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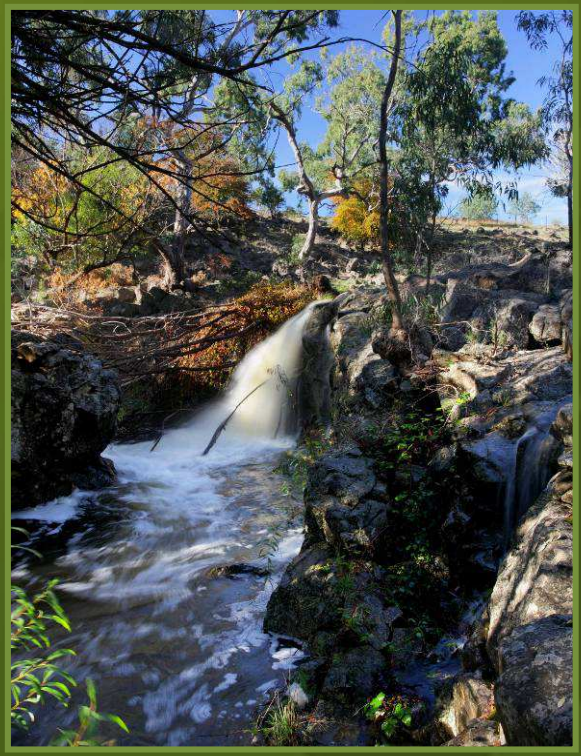
North Central CMA Region Environmental Water Management Plan for the Coliban River



EWMP Area: Coliban River downstream of Malmsbury Reservoir to Lake Eppalock

NORTH CENTRAL
Catchment Management Authority
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Front cover images:
Left: Ellis Falls, April 2010 (Imagine Pictures)
Top right: The Cascades, April 2010 (Imagine Pictures)
Bottom right: Coliban River at Lyell Rd, August 2014 (North Central CMA)

This is a working document, compiled from the best available information. It will be subject to revision in the future as new information becomes available.

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EXECUTIVE SUMMARY

The Coliban River Environmental Water Management Plan (EWMP) sets out long-term objectives for the priority environmental values of the Coliban River, downstream of Malmsbury Reservoir to Lake Eppalock. The EWMP is an important part of the Victorian Environmental Water Planning Framework. It provides the five to ten year management intentions, based on scientific information and stakeholder consultation that can be used by the respective agencies; North Central Catchment Management Authority (CMA), Department of Environment, Land, Water and Planning (DELWP) and the Victorian Environmental Water Holder (VEWH); for both short and longer-term environmental water planning.

This EWMP is not a holistic management plan for the river, but is focused on environmental water management so that Coliban River can provide environmental, social, cultural and economic values for all users. Actions such as pest plant and animal works are documented as complementary to environmental water management in this EWMP.

The following components are the main sections featured in the Coliban River EWMP. A summary of the main conclusions to facilitate appropriate environmental water management into the future are summarised below.

Hydrology and system operations

Flow in the Coliban River downstream of Malmsbury Reservoir is regulated by the operation of the Malmsbury, Lauriston and Upper Coliban storages. Due to this regulation the majority of natural flows are now harvested in the upstream storages. Current flows in the Coliban River are characterised by minimum flows passed down the river (particularly during winter). There is a lack of irrigation demand in the river (less than 100 ML entitlement) and the use of a pipe and channel network for the diversion of potable water from Malmsbury Reservoir to towns including Bendigo and Castlemaine reduces the provision of flows in the river. Therefore, flow in the river is influenced by the passing flow entitlement which is dependent upon catchment inflows, transfers of water to Lake Eppalock and major flood events in the catchment.

Water dependent values

The Coliban River is highly significant as a tributary river of the Campaspe River within the Murray-Darling Basin. The river passes through a variety of habitats types including woodland and grassland zones, instream woody habitat, submerged vegetation, waterfalls and pools. These habitats support a suite of small bodied native fish, Platypus (*Ornithorhynchus anatinus*) and Water Rats (*Hydromys chrysogaster*) including a number of species listed as significant.

Ecological condition and threats

The Coliban River is currently in relatively poor condition and is flow stressed as it does not have a sufficient environmental entitlement to maintain and improve the current ecological values exhibited at the waterway. The provision of improved environmental flows is required for the recovery of small bodied native fish and Platypus populations from the prolonged drought (period of 2000 to 2010) in this system. Downstream of Malmsbury Reservoir, the river is classified as an unregulated river; therefore the supply of stock and domestic licenses puts further pressure on environmental water.

Management objectives

A long-term management goal has been defined for the Coliban River:

Coliban River long term management goal

To rehabilitate resilient breeding populations of Platypus and small-bodied native fish in the upper half of the Coliban River through maintaining and increasing the cover and diversity of in-stream, fringing and riparian native vegetation communities, and to provide opportunities for these animals to disperse throughout the lower half of the river and beyond.

The ecological objectives and hydrological objectives that sit under the long-term management goal for the Coliban River were assessed in 2006 (SKM 2006a; 2006b; 2006c) and have been reviewed and refined during the development of this EWMP (North Central CMA and Jacobs 2015). These objectives prescribe the environmental watering regime for the river.

Managing risks to achieving objectives

The threats to achieving the ecological objectives that are external to environmental water have been identified. These include things such as introduced flora and fauna (including inhibiting willow infestations), land clearing, livestock access and grazing of river banks, sand slugs and high nutrient loads.

Environmental water delivery infrastructure

Malmsbury Reservoir can be managed to deploy all of the flow recommendations defined in this EWMP, however the following recommendations need to be investigated further to improve environmental water management in the Coliban River:

1. Exchange of storage volumes to increase environmental flows down the Coliban River: further discussions with Coliban Water and Goulburn Murray Water (GMW) to define the scenraios when additional water can be provided to the river via exchange of environmental entitlement held in Lake Eppalock to Malmsbury Reservoir.
2. Costs associated with deploying the CEWH entitlement: discussion between CEWH, VEWH Coliban Water and the North Central CMA are required to investigate opportunities to use the current CEWH environmental entitlement in the Coliban River.
3. Investigate potential to purchase new entitlments for the river.

Demonstrating outcomes

Monitoring is required to allow the CMA to adaptively manage annual environmental watering (intervention monitoring). It is also required to enable the CMA and VEWH to demonstrate the long term outcomes of the implementation of the Coliban River EWMP. As the State is currently reviewing the Victorian Environmental Flows Monitoring and Assessment Program (VEFMAP), the Coliban River EWMP recommends a suite of intervention and long-term monitoring activities that will meet the monitoring requirements.

Consultation

Key stakeholders, including DELWP, VEWH, Coliban Water and GMW have been engaged during the development of this EWMP. The community involved in the consultation phase of the Coliban River EWMP also played a crucial role in advising the North Central CMA on its management of environmental water. Community consultation was undertaken through telephone interviews with landholders and other interest groups.

Knowledge gaps

The management actions in the Coliban River EWMP are based on the best available information. A number of knowledge gaps have been identified during the development of the EWMP, particularly around investigating options to increase the environmental entitlement available to the river.

ACKNOWLEDGEMENTS

Acknowledgement of Country

The North Central Catchment Management Authority acknowledges Aboriginal Traditional Owners within the region, their rich culture and spiritual connection to Country. We also recognise and acknowledge the contribution and interest of Aboriginal people and organisations in land and natural resource management.

Contributions to the Coliban River EWMP

The information contained in the Coliban River Environmental Water Management Plan (EWMP) has been sourced from a variety of reports and field inspections and from individual knowledge and expertise. The North Central CMA acknowledges the assistance of the following people in preparing this EWMP:

- Chris Bromley, Alastair and Lisa Stables, David and Marion Maloney, Diane Jackson, John Dunham, John Sinnotts, John and Sue Walter, Community
- Richard Carter (Natural Resource Management Committee, North Central CMA)
- Suzanne Witteveen, Susan Watson and Andrea Keleher, Department of Environment and Primary Industries (DELWP Victoria)
- Keith Chalmers, Victorian Environmental Water Holder (VEWH)
- Lynley Strachan and Dale McGraw (Goulburn Murray Water)
- Aleksy Bogusiak and Steve Healy (Coliban Water)
- Andrew Sharpe, Peter Sandercock, Damien Cook, Melody Serena, Amanda Woodman and Eliza Wiltshire (Workshop Technical Panel)
- Terry Hillman and Jane Roberts (Expert Review Panel)
- Louissa Rogers, Phil Dyson, Emer Campbell, Rebecca Horsburgh and Darren White (North Central CMA).

CONTENTS

TABLES

FIGURES

1. Introduction

The North Central Catchment Management Authority (CMA) is being funded through the Department of Environment, Land, Water and Planning (DELWP) 'Victorian Basin Plan Environmental Water Management Plan Program' to prepare an Environmental Water Management Plan (EWMP) for the Coliban River.

1.1. Background

Management of environmental water is planned and implemented through a framework of key documents. Figure 1 illustrates the strategies, scientific reports and operational documents required for environmental water management in Victoria (Victorian Environmental Water Holder [VEWH] 2013). The North Central Catchment Management Authority (CMA) has recently developed the North Central Waterway Strategy - 2014-2022 which is an integrated strategy for managing and improving the region's waterways (rivers, streams and wetlands). The strategy sets priorities and outlines a regional works program to guide investment over the next eight years (North Central CMA 2014a).

The Coliban River sits within the Campaspe Catchment and is an identified program area in the Waterway Strategy. The following long-term resource condition target has been set for the Coliban River downstream of Malmsbury Reservoir (ISC reaches 18 and 19):

- *"The delivery of environmental flows are maximised contributing to increased hydrology and aquatic life ISC scores for Coliban River Reaches 18 & 19 by 2021"*

Five management outcome targets have also been set for the program area and include reduce the altered water regime threat score, improve planning for environmental water management, maintain or improve water quality, maintain vegetation structure and diversity, and increase landholder skills and awareness in riparian management practices. Please note that the management activities identified for this program area are subject to funding.

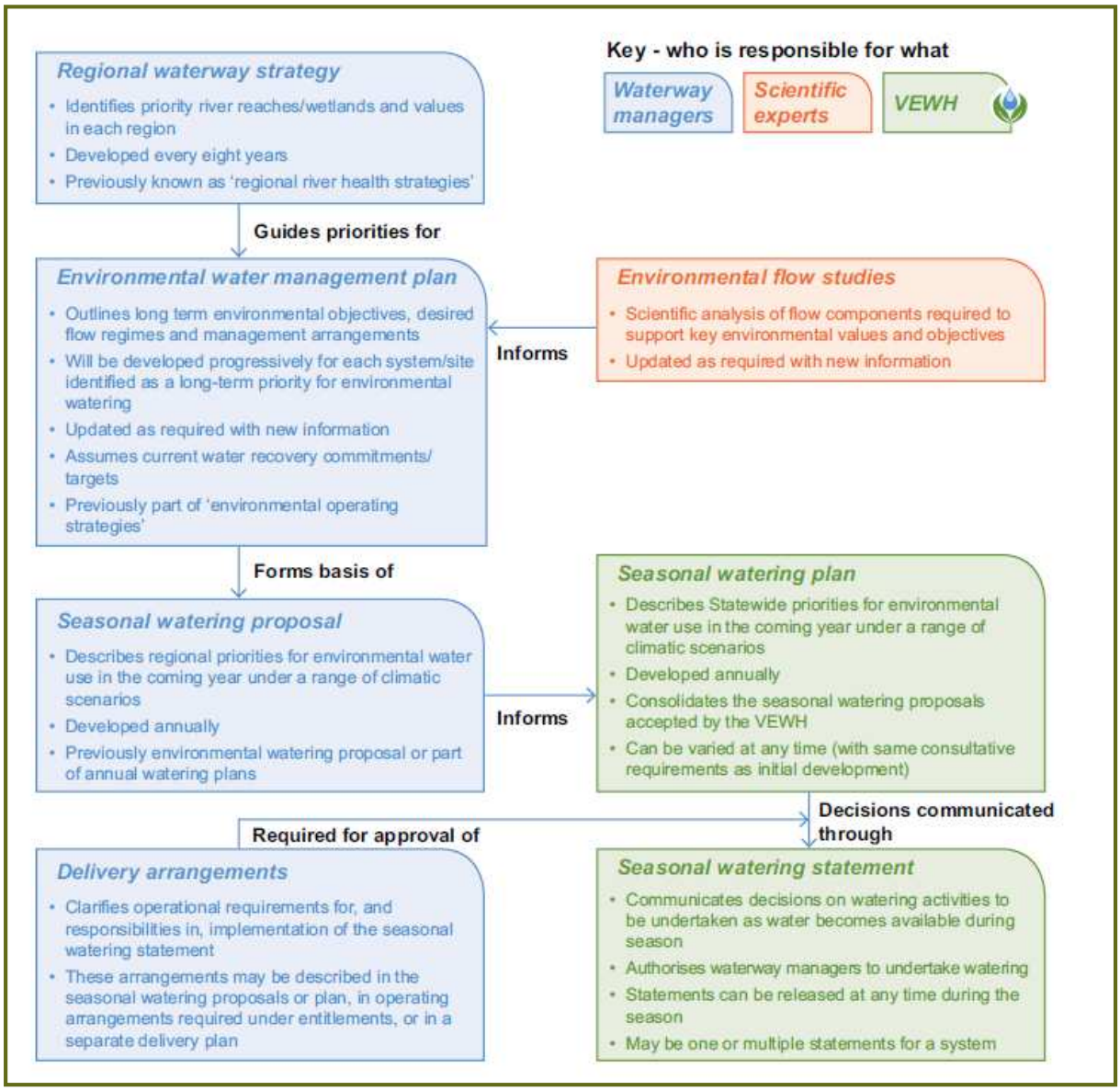

Figure 1: Planning framework for decisions about environmental water management in Victoria.

1.2. Purpose and scope of the Coliban River Environmental Water Management Plan

The Coliban River EWMP is a ten year management plan that describes the ecological values present, long-term goal for the river and priority ecological objectives and recommended flow regime to achieve the objectives. It is based on both scientific information and stakeholder consultation and will be used by the North Central CMA when making annual environmental watering decisions, as well as DELWP and the Victorian Environmental Water Holder (VEWH) for both short and longer-term environmental water planning (Department of Environment and Primary Industries [DEPI] 2014a).

The key purposes of the EWMP are to:

- identify the long-term objectives and water requirements for the river
- provide a vehicle for community consultation, including for the long-term objectives and water requirements of the river
- inform the development of seasonal watering proposals and seasonal watering plans

- inform Long-term Watering Plans that will be developed by the State under the Basin Plan Chapter 8 (DEPI 2014a).

The scope of this EWMP is the Coliban River downstream of Malmsbury Reservoir to Lake Eppalock (Figure 2).

1.3. Development Process

The Coliban River EWMP has been developed in collaboration with stakeholders including DELWP, VEWH and Coliban Water and Goulburn Murray Water (GMW). A number of tasks were undertaken to develop the EWMP including:

- **Scoping and collating information:** a review of technical work, monitoring and research that has been undertaken on the Coliban River to date.
- **Convening an Environmental Flows Technical Panel (EFTP):** The Campaspe River Environmental Flows Assessment (which included the Coliban River downstream of Malmsbury Reservoir) was undertaken in 2006. An EFTP was reconvened to refine the ecological objectives and update the flow regime (including rerunning the HEC-RAS model) based on monitoring results and up-to-date scientific understandings on flow requirements of flora and fauna (North Central CMA & Jacobs 2015).
- **Community Consultation:** Consultation was undertaken with adjoining landholders and community members who have had a long association with the waterway. Other stakeholders were directly engaged to provide technical and historic information including GMW, Coliban Water and Landcare members. A summary of the information sourced from this process is provided in Appendix 1.
- The outputs of the above three tasks were analysed and provided evidence for the following sections:
    - **Water dependent values:** environmental values were derived from various sources identified during data collation. Additional data identified during the EFTP review was also incorporated, specifically related to Platypus (*Ornithorhynchus anatinus*) and Water Rats (*Hydromys chrysogaster*). The water dependent values (fauna, vegetation communities and flora) are presented for the Coliban river downstream of Malmsbury Reservoir. Social values (cultural heritage, recreation and economic) are also described.
    - **Ecological condition and condition trajectory without environmental water:** the condition, as reported in the Murray Darling Basin Wide Sustainable Rivers Audit and the Victorian state-wide Index of Stream Condition, is discussed in light of Victorian Environmental Flows Monitoring and Assessment Program (VEFMAP) findings and analysis. The condition trajectory under a “do-nothing” scenario considers the flow regime under a consumptive water regulated system only.
    - **Management objectives:** the water management goal and the ecological objectives for the river are based on the water dependent values recorded in the river, the current condition and the condition trajectory. The objectives are also aligned with the broader environmental outcomes proposed in the Basin Plan draft Environmental Watering Strategy.

      Hydrological objectives and the flow recommendations are based on known watering requirements of the objectives and outputs of the HEC-RAS modelling.
    - **Managing risks:** the risks to achieving the ecological objectives for the Coliban River are based on monitoring data, community concerns (Appendix 1) and best-available

river health scientific knowledge as provided by the EFTP. Management actions to mitigate the risks are recommended (and included as Complementary Actions).

Risks associated with the delivery of environmental water are also documented. Management actions to mitigate these risks relate to intervention monitoring and operational decision making. The residual risk assumes that management actions are fully implemented.

- **Environmental water delivery infrastructure:** current constraints in delivering the environmental flow recommendations are identified.
- **Demonstrating outcomes:** monitoring to adaptively manage the delivery of environmental water and to demonstrate the outcomes against the ecological objectives are based on best available science monitoring method and recommendations made by the EFTP.
- **Knowledge gaps and recommendations:** knowledge gaps were identified during the process of developing the ecological objectives, management actions and undertaking the risk analysis. An action list with timeframes has been developed whilst developing the EWMP, including a review of this EWMP in five years time.

2. Site overview

The Coliban River catchment extends from the Great Dividing Range to Lake Eppalock and is made up of five major waterways; the Little Coliban River and Kangaroo Creek (both upstream of Malmsbury Reservoir) and Myrtle Creek and Sandy Creek. Originally named the Bernard River by Major Thomas Mitchell, it was later changed by the early settlers to the Coliban River after misreading Major Thomas's earlier recording of the Indigenous name 'Cobaw' (North Central CMA 2006a).

2.1. Site location

The Coliban River downstream of Malmsbury Reservoir to Lake Eppalock is referred to as Reach 1 in the *Campaspe River Environmental Flows Assessment* (SKM 2006a, 2006b and 2006c). It flows for approximately 58 kilometres before entering Lake Eppalock. Figure 2 illustrates the main features of the Coliban River EWMP area, including the two FLOWS assessment sites.

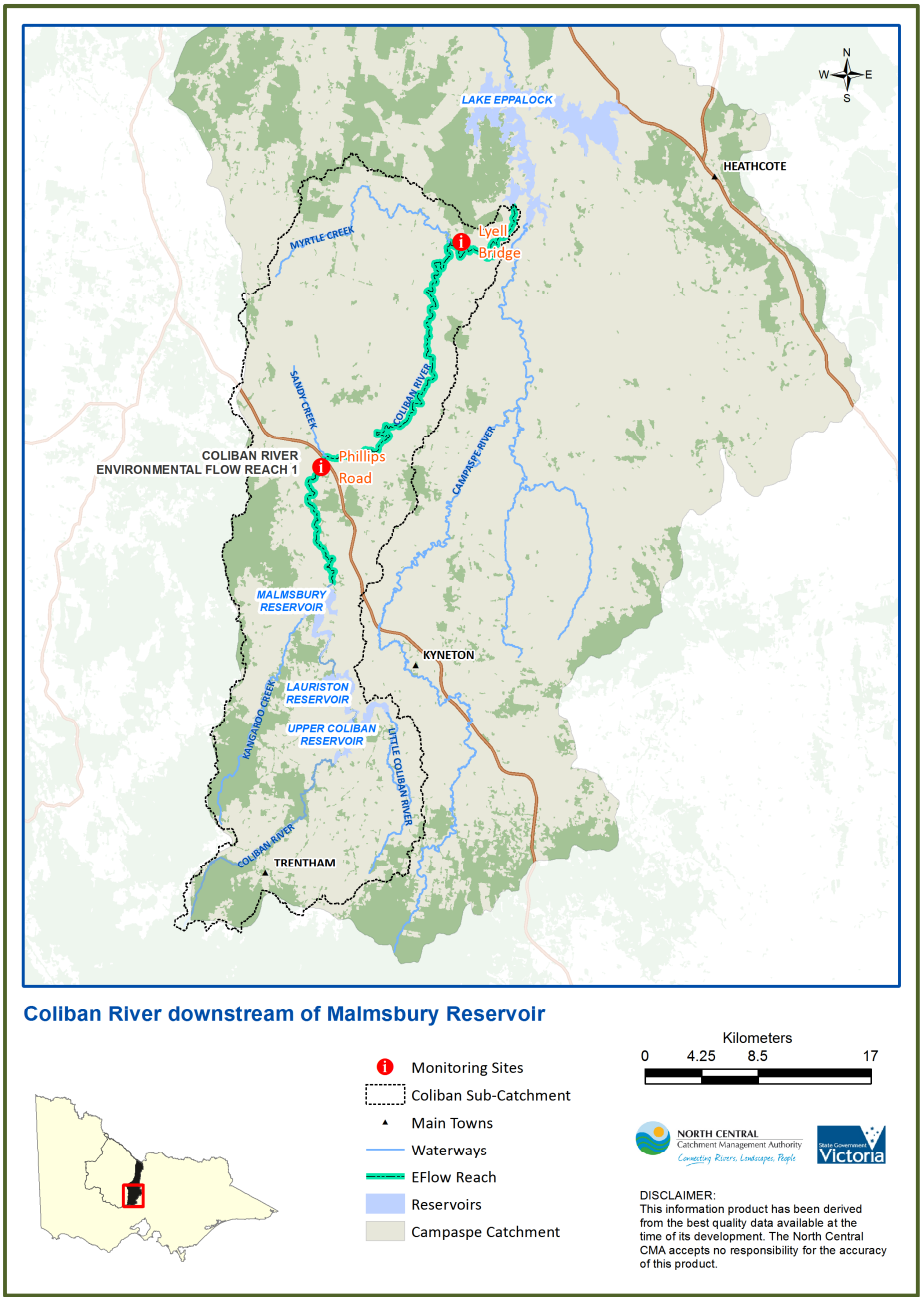

Figure 2: Coliban River EWMP area location map

2.2. Catchment setting

Climate

Annual rainfall in the Coliban River catchment ranges from 347 to 724 mm at Malmsbury Reservoir[1] (Bureau of Meteorology [BOM] 2015). Rainfall is generally higher in winter and most of the runoff occurs in late winter and early spring. The Coliban River catchment is approximately 15% of the Campaspe basin which covers 0.4 percent of the Murray-Darling Basin (MDB) and contributes about 0.9 percent of its total runoff (CSIRO 2008).

Hydro-physical characteristics

The Coliban River downstream of Malmsbury Reservoir primarily flows through basalt plains and granite hills landforms with occasional Sedimentary Hills deposits. The reach has a number of small waterfalls and rocky cascades, the natural pool and riffle sequence is evident upstream of Sandy Creek and in some lower sections near Lyell Bridge (refer to Figure 2). Sand inputs from Sandy Creek and other local sources have smothered many channel features through the middle of the reach (North Central CMA 2006b). Many sections of the river are also heavily impacted by willows, gorse and blackberries. Invading willows have substantially modified channel morphology (refer to Figure 7, Section 9).

2.3. Land status and management

The Coliban River flows through urban, peri-urban and rural townships including Malmsbury, Taradale and Metcalfe. The primary land use adjacent to the Coliban River is grazing and cropping farmland. There are six main areas of land in the Coliban River catchment set aside primarily for nature conservation protection[2], Parks Victoria is responsible for managing these reserves and parks.

A variety of land management practices in the Coliban River catchment have the potential to affect environmental, social and economic assets within the catchment if not properly managed. Sheep and cattle grazing are the major land uses on freehold land within the Coliban catchment and have caused extensive modification to the natural landscape.

A significant works program was recently completed within the upper Coliban River catchment (2008-11) which targeted the Kangaroo Creek and Coliban River. Figure 3 provides an analysis of the sections of the Coliban River that have been fenced off, this analysis has highlighted that a while there are many exposed areas (12 kms) with no fencing (brown), there is a high proportion (28 kms) of the river that has either been partially fenced (red or green) and approximately 20 kms is fully fenced (purple).

1 Malmsbury Reservoir (#088042); Record: 1872 to present; Elevation 470 m

[2] Pilchers Bridge Nature Conservation Reserve, Mt. Lofty Bushland Reserve, Coliban Falls Geomorphological Features Reserve, Mt. Alexander Regional Park, Metcalfe Nature Conservation Reserve and Taradale Nature Conservation Reserve

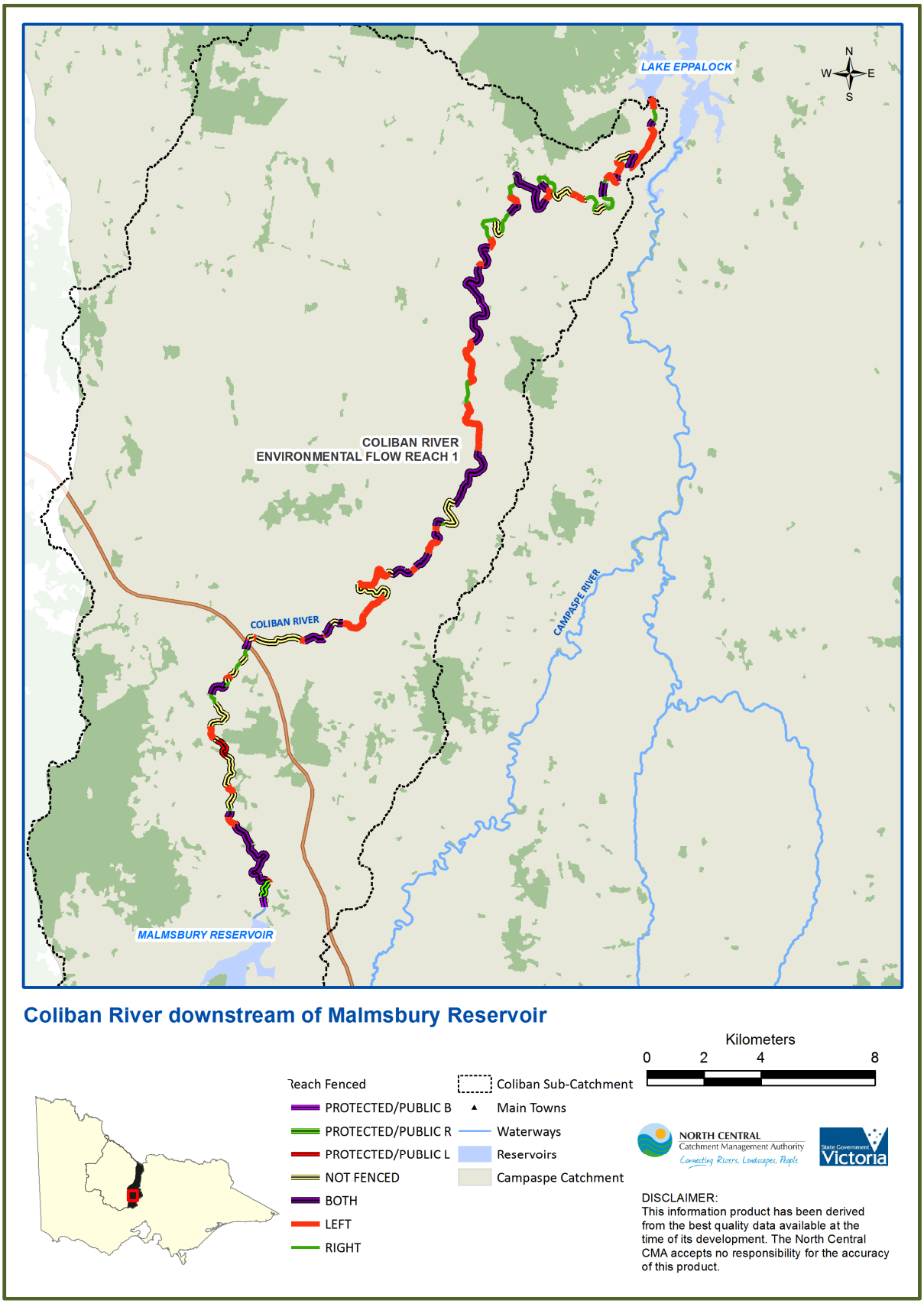

Figure 3: Sections of the Coliban River that are protected (fenced)

2.4. Environmental Water Management

There are several agencies directly involved in environmental water management in Victoria, and other agencies, such as public land managers, play an important role in facilitating the delivery of environmental watering outcomes. Table 1 summarises the agencies and groups that have involvement in environmental water management in the Coliban River downstream of Malmsbury Reservoir.

Table 1: Roles and responsibilities for environmental water in the Coliban River (DEPI 2013a)

Agency/group	Responsibilities/involvement
Department of Environment, Land, Water and Planning (DELWP)	Manage the water allocation and entitlements framework. Develop state policy on water resource management and waterway management approved by the Minister for Water and Minister for Environment and Climate Change. Develop state policy for the management of environmental water in regulated and unregulated systems. Act on behalf of the Minister for Environment and Climate Change to maintain oversight of the VEWH and waterway managers (in their role as environmental water managers).
Victorian Environmental Water Holder(VEWH)	Make decisions about the most effective use of the Water Holdings, including use, trade and carryover. Authorise waterway managers to implement watering decisions. Liaise with other water holders to ensure coordinated use of all sources of environmental water. Publicly communicate environmental watering decisions and outcomes.
Commonwealth Environmental Water Holder (CEWH)	Make decisions about the use of Commonwealth water holdings, including providing water to the VEWH for use in Victoria. Liaise with the VEWH to ensure coordinated use of environmental water in Victoria. Report on management of Commonwealth water holdings.
Murray-Darling Basin Authority (MDBA)	Implementation of the Murray-Darling Basin Plan - the Basin Plan sets legal limits on the amount of surface water and groundwater that can be taken from the Basin from 1 July 2019 onwards. Integration of Basin wide water resource management
North Central Catchment Authority (North Central CMA) Waterway Manager	Identify regional priorities for environmental water management in regional Waterway Strategies In consultation with the community assess water regime requirements of priority rivers and wetlands to identify environmental watering needs to meet agreed objectives identify opportunities for, and implement, environmental works to use environmental water more efficiently. Propose annual environmental watering actions to the VEWH and implement the VEWH environmental watering decisions. Provide critical input to management of other types of environmental water (passing flows management, above cap water) report on environmental water management activities undertaken.
Coliban Water	Water Corporation – Storage Manager and Resource Manager Ensure the provision of passing flows as outlined in the Bulk Entitlement

Agency/group	Responsibilities/involvement
	(Campaspe System - Coliban Water) Amendment Order 2012 Work with the VEWH and waterway managers in planning for the delivery of environmental water to maximise environmental outcomes Operate water supply infrastructure such as dams and irrigation distribution systems to deliver environmental water
Goulburn Murray Water (GMW)	Water Corporation – Storage Manager and Resource Manager Compliance with management of diversion limits in unregulated and groundwater systems (stock and domestic and entitlements held on the river).
Parks Victoria	Land Manager Implement the relevant components of EWMPs. Operate, maintain and replace, as agreed, the infrastructure required for delivery of environmental water, where the infrastructure is not part of the GMW irrigation delivery system. Where agreed, participate in the periodic review of relevant EWMPs. Manage and report on other relevant catchment management and risk management actions required due to the implementation of environmental water.
Input and advice into environmental watering	
Local Government	The Coliban Catchment also includes parts of four different Local Government areas – Hepburn, Mount Alexander, and Macedon Ranges Shires, and the City of Greater Bendigo. Each council administers a Planning Scheme that sets out policies and provisions for the use, development and protection of land in their area.
Traditional Owners/ Community Groups	The delivery of environmental water is likely to provide other benefits that depend on the condition of our waterways, such as supporting social and cultural values. These groups are currently engaged informally.
Environmental Water Advisory Group (EWAG)	Currently the North Central CMA does not convene an EWAG to provide community advice on environmental water delivery in the Coliban River. This is due to the river primarily being operated for stock and domestic supply as well as the limited environmental water holdings. An EWAG will be established if more water was made available for delivery in the future.

Other stakeholders with an interest in environmental watering include environmental groups, recreational users, other water entitlement holders, landholders and local communities. It is important that the interests and values of these groups are incorporated in planning for, and management of, environmental water (DEPI 2014a).

2.5. Environmental water sources

The Coliban River downstream of Malmsbury reservoir has limited access to water sources that include Commonwealth water holdings and passing flows. These are described below and summarised in Table 2.

Commonwealth Environmental Water Holder (CEWH)

Under the Federal Government's water buyback scheme or Restoring the Balance in the Murray-Darling Basin Program, as at 31st January 2015, a total of 28 ML of High Reliability Water Share (HRWS) has been purchased in the Coliban River catchment. This water is held by the CEWH, which is responsible for its management and deployment. The stated objective of this program is to purchase water entitlements so that the water can be used for environmental purposes (DoE 2014). The water purchased from the Coliban River catchment can be used to benefit environmental assets in this catchment and downstream.

The CEWH also has the option to trade water in and out of the Coliban as required (Australian Government 2013). The use of this water in the Coliban River system is not guaranteed and is considered unlikely due to the high cost associated with delivering this water (delivery costs charged by Coliban Water) and to date has not been delivered to the river (North Central CMA 2014b). Coliban Water has indicated that the current cost for using this entitlement is approximately $12,184 (Bogusiak, A, 2015, personal communication, [Coliban Water], 17th March).

Bulk Entitlement (Campaspe System - Coliban Water) Amendment Order 2012

This Bulk Entitlement was established in 1999 and was amended in 2012. Under this Bulk Entitlement Coliban Water is entitled to harvest all water in the Coliban River at Malmsbury subject to passing a flow through Malmsbury Reservoir of the lower of 8 ML per day or the natural flow on that day. The passing flow forms part of the Environmental Water Reserve at this point in the river. There is a provision to withhold the passing flow and store water in a 'passing flows account' to allow higher flows to be delivered. Under current rules environmental water is the first to spill from the storage as occurred in the 2013-14 season when the withheld passing flows were lost when Malmsbury Reservoir spilled in early September 2013.

Table 2: Environmental water sources for the Coliban River downstream of Malmsbury Reservoir

Water entitlement	Volume	Flexibility of management	Conditions on availability and use	Responsible agency
Commonwealth Water Holdings	28ML HRWS[1] within Coliban System	Fully flexible management	• Can be used across multiple systems, within relevant trade protocols • Requires approval from CEWH • Stored in Upper Coliban Storages • Irrigation allocation dependant • High cost associated with delivery is a constraint[2]	CEWH

Water entitlement	Volume	Flexibility of management	Conditions on availability and use	Responsible agency
Bulk Entitlement (Campaspe System - Coliban Water) Amendment Order 2012	• 8ML/d or actual system inflow • Compliance point is at Malmsbury Rail Bridge gauging station	• Fully flexible management • Flows can be stored in the Malmsbury Passing flows Account	• For the Reach below Malmsbury Reservoir the Passing Flow rate required is dependent upon storage inflows • In the event of a storage spill, the Malmsbury Passing Flows Account balance is reduced directly by the volume of water lost from the storages until a nil balance is held	Coliban Water
[1]Water shares are classed by their reliability and there are two types in Victoria: 1. High-reliability water shares (HRWS), which is a legally recognised, secure entitlement to a defined share of water. 2. Low reliability water shares (LRWS) which are water shares with a relatively low reliability of supply. Allocations are made to high-reliability water shares before low-reliability shares (DEPI 2014b).				
[2]Due to high cost of water delivery, it is unlikely that the Commonwealth will agree to deliver this water in the Coliban River.				

Please note that other potential sources of water are identified Section 8 and are key recommendations of this EWMP.

2.6. Related agreements, legislation, policy, plans and activities

There are a number of policies, strategies, plans and activities that are specifically relevant to the environmental water management of the Coliban River. Relevant state, national and international legislation, policy and agreements include:

- State legislation (such as the *Water Act 1989*, *Catchment and Land Protection (CaLP) Act 1994*, *Flora and Fauna Guarantee (FFG) Act 1988*, *Aboriginal Heritage Act 2006*, *Traditional Owner Settlement Act 2010*, *Conservation, Forests and Lands Act 1987* and *Crown Land (Reserves) Act 1978*
- National legislation (such as the *Water Act 2007* and *Water Amendment Act 2008* (Cth), the *Environment Protection and Biodiversity Conservation (EPBC) Act 1999* and the *Native Title Act 1993*)
- Murray-Darling Basin Authority policies (such as The Living Murray Initiative and the Murray-Darling Basin Plan). It is possible that with additional water recovered under the Basin Plan water could be made available for the Coliban River.
- International agreements (such as the Convention on Conservation of Migratory Species of Wild Animals (Bonn or CMS), Japan-Australia Migratory Bird Agreement (JAMBA), China-Australia Migratory Bird Agreement (CAMBA), Republic of Korea- Australia Migratory Bird Agreement) (ROKAMBA), refer to Section 4.1.1.

Strategies, programs and projects relevant to the Coliban River EWMP include:

- Victorian Waterway Management Strategy 2013 (VWMS) – this strategy outlines the direction for the Victorian Government's investment over an eight year period (beginning in 2012-13). The overarching management objective is to maintain or improve the environmental condition of waterways to support environmental, social, cultural and economic values (DEPI 2013a).

- 2014-2022 - North Central Waterway Strategy – this regional strategy is an action out of the VWMS and provides the framework for managing rivers and wetlands with the community over the next eight years. It delivers key elements of the VWMS including developing work programs to maintain or improve the environmental condition of waterways in the north central region. Works activities have been identified for the Coliban River (North Central CMA 2014a); however no funding has been secured for this program area to date.
- Victorian Environmental Flows Monitoring and Assessment Program (VEFMAP) – the Coliban River (Reach 1 of the Campaspe River Environmental Flows Assessment) is a part of this state-wide program. The project commenced in 2006 and has funded, water quality monitoring, vegetation and physical habitat mapping for the Coliban River. The future of this project is currently unknown; however vegetation surveys have been confirmed for 2016.
- Campaspe River EWMP – The Campaspe River EWMP was developed in 2014 and covers the Campaspe River downstream of Lake Eppalock to the Murray River (Reaches 2, 3 and 4 of the *Campaspe River Environmental Flows Assessment* (SKM 2006a, 2006b and 2006c).

3. Hydrology and system operations

3.1. River hydrology

Prior to regulation the Coliban River would have been a low energy river that contained fine grained sediments and occasional rocky outcrops. The channel would have been incised with deep pools scattered along its length, interrupted by infrequent riffles over gravel and an abundance of boulders and large woody debris. Flows would have been seasonally variable and in response to rainfall, with high, flash flows in winter and spring and low or no flows in summer and autumn (McGukin & Doeg 2001in SKM 2006a).

The catchment has undergone significant changes since Europeans first traversed it. The cumulative effects of the introduction of European farming techniques, native vegetation clearance, the gold rush, the construction of the Coliban reservoirs and water supply systems for agriculture and urban development are reflected in the current condition of the catchment (North Central CMA 2006a).

Between 1877 and 1941 the Upper Coliban (37,770 ML capacity), Lauriston (19,790 ML capacity) and Malmsbury (12,034 ML capacity) reservoirs were constructed on the Coliban River to provide water to Bendigo, Castlemaine, Kyneton as well as numerous smaller towns throughout the region. As a result year round flows in the Coliban River downstream of Malmsbury have reduced from an average of 202 ML/day to 127 ML/day (based on hydrological modelling) (SKM 2006b).

Average daily natural and current flows for each day of the year at Phillips Road and Lyell Road are presented in Figure 4. Plots are based on inputs to the Goulburn-Broken-Campaspe-Loddon REALM model and use estimated inflows from 1891-20012 (SKM 2006b and 2015). Under natural conditions the highest daily flows occur in September and the lowest flows occur between January and May. This seasonal flow pattern is retained under current conditions, but high spring flows are delayed. Annual discharge at the downstream end of the reach (Lyell Road) is approximately 90 ML/day higher than discharge at Phillips Road due to local catchment run-off and inflow from tributaries such as Sandy Creek and Myrtle Creek (SKM 2006b).

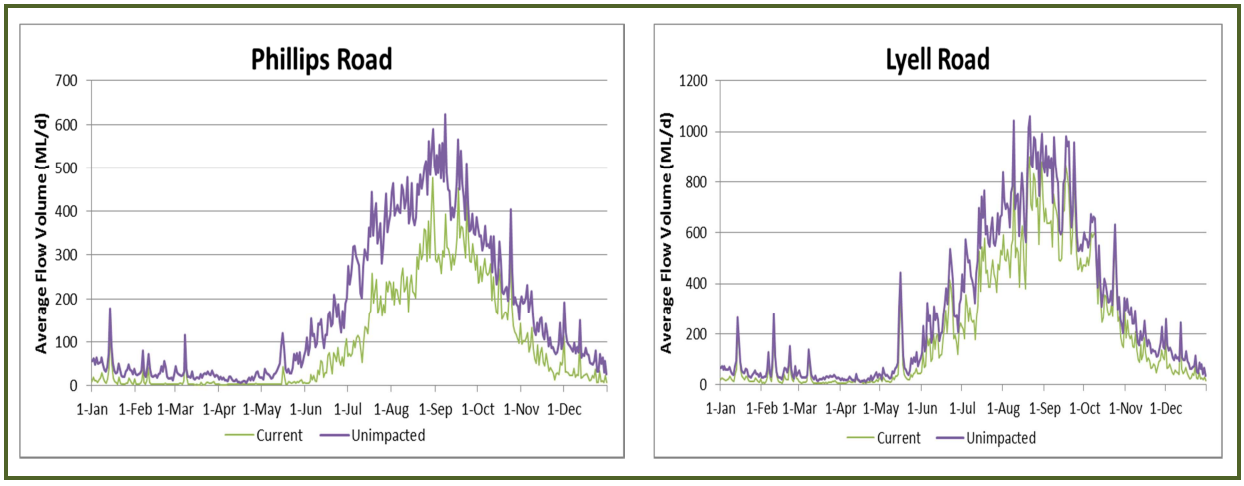

Figure 4: Average daily natural and current flows for the period 1891 to 2012

The majority of natural flows are now harvested in the upstream storages, with minimum flows passed down the river (particularly during winter). This is exacerbated by no irrigation releases in the river and the use of a pipe and channel network for the diversion of potable water from Malmsbury Reservoir (SKM 2006b). The passing flow released from Malmsbury Reservoir is aimed to maintain some flow in the Coliban River, but these flows are much lower than natural (North Central CMA 2014b).

During the early 2000s to late 2010, Victoria experienced a severe and extended drought, the Millennium Drought, during which time the Coliban River was severely flow stressed. Malmsbury Reservoir and Lake Eppalock remained below 15% capacity for an eight year period. Environmental water management operated under a Ministerial Qualification of Rights, which suspended the requirement to comply with the BE. As a result flows within the river were significantly reduced between 2006 and 2010 (North Central CMA 2010). In 2010-11 widespread heavy rains across northern Victoria resulted in two periods (September 2010 and January 2011) of high flow including overbank flows in the Coliban River. Inflows to Coliban system have reduced since the floods due low rainfall in the catchment. Coliban Water's operational demands are in excess of system inflows and the upper storages are now in a reducing phase (Coliban Water 2015).

3.2. System operations

Flow in the Coliban River is measured at few locations, with little or no measurement of tributary flows. Flow data is measured at two locations in the Coliban River EWMP area (Table 3).

Table 3: Victorian Water Quality Monitoring Network flow gauging stations

Gauging Station ID	Location	Period of Record
406200	Coliban River at Malmsbury	Records ceased in May 2000
406215	Coliban River at Lyell Rd	November 1976 to current

The gauging station in the upper reach is located at the Railway Bridge at Malmsbury, approximately 1 km downstream from the Malmsbury Reservoir; there is no tributary inflow above the Malmsbury gauging station; therefore, the flow data closely reflects the flow releases made from the reservoir. The gauging station in the lower reach is located at Lyell Road gauging station, located approximately 100m downstream of the Lyell Road continuous monitoring station.

There are a number of landholders who have opportunistic diversion licenses (stock and domestic) on the Coliban River. No releases are made for these licences; therefore landholders rely on unregulated flows or on the release of environmental flows for their supply. Table 4 provides a summary of the current allocation to water resources from the Coliban River.

Table 4: Allocations in the Coliban River downstream of Malmsbury Reservoir (Strachan L 2015, personal communication [GMW], 20 February)

Stream	Number Of Licences	Licence Type	Direct Extraction (ML)	Irrigation/ Domestic & Stock
Coliban River D/S Malmsbury	4	Take & Use	35.0	Irrigation
Coliban River D/S Malmsbury	33	Take & Use	66.0	D&S

3.2.1. Groundwater/surface water interactions

There is an absence of groundwater information available for the Coliban River catchment and as a result the assessment of groundwater and surface water interactions for this river is qualitative. The Coliban River is part of the Central Victorian Mineral Springs Groundwater Management Area (CVMS GMA) where there are five main aquifers. Groundwater systems are characterised by fractured rock aquifers with low hydraulic conductivities connecting to narrow alluvial floodplains that have formed in confined valleys. The Coliban River downstream of Malmsbury sits predominantly within undulating granite hills. The granite is a comparatively poor aquifer in the area with low yields and

variable groundwater salinity, but it can provide useful domestic and stock supply (GMW 2013). Groundwater recharge for this area has been estimated at 5% of annual rainfall, amounting to 30 mm year (CSIRO 2008). There are 28 licences in the Coliban Zone of the CVMS GMA with a total licence entitlement volume of 1,043 ML, GMW have also estimated that there are 343 active stock and domestic bores which corresponds to 686 ML/year.

Groundwater in the alluvial areas is expected to be hydraulically connected to the river. CSIRO (2008) in their assessment of water availability in the Campaspe state that the Coliban River upstream of Lake Eppalock is likely to be gaining, although there is no bore data to confirm this. Baseflows provides an important supply during dry periods to support species such as the Platypus. CSIRO (2008) highlight the potential for groundwater pumping to impact on streamflow, particularly where bores are located in close proximity to the river and for these impacts to be greater over summer periods). Field assessment in February 2015 identified springs at the valley margins of the floodplain and also higher on the connecting hillslopes, with sedges established at the point of groundwater discharge to the surface. This supports earlier qualitative assessment of groundwater surface water interactions by CSIRO (2008) and their statement that the river is gaining.

Little information can be found on the quality of the groundwater in the Coliban River catchment. CSIRO (2008) state that groundwater salinity values are typically less than 2000 mg/L TDS from the fractured rock aquifers in highland areas. There is anecdotal evidence to suggest that elevated sulphate levels may exist, with one landholder reporting of groundwater scalding their tomato leaves (Community Consultation – Appendix 1).

3.2.2. Water Quality

Water quality spot monitoring was undertaken at three sites in the Coliban River during the Qualification of Rights period. During this period dissolved oxygen was the critical monitoring parameter that informed when releases should be made, however levels often dropped below 2 mg/L. Salinity was consistently recorded within the ANZECC guidelines required range, there is also no evidence of saline pools. Turbidity levels at all of the monitoring sites were also below the guideline of 50 NTU.

Spot nutrient monitoring often reported results outside of the guidelines, especially total nitrogen. High nutrient loads are also likely to account for the excessive growth of filamentous algae that was noted in the Coliban River upstream of Dalhousie Bridge (near Taradale) in the 2006 environmental flow assessment and field visit in February 2015 (Sharpe A, 2015, personal communication, [Environmental Flows Technical Panel Jacobs], 2 February). Urban stormwater run-off, leaky septic tanks, diffuse run-off from agricultural grazing land and soil erosion are the main nutrient sources along the Coliban River (SKM 2006b). Unrestricted stock access along many sections of the Coliban River is likely to exacerbate nutrient inputs through increased bank erosion and direct faecal contamination. Algal blooms also periodically occur in Malmsbury Reservoir and Lake Eppalock (Strachan L, 2015, personal communication [Goulburn Murray Water], 2 February).

3.2.3. Environmental watering

As outlined in Section 2.4 there is a limited volume of environmental water available for the Coliban River. Environmental water management by the North Central CMA on the Coliban River commenced in 2006 in response to the drought and Qualification of Rights (QoR) imposed on the Bulk Entitlement (Campaspe System - Coliban Water) Order 1999. The Bulk Entitlement was amended in 2012 to document and formalise the arrangements that were established during the QoR period. `Environmental water management is focused on managing water quality, the provision of summer base flows and withholding some passing flows (Malmsbury Passing Flows Account) to enable the provision of summer freshes. Figure 5 provides a potential delivery schedule based on the priority flow components that are achievable with the water available.

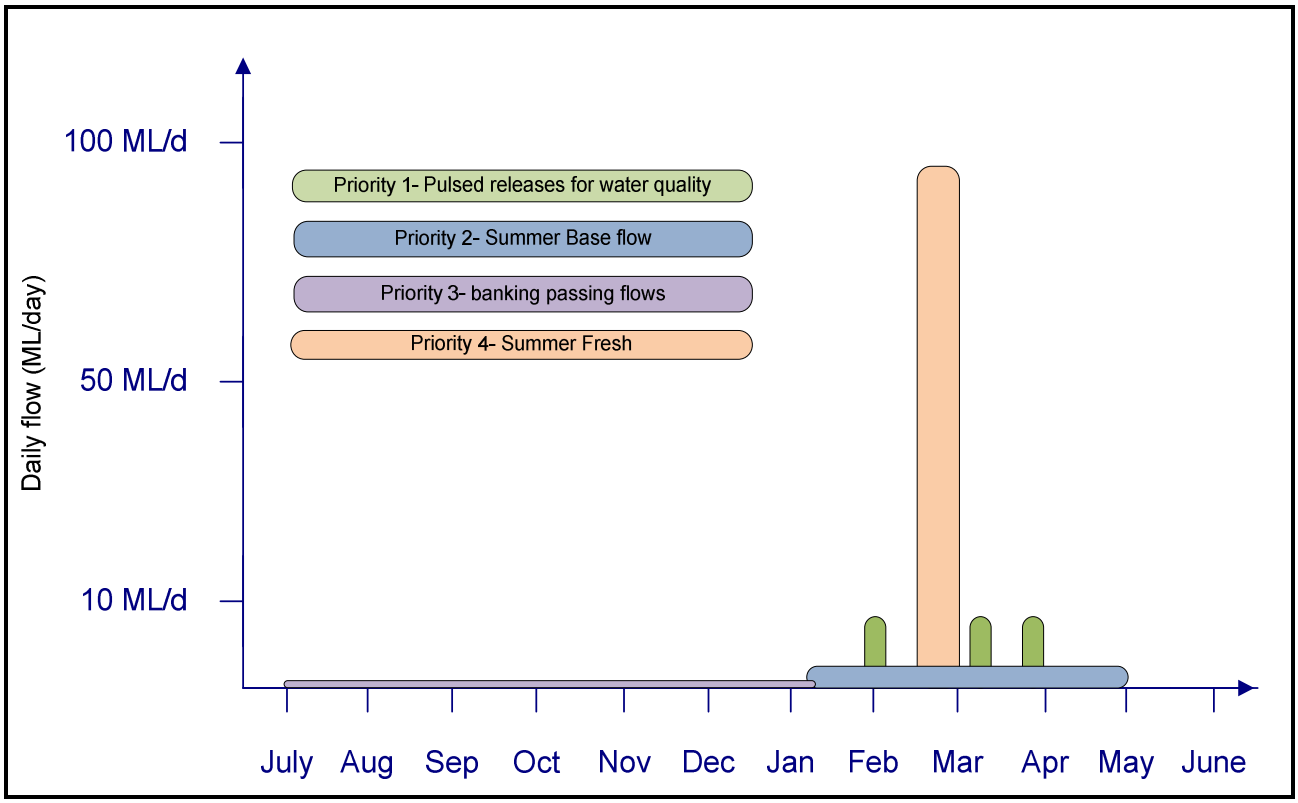

Figure 5: Priority watering actions for 2014-15 for the Coliban River System

4. Water dependent values

4.1. Environmental values

4.1.1. Listings

The Coliban River has high ecological value due to the diversity of flora and fauna values it supports. The local communities of Malmsbury, Taradale and Metcalfe particularly value the Platypus and Water Rat populations as well as the aesthetic and recreational values of the river (including Ellis Falls, Coliban Falls and the Cascades) (North Central CMA 2006a). Table 5 details the legislation, agreement and conventions and listings that are relevant to the Coliban River. As shown, management of the river falls within one international listing, one national listing and two Victorian State listings. A full flora and fauna list recorded at the Coliban River is shown in Appendix 2.

Table 5: Significance of Coliban River and its associated species

Legislation, Agreement or Convention	Jurisdiction	Present
Japan Australia Migratory Birds Agreement (JAMBA)	International	✓
China Australia Migratory Birds Agreement (CAMBA)	International	
Republic of Korea Australia Migratory Birds Agreement (ROKAMBA)	International	
Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention)	International	
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)	National	✓
Flora and Fauna Guarantee Act 1988 (FFG Act)	State	✓
Victorian advisory lists	State	✓

4.1.2. Fauna

The Coliban River is known to provide habitat for a range of native fauna species including 91 bird species, 12 mammals, seven fish and two frog species (DEPI 2014c; North Central CMA 2014b; McGukin & Doeg 2001). Of these, 19 species are considered significant with five listed under the EPBC Act, as shown in Table 6. The majority of these species are located in woodland or grassland habitats however some such as the Little Button-quail *(Turnix velox*) and Rainbow Bee-eater (*Merops ornatus*) are often observed occupying riparian habitats. Two species, the Musk Duck (*Biziura lobata*) and Australian Shoveler (*Anas rhynchotis*) are considered water dependant.

The Coliban River has also supported a number of native fish species with records of EPBC listed Murray Cod (*Maccullochella peelii*), Macquarie Perch (*Macquaria australasica*) and Trout Cod (*Maccullochella macquariensis*) as well as Golden Perch (*Macquaria ambigua*), Australian Smelt (*Retropinna semoni*), Flat-headed Gudgeon (*Philypnodon grandiceps*) and Mountain Galaxias (*Galaxias olidus*)[3]. River Blackfish (*Gadopsis marmoratus)* has historically been recorded in the Coliban River (during the past 30 years); however they have not been recorded in recent surveys.

Fish communities in the Coliban River are limited by the lack of instream habitat and by migration barriers. Detailed fish surveys in this section of the river have been a low priority and were not included in the VEFMAP fish survey monitoring. However, during recent field assessments good habitat (e.g. submerged hollow logs) for opportunistic small-bodied native fish species (e.g. Mountain Galaxias and Flat-headed Gudgeon) in the upper section of the reach was observed (Sharpe A, 2015, personal communication, [Jacobs] 2 February). The lower section has been impacted (to varying degrees) by accelerated rates of sand delivery, particularly downstream from Myrtle and Granite Creeks.

[3] The identification of 15 species within the Galaxias olidus complex indicates substantial genetic divergence has occurred in this group of fishes in eastern Australia (Raadik 2011). The species of *Galaxias* in the Coliban River needs to be identified in future fish surveys undertaken, seven of the species have been classified as either listed or nominated under the *FFG Act 1988* (DSE 2013).

Photograph 1 and 2 below provide pictures of the two FLOWs assessment sites (location identified in Figure 2).

Photograph 1: Coliban River at Phillips Rd (upper section), February 2015

Photograph 1: Coliban River at Lyell Bridge (lower section), February 2015

Table 6: Significant fauna species recorded on the Coliban River

Common name	Scientific name	Type	Last record	International agreement	EPBC status	FFG status	Vic status
Australasian Shoveler	*Anas rhynchotis*	WB	U				VU
Bluenose Cod (Trout Cod)	*Maccullochella macquariensis*	F	1993		EN	L	CR
Brush-tailed Phascogale	*Phascogale tapoatafa tapoatafa*	M	1993			L	VU
Golden Perch	*Macquaria ambigua*	F	1994				NT
Little Button-quail	*Turnix velox*	RB	1988				NT
Macquarie Perch	*Macquaria australasica*	F	1990		EN	L	EN
Murray Cod	*Maccullochella peelii*	F	1970		VU	L	VU
Musk Duck	*Biziura lobata*	WB	U				VU
Rainbow Bee-eater	*Merops ornatus*	RB	1959	J	M		

Legend
Type: Invertebrate, Fish, Amphibian, Reptile, Bird, Riparian Bird, Waterbird, Mammal, Unknown

International: Camba, Jamba, Rokamba, Bonn
EPBC status: EXtinct, CRitically endangered, ENdangered, VUlnerable, Conservation Dependent, Migratory
EPBC presence: Known to occur, Likely to occur, May occur
FFG status: Listed as threatened, Nominated, Delisted, Never Listed, Ineligible for listing

Vic status: presumed EXtinct, Regionally Extinct, Extinct in the Wild, CRitically endangered, ENdangered, Vulnerable, Rare, Near Threatened, Data Deficient, Poorly Known

Source: DEPI 2014c; DSE, 2013; McGukin & Doeg 2001.

Although not listed under legislation the national conservation status of Platypus has recently been elevated to near threatened (CSIRO 2014). Platypus numbers have been declining in many areas over the last few decades and the species has already disappeared from some catchments (Serena M, 2014, personal communication, [Australian Platypus Conservancy], July). Live-trapping studies conducted to date in the Coliban River catchment downstream of Malmsbury Reservoir were replicated surveys carried out in 2001 and 2010. The average capture frequency in 2001 (2.0 platypus/site/night) was four times greater than that recorded in 2010 (0.5 platypus/site/night).

The decline in Platypus numbers was attributed primarily to severely reduced surface flow that occurred in the latter years of the Millennium Drought; Platypus appeared to survive best in the vicinity of large permanent pools that provided reliable refuge habitat for the species (Serena 2015).

In February 2015 a landholder who hadn't seen a Platypus in seven years observed one upstream of Taradale (Sinnott J, 2015, personal observation, [local landholder], 25 July). Serena (2015) stated that the "*Platypus population is in a recovery phase and management focus should be on maximising their potential for successful reproduction and juvenile recruitment*". Water-Rats have also been recorded in the Coliban River. They occupy a wide range of aquatic environments; however their preferred habitat appears to be relatively slow-flowing water in small creeks, irrigation channels, swamps and wetlands, or pools and backwaters in larger rivers (Serena 2015)

4.1.3. Vegetation communities and flora

The majority of the Coliban River's length is located within the Goldfields Bioregion, with the exception of approximately 5 kilometres near Malmsbury Reservoir which is in the Central Victorian Uplands. The Goldfields Bioregion is characterised by a series of low hills and rolling plains with metamorphic and old volcanic rocks forming rugged slopes and ridges. Woodland and Grassy forests dominate the bioregion and occur predominately on the lower slopes and poorer soils (DEPI 2014d).

There are eight EVCs within the Goldfields Bioregion and three EVCs in the Central Victorian Uplands Bioregion which have been mapped along the Coliban River as shown in Table 7. The riparian zone was described by Marchant et al. (1997) as River Red Gum (*Eucalyptus camaldulensis*) woodland, with good continuity and an undertstorey of scattered natives, exotics shrubs and small trees. According to mapping, this zone is predominately Streambank Shrubland (EVC 851) with scattered patches of Creekline Grassy Woodland (EVC 68). The taxa belonging to Creekline Grassy Woodland are of particular importance being listed as a significant community under the *FFG Act 1988* (DEPI 2014e). The zone adjacent to the riparian zone is predominately Box Ironbark Forest (EVC 61) and is characterised by a variety of eucalypts and ironbark species, small trees, shrubs, herbs and grasses.

Table 7: Ecological Vegetation Classes (EVCs) recorded along the Coliban River

EVC no.	EVC name	Source	Bioregional Conservation Status
Goldfields Bioregion			
20	Heathy Dry Forest	DEPI 2014d	Least concern
22	Grassy Dry Forest	DEPI 2014d	Depleted
47	Valley Grassy Forest	DEPI 2014d	Vulnerable
55	Plains Grassy Woodland	DEPI 2014d	Endangered
61	Box Ironbark Forest	DEPI 2014d	Depleted
68	Creekline Grassy Woodland	DEPI 2014d	Endangered
175	Grassy Woodland	DEPI 2014d	Vulnerable
851	Stream Bank Shrubland	DEPI 2014d	Endangered
Central Victorian Uplands			
47	Valley Grassy Forest	DEPI 2014d	Vulnerable
55	Plains Grassy Woodland	DEPI 2014d	Endangered
851	Stream Bank Shrubland	DEPI 2014d	Vulnerable

Twelve significant flora species have been recorded along the Coliban River including EPBC listed Clover Glycine (*Glycine latrobeana*) and a further four species, Australian Anchor Plant (*Discaria pubescens*), Black Gum (*Eucalyptus aggregate*), Purple Diuris (*Diuris punctata var. Punctata*) and Swamp Diuris (*Diuris palustris*) which are FFG listed. At least nine of these species are water dependent and are located on the riparian or floodplain zones of the river.

Table 8 summarises the significant species recorded along the Coliban River.

Table 8: Significant flora species recorded on the Coliban River

Common name	Scientific name	Type	Last record	EPBC status	FFG status	Vic status
Ausfeld's Wattle	*Acacia ausfeldii*	T	Unknown			v
Australian Anchor Plant	*Discaria pubescens*	R	Unknown		L	r
Black Gum	*Eucalyptus aggregata*	R, W	Unknown		L	e
Blue Burr-daisy	*Calotis cuneifolia*	R	1875			r
Brooker's Gum	*Eucalyptus brookeriana*	R	Unknown			r
Clover Glycine	*Glycine latrobeana*	R	Unknown	VU	L	v
Creeping Grevillea	*Grevillea repens*	T?	Unknown			r
Golden Cowslips	*Diuris behrii*	T?	2003			v
Hypsela	*Hypsela tridens*	R, W	2002			k
Purple Diuris	*Diuris punctata var. Punctata*	W	Unknown		L	v
Swamp Diuris	*Diuris palustris*	W	Unknown		L	v
Tall Club-sedge	*Bolboschoenus fluviatilis*	W	2015		L	
Tufted Hair-grass	*Deschampsia cespitosa*	W	Unknown			r

Legend
Type: Wetland dependent, River terrestrial, Terrestrial
EPBC status: EXtinct, CRitically endangered, ENdangered, VUlnerable, Conservation Dependent, Not Listed
FFG status: Listed as threatened, Nominated, Delisted, Never Listed, Ineligible for listing

Vic status: presumed eXtinct, , endangered, vulnerable, rare, near threatened, data deficient, poorly known
Source: DEPI 2014c; DSE 2005.

4.1.4. Ecosystem function

'Ecosystem function' is the term used to define the biological, geochemical and physical processes and components that take place or occur within an ecosystem. Ecosystem functions relate to the structural components of an ecosystem (e.g. vegetation, water, soil, atmosphere and biota) and how they interact with each other, within ecosystems and across ecosystems (Maynard et al. 2012). Ecosystem functions critical to support the primary water dependent environmental values of the Coliban River include (but are not limited to):

- Food production – a critical ecosystem function is the conversion of matter to energy for uptake by biota. Structural components include substrate surfaces (e.g. instream woody habitat (IWH), rocks and gravel) for biofilms, and plant matter. Interactions between primary producers and consumers such as zooplankton and macroinvertebrates break down the carbon and nutrients required for higher order consumers
- Reproduction – recruitment of new individuals is important for the river's primary values, small bodied native fish and Platypus. Fish require nursery habitats such as slackwater areas to provide suitable conditions for native fish larvae metamorphosis (linked to food web function). Breeding is also required in most years for small bodied fish. Lactating Platypus females need to ingest the equivalent of up to 80% of their body mass in food each day, thereby limiting successful breeding to reliably perennial aquatic habitats supporting productive macro-invertebrate populations (Serena 2015).
- Movement/Dispersal – movement of individuals throughout the river is linked to the food web function. By providing alternative flows different areas of the river are accessible for foraging by fish and Platypus. Flow and connectivity also facilitates dispersal of juveniles either to other areas within the Coliban, Campaspe or the Murray River system.

The Basin Plan specifies the need to "identify priority environmental assets and priority ecosystem functions, and their environmental watering requirements" (Australian Government 2012, p68). Section 8.50 of the Basin Plan outlines the method for identifying ecosystem functions that require

environmental watering and their environmental watering requirements (Schedule 9—Criteria for identifying an ecosystem function). The Coliban River's ecosystem functions that meet the assessment indicators are described in Appendix 3.

4.2. Social values

4.2.1. Cultural heritage

Traditionally, Indigenous people have a strong affinity with waterways and water bodies, as a vital source of food, water and camping sites in traditional lifestyles. The Coliban River sits within the Dja Dja Wurrung clan to the west and Taungurung clan to the east. According to the Aboriginal Cultural Heritage sites register, there are nineteen sites of cultural significance along the Coliban River. These are predominantly shell deposits, scarred trees and mounds, with some artefact sites (Department of Planning and Community Development [DPCD] 2008).

4.2.2. Recreation

The Coliban River catchment itself is not a major tourist destination, but lies in the heart of a major tourist area, with the Macedon area to the east, the Daylesford area to the south-west and Lake Eppalock to the north. Tourists visiting those major centres have the opportunity to include the Coliban Catchment in any visit, with the main attractions being the natural values (fishing, bush walking, camping and site-seeing).

4.3. Economic

The Lauriston, Malmsbury and Upper Coliban reservoirs managed by Coliban Water provide the water supply needs for approximately 110,000 people and a wide range of industries and business (North Central CMA 2014a).

4.4. Conceptualisation of the site

The conceptual understanding of the ecology and ecological functions of the Coliban River is shown in Figure 6.

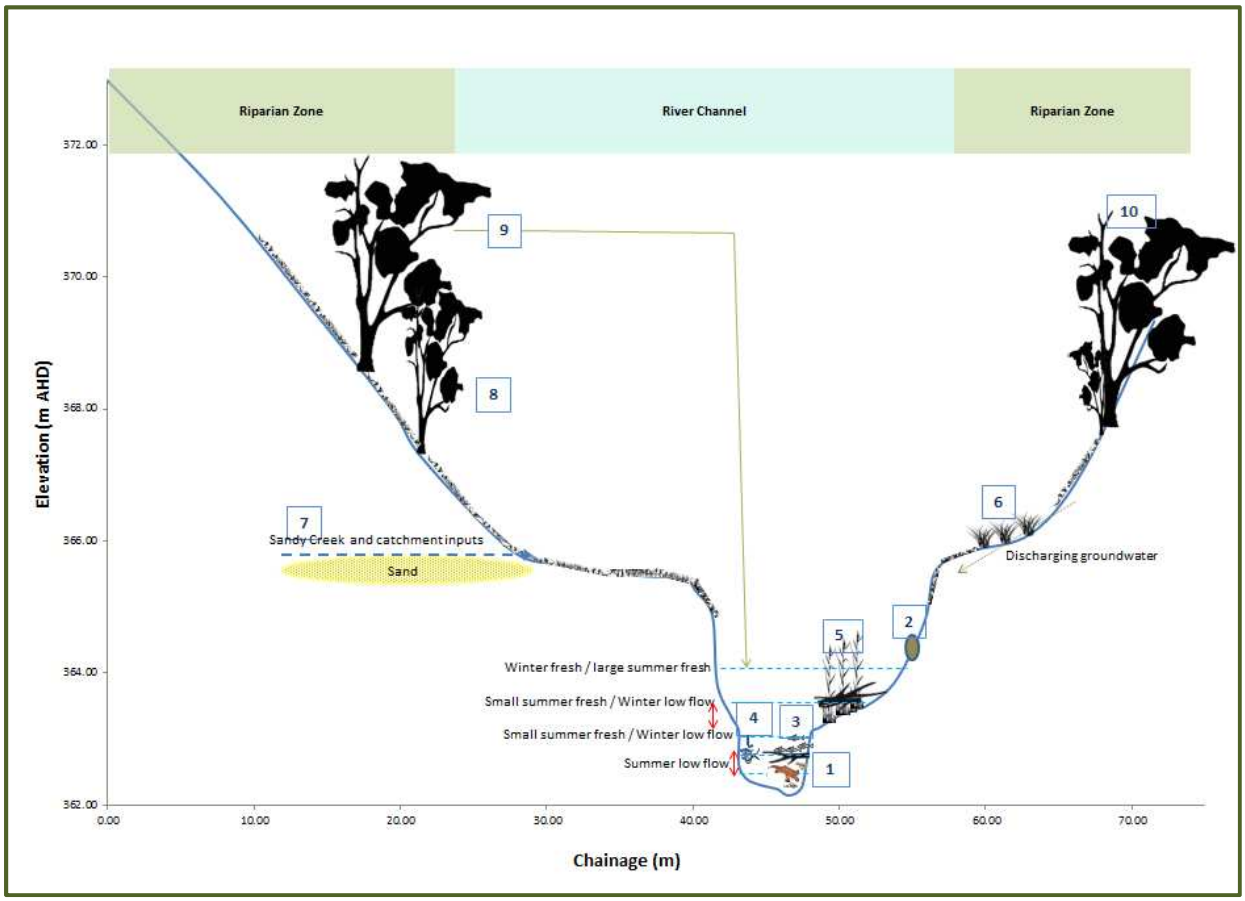

Figure 6: Cross section indicating conceptual understanding of the Coliban River ecology

Description of key ecosystem functions and services identified for the Coliban River (Figure 6):

1. Deep pools provide important habitat, particularly for native fish and Platypus and are critical during periods of low to no flow for refuge. Platypus appear to survive best in the vicinity of large permanent pools that provide reliable refuge habitat for the species. Sustained reductions in flow can increase adult Platypus mortality rates due to starvation, increased stress levels and increased predation, particularly if animals have to travel across dry land to access disjunct feeding areas along intermittent water bodies (Serena 2015).
2. High flows in August are expected to cue Platypus to establish breeding burrows higher on the bank.
3. The early life stages of fish require nursery habitats, and for many fish these are slackwater areas (no or negligible flow). These provide sheltered, usually warm, food-rich areas conducive for survival and growth.
4. Instream vegetation persists in the upper sections of the Coliban River, slow-flowing pools exhibit large stands of submerged taxa, such as *Triglochin spp.* Instream vegetation provides shelter and food for macroinvertebrates, small fish and tadpoles which provide food for Platypus and large bodied fish.
5. Emergent vegetation exists in the upper section of the Coliban River. Freshes from late winter to early summer will encourage germination of a diversity of emergent species (such as *Bolboschoenus spp. Eleocharis spp. and Phragmites*). Emergent vegetation provides shelter for macroinvertebrates and frogs, small fish when inundated. Both instream and emergent vegetation are carbon sources. Further downstream towards Lake Eppalcok emergent vegetation is present but stranded with no flow.
6. Distinct vegetation communities supported by discharging groundwater – little springs that supported flora (sedges).

7. Well-developed sandslugs occur in the Coliban River downstream of Sandy Creek – indicating accelerated sediment delivery to the channel.
8. The riparian zone is restricted to a very narrow margin along the river and is abutted by agricultural land and semi-rural properties. There is good cover of native grasses, however weeds (including Willows, Blackberry) are extensive in some areas.
9. Riparian vegetation is a source of carbon (e.g. leaf litter, insects) and instream woody habitat to the river.
10. Threatened terrestrial species are dependent on the riparian zone of the Coliban River as the catchment is extensively cleared.

4.5. Significance

The Coliban River is highly significant as a tributary river of the Campaspe River within the Murray-Darling Basin. The reach extends for approximately 58 kilometers from Malmsbury Reservoir to Lake Eppalock and passes through a variety of habitats types including woodland and grassland zones, instream woody habitat, submerged vegetation, waterfalls and pools. These habitats support a suite of small bodied native fish, Platypus and Water Rats including a number listed as significant. At a landscape scale the Coliban River also provides an important connection between habitats at its headwaters (i.e. in the Great Dividing Range), the Campaspe and Murray Rivers.

5. Ecological condition and threats

5.1. Context

As outlined in Section 3 the Coliban River system was impacted by the Millennium Drought between 2001 and 2010. The severe shortage of water resulted in a Ministerial Qualification of Rights being placed on the river from 2006 to 2011 and during this time all passing flows was ceased downstream of Malmsbury Reservoir and a small Environmental Reserve was established. This reserve was managed only for emergency releases in response to declining water quality. During this period the Coliban River received extended periods of no flow and contracted to a series of isolated pools.

The 2010-11 flooding of the Coliban River resulted in an increase in the flows within the river and into Coliban storages which facilitated an increase in passing flows. The floods essentially reset the river, however below average inflows into the catchment have occurred in 2011 to 2015.

Further, other threats such as introduced flora and fauna (including inhibiting willow infestations), land clearing, livestock access and grazing of river banks, sand slugs and high nutrient loads have all degraded the condition on the Coliban River.

5.2. Current condition

Previous condition assessments

The Sustainable Rivers Audit (SRA) was undertaken at a Murray-Darling Basin scale. The SRA provides scientifically robust assessments of the ecological health of the Basin's 23 river valleys, based on assessment of observations of fish, macroinvertebrates, vegetation, physical form and hydrology. These are then compared to the reference condition4 for the Valley to derive the score. SRA 1 is based on data collected from 2004 – 2007 and assessed fish, macroinvertebrates and hydrology. SRA 2 is based on data collected from 2008 to 2010 and includes additional reports on physical form and vegetation. Direct comparison between values for the two SRA assessment reports are valid in some cases (Davis et al. 2012) however, changes in methodology and additional information collated needs to be considered. The Campaspe Valley was divided into three zones, the upland (which includes the Coliban River), the slopes and the lowland. Table 9 details the results of the two SRA reports for the upland zone. It should be noted that the MDBA has issued a caveat that SRA 2 results should be interpreted in the context that prevailing climate conditions for period in which the data were collected included the severe Millennium Drought.

[4] Reference condition is an estimate of condition had there been no significant human intervention (i.e. pre European settlement) in the landscape, provides a benchmark for comparisons

Table 9: MDBA Sustainable River Audit indices ratings and trajectories for the Coliban River

Parameter	SRA 1	SRA 2
Fish (SR-F1)	Upland zone: Very poor 17	Upland zone: Very poor 34
Macroinvertebrates (SR-MI)	Upland zone: Poor 39	Upland zone: Moderate 61
Vegetation (SR-VI)	Not assessed	Very poor 22
Physical Form (SR PI)	Not assessed	Good 82
Hydrology	Upland zone: Good	Good 90
Ecosystem health Rating	Extremely Poor	Very Poor
Source: Adapted from Davis et al. 2008; Davis et al. 2012.		

The Index of Stream Condition (ISC) is a statewide assessment of river condition. ISC measures the relative health across hydrology, physical form, stream side zone, water quality and aquatic life against a reference condition[5]. Assessments were undertaken in 1999, 2004 and 2010 (DEPI 2013b). Due to the changes made to the methods for all five sub-indices, it is difficult to make direct comparisons using the sub-index scores. It should be noted that the ISC reaches are delineated differently to environmental flow reaches, the Coliban River ISC reaches 18 and 19 align with the Coliban River downstream of Malmsbury reservoir to Lake Eppalock. The results of the three assessments against the ISC reaches – scores out of 10 (aligned against FLOWS reaches) are shown in Table 10.

Table 10: 1999, 2004 and 2011 Index of Stream Condition sub - indices scores and trajectories for the Coliban River

ISC Reach No.	E-flow No.1	Physical Form			Stream-side zone			Hydrology			Water Quality			Aquatic Life			Total Score			Condition			Change
		99	04	10	99	04	10	99	04	10	99	04	10	99	04	10	99	04	10	99	04	10	
19	1	7	4	5	6	6	7	3	3	3	-	-	4	-	6	8	23	20	23	P	M	P	-
18	1	5	4	6	4	6	5	3	3	3	6	6	-	8	6	5	22	22	23	P	M	P	-
KEY: VP- very poor; P- poor; Ma- marginal; M- moderate; G- Good + -Positive; 0 -no change; -- negative 1indicative environmental flows reach number																							
Source: adapted from DSE 1999; DSE 2004; DEPI 2013																							

[5] Reference condition has the same definition as the SRA.

5.3. Condition trajectory – do nothing

The Coliban River downstream of Malmsbury Reservoir is flow stressed and does not have a sufficient environmental entitlement to maintain and improve the current ecological values exhibited at the waterway. This section of the river is also classified as an unregulated river; therefore the supply of stock and domestic licenses puts further pressure on the environmental water delivered as either passing flows or freshes provided from the withheld passing flows account.

If environmental water is not delivered to the Coliban River:

- Instream vegetation will not improve without intervention, *Triglochin procerum* is a resilient species, however improved flow in the river is required for other species (e.g. *Myriophyllum varrifolium*).
- Small bodied native fish populations will not recover from the prolonged drought. The habitat conditions (instream woody habitat and submerged vegetation) are good for opportunistic small-bodied native fish species (e.g. Mountain Galaxias and Flat-headed Gudgeon) and River Black fish (return of this species into the system).
- Breeding opportunities will be inhibited impacting the recovery of Platypus population from the prolonged drought.
- Macroinvertebrates are a critical component of the food web, both as a food source, and through functions such as breaking down carbon and detritus. Appropriate flows are required to ensure they complete their lifecycles to maintain their abundance and diversity.

6. Management objectives

6.1. Management goal

The long term management goal for the Coliban River has been derived from a variety of sources including technical reports, the VWMS and North Central Waterway Strategy 2014 goals and incorporates the environmental values identified in Section 4, and seeks to address the condition and condition trajectory discussed in Section 5.

Coliban River long term management goals:

To rehabilitate resilient breeding populations of Platypus and small-bodied native fish in the upper half of the Coliban River through maintaining and increasing the cover and diversity of in-stream, fringing and riparian native vegetation communities, and to provide opportunities for these animals to disperse throughout the lower half of the river and beyond.

6.2. Ecological objectives

The Coliban River ecological objectives established in the Campaspe River Environmental FLOWS assessment (SKM 2006c) have been reviewed and refined based on values proposed by community consultation and new information such as VEFMAP monitoring data (North Central CMA & Jacobs 2015). Ecological objectives are based on the key values of the site and describe the intended outcomes of environmental water delivery. They contribute towards achieving the long term management goal.

Ecological objectives are presented as primary objectives, with sub-objectives and secondary objectives. These have been collaboratively established by the North Central CMA and EFTP. Primary objectives are related to the key values of the Loddon River System and summarise the overall objectives for those values. The sub-objectives provide greater detail for achieving the primary objective. Secondary objectives either support the primary objectives (e.g. macroinvertebrates are a food source for fish and Platypus) or are objectives for values for which little baseline information is known (e.g. freshwater turtles). If the monitoring budget in future years is restricted it is anticipated that the North Central CMA will prioritise monitoring of primary objectives.

The ecological objectives and justifications shown in Table 11 are to be achieved through the provision of environmental water over the next ten years. Each ecological objective has also been coded (e.g. F1 for the first fish objective) to link which ecological objectives will be achieved by each flow recommendation (Section 6.3 and 6.4).

Table 11: Ecological objectives for the Coliban River downstream of Malmsbury Reservoir to Lake Eppalock

Objective	Justification
Primary objectives	
F1 Increase abundance and diversity of opportunistic small-bodied native fish such as Australian Smelt, Flat-headed Gudgeon and Mountain Galaxias.	These species would have historically been abundant throughout the reach, but populations declined during the drought. Permanent or near permanent flowing sections of the Coliban River near Taradale can support permanent populations of these species, but numbers will fluctuate in the downstream sections that more commonly cease-to-flow. Larger species such as Golden Perch and Murray Cod are stocked in Lake Eppalock, but are not likely to successfully breed in the Coliban River. Macquarie Perch also historically occurred in the Coliban River, but are unlikely to return to the reach in the next 10-20 years and so no specific flow recommendations are made for them at this time.
P1 Provide conditions that consistently support widespread successful breeding of Platypus to increase its resilience to future drought and floods and to provide surplus juveniles that can disperse to and colonise other suitable waterways.	The Coliban River historically supported a dense population of Platypus; their number declined significantly during the Millennium Drought and the population is now considered to be in a recovery phase. The upstream section of the reach should be able to support a permanent breeding population and the objective for that section will be to return the population to its pre-drought density. The downstream section of the reach has less suitable habitat for permanent habitation, but should be managed as an important corridor for dispersing juveniles, especially from late April to June. Note: Water rats are a boom and bust species that can rapidly increase their numbers when food is abundant and decline in abundance when food is scarce (e.g. during drought). Conditions that support successful breeding by Platypus and maintain fish should also broadly favour Water-rat survival and breeding.
V1 Maintain and increase cover and diversity of instream aquatics such as *Triglochin procerum, Myriophyllum varrifolium* and *Potamogeton* spp.	Instream vegetation is an important component of the stream ecosystem and provides habitat, sediment stability and support foodwebs. Diverse instream plants are common throughout upstream sections, but are sparse at sites at the downstream end of the reach.
V2 Maintain and increase abundance and diversity of emergent fringing vegetation such as *Phragmites, Juncus and Bolboschoenus* on benches and edges of channel, but limit their encroachment into the middle of the channel.	Emergent fringing vegetation is an important component of the stream ecosystem and provide habitat, bank stability and support foodwebs. Diverse fringing plants are common throughout upstream sections, but are less abundant and isolated from pools at low and cease-to-flow periods at the downstream end of the reach.
V3 Maintain adult riparian woody vegetation (e.g. River Red Gum, *Callistemon sieberi*, *Leptospermum lanigerum*, and *Acacia provincialis*) and facilitate recruitment	The most common EVC is EVC 851 'Stream Bank Shrubland', which has a canopy layer dominated by River Red Gums and a floristically diverse understorey. River Red Gum provides carbon to fuel foodwebs, shade, instream woody habitat to the river, and provide habitat for fauna. The riparian zone in this reach is variously affected by willows and grazing by livestock. In areas where both of these are controlled, the riparian zone has a good mix of overstorey trees, shrubs and native grasses, and some weeds. At grazed sites the shrub and understorey layers are more degraded.

Objective	Justification
WQ1 Maintain water quality that is able to support aquatic biota and ecological processes. Specifically: • Limit nutrient concentrations to prevent excessive algal growth and blooms. • Maintain dissolved oxygen levels above 2 mg/L in dry periods. • Prevent water temperature rising to dangerous levels and electrical conductivity rising above 3,000 EC	Minimum flows are required during low flow periods to prevent water quality deteriorating to critical levels for fish and macroinvertebrates. Note - because of the position of the Coliban River in the Campaspe River catchment the aquatic fauna is likely to be sensitive to high salinity and low dissolved oxygen.
Secondary objectives	
F2 Provide habitat and flow conditions that will allow River Blackfish to re-establish	This is an aspirational objective for this ten year EWMP; however, River Blackfish would have naturally occurred in the Coliban River. They have not been recorded for more than 20 years, but good habitat (e.g. submerged hollow logs) is present and there is the potential to re-establish a population either through natural recruitment or translocation. Translocation should only be considered if source populations come from the Campaspe River catchment.
M1 Maintain and increase overall abundance, diversity and productivity of macroinvertebrates and macroinvertebrate functional feeding groups to drive productive and dynamic foodwebs.	Macroinvertebrates are a critically important component of the foodweb. They make carbon from leaf litter and primary producers such as diatoms, algae and macrophytes available to higher order consumers such as fish and Platypus. Different functional groups serve different ecological functions; e.g. shredders convert fallen leaves to coarse and fine particulate organic matter that can be consumed by other biota and allows material to more readily move downstream; filter feeders can affect nutrient spiralling rates by sieving food from the water column. The Coliban River near Taradale features a good variety of macroinvertebrate habitats and therefore the objective for that section of the reach will be to maintain the macroinvertebrate community. Further downstream, remnant pools have less submerged and fringing vegetation and are therefore likely to have fewer macroinvertebrate functional groups.
G1 Maintain channel form, replenish benches and scour pools to maintain their depth	Channel form and habitat heterogeneity are critical to providing habitat and food for aquatic and riparian flora and fauna. Pools through this reach provide a critical drought (and potentially flood) refuge for aquatic fauna and flora, but sand has filled natural pools in sections of the reach, particularly downstream of Sandy Creek.
G2 Clean substrates including rocks, submerged wood and macrophytes	Regular flows that clean silt, fine sediment and biofilms from hard surfaces will increase their suitability for macroinvertebrates and biofilm production and lead to an overall increase in biological productivity and diversity.

6.3. Coliban River flow recommendations

Flow recommendations describe the water regimes required for achieving ecological objectives. All values identified have components of their life-cycle or process that are dependent on particular flow components for success e.g. Platypus require certain timing, duration and frequency of flooding to successfully breed and maintain their population.

To meet the hydrological requirements of the Coliban River EWMP, flow recommendations have been set considering the following factors:

- the preferred timing of watering events
- the recommended duration for watering events
- the tolerable intervals between events (condition tolerances)
- the volume required to provide these events – per event / per season.

The flow recommendations are presented as two seasons (summer and winter) as per the FLOWS method (DEPI 2013a). The summer season also encompasses autumn and the winter season encompasses spring. This roughly aligns with the natural shift from wetter weather and greater inflows in winter and spring, and dryer weather with greater evaporation and less inflows in summer and autumn. Where values require particular timing for water this has been identified (Table 12).

Table 12: Environmental flow recommendations for the Coliban River

Flow Component	Magnitude	Duration (at peak)	Frequency and timing	Condition tolerances	Ecological Objectives	How the Flow component supports the ecological objectives
Cease-to-flow	Not recommended					
Summer low flow	1 - 10 ML/day*	5 months (Dec to April)	Vary the magnitude of flow within the prescribed range throughout Dec-May. Higher magnitude in Dec, gradual decline through Jan-Feb then gradual rise from Mar-May	Target average low flow of 2.5-7 ML/day in average years. In dry years the low flow can be closer to 1-2.5 ML/day for most of the season, provided there is some variability. In wet years the flow can be 5-10 ML/day for most of the season	V1 V2 F1 F2 WQ1 M1 P1	Depths through riffle run habitats at Philips Rd site (Figure 2) for flows: • 1 ML/day: 1 cm • 2.5 ML/day: 2cm • 7 ML/day: 4-5 cm • 10 ML/day: 5-6 cm The trickle flow of 1 ML/day will provide for some water quality and flow through main rifle run habitats for macroinvertebrates. Not expecting fish to move through them under really low flows. Want to maintain a visible flow through the whole reach to maintain water quality. Riffle habitats will contract in both depth and width, with the area increasing as the flow magnitude is increased. Therefore increasing available area for macroinvertebrates.
Small summer fresh	25-50 ML/day	3-5 days[#]	2 per season between November and March	In very dry years the minimum aim should be to provide two 25 ML/day flow events. Where possible the flow magnitude of one or both events should be increased to 50 ML/day.	G2 V1 V2[p] V3 F1 F2 WQ1 M1 P1	Summer freshes will increase water depth by 5-20 cm compared to the summer low flow to provide some flow variability each year and more closely mimic natural variation between wet and dry years Flow of 25 ML/day is expected to flush pools to improve water quality throughout the reach. The flow magnitude will decrease with distance downstream, but it is critical that the event reach Lake Eppalock so that poor quality water is flushed through the system. Flow of 50 ML/day will provide a shear stress of 5.9 N/m^2, which will clean some substrates in fast flowing sections of the waterway.

Flow Component	Magnitude	Duration (at peak)	Frequency and timing	Condition tolerances	Ecological Objectives	How the Flow component supports the ecological objectives
Large summer fresh	160 ML/day	3 days	1-2 per season in wet years between November and March	In wet years (i.e. approximately 30% of years) one or both of the small summer freshes should be replaced with a higher magnitude flow. Ideally these flows should be delivered at least once every 4-5 years	G2 V1 V2 V3 F1 F2 WQ1 M1 P1	Summer freshes will increase water depth by 45 to 55 cm compared to the summer low flow to provide some flow variability each year and more closely mimic natural variation between wet and dry years. Flow of 160 ML/day will inundate low benches to promote growth and recruitment of fringing vegetation, clear sediment and biofilms from hard substrates in the bottom of the channel and increase water depth to facilitate fish movement. Flow should ideally be delivered at least once every 4-5 years to maintain viable vegetation communities on the margin of the channel and on low benches.
Winter low flow	15-25 ML/day	All season May to November (provide an early	Vary the magnitude of flow within the prescribed range throughout Jun-Nov to match the natural flow regime. Ramp the flow up slowly from May to deliver the highest magnitude in Jul-Sep, then gradually drop flow through Oct-Nov	In dry to average years the flow should be around 15 ML/day and increase to 25 ML/day for short periods (i.e. 1-2 weeks at a time). In wet years, the flow should be maintained at an average of 25 ML/day for as long as possible.	V1 V2 V3 F1 F2 WQ1 M1 P1	Recommended winter flow period commences in May to facilitate juvenile Platypus dispersal from late Autumn Without this flow Platypus will be more exposed to predators (will have to move through shallow habitats on route and will be vulnerable to foxes, cats etc.). Winter low flow will provide full rifle habitat for macroinvertebrates for at least six months of the year. Small bodied fish will be able to disperse throughout the reach. Flow wets a greater width of the channel – good for macroinvertebrates and provides plant zonation, limiting terrestrial species encroaching in the margins of the channel.

Flow Component	Magnitude	Duration (at peak)	Frequency and timing	Condition tolerances	Ecological Objectives	How the Flow component supports the ecological objectives
Winter fresh	At least 160 ML/day	3 days	2-3 times per year	To be provided in average to wet years.	G2 V1 V2 V3[p] F1 F2 M1 P1	The flow is the same magnitude as the large summer fresh. It will inundate low benches within the channel to support the growth of fringing vegetation and wet the banks to promote the growth of riparian vegetation. The flow will also allow small-bodied native fish to disperse throughout the reach and colonise sites where populations may have declined during low flow periods. Scheduling a winter fresh in early August will help to send a signal to female Platypus and Water rats to place breeding burrows high enough that they are less likely to be inundated later when juveniles are present.
Bankfull flow	6,000 ML/day	1 day	One in three years on average	To be provided in wet years, ideally between June and early August to minimise adverse consequences for Platypus and Water-rat reproduction, recruitment and dispersal.	G1 G2 V3	The flow will fill the entire channel in the upstream sections of the Reach near Taradale, but will not fill the channel further downstream. Bankfull flows at the downstream end of the reach are also required to scour sand from the channel and maintain pools, but those flows can only be provided by natural run-off from the local catchment and associated tributaries.
Overbank flows	As natural					

* To achieve the recommended summer low flow at the Philips Rd Taradale site it may be necessary to release more than the recommended volume from Malmsbury Reservoir due to losses and diversions.

[#] Monitoring required to assess flow duration to provide at least one day of flow through to Lake Eppalock

[p] Partially meets the objective

6.4. Ten year water regime and hydrological objectives

Historically river systems have been managed according to annual flow recommendations. However, to achieve long term objectives flow regimes need to be adaptable and variable from one year to the next. To meet the 'long-term' requirements of the Coliban River EWMP, a ten year flow regime been established considering the following factors and is shown in Table 13:

- the recommended number of watering events over a ten year period; and
- the tolerable intervals between events (condition tolerances)

It should be noted that the ten year watering regime is assuming water availability and will need to be adaptively managed and based on outcomes achieved in the previous year. Table 13 shows the detail of the flow recommendations within the watering regime including the ecological objectives supported by the different flow components.

Table 13: Ten year water regime for the Coliban River (assuming water availability)

Year	1	2	3	4	5	6	7	8	9	10
Focus objectives	V1 V2 F1 F2 P1	V1 V2 F1 F2 P1	V3 WQ2	V1 V2 V3 F1 F2 P1	V1 V2 V3 F1 F2 P1	V3 WQ2	V1 V2 F1 F2 P1	V1 V2 F1 F2 P1	V1 V2 F1 F2 P1	V3 WQ2
Summer low flow	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Small summer fresh[1]										
Nov-Dec	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Jan-March	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Large Summer fresh				2	2	2				
Winter Low Flow	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Winter Fresh				✓	✓	✓	✓			
Bankfull			✓			✓				✓

Note 1 – Except in years when large summer freshes are delivered

7. Risk Assessment

A qualitative risk assessment has been undertaken to assign the level of risk of threats to achieving the objectives as well as risks related to the delivery of environmental water through the implementation of this EWMP. The relationship between likelihood (probability of occurrence) and the severity (severity of the impact) provide the basis for evaluating the level of risk (Table 14).

Table 14: Risk Matrix

		Severity		
		Major	Moderate	Minor
Likelihood	Probable	High	High	Moderate
	Possible	High	Moderate	Low
	Improbable	Moderate	Low	Low

The results from the Coliban River EWMP risk assessment are presented in Table 15. Management measures relevant for the moderate to high level risks are recommended and the residual risk is then recalculated using the same risk matrix. Please note that short-term operational risks (e.g. environmental releases causes flooding of private land) are assessed as part of the development of the Coliban River System Seasonal Watering Proposal.

Table 15: Possible risks and mitigation measures associated with environmental water delivery to Coliban River

Threat	Outcome	Likelihood	Consequence	Risk rating	Management measure	Residual risk
Threats to achieving ecological objectives						
Grazing pressures	Grazing by domesticated, feral and/or native herbivores (e.g. cattle, sheep, rabbits, kangaroos and wallabies) may be prevent the maintenance and establishment of emergent vegetation on benches and recruitment of understorey and overstory species within the riparian zone.	Probable	Major	**H**	Fencing and stock exclusion have demonstrable benefits to aquatic and riparian vegetation. However fencing of the Coliban River is not currently funded, therefore mitigation of this risk is currently not available.	**M**
Increased levels of development/ lifestyle properties	Leading to potential increase nutrients from septics and reduced run off from intensification of farm dams	Probable	Major	**H**	Work with Coliban Water and local councils to understand growing development and put in place rules to protect the catchment	**M**
Weeds	Willows and woody weeds (e.g. Gorse) exist throughout the Coliban River and transform the ecology of the system (simplify habitat and put aquatic flora and fauna at risk)	Probable	Major	**H**	Willow removal works will increase cover and abundance of aquatic vegetation However river health works at the Coliban River are not currently funded, therefore mitigation of this risk is currently not available.	**M**
Sand slugs	Loss of deep pool habitats and substrates (including rocks, submerged wood and macrophytes)	Probable	Major	**H**	Riparian buffer revegetation areas to manage sources of sand inputs into the river	M
Introduced species - Exotic fish	High abundance of exotic fish limits the establishment and subsequent maintenance of in-stream (submerged) vegetation with flow on affects to the entire food web. Decline in distribution and abundance of small bodied fish.	Possible	Major	**M**	There is yet to be a broad scale successful method for controlling exotic fish which is a knowledge gap across the Murray-Darling Basin.	M

Threat	Outcome	Likelihood	Consequence	Risk rating	Management measure	Residual risk
Threats related to the delivery of environmental water						
Blackwater events	Blackwater events can lead to fish kills and severe stress to other aquatic fauna. Blackwater events are natural, however management needs to ensure high flows do not trigger an event. High flows in cool months to clear organic loads will reduce the likelihood of blackwater events during summer.	Possible	Major	**H**	The risk of blackwater events is lower at the upstream end of the reach because there is more riparian vegetation that can trap leaf litter and prevent it being washed in during an event, and because smaller volumes of water are needed to flush poor quality water through that part of the system. If a blackwater event does occur then sufficient water will need to be released from Malmsbury Reservoir to provide flow through to Lake Eppalock: *Ensure freshes provided in the Coliban River reach lake Eppalock for at least one day to ensure poor water quality is flushed at downstream section.*	**M**
Stock and domestic pumping of passing flow	Opportunistic diversion licences take from passing flows that are delivered to the river to achieve ecological objectives. It has been estimated that if each 33 licence holders pump approximately 0.1 ML/day that corresponds to 3-4ML/day which is equivalent to the passing flow (Strachan L, 2015, personal communication, [GMW] 17th February). While rare, licence holders could also take more than allocation	Probable	Major	H	On-going communication with community about their needs and work towards getting better environmental outcomes for the river and improved/alternative supply to GMW customers. Education program (e.g. Platypus requirements to return a successful breeding population back to the river)	M

Threat	Outcome	Likelihood	Consequence	Risk rating	Management measure	Residual risk
Inundation of platypus burrows	Winter high fresh drowning juvenile Platypus (inundate burrow entrance)	Possible	Moderate	**M**	Freshes scheduled in spring or summer should be coupled to a preceding event of similar or greater magnitude in August, i.e. around the time that breeding females are choosing nursery burrow sites, to encourage females to locate nesting chambers above the maximum height of the subsequent fresh. *Residual risk is assessed assuming likelihood of burrows being flooded as improbable*	**L**

8. Environmental water delivery infrastructure

The following section outlines the constraints and opportunities to deliver environmental water to the Coliban River downstream of Malmsbury Reservoir.

8.1. Infrastructure constraints

Malmsbury Reservoir has the necessary infrastructure to allow for the delivery of environmental flow components (except bankfull flows) down the Coliban River, however the outlet delivery configuration and flow measurement is considered complex. While no recommendations have been made to improve infrastructure in this EWMP it has been identified that it is difficult to manage smooth and controlled flows on the Coliban River due to:

- Operational constraints (i.e. operation of the Coliban Main Channel and demands from downstream channel users) further impact the timing and control of flows
- Operation of the Malmsbury Reservoir is labour intensive and a high Occupational Health and Safety risk
- Malmsbury Reservoir only has a bottom outlet (no variable height outlet), releases up to 60 ML/day can be made to the river. However this flow can be supplemented 500m downstream from the Coliban Main Channel (capacity of 170 ML/day) (Healy S, 2015, personal communication, [Coliban Water] 17th March).

8.2. Operation constraints

Coliban River Withheld Passing Flows Account

As per the passing flow clause within the Bulk Entitlement[6], environmental water is gained by withholding passing flows for later use. When storages spill, environmental water is the first to be lost and management therefore involves banking flows in late spring-early summer when the risk of spill is lower. Under ideal conditions, this will allow a small volume to be banked for deployment during the high risk summer period. There is however a risk that the volume banked will be insufficient in providing a minimum flow (as per flow recommendations) and as a result is often deployed for the purpose of preventing water quality issues (North Central CMA 2014b).

Exchange of storage volumes to increase environmental flows down the Coliban River

As with management of water across the Murray Darling Basin, there are opportunities to exchange within the connected water grid to increase the environmental water available to the Coliban River. Coliban Water have indicated that in average to wet years opportunities may exist to exchange environmental entitlement held in Lake Eppalock to Malmsbury Reservoir. This is only possible if water supply to Bendigo is coming from the Coliban storages. . Other issues that would need to be resolved include the costs of pumping water from Lake Eppalock are covered and there are no water quality issues (e.g. Blue Green Algae event).

Costs associated with deploying the CEWH entitlement

As outlined in Section 2.4 the cost of using the CEWH entitlement down the Coliban River is $12,184, this high cost has meant that this entitlement has never been used down the Coliban River. It also prevents the CEWH or VEWH purchasing additional water for the benefit of the river as the cost is prohibitive.

[6] *Bulk Entitlement (Campaspe System - Coliban Water) Amendment Order 2012*

8.3. Water delivery recommendations

Malmsbury Reservoir can be managed to deploy all of the flow recommendations defined in Section 6.3, however the following recommendations need to be investigated further to improve environmental water management in the Coliban River:

1. Exchange of storage volumes to increase environmental flows down the Coliban River: further discussions with Coliban Water and GMW to define the scenraios when additional water can be provided to the river via exchange of environmental entitlement held in Lake Eppalock to Malmsbury Reservoir.
2. Costs associated with deploying the CEWH entitlement: discussion with CEWH and VEWH are required to investigate opportunities to use the current CEWH environmental entitlment in the Coliban River
3. Potential to purchase new entitlements for the river: the current allocation of water esources to the Coliban River is insufficient, more water is required to achieve the management objectives identified in Section 6.

9. Complementary actions

Implementation of the above watering regime for the Coliban River will generate benefits to the environmental values of the river. Some objectives require complementary actions to be realised. These are directly related to the risk section, i.e. risk of not achieving objectives (Table 16).

Table 16: Complementary actions to enhance the outcomes of environmental water

Activity	Rationale
Planning guidelines/controls for catchment development	Increased levels of development/ lifestyle properties in the Coliban catchment are evident and pacing extra pressure on water resources and nutrient inputs into the waterway.
Improve gauging of flow and water quality	Flow in the Coliban River is measured at few locations, with little or no measurement of tributary flows.
Willow and woody weed management	Willows and other woody weeds (e.g. Gorse, Blackberry) exist throughout the Coliban River (Figure 7) and transform the ecology of the system (e.g. simplify habitat, impact on instream vegetation and reduces light and nutrient availability to instream aquatics). Removing willows in some sections will allow native plants in sections to re-establish.
Fencing and alternate stock watering points	Livestock have direct access to the Coliban River. This damages and inhibits the recruitment of native vegetation including River Red Gum trees.
Fitting guards or screens around the inlets to stock and domestic pumps to exclude fauna	Many instances are known of Platypus, Water rats and turtles being killed by being sucked into irrigation pumps.
Riparian buffer strips	Investigate management of further sand inputs to the river (Sandy Creek, Myrtle Creek and other catchment hot spots). Assess the potential for site specific sand extraction.

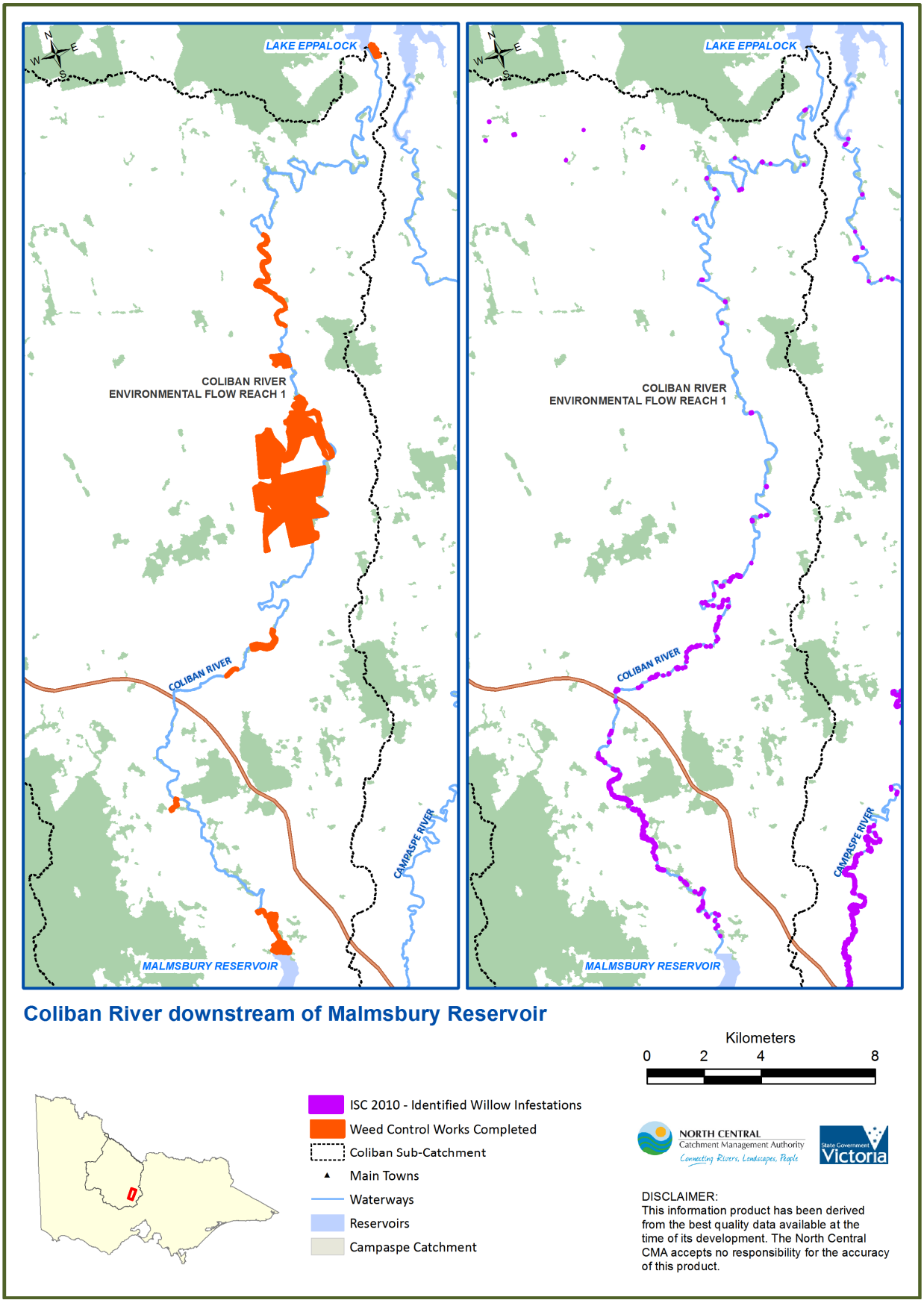

Figure 7: Mapped Willow infestations in the Coliban River

10. Demonstrating outcomes

Monitoring is required to demonstrate that watering is achieving long term environmental outcomes. Monitoring is also a critical component of the adaptive management for the Coliban River.

Two types of monitoring are recommended to assess the effectiveness of the proposed water regime on objectives and to facilitate adaptive management:

- Intervention monitoring
- Long-term condition monitoring.

Currently the main monitoring program for the release of environmental water on the Coliban River is the VEFMAP program. The State has recently reviewed the VEFMAP program which will inform the next phase of environmental watering monitoring to be undertaken.

The monitoring program below is specifically related to demonstrating achievement of the short and long-term objectives of the Coliban River EWMP.

10.1. Intervention monitoring

Intervention monitoring will assess the responses of key environmental values to a particular watering event e.g. fish spawning in response to a pulse in river flows. Monitoring the response to a watering event will be important to provide feedback on how the system is responding and whether any amendments need to be made to the operational management or determine if any risk management actions need to be enacted.

Current intervention monitoring

The North Central CMA conducts an ongoing environmental flow water resource planning program for the Coliban River, which is undertaken as part of the implementation of the Seasonal Watering Proposal. Each year environmental flows are released based on an assessment of the monitoring data as well as the water availability.

The internal CMA monitoring program is relatively limited and does not adequately cover the suite of ecological objectives and their response to flows. Current monitoring sites are identified in section 2.1, Figure 2.

Required intervention monitoring

Further intervention monitoring is required so that the CMA is able to adaptively manage the river over the next ten years to ensure that the delivery of environmental water is achieving objectives. The proposed intervention monitoring program and the objective that is being monitored is shown in Table 17.

Table 17: Required intervention monitoring for the implementation of the Coliban River EWMP

Objective	Monitoring question	When	Event	Method
Maintain and increase cover and diversity of instream aquatics, fringing vegetation	Is instream and emergent vegetation responding to flows? Are flows clearing sediment and biofilms?	Year 1 and 2[7]	Summer fresh	Vegetation surveys– existing survey sites established through VEFMAP Should include areas along the river that have been fenced and an agreement with landholder to exclude stock has been reached as well as sites with grazing pressure.
Maintain adult River Red Gum trees and facilitate successful recruitment	Are River Red Gum trees recruiting after winter fresh?	Year 4 and 5[8]	Winter fresh	Photopoints (germination success assessment)
Increase population size of opportunist small-bodied native fish	Has the abundance and diversity of small bodied fish increased?? Have River Blackfish been recorded?	In response to community observations	Summer low flow and freshes	Fish surveys (fyke nets)
Provide conditions that support breeding of Platypus and Water Rats	Are Platypus and Water Rats recovering and completing successful breeding cycle?	Annually	All events	A simple annual phone survey of a representative group of local landholders to ascertain if they have seen a Platypus or Water Rat in the previous 12 months and if so how often (once, occasionally, frequently/regularly) could also potentially provide useful information about where these species occur and their relative abundance.
Risk				
Drowning Platypus burrows during winter fresh	Is the August winter fresh encouraging Platypus to place their breeding burrows higher in the bank?	Winter Fresh	After August fresh	Survey height of burrow entrances relative to mAHD before and after flow release
Blackwater risk of managed summer events?	Are dissolved oxygen levels maintained at acceptable concentrations during summer fresh?	Each year	Summer fresh	Water quality - dissolved oxygen

[7] Instream and emergent vegetation intervention monitoring will need to occur in the first two years as a minimum, additional instream and emergent vegetation intervention monitoring will be required if response isn't as expected.

[8] Assumption that ten year flow regime proposed in this EWMP is followed. The actual timing will be dependent on adaptive management.

10.2. Long term monitoring

Long-term condition monitoring will provide information on whether the watering regime (and other factors) is causing a change in, or maintaining, the overall condition of the river (trend over time).

Current long-term condition monitoring

Funding has been confirmed under the VEFMAP program for vegetation surveys in 2016, however funding for monitoring beyond this time is unconfirmed.

Required long-term condition monitoring

The long-term condition monitoring requirements that will demonstrate changes in condition over time specifically focusing on demonstrating the long-term outcomes of the Coliban River EWMP is shown in Table 18.

Table 18: Required long-term condition monitoring for the Coliban River

Objective	Method	When
Fish	Small bodied fish – small mesh gauge fyke nets. Replicate sampling effort, distribution and time	Every 2-3 years preferred, maximum 5 years in November
Platypus	Live trapping surveys	Every 2-3 years preferred, maximum 5 years in November
Geomorphology/habitat	Map distribution of sediment slugs and impact they are having on pools	Years 5 and 10, or following significant flow events
Flow connectivity	Flow monitoring in Coliban River, • Phillips Road gauging station • Lyel Rd, near Lake Eppalock	Continuous

11.Knowledge gaps and recommendations

The Coliban River EWMP has been developed using the best available information. However, a number of knowledge gaps and recommendations have been identified through the development of the EWMP. These are summarised below with priority status in Table 19.

Table 19: Knowledge gaps and recommendations

Knowledge Gap	Objective	Recommendation	Who	Priority
Objectives				
Currently only providing the Coliban River with low summer flows and minimal freshes. There is a need to investigate options to increase the environmental entitlement available to the river.	All	Investigate the need for infrastructure upgrades and trade opportunities to improve water management and opportunities for multiple outcomes ?(e.g. environmental flows)	North Central CMA Coliban Water GMW	High
Is successful breeding of Platypus and Water Rats occurring in the Coliban River - nesting behaviour and appropriate population densities for this river system?	P1 W1	Seek funding for: • Annual phone surveys • Live Trapping surveys	CMA/ APC	Medium
Duration of freshes required to achieve flow connectivity to Lake Eppalock	WQ2	Monitor small summer freshes delivered and ensure flow reaches Lake Eppalock. Keep a record of flow releases (including duration, magnitude, weather conditions and time the flow took to reach Lake Eppalock). Consultation with landholders near Lake Eppalock will be useful in establishing when the flow gets close to Lake Eppalock.	CMA	Medium
Species identification of *Galaxias sp.*in the Coliban River	F1	Targeted surveys completed as part of any fish surveys Confirmation of which *Galaxias sp.* is present in the Coliban River	CMA/Research body	As required
Is it appropriate to return River Blackfish to the Coliban River	F2	Targeted surveys completed as part of any fish surveys Investigate option for translocation	CMA/ Research body	As required
Galaxias sp.	F1	Targeted surveys completed as part of any fish surveys. Confirmation of which *Galaxias sp.* is present in the Coliban River	CMA/ Research body	As required
Recommendations				
Investigate opportunities to exchange of environmental entitlement held in Lake Eppalock to Malmsbury Reservoir.	All	Further discussions with Coliban Water and GMW to define the scenarios when this exchange can occur and associated costs	CMA/ Coliban Water/GMW	High
Review of costs associated with deploying the CEWH environmental entitlement Purchase new entitlements for the river	All	Discussion with CEWH and VEWH are required to investigate opportunities to use the current CEWH environmental entitlement as well as the potential to purchase new entitlements for the river	CMA/ CEWH/ VEWH	High
There is currently no funded river health improvement project on the Coliban River	All	Develop a project to undertake the Complementary actions identified in Section 9 and seek funding for implementation	CMA/DELWP Victoria	High

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13.Abbreviations and acronyms

AVIRA	Aquatic Value Identification and Risk Assessment
BE	Bulk Entitlement
Bonn	The Convention on the Conservation of Migratory Species of Wild Animals (also known as the Bonn Convention or CMS)
CAMBA	China-Australia Migratory Bird Agreement
CEWH	Commonwealth Environmental Water Holder
CMA	Catchment Management Authority
CVMS GMW	Central Victorian Mineral Springs Groundwater Management Area
DELWP	Department of Environment, Land, Water and Planning
DEPI	Department of Environment and Primary Industries (Now DELWP in 2015)
DPI	Department of Primary Industries (Now an amalgamation DEPI in 2013)
DSE	Department of Sustainability and Environment (Now DEPI in 2013)
EPBC	*Environment Protection and Biodiversity Conservation Act 1999* (Cth)
EVC	Ecological Vegetation Class
EWMP	Environmental Water Management Plan
FFG	*Flora and Fauna Guarantee Act 1988* (Vic)
GL	Gigalitre (one billion litres)
GIS	Geographical Information System
GMW	Goulburn-Murray Water
HRWS	High Reliability Water Share
ISC	Index of Stream Condition
IVT	Inter Valley Transfer
JAMBA	Japan-Australia Migratory Bird Agreement
LRWS	Low Reliability Water Share
LTCE	Long Term Cap Equivalent
MDBA	Murray-Darling Basin Authority (formerly Murray-Darling Basin Commission, MDBC)
ML	Megalitre (one million litres)
ML/d	Megalitres per day
North Central RWS	North Central Regional Waterway Strategy
ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement
RWS	Regional Waterway Strategy
SRA	Sustainable River Audit
SWP	Seasonal Watering Proposal
TLM	The Living Murray Initiative
VEFMAP	Victorian Environmental Flows Monitoring and Assessment Program
VEWH	Victorian Environmental Water Holder
VWMS	Victorian Waterway Management Strategy
VWQN	Victorian Water Quality Network

Appendix 1: Community Consultation

Targeted Community Consultation – Summary Report

Method

Community Consultation for the Coliban River Environmental Water Management Plan (EWMP) has been undertaken via telephone interviews during the period of 19th January to 12th February 2015. To finalise the EWMP, local knowledge and input was required. The interviews were focussed on collecting information from the community in relation to the waterway, its values and current environmental water management. The information collected has been summarised below and will be used in developing the EWMP and reviewing the current environmental flow recommendations (SKM 2006c). The community consultation component of developing the plan is essential in ensuring that the plan is meaningful and robust into the future. Key information sought through this process is in the areas of local knowledge and providing local opinions about the values and threats to the waterway.

Community representatives interviewed

- Richard Carter (NRMC Representative)
- Chris Bromley
- Alastair and Lisa Stables
- David and Marion Maloney
- Diane Jackson
- John Sinnotts
- John Dunham
- John and Sue Walter (Malmsbury Landcare Group)
- Lynley Strachan (GMW)

1. **Coliban River information (general)**
   - Establishing a farm that grows organic and environmentally sustainable produce is a challenge. Key challenges we face are either too much water or not enough and the biggest is managing frosts.
   - Extending the riparian zone and establishing wind breaks (panted approximately 4000 trees) has really enhanced the natural environment on our property.
   - Gorse, Blackberries and Hawthorn are a real issue in the catchment. We have previously manually removed, however due to erosion issues the best management option is the cut and paint method (Glyphosate).
   - We have a stock and domestic entitlement; however we have just installed a 22,000L water tank to water our horticulture projects.
   - Need to fence off the waterway and get stock away from the river and Malmsbury reservoir (reduce runoff with high nutrient loads and therefore algal bloom events).
   - The river use to flood every two-three years.
   - Since we have removed Willows on our property, the water has been much clearer. Landholders and government agencies are not doing enough to remove noxious weeds.
   - We really enjoy having the river on our property, appreciate the water and animals that depend on it. Have done works to improve the river (e.g. Gorse and Willow removal and revegetation). The river gives us a lot of pleasure and we want to look after it.
   - Stock and domestic fees have increased substantially over the years. In 1992 it was about $50-70 per year. Now in 2015 it is $300-400 per year. When I really need the water, there is no water in the river to access.

2. Waterway values

Environmental

- We get real enjoyment from the Coliban River and the flowing water – it is a reward aspect of living here next to the river.
- We enjoy sitting by the water and watching the birds, Kangaroos, Swamp Wallabies and Echidnas.
- Have also had the opportunity to sight Platypus and Long-necked Turtles.
- Areas next to the river are extremely important as this is where the vegetation is in the best condition (especially gorge areas). Once you get away from the river there are more introduced species.
- Willows are a real problem for the river (other problem weeds include: Gorse, Broom, St John's Wort, Hawthorn and Blackberry).
- Revegetation efforts need to focus on the soils, sometimes EVC planting is not appropriate (e.g. Woolly Tea Tree is not natural to the district).
- Vegetation exhibited in the Malmsbury Common area include: Sedges and Grasses, Gypsywort and Knotweed.
- Use to observe Platypus and Water Rats frequently when we would visit the river.
- Malmsbury Reservoir is stocked with fish (some natives, Redfin and Trout).
- The removal of Willows in 2008-09 just downstream of Malmsbury Reservoir exposed some very deep pools, subsequent floods (2010-11) were one metre lower due to these works.
- The Eucalypts are looking very dry, drier than during the drought (some limbs have come down).
- There are a few springs that feed the river, however the moment the river stops running the water quality declines. In the 70s and 80s if the water stopped flowing it always maintained good quality water in the deep holes.
- We are reliant on the river for a few pet animals and our vegetable garden, when the river is very low the sulfur in the water burns the leaves on our tomato plants (water contains minerals).
- Our stock and domestic license is 2.5 ML, although I don't know how much we use. We have a 45,000L water tank, which we currently go through in approximately one week.
- The river is very sandy, there is a reasonable pool at the Coliban Bridge. I use to always see Platypus here, they rely on the river banks to burrow in, foxes are a real problem for this species.
- Carp are in the river and observed during periods of low flow. In the 70s and 80s we would never see one. Use to have Trout in the river.
- There are a lot of snags in the river, River Red Gums dropping trunks.
- The floods brought a lot of debris down the river, in some places lost 9-10 foot off the bank. Lost fencing also. The flood came and went pretty quickly (peak and fall), it was amazing to see this 1 in 100 year event.

Cultural Heritage

- There are special places in the Coliban River, however we are not prepared to share them to keep them protected.
- AAV fragments recorded in relation to the black brittle stone resembling Lydian stone that is the material most often used for small tools in this region along with quartz. Although this material was identified as tachylite, a glass-like form of

basalt (cutters and scrapers and sometimes set into wood using a resin, such as in spear points).

- A number of larger tools from the Coliban River catchment including axes were displayed by a local resident. These tools were found within the town of Malmsbury in the 1980's.
- Picture insert: Aboriginal midden, the water in the background is the Kangaroo Creek arm of the Reservoir, and the land is between the two arms just on the Coliban River side of the point.

Recreation

- Negative recreation occurs, have observed neighbours using the riparian zone for dune buggy adventures.
- The occasional fisherman is observed, however they often leave rubbish and there are also fire issues (e.g. smoking).
- Swimming at the cascades, Metcalfe and deep pools in the river.
- Fishing (especially near the reservoir as it is stocked).
- Bushwalking and camping, many reserves to enjoy in the area.

3. Current environmental water management

- Have had people doing surveys on our property, and was not aware of what was going on, however this has improved and it was interesting getting copies of the reports.
- An issue in relation to water management on the river is not knowing when there is going to be a flow.
    - Text message notification would be a great way to communicate the commencement of flows on the river for landholders who would like to know, we don't buy the local paper.
- After the floods in 2010-11 a section of the river was blocked by a Willow, it was hard work removing (although worthwhile intrinsically) and it can be hard as we have not received any assistance with the environmental work we do. There seems to be inconsistency with regard to the regulation on owners adjacent to waterways.
- More water is required to maintain the environmental values; I haven't seen a Platypus in years, however recently I have seen fish in the river.
- A flow release of 5 ML/day barely runs the river (this mono flow is not how the river would naturally run and this flow is managed like this month after month). Different flow regimes need to be trialled, e.g. Stop the river for 10 days, bank the water and release a flush down the river).
- Use environmental water by pulsing the river would be much better, variations could be provided to simulate natural flow and stimulate fish breeding,
- Stock and domestic: when walking down the river and there is a higher flow coming down the river you can hear all the pumps going as everyone is trying to fill their dams quickly.
- We need more sustained and regular flows down the river.
- Communication of flow releases down the river with landholders is relay important and needs improvement.
- GMW have previously managed the waterway and use to stop the river, bank the flows and release 50ML/day (this occurred in the early 2000s)

Appendix 2: Species list

Sources: DEPI 2014c, VEFMAP 2015

Common Name	Scientific Name	Last observed
Flora		
Annual Cat's-tail*	*Rostraria cristata*	1770
Ausfeld's Wattle	*Discaria pubescens*	unknown
Australian Anchor Plant	*Discaria pubescens*	unknown
Basket Willow*	*Salix X rubens*	1996
Beard Orchid	*Calochilus spp.*	1998
Bearded Oat*	*Avena barbata*	1998
Bidgee-widgee	*Acaena novae-zelandiae*	1998
Black Gum	*Eucalyptus aggregata*	unknown
Black-anther Flax-lily	*Dianella revoluta s.l.*	1998
Blackberry*	*Rubus fruticosus spp. agg.*	1996
Blackwood	*Acacia melanoxylon*	2003
Blue Burr-daisy	***Calotis cuneifolia***	**1875**
Blue Periwinkle*	*Vinca major*	1996
Blue Pincushion	*Brunonia australis*	1998
Bluebell	*Wahlenbergia spp.*	1998
Broad-fruit Club-sedge	*Isolepis cernua var. platycarpa*	1998
Broad-leaf Peppermint	*Eucalyptus dives*	1998
Brooker's Gum	*Eucalyptus brookeriana*	unknown
Broughton Pea	*Swainsona procumbens*	1770
Brown-top Bent*	*Agrostis capillaris*	1998
Bulbine Lily	*Bulbine bulbosa*	1770
Bundy	*Eucalyptus goniocalyx s.s.*	1998
Cape Ivy*	*Delairea odorata*	1996
Chilean Needle-grass*	*Nassella neesiana*	2000
Chocolate Lily	*Arthropodium strictum s.l.*	1998
Cleavers*	*Galium aparine*	1998
Clover Glycine	*Glycine latrobeana*	unknown
Cocksfoot*	*Dactylis glomerata*	1998
Common Blackberry*	*Rubus anglocandicans*	1998
Common Cudweed	*Euchiton involucratus s.l.*	1998
Common Early Nancy	*Wurmbea dioica subsp. dioica*	1892
Common Hovea	*Hovea heterophylla*	1998
Common Raspwort	*Gonocarpus tetragynus*	1998
Common Reed	*Phragmites australis*	1998
Common Rice-flower	*Pimelea humilis*	1998

Common Name	Scientific Name	Last observed
Common Tussock-grass	*Poa labillardierei var. labillardierei*	1998
Common Wheat-grass	*Elymus scaber var. scaber*	1998
Common Woodrush	*Luzula meridionalis var. densiflora*	1993
Cootamundra Wattle*	*Acacia baileyana*	1996
Copper-awned Wallaby-grass	*Austrodanthonia fulva*	1998
Crack Willow*	*Salix fragilis*	1998
Cranberry Heath	*Astroloma humifusum*	1998
Creeping Bossiaea	*Bossiaea prostrata*	1998
Creeping Grevillea	*Grevillea repens*	unknown
Curly Pocket-moss	*Fissidens megalotis*	1963
Cut-leaf Crane's-bill*	*Geranium dissectum*	1998
Daphne Heath	*Brachyloma daphnoides*	1998
Delicate Hair-grass*	*Aira elegantissima*	1998
Drooping Cassinia	*Cassinia arcuata*	1998
Dwarf Mat-rush	*Lomandra nana*	2003
English Broom*	*Cytisus scoparius*	2003
English Ivy*	*Hedera helix*	1996
Erect Chickweed*	*Moenchia erecta*	1887
Fen Sedge	*Carex gaudichaudiana*	1998
Fennel*	*Foeniculum vulgare*	1996
Flat Sedge	*Cyperus spp.*	1998
Flatweed*	*Hypochaeris radicata*	1998
Forest Sun-orchid	*Thelymitra arenaria*	1998
Fox-tail Fescue*	*Vulpia myuros f. megalura*	1971
Fuzzy New Holland Daisy	*Vittadinia cuneata var. cuneata*	1981
Gold-dust Wattle	*Acacia acinacea s.l.*	1998
Golden Cowslips	***Diuris behrii***	**2003**
Gorse*	*Ulex europaeus*	2005
Grass Triggerplant	*Stylidium graminifolium s.l.*	1998
Great Brome*	*Bromus diandrus*	1998
Green Rush	*Juncus gregiflorus*	1998
Grey Everlasting	*Ozothamnus obcordatus*	1998
Grey Parrot-pea	*Dillwynia cinerascens s.l.*	1998
Grey Tussock-grass	*Poa sieberiana var. sieberiana*	1998
Hairy Plume-grass	*Dichelachne hirtella*	1993
Hawthorn*	*Crataegus monogyna*	1996
Hill Wallaby-grass	*Austrodanthonia eriantha*	1998
Honey-pots	*Acrotriche serrulata*	1998

Common Name	Scientific Name	Last observed
Hop Clover*	*Trifolium campestre var. campestre*	1998
Hypsela	***Hypsela tridens***	**2002**
Kangaroo Grass	*Themeda triandra*	1998
Knotted Clover*	*Trifolium striatum*	1998
Large Quaking-grass*	*Briza maxima*	1998
Leafy Wallaby-grass	*Austrodanthonia bipartita s.s.*	1998
Long-hair Plume-grass	*Dichelachne crinita*	1998
Madrid Brome*	*Bromus madritensis*	1963
Many-flowered Mat-rush	*Lomandra multiflora subsp. multiflora*	1998
Marshwort*	*fam. Menyanthaceae gen. Nymphoides*	1979
Milkmaids	*Burchardia umbellata*	1998
Montpellier Broom*	*Genista monspessulana*	1996
Moss Sunray	*Hyalosperma demissum*	1770
Narrow-leaf Bitter-pea	*Daviesia leptophylla*	1998
Narrow-leaf Clover*	*Trifolium angustifolium var. angustifolium*	1998
Narrow-leaf Vetch*	*Vicia sativa subsp. nigra*	1998
Pacific Azolla	*Azolla filiculoides*	1965
Pale Sundew	*Drosera peltata subsp. peltata*	1998
Parrot's Feather*	*Myriophyllum aquaticum*	1979
Paspalum*	*Paspalum dilatatum*	1996
Paterson's Curse*	*Echium plantagineum*	2001
Perennial Rye-grass*	*Lolium perenne*	1998
Pink-bells	*Tetratheca ciliata*	2003
Pitch Weed*	*Madia sativa*	1909
Plain Sun-orchid	*Thelymitra nuda*	1998
Ploughshare Wattle	*Acacia gunnii*	1993
Pottia	*Tetrapterum cylindricum*	1963
Prairie Grass*	*Bromus catharticus*	1998
Prickly pear*	*Opuntia spp.*	1996
Purple Coral-pea	*Hardenbergia violacea*	1998
Purple Diruis	*Diuris punctata var. Punctata*	unknown
Pygmy Pocket-moss	*Fissidens taylorii*	1963
Radiata Pine*	*Pinus radiata*	1996
Raspwort	*Gonocarpus spp.*	2003
Red Box	*Eucalyptus polyanthemos subsp. vestita*	1998
Red Stringybark	*Eucalyptus macrorhyncha*	1998
River Bottlebrush	*Callistemon sieberi*	1998
River Red-gum	*Eucalyptus camaldulensis*	1998

Common Name	Scientific Name	Last observed
River Tea-tree	*Leptospermum obovatum*	1998
Rough Sow-thistle*	*Sonchus asper s.l.*	1998
Scented Sun-orchid	*Thelymitra megcalyptra*	1770
Serrated Tussock*	*Nassella trichotoma*	2008
Sheep's Burr	*Acaena echinata*	1998
Shiny Wallaby-grass	*Austrodanthonia induta*	1993
Showy Parrot-pea	*Dillwynia sericea*	1998
Silver Wattle	*Acacia dealbata*	2003
Silvertop Wallaby-grass	*Joycea pallida*	1998
Silvery Hair-grass*	*Aira caryophyllea*	1998
Slender Centaury*	*Centaurium tenuiflorum*	1894
Slender Fireweed	*Senecio tenuiflorus spp. agg.*	1998
Slender Rice-flower	*Pimelea linifolia*	1993
Small Wrinklewort	*Siloxerus multiflorus*	1875
Smooth Nardoo+	*Marsilea mutica*	1998
Smooth Parrot-pea	*Dillwynia glaberrima*	1998
Soft Brome*	*Bromus hordeaceus subsp. hordeaceus*	1998
Spear Thistle*	*Cirsium vulgare*	1998
Spike Wattle	*Acacia oxycedrus*	1892
Spiny-headed Mat-rush	*Lomandra longifolia subsp. longifolia*	1998
Sprawling Bluebell	*Wahlenbergia gracilis*	1998
Spreading Wattle	*Acacia genistifolia*	1998
Squirrel-tail Fescue*	*Vulpia bromoides*	1998
St Barnaby's Thistle*	*Centaurea solstitialis*	1889
Subterranean Clover*	*Trifolium subterraneum*	1998
Suckling Clover*	*Trifolium dubium*	1998
Sun Orchid	*Thelymitra spp.*	1998
Supple Spear-grass	*Austrostipa mollis*	1993
Swamp Diuris	*Diuris palustris*	unknown
Sweet Briar*	*Rosa rubiginosa*	2003
Tall Bluebell	*Wahlenbergia stricta subsp. stricta*	1998
Tall Sedge	*Carex appressa*	1998
Tall Sundew	*Drosera peltata subsp. auriculata*	1998
Texas Needle-grass*	*Nassella leucotricha*	1998
Toowoomba Canary-grass*	*Phalaris aquatica*	1998
Tufted Bluebell	*Wahlenbergia communis s.l.*	1998
Tufted Hair-grass	*Deschampsia cespitosa*	unknown
Upright Water-milfoil	*Myriophyllum crispatum*	1998

Common Name	Scientific Name	Last observed
Variegated Thistle*	*Silybum marianum*	1998
Wallaby Grass	*Danthonia s.l. spp.*	1998
Water Ribbons	*Triglochin procera s.l.*	1998
Wattle Mat-rush	*Lomandra filiformis subsp. filiformis*	1998
Wax-lip Orchid	*Glossodia major*	1998
Weeping Grass	*Microlaena stipoides var. stipoides*	1998
White Marianth	*Rhytidosporum procumbens*	1998
Wimmera Rye-grass*	*Lolium rigidum*	1998
Winged Slender-thistle*	*Carduus tenuiflorus*	1998
Wirilda+	*Acacia retinodes s.l.*	1998
Wiry Buttons	*Leptorhynchos tenuifolius*	1998
Woolly Wattle	*Acacia lanigera*	1998
Yam Daisy	*Microseris scapigera s.l.*	1993
Yellow Box	*Eucalyptus melliodora*	1998
Yellow Rush-lily	*Tricoryne elatior*	1998
Yorkshire Fog*	*Holcus lanatus*	1998
Fauna- birds		
Australasian Pipit	*Anthus novaeseelandiae*	1959
Australian Hobby	*Falco longipennis*	1959
Australian Magpie	*Gymnorhina tibicen*	2001
Australian Owlet-nightjar	*Aegotheles cristatus*	1959
Australian Raven	*Corvus coronoides*	1999
Australian Wood Duck	*Chenonetta jubata*	2001
Black-chinned Honeyeater	***Melithripterus gularis gularis***	**1959**
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	2000
Black-fronted Dotterel	*Elseyornis melanops*	1959
Black-shouldered Kite	*Elanus axillaris*	2001
Brown Falcon	*Falco berigora*	1999
Brown Goshawk	*Accipiter fasciatus*	2000
Brown Thornbill	*Acanthiza pusilla*	2001
Brown Treecreeper	***Climacteris picumnus victoriae***	**1998**
Brown-headed Honeyeater	*Melithreptus brevirostris*	1992
Buff-rumped Thornbill	*Acanthiza reguloides*	2000
Common Blackbird*	*Turdus merula*	2001
Common Bronzewing	*Phaps chalcoptera*	1958
Common Starling*	*Sturnus vulgaris*	1999
Crested Bellbird	***Oreoica gutturalis gutturalis***	**1959**
Crested Shrike-tit	*Falcunculus frontatus*	2000

Common Name	Scientific Name	Last observed
Crimson Rosella	*Platycercus elegans*	2001
Diamond Firetail	***Stagonopleura guttata***	**1972**
Dusky Moorhen	*Gallinula tenebrosa*	2001
Dusky Woodswallow	*Artamus cyanopterus*	2000
Eastern Rosella	*Platycercus eximius*	1995
Eastern Yellow Robin	*Eopsaltria australis*	2000
European Goldfinch	*Carduelis carduelis*	2001
Fairy Martin	*Petrochelidon ariel*	1959
Fan-tailed Cuckoo	*Cacomantis flabelliformis*	1959
Flame Robin	*Petroica phoenicea*	1991
Fuscous Honeyeater	*Lichenostomus fuscus*	1972
Galah	*Eolophus roseicapilla*	2000
Golden Whistler	*Pachycephala pectoralis*	1998
Grey Currawong	*Strepera versicolor*	1992
Grey Fantail	*Rhipidura albiscarpa*	2000
Grey Shrike-thrush	*Colluricincla harmonica*	2000
Hooded Robin	***Melanodryas cucullata cucullata***	**1972**
Horsfield's Bronze-Cuckoo	*Chrysococcyx basalis*	1959
House Sparrow*	*Passer domesticus*	2001
Jacky Winter	*Microeca fascinans*	1959
Laughing Kookaburra	*Dacelo novaeguineae*	2001
Little Button-quail	***Turnix velox***	**1988**
Little Eagle	*Hieraaetus morphnoides*	1993
Little Grassbird	*Megalurus gramineus*	2000
Little Raven	*Corvus mellori*	2001
Long-billed Corella	*Cacatua tenuirostris*	2000
Magpie-lark	*Grallina cyanoleuca*	2000
Masked Lapwing	*Vanellus miles*	2001
Mistletoebird	*Dicaeum hirundinaceum*	1998
Nankeen Kestrel	*Falco cenchroides*	1999
Noisy Friarbird	*Philemon corniculatus*	1959
Northern Mallard*	*Anas platyrhynchos*	2001
Olive-backed Oriole	*Oriolus sagittatus*	1999
Pacific Black Duck	*Anas superciliosa*	2001
Pallid Cuckoo	*Cuculus pallidus*	1958
Peregrine Falcon	*Falco peregrinus*	1959
Rainbow Bee-eater	***Merops ornatus***	**1959**
Red Wattlebird	*Anthochaera carunculata*	2001

Common Name	Scientific Name	Last observed
Red-browed Finch	*Neochmia temporalis*	2000
Red-rumped Parrot	*Psephotus haematonotus*	1999
Regent Honeyeater	***Anthochaera phrygia***	**1965**
Restless Flycatcher	*Myiagra inquieta*	1959
Rufous Whistler	*Pachycephala rufiventris*	2000
Sacred Kingfisher	*Todiramphus sanctus*	2000
Scarlet Robin	*Petroica boodang*	2000
Silvereye	*Zosterops lateralis*	2001
Southern Whiteface	*Aphelocephala leucopsis*	1959
Speckled Warbler	***Chthonicola sagittatus***	**1959**
Striated Pardalote	*Pardalotus striatus*	2000
Striated Thornbill	*Acanthiza lineata*	2000
Sulphur-crested Cockatoo	*Cacatua galerita*	2000
Superb Fairy-wren	*Malurus cyaneus*	2000
Swamp Harrier	*Circus approximans*	2000
Tawny Frogmouth	*Podargus strigoides*	1972
Tree Martin	*Petrochelidon nigricans*	2000
Varied Sittella	*Daphoenositta chrysoptera*	2001
Wedge-tailed Eagle	*Aquila audax*	1959
Weebill	*Smicrornis brevirostris*	1992
Welcome Swallow	*Petrochelidon neoxena*	2000
Whistling Kite	*Haliastur sphenurus*	1959
White-bellied Cuckoo-shrike	*Coracina papuensis*	1972
White-browed Babbler	*Pomatostomus superciliosus*	1959
White-browed Scrubwren	*Sericornis frontalis*	2001
White-faced Heron	*Egretta novaehollandiae*	2000
White-fronted Chat	*Epthianura albifrons*	1959
White-naped Honeyeater	*Melithreptus lunatus*	2001
White-plumed Honeyeater	*Lichenostomus penicillatus*	2000
White-throated Treecreeper	*Cormobates leucophaeus*	2000
White-winged Chough	*Corcorax melanorhamphos*	1998
Willie Wagtail	*Rhipidura leucophrys*	2000
Yellow Thornbill	*Acanthiza nana*	1999
Yellow-faced Honeyeater	*Lichenostomus chrysops*	2001
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	2000
Yellow-tufted Honeyeater	*Lichenostomus melanops*	1959
Fauna- other		
Australian Smelt	*Retropinna semoni*	1994

Common Name	Scientific Name	Last observed
Black Wallaby	*Wallabia bicolor*	1998
Bluenose Cod (Trout Cod)	***Maccullochella macquariensis***	**1994**
Brown Trout*	*Salmo trutta*	1994
Brush-tailed Phascogale	***Phascogale tapoatafa tapoatafa***	**2002**
Common Brushtail Possum	*Trichosurus vulpecula*	1998
Common Froglet	*Crinia signifera*	1998
Common Ringtail Possum	*Pseudocheirus peregrinus*	1991
Eastern Grey Kangaroo	*Macropus giganteus*	1998
European Carp*	*Cyprinus carpio*	1980
European Hare*	*Lepus europeaus*	1998
European Rabbit*	*Oryctolagus cuniculus*	1998
Flat-headed Gudgeon	*Philypnodon grandiceps*	1994
Goldfish*	*Carassius auratus*	1989
Koala	*Phascolarctos cinereus*	1998
Large Forest Bat	*Vespadelus darlingtoni*	1998
Little Forest Bat	*Vespadelus vulturnus*	1998
Macquarie Perch	***Macquaria australasica***	**1994**
Mountain Galaxias	*Galaxias olidus*	1994
Murray Cod	***Maccullochella peelii peelii***	**1930**
Platypus	*Ornithorhynchus anatinus*	2007
Rainbow Trout*	*Oncorhynchus mykiss*	1983
Redfin*	*Perca fluviatilis*	1994
River Blackfish	*Gadopsis marmoratus*	1930
Southern Brown Tree Frog	*Litoria ewingii*	1969
Southern Forest Bat	*Vespadelus regulus*	1998
Tench*	*fam. Cyprinidae gen. Tinca*	1994
Water Rat	*Hydromys chrysogaster*	1991
White-striped Freetail Bat	*Tadarida australis*	1998

Appendix 3 – Criteria and assessment indicators for the Coliban River's ecosystem function

Item	Criteria	Meets criteria	Description for the Coliban River
Criterion 1: The ecosystem function supports the creation and maintenance of vital habitats and populations			
1	**Assessment indicator:** An ecosystem function requires environmental watering to sustain it if it provides vital habitat including:		
	(a) a refugium for native water-dependent biota during dry periods and drought; or	✓	The Millennium Drought highlighted that the deeper pools in the Coliban River were critical for the survival of water dependent species. In particular small bodied native fish (e.g. Australian Smelt), Platypus and Water Rats.
	(b) pathways for the dispersal, migration and movement of native water-dependent biota; or	✓	Platypus are currently in a recovery phase post the Millennium Drought, and the Coliban River is an important source of Platypus for the populations in the Campaspe and Murray rivers (Melody Serena *pers.* comm. [Australian Platypus Conservancy], 2 February 2015).
	(c) a diversity of important feeding, breeding and nursery sites for native water-dependent biota; or	✓	The Coliban River currently exhibits key habitat features (e.g. submerged vegetation) important for small bodied native fish. The river bank habitat is critical for Platypus breeding burrows (Serena, 2015)
	(d) a diversity of aquatic environments including pools, rifle and run environments; or	✓	The Coliban River has a number of small waterfalls and rocky cascades, the natural pool and riffle sequence is evident upstream of Sandy Creek and in some lower sections of the river.
	(e) a vital habitat that is essential for preventing the decline of native water-dependent biota.	✓	The Coliban River and its riparian zone provide habitat for a significant number of threatened flora and fauna species. Providing improved flows is likely to enhance the fish assemblage; increasing flows to inundate key habitat would see abundances increase in wet years and decline in dry years (move to key refuge habitat). The Platypus population is heavily reliant on flows in the Coliban River - in the absence of adequate reproduction and recruitment, population size will decrease.
Criterion 2: The ecosystem function supports the transportation and dilution of nutrients, organic matter and sediment			
2	**Assessment indicator:** An ecosystem function requires environmental watering to sustain it if it provides for the transportation and dilution of nutrients, organic matter and sediment, including:		
	(a) pathways for the dispersal and movement of organic and inorganic sediment, delivery to downstream reaches and to the ocean, and to and from the floodplain; or	✓	The Coliban River is a key tributary to the Campaspe River and ultimately the Murray River dispersing nutrients, organic matter and sediment to the Murray River and its floodplain.
	(b) the dilution of carbon and nutrients from the floodplain to the river systems.	X	

Item	Criteria	Meets criteria	Description for the Coliban River
Criterion 3: The ecosystem function provides connections along a watercourse (longitudinal connections)			
3	**Assessment indicator:** An ecosystem function requires environmental watering to sustain it if it provides connections along a watercourse or to the ocean, including longitudinal connections:		
	(a) for dispersal and re-colonisation of native water-dependent communities; or	✓	Platypus in the Coliban River are an important source of dispersing Platypus population for the Campaspe and Murray rivers
	(b) for migration to fulfil requirements of life history stages; or	X	
	(c) For in-stream primary production.	✓	The Coliban River has an extensive coverage of instream woody habitat and submerged vegetation. Higher flows will flush silt and biofilms from the surface of the wood transporting it downstream to other habitat areas.
Criterion 4: The ecosystem function provides connections across floodplains, adjacent wetlands and billabongs (lateral connections)			
4	**Assessment indicator:** An ecosystem function requires environmental watering to sustain it if it provides connections across floodplains, adjacent wetlands and billabongs, including:		
	(a) lateral connections for foraging, migration and re-colonisation of native water-dependent species and communities; or	✓	There is very limited opportunity for floodplain inundation in the Coliban River catchment; however a number of secondary channels and floodrunners provide additional habitat for foraging when engaged.
	(b) lateral connections for off-stream primary production.	✓	The Coliban River so rarely overbank floods (only naturally occurring), the riparian zone is the principal lateral extent of the river and the principal way that the adjacent land connects to the river, and vice versa. The riparian zone has a relatively intact riparian canopy which is a source of carbon to the river.