Seasonal Watering Proposal for the Wimmera River System 2017-18

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Wimmera CMA

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However, it is acknowledged that the contents and views expressed within this report are those of the Wimmera Catchment Management Authority and do not necessarily reflect the views of the parties acknowledged below.

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Executive summary

This proposal is for the use of available water in the Wimmera Catchment to maximise environmental water related outcomes in 2017-18. The proposal is for the Lower Wimmera River, Burnt Creek, MacKenzie River, Bungalally Creek and Mt William Creek. These waterways have highly altered flow regimes due to water regulation for the Wimmera Mallee Headworks system. The delivery of environmental water to these waterways is intended to support the environmental assets within these waterways. These waterways and their floodplains support numerous environmental values 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 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 leading into 2017-18 have been characterised by a thirteen year drought between 1997 and 2010, floods and very wet conditions in 2010-11 and a subsequent series of four dry years followed by a flood event in spring 2016. Since 2010-11 environmental water releases have allowed many priority environmental flow components to be met, which has substantially improved the condition of fish and vegetation communities. This has meant that waterways were more resilient heading into the dry conditions in 2015-16 (Aquatic Ecology and Technology Consulting, 2016), where inflows were the fifth lowest on record. Environmental watering in 2015-16 played a critical part in protecting the environment and avoiding catastrophic events. Low allocations meant that there was only enough water to provide occasional flows to sustain very high priority refuges. Above average rainfall in winter and spring 2016 has generated substantial runoff into storages which raised allocations for almost all entitlements to 100% in 2016-17. Environmental water releases over drier months in late spring through to autumn have capitalised on the gains achieved by the floods and significant unregulated flows in winter/spring 2016.

This proposal outlines the range of proposed environmental watering actions for the Wimmera River system for the 2017-18 water year. The focus for 2017-18 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. A fresh in spring is planned for Reach 3 of MacKenzie River to encourage migration of platypus into this reach and potentially the lower Wimmera River. 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 conditions unfold throughout the year to provide these components. Four management scenarios have been developed to cover the range of possible conditions. These scenarios and associated watering actions are outlined in Table 16. The Bureau of Meteorology seasonal forecasts and allocations will be used to determine which scenario will be managed to. If climatic conditions vary throughout the year, so too will associated watering actions.

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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. 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.

The VEWH prepares a statewide seasonal watering plan each (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.

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; and

- inform the development of environmental water priorities in the VEWH's seasonal watering plan.

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 board. 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 km^2. 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, Flatheaded 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, 2016).

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 in the *Wimmera Waterway Strategy 2014-2022* (Wimmera CMA 2014)	FLOWS 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	Lochiel Railway Bridge 415246		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.	Alluvium 2013
Upper Burnt Creek	East Wonwondah 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. 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. 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

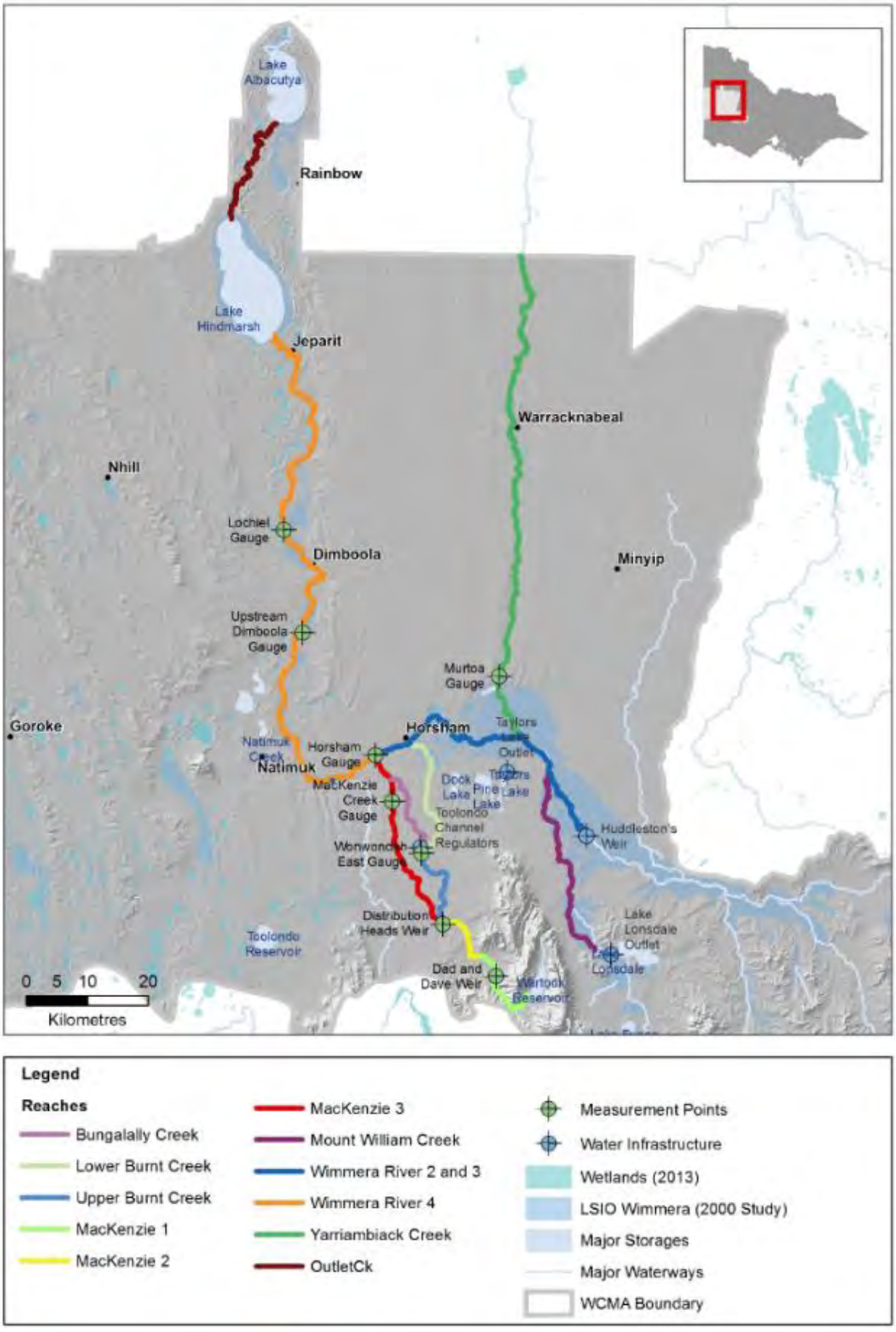


Figure 1. Wimmera system reaches, measurement points and target locations.

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 VEWH 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 2017/18 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	24,255	27,185	26,245	27,910	29,815
Current carryover (ML) to share between the Wimmera and Glenelg Systems	31,250				
Current forecast environmental allocation (ML) to share between the Wimmera and Glenelg Systems	47,474	54,369	56,397	64,103	71,810

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 releases.

Day-to-day environmental release operations are communicated to the public via a registered SMS service. Quarterly media releases have been published in local newspapers, on the Wimmera CMA web site and on Facebook to update the community regarding environmental releases planned and delivered, fish and vegetation survey results and water quality results. Examples of media releases 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 organised a number of events to engage with the community about the environmental watering program, including;

- Environmental Water Management Forum (August 2016), invited agency and community representatives to attend an information night at Dimboola Rowing Clubrooms. Presentations were provided 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 drought actions and other learnings.
- As part of the Dimboola Fishing Classic, the Wimmera CMA held the 'Carp Conversation' which included presentations by Jarod Lyon (Arthur Rylah Institute) and Dion Iervasi (Austral Research and Consulting) explaining the latest in regard to the release of the carp herpes virus and how native fish are making a comeback in response to environmental flows. These presentations were held on the 18th of November at the Dimboola Recreation Reserve and also included carp for people to consume and a display of electrofishing equipment.
- The Wimmera CMA held a community education event during the Horsham Fishing Competition in March 2017. 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.
- New signage was installed along the Wimmera River at Horsham, Dimboola and Jeparit in October 2016. These signs explain the purpose of environmental watering, how organisations monitor waterway condition and how flows are important for a healthy river which in turn helps the community. The signs were developed in conjunction with the Wimmera Anglers' Association and supported by local government. They include details of how the community can help monitor environmental watering action using Instagram.

- Citizen science was employed with an exciting project involving members of the Wimmera Anglers' Association undertaking eDNA sampling to identify the presence/absence of Freshwater Catfish and Golden Perch communities in response to flows at Dimboola.

Shared Community Benefits

During exceptionally dry periods, such as during 2015-16, 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 refulated waterways given that (unlike other parts of Victoria) they are not used to deliver irrigation water and unregulated flows are negligible or non-existant. Events that have directly benefitted from environmental water releases in the past include;

- Water skiing at the Horsham and Dimboola weir pools;
- Rowing at Horsham and Dimboola, including the Dimboola Rowing Regatta;
- The Kanamaroo Festival in Horsham which includes a waterskiing display;
- Horsham Dragon Boat Regatta;
- Horsham Triathlon; and
- The Horsham, Dimboola and Jeparit fishing competitions.

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 wetland or creek and the life it brings.

Wimmera Development Association, on behalf of Wimmera CMA and other partners (GWMWater, local government) is managing a project to quantify the broader social and economic benefits of water in the region (environmental and recreational water). This includes surveys of users at peak recreation periods such as public holidays and relevant stakeholders like committees of management. It is intended that there will be a longitudinal component which will track the impact of climate (i.e. droughts and floods) on social and economic benefits over the years.

Wimmera Aboriginal Water Project

Wimmera CMA, in partnership with the Barengi Gadgin Land Council (BGLC) are undertaking an Aboriginal Water scoping project for the Wimmera River system. This project due to be completed in June 2017, will ensure local Aboriginal values and uses of water are better incorporated in water resource planning and management in Victoria such as cultural flows.

BGLC is the trustee for the Native Title rights and interests of Traditional Owners from the Wotjobaluk, Jaadwa, Jadawadjali, Wergaia and Jupagulk family groups as well as a Registered Aboriginal Party. The organisation was established as a result of the first Native Title Settlement in Victoria, on the Wimmera River Reserve (on Crown land), which recognises the rights of Traditional Owners to hunt, fish, gather and camp under traditional laws and customs. The BGLC would like to improve access for traditional owners to other waterways that are not included in the Native Title settlement.

Cultural flows have been defined as "water entitlements that are legally and beneficially owned by Indigenous Nations of a sufficient and adequate quantity and quality to improve the spiritual, cultural, environmental, social and economic conditions of those Indigenous Nations. This is our inherent right". [1]

This scoping project will help build knowledge around Aboriginal Water and will assist the Wimmera CMA in developing environmental watering priorities that incorporate social, spiritual and cultural values of the Traditional Owners. The project objectives include:

- Document Traditional Owner aspirations for the Wimmera River system and priorities cultural hotspots through community cultural mapping and site visits including group/family/individual workshops and discussions;
- Identify alignment between environmental watering and cultural objectives;

[1] This definition was endorsed by representatives from thirty-one Indigenous nations at a joint meeting of the Murray Lower Darling River Indigenous Nations (MLDRIN) and the Northern Basin Aboriginal Nations (NBAN) -The Echuca Declaration, September 2010.

- Develop short, medium and long-term cultural flow objectives to improve cultural, environmental, social and economic conditions of Traditional Owners;
- Identify management options to achieve these objectives and
- Develop print and video case studies on Aboriginal water values, knowledge and management interests

Carp Conversation – Dimboola – November 2016

River Yarns – Aboriginal Waterway Assessments for the Wimmera River – March 2017

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	Consultation with the Board regarding proposed actions and communication approaches.	Provided information and decision papers regarding SWPs at Board meetings in early 2017. Monthly updates of EWR actions in Board reports.	Nil
Program Partners	VEWH	Involve VEWH in development of proposal to assist with aligning document with VEWH requirements	Direct engagement and via formal advisory groups (meetings between Glenelg Hopkins CMA, GWMWater, Wimmera CMA & VEWH, 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 and meetings).	DELWP have recently funded a number of projects to improve the efficiency of environmental flow delivery.
	CEWO	Discuss proposed watering actions when CEWO water becomes available.	Direct engagement.	CEWO may receive allocations for the first time since the water purchase for the environment if there is good rainfall in 2017.
Councils ad 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	Discuss 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 2017-18.	Periodic contact throughout the year and via annual environmental watering forum. Regular discussion regarding weir management (monthly/ weekly over summer).	Hindmarsh Shire Council are very interested in environmental water allocations available and its impact on the region's economy, tourism and the environment. Carp aggregations and leakage of water at Jeparit Weir are a concern.
	Horsham Rural City Council (HRCC)	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 2017-18.	Periodic contact throughout the year and via annual environmental watering forum. Regular discussion regarding weir management (monthly/ weekly over summer).	Council are very interested in environmental water allocations available and its impact on the region's economy, tourism and the environment.
	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.	Infrequent discussions occur to share information.
	Parks Victoria	Parks Victoria are interested in monitoring outcomes and flows relating to land they manage in the Grampians and the Wimmera Heritage River section.	Periodic contact throughout the year and via annual environmental watering forum.	Infrequent discussions occur to share information.
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 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. Regular discussions with group members and attend meetings throughout the year when requested.	The September 2016 floods meant that no regulated releases were needed with good flows along the creek.
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 after the March Labour Day weekend.
	Field and Game Australia	Communicate proposed environmental watering actions and seasonal outlook in relation to likely environmental water allocation for 2017/2018 next watering year.	Periodic contact throughout the year.	Infrequent discussions occur to share information.
	VRFish	Communicate proposed environmental watering actions and seasonal outlook in relation to likely environmental water allocation for 2017/2018 next watering year.	Periodic contact throughout the year and via annual environmental watering forum.	Infrequent discussions occur to share information.
	Natimuk Lake Water Ski Club	Communicate proposed environmental watering actions and seasonal outlook in relation to likely environmental water allocation for 2017/2018 next watering year.	Periodic contact throughout the year and via annual environmental watering forum.	In the past 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	Communicate proposed environmental watering actions and seasonal outlook in relation to likely environmental water allocation for 2017/2018 next watering year.	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. Raising water levels via environmental water assisted this through watering revegetated areas.
	Dimboola Fishing Classic	Communicate proposed environmental watering actions and seasonal outlook in relation to likely environmental water allocation for 2017/2018 next watering year.	Periodic contact throughout the year and via annual environmental watering forum.	WCMA staff organised presenters to talk about carp herpes virus and how native fish are making a comeback to coincide with Dimboola Fishing Classic. VEWH staff presented to Dimboola Fishing Classic Committee and sponsors in 2016.
	Horsham Triathlon Committee	Communicate proposed environmental watering actions and discuss the needs of this event.	Periodic contact throughout the year and via annual environmental watering forum.	Infrequent discussions occur to share information.
	Wimmera Anglers' Association	Communicate proposed environmental watering actions.	Periodic contact throughout the year and via annual environmental watering forum.	Wimmera CMA worked closely with the Wimmera Anglers' Association to deliver projects highlighting the role of environmental water in supporting angling opportunities.

	Who	Purpose of consultation	Form and timing of consultation	Issues identified/comments
	Dimboola Rowing Club	Communicate proposed environmental watering actions and discuss the needs of this event.	Periodic contact throughout the year and via annual environmental watering forum.	Infrequent discussions occur to share information.
	Jeparit Anglers' Club	Communicate proposed environmental watering actions.	Periodic contact throughout the year and via annual environmental watering forum.	Infrequent discussions occur to share information.
	Hindmarsh Ski Club	Communicate proposed environmental watering actions,	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 promote the benefits of environmental watering on fishing and the outcomes of the competition – including a Youtube video.
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.	Regular contact throughout the year and via annual environmental watering forum.	Future need to involve results of cultural mapping project relating to the Wimmera River in future water planning.
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.	It's 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.

Crowd at the Horsham Fishing Competition 2017 (left) and prize-winning Golden Perch (right)

3. 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 where identified by the Wimmera CMA 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* updates the previous information contained within the *Wimmera Bulk Entitlement Conversion – Environmental Flows Study* (SKM, 2003) that had previously been the guiding document for the region.

This study includes revised and more relevant environmental objectives, endorsed by community advisory groups and considers 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 by and large rely on passing and or unregulated flows to provide suitable inundation to achieve ecological outcomes. 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. 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.

Grey Teal breeding at Dock Lake – January 2017

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 *phragmites*.	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. Stimulate reproduction and recruitment of Wimmera Bottlebrush and maintain condition of current mature specimens. 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 1 ML baseflow, 30-160 ML/d fresh 400 bankfull 1,000ML/d overbank		Lower 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	
Lwr Mt William Creek	Baseflow/freshes/ bankfull/overbank	Geomorphic	Maintain structural integrity of channel. Maintains floodplain geomorphic features.	750/d ML/d bankfull 1,500 ML/d overbank			
Lwr 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.	5 ML/d baseflow 20-500 ML/d freshes 750 ML/d bankfull 1,500 ML/d overbank			
Lwr 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.	5 ML/d baseflow 20-500 ML/d freshes 750 ML/d bankfull 1,500 ML/d overbank			
Lwr 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.	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			

4. Seasonal review

4.1 Climatic conditions this year and seasonal outlook

The combination of negative Indian Ocean Dipole (IOD) conditions and La Ninã conditions have resulted in 2016 winter and spring rainfall ranging from average to above average (Figure 2).

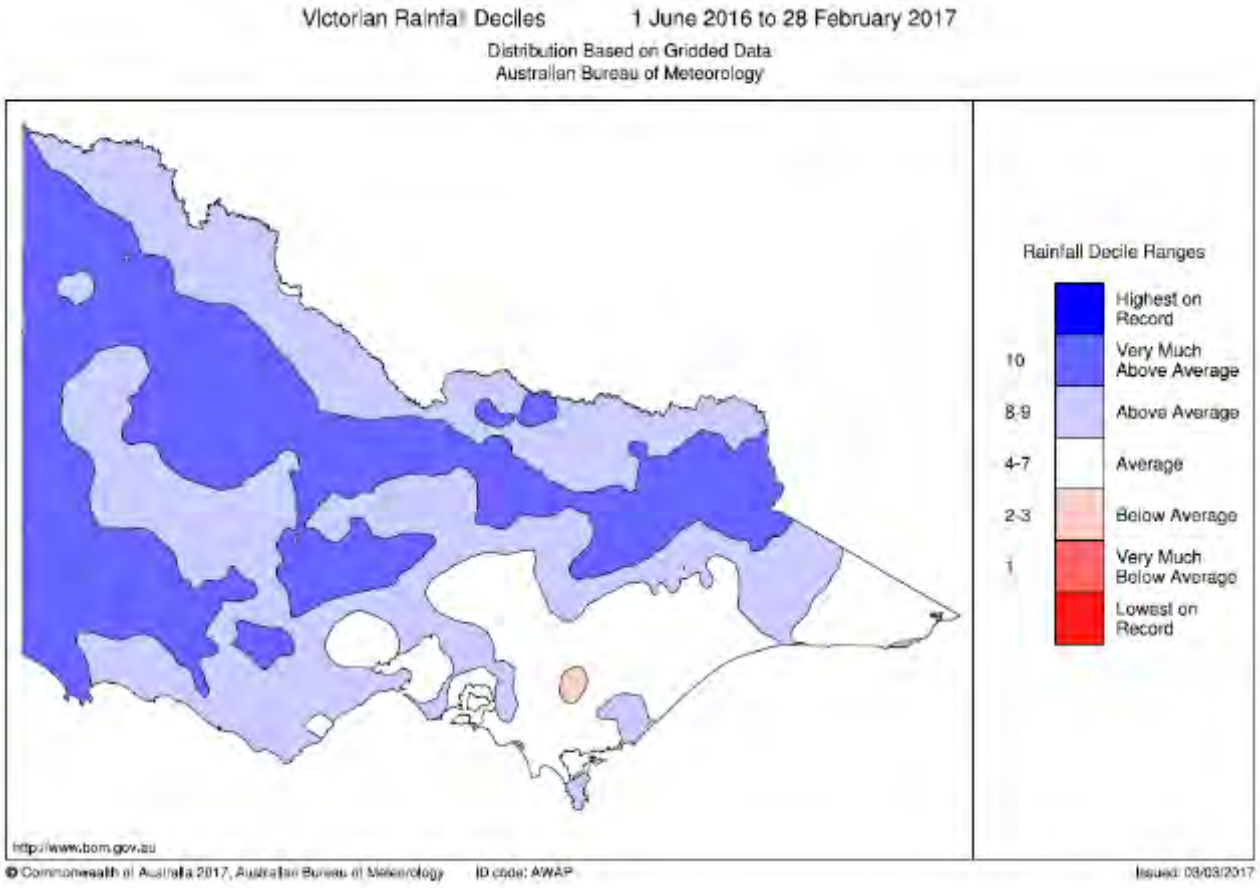


Figure 2. Bureau of Meteorology rainfall deficiencies from 1st June 2016 to 28 February 2017 (http://www.bom.gov.au/climate/drought/).

Above average rainfall over winter and spring has dramatically raised storage levels from 25% in July to 66.8% in early November (Figure 3). High rainfall in early September caused flooding across the Wimmera catchment. When flooding occurred, Lake Wartook was already above the full supply level, which caused the storage to spill. As a result of high spring inflows into Lake Lonsdale, storage levels were getting close to the maximum operating level in early October. Releases were made from Lake Lonsdale before storage levels reached the maximum operating level to reduce the flood risk for landholders downstream if another high rainfall event took place. In early October when Green Lake reached its full supply level and Lake Wartook was above its full supply level, water was able to be directed into Dock Lake for the first time in almost 20 years.

The above average rainfall in winter and spring has generated substantial runoff into storages. The cumulative natural inflow to water storages at the end of October was 235,480 ML. This is also equivalent to 156% of the July to October average (GWMWater October 2016 Reservoir Operations Update).

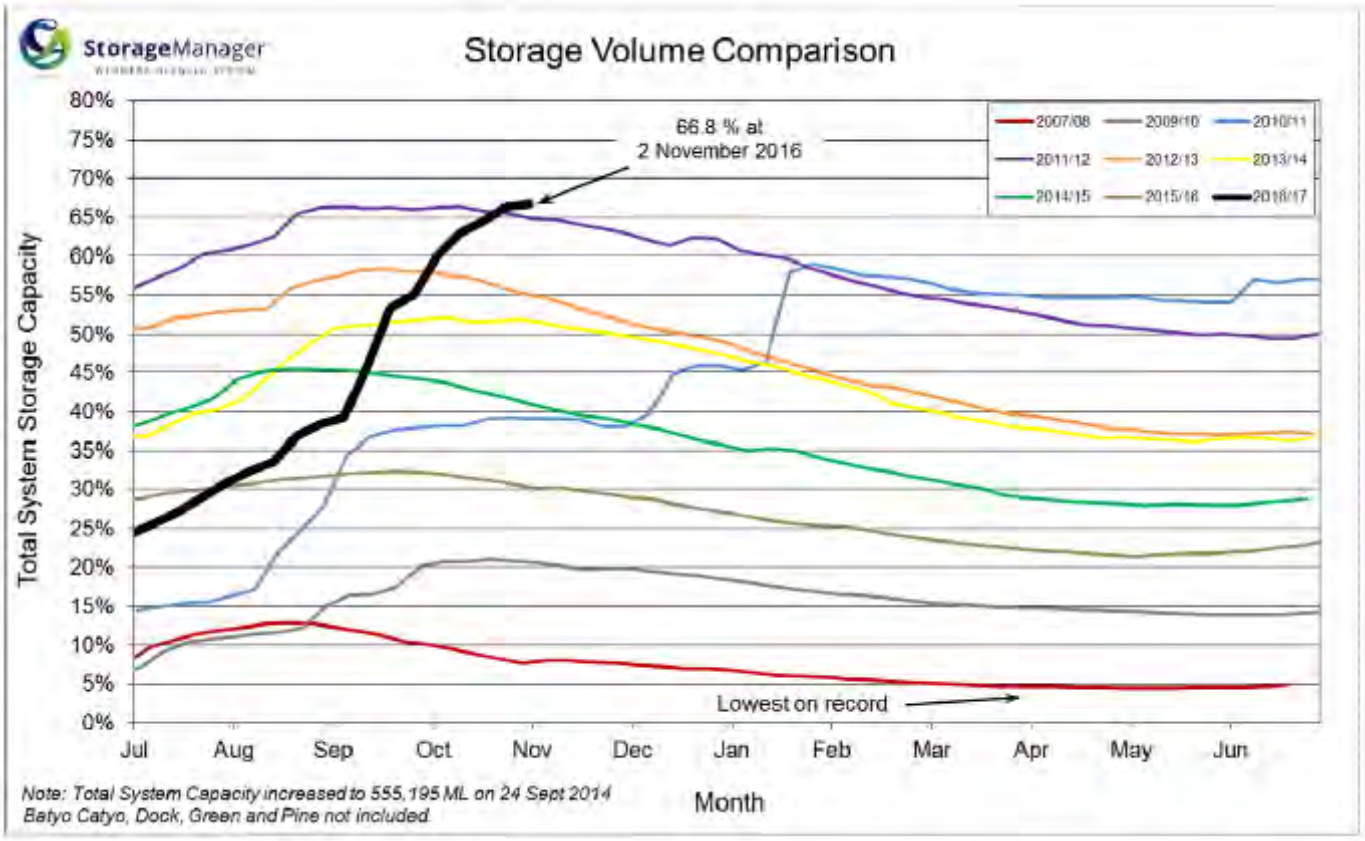


Figure 3. GWMWater storage volume comparison (GWMWater 2016).

During 2016-17 51,064 ML of passing flows were recorded at Huddleston's Weir and 3,321 ML at Lake Lonsdale (recorded up to end of February 2017). As a result of high natural flows, there was no need for regulated environmental water to be delivered in September and October. Passing flows from Lake Lonsdale were withheld for this reason but also this assisted water quality management for Taylor's Lake by the Storage Manager. Sustained flows in the Wimmera River over September and October led to approximately 158,520 ML entering Lake Hindmarsh, recorded in late October (approximately 37% full).

4.2 Review of 2016-17 watering, ecological observations and monitoring

The Wimmera system's regulated environmental water usage in 2016-17 was planned to be 12,911 ML based on the volume authorised by VEWH (Seasonal Watering Statement #2) to provide a proportion of summer baseflows and freshes for several waterways. Significant unregulated flows, combined with total passing flows of 52,014 ML (to the end of February 2017) enabled a high proportion of watering actions to be achieved in winter and spring without regulated releases. Results are summarised for various waterways in Table 5. Appendix 3 includes a table tracking the level of achievement of watering actions from 2005 through to 2017.

Table 5. Summary of the environmental water delivered compared to what was authorised and required to achieve compliance of priority watering actions (PWA).

Waterway	Water required to achieve PWA compliance under wet scenario (ML)	Environmental Water Authorised (ML)	Environmental Planned to be Delivered by 31st May (ML)
Wimmera River	24,150	6,940	7880
MacKenzie River	9,010	2,971	4196
Burnt Creek	3,767	1,225	
Mt William Creek	5,410	1,775	225
Bungalally Creek	500	0	0
Total	**42,837**	**12,911**	**11,805**

4.3 Wimmera River summary

Regulated releases were not able to take place during winter/spring given the initial 0% allocations and low volume of carryover available to meet priority watering actions later in 2016-17. However wet conditions led to above average streamflows in winter and flooding in early spring (refer to Table 6 and Figure 4). Peak overbank flows of 10,194 ML/d and 6,738 ML/d were recorded on the 21st of September and 11th of October 2016 respectively at Lochiel, refer to Figure 4. Refer to Table 6 for a summary of priority watering actions delivered by unregulated and passing flows between early August and early February for Reach 4 of the Wimmera River. Delivery of accumulated passing flows, started in November when the high natural flows dropped away. Passing flows released from Lake Lonsdale into lower Mt William Creek contributed some flow to the Wimmera River. Passing flows were released from Lake Lonsdale at a rate of 40 ML/d until late January, a total 3,321 ML.

Regulated releases from Taylors Lake started on the 24th of January with a fresh of 120 ML/d for 6 days then back to a release of 40 ML/d. Refer to Figure 4 below for flows measured at the Lochiel gauge, downstream of Dimboola from 1st of July 2016 until mid-February. Releases are planned for the Wimmera River until the end of May (at least) from Taylors Lake and Lake Lonsdale. As shown in Table 6 and Figure 4 environmental water releases have been important in consolidating the gains made over winter/spring through providing summer/autumn baseflows and freshes. They have generated excellent outcomes for water quality and aquatic communities (e.g. native fish).

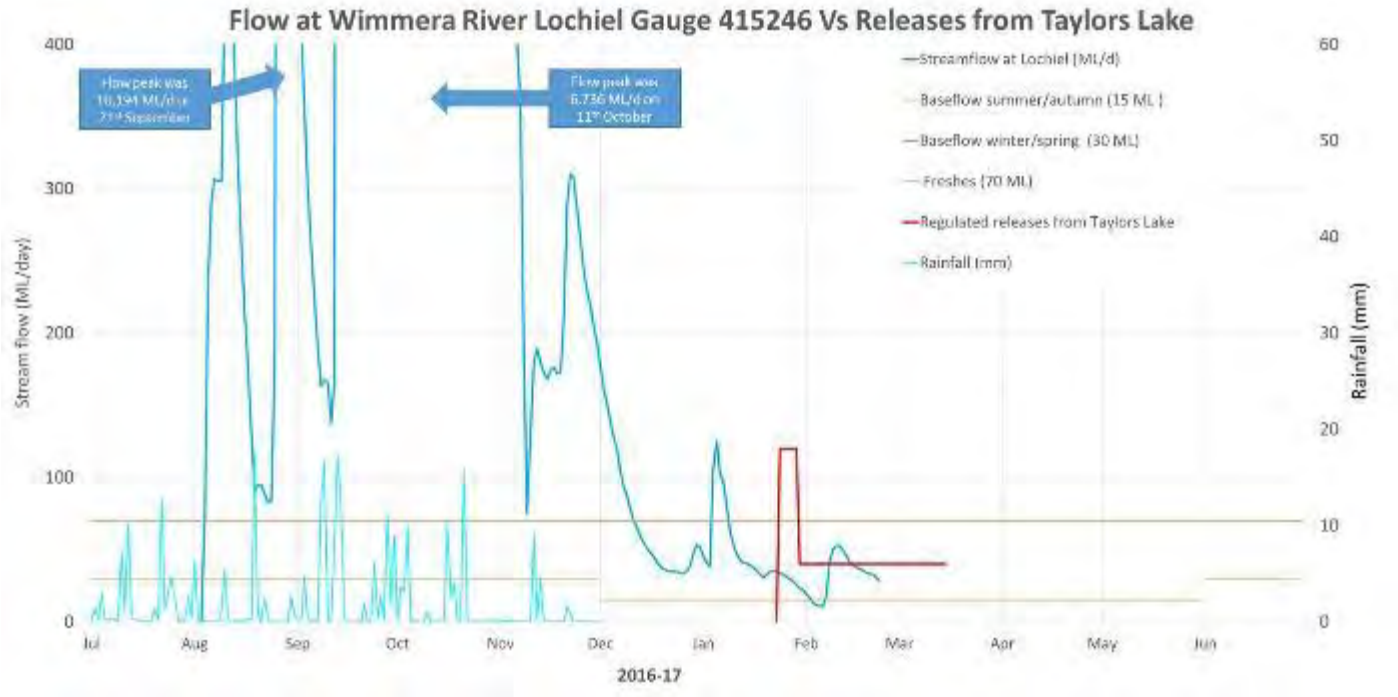


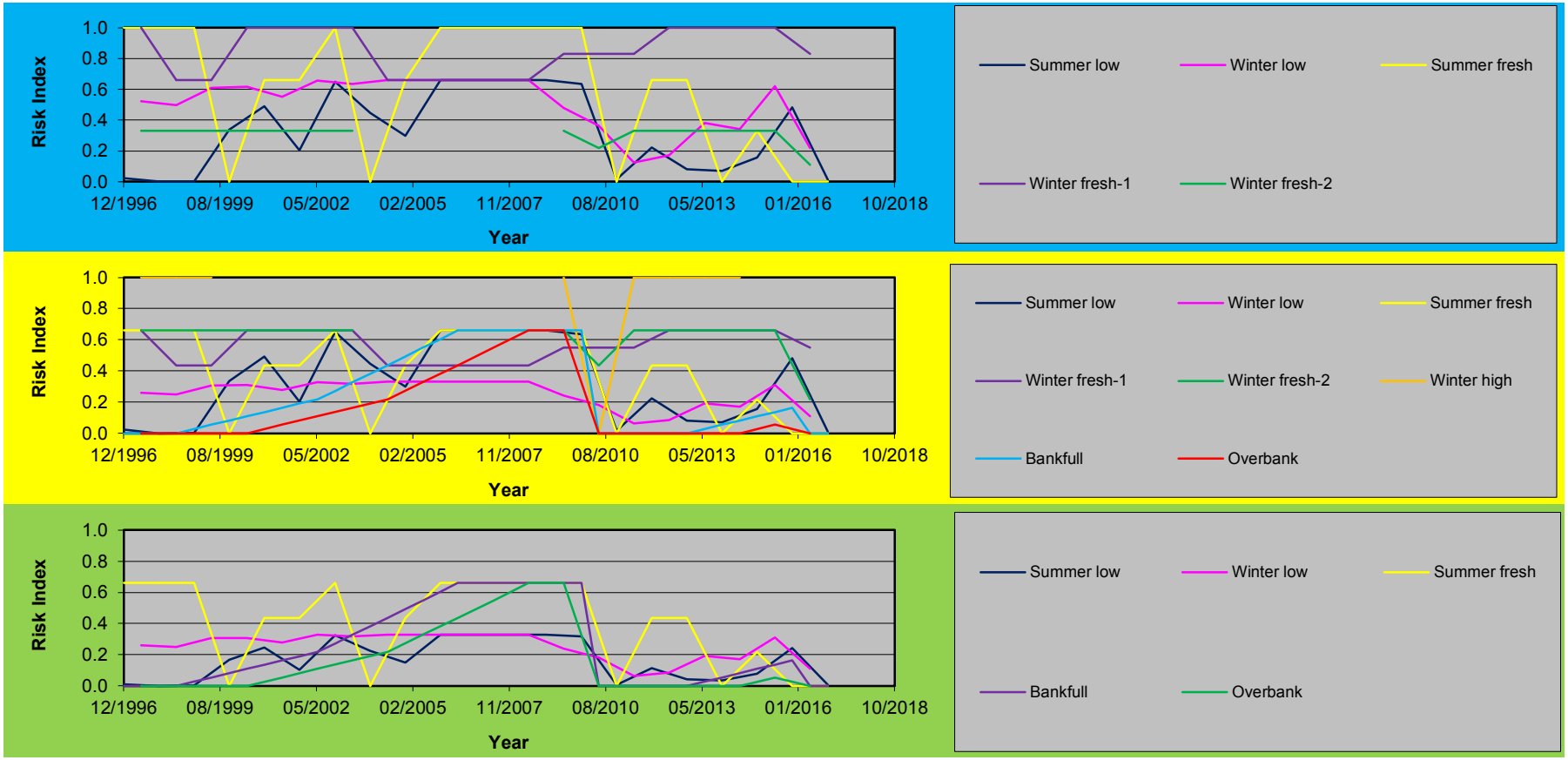
Figure 4. Flow at the Wimmera River at the Lochiel gauge (415246) July 2016 - February 2017.

Table 6.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 from 4th of August to end of November by unregulated flows
Summer/Autumn baseflow	15 ML/d	Baseflows were released from Taylors Lake and Lake Lonsdale that enabled this component to be achieved.
Summer/Autumn freshes	70 ML/d 2-7 days x 3	One delivered (Jan 2017), one slightly under target (50 ML/d) in Feb 2017, another one planned.
Winter/Spring freshes	70 ML/d 5 days x4	Unregulated flows mostly greater than 70 ML/d from early August to the end of November
Winter/Spring freshes	200 ML/d 3 days x3	Unregulated flows mostly greater than 200 ML/d from early August to the end of November
Winter/Spring freshes	1,300 ML/d 3 days x2	Unregulated flows greater than 1,300 ML/d for 27 days from mid-September to mid-October.
Anytime bankfull	2,000 ML/d 2 days x1	Unregulated flows greater than 2,000 ML/d for 23 days from mid-September to mid-October. (Not regulated water objective)
Winter/Spring overbank	6,000 ML/d 1 day x1	Unregulated flows greater than 6,000 ML/d for 11 days between mid-September to mid-October. (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 in summer/autumn 2016/17. Risks to fish and macroinvertebrates remain comparatively high with a need to implement low flows throughout the year.

Table 7. Risk indices for Fish (blue), Macroinvertebrates (yellow), Vegetation (green), Geomorphology (grey) and Water Quality (pink) for Reach 3 of the Wimmera River.



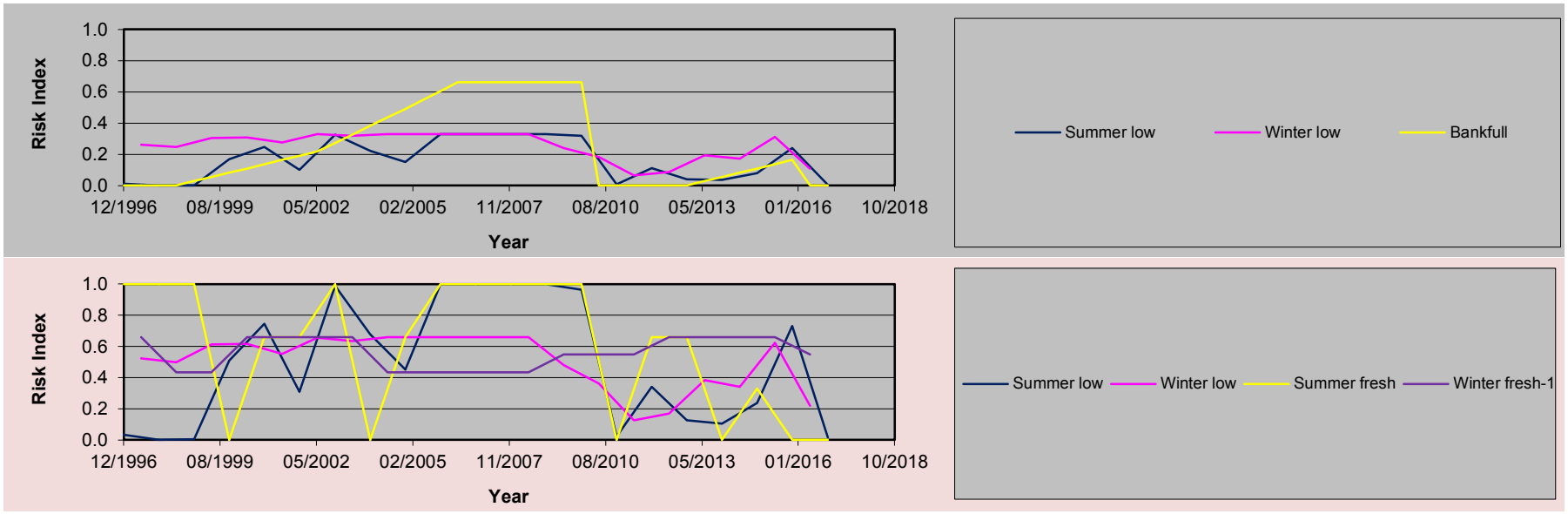
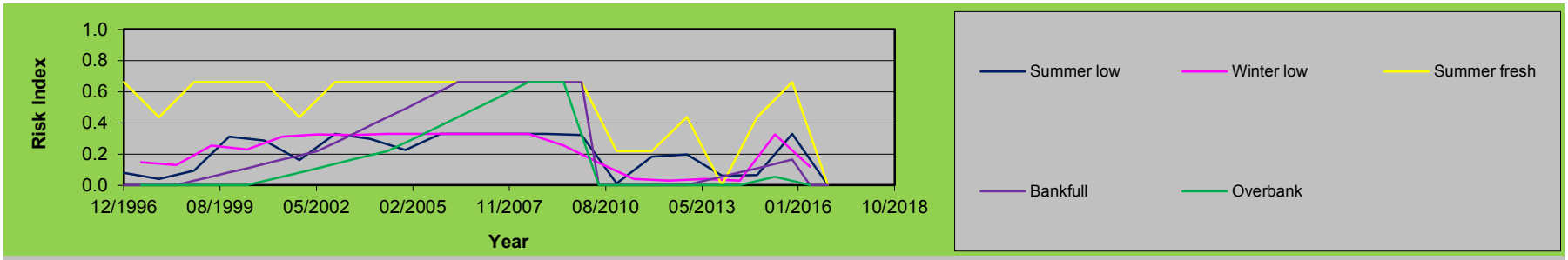
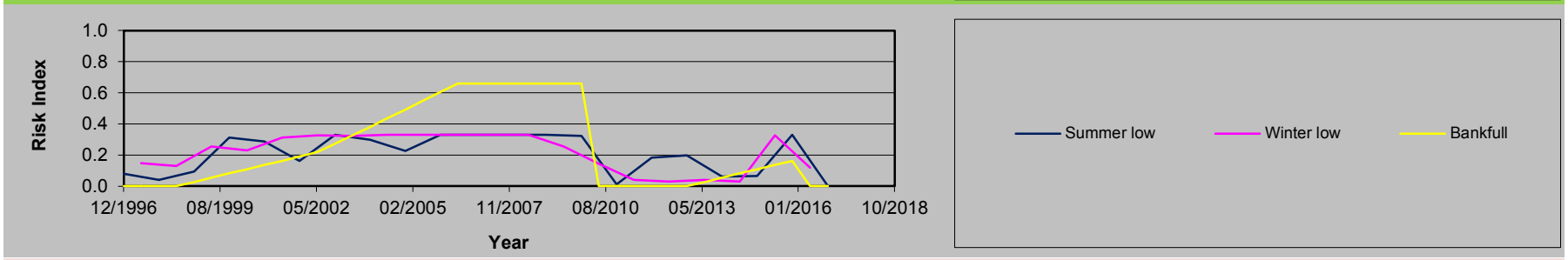
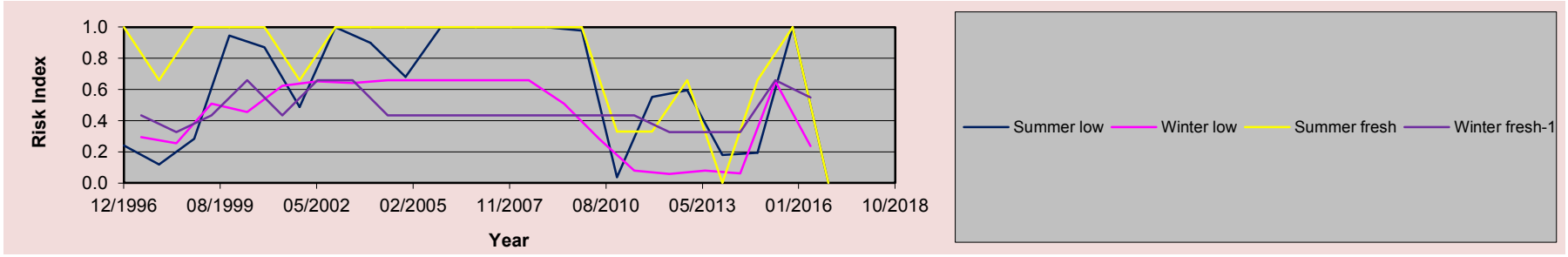


Table 8. Risk indices for Fish (blue), Macroinvertebrates (yellow), Vegetation (green), Geomorphology (grey) and Water Quality (pink) for Reach 4 of the Wimmera River.


Risk Index
1.0
0.8
0.6
0.4
0.2
0.0
12/1996
08/1999
05/2002
02/2005
11/2007
08/2010
05/2013
01/2016
10/2018
Year
Summer low
Winter low
Summer fresh
Bankfull
Overbank


Risk Index
1.0
0.8
0.6
0.4
0.2
0.0
12/1996
08/1999
05/2002
02/2005
11/2007
08/2010
05/2013
01/2016
10/2018
Year
Summer low
Winter low
Bankfull


Risk Index
1.0
0.8
0.6
0.4
0.2
0.0
12/1996
08/1999
05/2002
02/2005
11/2007
08/2010
05/2013
01/2016
10/2018
Year
Summer low
Winter low
Summer fresh
Winter fresh-1

Salinity levels at Tarranyurk (refer to Figure 5) reached 45,000 µS/cm over winter due to a prolonged period of 15 months of no flow. Streamflow in early August quickly lowered and maintained salinity levels to below 3,000 µS/cm. These flows also provided variable flow for macroinvertebrates, stimulated fish movement and provided a diversity of fish habitats. These flows had significant environmental benefits, supporting the Wimmera River's native fish populations, increasing the abundance of macroinvertebrates and abundance and health of submergent and riparian vegetation (Brooks 2016, Ecology Australia 2016). Summaries of these outcomes are provided below.

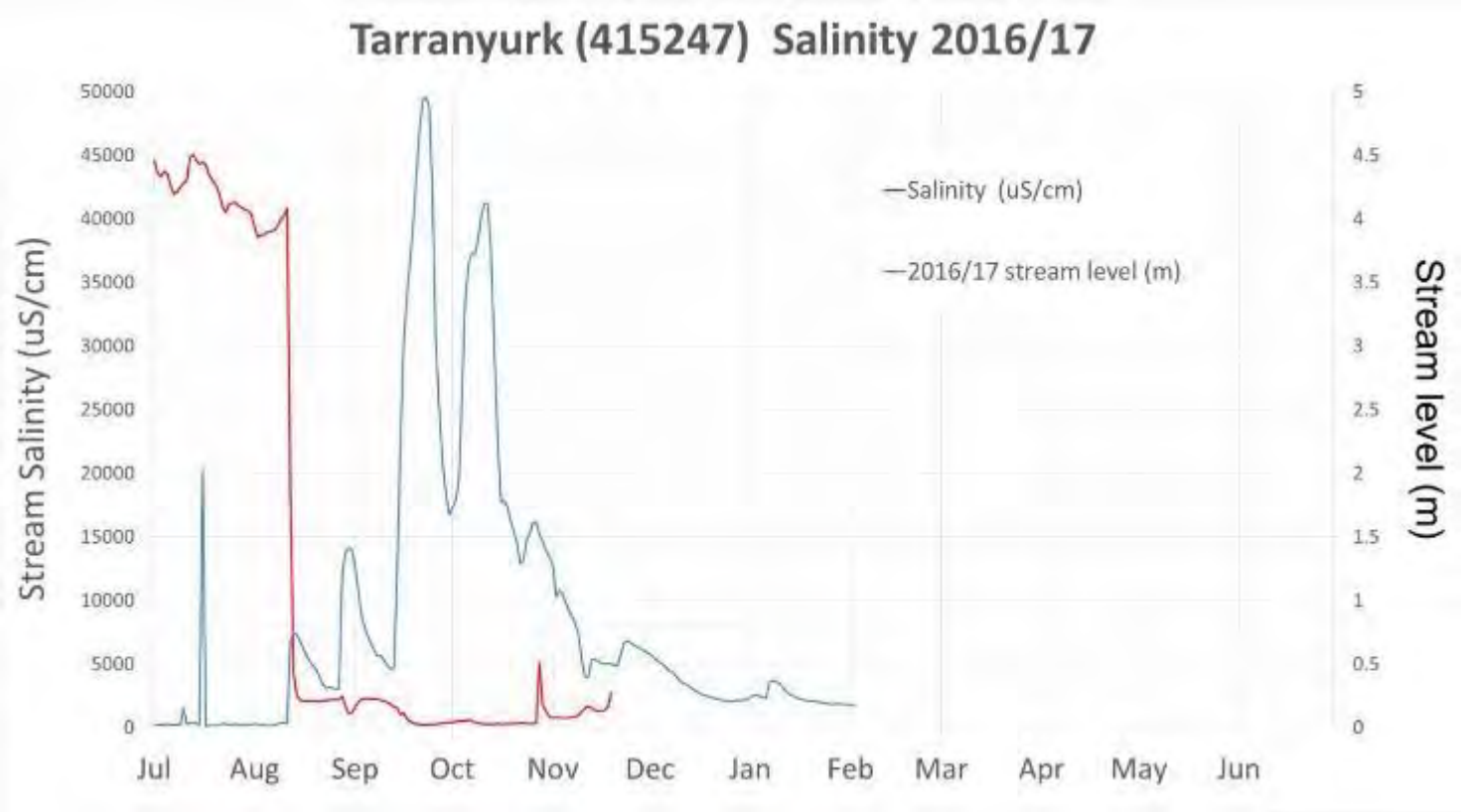


Figure 5. Tarranyurk July 2016 to June 2017 stream level and salinity measurements. There have been sensor malfunctions at the site in early 2017.

Qualitative Assessment of Ecosystem Function for the Wimmera River

A qualitative assessment of ecosystem function (macrophytes, riparian vegetation and macroinvertebrates) for the Wimmera River (Brooks 2016) outlined that increased environmental water availability has;

- Enhanced the condition and macroinvertebrate assemblage at the Jeparit site (refer to Figure 6);
- Created conditions that favour growth of submergent aquatic macrophytes;
- Lowered salinities and turbidity levels and sustained pool water levels leading to a greater diversity of submerged aquatic plants when compared to surveys dating back to 2005;
- Increases in the abundance and condition of obligate submerged aquatic plants represents a significant improvement in aquatic values following the drought; and
- Significantly improved the condition of riparian vegetation and expanded the abundance of emergent reeds and sedges (refer to Figure 7).

Chris Madden and Shane Brooks sampling macroinvertebrates on the Wimmera River – February 2016

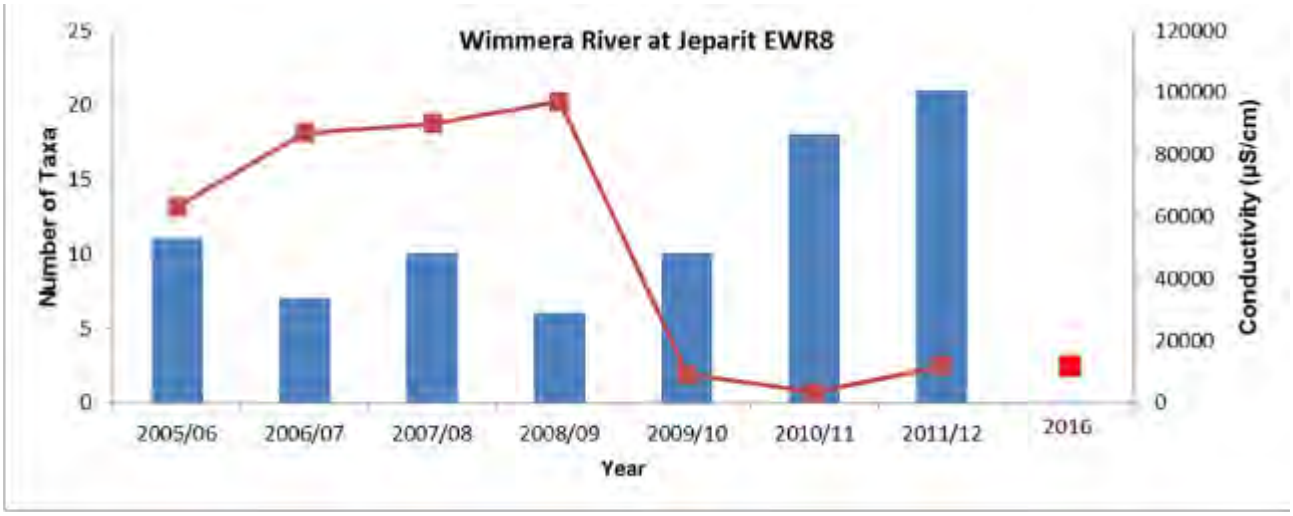


Figure 6. Relationship between macroinvertebrate species (blue) and salinity (red) with single point added for this survey in February 2016 (Brooks 2016).

Figure 7. Expansion of *Bolboschoenus* sp. to stabilise the sandy beach area at Picnic Bend upstream of Dimboola (Brooks 2016).

Jeparit Refuge Pool Fish Assessment

During severe drought conditions there are long periods where there is not enough environmental water available to deliver flows for the Wimmera River downstream of the Dimboola Weir. The Wimmera CMA have been developing a business case that when severe drought conditions occur again water can be delivered from the Wimmera Mallee Pipeline to an anabranch of the Wimmera River adjacent to Jeparit, creating a small refuge pool. This was funded as part of the Victorian Government's drought response measures.

It is envisaged that this refuge pool would preserve a portion of high value fish communities that are not feasible to retain in other parts of the lower Wimmera River during severe drought conditions. This refuge pool will help safeguard indigenous fish populations and stocked recreational species that have recovered following drought conditions so that they will be able to recolonise the Wimmera River at Jeparit when conditions improve. This refuge pool will also protect aquatic vegetation, adjacent riparian vegetation and the region's diverse suite of threatened and migratory bird species, as well as other flora and fauna. Other benefits include providing a water body the community can gravitate to whilst the rest of the river surrounding them is enduring the impacts brought about by the lack of water, such as odours form the hypersaline, anoxic pools that blow into the town with southerly winds and dust from a dry Lake Hindmarsh brought by northerly winds.

As part of the development of the business case, the Wimmera CMA contracted Ecology Australia (Ecology Australia 2016a) to to provide ecological information on the local fish population to assist this. The main candidates for translocation based on monitoring include Freshwater Catfish and Flat-headed Gudgeon. Other potential candidate species for translocation include Golden and Silver Perch, together with small-bodied species including Australian Smelt, Common Galaxias and Carp Gudgeon. A fish survey in the main channel of the river at Jeparit revealed the fish population was impacted by drought conditions with large numbers of Carp and Redfin and small numbers of native species. This highlights the importance of adequate flows and suitable quality in maintaining a meaningful fish community in the lower Wimmera River.

Lower Wimmera River VEFMAP Fish Monitoring

Key finding of a VEFMAP fish survey for the Lower Wimmera River undertaken in April and May 2016 (Ecology Australia 2016b) include;

- Freshwater Catfish were captured from both reaches, with Young-of-Year and likely one to two year old fish recorded from Reach 2;
- An increase in Flat-headed Gudgeon abundance was recorded from both reaches;
- An increase in fish species richness was recorded from Reach 2;
- An increase in Golden Perch abundance was recorded for both reaches; and
- A small increase in Carp abundance was recorded in both reaches, however carp abundance has remained lower during 2013-2016 period relative to the 2011-2012 period.

The populations of Freshwater Catfish and Silver Perch are likely to be under-represented by electrofishing. The self-sustaining Freshwater Catfish population is considered to be of conservation value, and the stocked populations of other large-bodied native species are of recreational fishing value. Additionally, some potential exists for additional indigenous species (e.g. Obscure Galaxias) to recolonise the lower Wimmera over time, provided water management and water availability can overcome current and future challenges expected to occur as a consequence of climate change. Over the drier years of the eight year VEFMAP monitoring period (e.g. 2009, 2010 and 2016), environmental watering is likely to have been directly responsible for protecting the fish community values of the Lower Wimmera River (including Freshwater Catfish and Golden Perch) by ensuring suitable water quality and habitat persisted at fish refuge locations, and this is expected to be a critical watering objective in future years, particularly downstream of Dimboola. There has also been positive trends in numbers of endemic species caught (Australian Smelt and Flat-Headed Gudgeons).

Recruitment was evident for the Flat-headed Gudgeon at all sites other than Spears Crossing (Reach 3) and analysis of the length classes indicates that the population is likely to be successfully recruiting on an annual basis (Robinson, 2016).Recruitment was evident for the non-indigenous Freshwater Catfish at two sites, with three fish below the 83 mm cut-off considered to represent recruits. Two of these fish, measuring 53 mm and 61 mm, are considered likely to be Young-of-Year (0+ years old), while another recruit at 80 mm could be a 1 year old + fish, or another Young-of-Year fish that was spawned earlier in the spring to summer season (Ecology Australia, 2016b). Juvenile Golden Perch of a size small enough (<75 mm) to be considered recruits (Robinson 2012) were recorded from one site in each reach, however these are considered likely to be recently stocked fingerlings, rather than natural recruits.

a) Freshwater Catfish juveniles (0+)

b) Freshwater Catfish juvenile (possible 1+)

Figure 8. Freshwater Catfish juveniles recorded at Gross Bridge (a) and Rokeskys Rd (b) (source Ecology Australia 2016b)

Table 9. Comparison of electrofishing results for Reach 2 of lower Wimmera River VEFMAP fish sampling for the current year (2016) and previous five years. (Indigenous fish – green shading, non-indigenous native fish – purple shading, exotic fish – orange shading)

Common name	Species	2010	2011	2012	2013	2014	2015	2016
Australian Smelt	*Retropinna semoni*		1			2		24
Flat-Headed Gudgeon	*Philypnodon grandiceps*	25	2	12	30	37	4	388
Freshwater Catfish	*Tandanus tandanus*		3	1	2			1
Golden Perch	*Macquaria ambigua*	1	2	12	11	20	11	39
Silver Perch	*Bidyanus bidyanus*			1	1	8	1	2
Carp Gudgeon complex	*Hypseleotris* sp.							1
Common Galaxias	*Galaxias maculatus*			4	7			1
Murray Cod	*Maccullochella peelii peelii*						1	
Eastern Gambusia	*Gambusia holbrooki*	55	23	4	5	90	22	95
Carp	*Cyprinus carpio*	82	260	282	76	57	47	60
Goldfish	*Carassius auratus*	16	53	41	3	32	12	53
Redfin Perch	*Perca fluviatilis*	76	20	24	39	35	4	360
	Total abundance	**255**	**364**	**381**	**174**	**281**	**102**	**1024**

% indigenous species	9.8	0.8	3.1	17.2	13.9	3.9	40.2
% non-indigenous species	0.4	1.4	4.7	12.1	10	12.7	4.3
Species richness	**6**	**8**	**9**	**9**	**8**	**8**	**11**
# indigenous	1	2	1	1	2	1	2
# non-indigenous	1	2	4	4	2	2	5

Table 10. Comparison of electrofishing results for Reach 3 of lower Wimmera River VEFMAP fish sampling for the current year (2016) and previous five years (Indigenous fish – green shading, non-indigenous native fish – purple shading, exotic fish – orange shading)

Common name	Species	2010	2011	2012	2013	2014	2015	2016
Australian Smelt	*Retropinna semoni*	11				6		
Flat-Headed Gudgeon	*Philypnodon grandiceps*	9	7	35		338	7	279
Freshwater Catfish	*Tandanus tandanus*		1		1		1	2
Golden Perch	*Macquaria ambigua*	6	1	5	18	16	16	30
Silver Perch	*Bidyanus bidyanus*				4	3	1	1
Carp Gudgeon complex	*Hypseleotris* sp.				4	2		
Common Galaxias	*Galaxias maculatus*			2	1			6
Eastern Gambusia	*Gambusia holbrooki*	17	17	8	19	51	2	64
Carp	*Cyprinus carpio*	169	381	186	59	53	64	103
Goldfish	*Carassius auratus*	6	26	3	3	16	8	5
Redfin Perch	*Perca fluviatilis*	66	30	22	38	40	18	510
Total abundance		284	463	261	150	525	117	1000
% indigenous species		7	1.5	13.4	12.7	65.5	6	27.9
% non-indigenous species		2.1	0.4	2.7	16	4	15.4	3.9
Species richness		7	7	7	9	9	8	9
# indigenous		2	1	1	0	2	1	1
# non-indigenous		1	2	2	5	3	3	4

Understanding carp distribution in the Lower Wimmera River

Cesar undertook an investigation into the distribution and movement of carp in response to hydrological conditions in the lower Wimmera River over 2015-16. eDNA samples taken at points along the lower Wimmera River were compared with electrofishing samples to determine whether the amount of target DNA present was correlated to carp abundance. This study found that there was a highly significant relationship between the concentration of carp eDNA in water samples and the number of carp captured at a site through electrofishing, demonstrating that high eDNA values are likely to indicate the presence of large numbers of carp. Average eDNA concentrations were higher at Dimboola and Horsham than O'Brees and Wundersitz indicating higher carp abundance in these areas (cesar 2016a), refer to Figure 9. An increase in carp eDNA in early December corresponds with an expected increase in carp activity in response to warmer water temperatures, an increase in flow due to environmental water releases and inundation of spawning habitats.

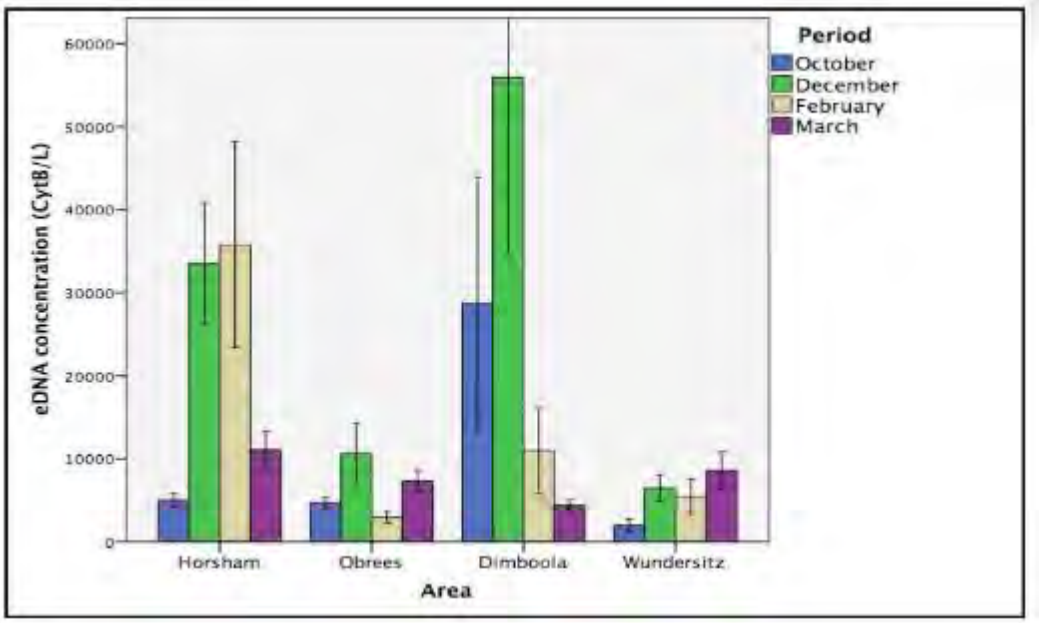


Figure 9. Average abundance of carp eDNA during each sampling period in all areas from October 2015 to March 2016. River flow runs from upstream (left) to downstream (right) along the x-axis.

Shared Community Benefits

Due to above average winter flows and flooding in spring there was no need to adjust the timing of flows specifically to support recreational and social community events. Regular baseflows and freshes provided by regulated releases have been important in enhancing conditions for events in summer/autumn 2017 such as the Horsham Triathlon, Jeparit Fishing Competition and Horsham Fishing Competition. The full range of events (regattas, fishing competitions etc.) have taken place in 2016/17 which has been well-received by the community. A highlight was the Horsham Fishing Competition, held on the March Labour Day Weekend with approximately 2000 entrants, including many visitors to the region. Competition Committee President Adele Rohde had the following to say "We have had more native fish than carp this year which is unheard of. That is a good testament to the health of our river."

4.4 MacKenzie River summary

Regulated releases were not able to take place during winter/spring given the initial 0% allocations and low volume of carryover requiring water to be saved for higher priority watering actions later in 2016. However good rainfall in winter and flooding in early spring (refer to Figure 10) led to good flows in the MacKenzie River in spring. Overbank flows of 1,002 ML/d and 597 ML/d were recorded on the 16th of September and 6th of October 2016 respectively at McKenzie Creek Reserve, refer to Figure 10. Unregulated flows between late August to early November delivered most of the winter and spring watering actions for Reach 3 of MacKenzie River, refer to Table 11 for a summary of priority watering actions delivered.

GWMWater continued releases from Lake Wartook until the end of November due to the storage levels being above the full supply level. Regulated releases for MacKenzie River started on the 7th of December with a series of summer/autumn freshes and baseflows interspersed with cease to flow periods, refer to Figure 10 for flows measured at the MacKenzie River at McKenzie Creek Reserve gauge (415251). Due to repairs for regulators at Dad and Dave and Distribution Heads that GWMWater was undertaking on behalf of VEWH there were some modifications with respect to preferred flows to enable their commissioning. The volume authorised in the Seasonal Watering Statement means that only limited flows can reach the compliance point for Reach 3.

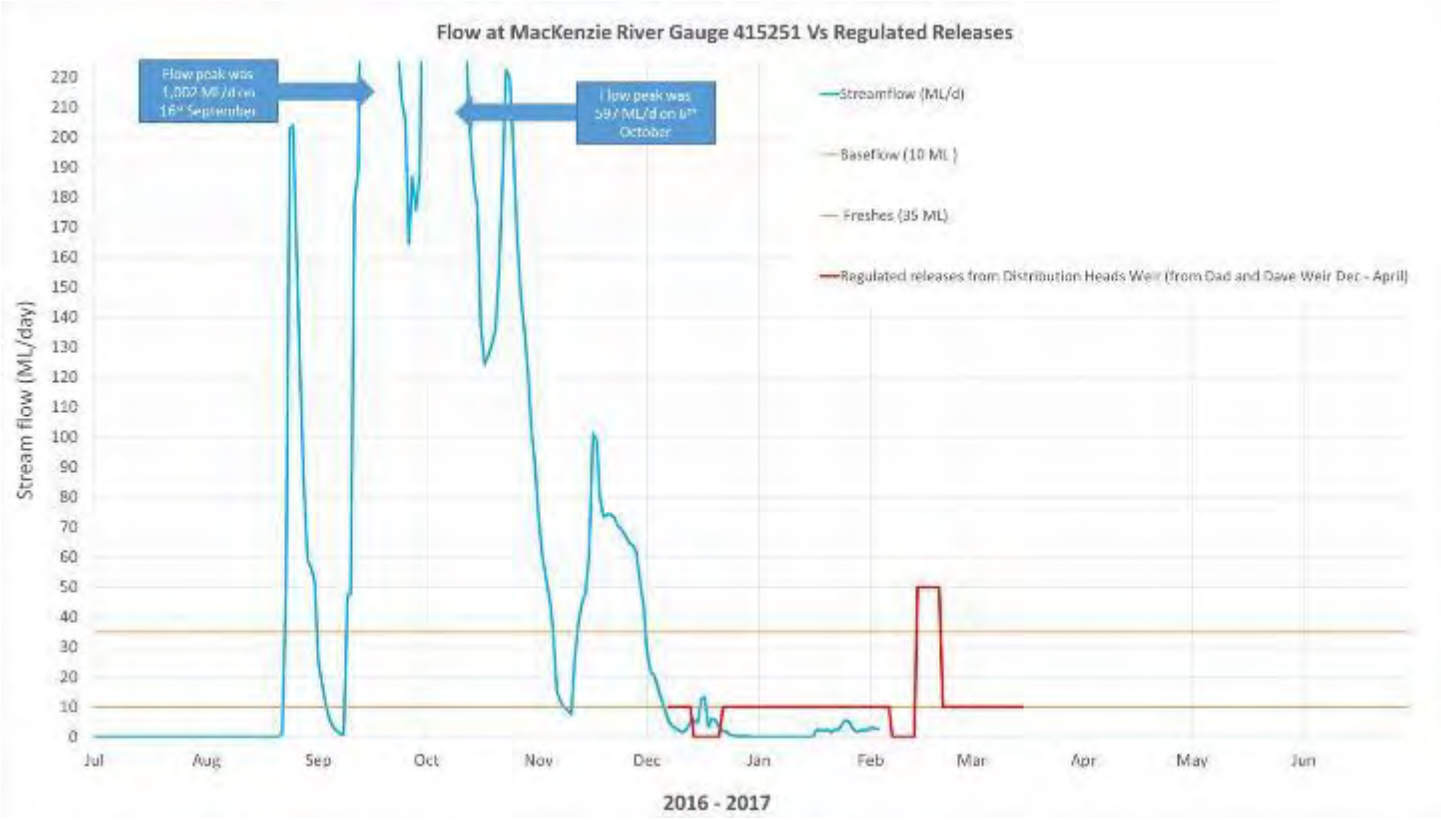


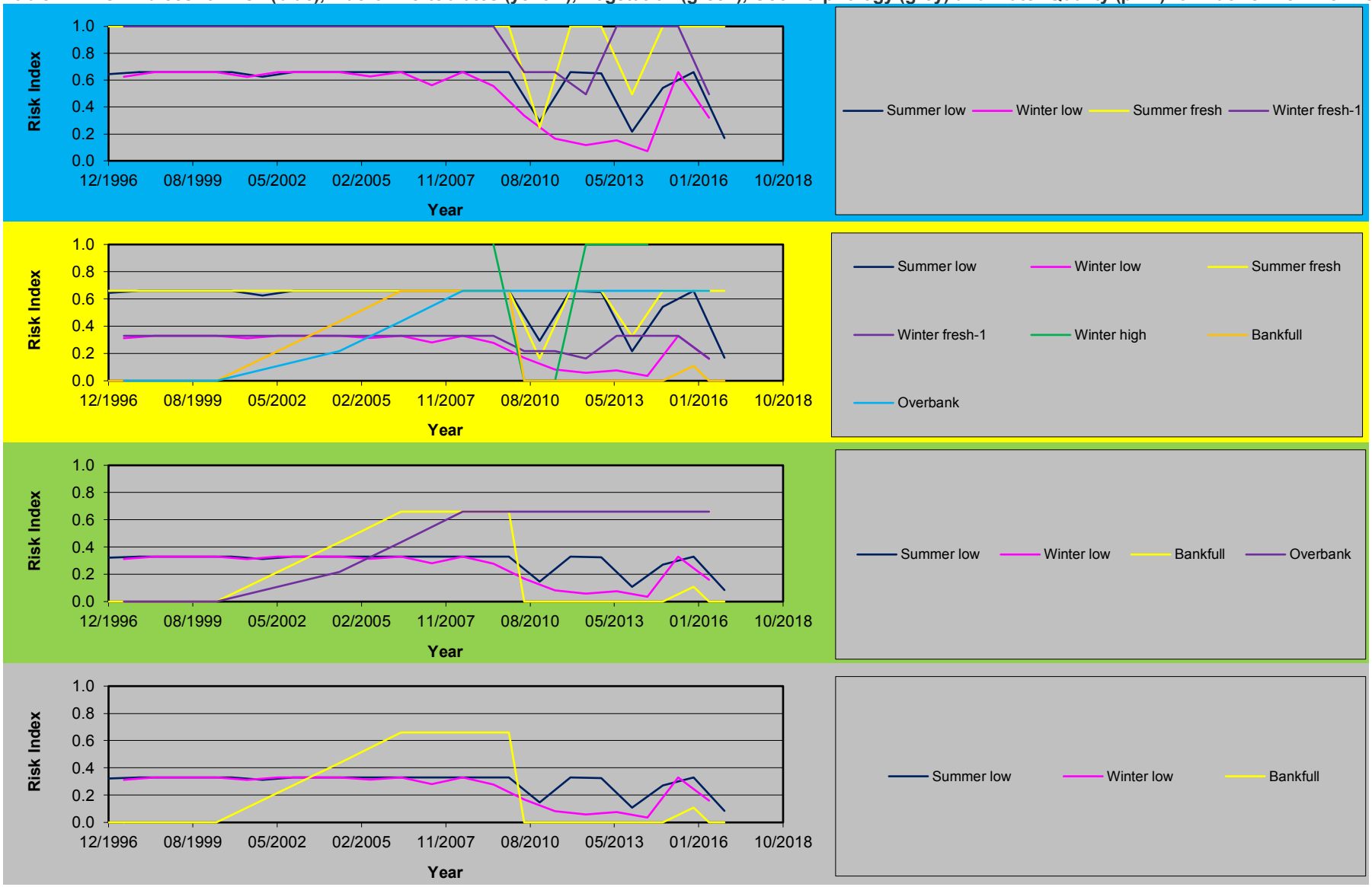
Figure 10. Flow summary for Reach 3 of MacKenzie River at McKenzie Creek Reserve stream gauge (415451).

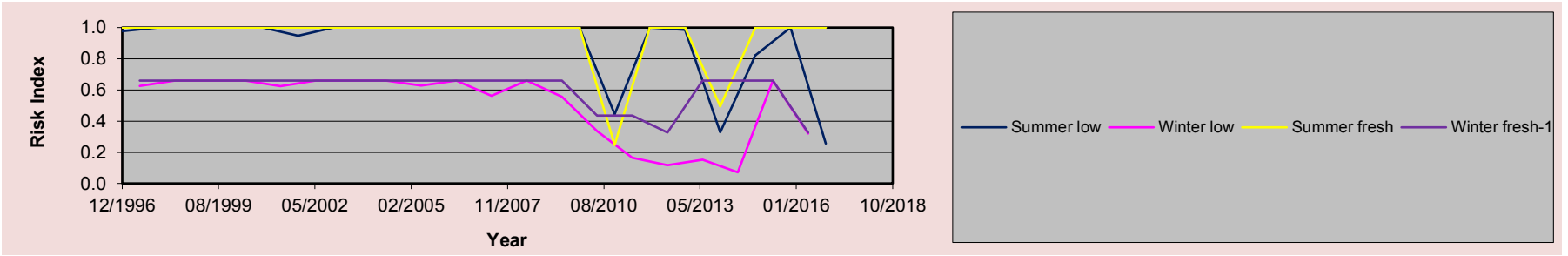
Table 11. Summary of Priority Watering Actions (PWA) delivered for Reach 3 of the MacKenzie River.

PWA delivered for reach 3 MacKenzie River	Flow magnitude/ duration/ frequency	Comment
Baseflows	10 ML/d	Delivered mostly from late August to early-December by unregulated flows, summer/autumn flows were under this threshold. Monitoring in 2017 will determine their effectiveness in meeting objectives.
Summer/Autumn freshes	35 ML/d x 3-4	One provided at the very start of summer through unregulated (spill) flows, a release of 50 ML/d in February at Dad and Dave, only delivered 20 ML/d at the stream gauge. Another fresh is planned with a higher release rate.
Winter/Spring freshes	35 ML/d 7 days x 5	Unregulated flows mostly greater than 35 ML/d from late August to early November
Winter/Spring freshes	190 ML/d 2 days x 1	Provided by unregulated flow
Winter/Spring freshes	500 ML/d 1 day x 1	Provided by unregulated flow
Anytime bankfull	1,000 ML/d 1 day x 1	Provided by maximum unregulated flow of 1002 ML/d on 16 September

Risks to ecological and physical objectives for the MacKenzie River Reach 3 is included in Table 12 below. The results highlight a reduction in risks to geomorphology brought about due to the wet conditions in winter/spring 2016. Risks to other ecological objectives remain high due to insufficient summer/autumn freshes so this will be a priority for 2016/17 and 2017/18.

Table 12. Risk indices for Fish (blue), Macroinvertebrates (yellow), Vegetation (green), Geomorphology (grey) and Water Quality (pink) for MacKenzie River Reach 3.





Platypus released into the MacKenzie River following monitoring 2016

Platypus Survey

cesar undertook a live-trapping surveys to assess the current status of platypuses in the MacKenzie River. Also surveys using environmental DNA (eDNA) were conducted throughout the Upper Wimmera River to identify any other remnant platypus populations in the region. Two platypuses (one adult female, one juvenile male) were captured in the MacKenzie River near Zumsteins (Reach 1). The juvenile captured is the fifth juvenile recorded in the last three years after no juveniles were detected in surveys conducted between 2006 and 2013. The female was first captured as a juvenile the previous year, confirming young are successfully recruiting into the population. The average catch per unit effort (CPUE) since 2012 (0.091, n = 4) is higher than average CPUE from 2008 to 2011 (0.062, n = 4) indicating the population is slowly increasing in abundance (cesar 2016). Key recommendations made by the report include;

- Annual monitoring of this population should continue due to its high regional significance in the Wimmera Catchment. Monitoring should include a combination of live-trapping and eDNA surveys and explore areas of MacKenzie River that have received little survey effort in recent years.
- A genetic analysis of the MacKenzie River population is recommended to determine the genetic health of the population and provide an indication of longer-term persistence and viability.
- Habitat quality in the MacKenzie River declines downstream of the Grampians National Park, primarily due to reduced flows. It is therefore important to continue to provide environmental flows beyond Dad and Dave weir to improve conditions for platypuses and allow the population to expand. The high sensitivity of eDNA to detect platypuses at low abundance provides an ideal technique to monitor the expansion of platypuses in the lower MacKenzie River.
- Dad and Dave Weir presents a barrier to platypuses dispersing downstream. Restoring operation of the fish ladder at Dad and Dave Weir would help facilitate colonisation of the lower MacKenzie River.
- platypusSPOT provides an effective platform to gather valuable local knowledge on platypus occurrence and raise awareness of river health issues within the community. Platypus sightings can be used to direct more rigorous investigations using live trapping or eDNA surveys.

Fish Monitoring

Fish monitoring undertaken by ARI as part of the Murray Darling Basin Authority's Sustainable Rivers Audit program in December 2016 in Reach 2 of MacKenzie River shows that good flows in this reach have allowed native fish to remain in good condition despite drought conditions. Refer to Figure 11 that show excellent native fish numbers and very low number of exotic fish. This is a stark improvement to survey results at the site in previous years (2012 and 2014) and shows the recovery of this reach from the impacts of drought when it dried out everywhere apart from the Redfin Holes in 2006/07 and 2008/09.

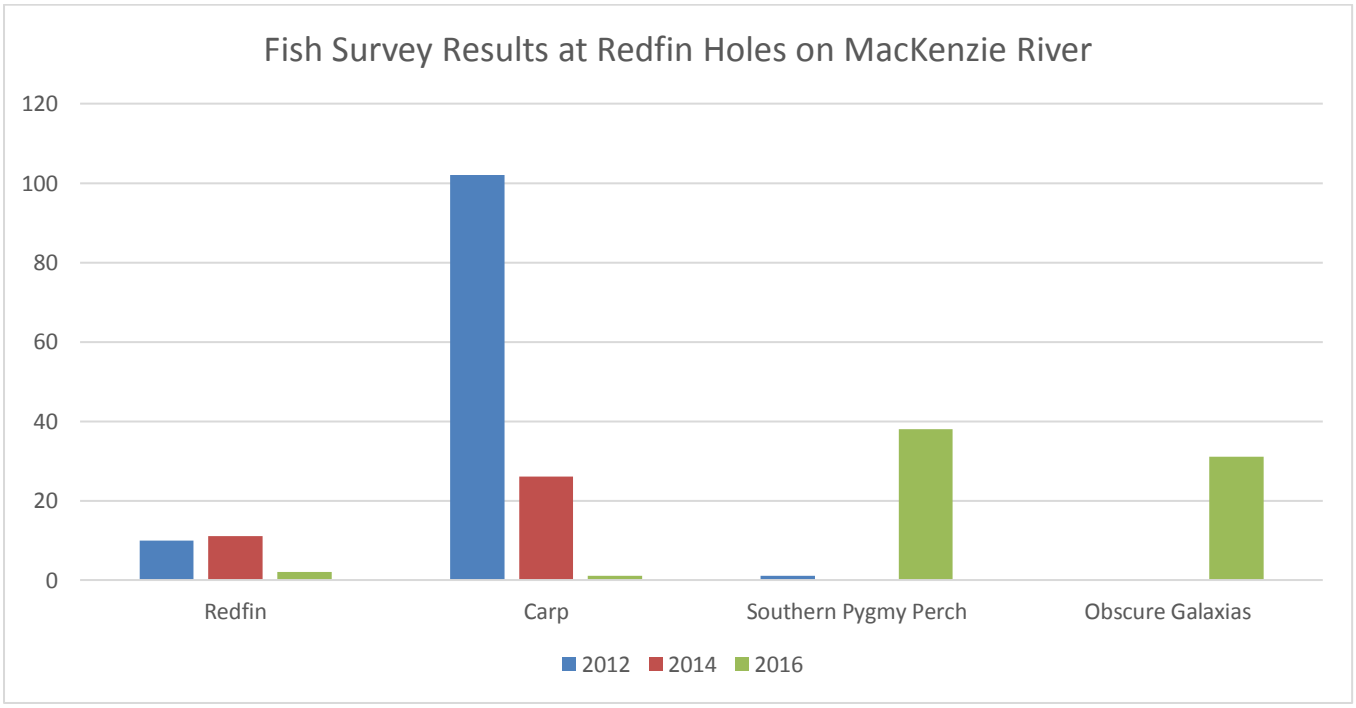


Figure 11. Fish survey results for the MacKenzie River at Redfin Holes (Biosis (2012), Austral (2014), Lauren Dodd (ARI) pers. comm.)

4.5 Burnt Creek summary

Regulated releases were not able to take place during winter/spring given the initial 0% allocations and low volume of carryover requiring water to be saved for higher priority watering actions later in 2016. The good rainfall during winter and spring led to above average flows in winter and flooding in early spring (refer to Figure 12). Overbank flows of 1,475 ML/d and 1,282 ML/d were recorded on 21st of September and the 6th of October respectively. Unregulated flows between late August and early November delivered virtually all winter and spring watering actions for upper Burnt Creek, refer to Table 13 for a summary of priority watering actions delivered.

Regulated releases began on the 6th of December comprising baseflows and summer/autumn freshes with planned cease to flow periods, including one coinciding with commissioning works following upgrades to infrastructure at Dad and Dave Weir and Distribution Heads.

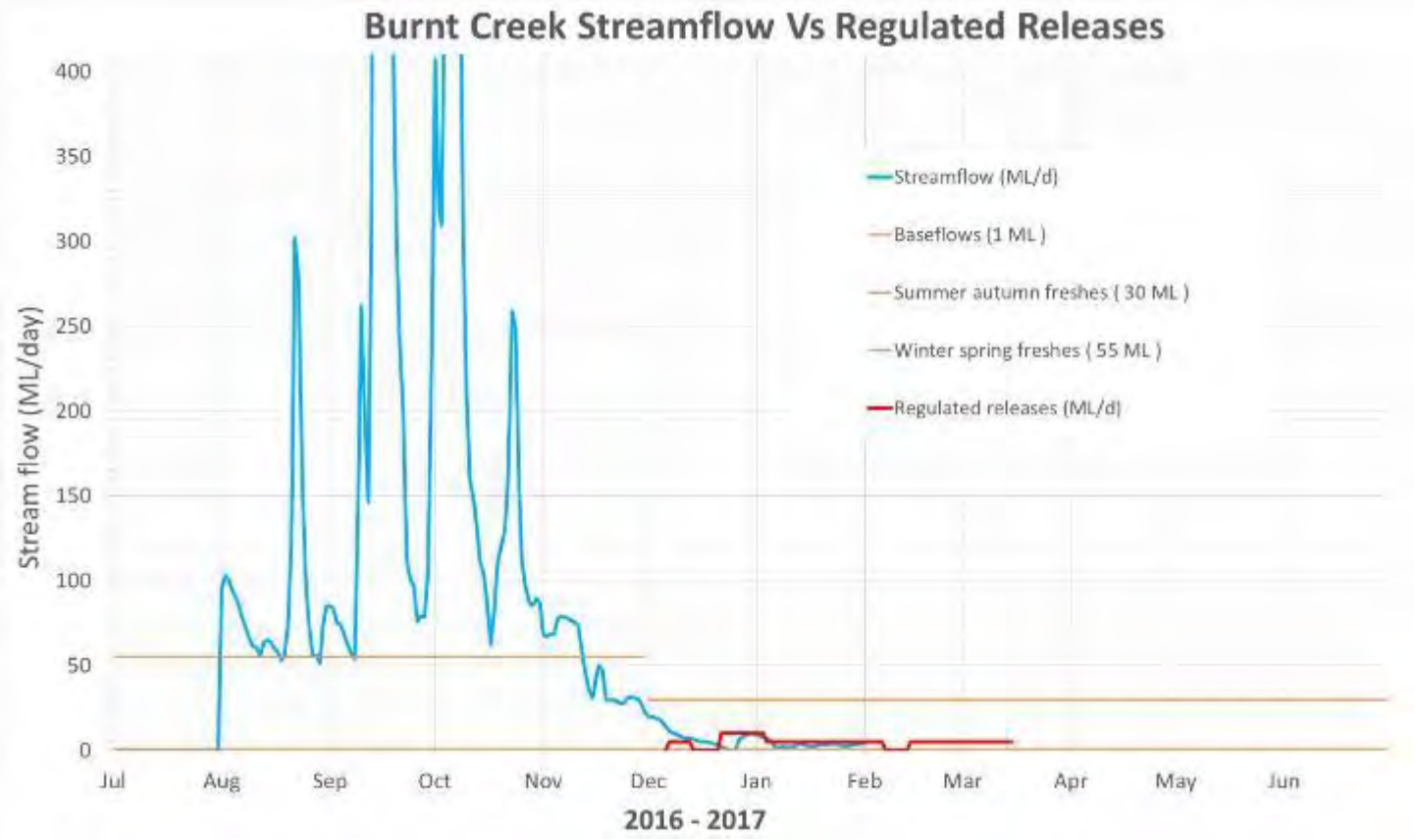


Figure 12 Burnt Creek streamflow at Wonwondah East gauge (415223).

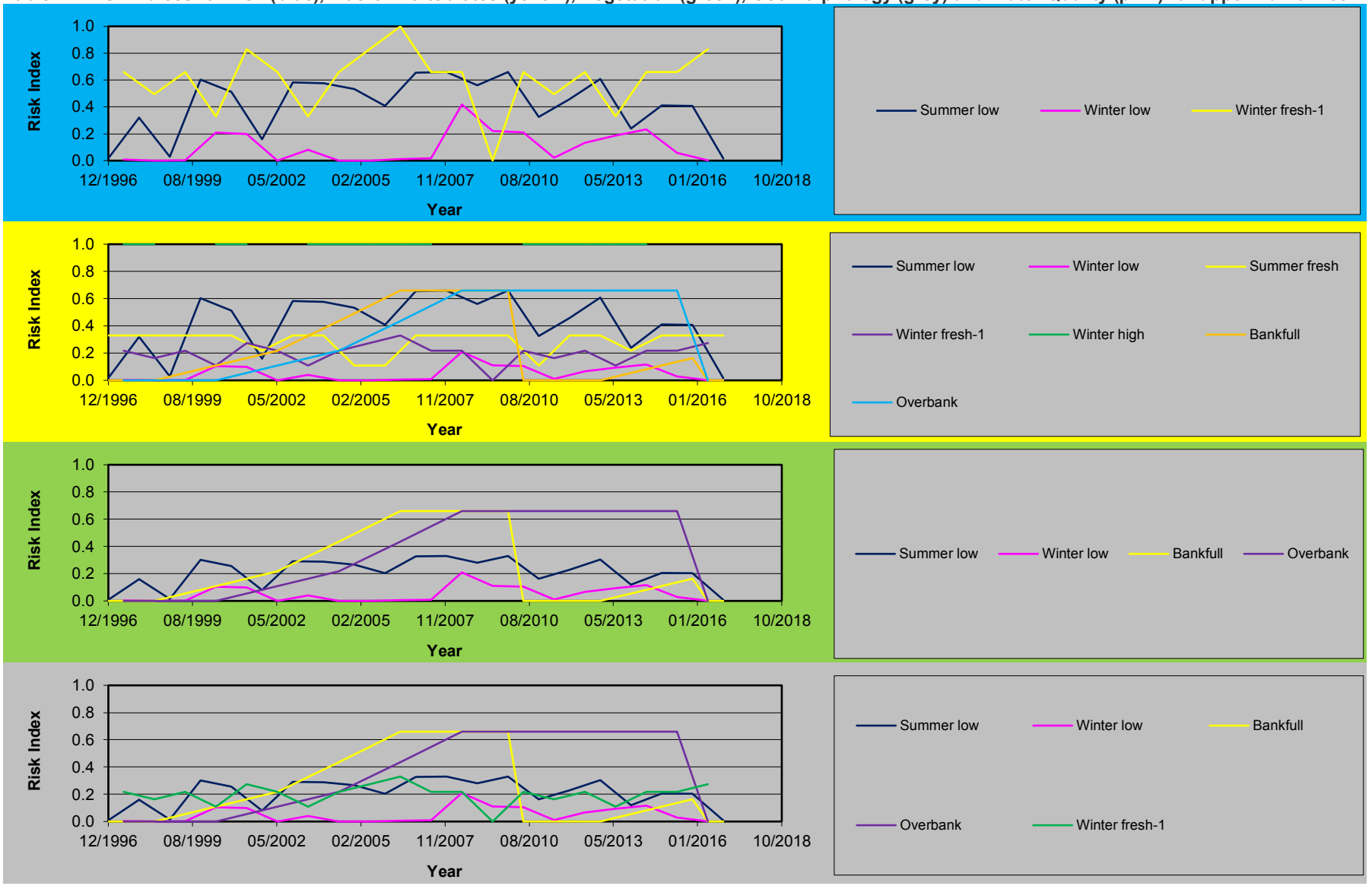
Table 13. Summary of Priority Watering Actions (PWA) delivered for upper Burnt Creek recorded at the Wonwondah East gauge (415223).

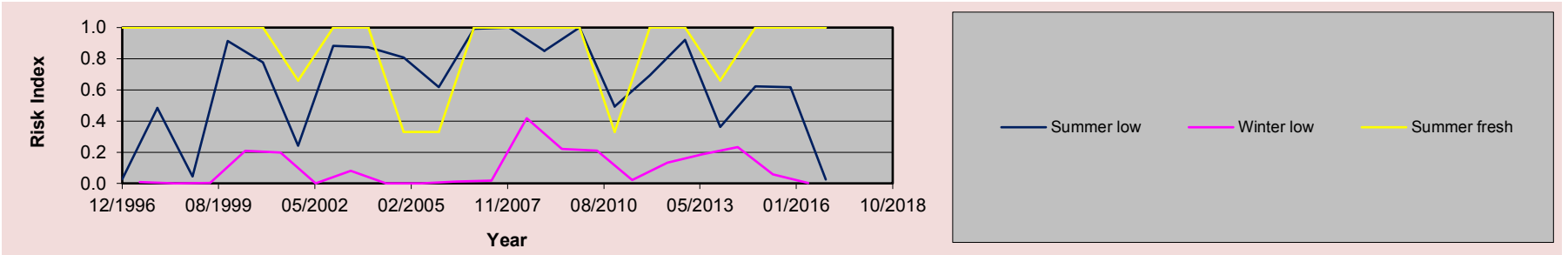
PWA delivered for upper Burnt Creek	Flow magnitude/ duration/ frequency	Comment
Baseflow all year	1 ML/d	Delivered mostly by unregulated flows from early August until regulated releases started in December.
Summer/autumn freshes	30 ML/d 3-7 days x 3	One achieved (April), one slightly underachieved (February), one more planned (May)
Winter/spring freshes	55 ML/d 7 days x 5	Unregulated flows mostly greater than 55 ML/d from early August to mid-November.
Winter/spring freshes	160 ML/d 3 days x 3	Unregulated flows greater than 160 ML/d for 31 days from late August to late October
Any time bankfull	400 ML/d 2 days x1	Unregulated flows greater than 400 ML/d for 6 days mid- September and 6 days early October.
Overbank	1,000 ML/d 1 day x1	Unregulated flows greater than 1,000 ML/d for 4 days mid-September and 3 days early-October

Limited ecological data exists regarding outcomes on the Burnt Creek in 2016-17, although fish surveys in autumn 2017 will provide additional information. Anecdotal information indicates that there has been improvement in vegetation outcomes.

Risks to ecological and physical objectives for the Upper Burnt Creek is included in Table 14 below. The results highlight a reduction in risks to all objectives apart from fish and water quality brought about due to the wet conditions in winter/spring 2016. Risks to fish and water quality remain high due to insufficient year round freshes so this will be a priority for 2016/17 and 2017/18.

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





Burnt Creek – September 2016

4.6 Bungalally Creek summary

No environmental flows were delivered to Bungalally Creek however there were significant unregulated flows in Bungalally Creek in winter and spring (Figure 12) which provided sufficient flows to achieve vegetation outcomes, in particular for River Red Gums. There is no stream flow monitoring available on Bungalally Creek.

Figure 13. Flooding along the Bungalally Creek (top) and Burnt Creek (bottom), 16 September 2016

4.7 Mt William Creek summary

Regulated releases were not able to take place during winter/spring given the initial 0% allocations and low volume of carryover requiring water to be saved for higher priority watering actions later in 2016. Again good rainfall let to substantial natural flows from Mt William Creek into Lake Lonsdale with it being empty at the start of July and reaching 8,690ML by the 6th of September. As a result of the wet spring, the lake contained 35,760 ML by the 25th of October. Due to good flows in the lower Mt William Creek and Wimmera River, passing flows were able to be accrued and used later once conditions dried out in November. The passing flow accrual also assisted GWMWater better manage water quality conditions in Taylor's Lake through selectively harvesting inflows into the Mt William Creek from the north-eastern Grampians. The total volume of passing flows released between early November and late January was 3,495 ML. Passing flows were released from Lake Lonsdale at a rate of 60 ML/d to meet objectives in the Seasonal Watering Proposal.

After a cease to flow through most of January and early February, releases re-commenced with baseflows for the Mt William Creek and in March larger volumes were provided from Lake Lonsdale via the Mt William Creek for the Wimmera River. No releases were required for the upper Mt William Creek due to the good unregulated flows and high levels in Lake Lonsdale.

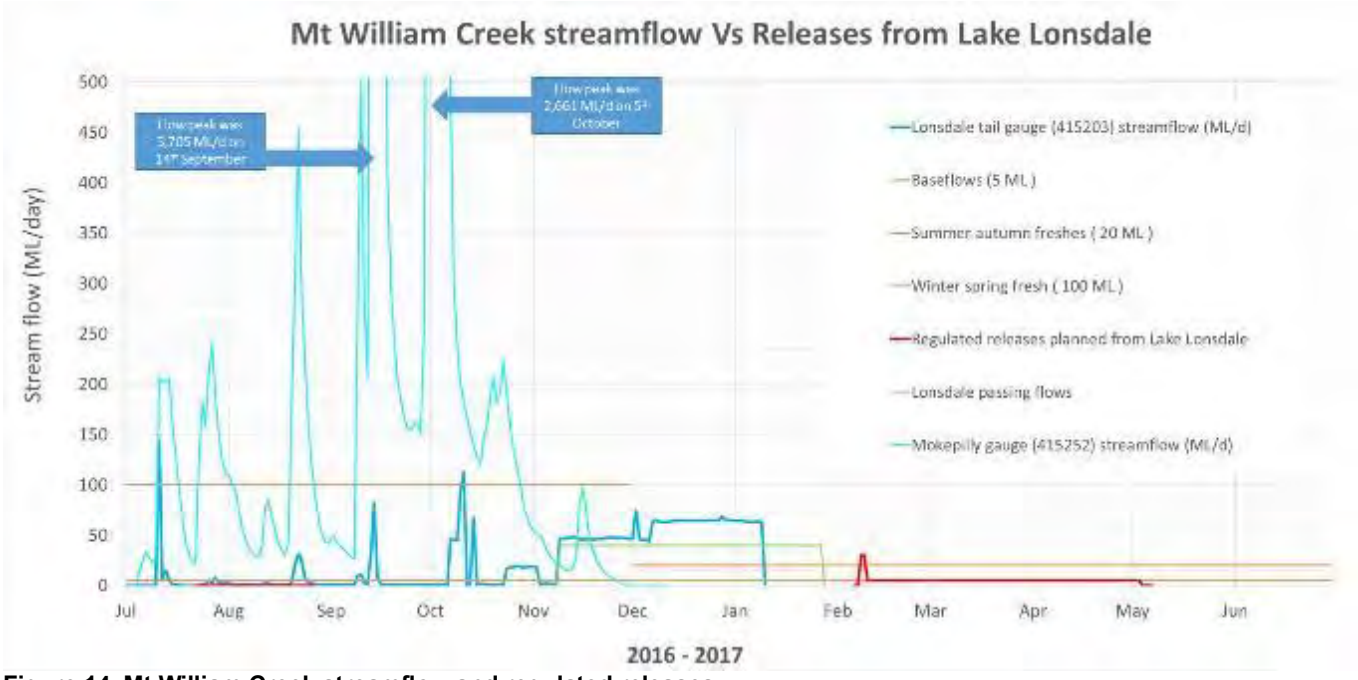
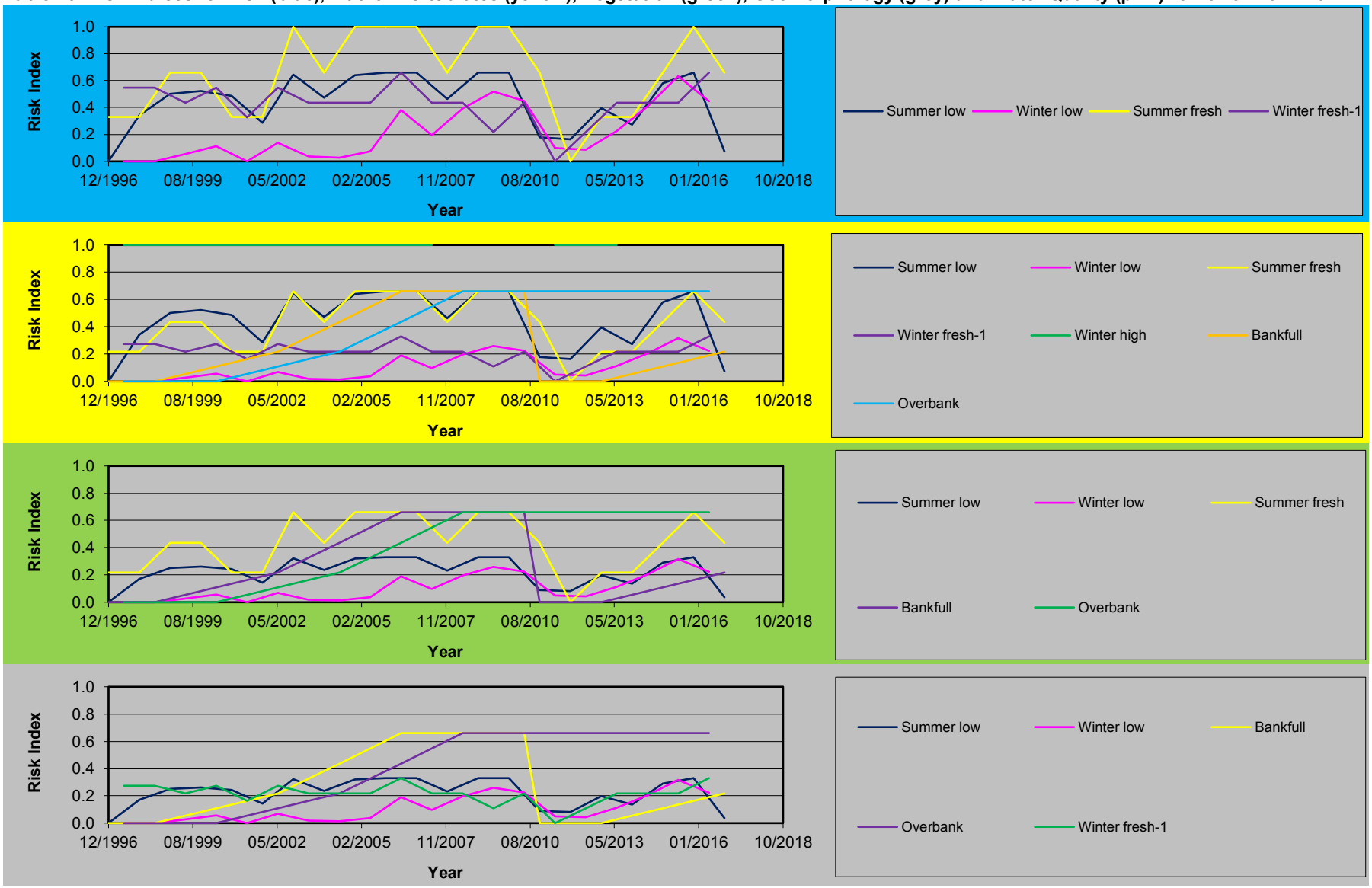
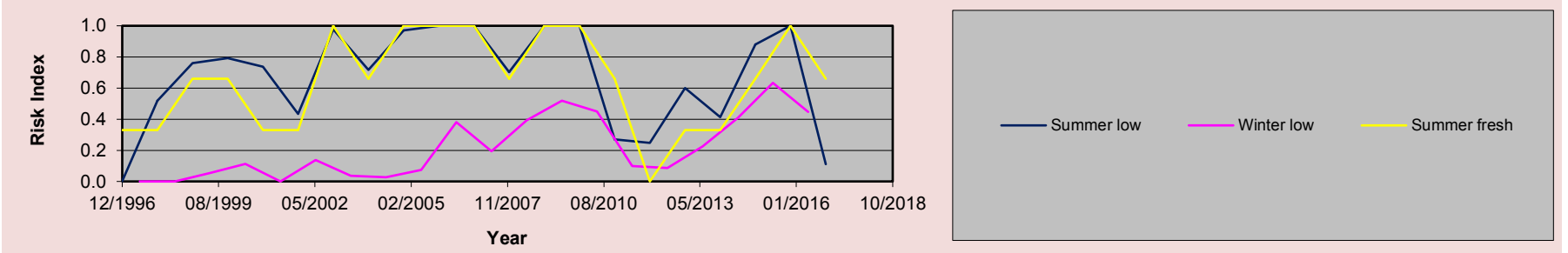


Figure 14. Mt William Creek streamflow and regulated releases.

Risks to ecological and physical objectives for the lower Mt William Creek is included in Table 15 below. The results highlight a reduction in risks to all objectives apart from geomorphology brought about due to the wet conditions in winter/spring 2016 and environmental water releases to date in 2016/17. 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.





Mt William Creek at Big Pipe Escape – April 2017

Limited fish monitoring was undertaken in the Mt William Creek as part of carp removal works funded as part of the drought assistance program for the region. Results indicated that large carp had moved upstream during the high flows in spring 2016.

4.8 Dock Lake summary

Given that Lake Wartook, Taylors Lake and Green Lake were full, unregulated water (spills and flood pre-releases) was diverted into Dock Lake in early October. The *Dock Lake FLOWS Study* (Jacobs, 2015) recommended that a volume between 271 ML and 973 ML be provided to the lake, starting sometime between May and September. Following this the lake should be allowed to dry out. The watering action is intended to provide a high quality wetland habitat that is likely to support a diverse range of flora and fauna species and communities (Jacobs, 2015). Water was provided through inflows in the Green Lake catchment and unregulated flows from the MacKenzie/Burnt system. This provided an opportunity to determine the viability of similar actions going forward. Bird monitoring results were very positive with large numbers of waterbirds present at the lake (over 1500 in January 2017) and instances of breeding of Black-winged Stilts, Chestnut Teal, Eurasian Coots and Whiskered Terns. Also notable was the presence of Plumed Whistling Ducks, a species not typically found this far south as it usually lives in tropical parts of Australia. There was a small vegetation response, although the late watering had enabled most of the lake bed to be colonised by thick exotic annual grasses which limited the ability of native species such as Common Nardoo to become abundant.

Figure 15. Pelicans, Whiskered Terns and Black-winged Stilts at Dock Lake, January 2017

5. 2017-18 Priority watering actions

Above average rainfall conditions in winter/spring 2016 has meant good carryover is available in 2017-18, approximately 31,250 ML, compared to 6,360 ML for 2016-2017 which in turn provides a vastly improved starting position. 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, and there is a need to share the water resource with the Glenelg River there are still likely to be shortfalls.

In addition to the Victorian Environmental Water Holder (VEWH) allocations, if there are reasonable inflows in winter/spring 2017 there is a likelihood that some Commonwealth Environmental Water Holder (CEWH) product of 28,000 ML will be available for use in the 2017-18 water year. Priority Watering Actions are outlined in further detail in Appendix 4.

5.1 Wimmera River Reach 4 Priority Watering Actions

Reach 4 of the Wimmera River is a priority reach based on its very high 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 2017-18 flows will be important in consolidating gains obtained by improved conditions in the last 6 months. Prior to this (August 2016) the lower Wimmera River downstream of Jeparit did not have any flow for almost 18 months so recent flows have reversed the trajectory of decline experienced beforehand due to high salinities and a lack of habitat with pools drying out.

5.2 MacKenzie River Reach 3 Priority Watering Actions

Very high environmental values mean that Reach 3 of the MacKenzie River is a high 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, therefore making it a priority for ongoing environmental water delivery. However it is understood that longer cease to flows and smaller freshes over summer/autumn may be beneficial in limiting the growth of the gambusia population in this reach (Ecology Australia, 2014). A fresh in late autumn however may assist in the dispersal of juvenile platypuses into this reach (Melody Serena, APC. *pers. comm.*). Water quality in the MacKenzie River is typically very good so it is important in boosting water quality in the Wimmera River.

Due to drought conditions, Reach 3 was completely dry for almost 18 months so native fish and other water-dependent fauna populations are recolonising this reach after flows commenced in August 2016. 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.

5.3 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. It also contains a small but viable population of platypus which are regionally important as the upper Wimmera River population of platypus remains highly vulnerable due to its small size and isolation (Josh Griffiths, cesar, *pers. comm.*).

5.4 Upper Burnt Creek Priority Watering Actions

Increased knowledge gained regarding the high quality of fish populations is the driver for proposed PWAs in upper Burnt Creek. 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. A population of the *FFG Act*-listed Western Swamp Crayfish has also been identified in this reach of Burnt Creek (Biosis, 2013). 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, 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 and 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.

5.5 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 although fish monitoring provided disappointing results which is somewhat attributable to the effect of barriers to fish movement from upstream (Biosis, 2013). Given the complete absence of flow from this reach apart from in periods of flood or environmental water releases given its extremely high levels of regulation, environmental water releases provide a lifeline for maintenance of its values. 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 2017/18. 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 is are stream crossings that may be impacted by the PWA (Earth Tech, 2006) although planning work has been undertaken to address this should funding for on-ground works be provided. If the on-ground works take place then this PWA can be attempted.

5.6 Bungalally Creek Priority Watering Actions

Bungalally 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. 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 2017/18. 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 should funding for on-ground works be provided. If the on-ground works take place then this PWA can be attempted.

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 over 100 ML is required to enable this reach to be filled and connected before the PWA (bankfull flows) can be delivered.

5.7 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 reach dead storage level in early February 2015. The small section of this reach 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 freshes 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. Due to water in Lake Lonsdale and good flows through this section in 2016, this watering action is not likely to be needed in 2017-18 water year.

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. The PWA has not related to a flow rate but rather topping up refuge pools to ensure that they provide meaningful habitat.

5.8 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 water quality and habitat availability. This reach also contains very high value macroinvertebrate and vegetation communities given the fact 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. 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.

5.9 Dock Lake Priority Watering Actions

The successful outcomes observed with the water provided by unregulated flows/spills in spring 2016 indicates that Dock Lake should become 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 outfalled at the same water level when inflows commence.

6. 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). High priority demands are in yellow, medium priority demands are in grey and low priority are in brown.

Wimmera Catchment			EXTREME DROUGHT 95% POE		VERY DRY 90% POE			DRY 75% POE			AVERAGE 50% POE			WET 25% POE		
Allocation against environmental (Shared with Glenelg System)			October VEWH Allocation 16,224 ML (40%)		October VEWH Allocation 23,119 ML (57%)			October VEWH Allocation 25,147 ML (62%)			October VEWH Allocation 32,853 ML (81%)			October VEWH Allocation 40,560 ML (100%)		
			Carry-over 31,250 ML		Carry-over 31,250 ML			Carry-over 31,250 ML			Carry-over 31,250 ML			Carry-over 31,250 ML		
			Spill loss 0 ML		Spill loss 0 ML			Spill loss 0 ML			Spill loss 0 ML			Spill loss 0 ML		
			October CEWH Allocation 0 ML		CEWH Allocation 0 ML			CEWH Allocation 0 ML			CEWH Allocation 0 ML			CEWH Allocation 0 ML		
			Total Available 47,474 ML		**Total Available 54,369 ML**			**Total Available 56,397 ML**			**Total Available 64,103 ML**			**Total Available 71,810 ML**		
Assumed available to the Wimmera			**28,484 ML**		**32,621 ML**			**33,838 ML**			**38,461 ML**			**43,086 ML**		
Expected climatic conditions and water available			Effectively no unregulated or passing flows (all systems). < 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 Flow			0 ML		1000 ML			5000 ML			15,000 ML			50,000 ML		
	Combined action		Max.total 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)
Priority Watering Actions	Wimmera River	Reach 3 Baseflows and freshes (summer/autumn)		Assumes water delivered for Reach 4 PWAs	7700	Min. 6860 ML Not required if Reach 4 PWA provided			7700	Min. 6860 ML Not required if Reach 4 PWA provided			8540	Min. 7640 ML Not required if Reach 4 PWA provided			9170	Min. 7820 ML Not required if Reach 4 PWA provided		
		Reach 3 Baseflows and freshes (winter/spring)		Assumes water delivered for Reach 4 PWAs	14640	Assumes water delivered for Reach 4 PWA		14640	14640	Assumes water delivered for Reach 4 PWAs		14640	14640	Assumes water delivered for Reach 4 PWAs		14640	14640	Assumes water delivered for Reach 4 PWAs		14640
		Reach 4 Baseflows and freshes (summer/autumn)	8160	Long cease to flow	9590	Min. 8490 ML	8490	1100	10080	Min. 8630 ML	8630	1450	10080	Min. 8980 ML	8980	1100	10570	Min. 9520 ML	9520	1050
		Reach 4 Baseflows and freshes (winter/spring)	7370	Lower than recommended	9200	Min. 6455 ML Lower than recommended	6455	2745	9580	Min. 6835 ML Lower than recommended	6835	2745	10420	Tier 1 assumes 5000 ML passing flows	5420	5000	11320	Tier 1 assumes 6000 ML passing flows	5320	6000
	MacKenzie River	Reach 2 Baseflows and freshes (summer/autumn)		Assumes water delivered for Reach 3 PWA	855	Min. 750 ML Not required if Reach 3 PWA provided			890	Min. 750 ML. Not required if Reach 4 PWA provided			1450	Min. 870 ML. Not required if Reach 4 PWA provided			1800	Min. 1050 ML. Not required if Reach 4 PWA provided		
		Reach 2 Baseflows (winter/spring)		Assumes water delivered for Reach 3 PWA	2745	Assumes water delivered for Reach 3 PWA		2745	2745	Assumes water delivered for Reach 3 PWA		2745	2745	Assumes water delivered for Reach 3 PWA		2745	2745	Assumes water delivered for Reach 3 PWA		2745
		Reach 3 Baseflows and freshes (summer/autumn)	2430	4 cease to flows	3465	Min. 2640 ML	2640	825	3465	Min. 2745 ML	2745	720	3710	Min. 2925 ML	2925	785	3710	Min. 3150 ML	3150	560
		Reach 3 Baseflows and freshes (winter/spring)	2945		2745	Min. 2180 ML Lower than recommended	2180	915	3445	Min. 2530 ML Lower than recommended	2530	915	3810		3810		4350		4350	
	Burnt Creek	Upper Burnt Creek Baseflows and freshes (summer/autumn)	950	4 cease to flows	1540	Min. 990 ML 4 cease to flows	990	550	1540	Min. 1170 ML 4 cease to flows	1170	370	1540	Min. 990 ML 4 cease to flows	990	550	1540	Min. 1180 ML	1180	360
		Upper Burnt Creek Baseflows and freshes (winter/spring)	200	Assumes unregulated flows	1080	Assumes unregulated flows	200	880	1410	Assumes unregulated flows	200	1210	2290	Assumes unregulated flows	200	2090	2840	Assumes unregulated flows	200	2640

Wimmera Catchment		EXTREME DROUGHT 95% POE			VERY DRY 90% POE				DRY 75% POE				AVERAGE 50% POE				WET 25% POE			
		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. 700 ML	700	525	1225	Min. 790 ML	790	435	1435	Min. 910 ML	910	525	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	Fill creek before bankfull delivered	300		300	Fill 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		**24255**		**56880**		**26885**	**21440**	**58465**		**26085**	**23790**	**64950**		**27295**	**28295**	**69470**		**28695**	**29805**
Environmental objectives		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.																		
Platypus																				
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 4 contains more detail regarding PWAs in relation to ecological objectives.

6.1.1. Shared Community Benefits

As highlighted in Section 2 Engagement – the community's interest in environmental watering activities is in part driven by other the benefits provided in terms of recreation and tourism. Implementation of planned watering activities will assist in achieving the shared benefits listed in Table 17.

Table 17. Shared benefits provided by proposed environmental watering activities in the Wimmera

Waterway	Additional benefits provided	How
Wimmera River	Rowing (Horsham and Dimboola) including Dimboola Regatta (November) Water-skiing (Horsham, Jeparit and Dimboola) including display at Horsham's Kannamaroo Festival in November Horsham Triathlon (February) Angling (throughout the year and along the entire reach) – main competitions are Horsham (March), Jeparit (April), Dimboola (October) Popular walking tracks at Horsham, Dimboola and Jeparit	Presence of sufficient water of good quality (baseflows and freshes) Robust fish communities (baseflows and freshes)
MacKenzie River	Angling (throughout the year and along the entire reach)	Robust fish communities (baseflows and freshes)
Burnt Creek	Angling (throughout the year and along the entire reach) Popular walking track at Horsham	Presence of sufficient water of good quality (baseflows and freshes) Robust fish communities (baseflows and freshes)
Mt William Creek	Angling (throughout the year and along the entire reach) Popular walking track at Dadswell's Bridge	Presence of sufficient water of good quality (baseflows and freshes) Robust fish communities (baseflows and freshes)
Dock Lake	Very popular for bird watching and duck hunting	Inundation

7. 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 previous 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.

8. Increasing Knowledge

Monitoring of waterways is critical in order to better understand the effectiveness of environmental watering activities (or lack thereof). This enhances community confidence in future environmental watering activities and enables adaptive management of future 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 to 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. 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) units on the Burnt Creek at Boggy Corner and Mt William Creek at Roses Gap helps address this issue, although they only provide water level data.

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, needed 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. In recent years VEFMAP fish monitoring has taken place at 12 sites along the Wimmera River and other waterways have been monitored on a rotating multi-year basis as part of the Wimmera CMA's regional fish monitoring program as well as the MDBA's Sustainable Rivers Audit. In 2017, sites on the Wimmera River will be monitored as part of the new Angler Report Card program instigated by DELWP.

- VEFMAP is changing the approach with respect to monitoring fish and vegetation and is likely to focus on the MacKenzie River, Burnt Creek and Mt William Creek in spring 2017.

- Should good water levels be present in regulated wetlands (Lake Hindmarsh, Dock Lake) bird monitoring will take place.

- Continue annual platypus surveys using trapping in MacKenzie River. Platypus monitoring using environmental DNA technology was successfully trialed in the lower MacKenzie River and Wimmera River in 2015, where water samples are tested for the presence of platypus DNA. Results showed a correlation between environmental DNA results and known platypus presence/absence. Platypus monitoring will take place in April 2017.

- Environmental DNA sampling is planned to take place on Mt William Creek in April 2017 to ascertain the distribution of River Blackfish.

9. Risk Management

Risk assessment and management is an important aspect of environmental water planning and a teleconference undertaken with VEWH, CMAs and GWMWater on 20 February 2017 to discuss risk management and environmental watering in detail. Table 18 illustrates the various risks covered in this workshop (likelihood and consequence) associated with planned environmental flow components.

Water flowing from Jeparit Weir – September 2016

Table 18. Risks associated with environmental water release components planned for 2017-18.

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	Possible	Moderate	High	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.	Likely	Moderate	High	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.	Possible	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.	Unlikely	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 release causes injury to river user	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	Environmental releases create rapid or unexpected changes in flow conditions, resulting in injury to river user.	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

10. Approval and endorsement

I, the authorised representative of the agency shown below, approve the Seasonal Watering Proposal for the Wimmera system 2017-18.

SIGNED FOR AND ON BEHALF OF Wimmera Catchment Management Authority

Signature of authorised representative

Name of authorised representative: David Brennan

Date:

Chris Bloink and Katie Stevenson (Ecology Australia) undertaking fish and crayfish surveys on the MacKenzie River

11. References

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Appendix 1: Media Information Regarding Environmental Water Releases

Environmental Water Releases
Summer update / December 2016

Season's Greetings | from our board, management and staff – have a safe and happy festive season

Community fills knowledge gaps in flow planning

This time last year, with low river levels and little rain on the immediate horizon, we were working closely with communities to look after fish refuge pools through a long hot summer, and plan for water events that would benefit the environment and community in our severely drought-affected rivers and streams.

What a difference a year makes!

Here's what we're up to and how you can get involved...

PlatypusSPOT app

Make sure you've installed the new platypusSPOT app so if you're lucky enough to see one of these amazing creatures you can log the sighting and help ongoing conservation and research.

The Wimmera platypus population is extremely fragile, making environmental water releases critical to provide habitat.

Wimmera Carp Conversation

The continuation of a healthy waterway and robust native fish community are vital in the war against carp. This is why we target our native fish with environmental releases – we're pleased to say their populations are making a comeback in part thanks to improved flows.

Water Monitoring

The community has been monitoring the Wimmera River since 1995 when Jeparit Waterwatch group started tracking trends in water quality and salinity. This year the Wimmera Anglers' Association has jumped on board and is using innovative eDNA technology to pinpoint Golden Perch and Freshwater Catfish. These data sources complement monitoring information we collect and fill key knowledge gaps underpinning trends in water quality and native fish populations are important in adaptively managing environmental flows.

Upload your photos to Instagram using #wimmerariver and #wimmerawaterways hashtags

We love to see photos that show changes in seasons and water levels or some cool plants or animals.

Why?

Environmental water is vital for maintaining water levels and the health of plants and animals along the river so we are looking for changes at specific locations.

Planned Summer Releases

This year's above average rainfall led to many benefits including a reduced need for environmental watering. After a relatively dry November and dry start to December all our creeks have stopped flowing.

Summer flows will be from:

- Lake Lonsdale for Mt William Creek
- Lake Wartook for Burnt Creek and Mackenzie River
- Taylors Lake for Wimmera River

These are vital for replenishing on the wet winter/spring – so native fish and other aquatic communities can complete breeding cycles. It also helps mitigate risks of blackwater given large quantities of decaying leaf litter and other organic matter have washed into rivers and creeks.

ENVIRONMENTAL WATER RELEASES WINTER UPDATE | August 2016

> *"Flows are a lifeline to communities that live along the river."*
>
> Mark Gaulke,
> Dimboola Ski Club president

It is with great excitement that Wimmera communities are seeing many of their local rivers and creeks start flowing, with the first natural flow reaching the end of the Wimmera River since 2012.

Well-timed rainfall in the upper catchment triggered this flow which kick started things in July. More than a month later, the river is still flowing and has reached to Jeparit. It is also filling Yarrambiack Creek. Now that the catchment is wet, the rivers and creeks are primed if we get follow up spring rain...

Why we love natural flows

The best kind of flow for a river is a natural flow because it provides greater connectivity and higher flow rates than equivalent environmental water releases can achieve. This is better for native plants, native fish and other creatures and means environmental water can be saved for use on a not so rainy day.

Why we have this flow

Prior to the completion of the Wimmera Mallee Pipeline, much of the flow in the Wimmera River was harvested into storages to run the channel system. In the piped system, passing flow and water harvesting rules for the Wimmera River and Mt William Creek mean a proportion of flows in the Wimmera River and Mt William Creek are allowed to continue downstream.

Wimmera River near Jeparit on May 31 2016 (top) and then on August 17 after the natural flow arrived

Environmental lifeline

During the successive dry years environmental water releases have provided a lifeline to the Wimmera River system, with the focus on building a resilient environment that could deal with the stresses of drought and bounce back quickly when wet conditions returned.

How resilient is the Wimmera River?

Freshwater ecologist Shane Brooks looked at how environmental water releases have impacted on habitat in the lower Wimmera River downstream of Dooen Lake outlet channel over the past 10 years.

We are used to reading about studies on birds, frogs, fish and animals, but this new study has gone much deeper. It looks at aquatic plants with names like Triglochin, Myriophyllum, Potamogeton, Baldellia ranunculoides, Rhagodia, Chenopodium and Typha – which all sound like they could be Pokémon Go characters.

The study reveals good news and a resilient river system. During the past essential dry years, environmental water releases have resulted in an improved spread and diversity of submerged and aquatic plants in the river. This is a stark contrast to during the Millennium Drought and pre-Wimmera Mallee Pipeline, where environmental water releases were much less, and the infrequent flows inhibited the response of plants such as completing life cycles – from germination to setting seed.

Many of these plants need clear water and frequent flows to survive and the study reveals an abundance of different plants which are also appearing in placement seed banks. These plants are vital in reducing algal blooms, oxygenating the water and providing habitat for small bugs and fish that sustain angling species like Golden Perch, Silver Perch and Freshwater Catfish. These plants were crucial for their survival through drought conditions and highlight that flows are important in times that are not drought or flood.

So next time you're out about near your local creek or river, keep your eyes peeled for Triglochin, Myriophyllum, Potamogeton, Baldellia ranunculoides, Rhagodia, Chenopodium and Typha and say thank you for the work they're doing in keeping our waterways healthy!

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				
			AVERAGE		Less than 7 days in total		
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 terrestrialisaton 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 higher benches, entraining organic debris and promoting	Yes (Alluvium 2013)

			WET	2 per period	3 days	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				
			AVERAGE		Less than 7 days in total		
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.
			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		
	June - Nov	200 ML/d	DRY	1 per period	1 day	Wets lower 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	1300 ML/d	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		
			AVERAGE				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.
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	Achieve shear stress to flush surface sediments from hard substrates to support	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	macroinvertebrates.	
Bankfull	Any	500 ML/d	WET	1 per period, or natural	1-day	Inundate riparian vegetation to maintain condition and facilitate recruitment (including *Callistemon Wimmerensis*). 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 *Callistemon Wimmerensis*). 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 source), fish movement and to maintain water	

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	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 water quality in pools. Triggers spawning in many Western Carp	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.
					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 WET	1 per period or natural	2 days	Inundate riparian vegetation to maintain condition and facilitate recruitment. Maintain structural integrity of channel.	Yes (Alluvium 2013)
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)
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		

Flow component	Timing	Magnitude	Climatic scenario	Frequency	Duration	Associated environmental objective	Is this flow component consistent with the environmental flow study? Include source.
	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	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 2017.

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
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	
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
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	
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
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	
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
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	
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
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
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 (winter spring done)

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
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		
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
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	
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		
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
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	
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	
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	
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
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
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
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

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 µS/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 uS/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 uS/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

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 heath 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 heath and maintenance of water quality and diversity of habitat.	350 – 1225 ML
Freshes June-November 1 event of 190 ML/day 1-2 days	Achieve shear stress to flush surface sediments from hard substrates to support acroinvertebrates.	Medium	Stimulate fish movement and maintain water quality. Flush surface sediments from hard substrates to support macroinvertebrates. Wet higher benches, entraining organic debris and promoting diversity of habitat.	190 – 380 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.	750 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's 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
Freshes June-Nov 1-5 events of 130 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.	Medium	Stimulate fish movement and maintain water quality. Flush surface sediments from hard substrates to support macroinvertebrates. Wet higher benches, entraining organic debris and promoting diversity of habitat.	100 - 2000 ML

Table 19. 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

PWA Target	Flow function	Priority	Rational	Volume (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 reached dead storage level on the 3rd of February 2015, where no further flows could be delivered to Lower Mt William Creek. 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 Dock Lake FLOWS Study (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