Piambie Environmental Water Management Plan

mallee catchment management authority

Department of Environment, Land, Water & Planning

State Government Victoria

Version number	Description		Issue date
1	First Draft Report	Leonie North (Sunraysia Environmental Pty Ltd)	09/04/2015
2	Second Draft Report	Sally Bates	17/04/2015
3	Internal Review	Leonie North	24/04/2015
4	External Review	Simone Wilkie (Riverness)	4/05/15
5	Board Endorsement	Mallee CMA Board Members	21/05/2015
6	Submission to DELWP	Susan Watson	1/06/2015
7	Updated watering regime to include flood events	Jane White	2/02/2018
8	Reviewed and updated	Jennifer Munro	6/03/2020

Citation

Please cite this document as:

Mallee CMA (2015) Piambie Environmental Water Management Plan, Mallee CMA, Mildura, Victoria.

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CONTENTS

Executive summary

Environmental Water Management Plans (EWMPs) have been developed for key sites in the Mallee region. The Mallee Waterway Strategy 2014-22 (Mallee CMA, 2014) covers 216 identified waterways which have been grouped into planning units according to hydrological interconnectedness and commonality of threats impacting on the waterways values; resulting in 23 Waterway Management Units. This Environmental Water Management Plan (EWMP) sets out the long-term objectives for the priority environmental values of Piambie. It is an important part of the Victorian Environmental Water Planning Framework and provides the long-term management intentions, based on scientific information and stakeholder consultation that can be used by the respective agencies; Mallee Catchment Management Authority (CMA), Department of Environment, Land, Water and Planning (DELWP) and the Victorian Environmental Water Holder (VEWH); for both short and longer-term environmental water planning.

Piambie is located in the Murray Fans bioregion within the Mallee Catchment Management Authority (Mallee CMA) region 5 km east of the township of Piambie and covers 2,170 ha. The target area for this EWMP covers 389 ha and includes Bridge Creek and Bridge Creek floodplain; a complex of three wetlands known as Fishers Lagoon Complex; and smaller wetlands close to the Murray River known as Piambie Bend East and Piambie Bend West.

Piambie consists of a forested floodplain area with a creek and several wetlands, ranging from deep to shallow freshwater. These provide habitat for a large range of fauna. Records indicate 47 species of bird and six listed species of native fauna observed at Piambie, including the Inland Carpet Python (*Morelia spilota metcalfei*) and White-bellied Sea-eagle (*Haliaeetus leucogaster*).

In addition, Piambie is one of only a handful of sites in the Mallee CMA region where Tough Scurf-pea (*Cullen tenax*) is known to occur. A key recommendation is to map the extent of this species to enable exclusion zones for earthworks. Other significant flora in the target area includes the iconic River Red Gum, Black Box and Lignum communities, which provide habitat to native fauna.

The floodplains and wetlands will continue to receive less than their optimal 'natural' frequency of flooding without intervention. This declining floodplain vegetation health, diversity of habitat types, and presence of water-dependent endangered species suggest the site would respond well to environmental watering.

The long-term management goal of the Piambie EWMP is to provide a flow regime that more closely reflects natural events, thus improving the capacity of the target area to provide a productive ecosystem for native flora and fauna.

To achieve this, ecological and hydrological objectives, were designed with the consideration of separate inundation zones. These have been developed to sustain the various ecological components of Bridge Creek and five targeted wetlands and have been incorporated into an optimal watering regime. The ecological objectives for the Piambie target area are outlined below:

Bridge Creek, Bridge Creek Floodplain

- Improve vegetation health and structure in the River Red Gum (*Eucalyptus camaldulensis)* communities (EVCs 106, 295, 809, 813, 818, 823)
- Improve vegetation health and structure in the Black Box (*Eucalpytus largiflorens)* communities (EVCs 103, 813, 818, 823)
- Improve vegetation health and structure in the Lignum (*Muehlenbeckia florulenta*) communities (EVCs 104, 813, 818, 823)

Fishers Lagoon Complex

- Increase aquatic macrophyte diversity and area in the Freshwater marsh habitats (EVCs 200, 810, 811)
- Maintain vegetation health and structure in the fringing River Red Gum communities (EVCs 106, 809, 813, 818, 823)

Piambie Bends East and West

- Increase aquatic macrophyte diversity and area in the Freshwater marsh habitats (EVCs 200, 810, 811)
- Maintain vegetation health and structure in the fringing River Red Gum communities (EVCs 106, 809, 813, 818, 823)

All Areas

Increase dissolved organic matter, particulate matter and macro-invertebrate productivity

The optimal watering regime for Piambie is outlined below:

Bridge Creek, Floodplain and Fishers Lagoon Complex
Inundate the length of Bridge Creek through to Fishers Lagoon Complex three years in ten with a maximum interval of seven years between events. Maintain water in the creek and on the floodplain for three months to improve health of fringing River Red Gum and floodplain Black Box and Lignum. Allow Fishers Lagoon Complex to recede slowly. It is expected water will be retained in Fishers Lagoon Complex for two years, resulting in inundation of this area for six in ten years to encourage aquatic macrophyte diversity.

Piambie Bends East and West
Inundate the wetlands and fringing River Red Gum Woodlands six times in ten years with a maximum interval of three years between events. Maintain water on the floodplain for two months to maintain the health of River Red Gum communities and in the wetland for four months to maintain wetland function.

The delivery of environmental water necessary for these water regimes will require the installation of infrastructure, outlined in this plan. The proposed infrastructure requires further investigation and design.

Acknowledgements

The EWMP was produced by the Mallee Catchment Management Authority, with funding from the Victorian Government. The valuable contributions of Parks Victoria, Jane Roberts, Terry Hillman, other agencies and community members are also acknowledged.

1 Introduction

This Environmental Water Management Plan (EWMP) has been prepared by Sunraysia Environmental on behalf of the Mallee CMA to establish the long-term management goals of the Piambie floodplain and its associated wetlands and creek system.

The key purposes of the EWMP are to:

- identify the long-term objectives and water requirements for Bridge Creek, identified as a high priority reach, and Fishers Lagoon Complex identified as a medium priority in the *Mallee Waterway Strategy* (MWS);
- identify the long-term objectives and water requirements for the Bridge Creek Floodplain and two other floodplain wetlands within the Piambie area (Piambie Bend East and Piambie Bend West);
- provide a vehicle for community consultation, including for the long-term objectives and water requirements of the wetland;
- inform the development of seasonal watering proposals and seasonal watering plans;
- inform Long-term Watering Plans that will be developed under Basin Plan requirements.

A context document has been created to complement the Mallee CMA EWMPs and should be read in conjunction with this document (Sunraysia Environmental, 2014).

2 Site overview

2.1 Site Location

The Mallee CMA region is situated in the north-west of Victoria. The area of responsibility is close to 39,000km² (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 CMA in the state.

Approximately 40% of the land area within the Mallee CMA boundary is public land, consisting mainly of national parks, reserves, wilderness, and large areas of riverine and dryland forests. The other 60% is predominantly dryland crops, 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.

In 2006, the Mallee CMA engaged consultants (Ecological Associates) to investigate water management options for the Murray River floodplain from Nyah to Robinvale. One of the major outcomes of these investigations was the development of a system of Floodplain Management Units (FMUs). These divide the floodplain into management units in which water regimes can be managed independently of another FMU, but that are relatively consistent in their ecological values and land uses. The Mallee CMA has based its environmental water management plans on these FMUs to achieve more effective management of hydrologically connected systems. In addition to this, the Mallee CMA has also used individual FMUs or groupings of FMUs to form Waterway Management Units (WMUs) for planning within its Mallee Waterway Strategy (MCMA, 2014).

The site for this plan is Piambie WMU sub unit. Piambie was formed from the grouping of the original FMU's Bridge Creek and Fishers Lagoon. Piambie now falls within the WMU of Heywood. Heywood encompasses both Piambie and Heywood Lakes WMU sub-units (MCMA, 2014). Piambie is located on the Murray River floodplain, approximately 5 km north east of the township of Piambie and 40 km north of Nyah, between 1275 and 1259 river km (Figure 1).

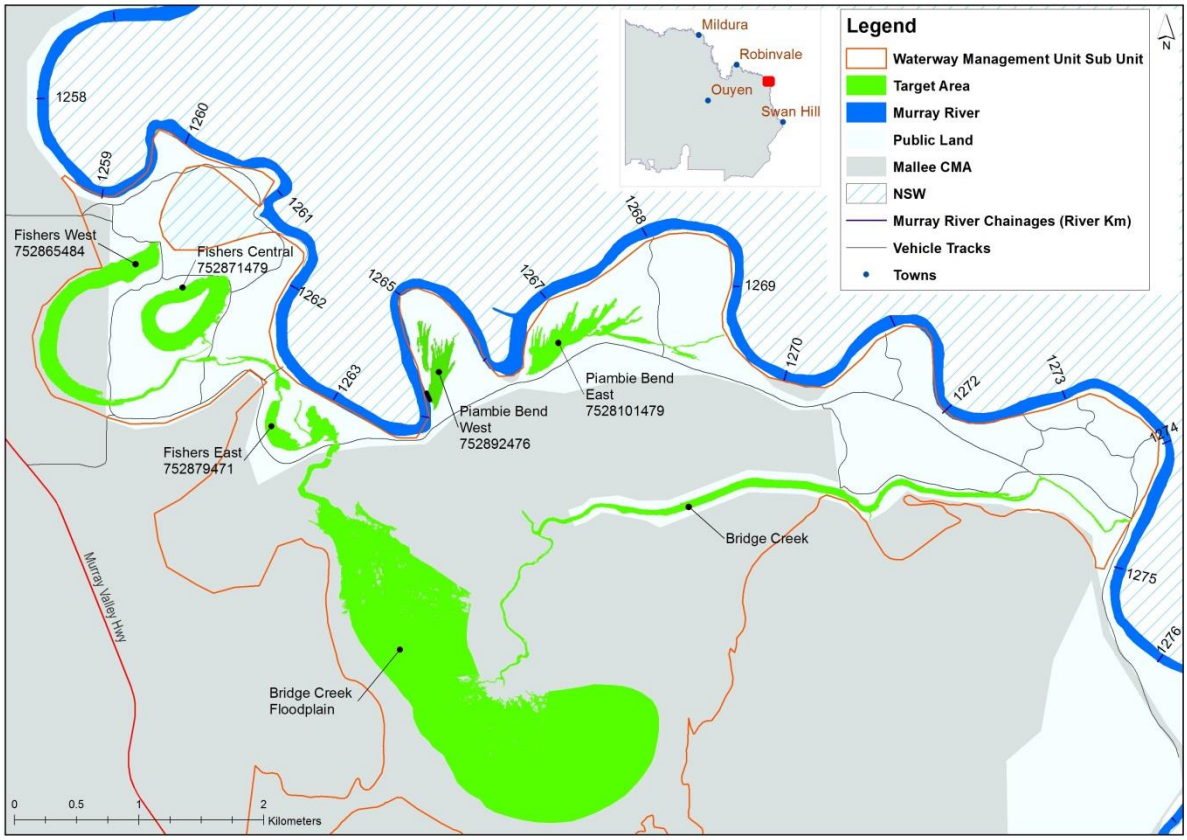


Figure 1 Piambie Target Area

2.2 Piambie

Piambie's target area includes Bridge Creek and Bridge Creek Floodplain and five of the nine wetlands: the Fishers Lagoon Complex, and two wetlands closer to the Murray River, referred to in this plan as Piambie Bend West and Piambie Bend East (Figure 1).

Bridge Creek is a wide creek bed fringed by River Red Gum and, on higher elevations, Black Box and Lignum. The creek meanders across the floodplain and becomes indistinguishable from the broader floodplain-wetland environment, before re-joining the northern end in a definable effluent, and flowing into Fishers Lagoon East, West and Central. Only the eastern most 7 km of Bridge Creek is indicated on Figure 1; the exact course across the floodplain is not currently recorded in the Mallee CMA spatial database; however the historical aerial imagery in Figure 2 provides an indication of flow path.

Figure 2. Imagery of the path of Bridge Creek across the Bridge Creek Floodplain

Bridge Creek Floodplain is not a mapped wetland. Higher flow volumes in Bridge Creek provide water to floodplain vegetation consisting of Lignum and Black Box communities.

Fishers Lagoon complex is mapped as three wetlands (Figure 1): Fishers Lagoon West (#7528 65484); Fishers Lagoon Central (#7528 71479); and Fishers Lagoon East (#7528 79471) and includes a rich mosaic of vegetation types.

Piambie Bend East (#7528 92476) and Piambie Bend West (#7528 101479) (Figure 1) are located close to the Murray River, consisting of herbland or marshland fringed by River Red Gum woodlands and grasslands.

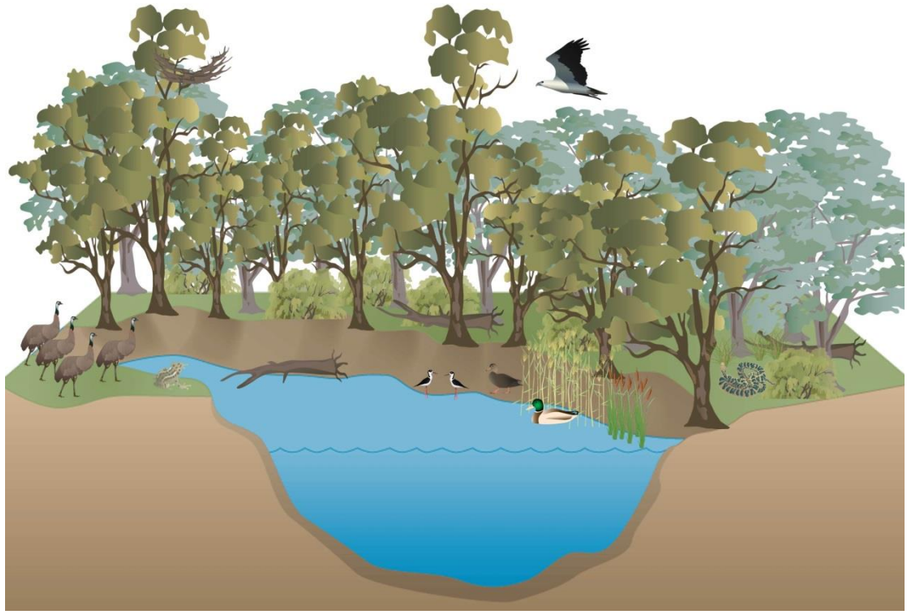
2.3 Conceptualisation of the Site

Piambie has been represented in a conceptual model. The model provides a visual representation of the site's processes and components that are discussed throughout this EWMP.

The vegetation structure of Piambie comprises **aquatic macrophytes** in Fishers Lagoon Complex and Piambie Bends East and West, and herbs and forbs at creek bed level. **River Red Gum** fringe the Creek, and on higher elevations of the floodplain, **Black Box** and **Lignum** are found.

Healthy vegetation structure provides habitat potential. Older Black Box and Red Gum can provide hollows for nests, **hollow logs** for the Inland **Carpet Python**, and a good understorey that is structurally diverse comprising **Lignum, grasses**, leaf matter and debris offer cover, forage, breeding and feeding sites.

Freshwater inflow**s** to the system will be delivered as environmental water to provide a range of feeding, breeding, watering points and habitats for native fauna. This inundation leads to the rapid release of nutrients from the soils, and the seed and egg banks of plants and aquatic invertebrates emerge. This pulse in aquatic macrophytes and invertebrates may provide food for aquatic fauna such as **frogs**, which in turn provides food for **waterbirds**. The wetland becomes more productive and surrounding vegetation such as **Lignum, understorey** and **Eucalypt** species benefit from periodic inundation as water levels rise and fall. Healthy vegetation may promote visitation by woodland birds such as the Regent Parrot, and terrestrial fauna for perching and nesting sites, and provides fallen timber and hollows for nesting and shelter.



Water Dependent Flora

- River Red Gum
- Black Box
- Lignum
- Reeds & Rushes

Habitat Value

- Grasses
- Fallen Timber
- Stick Nest

Wetland Fauna

- Small Waders
- Dabbling & Diving Ducks
- Grazing Waterfowl
- Frogs Species

Listed Species

- Inland Carpet Python
- White-bellied Sea-eagle
- Emu

2.4 Catchment Setting

Piambie is located in the Murray Fans bioregion, downstream of Nyah, and is characterised by a flat to gently undulating landscape on recent unconsolidated sediments with evidence of former stream channels, braided old river meanders, 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 (Chromosols and Sodosols) that support Riverine Grassy Forests and Riverine Grassy Chenopod Woodlands (DEPI 2014).

Piambie is located between several key sites on the Murray River: the junction of the Wakool and Murray Rivers is ten river kilometres upstream of Piambie; one kilometre upstream of this junction is the Nationally Important Major Mitchell Lagoons; and to the west is the Nationally Important Heywoods Lake.

The upstream extremity of Piambie marks the transition from the Riverine Tract to the Mallee Tract. The Mallee Tract extends from Wakool Junction to the Darling River Junction at Wentworth. Through this section, the river generally has a single channel within a large trench of 10-20 m (Thoms et al 2000).

West of Piambie the landscape follows a pattern typical of the Mallee CMA region, with floodplain giving way to grazing land, and elevated terraces of mallee dunes. To the south, the dunes surrounding Kenley have experienced significant irrigated horticultural development in recent years including winegrapes, almonds and citrus orchards. Significant irrigated horticultural development has also occurred around Piambie, extending from Heywoods Lake through the mallee dunes towards the Murray River floodplain. Cereal crops and grazing occur across parts of the floodplain. Piambie is bounded by the Murray River to the north and east.

Piambie is comprised predominantly of high level floodplain terraces and some deeply incised creeks and wetlands (EA 2006). Several former meander loops occur in low lying areas close to the Murray River.

2.5 Land Status and Management

Piambie includes the Proposed Murray River Park, the River Murray Reserve and several private tenures.

Public land extends as reserve along the Murray River frontage, and the eastern section of the creek for approximately 5 km, including approximately 2 km of creek reserve extending across private land (Figure 3). These areas are managed by Parks Victoria as a part of the proposed River Murray Reserve (VEAC 2008) in conjunction with the River Red Gum Forests Investigation (VEAC 2008). Relevant stakeholders are listed in Table 1.

Piambie is unusual in that it includes a large proportion of private land (64% or 1,386 ha) compared to the 784 ha of public land. The Proposed Murray River Park (formerly Piambie State Forest, VEAC 2008) at this location is supplemented by large areas of natural floodplain vegetation on areas of private land.

A meander loop of the Murray River forms a wetland around Canally Island. This area is currently under NSW jurisdiction (Figure 3), and outside the scope of this plan.

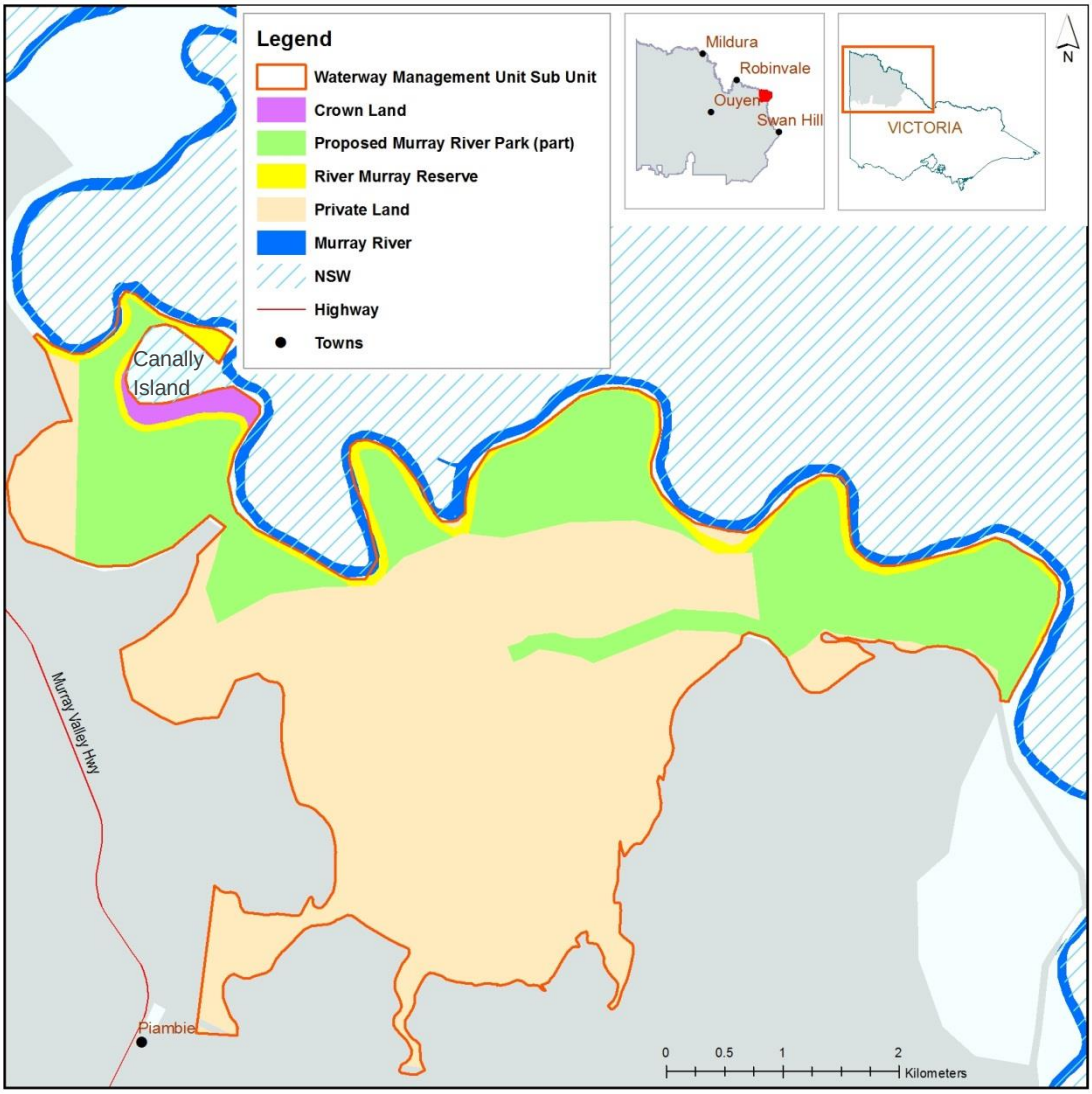


Figure 3. Land management boundaries at Piambie

Table 1. Stakeholders for Piambie

Group	Role
Parks Victoria	Land Manager
Mallee Catchment management Authority (Mallee CMA)	Regional environmental management
Department of Environment, Land, Water and Planning	State level environmental management
Goulburn Murray Water	River Murray operations
Swan Hill Rural City Council	Local Government
Aboriginal Stakeholders	Aboriginal Stakeholders, Provides assistance in planning and implementation of programs
Local Landholders	Land user, provides assistance in planning and implementation of programs
Kooloonong - Natya Landcare Group	Assistance in planning and implementation of programs
Victorian Environmental Water Holder	Determines locations and volumes for environmental water delivery

3 Creek and Wetland Characteristics

A brief overview of the main characteristics of the target area is provided in Table 2.

Table 2. Creek and Wetland Characteristics at Piambie

Characteristics	**Description**					
Name		Fishers Lagoon Complex				
	Bridge Creek	Fishers Lagoon East	Fishers Lagoon Central	Fishers Lagoon West	Piambie Bend West	Piambie Bend East
Mapping ID within area	N/A	#7528 79471	#7528 71479	#7528 65484	#7528 92476	#7528 101479
Area (ha)	25.8	11.3	21.4	30.8	8.6	16.5
Bioregion	Murray Fans					
Conservation status	Vulnerable & Endangered	Areas of Endangered, Vulnerable & Depleted			Areas of Depleted & Least Concern	Areas of Endangered, Vulnerable & Depleted
Land status	Private Land/ Reserve	Reserve	Reserve	Private Land / Reserve	Reserve	Reserve
Land manager	Landholder/ Parks Victoria	Parks Victoria	Parks Victoria	Landholder / Parks Victoria	Parks Victoria	Parks Victoria
Surrounding land use	Grazing/ Reserve	Reserve, Private Pump Access Road	Reserve	Irrigated agriculture / Reserve	Reserve	Reserve
Water supply	Murray River	Murray River	Murray River	Murray River	Murray River	Murray River
Commence to Flow (ML/day)*	29,200	60,700	60,700	14,000	168,000*	60,700*
1788 wetland category	N/A	Deep Freshwater Marsh	Permanent Open Freshwater	Permanent Open Freshwater	Deep Freshwater Marsh	Deep Freshwater Marsh
2013 wetland category and sub-category	N/A	Open water			Shallow Freshwater Marsh	Shallow Freshwater Marsh

Characteristics	Description					
Name	Bridge Creek	Fishers Lagoon Complex			Piambie Bend West	Piambie Bend East
		Fishers Lagoon East	Fishers Lagoon Central	Fishers Lagoon West		
Wetland depth at capacity	~2m	Unknown			Unknown	Unknown

** CTF values from Green & Alexander 2006, however it is suggested at least some of these are not accurate, in particular #7528 92476 and #7528 101479.*

3.1 Management Scale

3.1.1 Piambie EWMP Target Area

Piambie covers 2,170 ha, which includes Bridge Creek and nine wetlands. The whole of Piambie has a water requirement as a floodplain complex but the focus for this plan is restricted to a target area of 389 ha (Figure 1) including:

- Bridge Creek (25.8) and Bridge Creek Floodplain (275.9 ha);
- Fishers Lagoons Complex (63.5 ha);
- Piambie Bend East (16.5 ha); and
- Piambie Bend West (8.6 ha).

The 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 the Environmental Water Delivery Infrastructure Section.

Wetland #7528 71465 has been excluded from the target area as this wetland is positioned high on the floodplain (~57 m AHD) (Figure 5), and is outside the achievable inundation area. Wetland #7528 79464 is not intended to be watered due to its elevation and risk of inundating lower non-target areas. Two further wetlands close to the Murray River were not targeted for watering at the time of writing (#7528 123475 and #7528 126472) (Figure 4). These wetlands are important ecological assets that should benefit from Basin Plan flows along the Murray River.

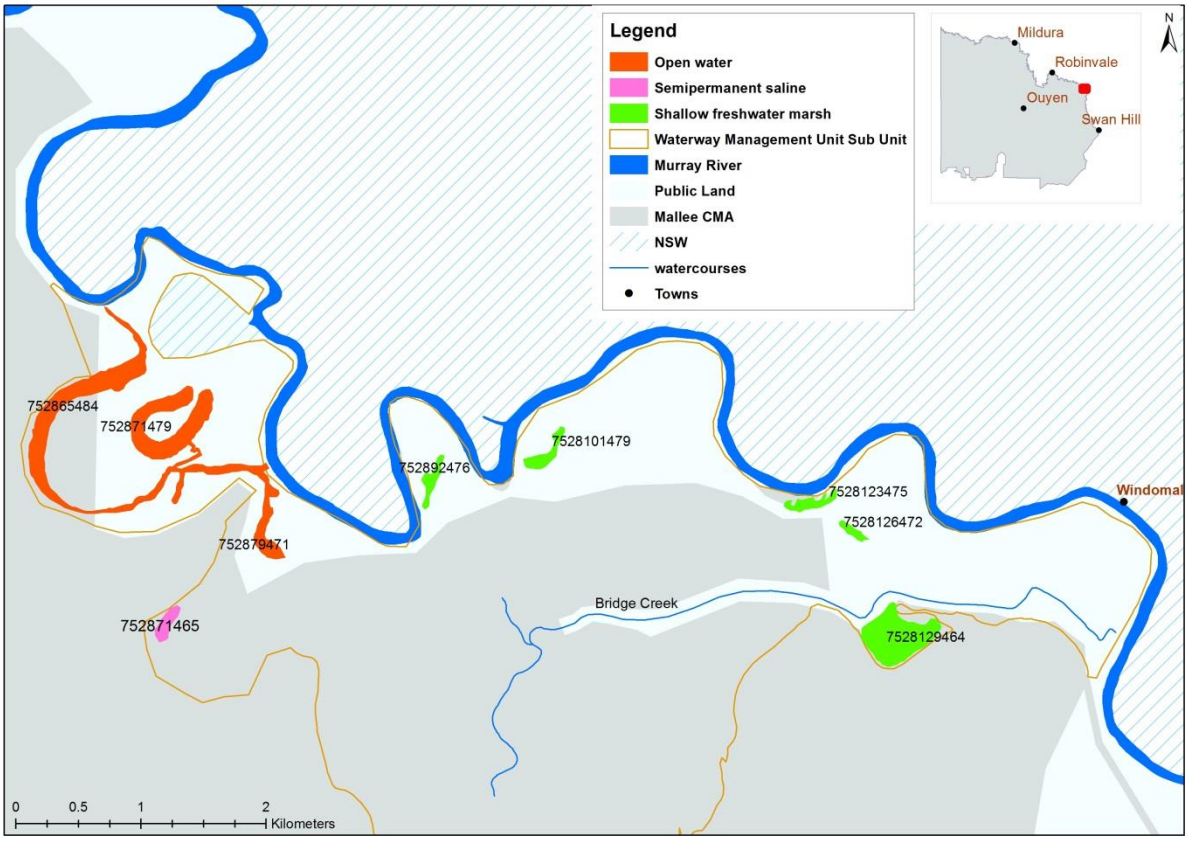


Figure 4. Wetlands at Piambie

3.1.2 Overview of the Watering Regime

Bridge Creek, Bridge Creek Floodplain and the Fishers Lagoon Complex can be watered as one management zone, with proposed infrastructure enabling inundation of an area of 365.2 ha.

Piambie Bend East (16.5 ha) and Piambie Bend West (8.6 ha), with proposed infrastructure, can each be watered independently of the other sites.

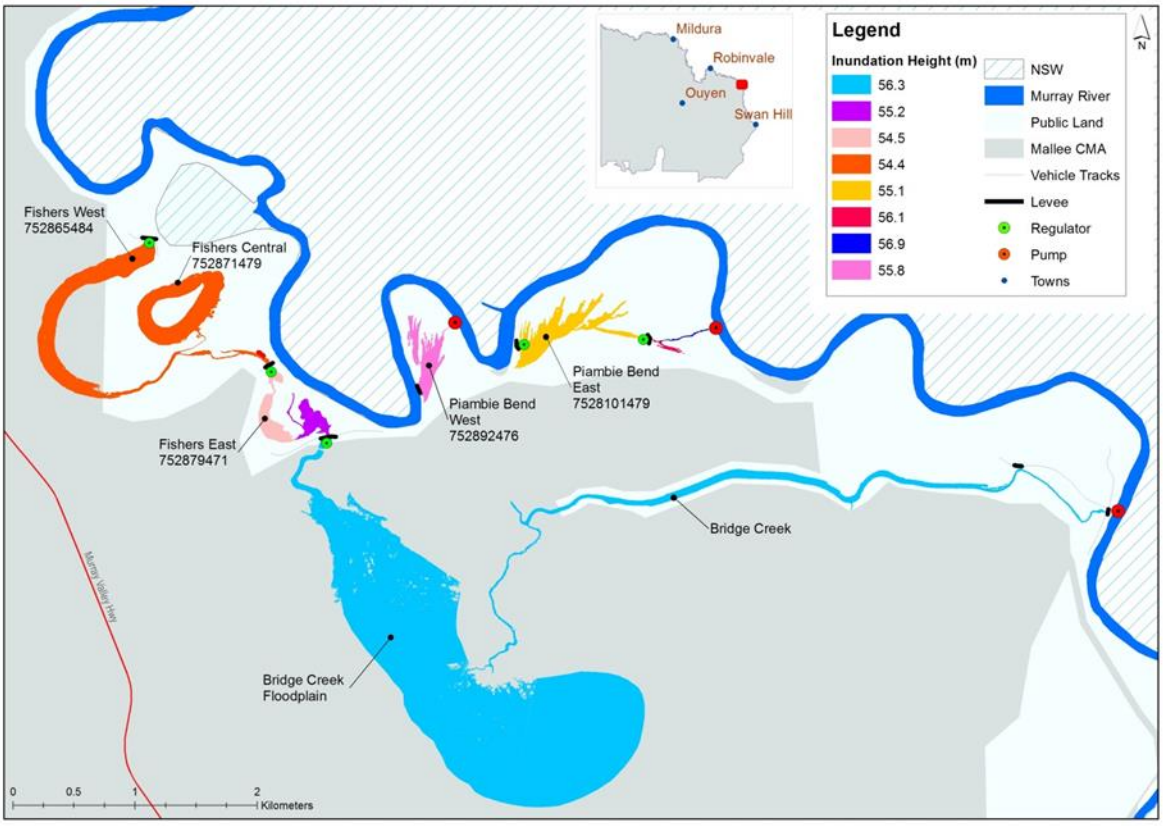


Figure 5. Proposed Infrastructure

3.2 Related Agreements, Policy, Plans and Activities

Piambie is situated on the Victorian floodplain of the Murray River which is the subject of investigation in many guises. These include Salinity Management Plans, environmental flow studies and Land Conservation Council Reviews. An investigation into River Red Gum Health by the Victorian Environmental Assessment Council (VEAC) in 2008 resulted in the Piambie area being changed from State Forest status to a Murray River Public Purposes Reserve in 2010.

The *Forest Management Plan for the floodplain State forests of the Mildura forest management area* (DSE 2004) notes Special Management Zones 704, 706, 707 and 708 within the Piambie area as Carpet Python (*Morelia spilota metcalfei*) Management Areas. The Plan also notes Special Protection Zones (SPZs) 710 and 711 for Tough Scurf-pea (*Cullen tenax*), and Bridge Creek Crown Reserve (40 m) as SPZs 705, 709 and 710. These zones combined encompass all of the public land within the Piambie unit.

The Mallee River Health Strategy (Mallee CMA 2006) refers to Bridge Creek and a description of high priority reach M3 of the Murray River, describing the significant value of the Bridge Creek area including the nearby occurrence of Wilga (*Geijera parviflora*) and the aforementioned Special Management Zones (SMZs) for the protection of Carpet Python.

The Mallee Waterway Strategy (Mallee CMA 2014) identifies Bridge Creek as a high priority waterway, and the Fishers Lagoon wetland complex as medium priority wetlands. Long term Resource Condition Targets include (Mallee CMA 2014):

- A. To improve the condition of riparian habitat associated with high and medium priority waterways by 2022.
- B. To improve the condition of aquatic habitat associated with high and medium priority waterways by 2022.
- C. To improve hydrology within high and medium priority waterways by 2022.
- D. To improve water quality within high and medium priority waterways by 2022.
- E. To increase the number of Cultural Heritage sites associated with priority waterways which are formally recorded and captured within registered management plans/agreements by 2022.
- F. To increase community understanding of, and participation in the management of, priority waterways by 2022.

Further information on management activities can be found in the *Mallee Waterway Strategy* (Mallee CMA 2014).

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 (DEPI 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 DEPI 2005). Duration, frequency and seasonality (timing) are the main components of the hydrological regime for wetlands, creeks and rivers.

The target area at Piambie is located on the Victorian floodplain of the Murray River (1275 km to 1259 km) just below river gauge (# 414200) below Wakool Junction. This area receives water from the Murray River, and the Edwards-Wakool system, which receives excess volume diverted from the Murray above the Barmah Choke.

Fishers Lagoon West commences to flow (*ctf*) with Murray River flows of 14,000 ML/day. Fishers Lagoon East and Central *ctf* are much higher, at 60,700 ML/day.

Bridge Creek commences to flow from its most eastern point at 1275 river km with Murray River flows of 29,700 ML/day. It is suggested that flows of 60,700 ML/d would enable water to flow along Bridge creek, into Bridge Creek Floodplain, and connect with the Fishers Lagoon Complex, which also connects to Fishers Lagoons Central and West.

Piambie Bend East would *ctf* with Murray River flows of 60,700 ML/d. The *ctf* value for Piambie Bend West of 168,000 ML/d is suspected to be incorrect, as the wetland is positioned close to the Murray River channel, on a narrow river bend.

4.1 Water Management and Delivery

4.1.1 Pre- Regulation

The junction of the Murray River and Edward-Wakool system occurs just upstream of Piambie. Prior to river regulation, the floodplain below the junction experienced inundation more frequently and these events had a greater duration (Ecological Associates 2007). Natural flows were highest in spring and lowest in autumn (Figure 6).

A Spells Analysis (Gippel 2014) for natural and baseline flows downstream of Euston (Figure 7) was the most representative for Piambie as it incorporates flows from the Edward River (Wakool Junction). However, its application has some limitations in this case, as the Euston data also incorporates inflows from the Murrumbidgee, the junction of which occurs downstream of Piambie.

According to the Spells Analysis, under natural conditions the floodplain in this reach of the Murray River experienced inundation twice as often and lasted twice as long:

- High flow events of 60,000 ML/day engaging the floodplain occurred on average 6.23 years in 10
- The median duration was 91 days (Gippel 2014).

4.1.2 Post regulation

The inundation events for waterways in the target area are now less frequent, with longer durations between events (Figure 7). The Spells Analysis for Euston suggests:

- High flow events of 60,000 ML/day engaging the floodplain occur on average 3.25 years in 10
- The median duration is now 38 days (Gippel 2014).

Preliminary analysis of gauge #414200 (below Wakool Junction) data since 1974 suggests the creek and the floodplain receive baseline flows of 60,700 ML/day on average only 2.5 years in 10 (Figure 8). This is slightly lower than the 3.25 years indicated using the Euston Downstream spells analysis. Euston generally receives higher peak flows (and includes Murrumbidgee flows). Euston and Wakool Junction follow similar peak flow patterns year on year, with a slight variation in inundation frequency for the wetlands (Figure 8). These frequencies are both lower than the natural frequency. From this data the connection of Bridge Creek via the Bridge Creek Floodplain to Fisher Lagoon Complex, and inundation of Piambie Bend East, occur less frequently than under natural conditions. This is also the likely scenario for Piambie Bend West. The flooding regime has additionally been affected by local works such as the construction of regulators that are no longer operational in the Fishers Lagoon Complex.

In addition to river regulation, a decade of drought has put extensive additional pressure on the river and the floodplain system, leading to a decline in river and floodplain health (Sunraysia Environmental 2008).

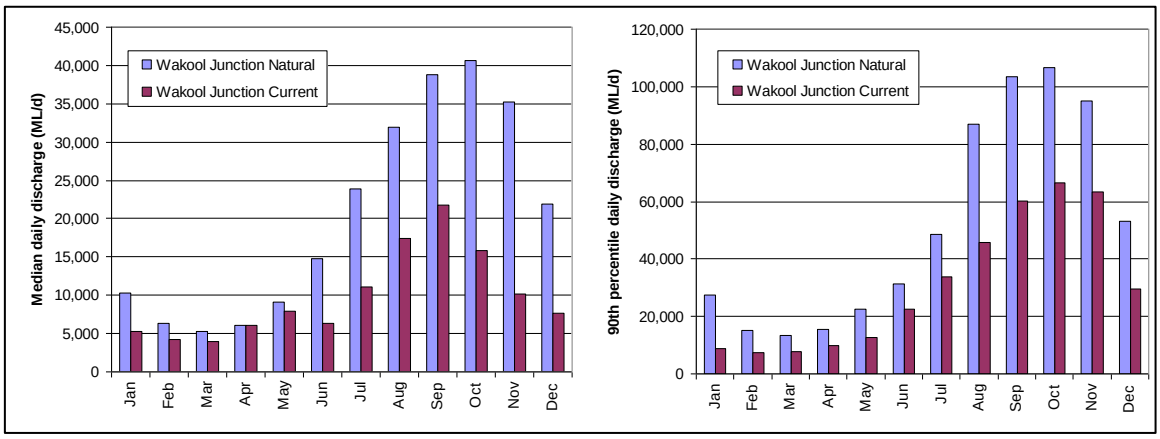


Figure 6. Distribution of median flows and 90th percentile flows for each month in the River Murray through the Piambie (Wakool Junction) for natural and current (benchmark) conditions. Source: derived from MDBC MSM-Bigmod 109-year data (Ecological Associates 2006).

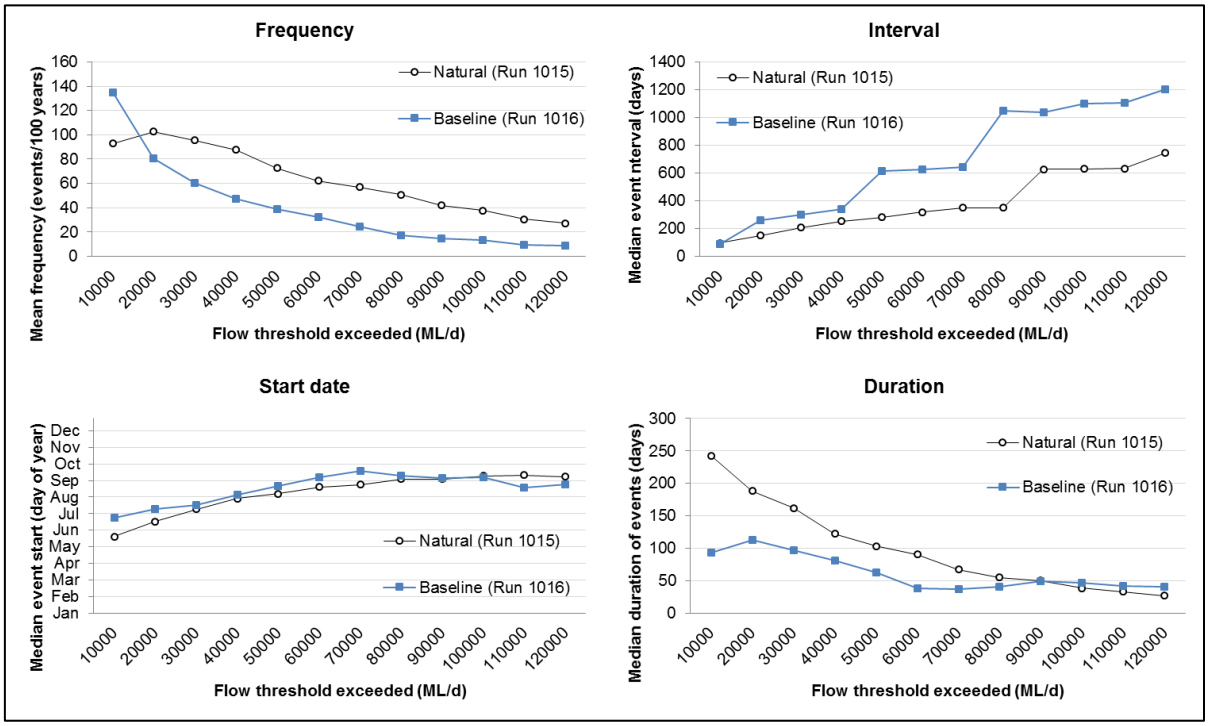


Figure 7. Comparison of Natural (pre-regulation) and Baseline Modelled Flow (post-regulation) scenarios for Euston Downstream (Gippel, 2014).

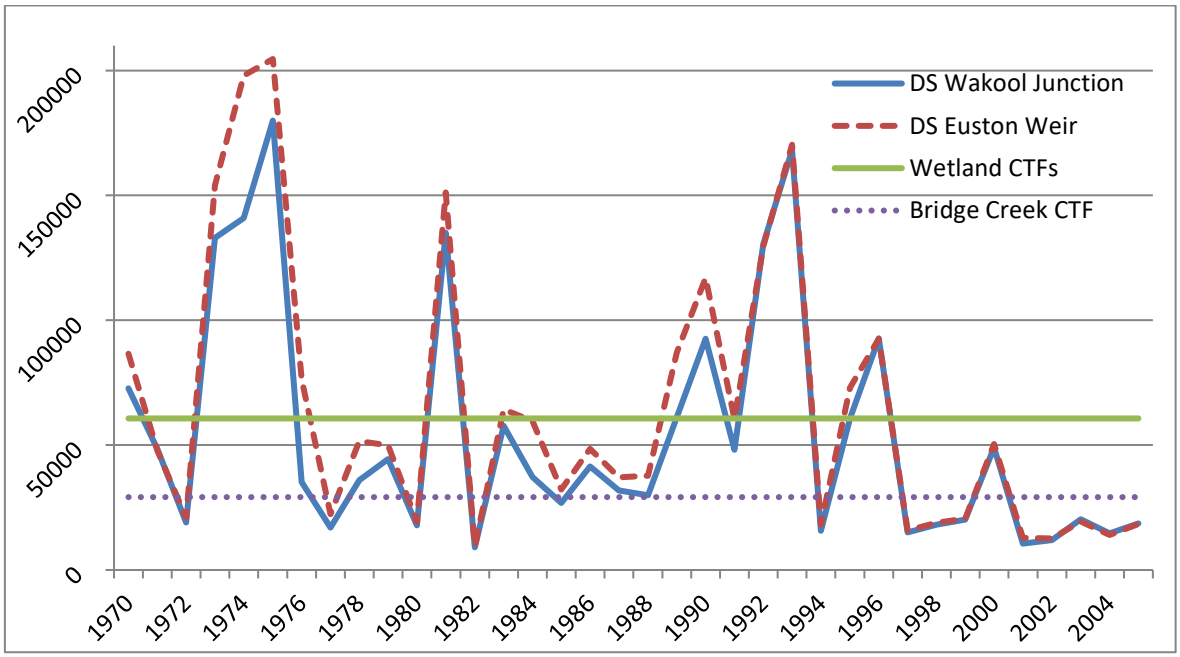


Figure 8. Comparison of Annual maximum flood peaks (ML/day) 1970-2005, DS Wakool Junction and Euston Weir, and *ctf* values at Piambie. Source: Chart generated based on data derived from MDBC (EA 2006) and *ctf* values (Green & Alexander 2006).

4.1.3 Previous Environmental Watering

Environmental watering began at Piambie in 2014, using water from the sources outlined in Table 3. Water was pumped from the Murray River into the eastern end of Bridge Creek (Figure 9a&b. Pump Site on the Murray River and levee constructed for delivery of environmental water to Bridge Creek.

), retained in the creek by a levee (**Error! Reference source not found.**) and allowed to flow westerly onto the Bridge Creek Floodplain and Fishers Lagoon East.

Table 3. A summary of recent environmental watering and natural flow events at Piambie

Water year	Time of inflow	Inflow source	Total volume (ML)	Area Inundated
2010-11	Spring, Summer and Autumn	Natural Flows	n/a	n/a
2014-15	Winter - Spring	VEWH/CEWH	1,200	Bridge Ck & f/pl 364 ha
2016-17	Spring	Natural Flows	n/a	n/a
2019-20	Spring	VEWH	776	Bridge Ck & floodplain

The extent of inundation achieved through the delivery of environmental water at Bridge Creek can be increased if further infrastructure were to be put in place. The section on Environmental Water Delivery Infrastructure discusses opportunities for future works.

At the time of writing, water had not yet been delivered to the Piambie Bend East and West wetlands.

Figure 9a&b. Pump Site on the Murray River and levee constructed for delivery of environmental water to Bridge Creek.

Figure 10. Environmental water delivery to Bridge Creek, December 2019.

5 Water Dependent Values

5.1 Environmental Values

Wetlands and waterways on the floodplain support a vast array of flora and fauna. 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.

5.1.1 Listings and Significance

5.1.1.1 Fauna

Native species recorded at Piambie are listed in Appendix 1. Of special interest and responsibility are the species listed in legislation, agreements or conventions that would benefit from the creek experiencing more frequent inundation. These are summarised in Table 4.

Table 4. Listed fauna recorded at the site

Scientific name	Common name	Type	International agreements	EPBC status	FFG status	DELWP status	Hollow Dependent
Climacteris picumnus	Brown Treecreeper	B	NL	NL	NL	NT	✓
Dromaius novaehollandiae	Emu	B	NL	NL	NL	NT	
Haliaeetus leucogaster	White-bellied Sea-Eagle	B	C	Ma, Mi	L	V	
Litoria Raniformis	Growling Grass Frog	A	NL	VU	L	EN	
Lophoictinia isura	Square-tailed Kite	B	NL	NL	L	V	
Morelia spilota metcalfei	Inland Carpet Python	R	NL	NL	L	EN	✓

Legend
Type: **R**eptile, **B**ird, **A**mphibian
EPBC status: **VU**lnerable, **Ma**rine, **Mi**gratory, **N**ot **L**isted
International Bird Agreements: **C**hina-Australia Migratory Bird Agreement, **N**ot **L**isted
FFG status: **L**isted as threatened, **N**ot **L**isted
DELWP status: **EN**dangered, **V**ulnerable, **N**ear **T**hreatened

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

The species listed in Table 4 include species that are indirectly dependent on water, i.e. they require riparian trees, vigorous ground cover and fallen timber. In order to provide breeding opportunities, habitat elements at Piambie such as temporary wetlands, Lignum, River Red Gum and Black Box communities must be maintained in good condition.

Inland Carpet Python
(*Morelia spilota metcalfei*)

Habitat
The Inland Carpet Python is known to inhabit River Red Gum and Black Box communities and utilises hollow-bearing logs and trees for shelter and incubation. It prefers areas with good litter and shrub cover both to shelter from predators and to ambush prey.

Breeding
Adults breed in spring, and may only breed every 3-4 years. Eggs are laid in December-January and incubated by the female (often in a hollow log) for 50-60 days. Hatchlings emerge February-March, and are independent of the adult at that time.

Food Sources
Adults feed on birds and small to medium sized mammals and often prey on animals found in tree hollows. Juveniles are thought to feed on lizards and possibly insects.

Threats
The Inland Carpet Python is slow moving and non-venomous, thus is can be exposed to predation and human interference without sufficient cover. The leading threat arises from loss or fragmentation of habitat including hollows, leaf litter and shrub cover. Availability of hollow logs of greater than 40 cm diameter is important for incubation sites.

Species Trajectory
Once widespread in typical habitats in northern Victoria, numbers have been significantly reduced since human settlement and this species is now listed as Threatened under the FFG Act. In 2010 there were fewer than 200 confirmed records of occurrences in Victoria.
Source: DSE 2003a & DSE 2010

Figure 11 - Inland Carpet Python

Fishers Lagoon Complex is described as an “important breeding area” for the nationally and State significant White-bellied Sea-Eagle (*Haliaeetus leucogaster*) (M. Rohde pers. comm. cited in Ecological Associates 2006). In the Mallee CMA region, the White-bellied Sea-eagle nests near water in large live or dead trees. They breed between April and August and create stick nests of up to 1.7 metres across. Known to forage over large expanses of open water, the White-bellied Sea-eagle feeds on fish, birds, reptiles, mammals, crustaceans and carrion. The Victorian population is thought to be as low as 100 breeding pairs (DSE 2003b). Deterioration of inland water resources and disturbance of nesting pairs by human activity are listed as threats for this species (Department of the Environment 2015).

Also recorded at Piambie is the Square-tailed Kite (*Lophoictinia isura*), which forage over eucalypt-dominated forests and woodlands including riparian woodlands. It builds a large stick platform nest up to 90 cm across, usually in the high fork of a living tree and feeds on small birds, reptiles and large insects. Healthy River Red Gum and Black Box will help to provide nest building materials and nesting sites for this species and the White-bellied Sea-Eagle. Environmental watering that promotes a productive ecosystem will also enhance food web development for these species.

The Inland Carpet Python (*Morelia spilota metcalfei*) (Figure 11) has been recorded at several sites at Piambie, which led to the designation of Special Management Zones for the species. The Inland Carpet Python is indirectly dependent on a healthy floodplain environment. A healthy wetland system will provide the necessary vegetation for cover, opportunities for shelter in hollows, and food sources, which may help promote a breeding population. Delivery of environmental watering under this plan will potentially encourage diversity and improve quality of floodplain vegetation, increasing the habitat value of the target area for this species. Watering events can be managed to minimise impact on potential breeding sites December to March.

The Brown Tree-creeper (*Climacteris Picumnus*) has also been recorded at Piambie. It is indirectly dependent on water, preferring forests bordering wetlands with an open understorey including Saltbush, Lignum, Cumbungi and grasses. It is dependent on tree hollows for nesting and fallen timber for foraging (OEH, 2014a). The Emu (*Dromaius novaehollandiae*) is known to feed on a wide variety of leaves, grasses, fruits and insects, the potential for such food sources can be enhanced through delivery of environmental water (OEH, 2014b).

There is one record of the Commonwealth listed Growling Grass Frog (*Litoria raniformis)* at or near Piambie. 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 for Piambie the site will not be managed specifically for this species. However, during a site visit to Bridge Creek and Fishers Lagoon East during a watering event in August 2014, the calls of several frog species were noted including the Eastern Common Froglet (*Crinia signifera*), Eastern Sing-bearing Froglet (*Crinia parinsignifera*), Spotted Marsh Frog (*Limnodynastes tasmaniensis*) and Eastern Banjo Frog (*Limnodynastes dumerilii*). It is expected that frog communities will benefit from delivery of environmental water at Piambie by improving vegetation complexity and providing habitat for feeding and breeding.

Piambie has also been the site of several Regent Parrot (*Polytelis anthopeplus*) surveys, including 2001 and 2003. During those surveys suitable habitat was found around lagoons and potential nest trees scattered along the river and throughout the bend (Ecosurveys 2002; 2004). Whilst no official sightings are recorded, the area has been identified as potential habitat for the EPBC listed Regent Parrot (Ecosurveys 2004). The species is recorded in the neighbouring WMU sub-units: Major Mitchell Lagoon; and Heywood. Careful management of environmental water at Piambie may improve habitat potential for the vulnerable Regent Parrot.

The Murray River in this reach offers habitat for native fish species. Channel specialists, such as the vulnerable Murray Cod (*Maccullochella peelii peelii*), which has been recorded near Piambie (Lintermans 2007), may use Bridge Creek during inundation as extended habitat. Smaller, vegetation dependent species such as the vulnerable Murray-Darling Rainbowfish (*Melanotaenia fluviatilis*) are also recorded in the vicinity of Piambie (Lintermans 2007) and may also use the Piambie wetland complex and aquatic macrophytes for feeding and breeding opportunities.

Waterbirds such as ducks and waders are also likely to benefit from delivery of environmental water through the expansion of foraging, feeding and breeding sites.

Provision of environmental water is likely to enhance vegetation quality, structure and diversity and consequently encourage the listed fauna that depend on a healthy ecosystem through the provision of habitat, hollows, nest building materials, foraging feeding and breeding sites at Piambie. It is also expected that delivery of environmental water to the wetlands and creek will offer additional feeding, breeding and foraging sites for aquatic species including fish and frogs.

5.1.1.2 Vegetation Communities

Within the target area, the most extensive Ecological Vegetation Class (EVC) is the Vulnerable Lignum Swampy Woodland. Parts of Bridge Creek are identified in the mapping as Bare Rock/Ground, Lignum Swampy Woodland, Lignum Swamp, and Floodway Pond Herbland. Fishers Lagoon Complex represents a diverse mosaic of EVCs including herbland, marsh, grassy wetland and woodlands. Eleven water dependent EVCs are identified within the target area; these are listed in Table 5, and shown in Figure 12. For a full list of EVCs mapped at Piambie and details on each see Appendix 2.

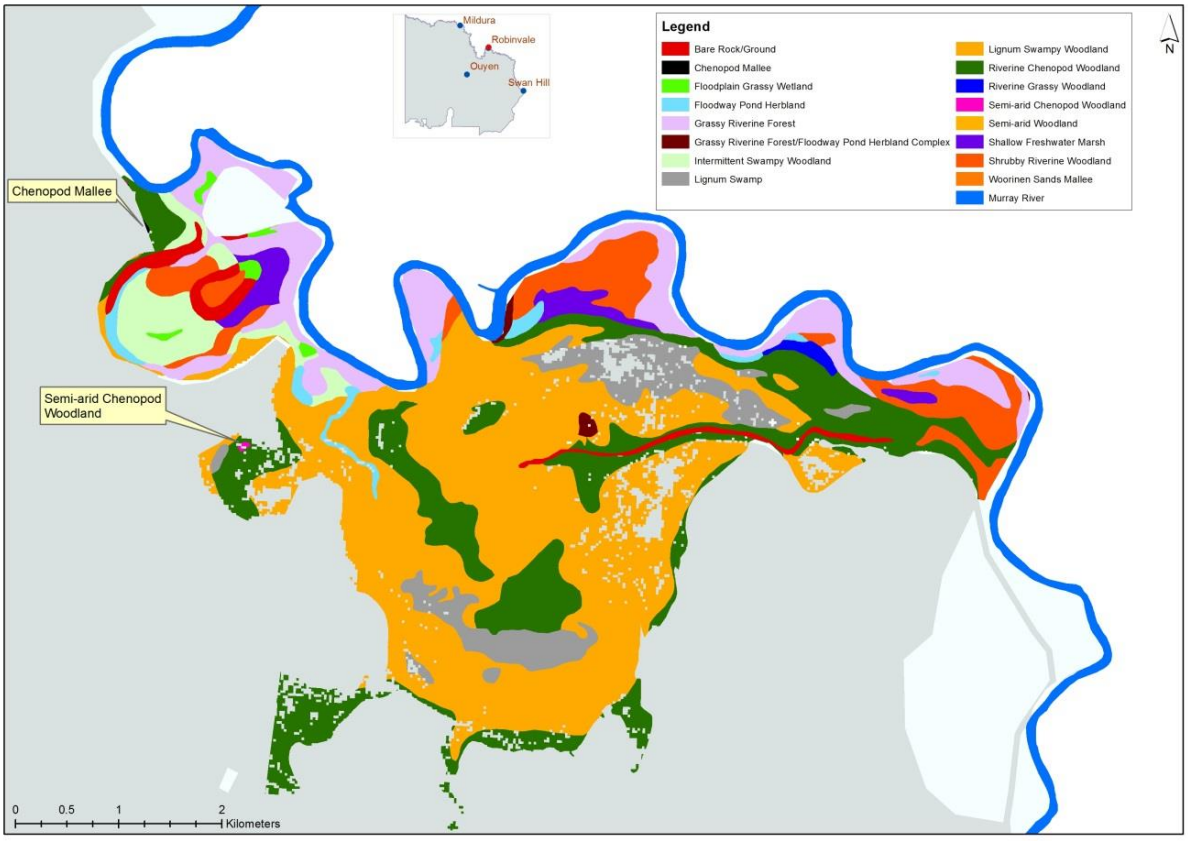


Figure 12. EVCs at Piambie

Table 5. Conservation status of water dependent EVCs in the target area

EVC no.	EVC name	Bioregional Conservation Status*	Character Species
		Murray Fans Bioregion	
103	Riverine Chenopod Woodland	Endangered	Black Box, Lignum
104	Lignum Swamp	Vulnerable	Lignum
106	Grassy Riverine Forest	Depleted	River Red Gum
200	Shallow Freshwater Marsh	Vulnerable	Herbland/ Rushland/ Sedgeland; River Red Gum (Fringing)
295	Riverine Grassy Woodland	Vulnerable (Terrestrial BCS)	River Red Gum, Black Box
809	Floodplain Grassy Wetland	Endangered	Typically treeless, or scattered River Red Gum
810	Floodway Pond Herbland	Depleted	Herbland
811	Grassy Riverine Forest/ Floodway Pond Herbland Complex	Vulnerable	River Red Gum
813	Intermittent Swampy Woodland	Vulnerable	River Red Gum
818	Shrubby Riverine Woodland	Least Concern (Terrestrial BCS)	River Red Gum, Black Box
823	Lignum Swampy Woodland	Vulnerable	River Red Gum, Black Box, Lignum

**The bioregional conservation status (BCS) of the wetland EVCs in this plan are based on expert advice but have not yet been formally approved by DEPI. In the case of Riverine Grassy Woodland and Shrubby Riverine Woodland, no preliminary wetland BCS has been advised, consequently the terrestrial BCS has been applied.*

Figure 13. Bridge Creek is fringed by River Red Gum. Black Box occurs on higher ground, visible in the background.

Across the Piambie target area, the overstorey is generally comprised of River Red Gum (*Eucalyptus camaldulensis*) and/or Black Box (*Eucalyptus largiflorens*) with a mid-storey of Lignum (*Muehlenbeckia florulenta*).

Black Box is the dominant tree species in the endangered Riverine Chenopod Woodland EVC that is mapped surrounding much of Bridge Creek and parts of the floodplain. River Red Gum lines the creek bank, with Black Box occurring on higher ground.

Bridge creek traverses the floodplain and its course becomes 'lost' as it passes through the vulnerable Lignum Swampy Woodland and the vulnerable Lignum Swamp before rejoining the creek path towards Fishers Lagoon East.

Black Box is co-dominant with River Red Gum in the Shrubby Riverine Woodland EVC that is within close proximity to Fishers Lagoon West and Central. The balance of this part of Piambie includes herbland, wetland, grassland and woodland EVCs comprising a diverse array of flora, with generally higher water requirements than the creek zones.

The endangered Floodplain Grassy Wetland occurs in two sites near Fishers Lagoon East and West (Figure 12). This EVC is naturally quite restricted within the Mallee CMA, however it is presumed to be even rarer due to reduced frequency and extent of inundation events.

Black Box provides essential habitat and foraging opportunities for a range of species including the Inland Carpet Python. Healthy Black Box helps provide important vegetative corridors to other areas above the floodplain for a range of transient terrestrial and avian native fauna. Black Box can tolerate a range of conditions from wet to dry (Roberts & Marston 2011), however under extended periods of dry conditions trees will suffer a decline in health and eventually death (Ecological Associates 2007).

Tangled Lignum is considered to be the most significant floodplain shrub in mainland Australia due to its extensive distribution, local dominance and value as habitat (Roberts & Marston 2011). Lignum occurs in many EVCs across the Piambie target area and, combined with other understorey species offers shelter for a range of birdlife, nesting sites for smaller birds, and cover for reptiles including the Inland Carpet Python.

River Red Gum is the most widespread eucalypt tree in Australia, occupying riparian habitats along water courses and wetlands (Roberts & Marston 2011). 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). Healthy River Red Gums contribute to the wetland ecosystem by depositing organic material, and fallen trees and branches provide structural habitat features for native fauna such as the Inland Carpet Python. Older trees can provide perching sites for birdlife, nesting sites for the White-bellied Sea-eagle, and Square-tailed Kite, as well as hollows for the Regent Parrot and Brown Treecreeper.

5.1.1.3 Flora

A full list of flora recorded at Piambie can be found in Appendix 3. Water dependent flora species listed in the various acts and agreements which have been recorded at Piambie are listed in Table 6.

Table 6. Listed flora species recorded at the site

Scientific name	Common name	EPBC status	FFG status	DEPI status	Water Dependent
Acacia melvillei	Yarran	NL	NL	V	
Bossiaea walkeri	Cactus Bossiaea	NL	NL	EN	
Brachyscome* sp. aff. *readeri	Riverina Daisy	NL	NL	R	✓
Cardamine lineariloba	Western Bitter-cress	NL	NL	V	✓
Cullen tenax	Tough Scurf-pea	NL	L	EN	✓
Fimbristylis aestivalis	Summer Fringe-sedge	NL	NL	K	✓
Geijera parviflora	Wilga	NL	L	EN	
Maireana aphylla	Leafless Bluebush	NL	NL	K	
Sclerolaena divaricata	Tangled Copperburr	NL	NL	K	

EPBC status: **N**ot **L**isted
FFG status: **L**isted as threatened, **N**ot **L**isted
DEPI status: **EN**dangered, **V**ulnerable, **R**are, **P**oorly **K**nown

The four listed water dependent flora species and the array of native flora recorded (Appendix 1) indicate that Piambie maintains good floristic diversity.

Of particular significance on the floodplain is the endangered Tough Scurf-pea (*Cullen tenax*). This species has been recorded in areas subject to seasonal flooding, and may be benefited by inundation through reduced competition from grasses (DSE 2015). In this part of the CMA region there is evidence to suggest that mass recruitment follows shallow flooding or heavy rain, and that extended dry periods can cause stalled growth or even death of mature plants (ABC database). Records of Tough Scurf-pea (*Cullen tenax*) led to the listing of two areas of public land within the WMU as Special Protection Zones.

Also of significance to the area is a large stand of around 250 trees of the endangered and FFG listed Wilga (*Geijera parviflora*), which comprise one of the most southerly occurrence of this species in Victoria (VHR T1116, 11164 & 11165).

Water dependent and flood tolerant flora species recorded at Piambie include Knob Sedge (*Carex inversa*), Spiny Flat-sedge (*Cyperus gymnocaulos*), Common Blown-grass (*Lachnagrostis filiformis*) and Common Nardoo (*Marsilea drummondii*) (Appendix 1). Emergent macrophytes are often found on the perimeter of ephemeral or seasonally inundated waterways and can provide essential habitat for frogs. During flooding, native fish will also utilise reed beds and semi-emergent vegetation where they feed on macro-invertebrates and shelter from predators (Ecological Associates 2007b). Emergent macrophytes require annual flooding of approximately 6-12 months depending on species. The return of an inundation cycle more closely mimicking natural conditions may encourage a diversity of species requiring differing water regimes.

5.1.3 Wetland Depletion and Rarity

Victoria's wetlands are currently mapped and are contained within a state wetland database, using an accepted statewide 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).

The target area of Piambie contains five wetlands (Table 7). These are categorised as: three Permanent Open Freshwater comprising the Fishers Lagoon Complex; and two Shallow Freshwater Marsh (Piambie Bend East and West). It has been estimated that about 4000 wetlands have been lost since European settlement, with more than 90% of these lost on private land (Mallee CMA 2006). Piambie represents an excellent opportunity to help protect wetlands and a creek system on private land.

Shallow Freshwater Marsh is the third most depleted category in the Murray Fans bioregion within the Mallee CMA Region, this makes Piambie Bend East and West significant in the Mallee (Mallee CMA 2006). The prevalence of permanent open freshwater has increased since European settlement, possibly as an outcome of regulation. Fishers Lagoon Complex is currently classed as Permanent Open Freshwater however the site is no longer constantly inundated, and consequently experiences drying periods.

Table 7. Changes in area of the wetlands in the target area by Corrick classification

Category	No of Wetlands in target area	Total area in target area (ha)	Decrease in wetland area from 1788 to 1994		
			% Change in area in Victoria	% Change in area In Mallee CMA	% Change in Murray Fans
Permanent Open Freshwater	3	60.3	-6	5	0
Shallow Freshwater Marsh	2	5.19	-60	-6	-10

Source: DEPI Biodiversity interactive maps, Mallee Wetland Strategy

5.1.4 Ecosystem Functions

Healthy creek and wetland ecosystems have the potential to support distinctive communities of plants and animals and provide numerous ecosystem services. These ecosystems can perform important functions necessary to maintain the hydrological, physical and ecological health of the river systems and floodplain. These ecosystem functions can include:

- providing extended foraging and breeding opportunities for native terrestrial fauna;
- providing extended foraging and breeding habitat for water birds during periods of inundation;
- absorbing and releasing floodwaters;
- in-stream primary production;
- 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.

Altered water regimes in the target area due to river regulation and extended dry conditions have seen a decrease in the frequency and extent of inundation on the floodplain and within Bridge Creek. This combined with the previous maintenance of a permanent water level in Fishers Lagoon West, and subsequent dry phases, has reduced the ability for the creek and wetlands to perform these valuable ecosystem functions.

5.2 Social

5.2.1 Cultural Value

The Mallee has been occupied for thousands of generations by Indigenous people with human activity dated as far back as 23,400 years ago. The region's rich and diverse Indigenous heritage has been formed through the historical and spiritual significance of sites associated with this habitation; together with the strong connection Traditional Owners continue to have with the natural landscapes of the Mallee.

Given the semi-arid climate of the region, ready access to more permanent water has been a major determinant of human habitation, and as such the highest density of identified Indigenous Cultural Heritage sites are located around or close to areas of freshwater sources.

Within the Mallee CMA region, the Murray River and its associated waterways were important habitation areas for multiple Aboriginal groups, containing many places of spiritual significance. The high number of Indigenous Cultural Heritage sites throughout the Murray floodplain is unique in Victoria, for both concentration and diversity. They include large numbers of burial, middens and hunting sites.

Waterways also play a large role in the region's more recent non-Indigenous heritage due to the historical infrastructure (e.g. buildings, irrigation and river navigation structures) they often contain. These places provide links to early industries and settlements and play a key part in the region's identity.

5.2.2 Cultural Heritage

Piambie is of significant cultural value to Indigenous and non-Indigenous people, with the area popular for fishing, camping, hunting, and as a meeting place. In regard to Indigenous cultural values the true extent of the number and types of sites present is still unknown.

Several early European records exist of different language groups within the area (Clark, cited in Bell 2013) including Tati Tati (Tindale, cited in Bell 2012) and Wadi Wadi (Howitt, cited in Bell 2012). Aboriginal people had a strong connection to the area and made use of the natural resources within the forest for bush medicine, basket weaving and other cultural activities.

Aboriginal people continue to have a connection to this country. The Wadi Wadi people are part of the Native Title Claim over the area. The Robinvale Aboriginal Community continues to value this country through traditional laws and customs.

European heritage reflects the pioneering history of the area. On his third expedition to the interior, Major Thomas Mitchell followed the Murrumbidgee River to its junction with the Murray River and, after returning from the Murray-Darling junction, he continued his exploration through the Piambie area. This history is reflected in the naming of the Major Mitchell Lagoons, south of Piambie.

European settlement followed Mitchell's exploration, and the area became part of a large squatting run, which was subsequently broken up into three parcels of land in 1884. Piambie is located on two of these parcels, purchased by Alice Creswick and Harry Creswick. The land was run under the Narrung Pastoral Licence until the lease was cancelled in 1919 (Fisher, cited in Bell 2012).

Bridge Creek is said to have gained its name from a bridge across the creek, the remnants of which are still visible (Figure 14). A camp was located on the northern bank of the creek, possibly for workers harvesting timber from the bend (pers. comm. Andrew Paul, March 2015).

5.2.3 Recreation

The region is popular for swimming, camping, fishing, boating, four-wheel driving, picnics, barbeques and walking and these uses will continue in the River Murray Reserve.

5.3 Economic

Parts of Piambie have been used for grazing in the past, and Fishers Lagoon West was used for private storage of water for many years. Due to this use as irrigation storage, minimum water levels were maintained to enable efficient and reliable operation. The landholder would pump water into Fishers Lagoon West when river flows were insufficient to maintain pool level. This no longer occurs.

The river frontage has been gazetted as River Murray Reserve and part of Bridge Creek is reserved. Areas of private land are used for grazing.

Figure 14. Remnants of the bridge that gave Bridge Creek its name.

5.4 Significance

Piambie is able to support a rich diversity of flora and fauna. Native vegetation is present along the entire length of Bridge Creek. An expanse of floodplain vegetation that was once used as grazing land is no longer grazed, and the vegetation is recovering. The iconic River Red Gum and Black Box are the principal sources of hollows, providing essential habitat to a range of species, including the endangered Inland Carpet Python and near threatened Brown Treecreeper. Healthy trees may also offer potential habitat for the endangered Regent Parrot, and nest building materials for the vulnerable White-bellied Sea-eagle and Square-tailed Kite.

The floodplain vegetation is, in places, dense and of good structural diversity. Large expanses of Lignum and Black Box and the associated understorey, and leaf litter and fallen timber, offer the Carpet Python excellent shelter and breeding sites, as well as opportunities for ambushing prey. Identification of this site as a Special Management Zone for Carpet Python indicates its high ecological value. Similarly, the Brown Treecreeper requires leaf litter and fallen timber for foraging. This species is also hollow dependent and is likely to benefit from a healthier overstorey.

In addition, Piambie is one of only a handful of known sites within the Mallee CMA region for the endangered Tough Scurf-pea, and as such, some parts of Piambie have been designated Special Protection Zones. It is believed that this species responds well to seasonal inundation.

The site is important to the local community as part of the Murray River Reserve, and landholders are in favour of environmental water delivery to Bridge Creek and the wetlands to help protect the site's significant ecological values.

With connectivity to the Murray River, the wetlands and creek at Piambie provide potential for refuge and/or extended breeding and foraging areas for native fauna species including fish and frogs.

The values contained within Piambie and specifically the target area for this plan makes this area a priority for protection and enhancement through environmental water management. Of particular significance is the potential to encourage aquatic vegetation as habitat for native fauna, and the potential to improve or maintain the River Red Gum, Black Box and Lignum communities. These vegetation groups form the basis for the functioning ecological system and are the primary focus of this plan.

6 Ecological Condition and Threats

6.1 Current Condition

6.1.1 Bridge Creek

In 2004, the easternmost 7 km of Bridge Creek was assessed using the Index of Stream Condition (ISC) assessment methodology (Figure 15). Scores for water quality or aquatic life were not calculated because the creek was dry at the time. No impediments to fish passage were recorded. The overall score was 20, which is considered moderate (Table 8).

Further information on the ISC scoring is provided in the *Mallee CMA Regional Context Document* (Sunraysia Environmental 2014).

Table 8. ISC sub-index and overall score for Bridge Creek

ISC sub-index	Reach #22	
	Score /10	Category
Streamside Zone	7	
Physical form	6	
Hydrology	2	
Water quality	n/a	
Aquatic Life	n/a	
Overall ISC score	20	Moderate

Figure 15. Photos captured as part of the ISC assessment in 2004. Source: ISC Website

6.1.2 Wetlands

The condition of the wetlands within the target area of Piambie has not been assessed using the Index of Wetland Condition (IWC) method.

Fishers Lagoon Complex is comprised of three wetlands: Fishers Lagoon East (**Error! Reference source not found.**); Fishers Lagoon Central; and Fishers Lagoon West. The latter (**Error! Reference source not found.**) was used as a holding basin for irrigation water and was kept inundated for many years, but now remains dry unless significant Murray River flows occur. Fishers Lagoon East is traversed by a private pump access track (**Error! Reference source not found.**).

The conditions of Piambie Bend East and West are not currently known.

Figure 16. Fishers Lagoon West (2015),

Figure 17. Fishers Lagoon East (2015)

Figure 18. The track crossing Fishers Lagoon East,

6.2 Condition Trajectory

Since regulation, a natural flood event through the entire length of Bridge Creek occurs much less frequently. This has reduced the volume and frequency of water available to the vegetation along the creek banks.

Local reports suggest Bridge Creek was able to hold water for approximately three years after inundation. It was also suggested that Bridge Creek dried out for 'the first time in a century' during the Millennium Drought (1997-2010) and that tree health declined dramatically (pers. comm. A. Paul, March 2015). Without intervention, it is believed that tree health will continue to decline if dry conditions persist.

Fishers Lagoon West experienced near-constant inundation for many years due to regulation, which is likely to have reduced diversity aquatic macrophytes and seasonal flora species. It now remains dry unless high river flows occur.

Piambie Bend East and West have experienced a reduction in inundation frequency and duration, which may have limited the diversity and extent of EVCs in the target areas.

The condition of Bridge Creek and the wetlands within the target area will continue to decline without regular and well-planned environmental watering targeting appropriate objectives.

The reduced flooding duration and frequency will continue to impact the ecology of the wetlands through:

- reduced organic matter recruitment;
- reduced connectivity for movement of organic matter and fish;
- reduction of suitable nesting and roosting sites for waterbird species that rely on flooded shrub land and forest;
- lower capacity to provide nesting sites for hollow-dependent birds and reptiles;
- reduced understorey quality as habitat and shelter for birds and reptiles; and
- limited food sources for all waterbird types, reptiles and amphibians through reduced recruitment of terrestrial and aquatic invertebrates and reduced extent of emergent and submergent marcrophytes

Without improvements to flow frequency and extent, the health of the ecosystem of Piambie is likely to further decline.

6.3 Water Related Threats

Threats to the ecological water-dependent values are the result of factors such as human intervention and climate, and include:

- Changed water regime and reduced flow capacity;
- Loss or reduction of wetland and creek connectivity;
- Loss of instream habitat;
- Water quality; and
- Introduction/increase of exotic aquatic and terrestrial flora and fauna

The regulation of the Murray River has altered the water regime at Piambie. Flow events of the magnitude required to allow flows into the creek and wetlands of the floodplain are less frequent and of shorter duration. Combined with dry conditions over the last decade, this has affected the vigour of the vegetation and placed trees under stress, affecting the productivity and functioning of the floodplain ecosystem.

Fishers Lagoon West, once an ephemeral wetland was modified and, for a period, was permanently inundated to maintain supply of irrigation water. Regulator structures were placed to achieve this and are likely to create a barrier to fish passage and prevent more frequent inundation of connected sections of the floodplain. When use of the lagoon for irrigation water ceased, a drying phase occurred, once more altering both the hydrology and the ecosystem, impacting productivity.

The Red Fox (*Vulpes vulpes)*, is a significant threat as a predator to the Inland Carpet Python. Although the fox is not a water related threat, it may have a substantial impact on water dependent ecological values at the site.

Agricultural and other weeds are an ongoing threat and management issue along the Murray River floodplain. These may pose a threat when water is applied as increased water availability can cause weeds to thrive and displace native vegetation. A list of exotic flora species identified at Piambie is provided in Appendix 1.

7 Management Objective

7.1 Management Goal

The overall goal proposed for the target area at Piambie is:

To provide a flow regime that more closely reflects natural events, thus improving the capacity of the target area to provide a productive ecosystem for native flora and fauna.

7.2 Ecological Objectives

Ecological objectives represent the desired ecological outcomes of the site based on the management goal above, as well as the key values outlined in the Water Dependent Values section. The ecological objectives are expressed as the target condition or functionality for each key value.

As with any healthy wetland ecosystem, ecological outcomes are interrelated. The objectives outlined in Table 9, if achieved, contribute to wetland productivity and improve the overall health of the system. Improving vegetation condition may provide access to additional food sources, feeding sites, breeding sites and habitat for key fauna species including the White-bellied Sea-eagle and the hollow dependent Inland Carpet Python.

Table 9. Ecological objectives for Piambie

Management Area	Ecological objective	Justification (value based)
Bridge Creek, Bridge Creek Floodplain	Improve vegetation health and structure in the River Red Gum communities (EVCs 106, 295, 809, 813, 818, 823) Improve vegetation health and structure in the Black Box communities (EVCs 103, 813, 818, 823) Improve vegetation health and structure in the Lignum communities (EVCs 104, 813, 818, 823)	A healthy vegetation structure includes diversity of species and age classes. The River Red Gum lining the creek is of limited age classes and shows poor recruitment. There is good ground cover of fallen timber and organic matter, and overstorey health is integral to maintaining this. On the floodplain, healthy communities of Black Box and Lignum should include a diversity of species and a healthy canopy may provide important habitat and refuge. Old trees of River Red Gum and Black Box with hollows may provide suitable hibernation habitat for the Inland Carpet Python, and nesting potential for the Regent Parrot and Brown Treecreeper. Fallen timber offers additional foraging potential for the Brown Treecreeper, and cover for the Inland Carpet Python, as well as nesting materials for the White-bellied Sea-eagle and Square-tailed Kite. Lignum can provide habitat and shelter for frogs and cover for the Inland Carpet Python. Wetland productivity may be improved through deposition of organic matter from all vegetation life forms present, enhancing food web provision.
Fishers Lagoon Complex	Increase aquatic macrophyte diversity and area in the Freshwater marsh habitats (EVCs 200, 810, 811) Maintain vegetation health and structure in the fringing River Red Gum communities (EVCs 106, 809, 813, 818, 823)	The Fishers Lagoon Complex has a mosaic of EVCs offering a diversity of River Red Gum communities from grasslands to sedgelands to woodlands, however a healthy wetland system requires a diversity of emergent and semi-emergent macrophytes, which may be promoted by delivering environmental water on a more regular basis. Seasonal aquatic habitat may be promoted through delivery of environmental water and draw down timed to promote growth of semi-emergent and emergent macrophytes. This may also improve habitat values for native fish and frogs. In turn this may offer additional feeding, breeding and hunting areas for the White Bellied Sea Eagle, and improve foraging areas for the Inland Carpet Python. Wetland productivity may be improved through deposition of organic matter from all vegetation life forms present, enhancing food web provision.
Piambie Bends East and West	Increase aquatic macrophyte diversity and area in the Freshwater marsh habitats (EVCs 200, 810, 811) Maintain vegetation health and structure in the fringing River Red Gum communities (EVCs 106, 809, 813, 818, 823)	These wetlands and floodplains comprise Shallow Freshwater Marsh, Floodway Pond Herbland, Grassy Riverine Forest and Shrubby Riverine Woodlands indicating diverse vegetation community types. A healthy wetland system requires a diversity of emergent and semi-emergent macrophytes, which may be promoted by delivering fluctuations in water levels. Deeper inundation can assist to maintain diversity in the forest and woodland areas providing feeding and breeding areas for water dependent fauna.

Management Area	Ecological objective	Justification (value based)
All	Increase dissolved organic matter, particulate matter and macroinvertebrate productivity	The release of energy and nutrients greatly increases productivity which increases bacteria and invertebrates. Providing food for large aquatic animals. (Ecological Associates, 2013)

Attainment of the ecological objectives is anticipated to have wider benefits for the target area and is expected to result in:

- Improvement of understorey productivity
- Improvement of floodplain productivity
- Reinstatement of diverse vegetation to Fishers Lagoon Complex
- Improvement of nesting opportunities in flooded trees lining the creek.

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.

River Red Gum, Black Box and Lignum are key floodplain species that support native fauna and contribute to wetland health and productivity. Associated plant species within the mapped EVCs help to form an ecologically sound environment. Through careful management of environmental water, recruitment of keystone species may help maintain the vegetation structure, condition and diversity. In time, some of the River Red Gum, as the key overstorey species lining the creek banks, are likely to fall into the creek and provide valuable structural habitat for native fish and frogs. Trees may also fall, or drop limbs above the water line, offering habitat for the Inland Carpet Python and other reptiles. Maintaining the structure of terrestrial vegetation at the creek is also likely to provide habitat values for native fauna.

In addition to the opportunity to maintain vegetation health and diversity, inundation of the Bridge Creek Floodplain offers additional foraging, feeding and breeding sites for waterbirds and enhanced cover for terrestrial native fauna.

Delivery of environmental water to Fishers Lagoon Complex may help promote greater diversity of aquatic macrophytes, extending aquatic forage and breeding habitat for fish and frogs, and offering food web enhancement for predatory native species such as the Inland Carpet Python and the White-bellied Sea-eagle.

Through environmental watering key habitat niches will potentially be maintained. The maintenance and recruitment of key flora species may assist over the longer term in the provision of hollows for the Inland Carpet Python and other hollow-dependent fauna.

7.3 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 centred on improving the vegetation health and structure where possible. The hydrological requirements to achieve each of these objectives are presented in Table 10 and are based on the assumption that maintenance of current health requires less frequent watering with longer intervals between events than for improving condition.

The following hydrological objectives address the underlying ecological objectives for each site:

- Seasonal emergent and semi-emergent macrophytes may occur within the target area wetlands. Flood requirements vary depending on species, however annual inundation may encourage germination, vegetative growth and/or reproduction (Rogers & Ralph 2011). Durations of six to twelve months are required to sustain vigorous growth. Following natural seasonality is encouraged.

- River Red Gum stands are the dominant species in eight of the eleven water dependent EVCs within the target area. River Red Gum trees fringe Bridge Creek and all target area wetlands. 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 Gums, 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).

- Black Box stands occur in four of the eleven water dependent EVCs within the target area, predominantly along Bridge Creek and on the Bridge Creek Floodplain. Black Box occurs on higher levels of the floodplain and requires flooding to occur every three to seven years with durations of two to six months. This species can tolerate shorter flood durations but plant vigour will suffer. Although timing of flood events is not crucial for Black Box it will affect understorey and other woodland flora. Black Box trees may survive prolonged periods of 12 to 16 years with no flooding but tree health will suffer and woodlands will become dysfunctional (Roberts & Marston 2011).

- Lignum is a dominant species in three of the water dependent EVCs within the target area, on higher elevations of the Bridge Creek floodplain and at Fishers Lagoon Complex. Lignum can tolerate a wide range of wet and dry conditions as well as moderate salinity levels. Flood requirements vary with frequencies of one to three years needed to maintain large shrubs with vigorous canopy, and flooding every three to five years for maintenance of healthy shrubs. Intervals of seven to ten years can be tolerated by small shrubs but growth will decline and these plants do not accommodate nesting by birds. Durations of three to seven months is required to sustain vigorous canopy, but continuous flooding is detrimental. Although timing of flooding is not crucial for Lignum, following natural seasonality is encouraged to provide for understorey and wetland plants (Roberts & Marston 2011).

These water requirements have been used as a guide to develop the hydrological objectives for Piambie.

Table 10. Hydrological objectives for the Piambie 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
		Min	Opt	Max	Min	Max	Min	Opt	Max	
Improve vegetation health and structure in the River Red Gum communities (EVCs 106, 295, 809, 813, 818, 823)	Bridge Creek, Bridge Creek Floodplain	2	3	7	1	7	2	3	8	Spring/Summer
Improve vegetation health and structure in the Black Box communities (EVCs 103, 813, 818, 823)		2	3	3	3	10	2	4	6	Winter/Spring
Improve vegetation health and structure in the Lignum communities (EVCs 104, 813, 818, 823)		3	5	10	1	7	3	5	7	Winter/Spring
Increase aquatic macrophyte diversity and area in the Freshwater marsh habitats (EVCs 200, 810, 811)	Fishers Lagoon Complex	3	6	10	0	3	1	6	12	Winter/Spring
Maintain vegetation health and structure in the fringing River Red Gum communities (EVCs 106, 809, 813, 818, 823)		3	4	7	2	7	2	3	8	Spring/Summer
Increase aquatic macrophyte diversity and area in the Freshwater marsh habitats (EVCs 200, 810, 811)	Piambie Bends East & West	3	6	10	0	3	1	6	12	Winter/Spring
Maintain vegetation health and structure in the fringing River Red Gum communities (EVCs 106, 809, 813, 818, 823)		3	4	7	2	7	2	3	8	Spring/Summer
Increase dissolved organic matter, particulate matter and macroinvertebrate productivity**	All									

***Ecological objective met by other hydrological objectives*

7.3.1 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 an optimal, minimum and maximum watering regime is identified as outlined in Table 10. The minimum objectives are likely to be provided in drought or dry years, the optimum objectives in average conditions and the maximum objectives in wet or flood years.

Due to the inter-annual variability of these estimates (particularly the climatic conditions, and the capacity for each site to retain water for several years), determination of the predicted volume requirements in any given year will need to be undertaken by the environmental water manager when watering is planned.

7.3.1.1 Fishers Lagoon Complex, and Bridge Creek and Floodplain

Fishers Lagoon Complex has a requirement for greater frequency and longer duration of inundation compared to Bridge Creek and Floodplain. Thus, the watering regime proposed is targeted at firstly the River Red Gum, Black Box and Lignum communities at a lower frequency, and secondly at delivering water via Bridge Creek to the Lagoons and Wetland, for retention over several years. The optimal watering regime is presented in the tables below.

Water Regime	Inundation area, duration and frequency
Optimal	Inundate the length of Bridge Creek through to Fishers Lagoon Complex three years in ten with a maximum interval of seven years between events. Maintain water in the creek and on the floodplain for three months to improve health of fringing River Red Gum and floodplain Black Box and Lignum. Allow Fishers Lagoon Complex to recede slowly. It is expected water will be retained in Fishers Lagoon Complex for 2 years, Fishers Lagoon Complex will be inundated six in ten years, encouraging aquatic macrophyte diversity.

7.3.1.2 Piambie Bend East and West

Environmental water has not yet been delivered to Piambie Bends East and West, and levees are required to retain water on the floodplains.

Water Regime	Inundation area, duration and frequency
Optimal	Inundate the wetlands and fringing River Red Gum Woodlands six times in ten years with a maximum interval of three years between events. Maintain water on the floodplain for two months to maintain the health of River Red Gum communities. Allow ponding in Piambie Bend West for four months to maintain wetland function. Allow natural recession and ponding for six to twelve months in deeper areas of Piambie Bend East.

9 Managing Risks to Achieve Objectives

Environmental water delivery plans will be developed for all wetland sites allocated environmental water. A broad risk assessment has been undertaken, using the risk rating outlined in Table 11, for the system to identify any major risks which would require mitigation measures; these are outlined in Table 12. A more detailed risk assessment will be undertaken by the Mallee CMA in the development of the delivery plan taking into consideration the broad risk assessment. These plans are signed-off by the Victorian Environmental Water Holder before delivery commences.

Table 11. Risk Rating

		Consequence				
Likelihood		Negligible 1	Minor 2	Moderate 3	Major 4	Extreme 5
	Almost Certain 5	Medium 5	Medium 10	High 15	High 20	High 25
	Likely 4	Low 4	Medium 8	Medium 12	High 16	High 20
	Possible 3	Low 3	Medium 6	Medium 9	Medium 12	High 15
	Unlikely 2	Low 2	Low 4	Medium 6	Medium 8	Medium 10
	Rare 1	Low 1	Low 2	Low 3	Low 4	Medium 5

Table 12: Environmental Water Delivery Risk Assessment

Risk Category	Risk #	Risk Type	Without Mitigation			Mitigation	After Mitigation		
			Likelihood	Consequence	Rating		Likelihood	Consequence	Rating
Quality Assurance issues lead to no achievement of objectives	1.0	Current recommendations on environmental flow inaccurate	Possible	Moderate	Medium	• Base decisions on referenced literature and CMA knowledge	Rare	Moderate	Low
	1.1	Storage Operator maintenance works affect ability to deliver water	Possible	Moderate	Medium	• Keep in contact with G-MW to identify delays to allow for adaptive management	Rare	Moderate	Low
Time	2.0	Limited CMA resource to deliver environmental release	Possible	Minor	Medium	• Ensure that environmental water management within the CMA is adequately resourced to undertake required delivery tasks	Rare	Moderate	Low
Cost	3.0	Cost of delivery exceeds available funding	Unlikely	Moderate	Low	• CMA to manage delivery and regularly monitor costs	Rare	Moderate	Low
Human	4.0	Environmental releases cause personal injury to river user	Unlikely	Major	Medium	• Ensure land manager/land holder is informed of delivery actions • Erect signage where risk is significant	Rare	Moderate	Low
Environmental	5.1	Releases followed by natural high flow events cause flooding of non-target areas	Possible	Minor	Medium	• Monitor River Murray flows and forecasts, manage delivery to allow additional capacity	Rare	Moderate	Low

Risk Category	Risk #	Risk Type	Without Mitigation			Mitigation	After Mitigation		
			Likelihood	Consequence	Rating		Likelihood	Consequence	Rating
	5.2	Improved conditions for non-native species (e.g. carp)	Possible	Moderate	Medium	• Adaptive management. Review current research findings and manage water delivery and recession according to current best practice.	Rare	Moderate	Low
	5.3	Releases cause over-watering of terrestrial flora species	Unlikely	Moderate	Medium	• Monitor terrestrial sites within close proximity of inundation zone if they are at risk	Rare	Moderate	Low
	5.4	Releases cause erosion/bank instability	Possible	Moderate	Medium	• Monitor delivery at high risk sites, slow delivery or re-engineer delivery	Rare	Moderate	Low
	5.5	Releases promote weed spread	Possible	Moderate	Medium	• Liaise with land managers to control invasive weeds in vicinity of watering sites • Monitor weed emergence after events	Rare	Moderate	Low
	5.6	Delivery promotes pest animal activity (foxes, rabbits, pigs)	Possible	Moderate	Medium	• Monitor pest animal activity • Liaise with landholders to control pest animal infestations	Rare	Moderate	Low
Compliance	6.0	Environmental water account is overdrawn	Possible	Major	Medium	• Ensure delivery contractor is aware of delivery volumes and adheres to delivery plan	Rare	Major	Low

Risk Category	Risk #	Risk Type	Without Mitigation			Mitigation	After Mitigation		
			Likelihood	Consequence	Rating		Likelihood	Consequence	Rating
	6.1	Environmental releases causes flooding of private land	Possible	Minor	Medium	• Landholder agreements undertaken for flooding on private land. Delivery plans will be developed and approved by VEWH.	Rare	Moderate	Low
	6.2	Environmental releases causes flooding of Crown land	Possible	Minor	Medium	• Land managers are signatories to the proposal	Rare	Moderate	Low
	6.3	Environmental releases causes flooding of access tracks	Possible	Minor	Medium	• Provide temporary signage where applicable • Manage delivery to avoid prolonged inundation of tracks • Liaise with users	Rare	Moderate	Low
Reputation	7.0	Unable to provide evidence in meeting ecological objective	Possible	Major	Medium	• Need to communicate ecological objectives • Ensure monitoring activities are undertaken • Establish monitoring framework • Adaptive management approach	Rare	Moderate	Low
	7.1	Key stakeholders not supportive of environmental water release	Possible	minor	Medium	• Continue to engage with stakeholders and undertake communications	Rare	Moderate	Low

10 Environmental Water Delivery Infrastructure

10.1 Constraints

The existing arrangements limit the extent of area that can be inundated by environmental watering at Piambie. Current infrastructure consists of:

- A low track crossing between Fishers Lagoon East and West that provides public access to the floodplain and a private pump site.
- Three regulators on Fishers Lagoon Complex that were constructed to retain water for irrigation (Figures 19 to 21). The current condition of these structures must be assessed. At least one structure is in a state of disrepair (pers. comm. M. Thompson, 7 April 2015).

Figure 19. Photograph taken of a regulator structure still in use near the western end of Fishers Lagoon West.

Figure 20. Photograph taken of a regulator structure in disrepair, this structure is located on the creek inlet to Central Fishers Lagoon.

Figure 21. Photograph taken of a regulator structure still in use near the eastern end of Fishers Lagoon West.

The most significant constraints to returning the Piambie system to a more natural water regime include the ability to hold back water in Bridge Creek to inundate the floodplain, and the ability to retain water in the Fishers Lagoon Complex at a sufficient depth.

10.2 Infrastructure and Complementary Works Recommendations

The infrastructure proposed would give greater control of the water levels in Fishers Lagoon Complex and would significantly increase the volume and extent of water able to be delivered to the floodplain of Bridge Creek and the wetlands on the Murray River. It would also provide opportunity to return flows to the river after a satisfactory duration. Returning water to the river would be dependent on accounting and water quality constraints.

10.2.1 Bridge Creek & Bridge Creek Floodplain Recommendations

Bridge Creek can currently receive environmental water using a diesel pump, pumping from the Murray River at the upstream connection point. By continuing to pump water into the creek, water flows across the floodplain towards, and eventually connects with, the Fishers Lagoon Complex. This involves inundation of approximately 364 ha, requiring approximately 1,580 ML of environmental water, however infrastructure is required to retain water on the floodplain and efficiently inundate the target area.

Local knowledge suggests the Fishers Lagoon Complex retains water for several years after inundation, as do several deeper pools within Bridge Creek (Ecological Associates 2006). It may be suitable to inundate Bridge Creek through to Fishers Lagoon Complex in some years, and merely the Creek and Floodplain in other years.

Recommended works for Bridge Creek include the formation of two levees: one at the eastern Murray River connection; and a second levee on an access track on the floodplain (Figure 22). These will help retain water in the creek and allow flow through to the floodplain and the Fishers Lagoon Complex.

A third levee and a regulator are recommended at the western end Bridge Creek floodplain where it connects with Fishers Lagoon East (Figure 22) to hold water on the floodplain to a height of 56.3 m AHD, and allow subsequent transfer to Fishers Lagoon East.

A second regulator structure and two levees are recommended to provide access to private irrigation infrastructure where the access track crosses the inundation zone (Fishers Lagoon East, Figure 22).

A third regulator structure is recommended at the downstream end of Fishers Lagoon West to enable retention of water within the lagoon system, and to enable water to be delivered to a height of 54.4 m AHD, also inundating Fishers Lagoon Central. This regulator could also facilitate natural flow events and enable fish passage to the wetlands. The regulatory structure currently located on the western end of Fishers Lagoon West may appropriate for environmental watering purposes.

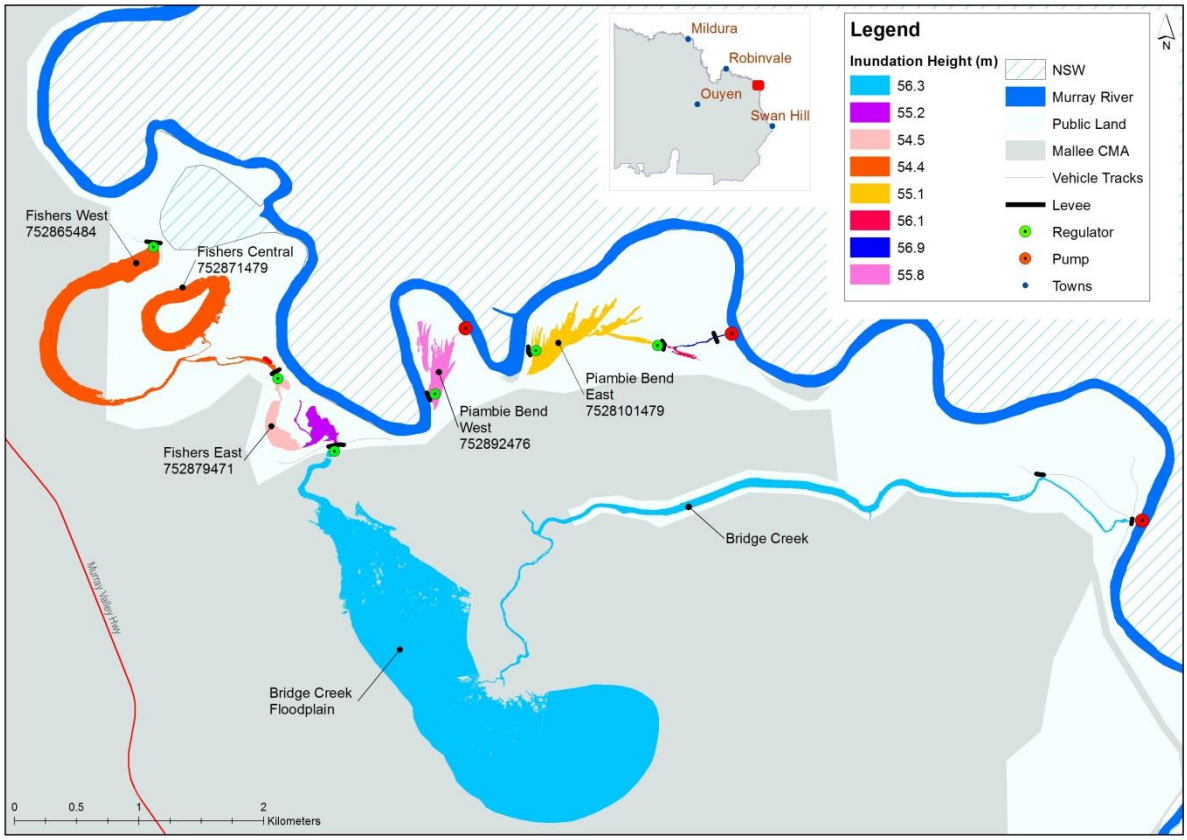


Figure 22. Maximum achievable inundation extent: Bridge Creek, Floodplain and Fishers Lagoon Complex showing locations of recommended infrastructure

10.2.2 Piambie Bends West Recommendations

Piambie Bend West can be watered by pumping from the Murray at an upstream location and allowing water to flow across the floodplain. This option would inundate an area of approximately 8.6 ha and require approximately 92 ML of environmental water.

A levee and regulator at the downstream connection point would help retain water on the floodplain and enable inundation above the wetland area (Figure 23).

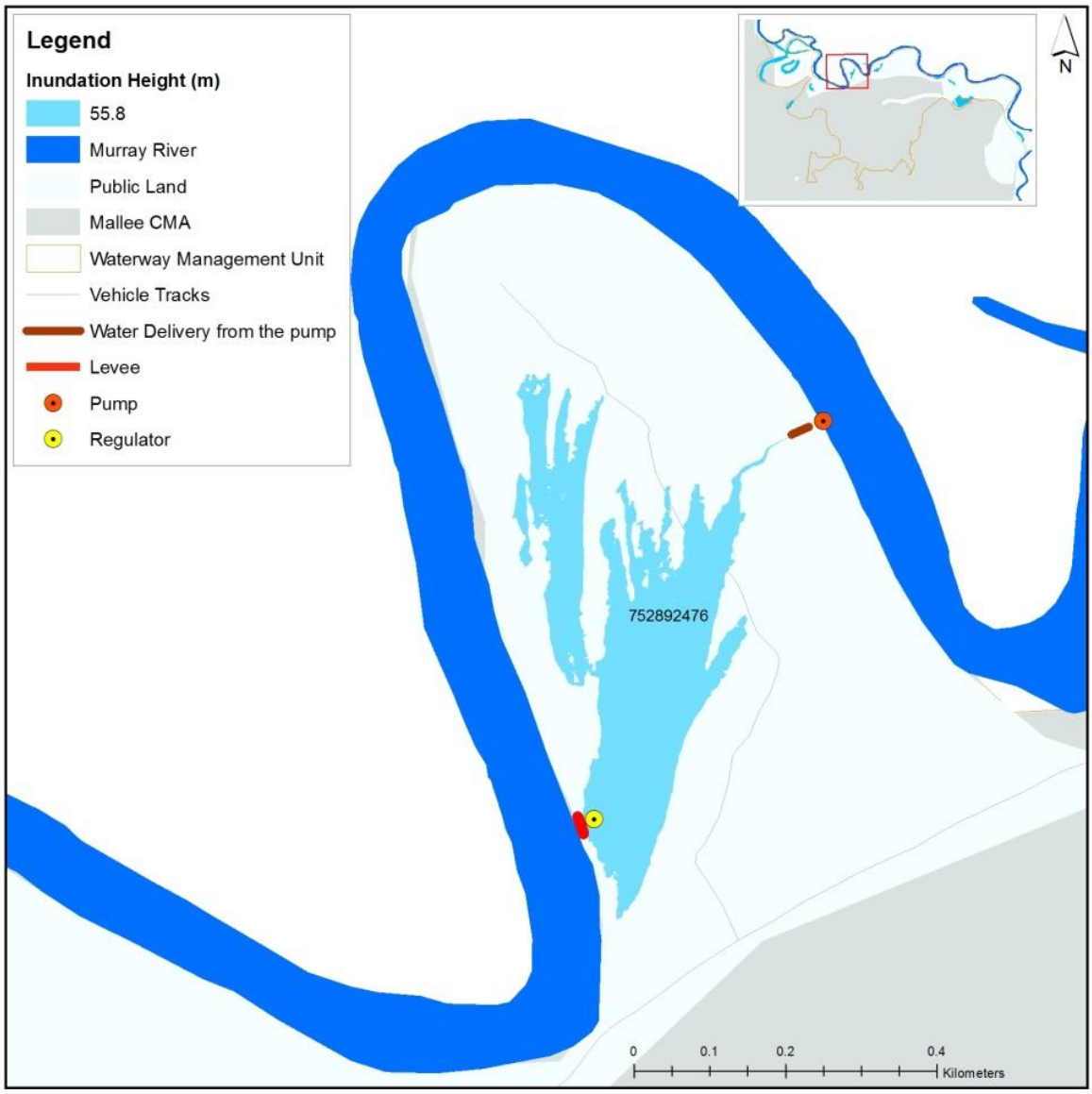


Figure 23 - Infrastructure and target area for Piambie Bend West

10.2.3 Piambie Bend East Recommendations

Piambie Bend East can be watered by pumping from the Murray at an upstream location and allowing water to flow across the floodplain. This option would inundate an area of approximately 16.5 ha and require approximately 144 ML of environmental water.

A levee and regulator at the downstream connection point would improve connectivity to the river, help retain water on the floodplain, and enable inundation above the wetland area. A levee and regulator where an access track crosses the upstream effluent, plus a levee at the river connection of this effluent would enable retention of water to 56.9 m AHD within the effluent and an associated floodrunner (Figure 24).

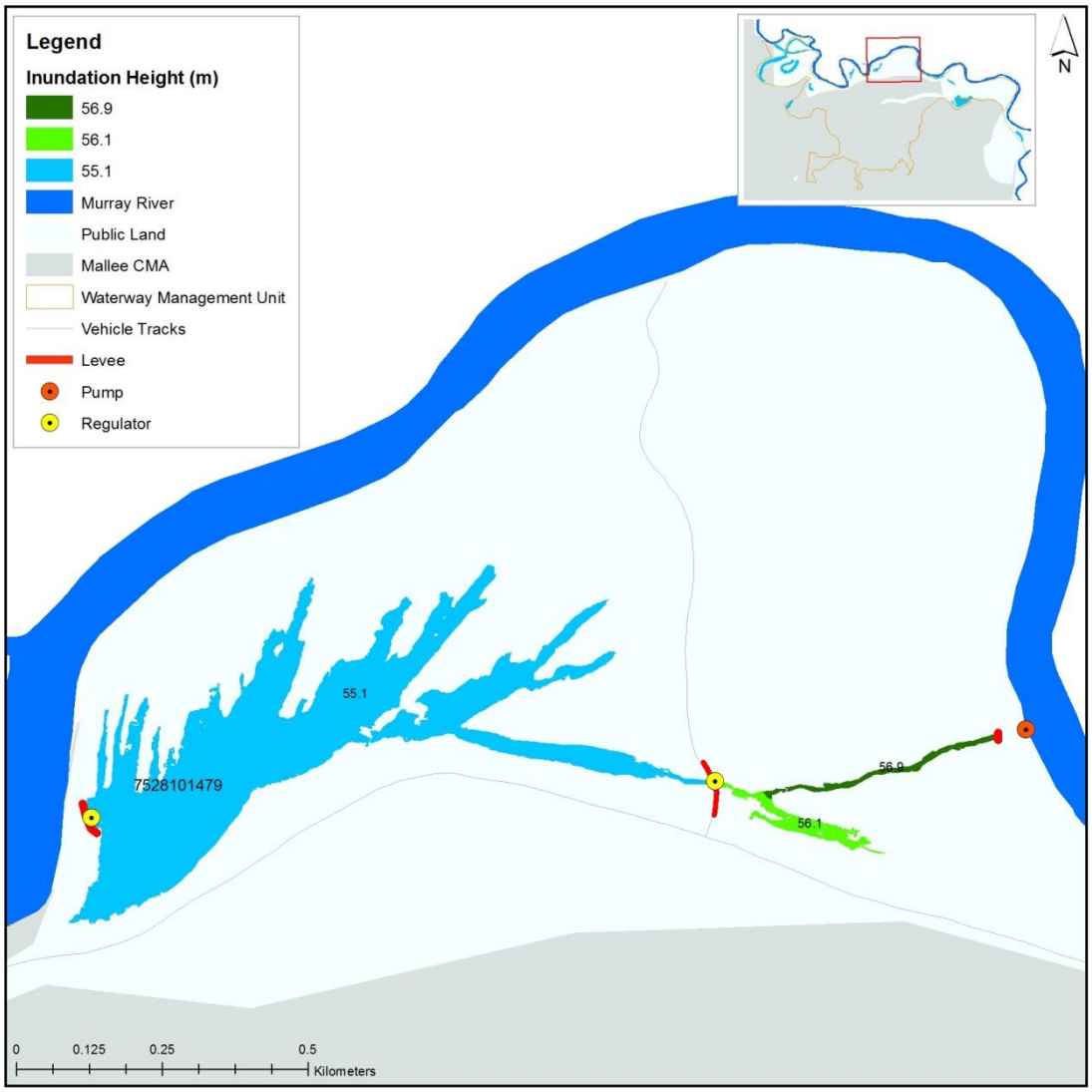


Figure 24 - Infrastructure and target area for Piambie Bend East

11 Demonstrating Outcomes

11.1 Monitoring Priorities at the Site

Monitoring of the impact of environmental watering events is proposed as outlined in Table 13.

Table 13. Proposed Monitoring for Piambie

Management Zone	Objective	Hypotheses	Indicator(s)	Frequency
All Zones	Improve/ Wetland Vegetation Condition	Delivery of environmental water as per plan will improve vegetation structure and condition	Photopoints IWC/ISC assessments	Annual Every 5 years
All Zones	Improve habitat potential for threatened species	Improving the vegetation structure and condition leads to improved habitat potential for threatened species	Assessment of habitat potential of EVCs Surveys of Carpet Python and log counts Surveys Regent Parrot and possible nesting sites	Every 5 years Every 5 years Every 5 years
All zones	Improve Tough Scurf-pea population size and extent	Delivery of environmental water as per plan will increase Tough Scurf-pea population	Survey & assessment of population size & extent	After each delivery event

Photo point monitoring will be conducted before and after watering events at Piambie to measure the success of environmental water in improving wetland and riparian vegetation communities.

Event based monitoring may be used to measure water quality, particularly in areas where irrigators are drawing water, or may be concerned about water quality, and to gauge the viability of discharging water back to the Murray River or allowing flow through to Fishers Lagoon Complex.

Other incidental observations that may occur in the course of the monitoring methods above include visitation by waterbirds and other species to the wetlands during and after watering events.

Detailed monitoring of environmental water delivery to Piambie would be dependent on funding from the State or Commonwealth Governments.

12 Consultation

This Plan was developed in collaboration with key stakeholders namely Parks Victoria, landholders, the Department of Environment and Primary Industries and local interest groups. Several meetings were held and phone calls made during the development phase to seek input and gather information from experts and stakeholders. Table 14 outlines consultation undertaken in the development of this plan.

Overall the community was positive about the possibility of future watering events at Bridge Creek/Fisher's Lagoon. Important issues that were raised included:

- Need to monitor the possible impact watering events may have on fences.
- Ensure watering events do not impede access to irrigation pumps.
- Need to carefully consider the watering regime of Fisher's Lagoon as one of the lagoons is needed as a holding basin for irrigation water.

Table 14. Consultation Process for development of the Piambie Environmental Water Management Plan

Meeting date	Stakeholders	Details
21 August 2014	Mallee CMA, Leonie North (Sunraysia Environmental, as author of this plan)	Site visit, discussion of system constraints and objectives of delivery of environmental water, inspection of private pump site access track.
25 March 2015	Landholder	Discussions on purpose of and need for environmental watering, movement of water on floodplain, history of the area & history of the bridge.
24 April 2015	Landholders	Determine current usage, access requirements, views on delivery of environmental water, risk of private property inundation, risk to private infrastructure and potential for black water events
30 April 2015	Landholder	Determine current usage, access requirements, views on delivery of environmental water, risk of private property inundation, risk to private infrastructure and potential for black water events
1 May 2015	Nearby landholder	Determine current usage, access requirements, views on delivery of environmental water and risk to private infrastructure.
15 May 2015	Mid-Murray Field Naturalists Club	Presentation on the Bridge Creek EWMP.

February 2015	Mallee CMW – Land and Water Advisory Group (Waterway health specialists)	Discuss ecological objectives and proposed environmental watering actions
02 March 2015	Aboriginal Reference Group	Discuss proposed environmental watering actions and direct engagement strategies with Traditional Owners

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. A cultural heritage management plan would be essential before any on ground works could be undertaken.

Table 15. Knowledge gaps and recommendations for the target area

Knowledge and data gaps	Action recommended	Priority level	Responsibility
Map and quantify population of Tough Scurf-pea (*Cullen tenax*)	Survey to quantify extent and size of population, map key areas, during growing season (Sept-May), identify exclusion zones for earthworks. Ongoing monitoring to assess effects of water delivery	1	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
Index of Wetland Condition/ Index of Stream Condition Assessments	IWC/ISC assessments undertaken to establish baseline condition and as the basis for ongoing monitoring of improvement over time	2	
Flow path of Bridge Creek	Use existing aerial imagery to map flow path and update Mallee CMA GIS data, ground truth as part of ISC assessment, or obtain/update LiDAR data.	3	
Accurate *ctf* values	Estimate *ctf* for all wetlands and update records accordingly	4	
Full extent of cultural Heritage values	Cultural heritage assessment and mapping of values within target area	5	
Impact of watering program on native vegetation	Continue to investigate and understand the range of species at the site, including surveys of vegetation, including aquatic macrophytes.	6	
Landholder Management Agreements	Landholder agreements should be signed outlining the proposed watering regimes and any inundation of private land.	7	
Stakeholder Agreements	Prior to the infrastructure upgrades proposed in this EWMP it is recommended that agreements with stakeholders and landholders be developed. These agreements should include details of the roles in management of the infrastructure, financial responsibilities for the infrastructure etc.	8	
Feasibility of Infrastructure and complementary works	Undertake feasibility assessment and costing of the additional works identified by Mallee CMA which would benefit environmental watering at the target area.	9	
Operating rules for structures	Development of operating rules for structures and each wetland within the target area.	10	

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Appendix 1: Flora and fauna species list

Flora – Native

Scientific Name	Common Name	Victorian Advisory List	EVC
Acacia ligulata	Small Cooba		
Acacia melvillei	Yarran	Vulnerable	
Amyema miquelii	Box Mistletoe		
Asperula conferta	Common Woodruff		
Bossiaea walkeri	Cactus Bossiaea	Endangered	
Brachyscome basaltica var. *gracilis*	Woodland Swamp-daisy		103, 106
Brachyscome sp. aff. *readeri*	Riverina Daisy	Vulnerable	103
Cardamine lineariloba	Western Bitter-cress	Vulnerable	
Carex inversa	Knob Sedge		
Convolvulus erubescens s.l.	Pink Bindweed		
Cullen tenax	Tough Scurf-pea	Endangered	
Cyperus gymnocaulos	Spiny Flat-sedge		813
Danthonia s.l. spp.	Wallaby Grass		
Daucus glochidiatus	Australian Carrot		
Dianella longifolia s.l.	Pale Flax-lily		
Enteropogon acicularis	Spider Grass		
Eremophila longifolia	Berrigan		103
Eucalyptus camaldulensis	River Red-gum		106, 813, 823
Eucalyptus largiflorens	Black Box		103, 813, 823
Eucalyptus microcarpa	Grey Box		103
Euchiton sphaericus	Annual Cudweed		811
Fimbristylis aestivalis	Summer Fringe-sedge	Poorly known	810
Geijera parviflora	Wilga	Endangered	
Geococcus pusillus	Earth Cress		
Goodenia heteromera	Spreading Goodenia		103
Goodenia pusilliflora	Small-flower Goodenia		103

Scientific Name	Common Name	Victorian Advisory List	EVC
Haloragis aspera	Rough Raspwort		813
Lachnagrostis filiformis s.l.	Common Blown-grass		104, 810, 809, 811
Linum marginale	Native Flax		
Lotus cruentus	Red Bird's-foot Trefoil		
Maireana aphylla	Leafless Bluebush	Poorly known	103
Malva preissiana s.l.	Australian Hollyhock		
Marsilea drummondii	Common Nardoo		104
Paspalidium jubiflorum	Warrego Summer-grass		106, 811
Picris angustifolia	Native Picris		
Plantago spp.	Plantain		
Rhodanthe corymbiflora	Paper Sunray		
Rumex brownii	Slender Dock		106
Sclerolaena divaricata	Tangled Copperburr	Poorly known	
Senecio glossanthus s.l.	Slender Groundsel		104, 811
Senecio quadridentatus	Cotton Fireweed		106, 811
Solanum esuriale	Quena		
Vittadinia dissecta s.l.	Dissected New Holland Daisy		
Vittadinia spp.	New Holland Daisy		
Wahlenbergia fluminalis	River Bluebell		106

Flora – Exotic

Scientific Name	Common Name
Arctotheca calendula	Cape weed
Avena fatua	Wild Oat
Bromus rubens	Red Brome
Capsella bursa-pastoris	Shepherd's Purse
Centaurea calcitrapa	Star Thistle
Centaurea melitensis	Malta Thistle
Cirsium vulgare	Spear Thistle

Scientific Name	Common Name
Erodium botrys	Big Heron's-bill
Erodium cicutarium	Common Heron's-bill
Hypochaeris glabra	Smooth Cat's-ear
Lactuca serriola	Prickly Lettuce
Lolium perenne	Perennial Rye-grass
Medicago spp.	Medic
Phalaris paradoxa	Paradoxical Canary-grass
Phyla canescens	Fog-fruit
Plantago coronopus	Buck's-horn Plantain
Reichardia tingitana	False Sow-thistle
Scorzonera laciniata	Scorzonera
Sonchus oleraceus	Common Sow-thistle
Trifolium arvense var. *arvense*	Hare's-foot Clover
Trifolium subterraneum	Subterranean Clover
Vulpia bromoides	Squirrel-tail Fescue
Vulpia myuros	Rat's-tail Fescue

Fauna – Native

Scientific Name	Common Name	Type	Victorian Advisory List	Count of Sightings
Acanthiza chrysorrhoa	Yellow-rumped Thornbill	B		1
Acanthiza reguloides	Buff-rumped Thornbill	B		2
Acanthiza uropygialis	Chestnut-rumped Thornbill	B		2
Anas gracilis	Grey Teal	B		2
Anas superciliosa	Pacific Black Duck	B		1
Aphelocephala leucopsis	Southern Whiteface	B		2
Cacatua galerita	Sulphur-crested Cockatoo	B		1
Chenonetta jubata	Australian Wood Duck	B		1
Climacteris picumnus victoriae	Brown Treecreeper (south-eastern ssp.)	B	Near threatened	2

Scientific Name	Common Name	Type	Victorian Advisory List	Count of Sightings
Colluricincla harmonica	Grey Shrike-thrush	B		1
Coracina novaehollandiae	Black-faced Cuckoo-shrike	B		1
Corcorax melanorhamphos	White-winged Chough	B		1
Corvus coronoides	Australian Raven	B		2
Cracticus nigrogularis	Pied Butcherbird	B		1
Crinia parinsignifera	Plains Froglet	A		1
Dacelo novaeguineae	Laughing Kookaburra	B		1
Dicaeum hirundinaceum	Mistletoebird	B		2
Elseyornis melanops	Black-fronted Dotterel	B		1
Entomyzon cyanotis	Blue-faced Honeyeater	B		1
Eolophus roseicapilla	Galah	B		3
Gerygone fusca	Western Gerygone	B		1
Grallina cyanoleuca	Magpie-lark	B		1
Gymnorhina tibicen	Australian Magpie	B		2
Haliaeetus leucogaster	White-bellied Sea-Eagle	B	Vulnerable	2
Lalage sueurii	White-winged Triller	B		1
Lichenostomus penicillatus	White-plumed Honeyeater	B		2
Litoria raniformis	Growling Grass Frog	A	Endangered	1
Lophoictinia isura	Square-tailed Kite	B	Vulnerable	2
Macropus fuliginosus	Western Grey Kangaroo	M		1
Malurus cyaneus	Superb Fairy-wren	B		1
Malurus lamberti	Variegated Fairy-wren	B		1
Manorina melanocephala	Noisy Miner	B		2
Melithreptus brevirostris	Brown-headed Honeyeater	B		1
Morelia spilota metcalfei	Carpet Python	R	Endangered	15
Ocyphaps lophotes	Crested Pigeon	B		1
Pachycephala rufiventris	Rufous Whistler	B		2

Scientific Name	Common Name	Type	Victorian Advisory List	Count of Sightings
Pardalotus striatus	Striated Pardalote	B		2
Petrochelidon neoxena	Welcome Swallow	B		1
Petrochelidon nigricans	Tree Martin	B		1
Petroica goodenovii	Red-capped Robin	B		1
Philemon citreogularis	Little Friarbird	B		2
Platycercus elegans flaveolus	Yellow Rosella	B		2
Platycercus eximius	Eastern Rosella	B		2
Plectorhyncha lanceolata	Striped Honeyeater	B		1
Poliocephalus poliocephalus	Hoary-headed Grebe	B		1
Pomatostomus ruficeps	Chestnut-crowned Babbler	B		1
Psephotus haematonotus	Red-rumped Parrot	B		1
Rhipidura leucophrys	Willie Wagtail	B		1
Smicrornis brevirostris	Weebill	B		2
Todiramphus sanctus	Sacred Kingfisher	B		2
Zosterops lateralis	Silvereye	B		1

Legend
Type: Amphibian, Reptile, Bird, Mammal

Fauna – Exotic

Scientific Name	Common Name	Type
Oryctolagus cuniculus	European Rabbit	M

Legend
Type: Mammal

Appendix 2: Ecological vegetation classes

Description of each EVC mapped at Piambie.

EVC no.	EVC name	Bioregional Conservation Status	Description
		Murray Fans	
86	Woorinen Sands Mallee	Depleted	(Terrestrial, outside target area) Mallee shrubland to 7 m tall, typically supporting a hummock grass (*Triodia* spp.) dominated understorey. This EVC could be considered intermediate between the heavier soil mallee woodlands and the lighter sandy soil mallee vegetation predominant on Lowan (siliceous) sand.
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.
98	Semi-arid Chenopod Woodland	Endangered	Sparse, low non-eucalypt woodland to 12 m tall of the arid zone with a tall open chenopod shrub-dominated understorey to a treeless, tall chenopod shrubland to 3 m tall. This EVC may occur as either a woodland (typically with a very open structure but tree cover >10%) or a shrubland (tree cover <10%) with trees as an occasional emergent.
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.
104	Lignum Swamp	Vulnerable	Typically treeless shrubland to 4 m tall, with robust (but sometimes patchy) growth of lignum. Widespread wetland vegetation type in low rainfall areas on heavy soils, subject to infrequent inundation resulting from overbank flows from rivers or local runoff.
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.

EVC no.	EVC name	Bioregional Conservation Status	Description
		Murray Fans	
200	Shallow Freshwater Marsh	Vulnerable	Shallow Freshwater Marsh occupies open sheets of water which are usually perennial although contract in size during the drier months. 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. Shallow Freshwater Marsh also occurs on deep brown anaerobic) silts where creeks and rivers broaden and flow slows as the water enters floodplains.
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.
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 River Red Gum. Restricted, Murray River floodplain, primarily within Barmah Forest.
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 (both EVCs)	EVC complex
813	Intermittent Swampy Woodland	Vulnerable	Eucalypt woodland to 15 m tall with a variously shrubby and rhizomatous sedgy – turf grass understorey, at best development dominated by flood stimulated species in association with flora tolerant of inundation. Flooding is unreliable but extensive when it happens. Occupies low elevation areas on river terraces (mostly at the rear point-bar deposits or adjacent to major floodways) and lacustrine verges (where sometimes localised to narrow transitional bands). Soils often have a shallow sand layer over heavy and frequently slightly brackish soils.

EVC no.	EVC name	Bioregional Conservation Status	Description
		Murray Fans	
818	Shrubby Riverine Woodland	Least Concern (Terrestrial BCS)	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. Dominant tree species; *Eucalyptus largiflorens Eucalyptus camaldulensis*
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.

Appendix 3: 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.

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 Mallee CMA Indigenous Facilitator
- Within a period not exceeding one working day 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;
- A separate contingency plan has been developed in the event that suspected human remains are discovered during the conduct of the activity.

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.