900 ML/d bankfull and overbank flows		500-1,000 ML/d bankfull and overbank flows	NA
MacKenzie River	Baseflow/freshes	Native fish	Increase the baseflow water depth to provide stimulus for fish movement. Provide flow variability to maintain water quality and diversity of fish habitats.	2-27 ML/d baseflow 5-130 ML/d fresh		10 ML/d baseflow 35-190 ML/d fresh	NA
Burnt Creek	Baseflow/freshes/bankfull/overbank	Vegetation	Inundate riparian vegetation to maintain condition and facilitate recruitment. Maintain edge habitats and shallow water habitats and inundated stream channel for riparian vegetation and prevents excessive instream terrestrial growth.	Upper		Lower	
				1 ML baseflow, 30-160 ML/d fresh 400 bankfull 1,000ML/d overbank		45 ML/d bankfull 90 ML/d overbank	
Burnt Creek	Freshes	Macroinvertebrates	Entrain organic debris in the channel to support macroinvertebrates. Maintain edge habitats and shallow water habitats and shallow water habitat availability for fish and macroinvertebrates. Also flushes surface sediments from hard substrates for macroinvertebrates. Disturb the algae/bacteria/organic biofilm present on rock or wood debris to support macroinvertebrate communities.	1 ML baseflow, 30-160 ML/d fresh 400 bankfull 1,000ML/d overbank		45 ML/d bankfull 90 ML/d overbank	
Burnt Creek	Freshes	Native fish and water quality	Maintain edge habitats and shallow water habitats and shallow water habitat availability for fish. Provide variable flow for fish movement and diversity of habitat.	1 ML baseflow, 30-160 ML/d fresh		NA	
Burnt Creek	Bankfull/overbank	Geomorphic	Maintain structural integrity of channel. Maintains floodplain geomorphic features.	400 bankfull 1,000ML/d overbank		45 ML/d bankfull, 90 ML/d overbank	
Mt William Creek	Baseflow/freshes/bankfull/overbank	Geomorphic	Maintain structural integrity of channel. Maintains floodplain geomorphic features.	Upper		Lower	
				>500 ML/d bankfull/overbank		750/d ML/d bankfull 1,500 ML/d overbank	
Mt William Creek	Baseflow/freshes/bankfull/overbank	Vegetation	Maintain edge habitats and shallow water habitat availability for near-permanent inundated stream channel for riparian vegetation and prevents excessive instream terrestrial species growth. Inundate riparian and floodplain vegetation to maintain condition and facilitate recruitment.	>500 ML/d bankfull/overbank		5 ML/d baseflow 20-500 ML/d freshes 750 ML/d bankfull 1,500 ML/d overbank	
Mt William Creek	Baseflow/freshes	Native fish and water quality	Provide variable flow during low flow season for fish movement and to maintain water quality and diversity of habitat. Prevent water quality decline by flushing pools during low flows. Wet low and highest benches, entraining organic debris and promoting diversity of habitat.	>24 ML/d baseflow, >1 ML/d - > 52 ML/d fresh		5 ML/d baseflow 20-500 ML/d freshes 750 ML/d bankfull 1,500 ML/d overbank	
Mt William Creek	Baseflow/freshes/bankfull/overbank	Macroinvertebrates	Maintain edge habitats and shallow water habitat availability for macroinvertebrates. Provide variable flow during low flow season for macroinvertebrates (over wood debris to increase biofilm abundance as a food source). Flush surface sediments from hard substrates to support macroinvertebrates.	>24 ML/d baseflow, >1 ML/d - > 52 ML/d fresh		5 ML/d baseflow 20-500 ML/d freshes 750 ML/d bankfull 1,500 ML/d overbank	
Bungalally Creek	Bankfull/overbank	Vegetation	Protect and restore riparian and floodplain EVCs. Inundate riparian vegetation to maintain condition and facilitate recruitment.	60 ML/d bankfull 150 ML/d overbank			
Bungalally Creek	Bankfull/overbank	Geomorphic	Maintains the floodplain geomorphic features and the structural integrity of the channel	60 ML/d bankfull 150 ML/d overbank			

5 Seasonal review

5.1 Climatic conditions this year and seasonal outlook

Coming off the back of average conditions over summer/autumn 2016/17, winter 2017 started off in promising fashion with reasonable rainfall. However spring 2017 was very dry in the eastern portion of the catchment (upper Wimmera River and Mt William Creek) and marginally wetter in the western portion (MacKenzie River catchment) (Figure 2).

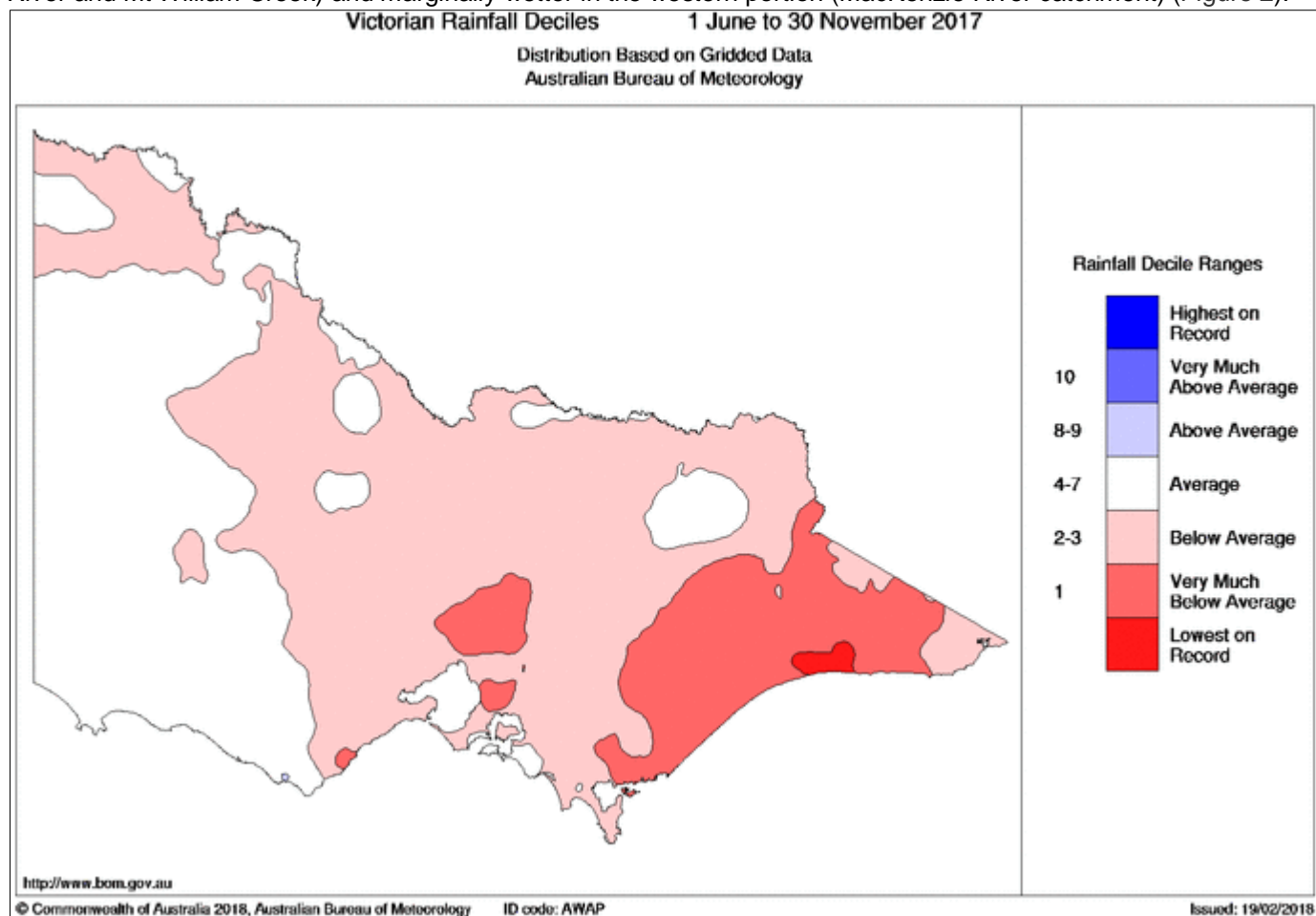


Figure 2. Bureau of Meteorology rainfall deficiencies from 1st June 2017 to 30 November 2017

<http://www.bom.gov.au/climate/drought/>.

This led to only modest rises in storage levels – mostly for reservoirs in the western section of the headworks system (Lake Wartook and Moora Moora Reservoir both filled and Rocklands Reservoir saw reasonable inflows) (Figure 3). Inflows to storages to the end of January 2018 totalled 67,250 ML which is tracking at about a 90% probability of exceedance year, which highlights the dry conditions. Therefore as of April 2018, allocations for high reliability entitlements (VEWH product for Wimmera/Glenelg Rivers) were at 81% whilst CEWH allocations remained at 0%.

The spatial discrepancy in rainfall meant that there was only very limited streamflows from the upper Wimmera River and Mt William Creek that were in turn able to be provided as passing/unregulated flows. Comparisons with 2016 (a wet year with about 30% probability of exceedance) are shown in Table 5. Although MacKenzie River at Wartook is mostly regulated by Lake Wartook upstream, there are flows due to upstream pickup and releases to meet target levels at Lake Wartook and it shows that difference in flow between years is proportionally much less than the other two locations.

Table 5. Annual streamflows for 2016 and 2017 at gauges in unregulated reaches (Mt William Ck and Wimmera River) and regulated reach (MacKenzie River)

Location	Flow 2016 (ML)	Flow 2017 (ML)	Percent of flow of 2017 cf. 2016
Mt William Creek at Mokepilly	35,022	3,614	10%
Wimmera River at Glenorchy	116,737	3,824	3%
MacKenzie River at Wartook	19,572	13,003	66%

During 2017-18, only 1,750 ML of passing flows were recorded at Huddleston's Weir and 2,078 ML at Lake Lonsdale (recorded up to end of March 2018) compared to 51,064 ML and 3,321 ML for those two locations respectively in 2016-17. Lake Wartook inflows were sufficient to require releases to adhere to the lake's filling target levels in September 2017. Taylor's Lake, which would normally receive the water was almost at capacity, therefore water was shared between the lower MacKenzie River, Burnt Creek and Bungalally Creek to provide environmental benefits and was a good outcome driven by collaboration between the Storage Manager and Wimmera CMA.

Summer 2017/18 was extremely dry and warm so there was no runoff into streams and flows were entirely due to regulated releases. Significant rainfall in autumn and winter 2018 will be required to generate runoff into waterways.

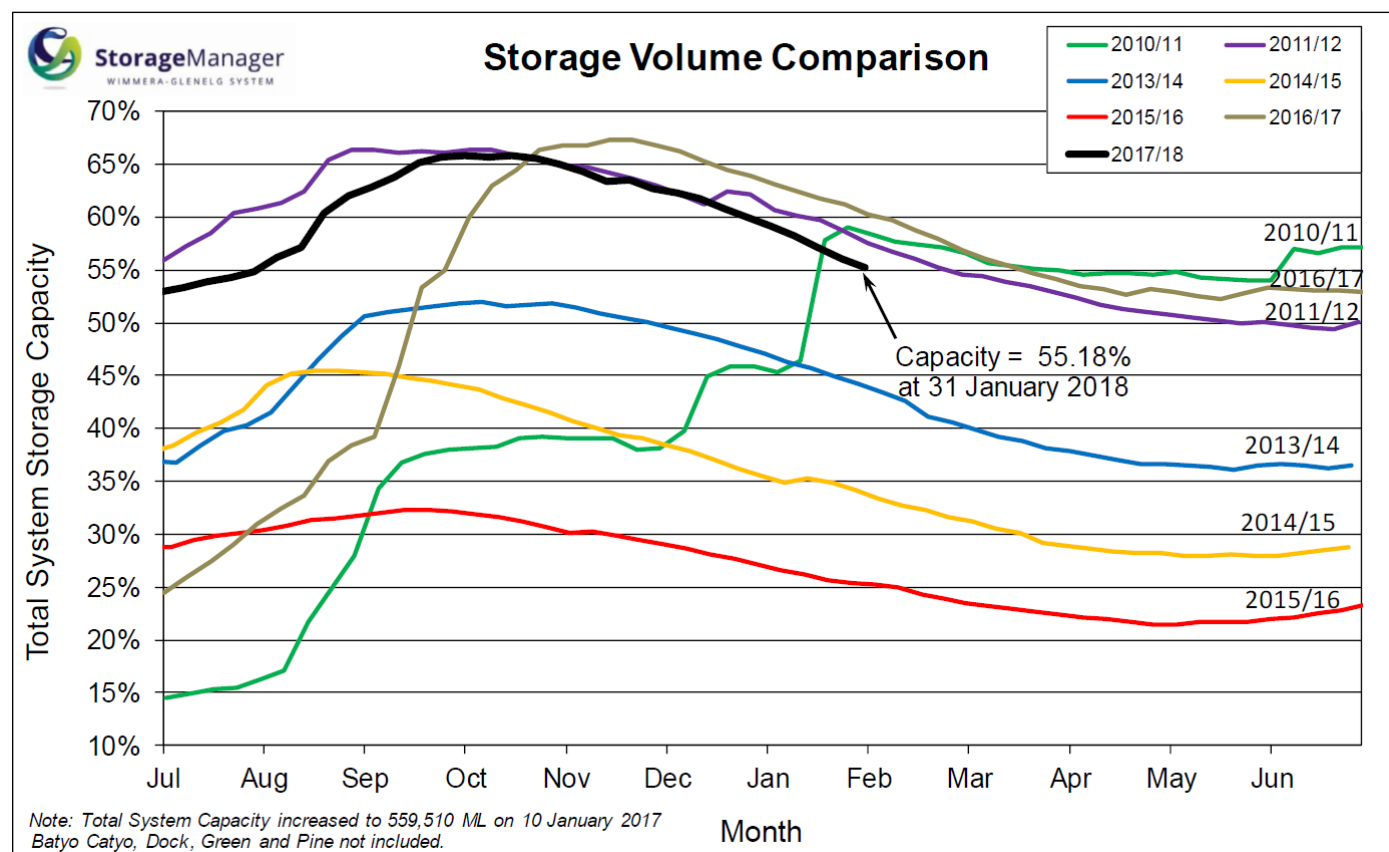


Figure 3. GWMWater storage volume comparison to end of January 2018 (GWMWater 2018).

5.2 Review of 2017-18 watering, ecological observations and monitoring

The Wimmera system's regulated environmental water usage in 2017-18 was planned to be 18,000 ML based on the volume authorised by VEW (Seasonal Watering Statement #1) to provide a proportion of baseflows and freshes for several waterways. Some unregulated flows meant that regulated releases were not required for some watering actions. Results are summarised for various waterways in Table 6. Planning through to the end of June (as of early April) indicates that approximately 17,609 ML of regulated water will be used (some of which is CEWO water).

Table 6. Summary of the environmental water delivered compared to what was authorised and required to achieve compliance of priority watering actions (PWA).

Waterway	Estimated water required to achieve PWA compliance under average scenario (ML)	Environmental Planned to be Delivered by 31 st March (ML)
Wimmera River	14,490	5240
MacKenzie River	7,230	4510
Burnt Creek	1,685	
Mt William Creek	3,875	680
Bungalally Creek	300	0
Dock Lake	400	0
Total	27,970	10,430

5.3 Wimmera River summary

The wet start to winter meant that limited releases were required, with the provision of some passing flows from Taylor's Lake (substituted from Lake Lonsdale) in early August until wet conditions returned in the middle of the month. A notable feature of Wimmera flows in winter/spring 2017 was that a large proportion of unregulated flows came from Norton Creek and other smaller tributaries downstream of Horsham rather than from the upper catchment.

When conditions began to dry out at the end of September, passing flows from Lake Lonsdale were used to provide flow components for the remainder of spring and into early summer. Then regulated releases commenced when passing flows were all used. Whilst releases ceased over Christmas/New Year's break, flows reduced to very low rates although never stopped flowing. A fresh in early in early January lifted flow rates although summer 2018 was notable for being hot and dry which led to substantial in-stream losses.

Refer to Figure below for flows measured at the Lochiel gauge, downstream of Dimboola from 1st of July 2017 until early-February. Releases are planned for the Wimmera River until the end of June (at least) from Taylors Lake and Lake Lonsdale. As shown in Table 7 and Figure environmental water releases have been important in consolidating the gains made over 2016-17 through providing summer/autumn baseflows and freshes. They have generated excellent outcomes for water quality and aquatic communities (e.g. native fish).

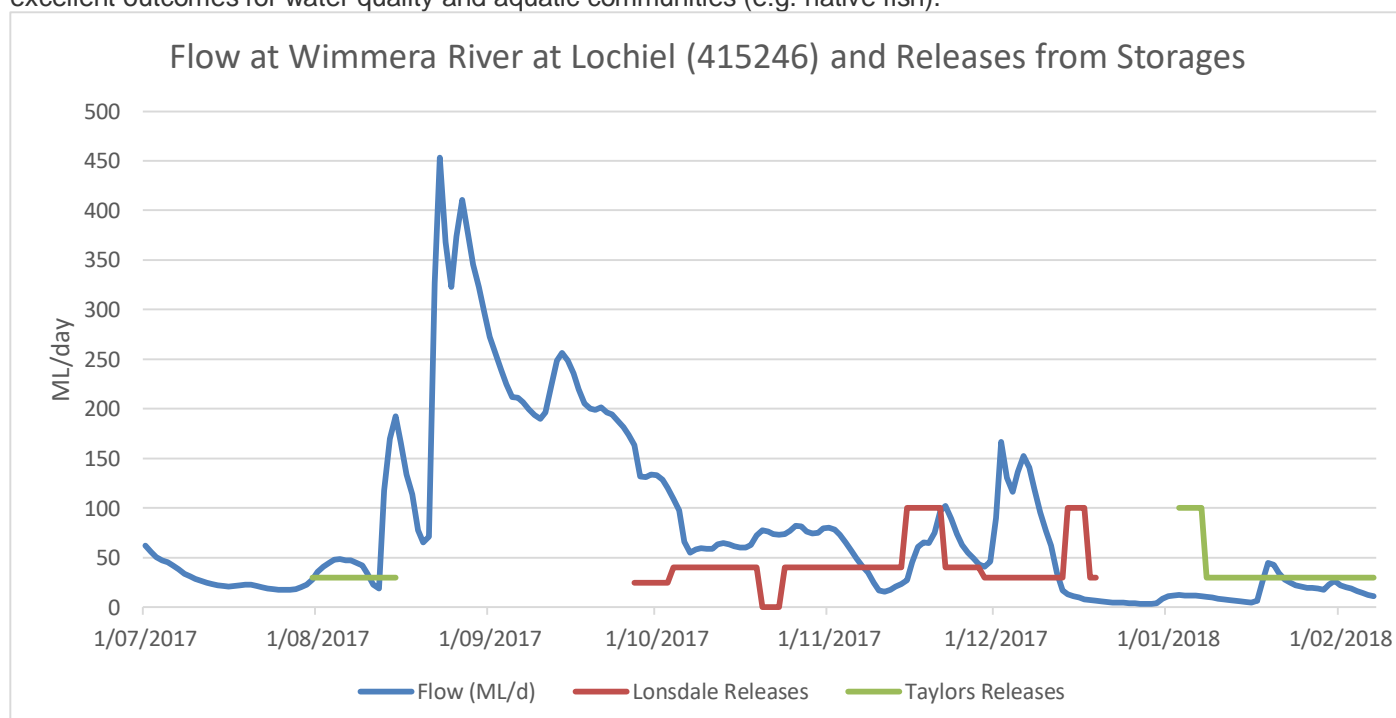


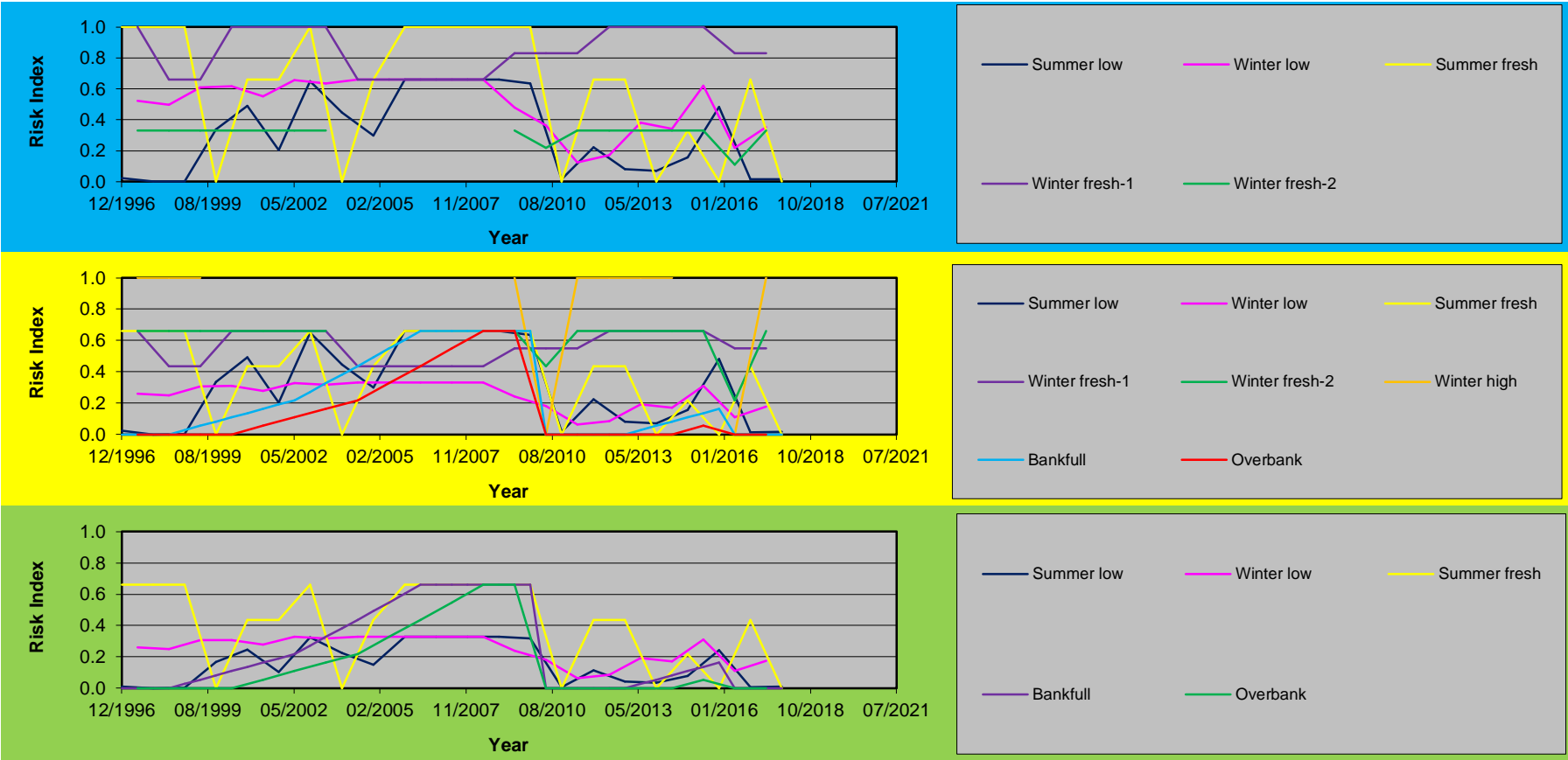
Figure 4. Flow at the Wimmera River at the Lochiel gauge (415246) July 2017 - February 2018.

Table 7. Summary of Priority Watering Actions (PWA) delivered for Reach 4 of the Wimmera River.

PWA delivered for reach 4 Wimmera River	Flow magnitude/ duration/ frequency	Comment
Winter/Spring baseflow	30 ML/d	Delivered due to a combination of unregulated, passing and regulated flows.
Summer/Autumn baseflow	15 ML/d	Regulated releases were provided to achieve this although hot, dry conditions and some minor operational issues led to some minor shortfalls.
Summer/Autumn freshes	70 ML/d 2-7 days x 3	One delivered (Dec 2017), one slightly under target (50 ML/d) in Jan 2018, another one planned for April.
Winter/Spring freshes	70 ML/d 5 days x 4	Unregulated flows mostly greater than 70 ML/d in early-mid June and from mid-August to early November
Winter/Spring freshes	200 ML/d 3 days x 3	Met naturally from unregulated flows provided freshes in mid-August, early and mid-September
Winter/Spring freshes	1,300 ML/d 3 days x 2	Unregulated flows insufficient to provide component. (Not regulated water objective unless unregulated component is large given capacity constraints)
Anytime bankfull	2,000 ML/d 2 days x 1	Unregulated flows insufficient to provide component. (Not regulated water objective)
Winter/Spring overbank	6,000 ML/d 1 day x 1	Unregulated flows insufficient to provide component. (Not regulated water objective)

Risks to ecological and physical objectives for the Wimmera River Reaches 3 and 4 are included in Tables 7 and 8 below. The results highlight a reduction in risks to all objectives brought about due to the wet conditions in winter/spring 2016, followed by environmental water releases since then, especially in relation to baseflows. However risks are still high with respect to summer/autumn freshes although they are an ongoing focus and will be delivered over the coming months as well as in 2018-19 should the water be available.

Table 8. Risk indices for Fish (blue), Macroinvertebrates (yellow), Vegetation (green), Geomorphology (grey) and Water Quality (pink) for Reach 3 of the Wimmera River.



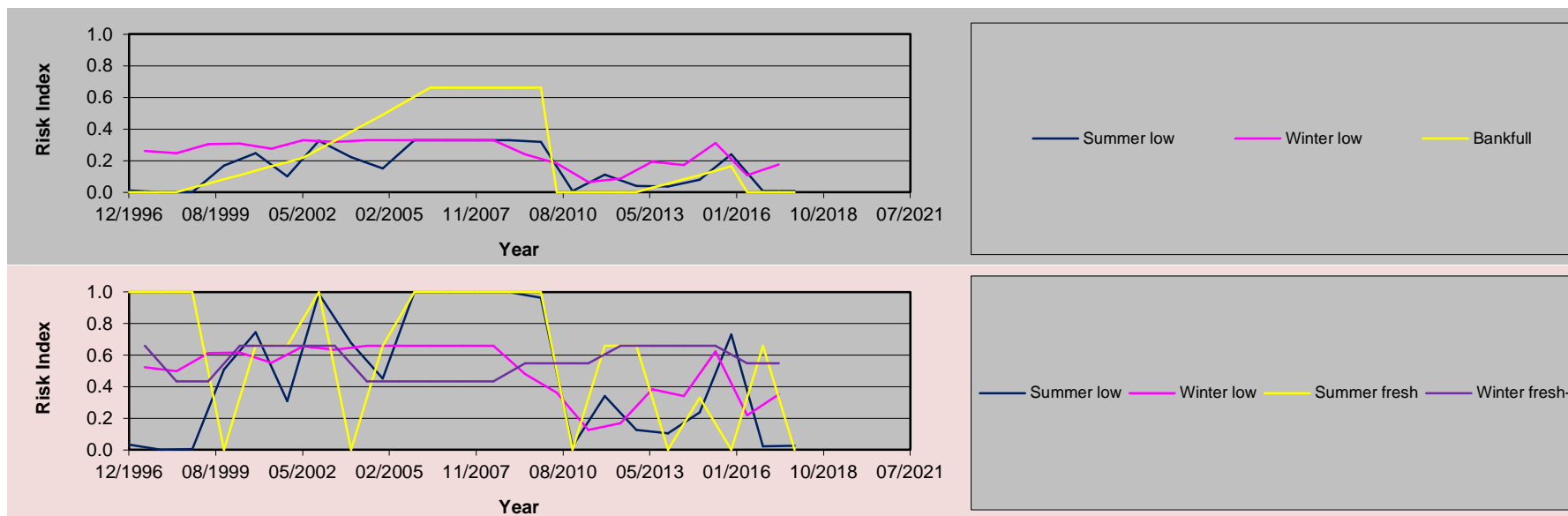
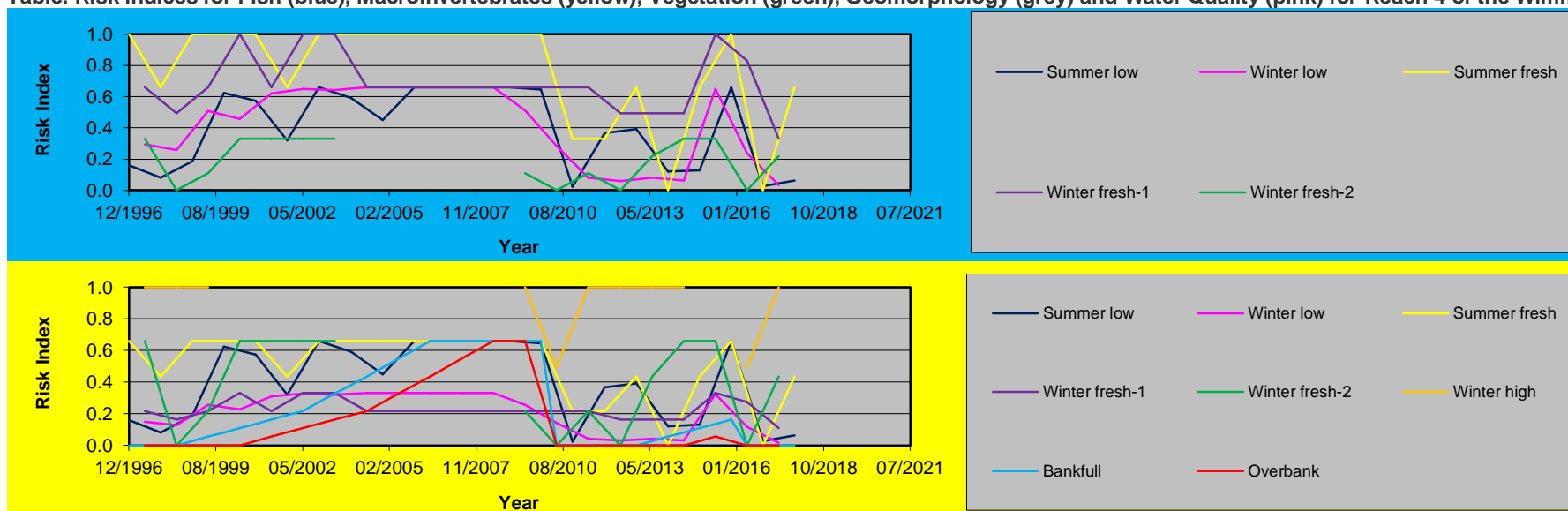
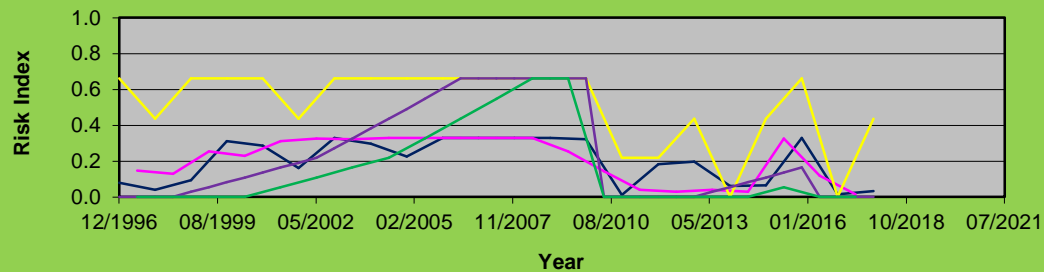


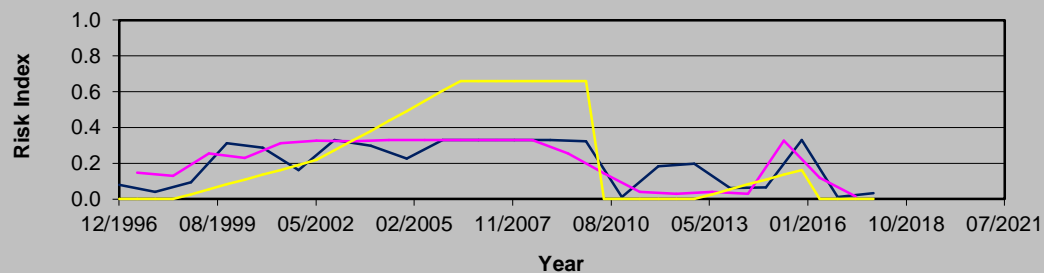
Table. Risk indices for Fish (blue), Macroinvertebrates (yellow), Vegetation (green), Geomorphology (grey) and Water Quality (pink) for Reach 4 of the Wimmera River.



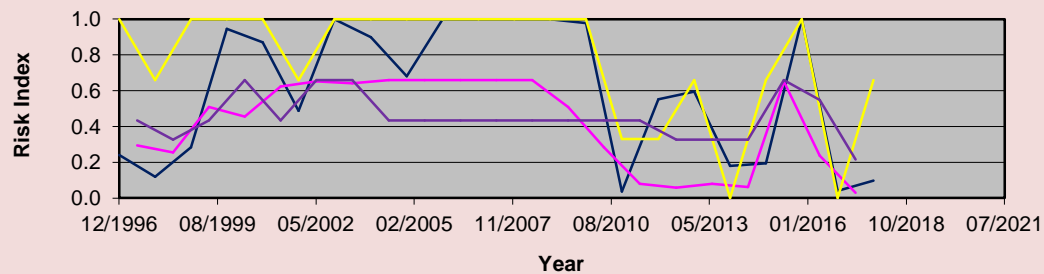


Summer low Winter low Summer fresh

Bankfull Overbank



Summer low Winter low Bankfull



Summer low Winter low Summer fresh Winter fresh-1

Salinity levels at Tarranyurk (refer to Figure) were comparatively low and much reduced compared to the peak of 45,000 $\mu\text{S}/\text{cm}$ in winter 2016 after a prolonged period of 15 months of no flow. Streamflows in winter/spring maintained salinity levels below 2,000 $\mu\text{S}/\text{cm}$. However the salinity rapidly escalated to above 10,000 $\mu\text{S}/\text{cm}$ when releases were ceased over Christmas/New Year's and flow rates dropped. However the fresh that took place in early January was able to create substantial temporary improvements in water quality.

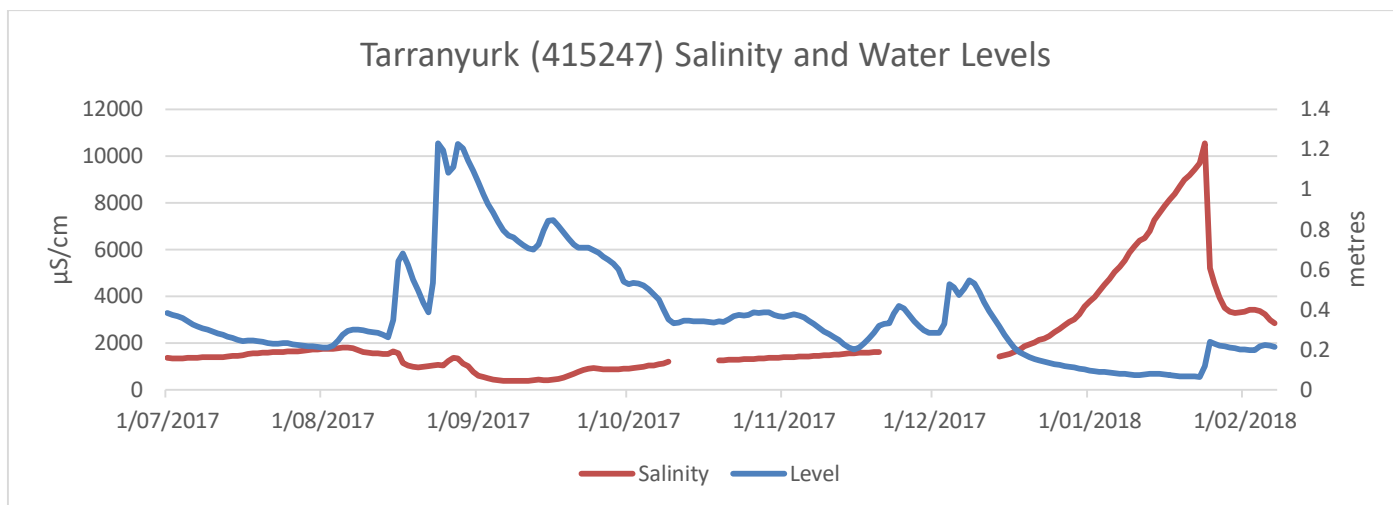


Figure 5. Tarranyurk July 2017 to February 2018 water level and salinity measurements. There have been periodic sensor malfunctions.

Wimmera River Angler Report Card Surveys

The preliminary surveys were held in March 2017 by staff from Arthur Rylah Institute (ARI) at eight sites along the Wimmera River from upstream of Horsham (Longerenong) to Jeparit using a combination of fyke nets and electrofishing. Whilst the focus was on angling species of interest (Golden Perch and Freshwater Catfish), there were observations of the small-bodied fish species that inhabit the Wimmera River. Golden Perch were captured at all sites with a variety of sizes ranging from 189g to 1804g. Only a couple of Freshwater Catfish were collected, an adult from Jeparit Weir and a juvenile from Horseshoe Bend however these numbers are similar to those caught as part of previous more comprehensive monitoring programs as Freshwater Catfish are difficult to catch in monitoring work. Whilst the 2018 survey results have not been processed yet, indications are that they are similarly positive.



Tagged Golden Perch at Wimmera River at Lower Norton, March 2018.

Wimmera Carp Monitoring Program

Austral Research and Consulting undertook an investigation into the abundance of carp in a number of sites across the Wimmera River catchment through repeated surveys from October 2016 to June 2017. Nine sites on the Wimmera River were surveyed on five occasions whilst two sites were used as control sites to compare the effectiveness of carp removal actions. The sites were grouped into 'riverine' and 'weir pool' sites given their slightly different characteristics (e.g. downstream connectivity).

Whilst the program was a drought initiative to ease the pressure on native fish and other biota confined to refuge pools, by the time it was implemented drought conditions were replaced by floods. Therefore the ability to determine the effectiveness of repeated carp removal actions was limited in the Wimmera River (although there were indications of effectiveness at other sites).

Indications from the electrofishing and eDNA monitoring were that the wet conditions in 2016 led to significant carp breeding in Lake Hindmarsh and fish were confined below Jeparit Weir. Carp breeding and overall numbers were much fewer in upstream sites highlighting the limited response to environmental watering actions over summer and autumn (Austral, 2018).

Table 9. Carp numbers caught as part of the Wimmera Carp Monitoring Program 2016-17. Sites labelled ^c are control sites. Sites in black are riverine sites and in red are weir pool sites (Austral, 2018). Sites are listed in most upstream to most downstream by group.

	Oct 16	Dec 16	Jan 2017	April 17	June 17
Lower Norton ^c					2
Quantong	15	15	22	24	9
Polkemmet	15	17	47	7	23
Lochiel	2	16	26	42	10
Spears Crossing	0	3	17	12	0
Antwerp	0	31	21	61	1
d/s Jeparit Weir	45	49	70	31	28
Bigwater	11	12	26	19	-
Horsham ^c			46		
Dimboola	7	4	19	10	17
Jeparit	6	2	13	13	9



Carp aggregation (left) and resultant large number of pelicans (right) below Jeparit Weir, December 2017.

Drought Refuge Management Strategy

Alluvium and Wimmera CMA have developed a drought refuge management strategy for the lower Wimmera River (downstream of Dimboola). Based on environmental values and physical attributes, five locations were identified where interventions such as supply from the Wimmera Mallee Pipeline would protect these refuges during extreme drought conditions. It also highlighted policy issues relating to extraction of water from drought refuges. An example site for refuge pool management actions is included below (Figure 6). Over the coming months, Wimmera CMA will be working with VEW and DELWP staff to progress the strategy in preparation for the next drought.



Figure 6. Example site for refuge management actions (Alluvium, 2018)

5.4 MacKenzie River summary

Regulated releases for baseflows commenced from Distribution Heads in July and this continued until mid-August and included a winter/spring fresh. Reasonable rainfall from mid-August to late September combined with high water levels in Lake Wartook meant that good unregulated flows (including releases to maintain storage target levels) were able to continue down the MacKenzie River throughout this period, providing additional fresh events but not reaching the high fresh volume from Reach 3 (190 ML/d), peaking at 120 ML/d (Figure 7). Large quantities of sand have washed out of the Grampians via Chinaman's Creek and into the river channel at Wartook following bushfires which has substantially reduced the channel capacity and limits the ability to provide larger regulated flows given substantial losses are now incurred when flows spill out into a swampy area and also cover access tracks (Figure 8).

When conditions dried out at the end of September, regulated releases recommenced to provide an additional two freshes in spring from Distribution Heads. When the metering point reverted to Dad and Dave in December (along with Burnt Creek flows), flow rates dropped in line with summer/autumn baseflow recommendations with short cease to flows in December/January followed by freshes. There is a baseflow target of 10 ML/day or natural and flows were generally around this target volume, although the hot, dry conditions led to larger instream losses than normal. Flows are recommended to be limited in summer/autumn to constrain recruitment of Eastern Gambusia in line with recommendations in Biosis (2013).

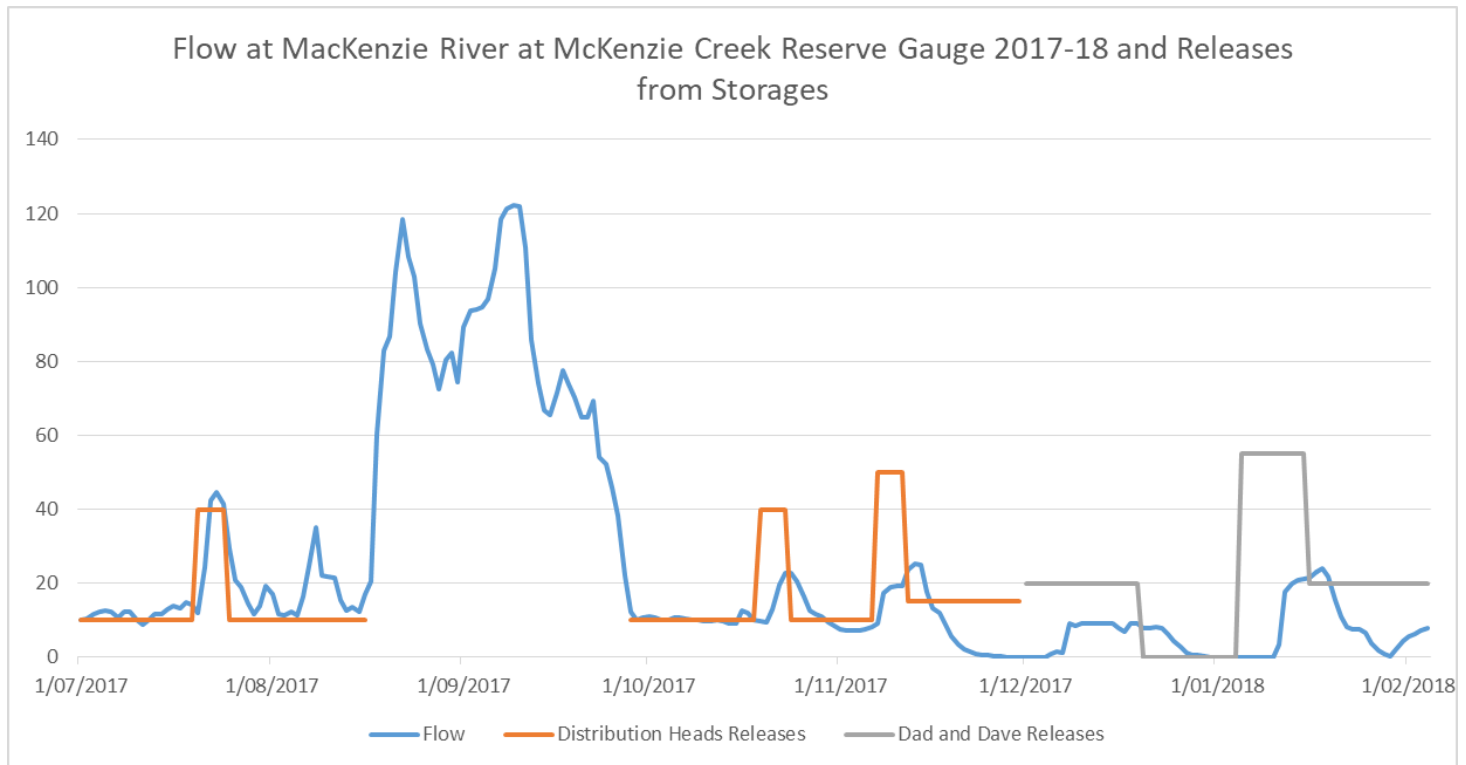


Figure 7. Flow summary for Reach 3 of MacKenzie River at McKenzie Creek Reserve stream gauge (415451).



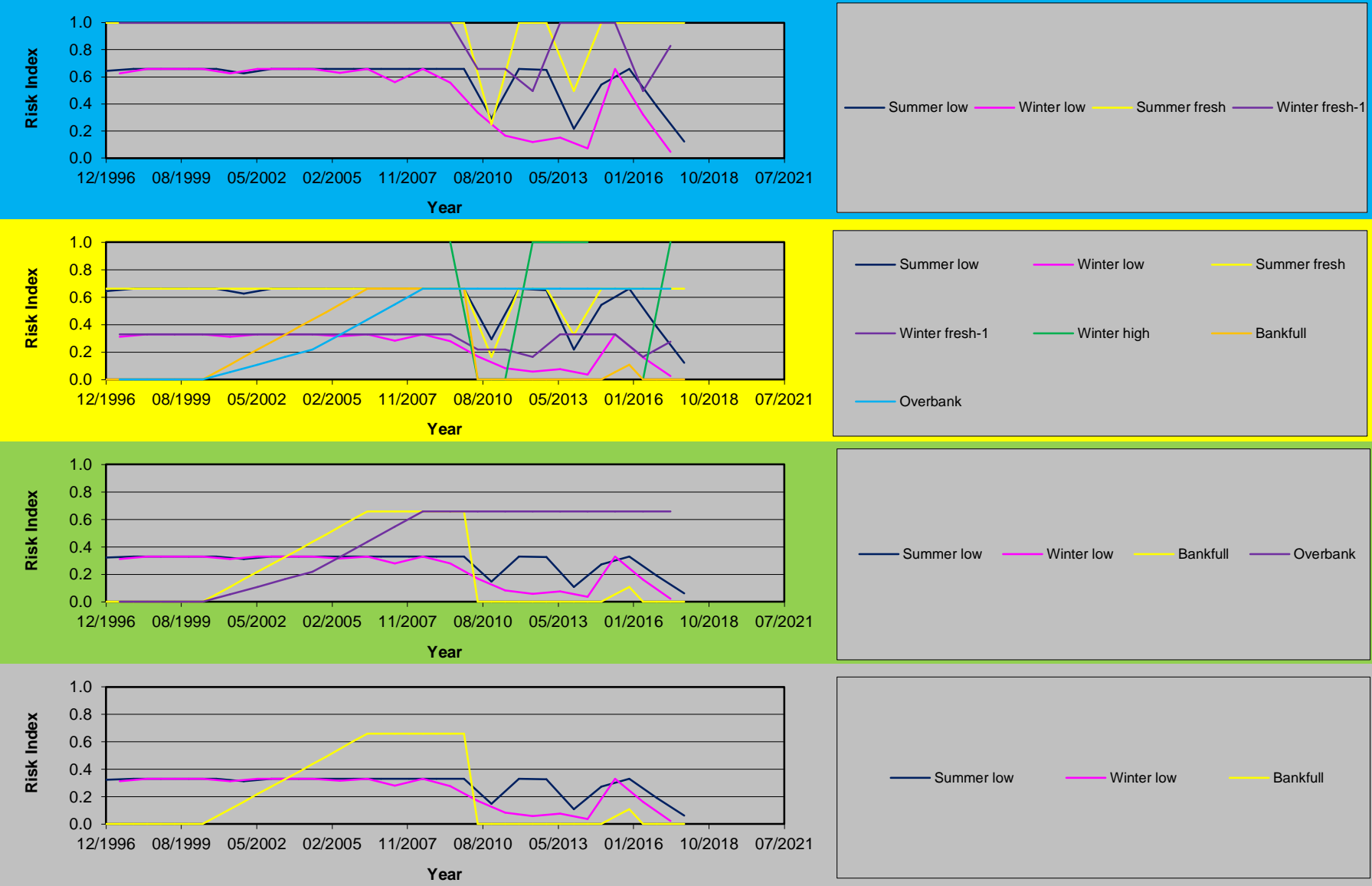
Figure 8. Chinaman's Creek was clogged with sand washing out from the Grampians following bushfires and sand has also tipped into the MacKenzie River at Wartook (located in background), May 2017.

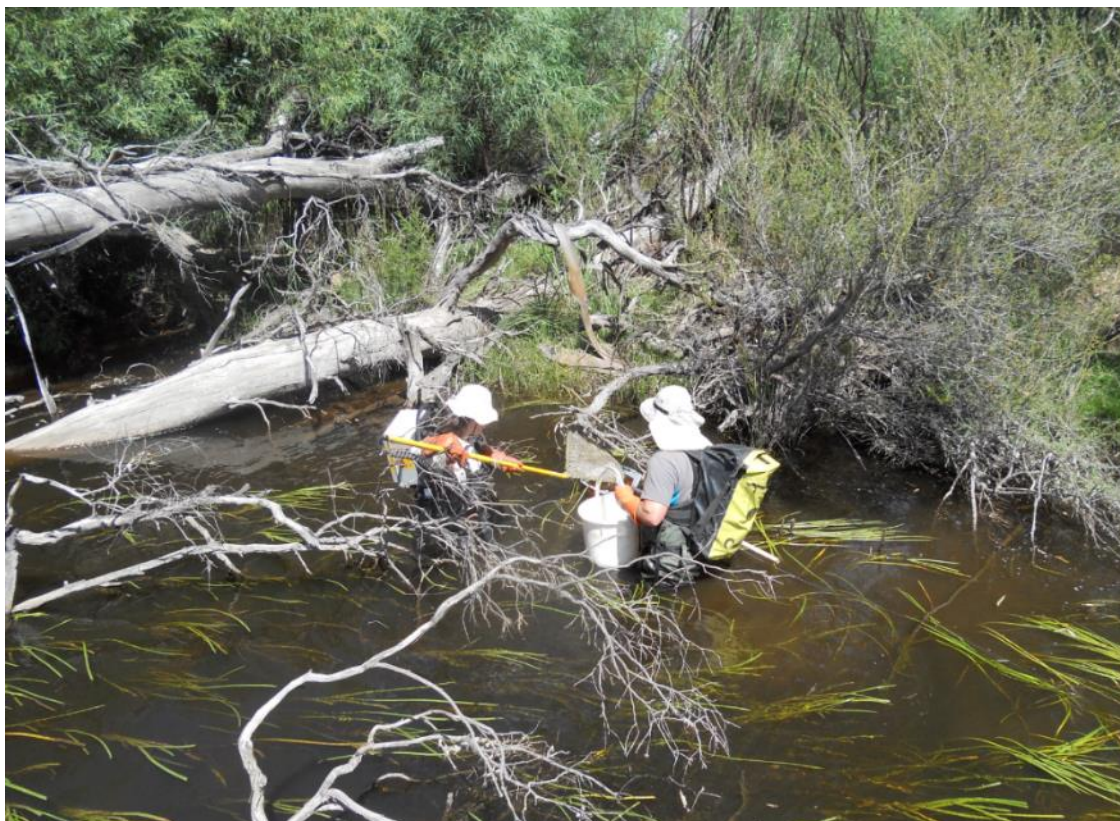
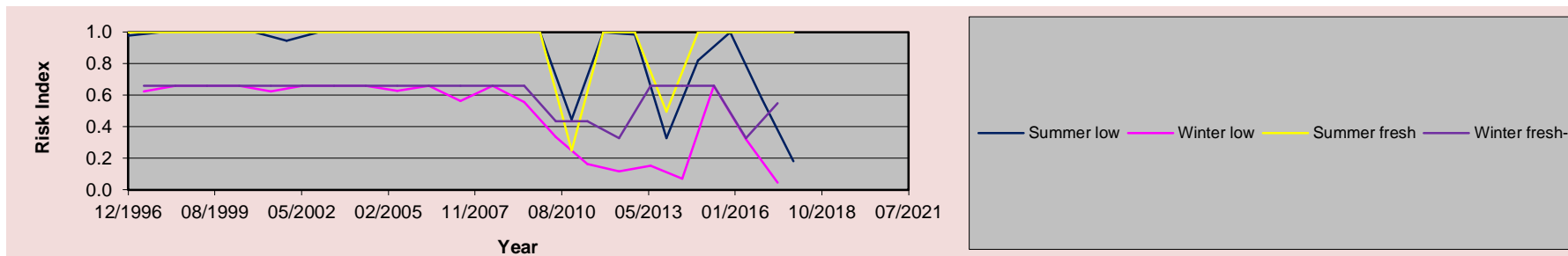
Table 10. Summary of Priority Watering Actions (PWA) delivered for Reach 3 of the MacKenzie River.

PWA delivered for Reach 3 MacKenzie River	Flow magnitude/ duration/ frequency	Comment
Baseflows	10 ML/d or natural	Been consistently delivered apart from short cease to flow events
Summer/Autumn freshes	35 ML/d 2-7 days x 3 - 4	Two freshes provided to date with two more planned (April/May) although target volumes have been impacted by high losses.
Winter/Spring freshes	35 ML/d 2-7 days x 5	Provided by a combination of regulated and unregulated flows, later freshes didn't quite reach target volumes due to increased losses.
Winter/Spring freshes	190 ML/d 1-2 days x 1	Unregulated flows insufficient to provide component. (Not regulated water objective unless unregulated component is large given capacity constraints)
Winter/Spring freshes	500 ML/d 1 day x 1	Unregulated flows insufficient to provide component. (Not regulated water objective). Average to wet years only.
Anytime bankfull	1,000 ML/d 1 day x 1	Unregulated flows insufficient to provide component. (Not regulated water objective). Wet years only

Risks to ecological and physical objectives for the MacKenzie River Reach 3 is included in Table 12 below. The high risks that exist for most values relate to summer freshes which are a focus of deliveries in 2017-18 and will continue to be the case in 2018-19. Ongoing summer/autumn low flows have been pivotal in reducing other risks.

Table 11. Risk indices for Fish (blue), Macroinvertebrates (yellow), Vegetation (green), Geomorphology (grey) and Water Quality (pink) for MacKenzie River Reach 3.





Joanne Kearns and Scott Raymond from Arthur Rylah Institute undertaking fish sampling on the MacKenzie River at Mt Victory Road, November 2017

Platypus Surveys

In 2017 cesar undertook two live-trapping surveys, one in autumn and one in spring to assess the current status of platypuses in the MacKenzie River. They also undertook environmental DNA (eDNA) sampling in the MacKenzie and Upper Wimmera catchment, including Mt William Creek to identify any other remnant platypus populations where they are not known to be present or are in very low numbers. Two platypuses (one adult female, one juvenile male) were captured in the MacKenzie River near Zumsteins in the April survey (Reach 1). The juvenile captured is the sixth juvenile recorded in the last four years after no juveniles were detected in surveys conducted between 2006 and 2013. The average catch per unit effort (CPUE) since 2012 (0.087, $n = 5$) is higher than average CPUE from 2008 to 2011 (0.062, $n = 4$) indicating the population is slowly increasing in abundance (cesar 2017). Another positive outcome from the survey was the presence of platypus DNA in water samples taken below Dad and Dave Weir providing the first reliable evidence of platypus in this reach since they were lost in the Millennium Drought. This has been also corroborated by a community platypus sighting near the Brimpaen-Laharum Road in early 2018 via the platypusSPOT website.

The live-trapping in spring undertaken for Project Platypus unfortunately did not lead to any platypus captures and eDNA sampling in the upper Wimmera catchment again showed no indication of platypus DNA. Platypus monitoring for the MacKenzie River took place in April 2018 with an adult male caught that had not been trapped before. The recommissioned fishway at Dad and Dave Weir should assist the dispersal of juveniles into this reach as well as reducing the threat of predation during foraging activities.

VEFMAP Fish Surveys

Fish surveys were conducted on the MacKenzie River in November 2017 as part of VEFMAP to analyse the response of fish populations to environmental watering, in particular associated with fringing and in-stream vegetation. Preliminary results are very encouraging in that there were high abundances of Southern Pygmy Perch at many sites as well as captures of other native species including River Blackfish, Flat-headed Gudgeons and Carp Gudgeons. Many of the Southern Pygmy Perch were young of year fish indicating a very successful recruitment event (Joanne Sharley, ARI, *pers. comm.*).

Ecology Australia Fish Surveys

Ecology Australia undertook fish surveys in March/April 2017 in the lower MacKenzie River and upper Burnt Creek on behalf of Wimmera CMA. Key findings from this work were that Southern Pygmy Perch were taking advantage of environmental watering to move downstream into new habitats, with records further downstream than previous surveys in 2012 and 2014 (Ecology Australia, 2017a). Unfortunately results (Table 12) also indicated higher numbers of carp than previous surveys. The presence of the threatened Western Swamp Crayfish at the most upstream site was a pleasing outcome.



Chris Bloink (Ecology Australia), measuring a River Blackfish in the MacKenzie River, March 2017.

Table 12. Summary of indigenous (green), non-indigenous (orange) and exotic (red) fishes and bycatch (blue) recorded from the MacKenzie River and Burnt Creek in March/April 2017. Sites MB2 and MB3 are in the upper Burnt Creek. Sites in the MacKenzie River from upstream to downstream are MB5, MB9, MB7, MB8 and MB6. (Ecology Australia, 2017a)

Species		Burnt Creek		MacKenzie River					Totals
Scientific name	Common Name	MB 2	MB3	MB5	MB6	MB7	MB8	MB9	
<i>Galaxias oliros</i>	Obscure Galaxias	5	3						8
<i>Nannoperca australis</i>	Southern Pygmy Perch	542	347	104	1		22	2	1018
<i>Hypseleotris</i> sp.	Carp Gudgeon Complex		1	2			7		10
<i>Carassius auratus</i>	Goldfish	3		95		2		8	108
<i>Carassius/Cyprinus</i>	Goldfish/Carp				1				1
<i>Cyprinus carpio</i>	Carp	1		16	18	34	29	100	244
<i>Gambusia holbrooki</i>	Eastern Gambusia	127		20	11		10		168
<i>Chelodina longicollis</i>	Eastern long-necked turtle					2			2
<i>Cherax destructor</i>	Common Yabby	31	12	13	1	29	24	58	168
<i>Gramastacus insolitus</i>	Western Swamp Crayfish	6	5	16					27
<i>Paratya australiensis</i>	Common Shrimp	100	100		10	50	500	100	860

5.5 Burnt Creek summary

Regulated releases were not required initially due to wet conditions meaning that runoff from the MacKenzie River downstream of Lake Wartook was being transferred via Burnt Creek to Taylors Lake. This continued through the rest of winter with regular rainfall events providing additional pick up. There were also brief releases to maintain the storage target level from Lake Wartook. This provided baseflows throughout winter/spring and well over a month (38 days) of flows consistently exceeding the winter/spring fresh threshold (55 ML/d). Another pulse in November was intended to flush surface sediments although its volume peaked at about 32 ML/d due to higher than anticipated losses so not at the desired rate.

Regulated releases began at Dad and Dave Weir on the 1st of December for both the MacKenzie River and Burnt Creek comprising baseflows and summer/autumn freshes with planned cease to flow periods, including over the Christmas/New Year's break. In early 2018, operational issues (drowning of visitor to MacKenzie Falls) hampered the provision of freshes so releases are planned in autumn 2018 to provide these actions.

For lower Burnt Creek, the operations at Lake Wartook and pickup for the MacKenzie River meant that unregulated flows were able to be directed to the lower Burnt Creek in early September to provide vegetation and fish outcomes. This was a positive outcome resulting from collaboration between the Storage Manager and Wimmera CMA. There is no gauging station on the lower Burnt Creek to provide flow data.

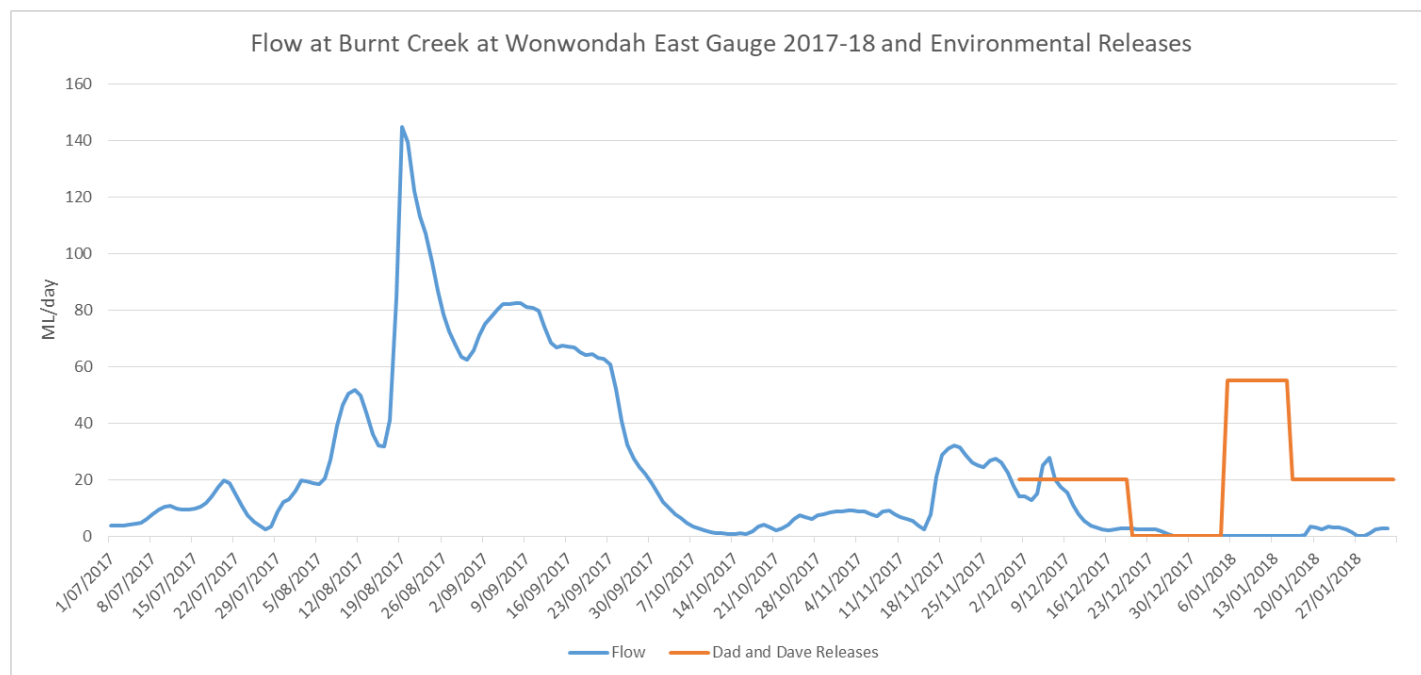


Figure 9 Burnt Creek streamflow at Wonwondah East gauge (415223).

Table 13. Summary of Priority Watering Actions (PWA) delivered for upper Burnt Creek recorded at the Wonwondah East gauge (415223).

PWA delivered for upper Burnt Creek	Flow magnitude/ duration/ frequency	Comment
Baseflow all year	1 ML/d	Delivered mostly by unregulated flows from July until regulated releases started in December.
Summer/autumn freshes	30 ML/d 3-7 days x 3	One achieved (December), two more planned for April/May after issues with operational deliveries in January/February
Winter/spring freshes	55 ML/d 3-7 days x 1-5	Unregulated flows mostly greater than 55 ML/d from mid-August to late September.
Winter/spring freshes	160 ML/d 1-3 days x 1-3	Unregulated flows were approximately 140 ML/d for two days in late August.
Any time bankfull	400 ML/d 2 days x 1	Unregulated flows insufficient to provide component. (Not regulated water objective). Ave-Wet years only.
Overbank	1,000 ML/d 1 day x 1	Unregulated flows insufficient to provide component. (Not regulated water objective). Wet years only.

VEFMAP Fish Surveys

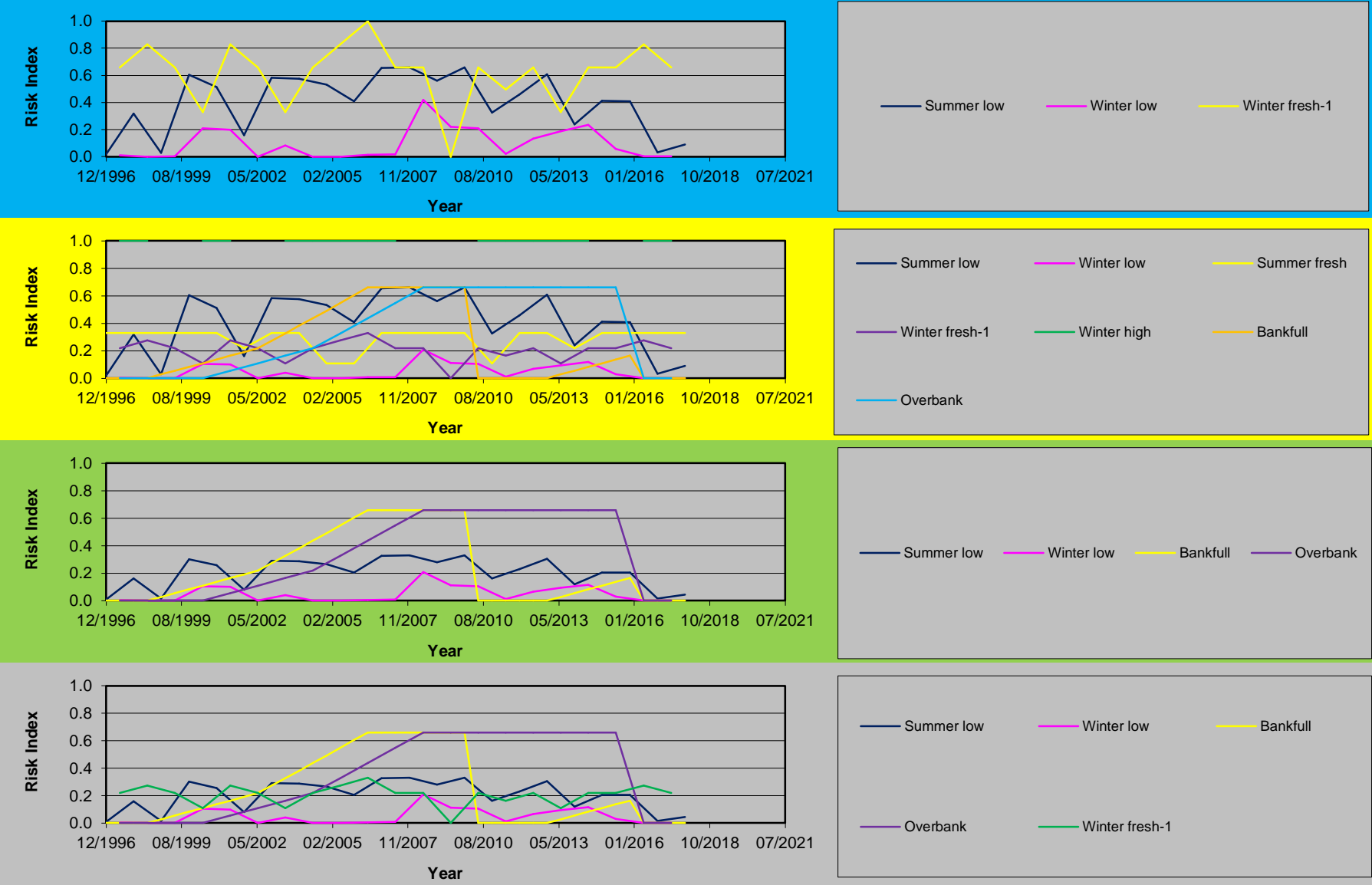
Fish surveys were conducted on the Burnt Creek in November and December 2017 as part of VEFMAP to analyse the response of fish populations to environmental watering, in particular associated with fringing and in-stream vegetation. Despite not having flows for a couple of months and low dissolved oxygen levels, the lower Burnt Creek had a good diversity of native fish species including Southern Pygmy Perch, Australian Smelt, Carp Gudgeon and Flat-headed Gudgeon. The upper Burnt Creek also had very high numbers of Southern Pygmy Perch including 507 at the Hickey Road site as well as one Obscure Galaxias at MacInnes Road (Joanne Sharley, ARI, *pers. comm.*).

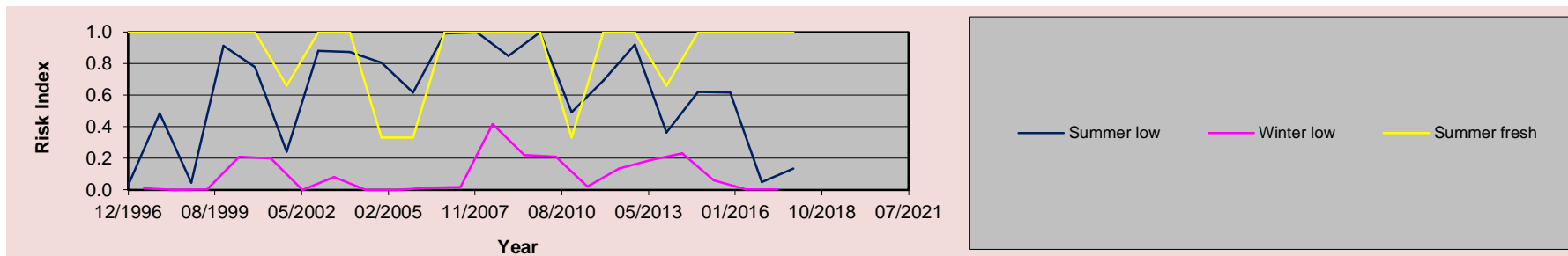
Ecology Australia Fish Surveys

As discussed in Section 5.4, Ecology Australia undertook fish surveys in April 2017 in the upper Burnt Creek on behalf of Wimmera CMA. At the two sites surveyed there, it was very positive to have almost 900 Southern Pygmy Perch. There was also a handful of Obscure Galaxias present although the decline in numbers and no evidence of recruitment is concerning along with the large numbers of Eastern Gambusia (Ecology Australia, 2017a). However the threatened Western Swamp Crayfish were found at both sites.

Risks to ecological and physical objectives for the Upper Burnt Creek is included in Table 14 below. The results highlight a continuation of low risk to most ecological values, although the winter freshes will need to be a focus in 2018-19 to further reduce the risks to fish populations (especially Obscure Galaxias).

Table 14. Risk indices for Fish (blue), Macroinvertebrates (yellow), Vegetation (green), Geomorphology (grey) and Water Quality (pink) for upper Burnt Creek.





Burnt Creek near Eagles Road – April 2018

5.6 Bungallally Creek summary

No regulated environmental flows were delivered to Bungallally Creek however there were unregulated flows in Bungallally Creek in September due to high water levels in Lake Wartook which provided sufficient flows to achieve vegetation outcomes, in particular for River Red Gums. This was able to be achieved due to good collaboration between the Storage Manager and Wimmera CMA. There is no stream flow monitoring available on Bungallally Creek.

5.7 Mt William Creek summary

Regulated releases were not initially required given unregulated flows coming from the creeks flowing from the north-eastern edge of the Grampians (e.g. Briggs Creek, Mud Hut Creek). The streamflow gauge is located at the very upstream end of this reach and so flows measured there do not factor in these contributions, however a Portable Automated Logger System (PALS) Unit located downstream at Roses Gap provides water level and salinity data after most tributaries have entered the Mt William Creek. Figure 10 shows the flows at Lake Lonsdale Tailgauge in response to regulated releases and passing flows as well as flows at Mokepilly which is unregulated given it is immediately upstream of Lake Lonsdale. It highlights the limited inflows into Lake Lonsdale given the comparatively dry conditions in spring, with flows dropping off rapidly in October. Rainfall seemed to be sufficient to generate reasonable runoff from the Grampians streams given the high proportion of impervious (rocky) catchment area. However in the areas east of the Grampians (which is the eastern half of the Mt William Creek catchment) there was very little run off. Therefore the tributaries downstream of Lake Lonsdale provided some reasonable flows throughout winter and early spring which led to water quality (salinity) being very good (Figure 11).

Salinity levels rose when passing flows and regulated releases commenced as unfortunately water quality in Lake Lonsdale is poorer than that coming from streams flowing from the Grampians but remained relatively constant until a planned cease to flow took place from the late December until late January led to modest salinity rises. Flows re-commencing in late January led to salinity levels dropping and remaining relatively constant. Higher flows are planned from mid-May to the end of June as Lake Lonsdale becomes the source of water for Wimmera River flows instead of Taylor's Lake. No releases have been required for the upper Mt William Creek to date due to the unregulated flows in 2017 and reasonable levels in Lake Lonsdale.

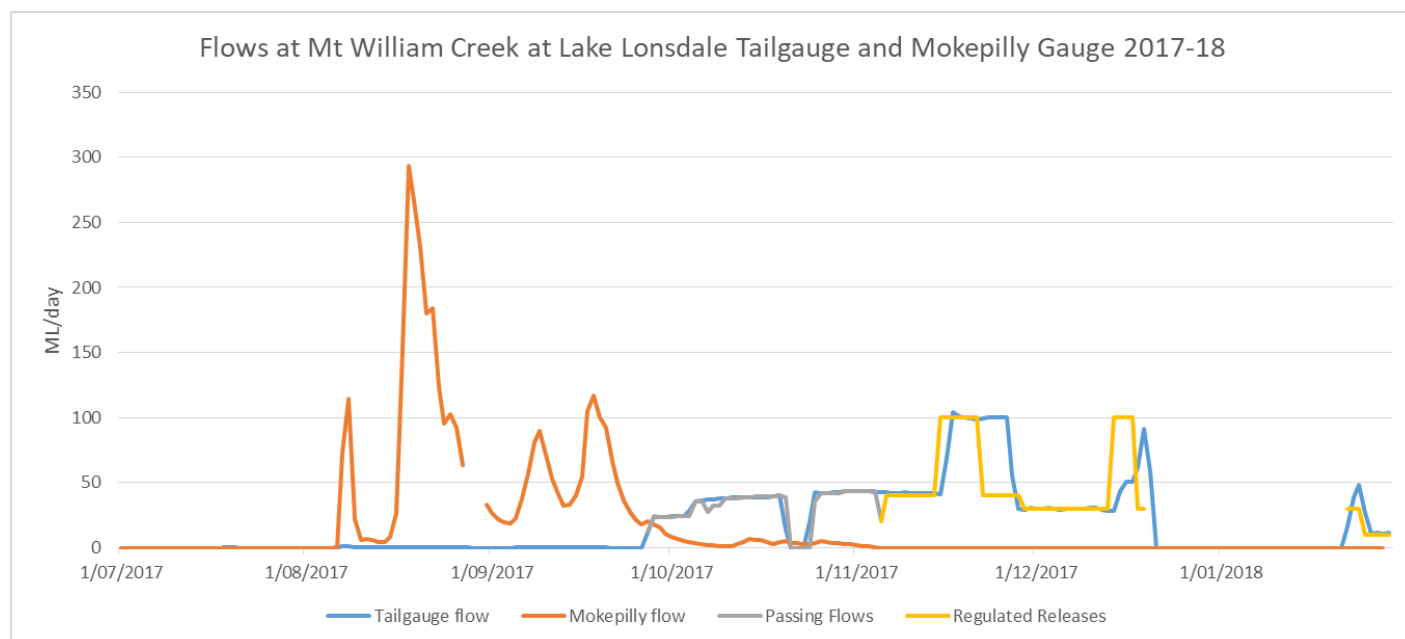


Figure 10. Mt William Creek streamflows and regulated releases/passing flows.

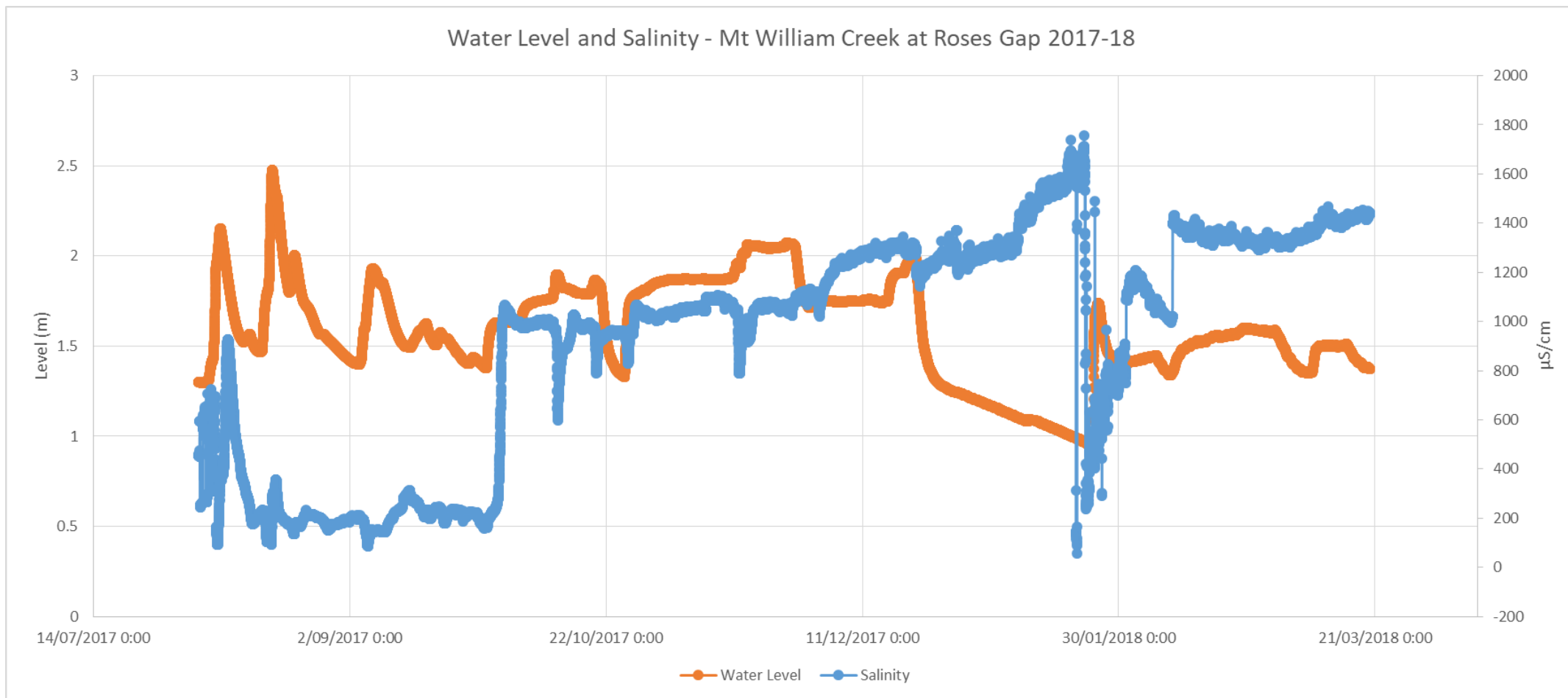
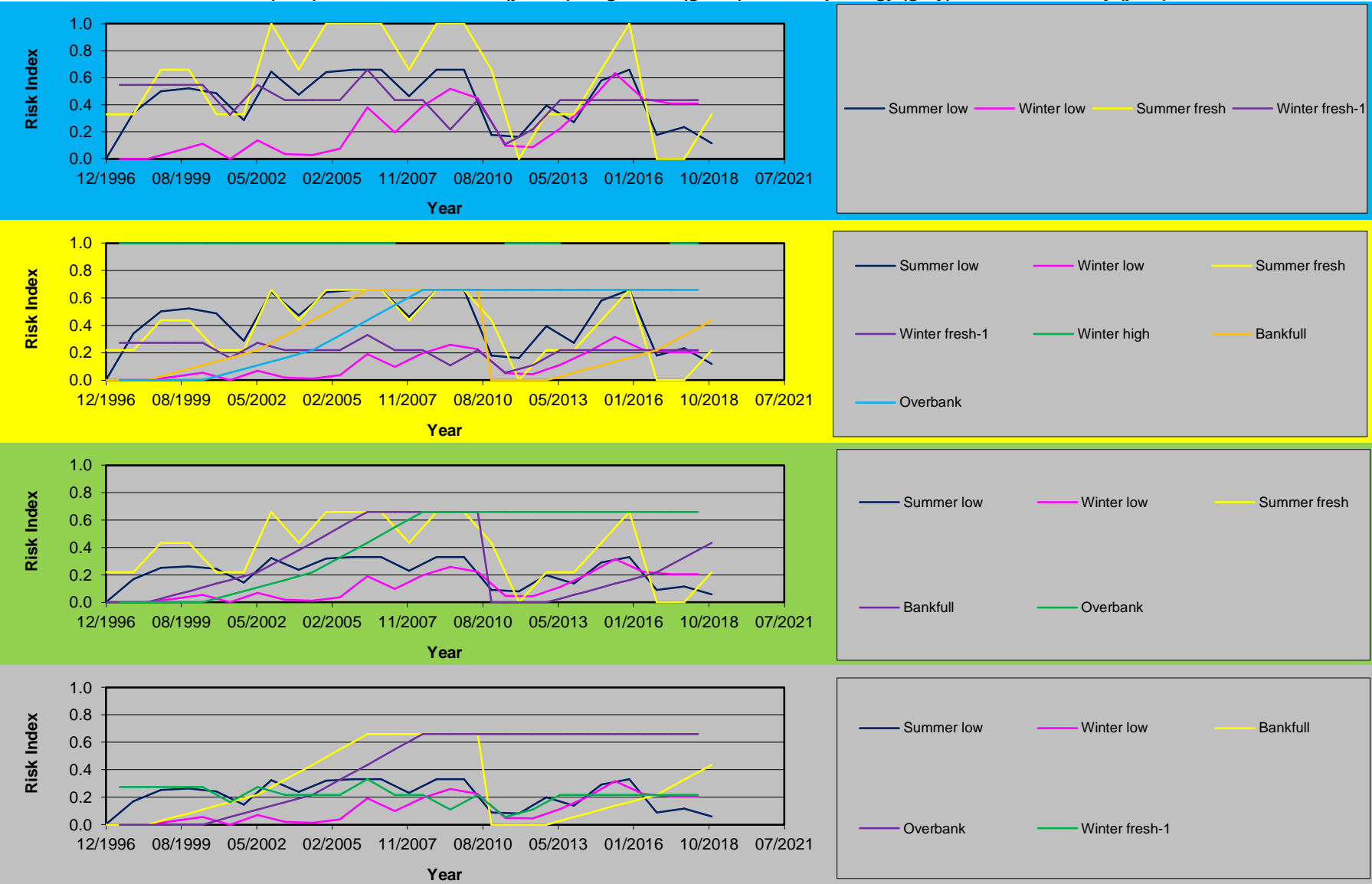
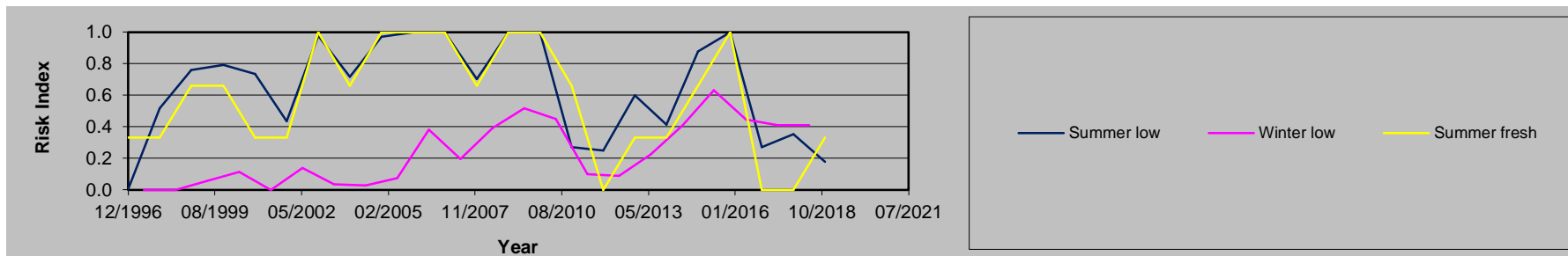


Figure 11. Mt William Creek water levels and salinity at Roses Gap

Risks to ecological and physical objectives for the lower Mt William Creek is included in Table 15 below. The results highlight that risks remain generally low. The risk posed by shortfalls in winter/spring low flows are not representative of the risk to the entire reach (given the gauge is immediately below Lake Lonsdale) which generally has had good levels of constant flow in winter/spring in 2016 and 2017 from unregulated flows. Overbank flows are required to reduce the risk for the macroinvertebrates and geomorphology objectives however this is not able to be provided by regulated releases or passing flows.

Table 15. Risk indices for Fish (blue), Macroinvertebrates (yellow), Vegetation (green), Geomorphology (grey) and Water Quality (pink) for lower Mt William Creek.





Soil moisture probe in Mt William Creek at Ledcourt – April 2018

Mt William Creek e-DNA Surveys

A dozen sites on the Mt William Creek and its upper tributaries were sampled for River Blackfish DNA by Wimmera CMA in June 2017. Given the time of year (at the start of winter), it provided a very good representation of available habitat. There were low flows near its headwaters but in the reach of the creek from where it left the National Park, downstream to Lake Lonsdale, water was only confined to several large pools. Downstream of Lake Lonsdale, small unregulated flows were occurring. Unfortunately the results were all negative, indicating that River Blackfish were not present (EnviroDNA, 2017). Three sites on the lower Mt William Creek were sampled in September 2017 for River Blackfish, rakali and platypus DNA for a monitoring project undertaken by Project Platypus. All samples came up negative although trace elements of rakali DNA were found in a sample taken from Dadswell's Bridge Weir Pool (EnviroDNA, 2018). Previous surveys have failed to find platypuses in recent years and highlighted that the River Blackfish population has been very small. Rakali have been previously observed in the creek immediately downstream of Lake Lonsdale.

VEFMAP Fish Surveys

Fish surveys were conducted on Mt William Creek in December 2017 as part of VEFMAP to analyse the response of fish populations to environmental watering, in particular associated with fringing and in-stream vegetation. It was especially pleasing to have a River Blackfish captured at Roses Gap following the disappointment of the e-DNA sampling results. Other notable findings included Obscure Galaxias at four of the eight sites surveyed and Flat-headed Gudgeons at six sites (Joanne Sharley, ARI, *pers. comm.*).

6 2018-19 Priority watering actions

Although inflows in 2017-18 have been very modest, there has been reasonable allocations, reaching 81% in April 2018 for the Victorian Environmental Water Holder (VEWH) regulated entitlement. Unprecedented record inflows would be required to generate any allocation for the Commonwealth Environmental Water Holder (CEWH) product which was at 0% allocation. However conditions were wet enough to provide sufficient passing and unregulated flows to offset some regulated water use and there remains reasonable carryover from wet conditions in 2016-17. Given at least 42,337 ML is needed to deliver all Priority Watering Actions (PWAs) for the Wimmera River system (not including wetlands) from a combination of regulated, unregulated and passing flows, wet conditions are required to provide unregulated and passing flows as well as boost allocations to avoid shortfalls. Wet conditions also provide high flow rates (e.g. bankfull flows) that cannot be provided by regulated watering actions. Priority Watering Actions are outlined in further detail in Appendix 4.

6.1 Wimmera River Reach 4 Priority Watering Actions

Reach 4 of the Wimmera River is a priority reach based on managing risks to environmental values and the critical role of flow in maintaining water quality for aquatic and riparian ecosystems. Delivering PWAs to this reach will also facilitate social outcomes such as fishing competitions, rowing regattas and triathlons through improved water quality in town weir pools. In 2018-19 flows will be important in consolidating gains obtained by improved conditions since spring 2016. Prior to this the lower Wimmera River downstream of Jeparit did not have any flow for almost 18 months so regular flows since late 2016 have reversed the trajectory of decline experienced beforehand due to high salinities and a lack of habitat with many pools drying out. Water in this reach will also assist with the potential watering of Ranch Billabong to boost riparian and wetland plant condition, in conjunction with cultural outcomes.

6.2 MacKenzie River Reach 3 Priority Watering Actions

Very high environmental values mean that the MacKenzie River is the highest priority for environmental watering. Important populations of indigenous fish species, platypuses and riparian vegetation rely on flow in the MacKenzie River to persist and disperse. The fish community which has been classified as being in 'excellent' condition (SKM, 2010) was largely understood to be confined to the upper reaches (Reaches 1 and 2) however subsequent monitoring (Biosis, 2013) has highlighted that it is also present in Reach 3 when water is present, as well the presence of *Flora and Fauna Guarantee Act*-listed Western Swamp Crayfish (Ecology Australia, 2017) therefore making it a priority for ongoing environmental water delivery. However it is understood that longer cease to flows and smaller freshes/baseflows over summer/autumn may be beneficial in limiting the growth of the Eastern Gambusia population in this reach (Ecology Australia, 2014). Gambusia are a small-bodied, aggressive pest fish species that compete with native fish a frog species for habitat and resources. A fresh in late autumn however may assist in the dispersal of juvenile platypuses into this reach (Melody Serena, Australian Platypus Conservancy, *pers. comm.*). Winter flows are also recommended for this reach to facilitate Obscure Galaxias spawning and larval survival (Ecology Australia, 2017). Water quality in the MacKenzie River is typically very good so flows in this reach are important in boosting water quality in the Wimmera River. A six to seven day fresh has been recommended for this reach in August/September to assist VEFMAP monitoring outcomes (Chris Jones, ARI, *pers. comm.*) which also aligns with the flow recommendations. Also low flows in autumn will assist in the germination of Water Ribbons (*Cycnogeton sp.*)

Prior to spring 2016, due to drought conditions, Reach 3 was completely dry for almost 18 months so native fish and other water-dependent fauna populations have since been steadily recolonising this reach. The high environmental values of the MacKenzie River provide a number of flow-on social benefits through the numbers of people who enjoy fishing and birdwatching when environmental water releases are taking place.

6.3 MacKenzie River Reach 2 Priority Watering Actions

The MacKenzie River Reach 2 supports the source population of indigenous fish that populate MacKenzie River Reach 3 and Burnt Creek during wet conditions. Platypuses appear to be recolonising this reach after disappearing in 2007 when the reach dried out. Expanding the size and spread of the platypus population in the MacKenzie River is vitally important as the upper Wimmera River population is now functionally extinct (Josh Griffiths, *pers. comm.*).

6.4 Upper Burnt Creek Priority Watering Actions

Year-round baseflows will assist the restoration and maintenance of fish communities in the upper reaches of Burnt Creek, especially when in combination with enhanced aquatic vegetation growth and recruitment. Populations of the *FFG Act*-listed Western Swamp Crayfish have been identified in this reach of Burnt Creek (Biosis, 2013, Ecology Australia, 2017). Like the MacKenzie River, this section of Burnt Creek is highly valued by the local community for angling. As Burnt Creek is supplied from the same sources as the lower MacKenzie River and is therefore highly regulated, without environmental watering the only flows taking place along this reach are typically transfers of inflows into the mid-MacKenzie River to Taylor's Lake in winter/spring. Therefore environmental water releases will be critical to supplement these flows, especially in the drier months. Baseflows and freshes in wetter months may be provided by catchment pickup or transfers from Moora Moora Reservoir or Lake Wartook to Taylor's Lake or releases to lower Burnt Creek, thereby reducing the need to make a specific release to target outcomes in the upper Burnt Creek. A two to three day fresh has been recommended for this reach in August/September to assist VEFMAP monitoring outcomes (Chris Jones, ARI, *pers. comm.*) which also aligns with the flow recommendations. Also low flows in autumn will assist in the germination of Water Ribbons (*Cycnogeton sp.*)

6.5 Lower Burnt Creek Priority Watering Actions

Lower Burnt Creek has valuable riparian vegetation in some sections which provides important habitat for terrestrial and aquatic species. Releases in previous years have been noted to lead to enhancement in the presence of frogs and waterbirds, including one of the first discoveries of a Peron's Tree Frog in the region. Given the complete absence of flow from this reach apart from in periods of flood or environmental water releases due to its extremely high levels of regulation, environmental water releases provide a lifeline for maintenance of its values. Despite the limited flows, a reasonable diversity of native fish species were captured in this section of the creek in November 2017 which have moved downstream from the Upper Burnt Creek, indicating the potential environmental outcomes that can be achieved. Results in the past were not as good which is somewhat attributable to the effect of barriers to fish movement from upstream (Biosis, 2013). A passing flow for the creek has been proposed as part of the review of the storage management rules which may be able to meet some PWAs should it be implemented in 2018/19. There is a strong desire amongst adjacent landholders to see increased flows for this reach and there have been a number of riparian enhancement projects to increase its environmental values.

Approximately 150 – 200 ML is required to fill pools in the creek before the PWA of a bankfull flow can take place. Historically the limited capacity of the waterway as well as the low volumes delivered for environmental and stock and domestic purposes has meant that there are two stream crossings that may be impacted by the PWA (Earth Tech, 2006) although planning work has been undertaken to address this, with funding available for on-ground works. If the on-ground works take place, then this PWA can be implemented. Wimmera CMA is working with Horsham Rural City Council to upgrade the crossings.

6.6 Bungallally Creek Priority Watering Actions

Bungallally Creek has riparian vegetation in some sections which provides important habitat for terrestrial and aquatic species and much like lower Burnt Creek, due to high levels of regulation, it only receives flows in times of flood or environmental water releases. The on-going collaboration between the Storage Manager and Wimmera CMA will be important for maximising the opportunities and outcomes from system water that can be directed to the creek. A passing flow for the creek has been proposed as part of the review of the storage management rules which may be able to meet some PWAs should it be implemented in 2018-19 although this may be challenging given the timeframe. Local landholders have a strong interest in the maintenance and enhancement of its riparian ecological values.

Historically the limited capacity of the waterway as well as the low volumes delivered for environmental and stock and domestic purposes has meant that there is a stream crossing that may be impacted by the PWA (Earth Tech, 2006) although planning work has been undertaken to address this, with funding available for on-ground works. If the on-ground works take place, then this PWA can be implemented. Wimmera CMA is working with Horsham Rural City Council to upgrade the crossing.

Due to the high level regulation of this system and the fact that it would only receive flows during high flow events, the creek bed will most probably be completely dry when watering commences. Previous experience shows that about 100 ML is required to enable this reach to be filled and connected before the PWA (bankfull flows) can be delivered.

6.7 Upper Mt William Creek Priority Watering Actions

The upper Mt William Creek supports good populations of endemic fish species and there are no European carp present in this reach due to the downstream barrier of Lake Lonsdale (Biosis, 2012). Following wet conditions in 2010-2011, several dry years caused Lake Lonsdale to dry out in 2015. Good inflows in 2016 led to it reaching its maximum operating level but water levels have been steadily declining since then. The small section of the creek upstream of Lake Lonsdale at Mokepilly can provide crucial drought refuge for endemic fish species like Southern Pygmy Perch. Protection of fish habitat in this reach with summer-autumn flows is considered important for maintenance of the fish community in this reach (SKM, 2005). The fish community in this reach in turn replenishes Lake Lonsdale during wet years, which like many lakes in the district provides a significant drawcard for anglers. With diminishing water levels in the lake, the action may be required if winter/spring proves to be dry.

A regulator has been constructed to deliver water to this location in early 2017, prior to this pumping or temporary structures were required to provide water to these refuge pools. It has been successfully tested but not used to deliver a PWA as yet. The PWA has not related to a flow rate but rather topping up refuge pools to ensure that they provide meaningful habitat and may happen in 2018-19 if it is a dry year and levels in the lower Mt William Creek and Lake Lonsdale decline or the creek at Mokepilly is at risk of losing its habitat values.



New regulator on Fyans Outlet Channel for Upper Mt William Creek (Photo: Adam Holloway, GWMWater)

6.8 Lower Mt William Creek Priority Watering Actions

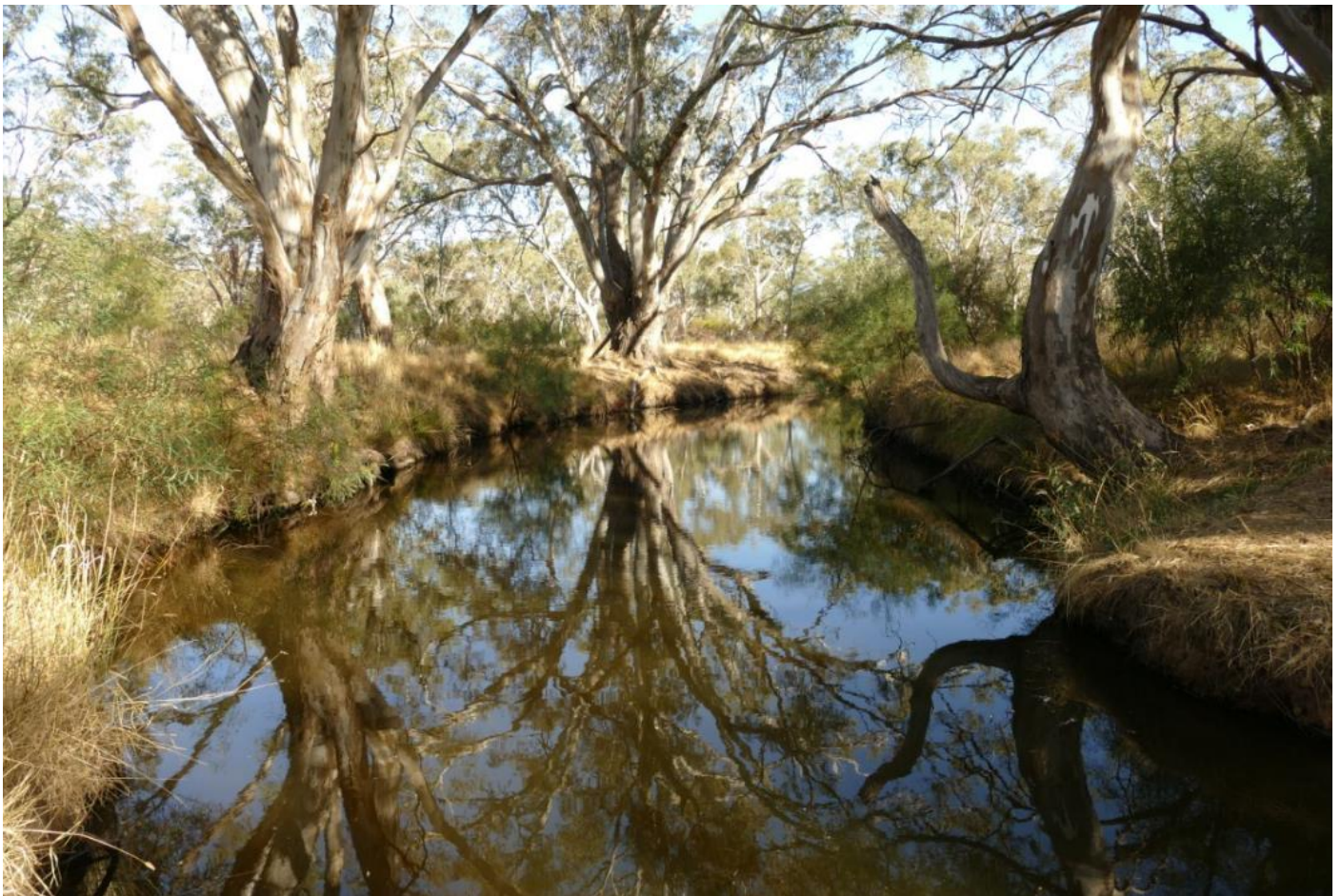
Maintenance of intact native fish populations in the lower Mt William Creek in order to facilitate dispersal to the Wimmera River is considered important, as is the need to provide flushing flows to prevent major declines in water quality (salinity) and habitat availability. This reach also contains very high value macroinvertebrate and vegetation communities given it flows through or near large tracts of public land, particularly the Grampians National Park. The presence of Lake Lonsdale at the top of this reach and historical diversions for consumptive supply means that this reach has been one of the most flow-stressed in all of Victoria (SKM, 2005a). A week-long fresh has been recommended for this reach in August/September to assist VEFMAP monitoring outcomes (Chris Jones, ARI, *pers.comm.*) which also aligns with the flow recommendations. Also low flows in autumn will assist in the germination of Water Ribbons (*Cycnogeton* sp.)

This reach also flows through the community of Dadswell's Bridge which has made a concerted effort to improve the community benefits of the creek through construction of a heritage walking trail focussing on the creek.

Typically there have been opportunities to achieve these PWAs through passing flows or regulated releases from Lake Lonsdale to meet objectives in the lower Mt William Creek and Wimmera River, however this has not always been the case, especially under ongoing dry conditions and shifting operational arrangements. Therefore there is a need to specify specific PWAs for this reach in case there are shortfalls in passing flows from Lake Lonsdale and lower Wimmera River demands are being met by passing flows at Huddleston's Weir and/or Taylor's Lake.

6.9 Dock Lake Priority Watering Actions

Successful outcomes such as Whiskered Tern and other waterbirds breeding following the water provided to the lake by unregulated flows/spills in spring 2016 indicates the value of Dock Lake becoming a PWA in line with the environmental flow study for the lake (Jacobs, 2015). Given the episodic nature of wetland watering in the Wimmera, the PWA applies during average to wet conditions only. Environmental water delivery would need to ensure that Green Lake (through which water must be routed to reach Dock Lake) would not increase in volume as a result with water being outfallen at the same water level when inflows commence. This currently requires Green Lake to be nearly full, given the outfall at lower lake levels has silted up as it has not been used for almost 20 years. Green Lake is likely to have high water levels in average-wet conditions from inflows from its own catchment and Storage Manager operations to protect water quality in Taylor's Lake.



Mt William Creek at Dadswell's Bridge Weir Pool – April 2018

7 Scenario Planning

Table 16. Summary of the Wimmera System environmental conditions, ecological objectives and environmental water requirements under a range of climatic (inflow) scenarios. Probability of Exceedance (POE) indicates likelihood of inflows being less than the % indicated based on historic inflows (e.g. a 95% Probability of Exceedance year means 95% of years will have greater inflows). Tier 1 are highest priority demands and within Tier 2 (lower priority demands), their relative priorities are in yellow (high), grey (medium) and brown (low). *Extreme Drought scenario allocation forecast estimated based on extrapolation from Very Dry scenario allocation forecast.

Wimmera Catchment		EXTREME DROUGHT 95% POE			VERY DRY 90% POE				DRY 75% POE				AVERAGE 50% POE				WET 25% POE			
Allocation against environmental entitlements (VEWH shared with Glenelg and not including Glenelg compensation flow)		October VEWH Allocation 8,112 ML (20%)*			October VEWH Allocation 14,196 ML (35%)				October VEWH Allocation 23,525 ML (58%)				October VEWH Allocation 32,853 ML (81%)				October VEWH Allocation 40,560 ML (100%)			
		October CEWH Allocation 0 ML			CEWH Allocation 0 ML				CEWH Allocation 0 ML				CEWH Allocation 0 ML				CEWH Allocation 0 ML			
		VEWH Carry-over 35,000 ML			VEWH Carry-over 35,000 ML				VEWH Carry-over 35,000 ML				VEWH Carry-over 35,000 ML				VEWH Carry-over 35,000 ML			
		CEWH Carry-over 7,200 ML			CEWH Carry-over 7,200 ML				CEWH Carry-over 7,200 ML				CEWH Carry-over 7,200 ML				CEWH Carry-over 7,200 ML			
		Spill loss 0 ML			Spill loss 0 ML				Spill loss 0 ML				Spill loss 0 ML				Spill loss 0 ML			
		Total Available 50,312 ML			Total Available 56,396ML				Total Available 65,725 ML				Total Available 75,053 ML				Total Available 82,760 ML			
Assumed available to the Wimmera		33,067 ML			36,717 ML				42,315 ML				47,911 ML				52,536 ML			
Expected climatic conditions and water available		Effectively no unregulated or passing flows (< 1000 ML total flows at Glenorchy)			Very little unregulated flow (~ 2000 ML for the Wimmera River at Glenorchy)				Some unregulated flows (~ 10,000 ML for the Wimmera River at Glenorchy)				Good unregulated flows (~ 50,000 ML for the Wimmera River at Glenorchy)				Significant unregulated flows (>100,000 ML for the Wimmera River at Glenorchy)			
Expected river conditions (inc. unregulated and, consumptive water)		Periodic unregulated flows for Reach 2 MacKenzie River, Upper Burnt Creek, lower Mt William Creek. Regulated releases provide flows at other times and locations			Periodic unregulated flows for Reach 2 MacKenzie River, Upper Burnt Creek, lower Mt William Creek. Regulated releases provide flows at other times and locations.				Periodic unregulated flows for Reach 2 MacKenzie River, Upper Burnt Creek, lower Mt William Creek. Regulated releases provide flows at other times and locations apart from modest passing flows.				Regular unregulated flows for Reach 2 MacKenzie River, Upper Burnt Creek, lower Mt William Creek. Reasonable passing flows and unregulated releases for the Wimmera River and lower Mt William Creek. Regulated releases provide flows at other times and locations.				Regular unregulated flows for Reach 2 MacKenzie River, Upper Burnt Creek, lower Mt William Creek. Frequent passing flows and unregulated releases for the Wimmera River and lower Mt William Creek. Regulated releases provide flows at other times and locations			
Estimated Passing Flows		0 ML			1000 ML				5000 ML				15,000 ML				50,000 ML			
		Combined action	Max. vol. (ML)	Comment	Max. vol. (ML)	Comment	Tier 1 (ML)	Tier 2 (ML)	Max. vol. (ML)	Comment	Tier 1 (ML)	Tier 2 (ML)	Max. vol. (ML)	Comment	Tier 1 (ML)	Tier 2 (ML)	Max. vol. (ML)	Comment	Tier 1 (ML)	Tier 2 (ML)
Waterway	Wimmera River	Reach 3 Baseflows and freshes (summer/autumn)		Assumes water delivered for Reach 4 PWAs only	7840	Min. 6680 ML Not required if Reach 4 PWA provided			7840	Min. 6680 ML Not required if Reach 4 PWA provided			8820	Min. 7440 ML Not required if Reach 4 PWA provided			9590	Min. 7940 ML Not required if Reach 4 PWA provided		
		Reach 3 Baseflows and freshes (winter/spring)		Assumes water delivered for Reach 4 PWAs only	14920	Assumes water delivered for Reach 4 PWA		14920	13610	Assumes water delivered for Reach 4 PWAs and 2580 ML passing flows		13610	13320	Assumes water delivered for Reach 4 PWAs and 5000 ML passing flows		13320	13070	Assumes water delivered for Reach 4 PWAs and 6000 ML passing flows		13070
		Reach 4 Baseflows and freshes (summer/autumn)	8200	Long cease to flow (21 days)	8575	Min. 8200 ML	8200	375	9000	Min. 8350 ML	8350	750	9800	Min. 9050 ML	9050	750	10675	Min. 9550 ML	9550	1225
		Reach 4 Baseflows and freshes (winter/spring)	7370	Lower than recommended	9200	Min. 7200 ML Lower than recommended	7200	2000	9580	Min. 7000 ML Assumes 2580 ML passing flows	7000	2580	10420	Tier 1 assumes 5000 ML passing flows	5420	5000	11320	Tier 1 assumes 6000 ML passing flows	5320	6000
		The Ranch Billabong		N/A		N/A			20	From Reach 4 flows so not additional water	20		20	From Reach 4 flows so not additional water	20		20	From Reach 4 flows so not additional water	20	
	MacKenzie River	Reach 2 Baseflows and freshes (summer/autumn)		Assumes water delivered for Reach 3 PWAs only	960	Min. 750 ML Not required if Reach 3 PWA provided			1030	Min. 750 ML. Not required if Reach 4 PWA provided			1590	Min. 870 ML. Not required if Reach 4 PWA provided			2010	Min. 1050 ML. Not required if Reach 4 PWA provided		
		Reach 2 Baseflows and freshes (winter/spring)		Assumes water delivered for Reach 3 PWAs only	2645	Assumes water delivered for Reach 3 PWA		2645	2545	Assumes water delivered for Reach 3 PWA		2545	2495	Assumes water delivered for Reach 3 PWA		2495	2395	Assumes water delivered for Reach 3 PWA		2395
		Reach 3 Baseflows and freshes (summer/autumn)	2430	4 cease to flows, > max recommended	4480	Min. 3320 ML	3320	1160	4480	Min. 3440 ML	3440	1040	4760	Min. 3700ML	3700	1060	4760	Min. 4120 ML	4120	640

Wimmera Catchment		EXTREME DROUGHT 95% POE			VERY DRY 90% POE				DRY 75% POE				AVERAGE 50% POE				WET 25% POE			
		Reach 3 Baseflows and freshes (winter/spring)	2945	Lower than recommended	2745	Min. 2180 ML Lower than recommended	2180	915	3445	Min. 2530 ML Lower than recommended	2530	915	3620	High fresh issues with sand in channel	3620		3970	High fresh issues with sand in channel	3970	
	Burnt Creek	Upper Burnt Creek Baseflows and freshes (summer/autumn)	950	4 cease to flows	1540	Min. 950 ML 4 cease to flows	950	590	1540	Min. 1165 ML 3 cease to flows	1165	375	1540	Min. 985 ML 3 cease to flows	985	555	1540	Min. 1180 ML	1180	360
		Upper Burnt Creek Baseflows and freshes (winter/spring)	200	Assumes unregulated flows partially offset volumes required	1080	Assumes unregulated flows partially offset volumes required	300	780	1455	Assumes unregulated flows partially offset volumes required	300	1155	2415	Assumes unregulated flows partially offset volumes required	300	2115	3015	Assumes unregulated flows partially offset volumes required	300	2715
		Lower Burnt Creek Bankfull											300	Fill creek before bankfull delivered	300		300	Fill creek before bankfull delivered	300	
	Mt William Creek	Upper Mt William Refuge Pool Filling	300		300		300		300		300		NA				NA			
		Lower Mt William Creek Baseflows and freshes (summer/autumn)	700	Long cease to flow (60 days)	1225	Min. 800 ML 40 day cease to flow	800	425	1225	Min. 800 ML 40 day cease to flow	800	425	1435	Min. 955 ML 21 day cease to flow	955	480	1435	Min. 1135 ML	1135	300
		Lower Mt William Baseflows and freshes (winter/spring)	1200		1200		1200		1770		1770		3290	Tier 1 assumes 1000 ML passing flows	2920	1000	4240	Tier 1 assumes 2000 ML passing flows	2240	2000
	Bungallaly Creek	Bankfull			NA				NA				300	Volume includes filling creek before bankfull delivered	300		300	Volume includes filling creek before bankfull delivered	300	
	Dock Lake	Low level inundation			NA				NA				400	Not to increase water in Green Lake	400		1000	Not to increase water in Green Lake	1000	
	Total Demand		24295		56710		24,450	23,810	57,820		25,675	23,395	64,525		27,970	26,775	69,640		29,445	27,705
Environmental objectives																				
Platypus		Provide continuous baseflows to the lower MacKenzie River to sustain a permanent connection with the Wimmera River to increase available habitat for the MacKenzie River platypus population and allow natural dispersal to other areas. Provide adequate freshes to allow connectivity between habitats from April to June to facilitate annual dispersion of Platypus juveniles into the Wimmera River.																		
Native fish		Maintain self-sustaining freshwater catfish population in the Wimmera River. Maintain self-sustaining endemic fish communities in Wimmera River, MacKenzie River, Mt William Creek and upper Burnt Creek. Maintain native recreational fish species in the Wimmera River.																		
Macroinvertebrates		Maintain suitable conditions (water quality and habitat) for a diverse and abundant macroinvertebrate community through providing flows that prevent declines in habitat and mobilise organic matter and sediment.																		
Water-dependent Vegetation		Maintain submerged and emergent aquatic vegetation quality, diversity and extent.																		
Water quality		Provide flows to try to prevent the exponential increase of salinity levels which cause fish kills, dieback of fringing and emergent vegetation and macroinvertebrate communities. Also mitigate issues with high nutrients levels leading to blue green algal blooms and organic matter creating blackwater events.																		
Geomorphic processes		Maintain channel capacity and diversity as well as prevent colonisation of waterways by terrestrial plant species.																		
High priority carryover requirements																				
Refuge Protection Volumes (7000 ML Wimmera River, 1000 ML MacKenzie River, 1000 ML Mt William Creek, 500 ML Burnt Creek)																				

Appendix 3 contains more detail regarding PWAs in relation to ecological objectives.

8 Delivery Constraints

The *Wimmera River System Environmental Water Management Plan* (Wimmera CMA, 2016) outlines delivery constraints in detail. Given the Wimmera-Mallee Headworks system was designed to harvest water to be released into the former stock and domestic and irrigation channel systems at comparatively modest rates, releases are only typically able to provide baseflows and freshes. Where bankfull and overbank flows are able to be provided (lower Mt William Creek, MacKenzie River and Burnt Creek) instream losses in swampy areas and risks to inundating freehold land make these releases unfeasible. Another factor is the inability to implement adequate rates of rise and fall for freshes in some locations due to the manual operation of some regulators. This is gradually being addressed through a series of repairs and upgrades including with VEWH funding repairs and upgrades to locations like Dad and Dave Weir which has enabled the fishway to be used for the first time since 2009.

9 Increasing Knowledge

Monitoring of waterways is critical in order to better understand the effectiveness of environmental watering activities across a range of climatic conditions. This enhances community confidence in future environmental watering activities and enables adaptive management of future environmental flows.

Although this Seasonal Watering Proposal has been developed using the best available information there are still a number of knowledge gaps and recommendations that remain that can enhance environmental water management in the Wimmera for the benefit of the entire region.

Environmental water deliveries are underpinned by an adaptive management approach. Compliance points for priority reaches are often some distance downstream, a higher release rate is required to cover instream losses through seepage, evaporation and diversion experienced between the delivery point and the compliance point. Therefore ongoing monitoring of flow rates at stream gauges enables environmental flows to be increased or decreased to efficiently meet recommendations. In time the current dataset will be increasingly refined to enable effective and efficient environmental water delivery through better understanding in-stream losses and timing of flows along various waterways.

Compliance monitoring is needed to show flows have been delivered in accordance with recommendations and at the times specified to target areas as precisely and as efficiently as possible. Locations where stream monitoring is needed include: Bungalally Creek, lower Mt William Creek at Dadswell's Bridge or Roses Gap, Reach 2 of the MacKenzie River near Distribution Heads Weir and lower Burnt Creek at the Western Highway crossing. If funded, the installation of these gauges will significantly improve environmental water managers' decision making through ensuring regulated releases are providing the recommended volumes at compliance points as well as quantifying the effect of various flow components on water quality. The installation of Portable Automated Logger System (PALS) unit at Roses Gap, funded by VEWH has been a valuable tool to inform decision making around environmental water releases.

Given the substantial expenditure of public funds that has been undertaken to recover water for environmental flows there is a need to demonstrate the outcomes this will achieve. Recommended condition monitoring, required to document trends and provide context for intervention monitoring though answering key questions around flow-ecology relationships are listed below;

- Fish monitoring provides a valuable annual snapshot into the ecological response of environmental flows. Annually sites on the Wimmera River will be monitored as part of the Angler Report Card program instigated by DELWP although the focus is on angling species rather than small bodied species. Occasionally other fish monitoring programs (e.g. Murray Darling Sustainable Rivers Audit, regional fish monitoring snapshots) will complement this data.
- VEFMAP has been focusing on vegetation and fish responses to environmental watering on the MacKenzie River, Burnt Creek and Mt William Creek in 2017-18. It is likely that elements of this will continue into 2018-19.
- Should good water levels be present in regulated wetlands (Lake Hindmarsh, Dock Lake) bird monitoring will take place.
- Continue annual platypus surveys using trapping and e-DNA sampling in the MacKenzie River.

10 Risk Management

Risk assessment and management is an important aspect of environmental water planning. A teleconference was undertaken with VEWH, CMAs and GWMWater on 20 February 2017 to discuss risk management and environmental watering in detail. Table 17 illustrates the various risks covered in this workshop (likelihood and consequence) associated with planned environmental flow components. Little has changed in the past 12 months to warrant major changes to the risk types, likelihoods and consequences.



Environmental water flowing through fishway at Dad and Dave – December 2017

Table 17. Risks associated with environmental water release components planned for 2018-19.

No	Risk category	Risk description	Likelihood	Consequence	Risk rating	Mitigation strategies	Lead organisation for action
1	Environmental	Insufficient water available for proposed watering actions to meet environmental objectives.	Possible	Major	Extreme	Adaptively prioritise and revise watering actions to optimise outcomes from water available considering seasonal conditions. Prioritise sites and/or watering actions Maximise use of consumptive water en-route for environmental benefit. Consider reserving contingency volume for current year and balancing against carryover needs for future years. Communicate with community and stakeholders around planned watering actions and any revisions required. Undertake complementary actions (e.g. carp removal, fencing).	CMA VEWH GWMWater VEWH CMA CMA
2	Environmental	Environmental water deliveries may generate or mobilise poor quality water (e.g. blackwater, BGA), with adverse water quality and environmental outcomes ; or Areas not targeted for environmental watering actions experience poor quality water (e.g. blackwater, BGA), with adverse water quality and environmental outcomes	Unlikely	Moderate	Medium	Ongoing monitoring to inform water deliveries, including arranging improved access to data. Adapt flow management based on antecedent conditions and local knowledge. Maximise use of consumptive water en route for environmental benefit. Establish environmental reserve to manage management needs. Communicate around current conditions and revised objectives. Undertake complementary actions, including provision of information to the community	CMA VEWH GWMWater VEWH CMA CMA
3	Environmental	Environmental deliveries create improved conditions for non-native species (e.g. carp, invasive weeds) leading to adverse environmental impacts. (Note: This risk addresses the incremental impact of environmental water deliveries on pest plant and animal populations, noting that even in the absence of environmental delivery actions these pests are likely to spread in waterways with adverse environmental impacts)	Possible	Minor	Medium	Adaptively manage flow to incorporate new knowledge from monitoring and research. Monitor invasive species extent and control existing populations (e.g. opportunistic removal of carp in dry conditions). Install physical barrier to prevent translocation (e.g. carp barriers). Develop management agreements with landholders that include pest plant and animal control measures.	CMA CMA CMA CMA
4	Reputation	Inability to demonstrate that environmental water objectives have been achieved, which may lead to a loss of public/political support for activities.	Unlikely	Moderate	Medium	Seek additional funding for and undertake targeted local monitoring (leveraging existing data sets where possible). Invest in monitoring and research to address knowledge gaps and influence existing monitoring programs.	CMA VEWH VEWH

No	Risk category	Risk description	Likelihood	Consequence	Risk rating	Mitigation strategies	Lead organisation for action
						Share new knowledge to promote adaptive management. Communicate monitoring results to local communities.	CMA
5	Legal	Environmental releases cause unauthorised inundation of private land, resulting in impacts on landowner activities and assets.	Possible	Minor	Medium	Ongoing communication with GWMWater and land managers in planning and delivery phases. Consider weather forecasts when planning releases and reschedule deliveries if forecasts indicate potential for flooding. Test and monitor delivery rate and respond to potential incidents. Maintain and inspect infrastructure, including upgrading infrastructure where required before delivery occurs. Identify likely areas of impact by understanding historical impacts and previous experience, and modify flow planning, or undertake works to reduce risk of inundation.	CMA GWMWater GWMWater GWMWater CMA
6	Business Cost	Insufficient staff resources available to deliver all planned environmental watering actions, leading to cancellation or interruption of deliveries.	Unlikely	Moderate	Medium	Ongoing communication with the GWMWater to understand constraints and develop a schedule of delivery to manage staff resources. Implement remote monitoring to minimise staff time in the field, within available funding. Continue to actively prioritise actions to match available resources and ensure key actions are delivered.	CMA GWMWater CMA
7	Business Cost	Volume delivered or released exceeds volume approved and/or ordered for use in the event or year.	Rare	Moderate	Medium	Communicate seasonal watering statements to all partners. Monitor delivery rate, provide delivery data to CMA/VEWH and respond to potential incidents. Monitor water use against volume approved for use in seasonal watering statement and adapt water orders if required. Monitor water use against volume approved and undertake regular communications with CMA and GWMWater as part of portfolio management activities. Prioritise sites and/or watering actions if insufficient water is available.	VEWH GWMWater CMA VEWH VEWH
8	Safety	Where delivery structures are unsafe and have limitations on their operation, planned environmental deliveries may not be feasible leading to a failure to achieve environmental outcomes.	Rare	Extreme	High	Upgrade or modify infrastructure to improve safety. Modify method of operation to avoid unsafe work practices and update safety procedures to reflect this (note: safe work procedures may need to be communicated to community/volunteer resources as well as agency staff where they undertake structure operations).	Asset owner Asset owner
9	Environmental	Flow rate at environmental flow compliance point not able to be demonstrated, which may lead to failure	Likely	Moderate	High	Install/upgrade stream gauge monitoring, in collaboration with GWMWater, to improve ability to demonstrate target flow rate achieved.	VEWH

No	Risk category	Risk description	Likelihood	Consequence	Risk rating	Mitigation strategies	Lead organisation for action
		to achieve target flows and environmental benefits not being achieved.					
10	Environmental	Target flow rate at environmental flow compliance point not achieved due to environmental conditions, (for example high losses at very dry sites, hot weather causing excessive evaporation, antecedent conditions and inflow rates) and environmental benefits not being achieved.	Likely	Moderate	High	Monitor flow rate and adjust delivery volume within approved volume.	CMA
11	Environmental	Target flow rate at environmental flow release or measurement point not delivered as ordered, leading to sub-optimal environmental outcomes.	Possible	Moderate	Medium	Monitor flow rate and adjust delivery to meet ordered flow rates. Ongoing communication with the CMA to manage infrastructure or maintenance constraints.	GWMWater GWMWater
12	Safety	Environmental releases create rapid or unexpected changes in water conditions, resulting in injury	Rare	Extreme	High	Communicate flow deliveries to communities and key stakeholders and avoid large flows or rapid changes in flow rate during periods of high river use. (e.g. using community SMS updates services). Erect signage where appropriate.	CMA CMA
13	Reputation	Community groups not supportive of environmental watering delivery.	Low	Major	High	Engage with the local community through a variety of avenues (e.g. workshops, forums, individually to communicate benefits of environmental watering). Develop Statewide communication products and engage with peak bodies	CMA VEWH CMA/VEWH

11 Approval and endorsement

I, the authorised representative of the agency shown below, approve the Seasonal Watering Proposal for the Wimmera system 2018-19.

SIGNED FOR AND ON BEHALF OF Wimmera Catchment Management Authority

Signature of authorised representative

Name of authorised representative: David Brennan

Date:



Tagged Golden Perch at Lower Norton as part of the Angler Report Card Surveys – February 2018

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Appendix 1: Media Information Regarding Environmental Water Releases

It's spring! As the weather warms up and the days get longer, what better place to enjoy it than by the banks of the Wimmera River or cruising along in your canoe or boat? Even better with a fishing rod in hand.

ENVIRONMENTAL FLOWS
Spring 2017 update

#wimmerariver
#wimmerawaterways

Wet lines Wimmera wide

The Wimmera... a flowing fish tale

Angling identity Rex Hunt is the voice of a new film touting the angling virtues of the Wimmera River.

"It's no secret my two passions are footy and fishing, and the Wimmera is the perfect breeding ground for both. Footy legends like Tim Watson and Adam Goodes grew up near the banks of the Wimmera River, one of my favourite inland rivers to fish. Just like country footy and netball clubs, the Wimmera River connects communities and towns, helps them prosper and makes them great places to visit and live."

Local angling expert Chris Spence and Jeparit Angling Club's Brett Ireland also lend their voices to the film, and their message is loud and clear – environmental flows help ensure anglers have a great day out on the water.

Chris caught his first fish in the Wimmera River when he was four years old, and it got him 'hooked for life'. He says he's proud to snuik that it's one of the best rivers in Victoria to fish, with one of the state's best golden perch fisheries and a unique catfish fishery as well.

"Now that we've seen firsthand what these environmental flows do when timed right, they're an absolute bonus to anglers. When flows are on we see a spark in activity and anglers can explore more water."

Watch the film via wcma.vic.gov.au



Want to know when the fish are biting?

To coincide with the film release, Wimmera CMA is launching a new webpage that provides up-to-date information on flows and water quality for the creeks and rivers that receive environmental flows. The map adds to other information sources such as Wimmera CMA's Facebook page and the SMS service that updates subscribers on the latest environmental flows.

Access the map via wcma.vic.gov.au

Planned Spring Flows

Baseflows and freshes:

Wimmera River
MacKenzie River
Upper Burnt Creek
Lower Mt William Creek

Water for wetlands supplied by pipeline:

Corapugna
Wai Wai Swamp
Tarkedia
Challambra Swamp
Sawpit Swamp
Crow Swamp

Environmental releases aim to mimic natural flow events, and complement natural flows.

Fish are more likely to be on the bite in the warmer months when small pulses flow down the river.

If there is heavy rain and natural flows are occurring, environmental flows are ceased.

ENVIRONMENTAL FLOWS Summer 2017 update

Season's Greetings

From our board, management and staff - have a safe and happy festive season!



#wimmerariver
#wimmerawaterways

Fish flourish from flows

Researchers have discovered a spike in Wimmera native fish numbers including an incredibly rapid spread from the Grampians all the way to Horsham of the previously declining Southern Pygmy Perch.

Research shows the small fish species is successfully breeding in both the MacKenzie River and Burnt Creek and extending their range. Their greatest numbers were found to be where aquatic plants were abundant, highlighting the value of habitat for these fish to breed and avoid predators.

Wet conditions during the past two years, combined with regular flows for the environment, have boosted fish numbers and allowed them to repopulate areas that had been impacted by years of drought.

They also caught Blackfish in the MacKenzie, downstream of the Grampians, the first for several years.

Fish ecologists from DELWP's Arthur Rylahs Institute made the discoveries during surveys for the Victorian Environmental Flow Monitoring and Assessment Program (VEFMAP).

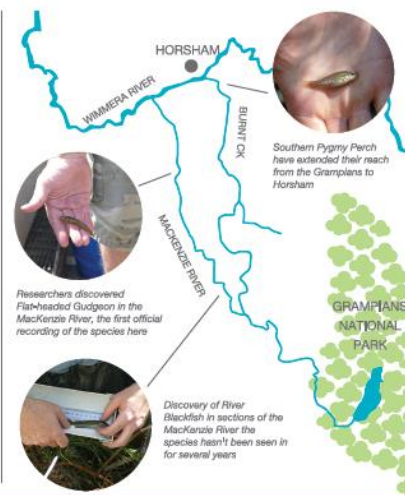
"People who have lived along these waterways for decades speak fondly of the fish populations and thanks to water for the environment and improved seasonal conditions, we are seeing fish species return. The community will be particularly excited about the Blackfish discovery." Wimmera CMA chief executive David Brennan

ENVIRONMENTAL GAINS

We are seeing significant environmental gains in both these systems. Over the past couple of years we have seen the Peron's Tree Frog populating the entire Burnt Creek system and now we are starting to see more fish make their way along the Burnt Creek and MacKenzie River.

WHY SO IMPORTANT?

The research is vital in gaining a better understanding of the impact of environmental flows. It also helps us improve timing and delivery of these flows to achieve the best results.



Summer Flows

Wimmera River and Mt William Creek
Summer low flows and freshes with a period of no flow (2-4 weeks) for part of Dec-Jan

MacKenzie River and upper Burnt Creek
Summer low flows and freshes with periods of no flow (1-2 weeks) for parts of Dec, Jan, Feb & March

www.wcma.vic.gov.au
03 5382 1544 • 24 Darlot Street Horsham 3400



www.wcma.vic.gov.au
03 5382 1544 • 24 Darlot Street Horsham 3400



Appendix 2: Environmental Flow Recommendations

Table 1. Environmental objectives and flow components for the Wimmera River Reaches 2 and 3. Compliance Point – Wimmera River @ Horsham (415200).

Flow component	Timing	Magnitude	Climatic scenario	Frequency	Duration	Associated environmental objective	Is this flow component consistent with the environmental flow study? Include source.
Cease to Flow	Dec-May	0 ML/d	DROUGHT	As infrequently as possible	Less than 21 days in total	Ensure stress on environmental values is not exacerbated beyond natural. Cease to flow periods should be completed with fresh lasting at least 7 days duration.	Yes (Alluvium 2013)
			DRY		Less than 7 days in total		
			AVERAGE				
Baseflow	Dec -May	10 ML/d or natural	ALL	Continuous	Continuous	Maintain edge habitats in deeper pools and runs, and shallow water habitat availability for macroinvertebrates and endemic fish. Maintains near permanent inundated stream channel for riparian vegetation and to prevent excessive in stream terrestrial growth.	Yes (Alluvium 2013)
	June-Nov	100 ML/d	ALL	Continuous	Continuous	Prevent terrestrialisation of the lower banks from invasive phragmites and provide increased flow and variability to support fish movement and diversity of habitat.	Yes (Alluvium 2013)
Freshes	Dec - May	35-40 ML/d	DROUGHT	2 per period	3 - 7 days	Periodically improving water quality by flushing pools during low flows.	Yes (Alluvium 2013)
			DRY				
	Dec -May	100 ML/d	AVERAGE	2 per period	2 - 7 days	Provide variable flow during low flow season for macroinvertebrates (over wood debris to increase biofilm abundance as a food source), fish movement and to maintain water quality and diversity of habitat.	Yes (Alluvium 2013)
			WET	3 per period			
	June - Nov	400 ML/d	DROUGHT	1 per period	1 day	Provide variable flow during high flow season for fish movement and to maintain water quality and diversity of habitat. Also flushes surface sediments from hard substrates for macroinvertebrates.	Yes (Alluvium 2013)
			DRY	3 per period	2 days		
			AVERAGE	5 per period	3 days		
			WET	5 per period	4 days		
	June - Nov	1,300 ML/d	DRY	1 per period	1 day	Wets benches, entraining organic debris and promoting diversity of habitat.	Yes (Alluvium 2013)
			AVERAGE	2 per period	2 days		
			WET	3 per period	3 days		
	June - Nov	2,600 ML/d	AVERAGE	1 per period	2 days	Disturbs algae/bacteria/organic biofilm present on rock or wood debris for macroinvertebrates. Wets	Yes (Alluvium 2013)

			WET	2 per period	3 days	higher benches, entraining organic debris and promoting diversity of habitat.	
Bankfull	Any	4,000 ML/d	AVERAGE	1 per period or natural	2 days	Inundate riparian vegetation to maintain condition and facilitate recruitment. Entrain organic debris in the channel to support macroinvertebrates. Maintain structural integrity of channel.	Yes (Alluvium 2013)
			WET	1 per period			
Overbank	Aug-Nov	8,000 ML/d	WET	1 per period	1 day	Inundate floodplain to maintain condition of adults and facilitate recruitment. Entrain organic debris from the floodplain to support macroinvertebrates. Maintains floodplain geomorphic features.	Yes (Alluvium 2013)

Table 2. Environmental objectives and flow components for the Wimmera River Reach 4. Compliance Point- Wimmera River @ Lochiel Railway Bridge (415246).

Flow component	Timing	Magnitude	Climatic scenario	Frequency	Duration	Associated environmental objective	Is this flow component consistent with the environmental flow study? Include source.
Cease to flow	Dec-May	0 ML/d	DROUGHT	As infrequently as possible	Less than 21 days in total	Limits cease to flow to ensure stress on environmental values is not exacerbated beyond the point of return.	Yes (Alluvium 2013)
			DRY		Less than 7 days in total		
			AVERAGE				
Baseflow	Dec-May	15 ML/d or natural	ALL	Continuous	Continuous	Maintain edge habitats in deeper pools and runs, and shallow water habitat availability for macroinvertebrates and endemic fish. Maintains near-permanent inundated stream channel for riparian vegetation and to prevent excessive in stream terrestrial species growth.	Yes (Alluvium 2013)
	Jun-Nov	30 ML/d	ALL	Continuous	Continuous	Provides flow variability to maintain diversity of habitats.	Yes (Alluvium 2013)
Freshes	Dec -May	70 ML/d	DROUGHT	1 per period	2-7days	Prevent water quality decline by flushing pools during low flows. Provide variable flow during low flow season for macroinvertebrates (over wood debris to increase biofilm abundance as a food source), fish movement and to maintain water quality and diversity of habitat.	Yes (Alluvium 2013)
			DRY	2 per period			
			AVERAGE				
			WET	3 per period			
	June -Nov	70 ML/d	DROUGHT	1 per period	1 day	Increase the baseflow water depth by to provide stimulus for fish movement (not	Yes (Alluvium 2013)
			DRY	3 per period	2 days		

Flow component	Timing	Magnitude	Climatic scenario	Frequency	Duration	Associated environmental objective	Is this flow component consistent with the environmental flow study? Include source.
	June - Nov	200 ML/d	AVERAGE	5 per period	3 days	required in drought years, frequently required in wet years). Provide flow variability to maintain water quality and diversity of fish habitats.	
			WET	5 per period	4 days		
			DRY	1 per period	1 day	Wets lower benches, entraining organic debris and promoting diversity of habitat.	Yes (Alluvium 2013)
		1300 ML/d	AVERAGE	2 per period	2 days		
			WET	3 per period	3 days		
			AVERAGE	1 per period	2 days	Flush surface sediments from hard substrates to support macroinvertebrates. Wets higher benches, entraining organic debris and promoting diversity of habitat.	Yes (Alluvium 2013)
			WET	2 per period	3 days		
Bankfull	Any	2,000 ML/d	AVERAGE	1 per period, or natural	2 days	Inundate riparian vegetation to maintain condition and facilitate recruitment. Entrain organic debris in the channel to support macroinvertebrates. Maintain structural integrity of channel.	Yes (Alluvium 2013)
			WET	1 per period			
Overbank	Aug-Nov	6,000 ML/d	WET	1 per period or natural	1day	Inundate floodplain vegetation to maintain condition and facilitate recruitment. Entrain organic debris from the floodplain to support macroinvertebrates. Maintains floodplain geomorphic features.	Yes (Alluvium 2013)

Table 3. Environmental objectives and flow components for MacKenzie River Reach 1 and 2. Compliance Point: Not present.

Flow component	Timing	Magnitude	Climatic scenario	Frequency	Duration	Associated environmental objective	Is this flow component consistent with the environmental flow study? Include source.
Cease to Flow	Dec -May	0 ML/d	DROUGHT	As infrequently as possible	Less than 80 days in total	Ensure stress on environmental values is not exacerbated beyond natural. Cease to flow periods should be completed with fresh lasting at least 7 days duration.	Yes (Alluvium 2013)
			DRY		Less than 30 days in total		Yes (Alluvium 2013)
			AVERAGE				

Flow component	Timing	Magnitude	Climatic scenario	Frequency	Duration	Associated environmental objective	Is this flow component consistent with the environmental flow study? Include source.
Baseflow	Dec -May	2 ML/d or natural	ALL	Continuous	Continuous	Maintain edge habitats in deeper pools and runs, and shallow water habitat availability for macroinvertebrates and endemic fish. Maintains near-permanent inundated stream channel to prevent excessive in stream terrestrial species growth.	Yes (Alluvium 2013)
	June - Nov	27 ML/d	ALL	Continuous	Continuous	Facilitate annual dispersal of juvenile platypus into the Wimmera River. Provides flow variability to maintain diversity of habitat.	Yes (Alluvium 2013)
Freshes	Dec -May	5 ML/d	DROUGHT	3 per period	4-7 days	Prevent water quality decline by flushing pools during low flows.	Yes (Alluvium 2013)
			DRY	4 per period	4-7 days		
	Dec -May	50 ML/d	AVERAGE	2 per period	2-7 days	Provide variable flow during low flow season for macroinvertebrates (over wood debris to increase biofilm abundance as a food source), fish movement and to maintain water quality and diversity of habitat.	Yes (Alluvium 2013)
			WET	3 per period	2-7 days		
	June- Nov	55 ML/d	DROUGHT	5 per period	2 days	Flush surface sediments from hard substrates to support macroinvertebrates.	Yes (Alluvium 2013)
			DRY	5 per period	4 days		
			AVERAGE	5 per period	5 days		
			WET	5 per period	7 days		
	June-Nov	130 ML/d	DROUGHT	1 per period	1 days	Increase the baseflow water depth by to provide stimulus for fish movement (not required in drought years, frequently required in wet years). Provide flow variability to maintain water quality and diversity of fish habitats.	Yes (Alluvium 2013)
			DRY	3 per period	2 days		
			AVERAGE	5 per period	3 days		
			WET	5 per period	4 days		
Bankfull	Any	500 ML/d	AVERAGE	1 per period	2 days	Inundate riparian vegetation to maintain condition and facilitate recruitment. Entrain organic debris in the channel to support macroinvertebrates. Maintain structural integrity of channel.	Yes (Alluvium 2013)
			WET	1 per period	2 days		

Flow component	Timing	Magnitude	Climatic scenario	Frequency	Duration	Associated environmental objective	Is this flow component consistent with the environmental flow study? Include source.
Overbank	Aug-Nov	900 ML/d	WET	1 per period	1 day	Inundate floodplain vegetation to maintain condition and facilitate recruitment. Entrain organic debris from the floodplain to support macroinvertebrates. Maintains floodplain geomorphic features.	Yes (Alluvium 2013)

Table 4. Environmental objectives and flow components for MacKenzie River Reach 3. Compliance Point: MacKenzie River @ McKenzie Creek Reserve (415251).

Flow component	Timing	Magnitude	Climatic scenario	Frequency	Duration	Associated environmental objective	Is this flow component consistent with the environmental flow study? Include source.
Cease to Flow	Dec-May	0 ML/d	DROUGHT	As infrequently as possible	Less than 80 days in total	Ensure stress on environmental values is not exacerbated beyond the point of no return. Cease to flow periods should be completed with fresh lasting at least 7 days duration.	Yes (Alluvium 2013)
			DRY		Less than 30 days in total		
			AVERAGE				
Baseflow	Any	10ML/d or natural	ALL	Continuous	Continuous	Maintain edge habitats and shallow water habitat availability for macroinvertebrates and endemic fish and near-permanent inundated stream channel for riparian vegetation and prevents excessive instream terrestrial species growth.	Yes (Alluvium 2013)
Freshes	Dec - May	35 ML/d	DROUGHT	3 per period	2-7 days	Provide variable flow during low flow season for macroinvertebrates (over wood debris to increase biofilm abundance as a food source), fish movement and to maintain water quality and diversity of habitat.	Yes (Alluvium 2013)
			DRY	3 per period	3-7 days		
			AVERAGE	4 per period	3-7 days		
			WET	4 per period	3-7 days		
	Jun-Nov	35ML/d	DROUGHT	5 per period	2 days	Stimulate fish movement and maintain water quality and diversity of habitat.	Yes (Alluvium 2013)
			DRY		4 days		
			AVERAGE		5 days		
			WET		7 days		
	Jun-Nov	190 ML/d	AVERAGE	1 per period	1 day		Yes (Alluvium 2013)

Flow component	Timing	Magnitude	Climatic scenario	Frequency	Duration	Associated environmental objective	Is this flow component consistent with the environmental flow study? Include source.
			WET		2 days	Achieve shear stress to flush surface sediments from hard substrates to support macroinvertebrates.	
Bankfull	Any	500 ML/d	WET	1 per period, or natural	1-day	Inundate riparian vegetation to maintain condition and facilitate recruitment (including <i>Callistemon Wimmerensis</i>). Entrain organic debris in the channel to support macroinvertebrates. Maintain structural integrity of channel.	Yes (Alluvium 2013)
Overbank	Aug-Nov	1000 ML/d	WET	1 per period, or natural	1 day	Inundate floodplain vegetation to maintain condition and facilitate recruitment (including <i>Callistemon Wimmerensis</i>). Entrain organic debris in the channel to support macroinvertebrates. Maintains floodplain geomorphic features.	Yes (Alluvium 2013)

Table 5. Environmental objectives and flow components for Lower Mt William Creek (below Lake Lonsdale). Compliance Point: Mt William Creek at Lake Lonsdale Tail gauge (415203).

Flow component	Timing	Magnitude	Climatic scenario	Frequency	Duration	Associated environmental objective	Is this flow component consistent with the environmental flow study? Include source.
Cease to Flow	Dec -May	0 ML/d	DROUGHT	As infrequently as possible	Less than 90 days in total	Ensure stress on environmental values is not exacerbated beyond the point of no return. Cease to flow periods should be concluded with fresh lasting at least 7 days duration.	Yes (Alluvium 2013)
			DRY		Less than 30 days in total		
			AVERAGE				
Baseflow	Any	5 ML/d or natural	All	Continuous	Continuous	Maintain edge habitats and shallow water habitat availability for macroinvertebrates and endemic fish and near-permanent inundated stream channel for riparian vegetation and prevents excessive instream terrestrial species growth.	Yes (Alluvium 2013)
Freshes	Dec-May	20 ML/d	DROUGHT	3 per period	2-7 days	Prevent water quality decline by flushing pools during low flows.	Yes (Alluvium 2013)
			DRY	3 per period	4-7 days		
	Dec -May	30 ML/d	AVERAGE	3 per period	2-7 days	Provide variable flow during low flow season for macroinvertebrates (over wood debris to increase biofilm abundance as a food	

Flow component	Timing	Magnitude	Climatic scenario	Frequency	Duration	Associated environmental objective	Is this flow component consistent with the environmental flow study? Include source.
			WET	3 per period	3-7 days	source), fish movement and to maintain water quality and diversity of habitat.	Yes (Alluvium 2013)
	June-Nov	100 ML/d	DROUGHT	1 per period	3 days	Wets benches, entraining organic debris and promoting diversity of habitat. Flush surface sediments from hard substrates to support macroinvertebrates. Wets low benches, entraining organic debris and promoting diversity of habitat.	Yes (Alluvium 2013)
			DRY	3 per period	3 days		
			AVERAGE	3 per period	5 days		
			WET	5 per period	7 days		
	Jun-Nov	500 ML/d	DRY	1 per period	1 days	Wets highest benches, entraining organic debris and promoting diversity of habitat	Yes (Alluvium 2013)
			AVERAGE	2 per period	2 days		
			WET	3 per period	2 days		
Bankfull	Any	750 ML/d	AVERAGE	1 per year or natural	2 days	Inundate riparian vegetation to maintain condition and facilitate recruitment. Entrain organic debris in the channel to support macroinvertebrates. Maintain structural integrity of channel.	Yes (Alluvium 2013)
			WET	1 per year	4 days		
Overbank	Aug - Nov	1,500 ML/d	WET	1 per year	1 day	Inundate floodplain vegetation to maintain condition and facilitate recruitment. Entrain organic debris from the floodplain to support macroinvertebrates. Maintains floodplain geomorphic features.	Yes (Alluvium 2013)

Table 6. Environmental objectives and flow components for Upper Mt William Creek (above Lake Lonsdale). Compliance Point: Mt William Creek @ Mokepilly (415252).

Flow component	Timing	Magnitude	Climatic scenario	Duration	Associated environmental objective	Is this flow component consistent with the environmental flow study? Include source.
Cease to Flow	Dec-May	0 ML/d	1 per period	90 days maximum	Provides a physical disturbance to the exposed river channel. Leads to an increase in macroinvertebrate species diversity.	Yes (SKM 2005)
Baseflow	June-Nov	Minimum 24 ML/d	Continuous	Continuous	Improve water quality in pools, provides access to habitat for fish and macroinvertebrates	Yes (SKM 2005)
Freshes	Dec –May	> 1 ML/d	2 per year	5 days	Prevents sediment accumulation that can smother habitat. Assists in maintaining and access to suitable habitat for macroinvertebrate and fish species. Assists in maintenance of wetted channel during summer low flow period and improves	Yes (SKM 2005)

Flow component	Timing	Magnitude	Climatic scenario	Duration	Associated environmental objective	Is this flow component consistent with the environmental flow study? Include source.
					water quality in pools. Triggers spawning in many Western Carp Gudgeon as well as a number of other key native fish species.	
	June-November	>52 ML/d	4 per year	7 days	Provides disturbance to macroinvertebrate communities which increases abundance and diversity in native fish species and triggers spawning in Western Carp Gudgeon. Improves water quality in pools.	
	Winter-Spring	>500 ML/d	2 per year	2 days	Transport the sediment downstream to prevent the smothering of key habitats. Flushed fine sediment and organic material from pools. Reduces vegetation encroachment in to channel and disturbs terrestrial vegetation on bank.	

Table 7. Environmental objectives and flow components for Bungalally Creek. Compliance Point: Not Present.

Flow component	Timing	Magnitude	Climatic scenario	Frequency	Duration	Associated environmental objective	Is this flow component consistent with the environmental flow study? Include source.
Bankfull	Any	60 ML/d	AVERAGE	1 per period or natural	2 days	Inundate riparian vegetation to maintain condition and facilitate recruitment. Maintain structural integrity of channel.	Yes (Alluvium 2013)
			WET				
Overbank	Aug-Nov	150 ML./d	WET	1 per period or natural	1 days	Inundate floodplain vegetation to maintain condition and facilitate recruitment. Maintains floodplain geomorphic features.	Yes (Alluvium 2013)

Table 8. Environmental objectives and flow components for Burnt Creek Reach 1 (upper Burnt Creek). Compliance Point: Burnt Creek at Wonwondah East (415223).

Flow component	Timing	Magnitude	Climatic scenario	Frequency	Duration	Associated environmental objective	Is this flow component consistent with the environmental flow study? Include source.
Cease to Flow	Dec-May	0 ML/d	DROUGHT	As infrequently as possible	Less than 80 days in total	Ensure stress on environmental values is not exacerbated beyond the point of no return. Cease to flow periods should be concluded with fresh lasting at least 7 days duration.	Yes (Alluvium 2013)
			DRY		Less than 30 days in total		
			AVERAGE				
Baseflow	All year	1 ML/d or natural	ALL	Continuous	Continuous	Maintain edge habitats and shallow water habitat availability for fish and macroinvertebrates and inundated stream channel for riparian vegetation and prevents excessive instream terrestrial growth.	Yes (Alluvium 2013)

Flow component	Timing	Magnitude	Climatic scenario	Frequency	Duration	Associated environmental objective	Is this flow component consistent with the environmental flow study? Include source.
Freshes	Dec - May	30 ML/d	DROUGHT	3 per period	2-7 days	Prevent water quality decline by flushing pools during low flows.	Yes (Alluvium 2013)
			DRY	3 per period	4-7 days		
			AVERAGE	3 per period	2-7 days		
			WET	3 per period	3-7 days		
	Jun-Nov	55 ML/d	DROUGHT	1 per period	3 days	Provide variable flow for fish movement and diversity of habitat. Also flushes surface sediments from hard substrates for macroinvertebrates.	
			DRY	3 per period	3 days		
			AVERAGE	5 per period	5 days		
			WET	5 per period	7 days		
	May - Jun	160 ML/d	DRY	1 per period	1 day	Disturb the algae/bacteria/organic biofilm present on rock or wood debris to support macroinvertebrate communities.	
			AVERAGE	2 per period	2 days		
			WET	3 per period	3 days		
Bankfull	Any	400 ML/d	AVERAGE	1 per period, or natural	2 days	Inundate riparian vegetation to maintain condition and facilitate recruitment. Entrain organic debris in the channel to support macroinvertebrates. Maintain structural integrity of channel.	Yes (Alluvium 2013)
			WET				
Overbank	Aug-Nov	1,000 ML/d	WET	1 per year	1 day	Inundate floodplain vegetation to maintain condition and facilitate recruitment. Entrain organic debris from the floodplain to support macroinvertebrates. Maintains floodplain geomorphic features.	Yes (Alluvium 2013)

Table 9. Environmental objectives and flow components for Burnt Creek Reach 2 (lower Burnt Creek). Compliance Point: Not Present.

Flow component	Timing	Magnitude	Climatic scenario	Frequency	Duration	Associated environmental objective	Is this flow component consistent with the environmental flow study? Include source.
Bankfull	Any	45 ML/d or natural	AVERAGE	1 per period, or natural	2 days	Inundate riparian vegetation to maintain condition and facilitate recruitment. Entrain organic debris in the channel to support macroinvertebrates. Maintain structural integrity of channel.	Yes (Alluvium 2013)
			WET				
Overbank	Aug - Nov	90 ML/d	WET	1 per period	1 day	Inundate floodplain vegetation to maintain condition and facilitate recruitment. Entrain organic debris from the floodplain to support macroinvertebrates. Maintains floodplain geomorphic features.	Yes (Alluvium 2013)

Table 10. Environmental objectives and flow components for Dock Lake Compliance Point: Not Present.

Flow component	Timing	Magnitude	Climatic scenario	Frequency	Duration	Associated environmental objective	Is this flow component consistent with the environmental flow study? Include source.
Inundation (partial fill)	Any	Between 271 ML and 973 ML	DRY/AVERAGE/WET	1 in 2 years (WET) 1 in 3-4 years (AVE) 1 in 5 years (DRY)	3 to 14 months	Wetland vegetation and bird life cycles with ancillary benefits for frogs, macroinvertebrates and turtles	Yes (Jacobs 2015)

Appendix 3: Flow components that have been delivered from 2005 to 2018.

Reach	Flow Component	Hydrological achievement of flow components over time												
		'05-06	06-07	07-08	08-09	09-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18
4 Wimmera River	Summer autumn baseflows 15 ML/d	E/U	E/U	E/U	E/U	E/U	E/U	E/U	E/U	E/U	E/U	E	E	E
4 Wimmera River	Winter spring baseflows 30 ML/d	U	U	U	U	U	E/U	E/U	E/U	E/U	E/U	U	U	E/U
4 Wimmera River	Summer-autumn freshes 70 ML/d x 1-3 x 2-7 d	E/U	E/U	E/U	E/U	E/U	E/U	E/U	E/U	E/U	E/U	E	E	E
4 Wimmera River	Winter-spring freshes 70 ML/d x 1-5 x 1-4 d	U	U	U	U	U	E/U	E/U	E/U	E/U	E/U	U	U	U/E
2 MacKenzie River	Summer autumn, baseflows 2 ML/d	E/U/O	E/U/O	E/U/O	E/U/O	E/U/O	E/U/O	E/U/O	E/U/O	E/U/O	E/U/O	E/O	E	E
2 MacKenzie River	Winter spring baseflows 27 ML/d	U	U	U	U	U	E/U/O	E/U/O	E/U/O	E/U/O	E/U/O	U/O	U	U/E
2 MacKenzie River	Summer-autumn freshes 5 to 50 ML/d x 2-4 x 2-7 d	E/U	E/U	E/U	E/U	E/U	E/U	E/U	E/U	E/U	E/U	E	E	E
2 MacKenzie River	Winter-spring freshes 55 ML/d x 5 x 2-7d	U	U	U	U	U	E/U	E/U	E/U	E/U	E/U	U	U	U/E
2 MacKenzie River	Winter-spring freshes 130 ML x 1-5 x 1-4 d	U	U	U	U	U	E/U	E/U	E/U	E/U	E/U	U	U	U
3 MacKenzie River	Summer, autumn, Winter, spring baseflows 10 ML/d	E/U	E/U	E/U	E/U	E/U	E/U	E/U	E/U	E/U	E/U		U/E	E/U

Reach	Flow Component	Hydrological achievement of flow components over time												
		'05-06	06-07	07-08	08-09	09-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18
3 MacKenzie River	Summer-autumn freshes 35 ML/d x 3-4 x 2-7 d	U	U	U	U	U	E/U	E/U	E/U	E/U	E/U		E	E
3 MacKenzie River	Winter-spring freshes 35 ML/d x 5 x 2-7 d	U	U	U	U	U	E/U	E/U	E/U	E/U	E/U		U	U
Lower Mt William	Summer, autumn, Winter, spring baseflows 5 ML/d	E/U	E/U	E/U	E/U	E/U	E/U	E/U	E/U	E/U	E/U	U	E/U	E
Lower Mt William	Summer-autumn freshes 20-30 ML x 3 x 2-7 d	E/U	E/U	E/U	E/U	E/U	E/U	E/U	E/U	E/U	E/U		E	E
Lower Mt William	Winter-spring freshes 100-500 ML/d x 1-5 x 1-7d	E/U	E/U	E/U	E/U	E/U	E/U	E/U	E/U	E/U	E/U		U	U
Upper Mt William Creek	Summer-autumn freshes 500 ML	U	U	U	U	U	U/E	U/E	U/E	U/E	E/U	E/U	U	U
Upper Burnt Creek	Summer autumn Winter-spring baseflows 1 ML/d	E/U/O	E/U/O	E/U/O	E/U/O	E/U/O	E/U/O	E/U/O	E/U/O	E/U/O	E/U/O	E/O/U	E/U	E/U
Upper Burnt Creek	Summer-autumn freshes 30 ML/d x 3 x 2-7d	E/U	E/U	E/U	E/U	E/U	E/U	E/U	E/U	E/U	E/U	E	E	E
Upper Burnt Creek	Winter-spring freshes 55 ML/d x 1-5 x 3-7d	U	U	U	U	U	U	U/E	E/U	E/U	E/U	O/U	U	U
Upper Burnt Creek	Autumn-winter freshes 160 ML/d x 1-3 x 1-3d	U	U	U	U	U	U	U/E	U	U	U	O/U	U	U
Lower Burnt Creek	Winter-spring freshes 45ML/d x1 x 2d	U	U	U	U	U	U	U	E/U	E/U	E/U		U	U
Bungalally Creek	Winter-spring freshes 60 ML/d x 1 x 2d	U	U	U	U	U	U	U	E/U	E/U	E		U	U

Key for Table.

	No significant part of the flow component achieved
	Flow component partially achieved
	Flow component has been completely achieved, i.e. complete duration, frequency and magnitude was achieved
E	Managed environmental water release
O	Consumptive water en route/other managed flow
U	Unregulated flows
X	Unknown

Appendix 4: Priority Watering Actions

Table 11. Priority Watering Actions Wimmera Reach 4.

PWA Target	Flow function	Priority	Rationale	Volume (ML)
Baseflow Dec-May 15 ML/day	Maintain edge habitats in deeper pools and runs, and shallow water habitat availability for macroinvertebrates and endemic fish. Maintains near-permanent inundated stream channel for riparian vegetation and to prevent excessive in stream terrestrial species growth.	Very High	Salinity levels in the lower Wimmera River reach 50,000 $\mu\text{S}/\text{cm}$ during cease to flow conditions. This flow component plays a critical role in maintaining water quality for aquatic and riparian ecosystems. This flow mitigates severe salinity impacts so reduces likelihood of fish kills, algae blooms and die back of fringing vegetation and macroinvertebrates which were common events during the 2002 to 2010 when there were long cease to flow periods. This baseflow also supports vegetation in low benches.	9,100 ML
Baseflow June-Nov 30 ML/day	Provides flow variability to maintain diversity of habitats.	Very High	It is of high importance to maintain constant baseflows in the lower Wimmera River during winter and spring when there are periods of low rainfall. Salinity levels in the lower Wimmera River reach 50,000 $\mu\text{S}/\text{cm}$ during cease to flow conditions. This flow component plays a critical role in maintaining water quality for aquatic and riparian ecosystems. This flows diminish the high risk of die back of vegetation and fish fills which were common events during the 2002 to 2010 when there were long cease to flow periods.	9,150 ML
Freshes Dec-May, 1-3 events of 70 ML/day 2-7 days	Prevent water quality decline by flushing pools during low flows. Provide variable flow during low flow season for macroinvertebrates (over wood debris to increase biofilm abundance as a food source), fish movement and to maintain water quality and diversity of habitat.	Very High	Salinity levels in the lower Wimmera River reach 50,000 $\mu\text{S}/\text{cm}$ during cease to flow conditions. This flow component plays a critical role in freshening the water quality during very hot period of the year where evaporation and seepage levels are high and baseflows are not able to prevent water quality decline in refuge pools. These freshes maintain water quality for aquatic and riparian ecosystems. These freshes diminish the high risk of algal blooms, die back of vegetation and fish fills which were common events during the 2002 to 2010 when there were long cease to flow periods.	980 ML
Freshes - smaller June-Nov 1-5 events of 70 ML/day 1-4 days	Increase the baseflow water depth by to provide stimulus for fish movement (not required in drought years, frequently required in wet years). Provide flow variability to maintain water quality and diversity of fish habitats. Wets lower benches, entraining organic debris and promoting diversity of habitat.	Very High	This flow component plays a critical role in freshening the water quality during winter and spring periods when there is low rainfall. These freshes are useful when baseflows are not able to prevent water quality decline. These freshes provide flow variability to stimulate fish movement and maintain a healthy water quality for aquatic and riparian ecosystems.	350 - 1225 ML
Freshes - medium June-Nov 1-3 events of 200 ML/day 1-3 days	Provide variable flow during high flow season for fish movement and to maintain water quality and diversity of habitat. Also flushes surface sediments from hard substrates for macroinvertebrates	Medium	Wet lower benches, entraining organic debris and promoting diversity of habitat	190 - 380 ML

PWA Target	Flow function	Priority	Rationale	Volume (ML)
Inundation of Ranch Billabong	Provide water to disconnected anabranch of Wimmera River at Dimboola via pumping	High	Provides cultural outcomes given the significance of the site and also some riparian and aquatic vegetation outcomes (e.g. Common Sneezeweed).	20 ML

Table 12. Priority Watering Actions MacKenzie River Reach 3.

PWA Target	Flow function	Priority	Rationale	Volume (ML)
Baseflow all year 10 ML/day	Maintain edge habitats and shallow water habitat availability for macroinvertebrates and endemic fish and near-permanent inundated stream channel for riparian vegetation and prevents excessive instream terrestrial species growth. Facilitate annual dispersal of juvenile platypus into the Wimmera River.	High (Very High June-November)	Prevents reach 2 and reach 3 from drying out completely and loss of high value fish and platypus communities. Lack of flows would see it dry out in a few weeks thereby losing a high value fish community and opportunities for fish movement/dispersal.	5475 ML
Freshes December-May 3-4 events of 35 ML/day 2-7 days	Provide variable flow during low flow season for macroinvertebrates (over wood debris to increase biofilm abundance as a food source), fish movement and to maintain water quality and diversity of habitat.	High	This watering action benefits native fish movement and macroinvertebrate health and maintenance of water quality and dispersal of the very high value platypus population.	210 – 980 ML
Freshes June-November 5 events of 35 ML/day 2-7 days	Stimulate fish movement and maintain water quality and diversity of habitat.	Very High	This watering action benefits native fish movement and macroinvertebrate health and maintenance of water quality and diversity of habitat.	350 – 1225 ML

Table 13. Priority Watering Actions MacKenzie River Reach 2.

PWA Target	Flow function	Priority	Rationale	Volume (ML)
Baseflow Dec-May 2 ML/day	Maintain edge habitats in deeper pools and runs, and shallow water habitat availability for macroinvertebrates and endemic fish. Maintains near-permanent inundated stream channel to prevent excessive in stream terrestrial species growth.	Very High	This reach of Mackenzie River supports the source population of indigenous fish (River Blackfish, Mountain Galaxias, Flathead Gudgeon, Southern Pygmy Perch) and a population of platypus that are regionally important. This watering action prevents this reach from drying out completely and loss of high value fish and platypus communities.	950 ML
Baseflow June-Nov 27 ML/day	Facilitate annual dispersal of juvenile platypus into the Wimmera River. Provides flow variability to maintain diversity of habitat.	High	Whilst these flows are typically generated through pickup, if it is a dry winter spring there's still a risk that it could dry out in parts.	5,490 ML

PWA Target	Flow function	Priority	Rationale	Volume (ML)
Freshes Dec-May 2-4 events of 5-50 ML/day 2-7 days	Prevent water quality decline by flushing pools during low flows. Provide variable flow during low flow season for macroinvertebrates (over wood debris to increase biofilm abundance as a food source), fish movement and to maintain water quality and diversity of habitat.	Very High	Smallish volume has typically meant it has been delivered with baseflows to get the full suite of flow for the reach. This watering action prevents water quality decline and supports fish movement. This watering action is important to reduce salinity levels and vegetation diversity on banks.	60 – 1050 ML
Freshes June-Nov 5 events of 55 ML/day 2-7 days	Provide variable flow during low flow season for macroinvertebrates (over wood debris to increase biofilm abundance as a food source), fish movement and to maintain water quality and diversity of habitat. Flush surface sediments from hard substrates to support macroinvertebrates.	High	Provides some variation of flow to encourage fish movement, healthy macroinvertebrate communities, maintains water quality and mobilisation of sediment.	250 - 875 ML

Table 18. Priority Watering Actions Upper Burnt Creek.

PWA Target	Flow function	Priority	Rational	Volume (ML)
Baseflow all year 1 ML/day	Maintain edge habitats and shallow water habitat availability for fish and macroinvertebrates and inundated stream channel for riparian vegetation and prevents excessive instream terrestrial growth.	Very High	This watering action is critical for supporting a good native fish community as well as Western Swamp Crayfish.	1,825 ML
Fresh Dec-May 3 events of 30 ML/day 2-7 days	Prevent water quality decline by flushing pools during low flows	Very High	This watering action provides good vegetation, macroinvertebrates and native fish outcomes.	1,050 ML
Fresh Jun-Nov 1-5 events of 55 ML/day 3-7 days	Provide variable flow for fish movement and diversity of habitat. Also flushes surface sediments from hard substrates for macroinvertebrates. Disturb the algae/bacteria/organic biofilm present on rock or wood debris to support macroinvertebrate communities.	Very High	This watering action provides good vegetation, macroinvertebrates and native fish outcomes.	180 – 630 ML
Fresh May-Jun 1-3 events of 160 ML/day 1-3 days	Disturb the algae/bacteria/organic biofilm present on rock or wood debris to support macroinvertebrate communities.	Medium	This watering action provides good vegetation, macroinvertebrates and native fish outcomes.	160 - 1440 ML

Table 15. Priority Watering Actions Lower Burnt Creek.

PWA Target	Flow function	Priority	Rational	Volume (ML)
Bankfull Any month 1 event of 45 ML/d for 2 days	Inundate riparian vegetation to maintain condition and facilitate recruitment. Entrain organic debris in the channel to support macroinvertebrates. Maintain structural integrity of channel.	High	This watering action is critical for supporting a good fish community as well as Western Swamp Crayfish.	300 ML
Overbank Aug-Nov 1 event of 90 ML/d for 1 day	Inundate floodplain vegetation to maintain condition and facilitate recruitment. Entrain organic debris from the floodplain to support macroinvertebrates. Maintains floodplain geomorphic features.	Medium	This watering action provides good vegetation, macroinvertebrates and native fish outcomes.	180 ML

Table 16. Priority Watering Actions Bungalally Creek.

PWA Target	Flow function	Priority	Rationale	Volume (ML)
Bankfull Any time of year 1 event of 60 ML/day for 2 days	Inundate riparian zone to maintain condition of adults and facilitate recruitment for riparian EVCs Maintain structural integrity of channel and prevents loss of channel diversity through lack of flow variability.	Medium	Bungalally Creek has valuable riparian vegetation in some sections which provides important habitat for terrestrial and aquatic species and much like Reach 2 of the Burnt Creek. Due to the high level regulation of this system and the fact that it would only receive flows during high flow events, the creek bed will most probably be completely dry when watering commences.	300 ML

Table 17. Priority Watering Actions Upper Mt William Creek.

PWA Target	Flow function	Priority	Rationale	Volume (ML)
Fill refuge pools during dry conditions	Prevents sediment accumulation that can smother habitat. Assists in maintaining and access to suitable habitat for macroinvertebrate and fish species. Assists in maintenance of wetted channel during summer low flow period and improves water quality in pools. Triggers spawning in many Western Carp Gudgeon as well as a number of other key native fish species.	Very High	Lake Lonsdale levels are reducing following dry conditions in 2017. It is very important to continue to monitor these refuge pools that provide crucial drought refuge to high value native fish populations, River Blackfish, Mountain Galaxias, Australian Smelt, Flathead Gudgeon, short finned eel and the 'vulnerable' Southern Pygmy Perch, (Biosis 2012), (SKM 2005).	300 ML

Table 18. Priority Watering Actions Lower Mt William Creek.

PWA Target	Flow function	Priority	Rationale	Volume
Baseflow year round 5 ML/day	Maintain edge habitats and shallow water habitat availability for macroinvertebrates and endemic fish and near-permanent inundated stream channel for riparian vegetation and prevents excessive instream terrestrial species growth.	High	The lower Mt William Creek contains high value native fish populations, River Blackfish, Mountain Galaxias, Australian Smelt, Flat-headed Gudgeon, short finned eel and the 'vulnerable' Southern Pygmy Perch, (Austral 2015). The absence of flow would place these very high environmental values at risk.	1,825 ML
Fresh Dec-May 3 events of 20 to 30 ML/day 2-7 days	Prevent water quality decline by flushing pools during low flows. Provide variable flow during low flow season for macroinvertebrates (over wood debris to increase biofilm abundance as a food source), fish movement and to maintain water quality and diversity of habitat.	Very High	This watering action provides a much needed improvement to water quality getting water to the bottom end of the creek which baseflows tend not to be able to do.	90 - 525 ML
Fresh June-Nov 1-5 events of 100 ML/day 1-7 days	Wets benches, entraining organic debris and promoting diversity of habitat. Flush surface sediments from hard substrates to support macroinvertebrates. Wets low benches, entraining organic debris and promoting diversity of habitat.	Medium	If flow for the Wimmera River is provided from Taylors Lake then these freshes are important to water the Wimmera River above Taylors. This watering action also provides a dispersal mechanism for high value native fish communities as well as vegetation and macroinvertebrate outcomes.	285 - 3325 ML

Table 19. Priority Watering Actions Dock Lake

PWA Target	Flow function	Priority	Rationale	Volume (ML)
Provide low-level inundation for high quality wetland habitat	Provides abundant vegetation response and subsequent bird-breeding events for a number of wetland bird species.	High	Aligns with objectives and recommendations in <i>Dock Lake FLOWS Study</i> (Jacobs, 2015). Water provided from unregulated flows/spills in 2016 led to a significant bird-breeding event and an abundance of wetland birds.	300 - 1000ML