Murrumbidgee Junction
Waterway Management Unit
Environmental Water Management Plan

Mallee Catchment Management Authority

mallee
catchment management authority

State Government Victoria
Department of Environment and Primary Industries

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Cover Photograph: Entrance to Murrumbidgee Junction wetlands during high flow event, April 2012. Credit: Rod Robinson

EXECUTIVE SUMMARY

Environmental Water Management Plans have been developed for key sites in the Mallee region by the Mallee Catchment Management Authority in partnership with the Victorian Department of Environment and Primary Industries. These plans are based on Waterway Management Units (WMUs) of the Murray River floodplain and have been developed to guide future environmental water events at these sites.

The Murrumbidgee Junction WMU is on the Victorian floodplain of the Murray River 45 km south-east of Robinvale, near the township of Boundary Bend. It takes in the area covered by the River Murray Park as defined in the VEAC River Red Gum Investigation (VEAC 2008). This plan focuses on a target area within the WMU known as the Narrung Wetlands for environmental watering events and related infrastructure development to inundate an area of 80 ha over three large billabongs.

Environmental values for the Murrumbidgee Junction WMU include a diverse range of water dependent flora and fauna species listed under state, national and international treaties, conventions, Acts and initiatives including the Growling Grass Frog and Carpet Python. Breeding of the nationally listed Regent Parrot has also been recorded in the area. The site contains a number of endangered water dependent Ecological Vegetation Classes and wetlands including Floodplain Grassy Woodland and Riverine Chenopod Woodland. The target area has significant historic and social values for the local community and the local indigenous community has strong connections to the area. The values which are central to the management of the site are the Semi-permanent wetlands, the River Red Gum communities and the Regent Parrot population.

Murrumbidgee Junction Waterway Management Unit management goals:

To provide a watering regime to:

- reinstate and maintain the character of the semi-permanent wetlands
- maintain and improve River Red Gum communities within the target area
- maintain and improve Regent Parrot habitat

To achieve these objectives, a long-term watering regime has been developed.

Minimum watering regime
Inundate the target area four times in ten years with a maximum interval of three years between events. Allow ponding on the floodplain for three months and in the wetlands for four months.

Optimal watering regime
Inundate the target area eight times in ten years with a maximum interval of two years between events. Allow ponding on the floodplain for 5 months and in the wetlands for ten months.

Maximum watering regime
Inundate the target area nine times in ten years with a maximum interval of one year between events. Allow ponding on the floodplain for six months and in the wetlands for twelve months.

The constraints on the current ability to water the Murrumbidgee Junction WMU are the sills which disconnect the wetlands from the river and the normal operating levels of the River Murray which is below the commence to flow requirements of the wetlands. Specifically the inlet level to the creek feeding the wetlands is higher than regulated river levels which reduces the frequency and duration of water entering the billabongs. The proposed infrastructure would retain water in the wetlands through the use of a regulator and earthen block banks to prevent water draining back to the river. Under current conditions the wetlands frequently dry out, while the anticipated inflows or pumping would require 1088 ML to increase the frequency and duration of inundation (Alluvium 2011).

A full Cultural Heritage Management Plan has been prepared and approved for the proposed infrastructure to enable environmental watering and detailed designs for the proposed works have been completed. Funding is available to commence construction.

TABLE OF CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

ACKNOWLEDGEMENTS

The Mallee Catchment Management Authority acknowledges the Victorian State Government for funding the development of the environmental watering plans. They also acknowledge the contribution to the development of the plans by Parks Victoria, Jane Roberts, Terry Hillman, other agencies and community members.

ABBREVIATIONS AND ACRONYMS

ANCA	Australian Nature Conservation Agency
AVIRA	Aquatic Value Identification and Risk Assessment
CAMBA	China-Australia Migratory Bird Agreement
CMAs	Catchment Management Authorities
DEH	Department of Environment and Heritage
DEPI	Department of Environment and Primary Industries
DNRE	Department of Natural Resources and Environment
DSE	Department of Sustainability and Environment
EA	Ecological Associates
EPBC	Environment Protection and Biodiversity Conservation Act
EVC	Ecological Vegetation Class
EWaMP	Environmental Water Management Plan
EWH	Environmental Water Holder
EWR	Environmental Water Reserve
FFG	Flora Fauna Guarantee Act
FSL	Full Supply Level
G-MW	Goulburn-Murray Water
JAMBA	Japan-Australia Migratory Bird Agreement
MCMA	Mallee Catchment Management Authority
MDBA	Murray-Darling Basin Authority (formally Murray-Darling Basin Commission, MDBC)
Ramsar	Global treaty adopted in the Iranian city of Ramsar in 1971 that focuses on the conservation of internationally important wetlands
ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement
RRG	River Red Gum
TLM	The Living Murray Initiative
TSL	Targeted Supply Level
VEAC	Victorian Environmental Assessment Council
VEWH	Victorian Environmental Water Holder
VWMS	Victorian Waterway Management Strategy
WMU	Waterway Management Unit

1. INTRODUCTION

1.1. Background

Environmental water management in Victoria is entering a new phase as ongoing water recovery sees significant volumes of water being returned to the environment. The increasing environmental water availability is providing new opportunities to protect, restore and reinstate high value ecosystems throughout northern Victoria. The spatial coverage of environmental watering has expanded considerably in recent years and this trend will continue into the future.

Environmental watering in Victoria has historically been supported by management plans which document key information such as the watering requirements of a site, predicted ecological responses and water delivery arrangements. State and Commonwealth environmental watering programs now have the potential to extend beyond those sites which have been watered in the past. Therefore, new plans are required to provide a transparent and informed approach to environmental water delivery across new environmental watering sites.

1.2. Purpose

The Victorian Catchment Management Authorities (CMAs) and Department of Environment and Primary Industries (DEPI) are working together to develop new Environmental Water Management Plans for both current and future environmental watering sites throughout northern Victoria. The primary purpose of the plans is to provide a consistent set of documents that support the Seasonal Watering Proposals to be submitted by CMAs to the Victorian Environmental Water Holder (VEWH) each year. The supporting information includes:

- water dependent environmental, social and economic values;
- water dependent environmental condition, threats and objectives;
- long-term water regime requirements to meet environmental objectives, under a range of climatic conditions;
- environmental watering management responsibilities;
- recent records of water delivery;
- opportunities for improved efficiency or capacity through structural works or other measures; and
- scientific knowledge gaps and recommendations for future work.

1.3. Site location

The Mallee CMA is situated in the north-west of Victoria. The area of responsibility is close to 39,000 km^2 (3.9 million ha), with a regional population estimated to be 65,000. Population centres include Mildura, Birchip, Sea Lake, Ouyen, Robinvale, Red Cliffs and Merbein.

The boundaries of the Mallee CMA region cover almost one fifth of Victoria, making it the largest area managed by a Catchment Management Authority in the state.

Approximately 40% of the land area within the Mallee CMA boundary is public land, consisting mainly of National Parks, reserves, wilderness areas and large tracts of riverine and dryland forests. The other 60% is predominantly dryland cropping by area, but there is also a significant investment in irrigation of grapes, citrus, almonds, olives, and vegetables along the Murray River corridor which contributes over 40% of the value of agricultural

production for the region.

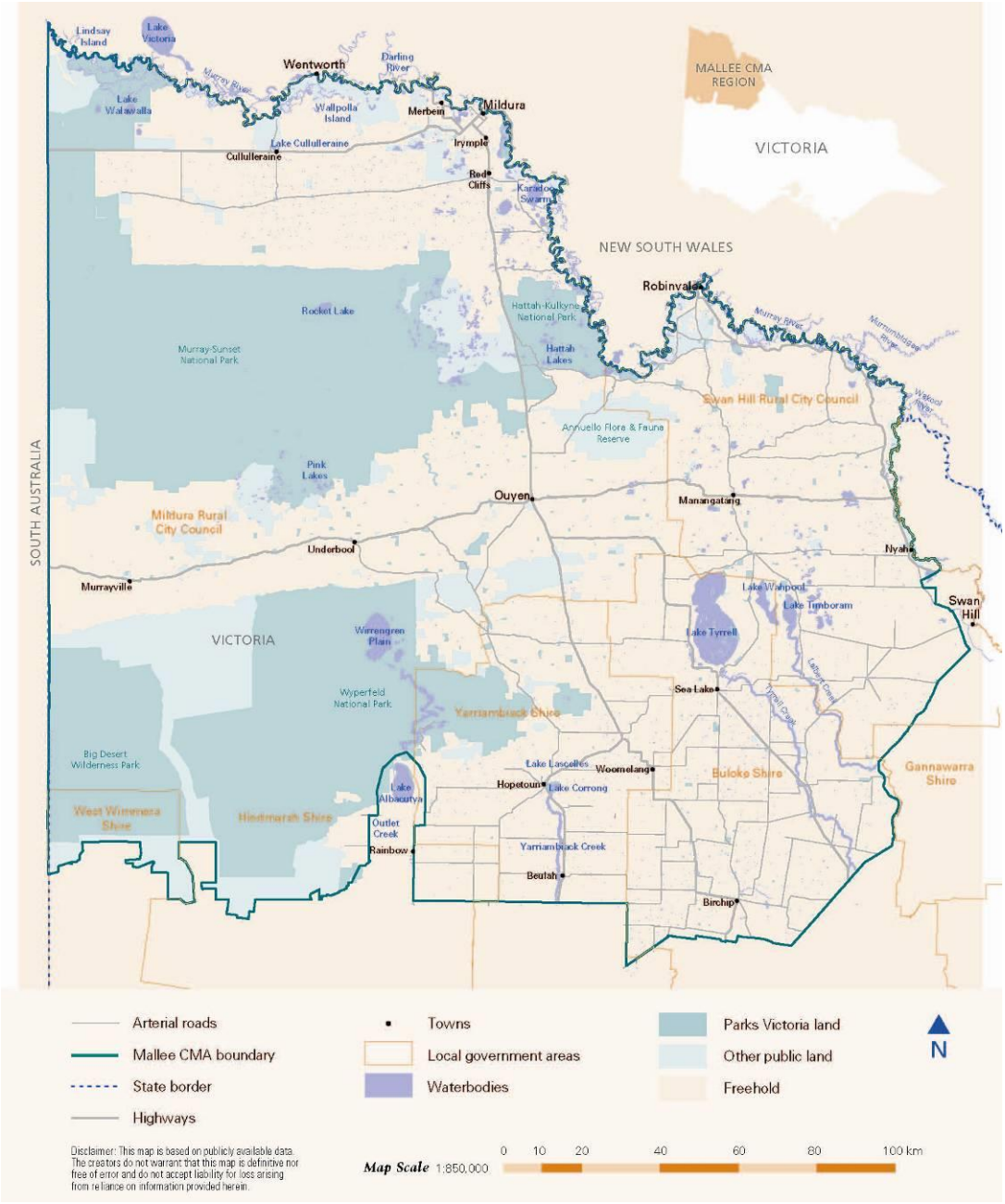

Figure 1 Map of the CMA region

In 2006 the Mallee CMA engaged consultants, Ecological Associates, to investigate water management options for the Murray River floodplain from Robinvale to Wallpolla Island. One of the major outcomes of these investigations (EA, 2006) was the development of a system of Waterway Management Units (WMUs). These divide the floodplain into management units which are areas in which water regimes can be managed independently of another WMU but which are relatively consistent in their ecological values and land uses. The Mallee CMA has based its environmental water management plans on these WMUs to achieve more effective management of hydrologically connected systems. The site for this plan is the Murrumbidgee Junction WMU situated 45 km south-east of Robinvale on the Murray River floodplain (see Figure 2, p9).

1.4. Consultation

This Plan was developed in collaboration with key stakeholders namely Parks Victoria, the Robinvale Claimant Group, Tati Tati community, Latji Latji community, the Department of Environment and Primary Industries and local interest groups.

Table 1 Consultation Process for development of Murrumbidgee Junction WMU Plan

Meeting Date	Stakeholders	Details
12 May 2011	Robinvale Claimant Group Tati Tati representatives (Latji Latji were unable to attend)	Discussion of the proposal and the process of developing a CHMP
7 Jun 2011	Robinvale Claimant Group Tati Tati representatives Parks Victoria	Site visit, including design consultants and geotechnical testers to discuss the proposed works.
9 Aug 2011	Boundary Bend Community	Overview of environmental plans for the area
25 Aug 2011	Mallee CMA Technical Advisory Committee	Update on EWaMP plans
15 Dec 2011	Latji Latji Robinvale Aboriginal Community	Site visit to discuss management recommendations for the CHMP

1.5. Information sources

Information used in the development of this Plan was compiled from various sources (References, Section 10) including river health and catchment strategies, consultant reports and wetland and park management plans. A number of state-wide data sets and digital mapping layers were used including the:

- Flora Information System of Victoria;
- Atlas of Victorian Wildlife;
- Bioregional Conservation Status of Ecological Vegetation Classes;
- Wetland Environments and Extent up to 1994; and
- Aerial photography
- Digital Elevation and LiDAR modelling

This information was supplemented by discussions with people with an intimate knowledge of the study area, its environmental values and the management and operation of the Narrung wetlands within the Murrumbidgee Junction Waterway management unit.

1.6. Limitations

The information sources used in the development of this report have a number of limitations. These limitations include that the data contained in the Flora Information System and the Atlas of Victorian Wildlife comes from a combination of incidental records and systematic surveys. The data varies in accuracy and reliability due to the distribution and intensity of survey efforts. In addition, the lack of knowledge about the distribution and characteristics of invertebrates and non-vascular plant species means the data is weighted towards the less cryptic elements of flora and fauna, i.e. vascular flora and vertebrates. This report also draws on material collated from management plans, research documents and published literature. These sources vary in their age and hence the degree to which

they reflect the current situation. However, the Plan is intended to be a live document and will be amended as new information becomes available.

2. SITE OVERVIEW

2.1 Catchment setting

The Murrumbidgee Junction Waterway Management Unit is located 45 km south-east of Robinvale in the Victorian floodplain of the Murray River. It is within the Murray Fans bioregion within the Mallee CMA region. The Murray Fans bioregion is characterised by a flat to gently undulating landscape on recent unconsolidated sediments with evidence of former stream channels, old river meanders and palaeochannels and broad floodplain areas associated with major river systems and prior steams (known as braided / anastomosing streams). Alluvium deposits from the Cainozoic period gave rise to the red brown earths and texture contrast soils (Dermosols, Kurosols, Chromosols and Sodosols). (DSE website bioregions description).

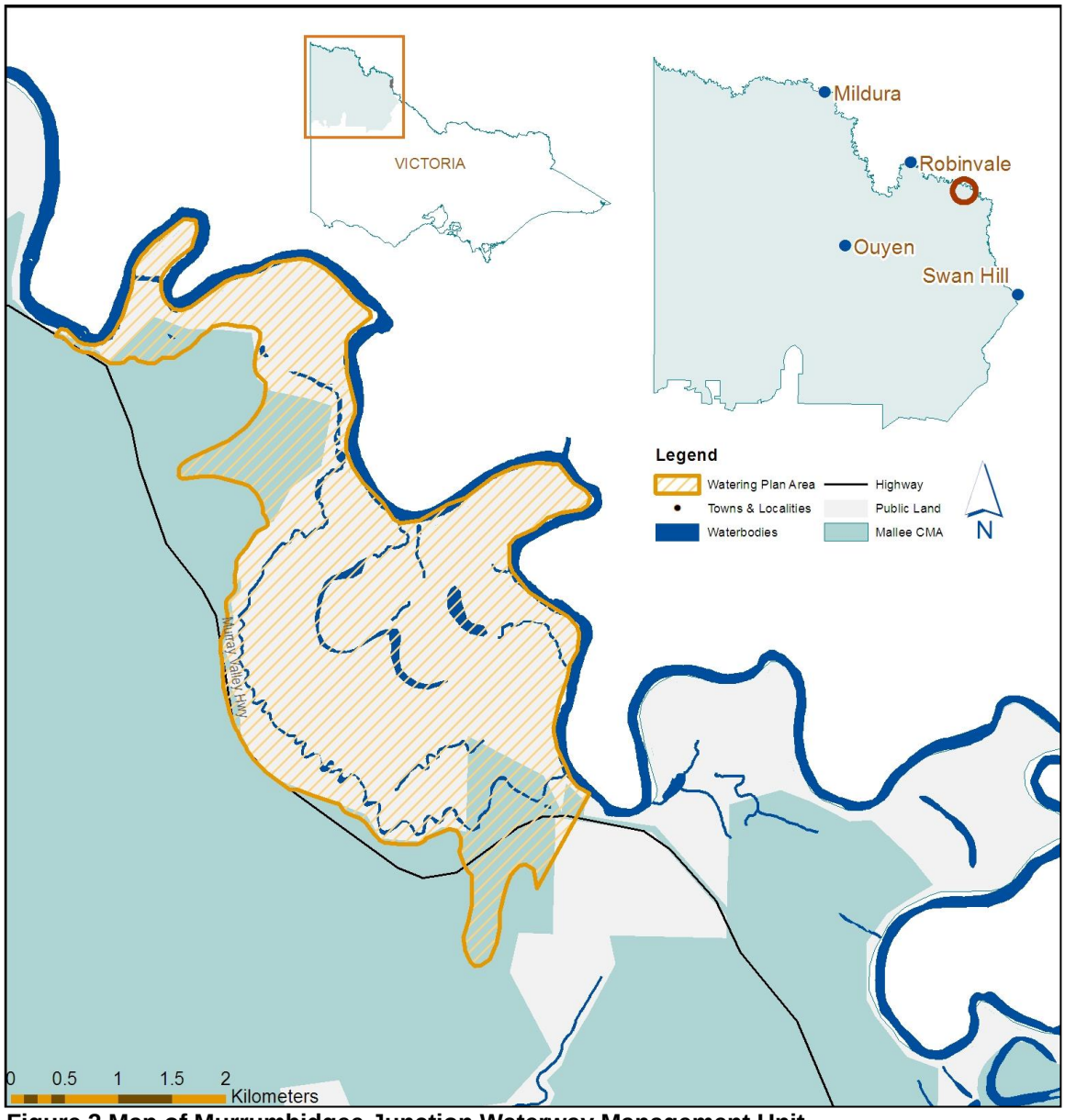

Figure 2 Map of Murrumbidgee Junction Waterway Management Unit

The Waterway Management Unit boundary indicates the area for which water regimes can be managed largely independently of each other. The whole WMU has a water requirement as a floodplain complex but the focus for this plan is restricted to a target area within the WMU of 80 ha, as shown in Figure 3. This target area is the extent to which environmental water is able to be managed with proposed infrastructure in place. Constraints and proposed infrastructure are discussed fully in Sections 4 and 8. Expansion of the target area is possible only with significant alterations to River Murray operations such as large releases from storage which is beyond the scope of this plan but is being addressed at a Basin scale.

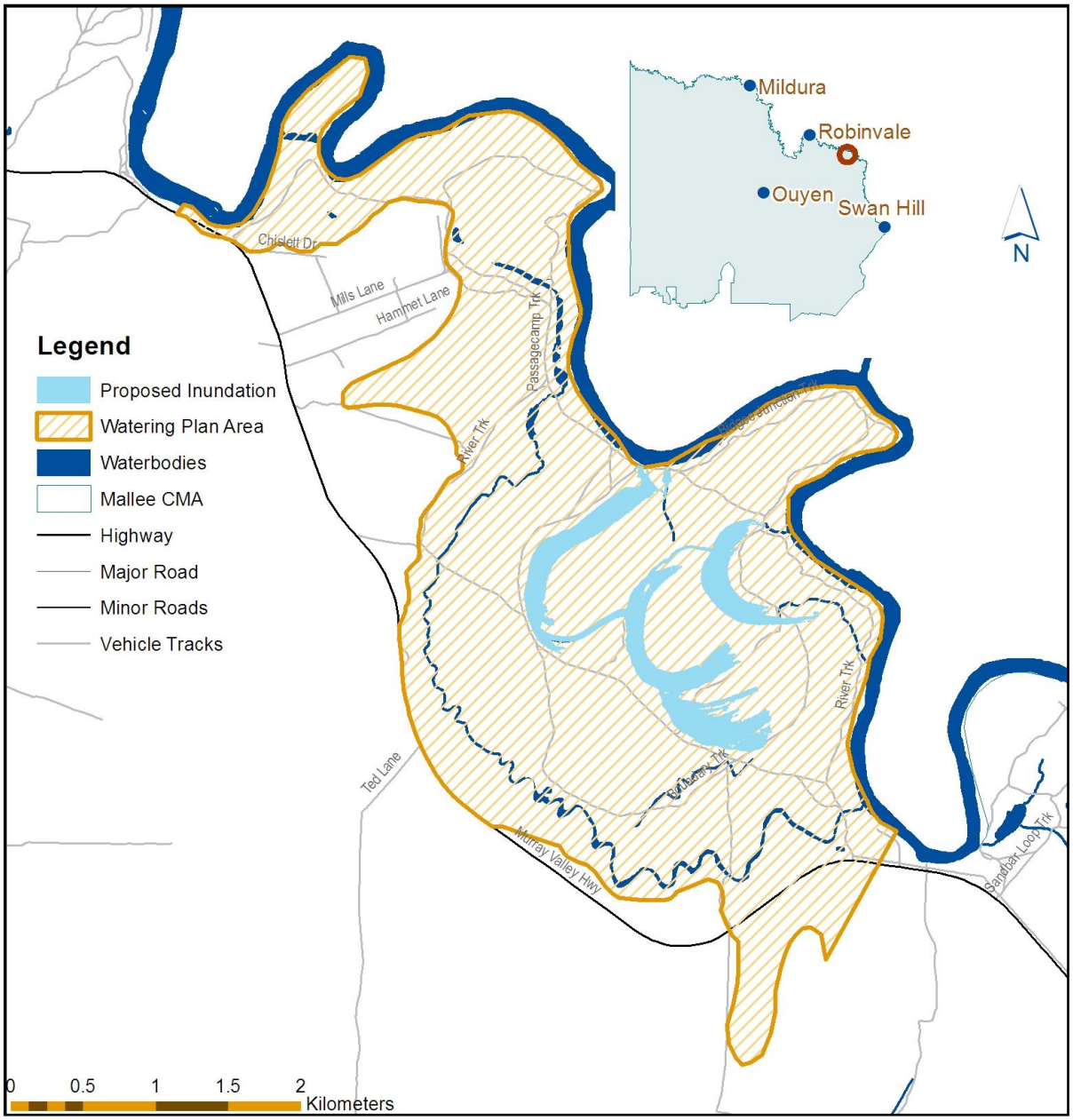

Figure 3 Target area showing achievable inundation extent of Murrumbidgee Junction WMU

2.2 Land status and management

The Murrumbidgee Junction WMU area has historically been managed by the Department Environment and Primary Industries as State Forest (Murrumbidgee State Forest) as part of the Murray River Reserve under the Land Conservation Council Final Recommendations (LCC, 1989). In recommendations from the Victorian Environmental Assessment Council River Red Gum Forests Investigation (VEAC 2008, p 67) the area has been declared a Regional Park with Parks Victoria as the land manager. This recommendation came into effect in July 2010.

Table 2 Stakeholders for the Murrumbidgee Junction WMU

Group	Role
Parks Victoria	Land Manager
Mallee CMA	Regional environmental management
Department of Environment and Primary Industries	State level environmental management
Goulburn Murray Water	River Murray operations
Murray-Darling Basin Authority	River Murray operations
Swan Hill Rural City Council	Local Government
Robinvale Claimant Group, Tati Tati and Latji Latji representatives	Indigenous Representation
Boundary bend Progress Association	Assistance in planning and implementation of programs

2.3 Wetland characteristics

A brief overview of the main characteristics of the target area within the WMU is given in Table 3.

Table 3 Summary of target area characteristics

Characteristics	Description
Name	Murrumbidgee Junction Waterway Management Unit target area
Wetland mapping ID within area (DEPI wetland layer 1994)	Includes 3 registered wetlands: #7528 9534, #7528 15527, #7528 21532
Target Area	80ha
Bioregion	Murray Fans
Conservation status	Bioregional Conservation Status: areas of EVC listed as endangered, vulnerable, depleted and least concern.
Land status	Regional Park
Land manager	Parks Victoria
Surrounding land use	Regional Park
Water supply	Natural inflows from the River Murray when the river level is above 53mAHD and the water level in the wetlands is below this level. This is the equivalent discharge of more than 30,000ML/day in the River Murray. Environmental water was pumped from the river in 2005.
1788 wetland category	Deep Freshwater Marsh (3)
1994 wetland category and sub-category	Deep Marsh, open water (3)
Wetland Water Regime Class	Semi-permanent wetland
Wetland depth at capacity	2.2m

2.4 Environmental water

The Environmental Water Reserve (EWR) is the legally recognised amount of water set aside to meet environmental needs. The Reserve can include minimum river flows, unregulated flows and specific environmental entitlements. Environmental entitlements can be called out of storage when needed and delivered to wetlands or streams to protect their environmental values and health.

The Victorian Minister for Environment and Climate Change has appointed Commissioners to Victoria's first independent body for holding and managing environmental water, The Victorian Environmental Water Holder (VEWH). They will be responsible for holding and managing Victoria's environmental water entitlements, and making decisions on their use.

Environmental Water for the study site may be sourced from the water entitlements and their agencies listed in Table 4 and further explained in Appendix 1.

Table 4 Summary of environmental water sources available to Murrumbidgee Junction WMU

Water Entitlement	Responsible Agency
River Murray Unregulated Flows	Murray Darling Basin Authority
Murray River Surplus Flows	
Victorian River Murray Flora and Fauna Bulk Entitlement	Department of Environment and Primary Industries
Commonwealth water	Commonwealth Environmental water Holder
Donated Water	Mallee CMA

Other sources of water may become available through water trading or changes in water entitlements.

2.5 Legislative Policy Framework

There is a range of international treaties, conventions and initiatives, as well as National and State Acts, policies and strategies that determine management of the target area. Table 5 includes key legislation relevant to the listed flora and fauna and Ecological Vegetation Classes found within the site. For the functions and major elements of each refer to Appendix 2.

Table 5 Legislation, agreements, convention and listings relevant to the target area

Legislation, Agreement or Convention	Jurisdiction
CAMBA	International
JAMBA	International
EPBC	National
FFG	State
DEPI advisory lists	State

2.6 Related Plans and Activities

The Murrumbidgee Junction WMU is situated on the Victorian floodplain of the Murray River which has been included in large scale investigations. These include Salinity Management Plans, Flow studies and Land Conservation Council Reviews. There have also been local investigations. The 2006 investigation by Ecological Associates into water management

options for the Murray River floodplain from Nyah to Robinvale proposed infrastructure upgrades to enable more frequent inundation of the target area in the Murrumbidgee Junction WMU which is outlined as part of this plan.

The Murrumbidgee Junction WMU is within the area covered by the Nyah to Robinvale Mallee CMA Frontage Action Plan (MCMA 2003) and has the potential to attract future funding and works through that project.

The Department of Environment and Primary Industries (DEPI), Parks Victoria and the Mallee CMA have invested significant resources into the area in recent years in both environmental watering in 2005 and complementary on ground works such as track upgrading, pest plant and animal control, and improved signage to decrease recreational pressures on the floodplain.

A Cultural Heritage Management Plan (Bell 2012) was developed and approved by Aboriginal Affairs Victoria for the regulating structures, sandbag levees and access tracks at the Narrung wetlands target area within the Murrumbidgee Junction WMU.

A detailed design report (Alluvium 2011) for the water management option has been developed as well a drawings and cost estimates for the structures.

3. WATER DEPENDENT VALUES

3.1 Environmental

Wetlands and waterways on the floodplain are a vital component of the landscape which support a vast array of flora and fauna which may vary greatly with the type of wetland/waterway system. The habitat provided by vegetation communities around wetlands is essential for maintaining populations of water dependent fauna species. Other ecological functions provided by floodplain complexes include water filtration, slowing surface water flow to reduce soil erosion, flood mitigation and reducing nutrient input into waterways. Protecting the ecological functioning of wetlands ensures these vital services are maintained.

3.1.1 Wetland depletion and rarity

Victoria's wetlands are currently mapped and are contained within a state wetland database, using an accepted state-wide wetland classification system, developed by Andrew Corrick from the Arthur Rylah Institute. Mapping was undertaken from 1981 using 1:25,000 colour aerial photographs, along with field checking. This database is commonly known as the 1994 wetland layer and contains the following information:

- categories (primary) based on water regime and
- subcategories based on dominant vegetation

None of the post-1994 wetland mapping is contained within this State wetland database.

At the same time, an attempt was made to categorise and map wetland areas occupied prior to European settlement. This was largely interpretive work and uses only the primary category, based on water regime. This is known as the 1788 layer.

It has been possible to determine the depletion of wetland types across the state using the primary category only, based on a comparison of wetland extent between the 1788 and 1994 wetland layers.

Comparison between the wetland layers has demonstrated the impact of European settlement and development on Victorian wetlands. This has been severe, with approximately one-third of the state's wetlands being lost since European settlement; many of those remaining are threatened by continuing degradation from salinity, drainage and agricultural practices (ANCA 1996).

Across the state, the greatest decreases in original wetland area have been in the freshwater meadow (43 per cent decrease), shallow freshwater marsh (60 per cent decrease) and deep freshwater marsh (70 per cent decrease) categories (DNRE 1997).

The Murrumbidgee Junction WMU target area contains three wetlands of approximately 7ha each in size (EA 2006). They have all been classified using the Corrick-Norman wetland classification system as Deep Freshwater Marsh (Table 9 and Figure 6). Deep Freshwater Marshes are the most depleted (70% change) wetland in Victoria based on a comparison of the geospatial wetland layers (1788 and 1994). In the Mallee CMA region they are the second most depleted (-45% change) and in the Murray Fans Bioregion the third most depleted (-6% change).This makes them significant in terms of representativeness. The target area of inundation will occupy an area of 80 ha within the Murrumbidgee Junciton WMU which has a total area of 1230 ha.

Table 6 Changes in area of the wetlands in the target area by Corrick classification

Category	No of Wetlands in target area	Area of wetlands (ha)	Total inundation area (ha)	Decrease in wetland area from 1788 to 1994		
				% Change in area in Victoria	% Change in area In Mallee CMA	% Change in Murray Scroll Belt
Deep Freshwater Marsh	3	21	80	-70	-45	-6

Source: DEPI Biodiversity interactive maps, Mallee Wetland Strategy

Several wetland classification systems exist and some of these are more relevant to the Mallee region (MCMA 2012). Ecological Associates (2007) proposed four categories, or Wetland Water Regime Classes, based on the residency time of water in the wetlands under natural conditions. These include:

- Semi-permanent Wetlands
- Persistent Temporary Wetlands
- Temporary Wetlands
- Episodic Wetlands

Immense detail and hydrological modeling was involved in the development of these Water Regime Classes. Although that level of detail and information is beyond the scope of this report, existing knowledge such as commence to flow rates for these wetlands, flow data for this reach of the Murray River (natural and current) and local knowledge has been used to classify the wetlands within the target area as Semi-permanent Wetlands.

The target area within the Murrumbidgee Junction WMU consists of three deep semi-permanent billabongs known collectively as the Narrung Wetlands and some surrounding floodplain area. Semi-permanent wetlands very rarely dry out and should ideally be full or close to full. Drying may occur under drought conditions and this can lead to colonisation of the wetland bed by terrestrial species. Water levels usually fall in summer and autumn and fill in winter. Drops in water level during summer and autumn allow exposure of fringing macrophytes which can be excluded by persistent flooding. Flooding should overtop the wetland level and reach the understorey of Red Gum woodlands encouraging growth of emergent macrophyte species. These wetlands provide semi-permanent habitat for a diverse range of waterbirds and are the primary habitat for Egrets and deep-water foraging ducks such as the Hardhead and Musk Duck (EA 2007a).

3.1.2 Listings and significance

Fauna

The Narrung wetlands provide habitat for a large range of fauna. Native species recorded in the WMU are listed in Appendix 3. This list includes a range of water dependent species which will benefit from the wetlands in the target area receiving water on a more regular basis. Of special interest and responsibility are the water dependent species listed in legislation, agreements or conventions. These are summarised in Table 6.

Table 7 Listed fauna recorded in the Murrumbidgee WMU

Common name	Scientific name	Type	International agreements	EPBC status	FFG status	DEPI status
Australasian Shoveler	*Anas rhynchotis*	B				VU
Eastern Great Egret	*Ardea modesta*	B	CAMBA & JAMBA		L	VU
Hardhead	*Aythya australis*	B				VU
Musk Duck	*Biziura lobata*	B				VU
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	B	CAMBA		L	VU
Regent Parrot*	*Polytelis anthopeplus monarchiodes*	B		VU	L	VU
Carpet Python*	*Morelia spilota metcalfei*	R			L	EN
Growling Grass Frog	*Litoria raniformis*	A		VU	L	EN
Royal Spoonbill	*Platalea regia*	B				VU

Legend
Type: Invertebrate, Fish, Amphibian, Reptile, Bird, Mammal
EPBC status: EXtinct, CRitically endangered, ENdangered, VUlnerable, Conservation Dependent, Not Listed

FFG status: Listed as threatened, Nominated, Delisted, Never Listed, Ineligible for listing
DEPI status: presumed EXtinct, Regionally Extinct, Extinct in the Wild, CRitically endangered, ENdangered, Vulnerable, Rare, Near Threatened, Data Deficient, Poorly Known, Not Listed

*Species are included as water dependent due to habitat requirements.

The species listed in Table 6 include species that forage or nest in or on water or require flooding to trigger breeding and fledging which makes them water-dependent in some respect. The list also includes two species, Regent Parrot and Carpet Python that are indirectly dependent on water, i.e. they require riparian trees, vigorous ground cover and fallen timber.

The eastern Regent Parrot, *Polytelis anthopeplus monarchiodes,*is listed as nationally vulnerable under the EPBC Act, with estimates of only 2,900 birds left in the wild. This species breeds almost exclusively in River Red Gum, *Eucalyptus camaldulensis*, forest and woodland, typically in large, older and healthy hollow-bearing trees close to water. They mostly feed in large blocks of intact mallee woodlands usually within 5-10km (maximum 20km) of nest sites, but also consume flower buds of River Red Gum and Black Box, *Eucalyptus largiflorens*. Eastern Regent Parrots are reluctant to fly through open areas and require corridors of vegetation between nesting and foraging sites.

Regent Parrot breeding is known to occur along the lower Murrumbidgee River floodplains in NSW and a Victorian nest site has been identified within the Murrumbidgee WMU. An essential flight path linking nesting sites on the lower Murrumbidgee River (NSW) and an unknown foraging site within Victoria also passes through the WMU (Webster 2005). Identification of such strategic flyways and preservation and enhancement of their vegetative features are specific objectives of the Regent Parrot Recovery Plan (Baker-Gabb & Hurley 2011).

A decrease in health and death of River Red Gums along the River Murray as a result of current water regimes, as well as drought, have contributed to the decline of the Regent Parrot. Smith (2004, cited in Baker- Gabb & Hurley 2011, p. 10) states that River Red Gum forests and woodlands in the Regent Parrots known distribution are under duress and many nest trees are likely to die due to reduced flooding, drought and prolonged inundation. The inclusion of the Regent Parrot habitat in environmental watering programs, especially known and potential breeding habitat and essential flyways, is a key action listed in the Recovery Plan for this species (Baker-Gabb & Hurley 2011).

The listed White-bellied Sea-Eagle, *Haliaeetus leucogaster*, is considered to be rare in Victoria and has been recorded within the target area. Marchant & Higgins (1993, cited in

DSEWPC 2013) state that this species is known to breed around the Murray and Murrumbidgee Rivers. White-bellied Sea-Eagles construct nests close to water in the upper branches of trees, typically River Red Gum in the Mallee region. Breeding occurs roughly between April and October (MCMA 2010). They forage over water for fish and also prey on mammals, reptiles and birds (EA 2007a). Reduced flooding has led to a decline in the availability of River Red Gum nest sites and reduced aquatic prey for the White-bellied Sea-Eagle (EA 2007a).

The state listed Inland Carpet Python, *Morelia spilota metcalfei,* has been recorded within this WMU. This rare species inhabits River Red Gum and Black Box woodlands along watercourses. The hollows which occur in both these Eucalypt species are utilised by Carpet Pythons for shelter and for ambush of other hollow-using prey species such as birds and small to medium sized mammals. Hollows in fallen logs are also used by female Carpet Pythons for incubation of eggs. Habitat degradation and loss of hollow-bearing trees as a result of altered flood regimes in riverine areas are a key threatening process to this species. When determining areas where flooding is to be promoted through environmental watering, the presence of the Carpet Python and its potential habitat should be a significant consideration (DSE 2003).

Open water wetlands have the potential to support native fish populations (EA 2006) and native species such as Flat-headed Gudgeon and Dwarf Flat-headed Gudgeon have been recorded within the target area. These wetlands frequently dry out due to river regulation (Alluvium 2011). Primary productivity of wetlands increases on re-inundation after a dry phase as terrestrial plants that have colonised the wetland bed under dry conditions now provide nutrients and habitat for aquatic fauna (Ellis & Pike 2011). At Margooya Lagoon a managed dry phase was initiated after the wetland had been permanently inundated for almost 50 years. Re-inundation of this wetland through environmental watering was timed to coincide with spawning of native fish species in the Murray River close to the Lagoon inlet. This resulted in eggs and larvae of Golden perch and Silver perch being transported into the wetland through the pumps (Ellis & Pike 2011a). Ellis (2010, cited in Ellis & Pyke 2011, p.14) found that both species displayed rapid growth which was attributed to the productive nursery habitat provided by flooding the wetland after a dry phase. Although fish are not a direct objective of this management plan, it is expected that environmental watering at Narrung wetlands may facilitate an increase in suitable fish habitat and recruitment of native species.

There is one record of the Commonwealth listed Growling Grass Frog, *Litoria raniformis,* within the Murrumbidgee Junction WMU. This species is usually found in seasonally flooded wetlands with complex aquatic vegetation communities and relies on drought refuges to survive dry periods. The Growling Grass Frog is particularly sensitive to changes in wetland hydrology and prefers annual flooding and long periods of inundation (five to seven months) due to a long larval phase. This frog requires flooding in spring/summer for successful recruitment as this is when it is active and breeding takes place. It can be excluded from wetlands under reduced flood frequency (Rogers & Ralph 2011). As there is only one record of the Growling Grass Frog within the Murrumbidgee WMU the site will not be managed specifically for this species. However, it is expected that over-riding management objectives will benefit this and other frog species.

Fauna of floodplain wetland habitat show adaptations that improve performance in response to flooding. The most prominent response of many of these species is reproduction (Rogers & Ralph 2011). In order to provide breeding opportunities, habitat elements within the WMU such as temporary wetlands and River Red Gum communities, which also rely on flooding, must be maintained in good condition.

Vegetation communities

Within the target area of the Murrumbidgee Junction WMU, the most extensive EVCs are Floodplain Grassy Wetland, Shallow Freshwater Marsh, Shrubby Riverine Woodland and Floodway Pond Herbland. Floodplain Grassy Wetland and Riverine Chenopod Woodland are both endangered EVCs. River Red Gums dominate most of the EVC's in the target area and occur in the two endangered EVC's.

Floodplain Grassy Wetland occurs on the most flood-prone areas of the floodplain and covers a significant portion of the target inundation area. This endangered EVC is dominated by aquatic grasses which persist as turf during dry phases. On re-flooding these grasses provide habitat and nutrients for aquatic fauna. Trees are typically absent but thickets of River Red Gum saplings or scattered mature trees may occur (DSE 2009). This EVC prefers flooding every 7-10 years in a ten year period for a duration of 3-9 months (VEAC 2008).

Riverine Chenopod Woodland is a eucalypt woodland that occurs on elevated riverine terraces. This endangered EVC is dominated by Black Box trees and Lignum shrubs with a grassy understorey (DSE 2009). Under natural conditions this habitat would have experienced irregular shallow flooding of 1 in 10-25 years with ponding of 1-3 months (VEAC 2008).

The Narrung wetlands support various woodland EVC's (Table 7), some of declining health. Where wetlands and woodlands are combined in close proximity, conservation significance is high. Woodlands provide habitat and grazing opportunities for fish through snags and debris deposited in the water. They also provide important refuges for birds, reptiles and mammals, such as perches and nesting hollows. When flooded, the woodland floor becomes an extension of the wetland habitat, thereby extending food and shelter opportunities for aquatic fauna (EA 2006). Ecological Associates (2007b) state that under a more frequent flood regime the mature Red Gum woodlands in the Murrumbidgee WMU target area would support an understorey of aquatic macrophytes, providing habitat and feeding grounds for aquatic fauna.

For a full list of EVCs within the entire WMU and details on each see Appendix 4. The EVCs within the target area and their conservation status can be seen in Figure 4, and Table 7.

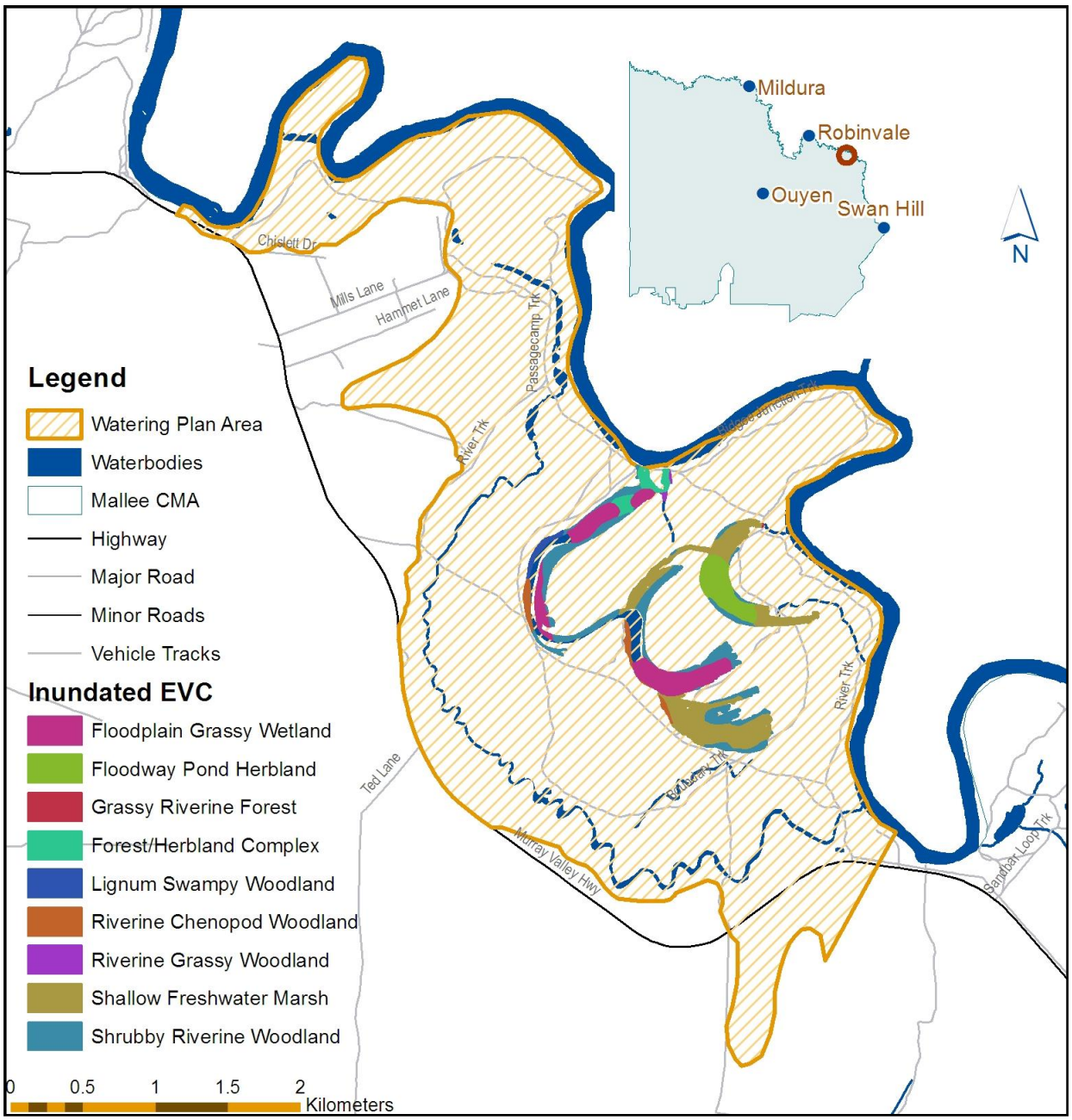

Figure 4 EVCs within the target area of the Murrumbidgee Junction WMU

Table 8 Conservation status of water dependent EVCs in the target area of the Murrumbidgee Junction WMU

EVC no.	EVC name	Bioregional Conservation Status
		Murray Fans Bioregion
809	Floodplain Grassy Wetland	Endangered
810	Floodway Pond Herbland	Depleted
106	Grassy Riverine Forest	Depleted
811	Forest/Herbland Complex	Depleted
823	Lignum Swampy Woodland	Vulnerable
103	Riverine Chenopod Woodland	Endangered
295	Riverine Grassy Woodland	Vulnerable
200	Shallow Freshwater Marsh	Vulnerable
818	Shrubby Riverine Woodland	Least Concern

Flora species

A full list of flora recorded at the Murrumbidgee Junction site can be found in Appendix 3. Water dependent flora species listed in the various acts and agreements which have been recorded in a 10km search radius of the Murrumbidgee Junction WMU are listed in Table 8.

Table 9 Listed water dependent flora species recorded within 10km radius of the site

Common name	Scientific name	EPBC status	FFG status	DEPI status
Jerry-jerry	*Ammannia multiflora*	NL	NL	V
Riverina Bitter-cress	*Cardamine moirensis*	NL	NL	R
Cotton Sneezeweed	*Centipeda nidiformis*	NL	NL	R
Hoary Scurf-pea	*Cullen cinereum*	NL	L	E
Winged Peppercress	*Lepidium monoplocoides*	EN	L	E
Dwarf Swainson-pea	*Swainsona phacoides*	NL	L	E
Coral Saltbush*	*Atriplex papillata*	NL	NL	R
Western Bitter-cress*	*Cardamine lineariloba*	NL	NL	V
Bush Minuria*	*Minuria cunninghamii*	NL	NL	R
Twiggy Sida*	*Sida intricata*	NL	NL	V

EPBC status: EXtinct, CRitically endangered, ENdangered, VUlnerable, Conservation Dependent, Not Listed
FFG status: Listed as threatened, Nominated, Delisted, Never Listed, Ineligible for listing
DEPI status: presumed EXtinct, Regionally Extinct, Extinct in the Wild, CRitically endangered, ENdangered, Vulnerable, Rare, Near Threatened, Data Deficient, Poorly Known, Not Listed
*Found around lakes and watercourses, and could potentially be found around wetlands.

River Red Gums are the most widespread eucalypt tree in Australia, occupying riparian habitats along water courses and wetlands (Roberts & Marston 2011). They provide extensive habitat for a range of fauna such as the listed Carpet Python, White-bellied Sea-Eagle and the Regent Parrot which almost exclusively use this tree species for nesting. River Red Gum flower buds are also a food source for the Regent Parrot. However, trees in poor condition have little contribution to the function and productivity of the ecosystem and the quality of woodland habitat is greatly reduced (Roberts & Marston 2011). River Red Gums also deposit organic woody debris to wetlands which provide structural habitat features for wetland fauna such as perching sites for waterbirds and snags for fish (EA 2006).

Black Box Woodlands occur in the less frequently flooded areas of the floodplain. They provide essential habitat and foraging opportunities for a range of species including mammals and reptiles and support a high proportion of ground foraging and hollow-nesting birds. Regent Parrots have been recorded using hollows in Black Box for breeding (Baker-Gabb & Hurley 2011). Black Box Woodlands are particularly important to the endangered Carpet Python which utilise hollows, fallen logs and leaf litter for shelter and to find prey. These woodlands are also an important connection to surrounding Mallee landscape, allowing movement of fauna between these landscapes (EA 2007a). This is particularly significant for Regent Parrots within the Murrumbidgee WMU. Black Box can tolerate a range of conditions from wet to dry and saline to fresh (Roberts & Marston 2011). However, under extended periods of dry conditions trees will suffer a decline in health and, eventually, death (EA 2007a). Although targeting Black Box communities is not a direct objective of this plan it is likely that they will benefit from the proposed watering regime through lateral movement of water through the soil profile and continue to provide essential habitat function for fauna species within the WMU.

Murrumbidgee Junction State Forest has particular significance as it is the northern-most occurrence of Grey Box, *Eucalyptus microcarpa,* in Victoria (McKane 1992). Although this species occurs on higher terraces that are not inundated by flooding (EA 2006), it is expected that trees will benefit from the lateral movement of water through the soil profile.

Five of the water dependent EVCs in which the listed species are noted as being typical

have River Red Gum as the dominant species. This gives an indication of the importance of maintaining these EVCs through an environmental water program to maintain and improve the health of the River Red Gums. However, flood frequency in River Red Gum determines understorey composition (Roberts and Marston 2011). Any proposed watering program must also consider the possible effects on other listed species and EVC's as well as the wide range of water dependent flora in the target area.

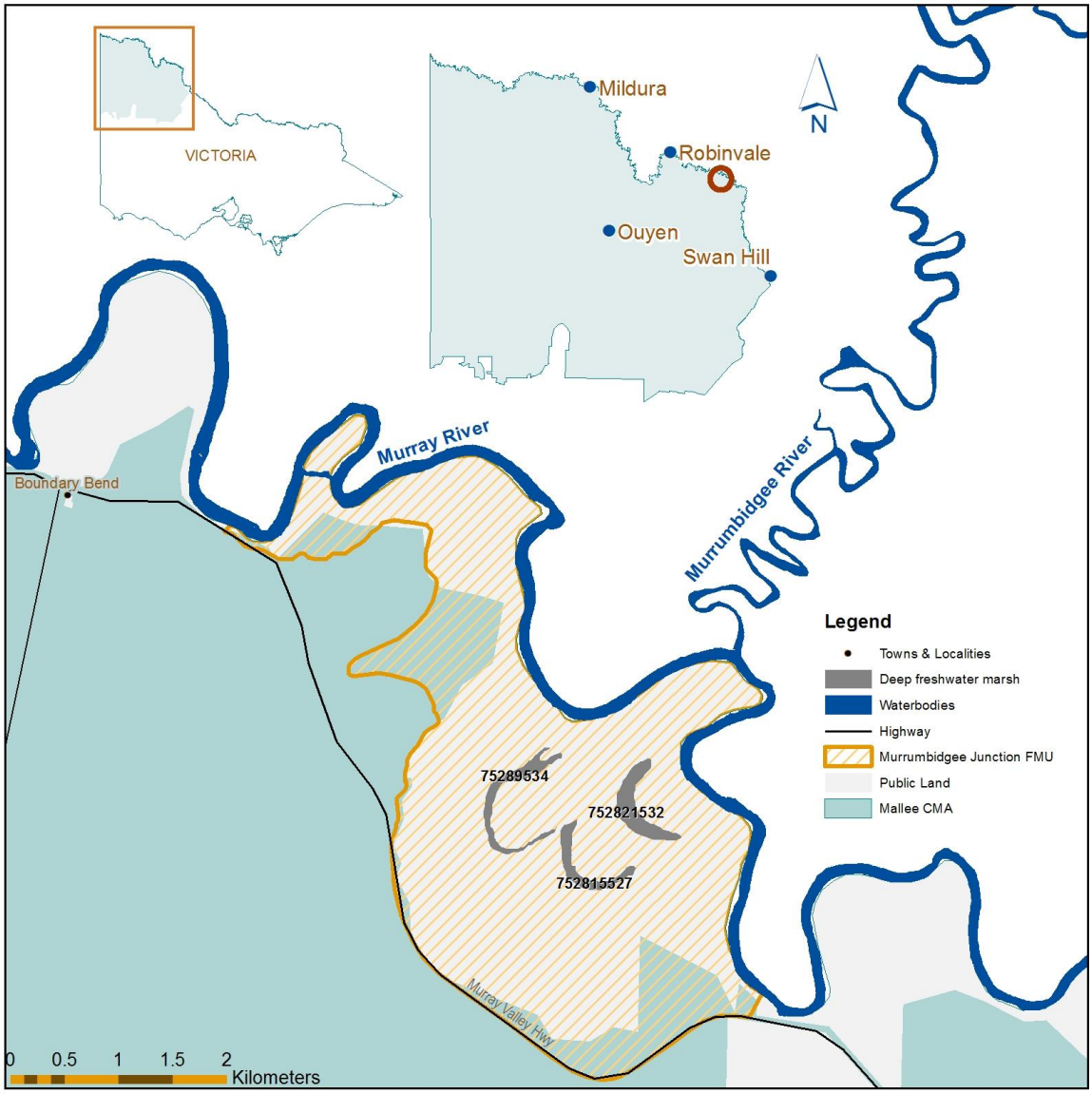

Figure 5 Wetland classifications within Murrumbidgee Junction WMU

3.1.3 Ecosystem functions

Wetland ecosystems support distinctive communities of plants and animals and provide numerous ecosystem services to the community (DSE 2005). Floodplain wetlands perform important functions necessary to maintain the hydrological, physical and ecological health of river systems. These ecosystem functions include:

- enhancing water quality through filtering sediments and re-using nutrients;
- absorbing and releasing floodwaters;
- providing organic material to rivers to maintain riverine food chains; and
- providing feeding, breeding and drought refuge sites for an array of flora and fauna, especially waterbirds and fish.

The target area within this WMU contains a floodplain wetland complex of three wetlands which are categorised as Deep Freshwater Marshes. Altered water regimes in the target area due to river regulation and dry conditions have seen a decrease in the frequency of inundation in these floodplain wetlands and therefore a decrease in the ability for these wetlands to perform these valuable ecosystem functions.

Whilst not a specific objective, these wetlands have the potential to provide a refuge for large fish species and a productive feeding and breeding habitat for waterbirds, frogs and other fauna.

3.2 Social

3.2.3 Cultural heritage

The Narrung Wetlands is an important cultural site for the local indigenous people. Bell (2012) states that a total of 1088 Aboriginal places have been registered within the north-eastern portion of the Mallee Basin geographic region. These included scarred trees (871), earth features (78), shell deposits (75), artifact scatters (43), burial/human remains (19) and two historical places. Predictive models expect Aboriginal places to be situated close to ephemeral or permanent water sources and the River Murray is known to be well-utilised by Aboriginal people.

During his exploration of the Narrung area during 1836, Major Thomas Mitchell documented early encounters with Aboriginal people. Maps indicating locations of tribes were produced for the area from 1904, with subsequent maps displaying discrepancies within tribal boundaries. A search of the Victorian Aboriginal Heritage Register identified 29 archaeological reports in the geographic region, with the majority associated with the irrigation, construction and housing developments in the region (Bell 2012).

Two Native Title Claimant groups cover the area, the Robinvale Aboriginal Community (RAC) and Latji Latji Peoples (Latji Latji). There is currently no Registered Aboriginal Party (RAP) appointed, however the Tati Tati Aboriginal Corporation in the area has applied for RAP status in the past. A contingency plan (Appendix 7) is in place should any evidence of cultural heritage sites be discovered during site visits or works.

European heritage reflects the pioneering history of the area and Narrung was visited by Captain Charles Sturt (1830) and Major Thomas Mitchell (1836). Mitchell set up a camp site, known as Passage Camp on his third expedition to the interior. Drovers commenced overlanding stock via the area shortly after and Narong, Narrung or Neroney pastoral run was gazetted in 1848. Within ten years of Mitchell's third expedition, the area was taken up by squatting runs of cattle and sheep. The large squatting and pastoral runs were subdivided in the 1850-1870s into agricultural allotments (Bell 2012).

3.2.4 Recreation

The region is popular for swimming, camping, fishing, boating, four wheel driving, picnicking, and walking. The Murrumbidgee Junction forms part of the Major Mitchell Trail. Passage Camp provides fire places for campers and a walking trail to the old Narrung town site (Discover the Murray River website) Passage Camp is also listed on Australian Campsites.com.au and Explore Australia. VEAC recommendations (2008) continue to allow camping and campfires in the area.

3.3 Economic

The Murrumbidgee Junction WMU has been used for grazing, and domestic firewood collection in the past. The surrounding areas are used for irrigated horticulture and dryland cropping. The site is close to the township of Boundary Bend, which boasts thriving olive and almond growing and associated industries. The town and surrounding area has a population of 182.

3.4 Significance

The environmental, social and economic values outlined indicate the significance of this site. While these values do not constitute the Murrumbidgee Junction WMU being a unique or pristine site, the riparian and floodplain communities of the Murray River are important to the functioning of the river system and its sustainability. The area is rich in biodiversity, essential as habitat to native species and a refuge for listed flora and fauna species. The wetlands have the potential to provide a refuge for native fish species and productive feeding and breeding habitat for waterbirds, frogs and other fauna.

The cultural importance of this site is considered very significant as a place where early explorers established camps and an array of evidence of indigenous occupation and use. These social and cultural values are important to local communities of the area and visitors alike. The values contained within the Murrumbidgee Junction WMU and specifically the target area for this plan makes this area a priority for protection and enhancement through environmental water management.

Of particular significance are the River Red Gum communities and the semi-permanent wetlands and creeks throughout the target area. These wetland and woodland communities form the basis for the functioning ecological system and provide essential habitat for listed species such as the Regent Parrot.

4. HYDROLOGY AND SYSTEM OPERATIONS

Wetland hydrology is the most important determinant in the establishment and maintenance of wetland types and processes. It affects the chemical and physical aspects of the wetland which in turn affects the type of flora and fauna that the wetland supports (DSE 2005). A wetland's hydrology is determined by surface and groundwater inflows and outflows in addition to precipitation and evapotranspiration (Mitsch and Gosselink, 2000 in DSE 2005). Duration, frequency and seasonality (timing) are the main components of the hydrological regime for wetlands and rivers.

The target area within the Murrumbidgee Junction Waterway Management Unit is located on the Victorian floodplain of the Murray River (chainage 1246 km to 1259 km) between river gauges Wakool Junction (# 414200) and Euston (# 414203) on the River Murray and is downstream of the Murrumbidgee River gauge at D/S Balranald weir (#410130). The commence to flow for the wetlands is between 30,000 - 73,900 ML/day at Wakool Junction (Alexander and Green, 2006).

4.1 Water management and delivery

4.1.1 Pre-regulation

The Murrumbidgee WMU is situated on the Murray River floodplain but is also influenced by the flows in the Wakool and Murrumbidgee Rivers. Prior to river regulation in the reach of the Murray River past the Murrumbidgee Junction WMU, the river level exceeded the wetland bed for most of the year and the wetlands would have been semi-permanent. The benches fringing the wetland would have been inundated in most years for over four months (Alluvium 2011). This inundation regime facilitated recruitment and preservation of floodplain and wetland species and essential wetland ecological processes.

4.1.2 Post-regulation

In this part of the Murray River, the frequency, duration and size of floods have been reduced due to effects of major storages in Murray River and its tributaries (Thoms et al, 2000, p 106). Under current conditions the wetlands frequently dry out and the benches are inundated for much shorter periods and less frequently (Alluvium 2011). Extreme low flows have been significantly reduced and there has been a reduction in the frequency and duration of larger flows which are required to flood anabranches and wetland habitats.

The commence to flow (ctf) for the wetlands and benches in the target area are flows of more than 30,000ML/day (Green & Alexander, 2006). Flows of more than 80,000 ML/day are required to completely inundate the wetlands, a flow volume which is rarely met (EA 2007b). Regulation has reduced the frequency to less than one per year on average, the duration has more than halved and the interval between events has increased considerably (EA, 2006).

The seasonal distribution of flows in this section of the Murray River shows that, despite a reduction in discharge, the river retains the same annual pattern of higher flows in winter and spring with lower flows in summer and autumn (Figure 6).

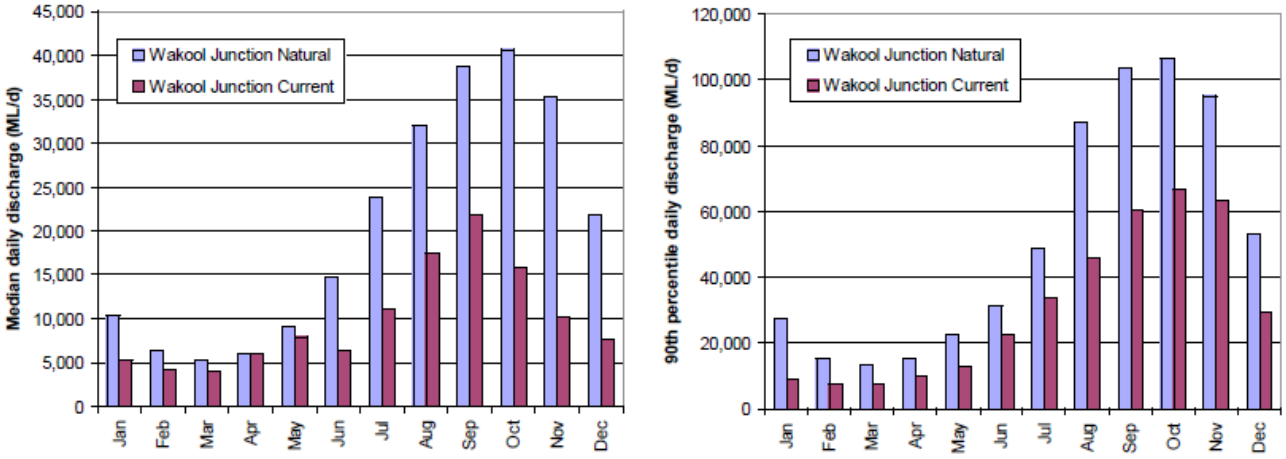

Figure 6: Distribution of median flows and 90th percentile flows for each month in the River Murray through Nyah to Robinvale section for natural and current (benchmark) conditions. Source: derived from MDBC MSM-Bigmod 109-year data (EA 2006).

This section of the Murray is one of the longest free-flowing sections in a highly regulated waterway. This negates the possibility of manipulating weir pool levels to facilitate inundation of the target area and restricts control of environmental watering events to pumping from the river onto the floodplain and controlling water height on the floodplain with small levees, regulators and culverts.

4.1.3 Environmental watering

Environmental watering occurred in the Narrung wetlands in 2005. The water for this event was from sources outlined in Table 10. The water was pumped onto the floodplain using temporary earth banks and mobile pumps. The extent of inundation is shown in Figure 7. This site also received natural inflows due to high River Murray flows during 2010-11 and 2011-12.

Table 10 A summary of recent environmental watering events in Murrumbidgee Junction WMU

Water year	Time of inflow	Inflow source	Source volume (ML)	Total volume (ML)	Cost of delivery ($)	Area (ha) Inundated
2005	Spring	River Murray Unregulated Flow	887	1019	$30-45/ML	80
		Victorian River Murray Flora & Fauna Bulk Entitlement	132			
2005	Autumn	Victorian River Murray Flora & Fauna Bulk Entitlement	640	640		80

The cost of delivery is dependent on factors such as fuel prices, river heights, site access, type of pump required, volume to be pumped etc

The initial purpose of the emergency watering program was to assist the vegetation during the prolonged dry conditions which had resulted in a drastic decline in River Red Gum health on the Murray River floodplain. The watering event filled three wetlands and flooded adjacent riparian zone and was effective in improving the health of trees lining the creeks and wetlands in the target area, and had the added benefit of providing some drought refuge for waterbirds. Anecdotal evidence indicated a positive response by the River Red Gums to the watering through increased foliage vigour.

Once the trees began to respond positively to the environmental watering and dry conditions abated, the purpose of the environmental watering has changed from emergency response to long term sustainability of the system.

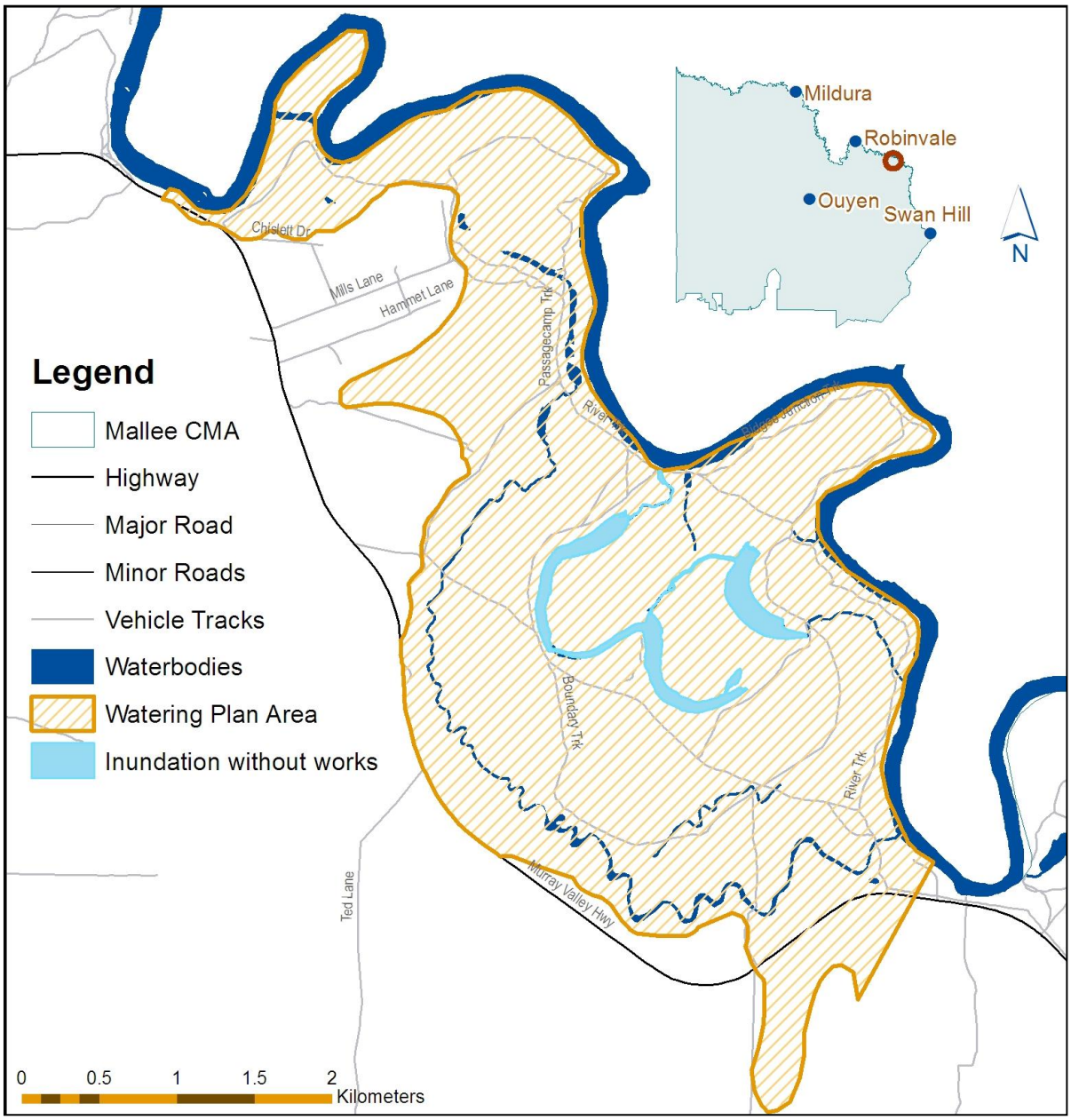

Figure 6 Inundation extent of the Murrumbidgee Junction WMU during 2005 watering event

5. THREATS AND CONDITION

5.1 Water dependent threats

The values for the target area of the Narrung Wetlands are described in section 3. Threats to these values are the result of such factors as human intervention and climate variability. Some of the threats which may have an impact on the target area include:

- Changed water regime
- Loss or reduction of wetland connectivity
- Introduction/increase of exotic flora and fauna

The regulation of the Murray River has seen the water regime altered so that it has gone from almost annual inundation for over four months to being frequently dry. This altered water regime poses a considerable threat to the water dependent EVCs and associated flora and fauna of the target area.

The wetlands present in the target area are classified as Deep Freshwater Marsh (Table 9). Wetlands have decreased in area in Victoria and the Mallee CMA region since 1788 with Deep Freshwater Marsh being the second most depleted category in the Mallee CMA region and the most depleted in Victoria (MCMA 2006A). Reduction in wetland area and loss of wetland connectivity threaten the vegetation communities surrounding the wetlands and therefore the fauna communities which inhabit the target area are also threatened.

Loss of connectivity between wetlands and the Murray River also inhibits the movement of native fish. Species which move between the river and the floodplain and wetlands for spawning and as a nursery area, such as Bony bream, are particularly susceptible to decline under reduced connectivity.

Regent Parrots, White-bellied Sea-Eagles and other listed speices nest in River Red Gum adjacent to waterbodies. Reduced flooding and subsequent loss of River Red Gum habitat directly threaten these species.

Agricultural and other weeds are an ongoing threat and management issue along the Murray River floodplain. Several species have been recorded at or near the site and need to be managed. Frequent or prolonged drying of the wetlands could lead to encroachment of terrestrial weeds into the wetland.

Common carp are a problem within the wetlands. Carp have been found to contribute to the loss of aquatic vegetation and increased turbidity, resulting in loss of habitat for waterfowl (Purdy & Loyn 2008). This species competes with the native fish for habitat and food as well as having a detrimental effect on water quality (MCMA 2003). Carp can be managed through carp screens at the outlet and using the proposed regulator to initiate a drying phase in the wetlands (Alluvium 2011).

5.2 Current condition

One method for assessing the current condition of a wetland is the Index of Wetland Condition (IWC) developed by DEPI. The IWC defines wetland condition as the state of the biological, physical, and chemical components of the wetland ecosystem and their interactions. No assessments have been undertaken to date at Narrung wetlands and this has been included as an information gap to be addressed (Section 9).

The altered water regime is considered the major threat for the target area of the WMU and is the primary factor behind the development of this environmental water management plan. The wetlands within the target area no longer receive inflows from the river at the same

frequency or duration as they would have pre river regulation.

The health of River Red Gum stands in and around the Narrung Wetlands was found to generally be poor or degraded according to a study investigating the condition of the species along the Victorian Murray River Floodplain (Cunningham *et al*. 2006).

5.3 Condition trajectory

Without management intervention in the form of environmental watering, water dependent condition within the target area is expected to worsen. Dry conditions will continue to impact already stressed vegetation, including key species like River Red Gum and aquatic macrophytes. This will result in loss of valuable habitat for listed wetland birds, frogs and fish and wetland productivity and biodiversity which is directly dependent on water will continue to decline.

Management intervention has already begun in the Murrumbidgee Junction WMU with environmental watering events in 2005/6 as outlined in section 4.1.3.

Photographic and anecdotal evidence indicates an increase in River Red Gum canopy health following these watering events. If this intervention is not continued the benefits from these watering events such as River Red Gum recovery may not be sustained and the floodplain will continue to become drier, resulting in reduced productivity, less carbon flux, and reduced functioning. Due to river regulation, flooding alone may not be enough to sustain these communities. Photographic evidence from nearby Hattah Lakes shows the positive effect that environmental watering has on foliage vigour in River Red Gums.

Photos: Lorraine Ludwig and Shane Southon, Parks Victoria

Figure 7 River Red Gum communities at two Hattah sites before and after environmental water events

6. MANAGEMENT OBJECTIVES

6.1 Seasonally adaptive approach

Victoria has adopted an adaptive and integrated management approach to environmental management. A key component of this approach for environmental watering is the 'seasonally adaptive' approach, developed through the Northern Region Sustainable Water Strategy and incorporated into the Victorian Waterway Management Strategy.

The seasonally adaptive approach identifies the priorities for environmental watering, works and complementary measures, depending on the amount of water available in a given year. It is a flexible way to deal with short-term climatic variability and helps to guide annual priorities and manage droughts. The approach is outlined in
11.

The seasonally adaptive approach has been used to guide the watering regime under various climatic scenarios. In drier periods, restricted water resource availability will potentially limit the number of ecological objectives which can realistically be provided through environmental water management. However, these ecological objectives can be achieved in wetter periods as water resource availability increases.

Table 11 The seasonally adaptive approach to river and wetland management (DSE, 2009)

	Drought	Dry	Average	Wet to very wet
Long-term ecological objectives	Long-term objectives to move towards ecologically healthy rivers - set through regional river health strategies and sustainable water strategies and reviewed through the 15-year resource review			
Short-term ecological objectives	• Priority sites have avoided irreversible losses and have capacity for recovery	• Priority river reaches and wetlands have maintained their basic functions	• The ecological health of priority river reaches and wetlands has been maintained or improved	• The health and resilience of priority river reaches and wetlands has been improved
Annual management objectives	• Avoid critical loss • Maintain key refuges • Avoid catastrophic events	• Maintain river functioning with reduced reproductive capacity • Maintain key functions of high priority wetlands • Manage within dry-spell tolerances	• Improve ecological health and resilience	• Maximise recruitment opportunities for key river and wetland species • Minimise impacts of flooding on human communities • Restore key floodplain linkages
Environmental water reserve	• Water critical refuges • Undertake emergency watering to avoid catastrophic events • Provide carryover (for critical environmental needs the following year) • If necessary, use the market to sell or purchase water	• In priority river reaches provide summer and winter baseflows • Water high priority wetlands • Provide river flushes where required to break critical dry spells • Provide carryover (for critical environmental needs the following year) • If necessary, use the market to sell or purchase water	• Provide all aspects of the flow regime • Provide sufficient flows to promote breeding and recovery • Provide carryover to accrue water for large watering events • If necessary, use the market to sell or purchase water	• Provide overbank flows • Provide flows needed to promote breeding and recovery • If necessary, use the market to sell or purchase water
River and wetland catchment activities	• Protect refuges (including stock exclusion) • Increase awareness of the importance of refuges • Enhanced monitoring of high risk areas and contingency plans in place • Investigate feasibility of translocations • Environmental emergency management plans in place • Protect high priority river reaches and wetlands through fencing; pest, plant and animal management; and water quality improvement works • Implement post-bushfire river recovery plans	• Protect refuges • Protect high priority river reaches and wetlands through fencing, revegetation, pest plant and animal management, water quality improvement and in-stream habitat works • Environmental emergency management plans in place • Improve connectivity • Implement post-bushfire river recovery plans	• Protect and restore high priority river reaches and wetlands through fencing, revegetation, pest plant and animal management, water quality improvement and in-stream habitat works • Monitor and survey river and wetland condition • Improve connectivity between rivers and floodplain wetlands	• Protect and restore high priority river reaches and wetlands through fencing, revegetation, pest plant and animal management, water quality improvement and in-stream habitat works • Monitor and survey river and wetland condition • Improve connectivity between rivers and floodplain wetlands • Emergency flood management plans in place • Implementation of post-flood river restoration programs

6.2 Management goal

The overall goal proposed for Murrumbidgee Junction Waterway management unit target area has been developed through consultation with various experts and stakeholders including Parks Victoria, the Robinvale Claimant Group, Tati Tati and Latji Latji representatives and local residents. The goal considers the values the wetland supports and the potential threats that need to be managed. This includes consideration of the values the wetland has historically supported and the likely values it could support into the future.

Murrumbidgee Junction Waterway Management Unit management goal:

To provide a watering regime to:

- reinstate and maintain the character of the semi-permanent wetlands
- maintain and improve River Red Gum communities within the target area
- maintain and improve Regent Parrot habitat

6.3 Ecological and hydrological objectives

6.3.1 Ecological objectives

Ecological objectives represent the desired ecological outcomes of the site based on the key values outlined in section 3. In line with the Victorian Waterway Management Strategy (VWMS) the ecological objectives are expressed as the target condition or functionality for each key value. The ecological objectives involve establishing one of the following trajectories of each key value, which is related to the present condition or functionality of the value:

- maintain
- improve
- protect
- re-instate

Table 12 Ecological objectives for the site

Ecological objective	Justification (value based)
Reinstate character of Semi-permanent wetlands	Returning the wetlands to a more natural flooding regime will provide habitat and breeding opportunities for wetland and floodplain fauna such as fish, frogs and waterbirds.
Maintain character of Semi-permanent wetlands	Maintaining the health of the Semi-permanent wetland communities is the next logical progression towards improving biodiversity and the broader ecological values of the site.
Maintain health of River Red Gum communities	River Red Gums are a keystone species and their health is essential to maintaining a functioning floodplain and river system. As the key ecological value for the site the downward trend in health must be stopped as a first priority.
Improve health of River Red Gum communities	An improvement in the health of the River Red Gum communities is the next logical progression towards improvement of the broader ecological values of the site.
Maintain Regent Parrot habitat	The site has been identified as a breeding site and flight path for this federally listed species and key habitat requirements of the Regent Parrot will benefit from environmental watering.
Improve Regent Parrot habitat	Improvement of habitat may enable the target area to recruit and sustain larger populations of Regent Parrot.

The first ecological objective is to reinstate a more semi-permanent water regime to the wetlands and to maintain the current level of health of the River Red Gum communities in the target area and not allow any further decline due to lack of water. The second objective is more ambitious and aims to maintain the semi-permanent wetland community and see an improvement in the health of the River Red Gums. It is expected that implementing a water regime to promote the health of River Red Gum stands will benefit the Regent Parrot population and other key species that utilise these trees. Attainment of the ecological objectives is anticipated to have wider benefits for the target area and is expected to result in gains such as improving water bird nesting opportunities in flooded trees lining wetlands, providing habitat and refuge for native fish and frogs.

As more is learnt about the area and the response to the watering events are monitored the principles of adaptive management along with availability of environmental water sources will guide future requirements and management actions at this and other environmental watering sites.

6.3.2 Hydrological objectives

Hydrological objectives describe the components of the water regime required to achieve the ecological objectives at this site. The ecological objectives at this site are to provide a watering regime to:

- reinstate and maintain the character of the semi-permanent wetlands
- maintain and improve River Red Gum communities within the target area
- maintain and improve Regent Parrot habitat

Semi-permanent wetlands should only dry out very rarely and should only be dry for 5% of the time. Water level should be above 50% of the wetland capacity 80% of the time. The wetland should reach retention level in 50% of years with a minimum duration of four weeks, with the ideal duration being twelve weeks. Breeding in frogs, fish and waterbirds requires events of twelve week duration in 50% of years, although a frequency of 30% of years may be sufficient for less productivity in these species. In order to replicate natural inflows, water levels should peak in August providing winter flooding and gradual retreat of water level over spring (EA 2007a).

River Red Gum stands are found in Woodland EVC's within the target area. River Red Gum Woodlands require flooding every two to four years with durations of two to four months. Flood events may differ and a variance in ponding duration around the mean requirement for this species is encouraged. Although the timing of flooding is not vital for River Red Gum, spring-summer flooding encourages greater growth. Timing is important for understorey plant communities however. The critical interval for Red Gum Woodlands is five to seven years to prevent deterioration of tree condition (Roberts & Marston 2011).

The Regent Parrot requires mature, healthy, hollow-bearing River Red Gum close to water for nesting. They feed on Red Gum and Black Box flower buds and utilise Black Box woodlands as flight paths to surrounding Mallee foraging sites. It is expected that providing a water regime which will sustain and enhance Red Gum and Black Box communities within the target area will also help sustain Regent Parrot populations in the area.

As this site requires pumping of water onto the floodplain which is a time consuming process, the duration and volumes of the events remains the same in both scenarios in order to ensure complete inundation of the target area. Higher flow events in the Murrumbidgee and Wakool rivers also need to be considered when determining requirements for the Murrumbidgee Junction WMU as the higher flows have a direct impact on the target area.

Table 13 Hydrological objectives for Murrumbidgee Junction Floodplain Management Unit target area

Ecological objective	Water management area	Hydrological objectives												
		Mean frequency of events (number per 10 years)			Tolerable interval between events (years)		Duration of ponding (months)			Preferred timing of inflows	Target supply level (m)	Volume to fill to TSL[1] (ML)	Volume to maintain at TS (ML)	Total volume per event (ML)
		Min	Opt	Max	Min	Max	Min	Opt	Max					
Maintain health of River Red Gum communities	Wetland/ floodplain	3	4	5	1	3	3	5	6	Winter/spring	2.3	1,088	250	1338
Improve health of River Red Gum communities		4	8	10	0	2	3	5	6	Winter/spring	2.3	1,088	250	1338
Reinstate/Maintain semi-permanent water regime		5	9	10	0	2	4	10	12	Winter				

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6.3.3 Watering regime

The wetland watering regime has been derived from the ecological and hydrological objectives. To allow for adaptive and integrated management, the watering regime is framed using the seasonally adaptive approach. This means that a watering regime is identified for optimal conditions, as well as the maximum and minimum tolerable watering scenarios. The minimum watering regime is likely to be provided in drought or dry years, the optimum watering regime in average conditions and the maximum watering regime in wet or flood years.

The optimal, minimum and maximum watering regimes are described below. Due to the inter-annual variability of these estimates (particularly the climatic conditions), determination of the predicted volume requirements in any given year will need to be undertaken by the environmental water manager when watering is planned.

Minimum watering regime

Inundate the target area four times in ten years with a maximum interval of three years between events. Allow ponding on the floodplain for three months and in the wetlands for four months.

Optimal watering regime

Inundate the target area eight times in ten years with a maximum interval of two years between events. Allow ponding on the floodplain for 5 months and in the wetlands for ten months.

Maximum watering regime

Inundate the target area nine times in ten years with a maximum interval of one year between events. Allow ponding on the floodplain for six months and in the wetlands for twelve months.

7. POTENTIAL RISKS OF AND MITIGATION MEASURES FOR ENVIRONMENTAL WATERING

A table of potential risks and means for mitigating these is used as the basis for assessing the risk of environmental water delivery at this site. The terms for values that may be impacted come from the Aquatic Value Identification and Risk Assessment (AVIRA) Report (Peters, 2009).

The table identifies potential risks, events that could cause such risks, the outcomes of such risks, and the actual values that could subsequently be impacted by each risk. Mitigation strategies for each event are also identified.

Table 14 Potential risks associated with environmental water delivery

#	Risk	Description	Potential Impacts								Mitigation
			Environmental					Social		Economic	
			Fish *Water regime does not support breeding and feeding requirements*	**Birds** *Water regime does not support breeding and feeding requirements*	**Amphibians** *Water regime does not support breeding and feeding requirements*	**Invertebrate** *Water regime does not support breeding and feeding requirements*	**Native aquatic flora** *Watering requirement does not support establishment and growth.*	Reduced public access and use	Degradation of cultural heritage sites	Flooding of adjacent land	
1	Required watering regime not met	Flood duration too long or short	✓	✓	✓		✓	✓			Determine environmental water requirements based on seasonal conditions and to support potential bird breeding events Monitor flood duration to inform environmental water delivery Monitor the ecological response of the wetland to flooding Add or drawdown water where appropriate or practical
		Flood timing too late or early	✓	✓	✓		✓	✓			Liaise with Goulburn-Murray Water to seek optimum timing of water delivery Monitor flood timing to inform environmental water delivery Monitor the ecological response of the wetland to flooding
		Flooding depth too shallow or deep	✓	✓			✓	✓	✓	✓	Determine environmental water requirements based on seasonal conditions and to support potential bird breeding events Monitor flood depth to inform environmental water delivery Liaise with adjoining landowners prior to and during the delivery of environmental water to discuss and resolve potential or current flooding issues Add or drawdown water where appropriate or practical
		Flood frequency too long or short	✓	✓	✓	✓	✓	✓			Prioritise water requirements of wetlands in seasonal watering proposals according to their required water regimes and inundation history Monitor the condition of the wetland Monitor the ecological response of the wetland to flooding

2	Poor water quality	Low dissolved oxygen	✓	✓			✓				Monitor dissolved oxygen levels and the ecological response of the wetland to flooding Add or drawdown water where appropriate or practical
		High turbidity	✓				✓				Monitor turbidity levels and the ecological response of the wetland to flooding Add or drawdown water where appropriate or practical
		High water temperature	✓				✓				Monitor water temperature and the ecological response of the wetland to flooding Add or drawdown water where appropriate or practical
		Increased salinity levels	✓		✓	✓	✓				Monitor salinity levels and the ecological response of the wetland to flooding Add or drawdown water where appropriate or practical
		Increased nutrient levels									Monitor nutrient and Blue Green Algae levels, and the ecological response of the wetland to flooding Place public warning signs at the wetland if BGA levels are a public health risk Add or drawdown water where appropriate or practical
		Increased organic matter	✓				✓				Implement the required water regime
3	Pest aquatic plant and animal invasion	Introduction of pest fish	✓		✓	✓	✓				Monitor the ecological response of the wetland to flooding Install a carp screen Implement an appropriate drying regime
		Growth and establishment of aquatic pest plants	✓	✓	✓	✓	✓				Monitor the abundance of native and pest aquatic plants Control pest plants in connected waterways Spray or mechanically remove pest plants Implement an appropriate drying regime

8. ENVIRONMENTAL WATER DELIVERY INFRASTRUCTURE

8.1 Constraints

The lower occurrence of flows in the River Murray above the current commence to flow required for the wetlands and elevated sills within the inlet channel which would allow smaller peaks to enter the wetlands (EA 2006) do not meet the hydrological objectives outlined in the plan. There are also a number of potential locations where water could drain back to the River Murray if inundation levels are high enough.

The temporary earth banks used for the 2005 environmental watering event (Section 4.1) in the Murrumbidgee Junction WMU were removed after the event. Reinstating these each time the site is to be watered would mean recurring installation and maintenance costs as well as the associated vandalism and safety risks. The temporary banks do not allow fish passage and restrict access to the site.

8.2 Infrastructure recommendations

"Investigations on Water Management Options for the Murray River-Nyah to Robinvale Stage II" conducted by Ecological Associates (EA 2007b) concluded that the best environmental value for money spent would be achieved at the Murrumbidgee Junction through the installation of a regulator at the downstream end of the effluent with the River Murray. The structure could be placed in an open area, clear of trees. Embankments were also recommended to match the retention level of the structure to the natural river levee.

A detailed design report for the works has been developed by Alluvium (2011). The recommendations from 2007 were further developed to include pumping infrastructure which would significantly increase the volume of water able to be delivered and area of floodplain able to be inundated (Table 16). The design criteria for the regulator are:

- Design minimum flow rate of 1.3 m3/s (113 ML/d)
- Able to pass flows both ways
- Able to cater for flows overtopping the structure above water level 54.8 m AHD
- Manual operation
- Caters for overshot passage of flows
- Caters for vehicular access across the structure
- Caters for fish passage into wetlands
- Carp screens to prevent large bodied specimens returning to the River.

The design criteria for the blockbanks are:

- Sandbags be used to infill the Northern blockbank to avoid impacts on cultural heritage assets
- Use of the existing access track on the Eastern blockbank.

The pump will operate at 0.6 m^3/s to fill the wetlands to the target inundation from empty. This will take approximately 21 days. The inundation extent achieved from the installation of this infrastructure would match the inundation of the 2005 event of 80 ha.

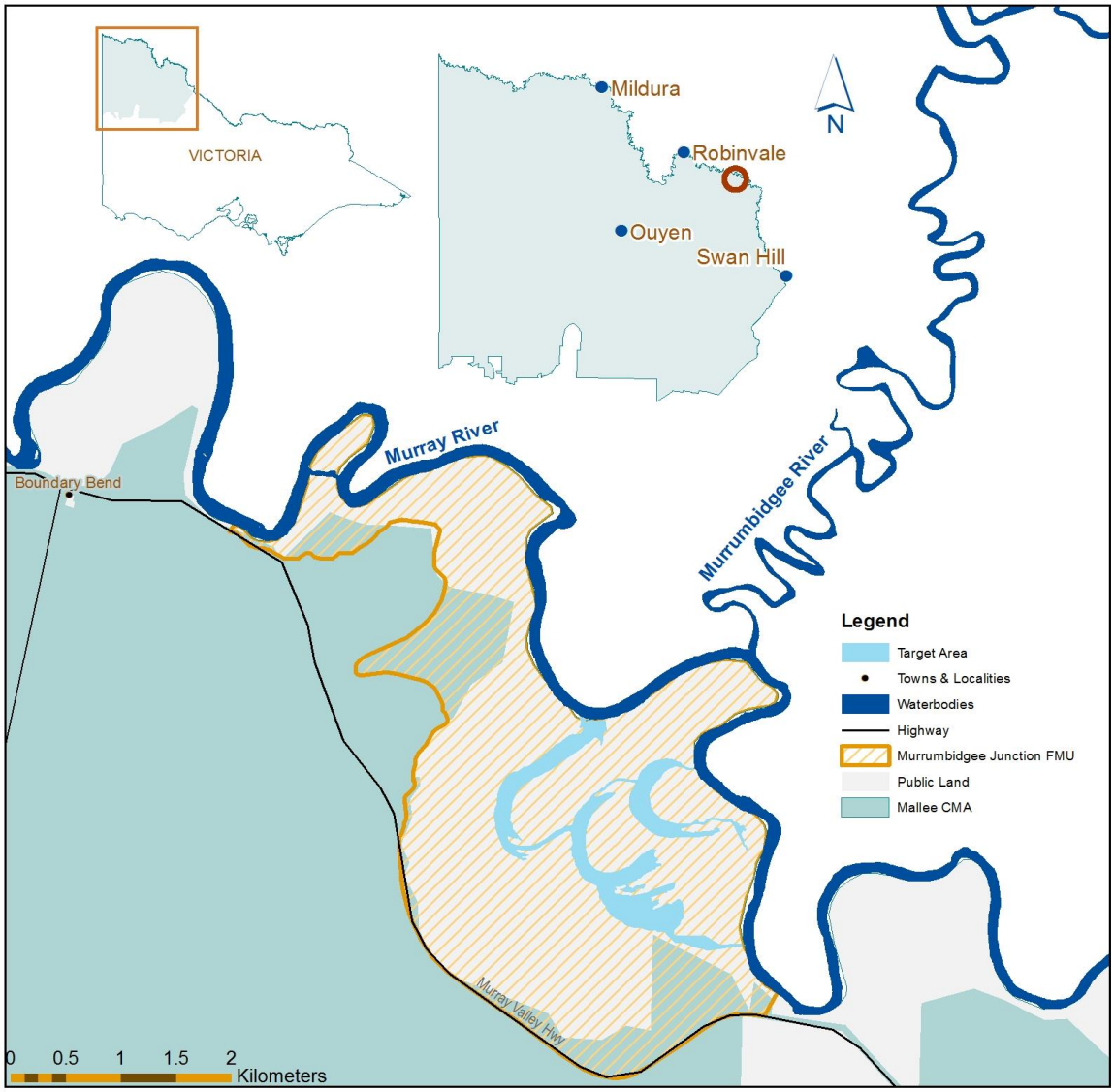

Figure 8 Anticipated inundation extent of Murrumbidgee target area with proposed works

9. KNOWLEDGE GAPS AND RECOMMENDATIONS

This plan is based on best information at the time of writing. In some cases this information is scarce or outdated. Further investigation and information collection will continue and the results of this further work will continue to build a better picture of the site and add rigor to future planning. Some areas where further knowledge would be beneficial are outlined in Table 15.

Table 15 Knowledge gaps and recommendations for the target area

Knowledge and data gaps	Action recommended	Responsibility
Index of Wetland Condition	Undertake investigations at Narrung wetlands	Implementation of any of these recommendations would be dependent on investment from Victorian and Australian Government funding sources as projects managed through the Mallee CMA
Impacts of nearby irrigation on wetland health	Investigation of surface water, groundwater and irrigation water interaction	
Role of wetland on fish breeding and population	Monitoring of fish population	
Accurate depth and volumes for the wetland	Install depth gauges and bathymetric survey	
Bird species breeding at the site	Data collection and monitoring	
Bat population in the area	Data collection and monitoring	
Impacts of climate variability	Data collection and monitoring	

A future possibility for increasing the extent of inundation possible within the Murrumbidgee Junction WMU is by working with local landholders to upgrade the irrigation infrastructure and access tracks in the northern section of the WMU to enable flow and fish passage into Wakool Creek in higher flow events. This would increase the inundation area to include Black Box and lignum communities.

10. REFERENCES

Alluvium (2011) Detail Design Report – Murrumbidgee Junction Wetlands Watering for Mallee CMA, Mildura. August 2011

ANCA (1996) *A Directory of Important Wetlands in Australia Second Edition.* Australian Nature Conservation Agency , Canberra, ACT

Baker-Gabb, D. & Hurley, V. G. (2011). *National Recovery Plan for the Regent Parrot (eastern subspecies) Polytelis anthopeplus monarchoides.* Department of Sustainability and Environment, Melbourne, Victoria.

Bell, J. (2012) *Construction of three regulator structures at Narrung Wetlands, near Boundary Bend Cultural Heritage Management Plan.* Report for the Mallee Catchment Management Authority. Jo Bell Heritage Services Pty Ltd. January 2012.

Cunningham, S. C., Mac Nally, R., White, M., Read, J., Baker, P., Thomson, J. & Griffioen, P. (2006). *Mapping the Current Condition of River Red Gum (Eucalyptus camaldulensis Dehnh.) Stands Along the Victorian Murray River Floodplain.* Department of Sustainability and Environment, Melbourne, Victoria.

DEWHA (2008). *Commonwealth Environmental Water Holder 2008-09 Business Plan*, Department of Environment, Water, Heritage and the Arts, Canberra, ACT.

DNRE (1997). *Victoria's Biodiversity – Our Living Wealth – Sustaining Our Living Wealth and Directions in Management.* Department of Natural Resources and Environment, East Melbourne, Victoria

DSE (2003). *Action Statement; Inland Carpet Python, Morelia spilota metcalfei.* Department of Sustainability and Environment, East Melbourne, Victoria.

DSE (2003). *Action Statement; White-bellied Sea-Eagle, Haliaeetus leucogaster.* Department of Sustainability and Environment, East Melbourne, Victoria.

DSE (2009). *A Field Guide to Victorian Wetland Ecological Vegetation Classes for the Index of Wetland Condition.* Department of Sustainability and Environment, Melbourne, Victoria.

DSE (2005) *Index of Wetland Condition. Conceptual framework and selection of measures.* Department of Sustainability and Environment, East Melbourne, Victoria

DSE, (2008). *NVIRP clarification of net water savings, net environmental gain and refurbishment of water infrastructure to the current best environmental practice*. Compiled by John Cooke and Paulo Lay, Department of Sustainability and Environment, East Melbourne, Victoria

DSE, (2009). *Northern Region: Sustainable Water Strategy*. Department of Sustainability and Environment, East Melbourne, Victoria.

EA (2006) *Investigation of Water Management Options for the Murray River – Nyah to Robinvale: Final Report,* Ecological Associates for *Mallee Catchment Management Authority Mildura , Victoria*

EA (2007a). *Feasibility Investigation of Options for Hattah Lakes, Final Report.* Ecological Associates for *Mallee Catchment Management Authority Mildura, Victoria.*

EA (2007b) *Investigations on Water Management Options for the Murray River- Nyah to Robinvale Stage II,* Ecological Associates for *Mallee Catchment Management Authority Mildura, Victoria.*

Ellis, I. & Pyke, L. (2011a). *Assessment of fish movement to and from Margooya Lagoon upon reconnection to the Murray River during elevated flows:Spring 2010.* Final Report prepared for the Mallee Catchment Management Authority by The Murray-Darling Freshwater Research Centre, MDFRC Publication 27/2011, June, 19pp.

Green, D and Alexander, P (2006), *River Murray Wetland Database: NSW, Victoria. Wetland Commence to flow levels, June 2006* NSW Wetland Working Group Albury, NSW.

LCC (1989) *Mallee Area Review Final Recommendations* Land Conservation Council, Melbourne Victoria

McKane, B (1992) *Environmental Report: Nyah – South Australian Border Salinity Management Plan*. Department of Conservation and Environment Mildura, Victoria.

MCMA (2003) *Murray River Frontage Action Plan – Nyah to Robinvale* Mallee Catchment Management Authority Mildura, Victoria

MCMA, (2006) *Mallee River Health Strategy* Mallee Catchment Management Authority Mildura, Victoria

MCMA, (2006A) *Mallee Wetland Strategy* Mallee Catchment Management Authority Mildura, Victoria

MCMA, (2010). *Mallee Catchment Facts; White-bellied Sea-Eagle, Haliaeetus leucogaster*. Mallee Catchment Management Authority, Mildura, Victoria.

Peters, G. (2009_ *Aquatic Value Identification and Risk Assessment (AVIRA). Environmental, Social and Economic Values and Threats.* Riverness Protection & Restoration Services, Belmont, Victoria

Roberts, J. & Marston, F. (2011). *Water Regime for Wetland and Floodplain Plants: A Source Book for the Murray-Darling Basin.* National Water Commission, Canberra, ACT.

Rogers, K. & Ralph, T. J. (2011). *Floodplain Wetland Biota in the Murray-Darling Basin: Water and Habitat Requirements.* CSIRO publishing, Collingwood, Victoria.

Sinclair SJ (2004) *River Red Gum decline in the Nyah-Piangil Area: Is the semi-parasitic Pale-fruit Ballart involved?* Report to Mallee CMA. Arthur Rylah Institute for Environmental Research. Heidelberg, Victoria

Thoms, MC, Suter, P., Roberts, J., Koehn, J., Jones, G., Hillman, T. and Close, A. (2000). *Report of the River Murray Scientific Panel on Environmental Flows: River Murray – Dartmouth to Wellington and the Lower Darling River*, River Murray Scientific Panel on Environmental Flows, Murray Darling Basin Commission, Canberra ACT

VEAC (2008). *Identifying Flood-Dependent Natural Values on the Victorian Floodplains of the River Murray and its Tributaries.* Victorian Environmental Assessment Council, East Melbourne, Victoria.

VEAC (2008) *River Red Gum Investigation* Victorian Environmental Assessment Council East Melbourne, Victoria.

Webster, R. & Belcher, C. (2005). *A Survey of Regent Parrot, Polytelis anthopeplus monarchoides, Breeding Colonies along the Murray River in Victoria.* Ecosurveys, Deneliquin, NSW.

WEBSITES

Department of Sustainability and Environment Bioregions:
http://www.dse.vic.gov.au/conservation-and-environment/victorias-bioregions#bioregion

Department of Planning and Community Development:
http://www.dpcd.vic.gov.au/indigenous/heritage-tools/areas-of-cultural-sensitivity/46rostr-mallee-region-maps

Discover the Murray River:
http://www.murrayriver.com.au/piangi

DSEWPC, (2013). Haliaeetus leucogaster in Species Profile and Threats Database, Department of Sustainability, Environment, Water, Population and Communities, Canberra. Available from: http://environment.gov.au/sprat. Accessed Wed, 4 Sep 2013.

APPENDIX 1: ENVIRONMENTAL WATER SOURCES

Sources of environmental water potentially available for this site under current arrangements and in the future.

Commonwealth Environmental Water Holder (CEWH)

Under *Water for the Future* the Commonwealth Government committed $3.1 billion to purchase water in the Murray-Darling Basin over 10 years. The Commonwealth Environmental Water Holder will manage their environmental water.

The Commonwealth Water Act 2007 identified that "the Commonwealth Environmental Water Holder must perform its functions for the purpose of protecting or restoring environmental assets so as to give effect to relevant international agreements". Wetlands listed as of International Importance (Ramsar) are considered priority environmental assets for use of the commonwealth environmental water (DEWHA 2008).

Victorian Environmental Water Holder (VEWH)

The VEWH (when established in June 2011) will be responsible for holding and managing Victorian environmental water entitlements and allocations and deciding upon their best use throughout the State. The environmental entitlements held by the VEHW that could potentially be made available to this site include:

- the Victorian River Murray Flora and Fauna Bulk Entitlement; and
- future Northern Victoria Irrigation Renewal Project Environmental Entitlement.

In 1987 an annual allocation of 27600 ML of high security water was committed to flora and fauna conservation in Victorian Murray wetlands. In 1999, this became a defined entitlement for the environment called the Victorian River Murray Flora and Fauna Bulk Entitlement.

The Northern Victoria Irrigation Renewal Project (NVIRP) water savings are predicted to provide up to 75 GL as a statutory environmental entitlement, which will be used to help improve the health of priority stressed rivers and wetlands in northern Victoria (DSE, 2008). The entitlement will have properties which enable the water to be used at multiple locations as the water travels downstream (provided losses and water quality issues are accounted for); meaning that the water can be called out of storage at desired times to meet specific environmental needs.

The Living Murray Initiative (TLM)

The Living Murray (TLM) was established in 2002 as a partnership of the Commonwealth, NSW, Victorian, South Australian and ACT governments. The long term goal of this program is to achieve a healthy working Murray River system for the benefit of all Australians.

In 2004, under the 'First Step' decision, Ministers from TLM partner governments committed to recover a long term average of 500 GL of water to improve environmental outcomes at six Icon Sites. The recovery of the 500 GL target is now nearing completion and this water can be used for environmental watering at any of the following six Icon Sites: River Murray Channel, Barmah–Millewa Forest, Gunbower–Koondrook–Perricoota Forest, Hattah Lakes, Chowilla Floodplain and Lindsay–Wallpolla Islands, Lower Lakes, and Coorong and Murray Mouth.

Donations

People who hold water entitlements sometimes donate water to their local catchment management authority for environmental use. Additionally, people have donated money to non-governmental organisations to buy temporary water allocation for environmental use. While the scale of donated water is generally small relative to other water sources, it can provide a valuable contribution, especially in times of critical needs.

River Murray Unregulated Flow (RMUF)

Unregulated flows in the River Murray system are defined as water that cannot be captured in Lake Victoria and is, or will be, in excess of the required flow to South Australia. If there is a likelihood of unregulated flow event in the River Murray system, the Authority provides this advice to jurisdictions The Upper States then advise the Authority on altered diversion rates and environmental releases within their existing rights to unregulated flows.

Based on the information received from Jurisdictions, the Authority reassesses the event and, if necessary, limits Upper States' access to ensure that the unregulated flow event is not over committed. The Authority then issues formal unregulated flow advice to jurisdictions including any limits to States access.

Depending on the volume of water remaining, the Authority advises EWG and the Water Liaison Working Group (WLWG) on the availability and volume of RMUF. Whilst there is a range of measures that can be undertaken by Upper States as part of their 'prior rights' during unregulated flows, RMUF events are prioritised solely for the environment.

APPENDIX 2: LEGISLATIVE FRAMEWORK

International agreements and conventions

Ramsar Convention on Wetlands (Ramsar)

The Australian Government is a Contracting Party to the convention, which is an inter-governmental treaty whose mission is "the conservation and wise use of all wetlands through local, regional and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world".

Bilateral migratory bird agreements

Australia is a signatory to the following international bilateral migratory bird agreements:

- Japan-Australia Migratory Bird Agreement (JAMBA);
- China-Australia Migratory Bird Agreement (CAMBA); and
- Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA).

These agreements require that the parties protect migratory birds by:

- limiting the circumstances under which migratory birds are taken or traded;
- protecting and conserving important habitats;
- exchanging information; and
- building cooperative relationships.

Convention on the Conservation of Migratory Species of Wild Animals (Bonn)

This convention (known as the Bonn Convention or CMS) aims to conserve terrestrial, marine and avian migratory species throughout their range. It is an intergovernmental treaty, concluded under the aegis of the United Nations Environment Programme, concerned with the conservation of wildlife and habitats on a global scale. The Convention was signed in 1979 in Bonn, Germany, and entered into force in 1983.

Commonwealth legislation

Environment Protection and Biodiversity Conservation Act 1999 (EPBC)

This is the key piece of legislation pertaining to biodiversity conservation within Australia. It provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places – defined in the EPBC Act as matters of national environmental significance.

Water Act 2007 (Commonwealth Water Act)

This establishes the Murray-Darling Basin Authority (MDBA) with the functions and powers, including enforcement powers, needed to ensure that Basin water resources are managed in an integrated and sustainable way.

Aboriginal and Torres Straight Islander Heritage Protection Act 1984

This aims to preserve and protect areas and objects in Australia and Australian waters that are of particular significance to indigenous people from injury or desecration.

State legislation and listings

Flora and Fauna Guarantee Act 1988 (FFG)

This is the key piece of Victorian legislation for the conservation of threatened species and communities and for the management of potentially threatening processes.

Advisory lists of rare or threatened species in Victoria (DEPI)

Three advisory lists are maintained by DEPI for use in a range of planning process and in setting priorities for actions to conserve biodiversity. Unlike other threatened species lists, there are no legal requirements or consequences that flow from inclusion of a species on an advisory list. The advisory lists comprise:

- Advisory List of Rare or Threatened Plants In Victoria – 2005
- Advisory List of Threatened Vertebrate Fauna in Victoria – 2007
- Advisory List of Threatened Invertebrate Fauna in Victoria – 2009

Environmental Effects Act 1978

Potential environmental impacts of a proposed development are subject to assessment and approval under this Act. A structural works program and any associated environmental impacts would be subject to assessment and approval under the Act.

Planning and Environment Act 1987

This controls the removal or disturbance to native vegetation within Victoria by implementation of a three-step process of avoidance, minimisation and offsetting.

Water Act 1989 (Victorian Water Act)

This is the key piece of legislation that governs the way water entitlements are issued and allocated in Victoria. The Act also identifies water that is to be kept for the environment under the Environmental Water Reserve. The Act provides a framework for defining and managing Victoria's water resources.

Aboriginal Heritage Act 2006

All Aboriginal places, objects and human remains in Victoria are protected under this Act.

Other relevant legislation

The preceding legislation operates in conjunction with the following other Victorian legislation to influence the management and conservation of Victoria's natural resources as well as outline obligations with respect to obtaining approvals for structural works:

- Environment Protection Act 1970
- Catchment and Land Protection Act 1994
- Heritage Act 1995
- Conservation, Forests and Lands Act 1987
- Land Act 1958
- Heritage Rivers Act 1992
- Wildlife Act 1975
- Murray Darling Basin Act 1993
- National Parks Act 1975
- Parks Victoria Act 1998
- Forests Act 1958

APPENDIX 3: FLORA AND FAUNA SPECIES LIST

Flora – Native

Scientific Name	Common Name	Records
Acacia brachybotrya	Grey Mulga	5
Acacia halliana	Hall's Wattle	1
Acacia ligulata	Small Cooba	10
Acacia melvillei	Yarran	1
Acacia oswaldii	Umbrella Wattle	3
Acacia rigens	Nealie	3
Acacia salicina	Willow Wattle	1
Acacia stenophylla	Eumong	4
Acacia wilhelmiana	Dwarf Nealie	9
Acaulon chrysacanthum	Pygmy Moss	8
Acaulon leucochaete	Pygmy Moss	4
Acaulon spp.	Pygmy Moss	9
Acaulon triquetrum	Triangular Pygmy-moss	6
Actinobole uliginosum	Flannel Cudweed	4
Adriana urticoides var. hookeri	Mallee Bitter-bush	1
Ajuga australis	Austral Bugle	6
Alectryon oleifolius subsp. canescens	Cattle Bush	4
Aloina aloides var. ambigua	Tall Aloe-moss	1
Alternanthera denticulata s.l.	Lesser Joyweed	2
Alternanthera denticulata s.s.	Lesser Joyweed	5
Alternanthera nodiflora	Common Joyweed	1
Ammannia multiflora	Jerry-jerry	1
Amyema miquelii	Box Mistletoe	5
Amyema miraculosa subsp. boormanii	Fleshy Mistletoe	2
Amyema spp.	Mistletoe	1
Aristida holathera var. holathera	Tall Kerosene Grass	3
Asperula gemella	Twin-leaf Bedstraw	4
Asteraceae spp.	Composite	1
Atriplex acutibractea subsp. karoniensis	Pointed Saltbush	1
Atriplex angulata	Angular Saltbush	1
Atriplex eardleyae	Small Saltbush	1
Atriplex leptocarpa	Slender-fruit Saltbush	9
Atriplex lindleyi	Flat-top Saltbush	3
Atriplex lindleyi subsp. inflata	Corky Saltbush	1
Atriplex papillata	Coral Saltbush	2
Atriplex pumilio	Mat Saltbush	2
Atriplex semibaccata	Berry Saltbush	3
Atriplex spp.	Saltbush	4
Atriplex suberecta	Sprawling Saltbush	3
Atriplex vesicaria	Bladder Saltbush	1
Austrostipa elegantissima	Feather Spear-grass	5

Austrostipa eremophila	Desert Spear-grass	1
Austrostipa mollis	Supple Spear-grass	8
Austrostipa nodosa	Knotty Spear-grass	1
Austrostipa scabra subsp. falcata	Rough Spear-grass	21
Austrostipa spp.	Spear Grass	6
Barbula crinita	Dusky Beard-moss	1
Barbula spp.	Beard Moss	10
Billardiera cymosa s.s.	Sweet Apple-berry	2
Bossiaea walkeri	Cactus Bossiaea	5
Brachyscome basaltica var. gracilis	Woodland Swamp-daisy	1
Brachyscome ciliaris	Variable Daisy	3
Brachyscome ciliaris var. ciliaris	Variable Daisy	1
Brachyscome lineariloba	Hard-head Daisy	4
Bryobartramia novae-valesiae	Earth Moss	1
Bryum s.l. spp.	Thread Moss	3
Bulbine semibarbata	Leek Lily	2
Bursaria spinosa subsp. spinosa	Sweet Bursaria	1
Calandrinia eremaea	Small Purslane	19
Callitris glaucophylla	White Cypress-pine	1
Callitris gracilis subsp. murrayensis	Slender Cypress-pine	1
Callitris verrucosa	Scrub Cypress-pine	1
Calocephalus sonderi	Pale Beauty-heads	13
Calotis erinacea	Tangled Burr-daisy	10
Calotis hispidula	Hairy Burr-daisy	5
Calotis spp.	Burr Daisy	2
Cardamine lineariloba	Western Bitter-cress	1
Cardamine moirensis	Riverina Bitter-cress	1
Carex bichenoviana	Plains Sedge	1
Carex inversa	Knob Sedge	2
Carpobrotus modestus	Inland Pigface	5
Centipeda cunninghamii	Common Sneezeweed	4
Centipeda minima subsp. minima s.s.	Spreading Sneezeweed	2
Centipeda nidiformis	Cotton Sneezeweed	1
Chamaesyce drummondii	Flat Spurge	4
Chenopodium curvispicatum	Cottony Saltbush	3
Chenopodium desertorum	Frosted Goosefoot	6
Chenopodium desertorum subsp. desertorum	Frosted Goosefoot	1
Chenopodium desertorum subsp. rectum	Frosted Goosefoot	4
Chenopodium nitrariaceum	Nitre Goosefoot	7
Chenopodium pumilio	Clammy Goosefoot	2
Chrysocephalum apiculatum s.l.	Common Everlasting	1
Chrysocephalum vitellinum	Annual Everlasting	4
Clematis microphylla s.l.	Small-leaved Clematis	6
Codonocarpus cotinifolius	Bell-fruit Tree	2
Convolvulus erubescens spp. agg.	Pink Bindweed	1
Crassula colorata	Dense Crassula	23

Crassula sieberiana s.l.	Sieber Crassula	14
Crossidium geheebii	Gypsum Moss	6
Cryptandra tomentosa	Prickly Cryptandra	1
Cullen cinereum	Hoary Scurf-pea	1
Cullen discolor	Grey Scurf-pea	2
Cullen tenax	Tough Scurf-pea	2
Cynodon dactylon	Couch	8
Cynodon dactylon var. pulchellus	Native Couch	2
Cyperus gymnocaulos	Spiny Flat-sedge	4
Dampiera marifolia	Velvet Dampiera	3
Daviesia arenaria	Mallee Bitter-pea	4
Dianella revoluta s.l.	Black-anther Flax-lily	1
Dianella revoluta var. revoluta s.l.	Black-anther Flax-lily	9
Didymodon spp.	Beard Moss	1
Didymodon torquatus	Beard Moss	2
Dodonaea bursariifolia	Small Hop-bush	5
Dodonaea viscosa subsp. angustissima	Slender Hop-bush	15
Eclipta platyglossa	Yellow Twin-heads	3
Einadia nutans subsp. nutans	Nodding Saltbush	24
Eleocharis acuta	Common Spike-sedge	4
Eleocharis pusilla	Small Spike-sedge	1
Enchylaena tomentosa var. tomentosa	Ruby Saltbush	50
Enneapogon avenaceus	Common Bottle-washers	2
Enteropogon acicularis	Spider Grass	11
Ephemerum cristatum	Earth Moss	2
Eragrostis infecunda	Southern Cane-grass	1
Eragrostis spp.	Love Grass	1
Eremophila divaricata subsp. divaricata	Spreading Emu-bush	2
Eremophila glabra	Common Emu-bush	7
Eremophila longifolia	Berrigan	1
Erodium crinitum	Blue Heron's-bill	2
Eucalyptus camaldulensis	River Red-gum	9
Eucalyptus costata subsp. murrayana	Yellow Mallee	10
Eucalyptus dumosa	Dumosa Mallee	7
Eucalyptus gracilis	Yorrell	4
Eucalyptus largiflorens	Black Box	15
Eucalyptus leptophylla	Slender-leaf Mallee	5
Eucalyptus microcarpa	Grey Box	3
Eucalyptus oleosa subsp. oleosa	Oil Mallee	3
Eucalyptus socialis subsp. socialis	Grey Mallee	10
Exocarpos aphyllus	Leafless Ballart	6
Exocarpos sparteus	Broom Ballart	5
Fissidens megalotis	Curly Pocket-moss	1
Funaria hygrometrica	Common Cord-moss	2
Funaria microstoma	Cord Moss	1
Funaria spp.	Cord Moss	2

Gahnia lanigera	Desert Saw-sedge	1
Geijera parviflora	Wilga	1
Gemmabryum pachythecum	Acorn-fruited Thread-moss	1
Gemmabryum spp.	Thread Moss	1
Geococcus pusillus	Earth Cress	1
Gigaspermum repens	Pineapple Moss	2
Glischrocaryon behrii	Golden Pennants	1
Glycine canescens	Silky Glycine	1
Goodenia fascicularis	Silky Goodenia	5
Goodenia glauca	Pale Goodenia	13
Goodenia varia	Sticky Goodenia	2
Goodenia willisiana	Sandhill Goodenia	9
Grevillea huegelii	Comb Grevillea	1
Grevillea pterosperma	Desert Grevillea	10
Gyrostemon australasicus	Wheel Fruit	1
Hakea leucoptera subsp. leucoptera	Silver Needlewood	2
Hakea tephrosperma	Hooked Needlewood	2
Halgania cyanea	Rough Halgania	7
Haloragis aspera	Rough Raspwort	1
Haloragis glauca f. glauca	Bluish Raspwort	1
Haloragis odontocarpa	Toothed Raspwort	3
Helichrysum leucopsideum	Satin Everlasting	1
Hemarthria uncinata var. uncinata	Mat Grass	1
Hibbertia australis	Upright Guinea-flower	1
Hibbertia virgata	Twiggy Guinea-flower	1
Hybanthus floribundus subsp. floribundus	Shrub Violet	4
Isolepis spp.	Club Sedge	1
Juncus subsecundus	Finger Rush	2
Lachnagrostis filiformis s.l.	Common Blown-grass	2
Lachnagrostis filiformis s.s.	Common Blown-grass	5
Lawrencia glomerata	Clustered Lawrencia	1
Lawrencia squamata	Thorny Lawrencia	4
Leiocarpa leptolepis	Pale Plover-daisy	1
Lepidium monoplocoides	Winged Peppercress	1
Lepidium spp.	Peppercress	2
Leptospermum coriaceum	Mallee Tea-tree	3
Lobelia concolor	Poison Pratia	2
Lomandra juncea	Desert Mat-rush	1
Lomandra leucocephala subsp. robusta	Woolly Mat-rush	8
Lotus australis var. australis	Austral Trefoil	3
Lotus cruentus	Red Bird's-foot Trefoil	2
Maireana brevifolia	Short-leaf Bluebush	9
Maireana decalvans	Black Cotton-bush	7
Maireana erioclada	Rosy Bluebush	1
Maireana pentatropis	Erect Bluebush	3
Maireana spp.	Bluebush	2

Maireana trichoptera	Hairy-wing Bluebush	1
Maireana turbinata	Satiny Bluebush	1
Malacocera tricornis	Goat Head	1
Malva preissiana s.l.	Australian Hollyhock	1
Marsdenia australis	Doubah	2
Marsilea costulifera	Narrow-leaf Nardoo	1
Marsilea drummondii	Common Nardoo	7
Melaleuca lanceolata subsp. lanceolata	Moonah	2
Microseris spp.	Yam Daisy	1
Minuria cunninghamii	Bush Minuria	1
Morgania glabra spp. agg.	Blue Rod	1
Muehlenbeckia diclina	Twiggy Lignum	1
Muehlenbeckia florulenta	Tangled Lignum	9
Myoporum platycarpum subsp. perbellum	Sugarwood	2
Myosurus australis	Mousetail	1
Myriophyllum papillosum	Robust Water-milfoil	1
Nitraria billardierei	Nitre-bush	2
Olearia lepidophylla	Club-moss Daisy-bush	3
Olearia muelleri	Mueller Daisy-bush	1
Olearia pimeleoides	Pimelea Daisy-bush	8
Opercularia turpis	Twiggy Stinkweed	2
Osteocarpum acropterum var. deminutum	Babbagia	2
Ottelia ovalifolia subsp. ovalifolia	Swamp Lily	2
Oxalis perennans	Grassland Wood-sorrel	5
Panicum effusum	Hairy Panic	1
Paspalidium constrictum	Knottybutt Grass	3
Paspalidium jubiflorum	Warrego Summer-grass	21
Phascum robustum	Ball Moss	2
Phascum robustum var. robustum	Ball Moss	1
Phebalium bullatum	Desert Phebalium	1
Physcomitrella patens subsp. readeri	Earth Moss	1
Picris angustifolia	Native Picris	2
Picris squarrosa	Squat Picris	6
Pimelea micrantha	Silky Rice-flower	1
Pimelea trichostachya	Annual Rice-flower	4
Pittosporum angustifolium	Weeping Pittosporum	4
Plantago cunninghamii	Clay Plantain	2
Plantago turrifera	Crowned Plantain	2
Poa labillardierei var. labillardierei	Common Tussock-grass	1
Podolepis capillaris	Wiry Podolepis	8
Pogonolepis muelleriana	Stiff Cup-flower	2
Polycalymma stuartii	Poached-eggs Daisy	4
Polygonum plebeium	Small Knotweed	2
Pottia spp.	Pottia	1
Prostanthera serpyllifolia subsp. microphylla	Small-leaf Mint-bush	1
Pseudognaphalium luteoalbum	Jersey Cudweed	6

Pseudoraphis spinescens	Spiny Mud-grass	2
Pterygoneurum ovatum	Earth Moss	2
Pterygoneurum spp.	Earth Moss	2
Ptilotus polystachyus var. polystachyus	Long Tails	3
Ptilotus seminudus	Rabbit Tails	5
Ranunculus pentandrus var. platycarpus	Inland Buttercup	1
Ranunculus pumilio	Ferny Small-flower Buttercup	1
Ranunculus pumilio var. pumilio	Ferny Small-flower Buttercup	1
Rhagodia spinescens	Hedge Saltbush	19
Rorippa laciniata	Jagged Bitter-cress	2
Rumex brownii	Slender Dock	2
Rumex tenax	Narrow-leaf Dock	1
Rytidosperma caespitosum	Common Wallaby-grass	24
Salsola tragus	Prickly Saltwort	8
Salsola tragus subsp. tragus	Prickly Saltwort	2
Salvia spp.	Sage	1
Santalum leptocladum	Southern Sandalwood	5
Sarcozona praecox	Sarcozona	2
Schoenus subaphyllus	Desert Bog-sedge	1
Scleranthus minusculus	Cushion Knawel	4
Sclerochlamys brachyptera	Short-wing Saltbush	7
Sclerolaena diacantha	Grey Copperburr	18
Sclerolaena muricata	Black Roly-poly	2
Sclerolaena muricata var. villosa	Grey Roly-poly	1
Sclerolaena obliquicuspis	Limestone Copperburr	3
Sclerolaena parviflora	Mallee Copperburr	6
Sclerolaena tricuspis	Streaked Copperburr	7
Senecio glossanthus s.l.	Slender Groundsel	10
Senecio quadridentatus	Cotton Fireweed	6
Senecio runcinifolius	Tall Fireweed	3
Senna artemisioides spp. agg.	Desert Cassia	1
Senna form taxon 'coriacea'	Broad-leaf Desert Cassia	4
Senna form taxon 'filifolia'	Fine-leaf Desert Cassia	4
Senna form taxon 'petiolaris'	Woody Cassia	5
Sida corrugata	Variable Sida	6
Sida intricata	Twiggy Sida	1
Sida trichopoda	Narrow-leaf Sida	8
Solanum esuriale	Quena	3
Solanum spp.	Nightshade	3
Sphaeromorphaea australis	Spreading Nut-heads	1
Sporobolus mitchellii	Rat-tail Couch	7
Spyridium eriocephalum var. eriocephalum	Heath Spyridium	1
Stelligera endecaspinis	Star Bluebush	14
Stemodia florulenta	Blue Rod	1
Stenopetalum lineare	Narrow Thread-petal	4

Swainsona phacoides	Dwarf Swainson-pea	6
Tetragonia eremaea s.s.	Desert Spinach	1
Tetragonia moorei	Annual Spinach	1
Teucrium racemosum s.s.	Grey Germander	1
Thysanotus baueri	Mallee Fringe-lily	2
Tortula atrovirens	Flamingo Moss	1
Tortula pagorum	Screw Moss	1
Tortula papillosa	Screw Moss	1
Tortula spp.	Screw Moss	1
Triglochin multifructa	Northern Water-ribbons	1
Triodia scariosa	Porcupine Grass	10
Triptilodiscus pygmaeus	Common Sunray	1
Triraphis mollis	Needle Grass	1
Verbena officinalis s.l.	Common Verbena	1
Vittadinia cervicularis	Annual New Holland Daisy	1
Vittadinia cervicularis var. cervicularis	Annual New Holland Daisy	4
Vittadinia cervicularis var. subcervicularis	Annual New Holland Daisy	7
Vittadinia cuneata	Fuzzy New Holland Daisy	1
Vittadinia dissecta s.l.	Dissected New Holland Daisy	9
Vittadinia dissecta var. hirta	Dissected New Holland Daisy	6
Vittadinia gracilis	Woolly New Holland Daisy	7
Vittadinia spp.	New Holland Daisy	7
Wahlenbergia fluminalis	River Bluebell	10
Walwhalleya proluta	Rigid Panic	6
Westringia rigida	Stiff Westringia	5
Xerochrysum bracteatum	Golden Everlasting	1
Zygophyllum ammophilum	Sand Twin-leaf	2
Zygophyllum apiculatum	Pointed Twin-leaf	2
Zygophyllum aurantiacum subsp. aurantiacum	Shrubby Twin-leaf	5
Zygophyllum ovatum	Dwarf Twin-leaf	2

Flora – Exotic

Scientific Name	Common Name	Records
Alopecurus geniculatus	Marsh Fox-tail	1
Arctotheca calendula	Cape Weed	3
Asparagus asparagoides	Bridal Creeper	4
Asparagus officinalis	Asparagus	9
Asphodelus fistulosus	Onion Weed	8
Aster subulatus	Aster-weed	1
Avena barbata	Bearded Oat	9
Avena spp.	Oat	2
Brassica tournefortii	Mediterranean Turnip	30
Briza maxima	Large Quaking-grass	1
Bromus diandrus	Great Brome	14

Bromus rubens	Red Brome	22
Carthamus lanatus	Saffron Thistle	1
Centaurea melitensis	Malta Thistle	2
Chenopodium album	Fat Hen	1
Chondrilla juncea	Skeleton Weed	6
Chrysanthemoides monilifera	Boneseed	1
Chrysanthemoides monilifera subsp. monilifera	African Boneseed	1
Cirsium vulgare	Spear Thistle	6
Conyza bonariensis	Flaxleaf Fleabane	4
Conyza sumatrensis	Tall Fleabane	1
Cotula bipinnata	Ferny Cotula	3
Crassula natans var. minus	Water Crassula	1
Cucumis myriocarpus subsp. leptodermis	Paddy Melon	1
Dittrichia graveolens	Stinkwort	1
Echium plantagineum	Paterson's Curse	2
Eichhornia crassipes	Water Hyacinth	6
Gazania linearis	Gazania	1
Heliotropium europaeum	Common Heliotrope	1
Herniaria cinerea	Hairy Rupture-wort	1
Hordeum glaucum	Northern Barley-grass	1
Hordeum marinum	Sea Barley-grass	2
Hordeum murinum s.l.	Barley-grass	14
Hypochaeris glabra	Smooth Cat's-ear	30
Hypochaeris radicata	Flatweed	3
Lactuca saligna	Willow-leaf Lettuce	2
Lactuca serriola	Prickly Lettuce	5
Lamarckia aurea	Golden-top	1
Leontodon taraxacoides subsp. taraxacoides	Hairy Hawkbit	1
Lepidium africanum	Common Peppercress	2
Limonium sinuatum	Notch-leaf Sea-lavender	1
Lolium rigidum	Wimmera Rye-grass	6
Lycium ferocissimum	African Box-thorn	2
Marrubium vulgare	Horehound	3
Medicago minima	Little Medic	19
Medicago polymorpha	Burr Medic	8
Medicago sativa subsp. sativa	Lucerne	1
Mesembryanthemum spp.	Ice Plant	1
Oenothera stricta subsp. stricta	Common Evening-primrose	3
Opuntia robusta	Wheel Cactus	4
Opuntia spp.	Prickly Pear	5
Osteospermum clandestinum	Tripteris	18
Parapholis incurva	Coast Barb-grass	1
Pentameris airoides subsp. airoides	False Hair-grass	4
Phalaris minor	Lesser Canary-grass	1
Phalaris paradoxa	Paradoxical Canary-grass	1
Phyla canescens	Fog-fruit	6

Poa bulbosa var. bulbosa	Bulbous Meadow-grass	1
Polycarpon tetraphyllum	Four-leaved Allseed	2
Reichardia tingitana	False Sow-thistle	7
Rostraria pumila	Tiny Bristle-grass	3
Salvia verbenaca	Wild Sage	2
Schismus barbatus	Arabian Grass	16
Scorzonera laciniata	Scorzonera	1
Silene apetala var. apetala	Mallee Catchfly	16
Silene nocturna	Mediterranean Catchfly	6
Sisymbrium erysimoides	Smooth Mustard	4
Sisymbrium irio	London Rocket	2
Solanum nigrum s.s.	Black Nightshade	1
Solanum nigrum sensu Willis (1972)	Black Nightshade	2
Sonchus asper s.l.	Rough Sow-thistle	2
Sonchus oleraceus	Common Sow-thistle	20
Spergularia rubra s.l.	Red Sand-spurrey	7
Spergularia rubra s.s.	Red Sand-spurrey	1
Tragopogon porrifolius subsp. porrifolius	Salsify	1
Trifolium glomeratum	Cluster Clover	1
Verbesina encelioides subsp. encelioides	Crownbeard	1
Vulpia bromoides	Squirrel-tail Fescue	1
Vulpia myuros	Rat's-tail Fescue	15
Vulpia myuros f. myuros	Rat's-tail Fescue	2
Vulpia spp.	Fescue	2
Xanthium strumarium spp. agg.	Noogoora Burr species aggregate	1

Fauna – Native

Common Name	***Scientific Name***	**Type**	**Records**
Peaceful Dove	Geopelia striata	B	3
Common Bronzewing	Phaps chalcoptera	B	2
Crested Pigeon	Ocyphaps lophotes	B	4
Eurasian Coot	Fulica atra	B	2
Great Crested Grebe	Podiceps cristatus	B	1
Australasian Grebe	Tachybaptus novaehollandiae	B	2
Hoary-headed Grebe	Poliocephalus poliocephalus	B	2
Great Cormorant	Phalacrocorax carbo	B	3
Little Black Cormorant	Phalacrocorax sulcirostris	B	4
Darter	Anhinga novaehollandiae	B	2
Australian Pelican	Pelecanus conspicillatus	B	3
Masked Lapwing	Vanellus miles	B	1
Black-fronted Dotterel	Elseyornis melanops	B	2
Australian Pratincole	Stiltia isabella	B	1
Australian Bustard	Ardeotis australis	B	1
Australian White Ibis	Threskiornis molucca	B	1

Straw-necked Ibis	Threskiornis spinicollis	B	1
Royal Spoonbill	Platalea regia	B	1
Yellow-billed Spoonbill	Platalea flavipes	B	1
Eastern Great Egret	Ardea modesta	B	3
White-faced Heron	Egretta novaehollandiae	B	3
White-necked Heron	Ardea pacifica	B	3
Australian Wood Duck	Chenonetta jubata	B	5
Black Swan	Cygnus atratus	B	1
Pacific Black Duck	Anas superciliosa	B	8
Grey Teal	Anas gracilis	B	6
Australasian Shoveler	Anas rhynchotis	B	1
Pink-eared Duck	Malacorhynchus membranaceus	B	1
Hardhead	Aythya australis	B	1
Musk Duck	Biziura lobata	B	1
Collared Sparrowhawk	Accipiter cirrhocephalus	B	1
Little Eagle	Hieraaetus morphnoides	B	1
White-bellied Sea-Eagle	Haliaeetus leucogaster	B	3
Whistling Kite	Haliastur sphenurus	B	2
Square-tailed Kite	Lophoictinia isura	B	2
Southern Boobook	Ninox novaeseelandiae	B	2
Sulphur-crested Cockatoo	Cacatua galerita	B	6
Major Mitchell's Cockatoo	Lophocroa leadbeateri	B	1
Little Corella	Cacatua sanguinea	B	1
Long-billed Corella	Cacatua tenuirostris	B	1
Galah	Eolophus roseicapilla	B	13
Regent Parrot	Polytelis anthopeplus	B	6
Crimson Rosella	Platycercus elegans elegans	B	3
Yellow Rosella	Platycercus elegans flaveolus	B	3
Eastern Rosella	Platycercus eximius	B	3
Mallee Ringneck	Barnardius zonarius barnardi	B	1
Western Ringneck	Barnardius zonarius zonarius	B	1
Red-rumped Parrot	Psephotus haematonotus	B	5
Mulga Parrot	Psephotus varius	B	2
Blue Bonnet	Northiella haematogaster	B	1
Budgerigar	Melopsittacus undulatus	B	1
Laughing Kookaburra	Dacelo novaeguineae	B	6
Sacred Kingfisher	Todiramphus sanctus	B	6
Rainbow Bee-eater	Merops ornatus	B	2
Fork-tailed Swift	Apus pacificus	B	1
Pallid Cuckoo	Cuculus pallidus	B	1
Welcome Swallow	Hirundo neoxena	B	5
Tree Martin	Hirundo nigricans	B	4
Grey Fantail	Rhipidura albiscarpa	B	2
Willie Wagtail	Rhipidura leucophrys	B	10
Jacky Winter	Microeca fascinans	B	3
Red-capped Robin	Petroica goodenovii	B	3

Rufous Whistler	Pachycephala rufiventris	B	6
Grey Shrike-thrush	Colluricincla harmonica	B	7
Magpie-lark	Grallina cyanoleuca	B	8
Crested Bellbird	Oreoica gutturalis	B	1
Black-faced Cuckoo-shrike	Coracina novaehollandiae	B	3
White-winged Triller	Lalage sueurii	B	2
White-browed Babbler	Pomatostomus superciliosus	B	1
Chestnut-crowned Babbler	Pomatostomus ruficeps	B	4
Western Gerygone	Gerygone fusca	B	2
Weebill	Smicrornis brevirostris	B	10
Southern Whiteface	Aphelocephala leucopsis	B	4
Chestnut-rumped Thornbill	Acanthiza uropygialis	B	4
Buff-rumped Thornbill	Acanthiza reguloides	B	2
Yellow-rumped Thornbill	Acanthiza chrysorrhoa	B	3
Brown Songlark	Cincloramphus cruralis	B	2
Rufous Songlark	Cincloramphus mathewsi	B	4
Superb Fairy-wren	Malurus cyaneus	B	3
Splendid Fairy-wren	Malurus splendens	B	1
Variegated Fairy-wren	Malurus lamberti	B	1
Varied Sittella	Daphoenositta chrysoptera	B	1
Brown Treecreeper (south-eastern ssp.)	Climacteris picumnus victoriae	B	7
Mistletoebird	Dicaeum hirundinaceum	B	3
Spotted Pardalote	Pardalotus punctatus	B	1
Silvereye	Zosterops lateralis	B	2
Brown-headed Honeyeater	Melithreptus brevirostris	B	3
Striped Honeyeater	Plectorhyncha lanceolata	B	1
Yellow-plumed Honeyeater	Lichenostomus ornatus	B	1
White-plumed Honeyeater	Lichenostomus penicillatus	B	8
Noisy Miner	Manorina melanocephala	B	7
Yellow-throated Miner	Manorina flavigula	B	2
Red Wattlebird	Anthochaera carunculata	B	2
Spiny-cheeked Honeyeater	Acanthagenys rufogularis	B	2
Blue-faced Honeyeater	Entomyzon cyanotis	B	1
Little Friarbird	Philemon citreogularis	B	4
White-winged Chough	Corcorax melanorhamphos	B	4
Grey Currawong	Strepera versicolor	B	1
Pied Butcherbird	Cracticus nigrogularis	B	5
Grey Butcherbird	Cracticus torquatus	B	1
Australian Magpie	Gymnorhina tibicen	B	8
Australian Raven	Corvus coronoides	B	9
Little Raven	Corvus mellori	B	2
Striated Pardalote	Pardalotus striatus	B	6
Platypus (1970)	Ornithorhynchus anatinus	M	2
Short-beaked Echidna	Tachyglossus aculeatus	M	1
Common Brushtail Possum	Trichosurus vulpecula	M	2

Feathertail Glider	Acrobates pygmaeus	M	2
Black Wallaby	Wallabia bicolor	M	1
Western Grey Kangaroo	Macropus fuliginosus	M	4
Water Rat	Hydromys chrysogaster	M	1
Marbled Gecko	Christinus marmoratus	R	4
Southern Legless Lizard	Delma australis	R	2
Burton's Snake-Lizard	Lialis burtonis	R	1
Grey's Skink	Menetia greyii	R	3
Western Blue-tongued Lizard	Tiliqua occipitalis	R	1
Carpet Python	Morelia spilota metcalfei	R	16
Plains Froglet	Crinia parinsignifera	A	2
Growling Grass Frog	Litoria raniformis	A	1
Flat-headed Gudgeon	Philypnodon grandiceps	F	1
Dwarf Flat-headed Gudgeon	Philypnodon sp. nov.	F	1

Legend
Type: Invertebrate, Fish, Amphibian, Reptile, Bird, Mammal

Fauna – Exotic

Common Name	***Scientific Name***	**Type**	**Records**
Common Blackbird	*Turdus merula*	B	1
House Sparrow	*Passer domesticus*	B	2
Common Starling	*Sturnus vulgaris*	B	3
European Rabbit	*Oryctolagus cuniculus*	M	3

Legend
Type: Invertebrate, Fish, Amphibian, Reptile, Bird, Mammal

APPENDIX 4: ECOLOGICAL VEGETATION CLASSES

Description of each EVC in the Murrumbidgee Junction WMU

EVC no.	EVC name	Bioregional Conservation Status	Description
		Murray Fans	
809	Floodplain Grassy Wetland	Endangered	Wetland dominated by floating aquatic grasses (which persist to some extent as turf during drier periods), occurring in the most flood-prone riverine areas. Typically treeless, but sometimes with thickets of saplings or scattered more mature specimens of Eucalyptus camaldulensis. Occupies temporary shallow lakes in the most flood-prone riverine areas, also occurs as a narrow intermediate band around some floodway ponds.
810	Floodway Pond Herbland	Depleted	Low herbland to < 0.3 m tall with occasional emergent life forms, usually with a high content of ephemeral species. Floors of ponds associated with floodway systems. Typically heavy deeply cracking clay soils. Characteristically smaller wetlands with a more regular flooding and drying cycle in comparison to sites supporting Lake Bed Herbland.
811	Grassy Riverine Forest /Floodway Pond Herbland Complex	Depleted	Eucalypt forest or woodland of flood-prone areas, where herbaceous species characteristic of drying mud within wetlands (Floodway Pond Herbland or in part Lake Bed Herbland) are conspicuous in association or fine-scale mosaic with Paspalidium jubiflorum and other species characteristic of Grassy Riverine Forest. Restricted extent, Murray River system mainly in far north-west, but upstream at least as far as Barmah Forest.
106	Grassy Riverine Forest	Depleted	Occurs on the floodplain of major rivers, in a slightly elevated position where floods are infrequent, on deposited silts and sands, forming fertile alluvial soils. River Red Gum forest to 25 m tall with a groundlayer dominated by graminoids. Occasional tall shrubs present.
808	Lignum Shrubland (Murray Mallee Bioregion)	Vulnerable	Relatively open shrubland of species of divaricate growth form. The ground-layer is typically herbaceous or a turf grassland, rich in annual/ephemeral herbs and small chenopods. Characterised the open and even distribution of relatively small Lignum shrubs. Occupies heavy soil plains along Murray River, low-lying areas on higher-level (but still potentially flood-prone) terraces.
823	Lignum Swampy Woodland	Vulnerable	Understorey dominated by Lignum, typically of robust character and relatively dense (at least in patches), in association with a low Eucalypt and/or Acacia woodland to 15 m tall. The ground layer includes a component of obligate wetland flora that is able to persist even if dormant over dry periods.
103	Riverine Chenopod Woodland	Endangered	Eucalypt woodland to 15 m tall with a diverse shrubby and grassy understorey occurring on most elevated riverine terraces. Confined to heavy clay soils on higher level terraces within or on the margins of riverine floodplains (or former floodplains), naturally subject to only extremely infrequent incidental shallow flooding from major events if at all flooded.
295	Riverine Grassy Woodland	Vulnerable	Occurs on the floodplain of major rivers, in a slightly elevated position where floods are rare, on deposited silts and sands, forming fertile alluvial soils. River Red Gum woodland to 20 m tall with a groundlayer dominated by graminoids and sometimes lightly shrubby or with chenopod shrubs.
97	Semi-arid Woodland	Vulnerable	Non-eucalypt woodland or open forest to 12 m tall, of low rainfall areas. Occurs in a range of somewhat elevated positions not subject to flooding or inundation. The surface soils are typically light textured loamy sands or sandy loams.
200	Shallow Freshwater Marsh	Vulnerable	Generally, shallow freshwater marshes are no more than half a metre deep and usually dry out in summer. They are usually formed in volcanic flow beds. Large stands of River Red Gum or Lignum are often found around shallow freshwater marshes, with reeds, rushes and Cane Grass, or low-growing herbs and sedges, dominating the vegetation.
818	Shrubby Riverine Woodland	Least Concern	Eucalypt woodland to open forest to 15 m tall of less flood-prone (riverine) watercourse fringes, principally on levees and higher sections of point-bar deposits. The understorey includes a range of species shared with drier floodplain habitats with a sparse shrub component, ground-layer patchily dominated by various life-forms. A range of large dicot herbs (mostly herbaceous perennial, several with a growth-form approaching that of small shrub) are often conspicuous.

824	Woorinen Mallee	Vulnerable	Widespread mallee woodland to 12 m tall, associated with the east-west orientated calcareous dunefields of the Woorinen Formation with a low, open chenopod dominated shrub understorey. A diverse array of sub-shrubs, herbs and grasses are also present. Typically occurs on fine textured red-brown sandy loam and clay loam soils.

APPENDIX 5: INDEX OF WETLAND CONDITION METHOD

Sub-indices

The table below shows what is measured for each of the six sub-indices and how each sub-index is scored. The sections below describe this in greater detail. Further information can be found on the IWC website (www.dse.vic.gov.au/conservation-and-environment/biodiversity/wetlands/index-of-wetland-condition).

IWC sub-indices and measures

Sub-index	What is measured	How it is scored
Wetland catchment	The intensity of the land use within 250 metres of the wetland	The more intensive the landuse the lower the score
	The width of the native vegetation surrounding the wetland and whether it is a continuous zone or fragmented	The wider the zone and more continuous the zone, the higher the score
Physical form	Whether the size of the wetland has been reduced from its estimated pre-European settlement size	A reduction in area results in a lowering of the score
	The percentage of the wetland bed which has been excavated or filled	The greater the percentage of wetland bed modified, the lower the score
Hydrology	Whether the wetland's water regime (i.e. the timing, frequency of filling and duration of flooding) has been changed by human activities	The more severe the impacts on the water regime, the lower the score
Water properties	Whether activities and impacts such as grazing and fertilizer run-off that would lead to an input of nutrients to the wetland are present	The more activities present, the lower the score
	Whether the wetland has become more saline or in the case of a naturally salty wetland, whether it has become more fresh	An increase in salinity for a fresh wetland lowers the score or a decrease in salinity of a naturally salty wetland lowers the score
Soils	The percentage and severity of wetland soil disturbance from human, feral animals or stock activities	The more soil disturbance and the more severe it is, the lower the score
Biota	The diversity, health and weediness of the native wetland vegetation	The lower the diversity and poorer health of native wetland vegetation, the lower the score
		The increased degree of weediness in the native wetland vegetation, the lower the score

Scoring method

Each subindex is given a score between 0 and 20 based on the assessment of a number of measures as outline above. Weightings are then applied to the scores as tabulated below. The maximum possible total score for a wetland is 38.4. For ease of reporting, all scores are normalised to an integer score out of 10 (i.e. divide the total score by 38.4, multiply by 10 and round to the nearest whole number).

IWC sub-index	Weight
Biota	0.73
Wetland catchment	0.26
Water properties	0.47
Hydrology	0.31
Physical form	0.08
Soils	0.07

Five wetland condition categories have been assigned to the sub-index scores and total IWC scores as tabulated over page. The five category approach is consistent with the number of categories used in other condition indices such as the Index of Stream Condition. Biota sub-index score categories were determined by expert opinion and differ to those of the other sub-indices.

Non-biota sub-index score range	Biota sub-index score range	Total score range	Wetland condition category
0-4	0-8	0-2	Very poor
5-8	9-13	3-4	Poor
9-12	14-16	5-6	Moderate
13-16	17-18	7-8	Good
16-20	19-20	9-10	Excellent
N/A	N/A	N/A	Insufficient data

APPENDIX 6 CULTURAL HERITAGE CONTINGENCY PLAN

CONTINGENCY PLANS

In the event that Aboriginal cultural heritage is found during the conduct of the activity, contingency measures are set out below. The contingency measures set out the sponsor's requirements in the event that Aboriginal cultural heritage is identified during the conduct of the activity.

1 Management of Aboriginal Cultural Heritage found during the Activity

In the event that new Aboriginal cultural heritage is found during the conduct of the activity, then the following must occur:

* The person who discovers Aboriginal cultural heritage during the activity will immediately notify the person in charge of the activity;
* The person in charge of the activity must then suspend any relevant works at the location of the discovery and within 5m of the relevant place extent;
* In order to prevent any further disturbance, the location will be isolated by safety webbing or an equivalent barrier and works may recommence outside the area of exclusion;
* The person in charge of the activity must contact the and the **Mallee CMA Indigenous Facilitator**
* Within a period not exceeding 1 working days a decision/ recommendation will be made by the the **Mallee CMA Indigenous Facilitator** and the **Aboriginal stakeholder** ;
* as to the process to be followed to manage the Aboriginal cultural heritage in a culturally appropriate manner, and how to proceed with the works;
  ○

Separate contingency plan has been developed in the event that suspected human remains are discovered during the conduct of the activity.

* .

2 Notification of the Discovery of Skeletal Remains during the carrying out of the Activity

1. Discovery:

* If suspected human remains are discovered, all activity in the vicinity must ***stop*** to ensure minimal damage is caused to the remains, and,
* The remains must be left in place, and protected from harm or damage.

2. Notification:

* Once suspected human skeletal remains have been found, Victoria Police (use the local number) and the Coroner's Office (1300 309 519) must be notified immediately;
* If there is reasonable grounds to believe that the remains could be Aboriginal, the DSE Emergency Co-ordination Centre must be immediately notified on 1300 888 544; and
* All details of the location and nature of the human remains must be provided to the relevant authorities.
* If it is confirmed by these authorities that the discovered remains are Aboriginal skeletal remains, the person responsible for the activity must report the existence of the human remains to the Secretary, DPCD in accordance with s.17 of the Act.

3. Impact Mitigation or Salvage:

* The Secretary, after taking reasonable steps to consult with any Aboriginal person or body with an interest in the Aboriginal human remains, will determine the appropriate course of action as required by

s.18(2)(b) of the Act.

∗ An appropriate impact mitigation or salvage strategy as determined by the Secretary must be implemented.

4. Curation and Further Analysis:

∗ The treatment of salvaged Aboriginal human remains must be in accordance with the direction of the Secretary.

5. Reburial:

∗ Any reburial site(s) must be fully documented by an experienced and qualified archaeologist, clearly marked and all details provide to AAV;

Appropriate management measures must be implemented to ensure that the remains

ARE NOT DISTURBED IN THE FUTURE