Carina Bend Environmental Water Management Plan

mallee
catchment management authority

Document Control

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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) identified 23 Waterway Management Units (WMU) from 216 targeted waterways in the Mallee. The interconnectedness and commonality of threats impacting on the waterway values were used to group the WMUs into planning units. This EWMP has been developed for the Carina Bend WMU sub-unit, hereafter referred to as Carina Bend. The EWMP will help to guide future environmental watering activities for this area.

The Carina Bend FMU features a lagoon system nearly 5km in length (Carina Bend Wetland) as well as two smaller, unnamed wetlands and low meander scroll complexes supporting River Red Gum woodland vegetation communities. The central floodplain supports higher terraces with Black Box and lignum vegetation communities.

Carina Bend supports species of high conservation significance including Regent Parrot, Brown Tree-creeper and White-browed Tree-creeper and Carpet Python. These species rely on the health of large mature River Red Gums, which are prevalent with the target area. The wetland potentially provides excellent seasonal habitat for fish, frogs and waterfowl.

The management goal for Carina Bend is “To provide a water regime that will support the health of fringing mature River Red Gum and provide seasonal habitat for native fish, frogs and waterfowl.”

The ecological objectives to support the management goal for Carina Bend are:

- Support the health of mature River Red Gum trees along the wetland perimeter
- Provide seasonal aquatic habitat that supports a diverse population of native fish and frogs
- Reliable nesting and feeding habitat for waterfowl in winter and spring
- Diverse macrophyte and frog population supported by healthy Lignum Swampy Woodland vegetation

The optimal watering regime is to maintain Carina Bend Wetland as a semi-permanent freshwater wetland, with a seasonally inundated fringe.

Fill Carina Bend Wetland every second year in late winter/early spring to 46m AHD, with water levels falling naturally by seepage and evaporation over summer and autumn. In every fourth year, fill wetland to 46.7m AHD to inundate the Lignum communities in September, with water levels falling naturally by seepage and evaporation over summer and autumn.

There is currently no infrastructure in place to manage watering of the target area. Recommendations that will significantly enhance the area able to be inundated with environmental water have been made.

1 Introduction

This Environmental Water Management Plan (EWMP) has been prepared by the Mallee Catchment Management Authority (CMA) to establish the long-term management goals of Carina Bend.

The key purposes of the EWMP are to:

- identify long-term objectives and water requirements for the wetlands, which have been identified as a priority by the Mallee CMA;
- provide a vehicle for community consultation, including for the long-term objectives and water requirements of the wetlands;
- inform the development of seasonal watering proposals and seasonal watering plans; and
- inform the long-term watering plans to be developed under the Basin Plan requirements.

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 39,000 km^2 (3.9 million ha) and has 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 irrigated horticulture including grapes, citrus, almonds, olives and vegetables along the Murray River corridor. Irrigated crops contribute over 40% of the value of agricultural production for the region.

In 2006, the Mallee CMA engaged consultants (Ecological Associates, 2006) to investigate water management options for the Murray River floodplain from Robinvale to Wallpolla Island. 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, but which are relatively consistent in their ecological values and land uses. The Mallee CMA has based its environmental water management plans on these FMUs to support 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.

The site for this plan is the Carina Bend FMU, hereafter referred to as Carina Bend in this document. Carina Bend is located within the Happy Valley WMU, 25km south west of Robinvale on the Murray River floodplain Figure 1.

A regional context document (North, 2014a) has been prepared to compliment the Mallee CMA EWMPs and should be read in conjunction with this document.

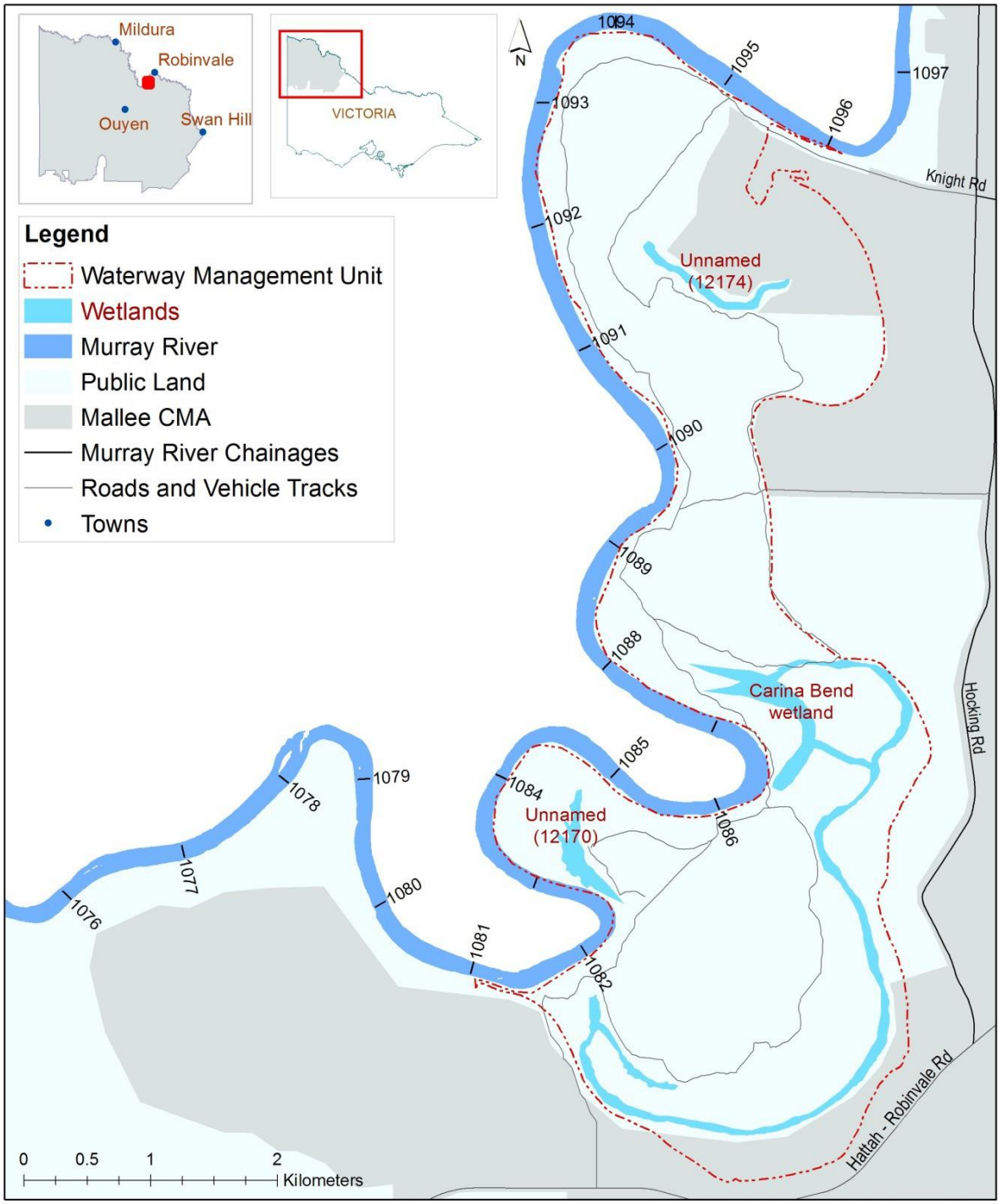


Figure 1 – Carina Bend

2.2 Catchment setting

Carina Bend is in the Robinvale Plains bioregion within the Mallee CMA region. The majority of the bioregion is a narrow gorge confined by the cliffs along the Murray River. These are entrenched within older up-faulted Cainozoic sedimentary rocks. Alluvium deposits from the Cainozoic period gave rise to the red brown earths, cracking clays and texture contrast soils (Vertosols, Chromosols and Sodosols). The floodplain supports Riverine Grassy Forest and Riverine Grassy Chenopod Woodland ecosystems (DEPI, 2014).

2.3 Carina Bend

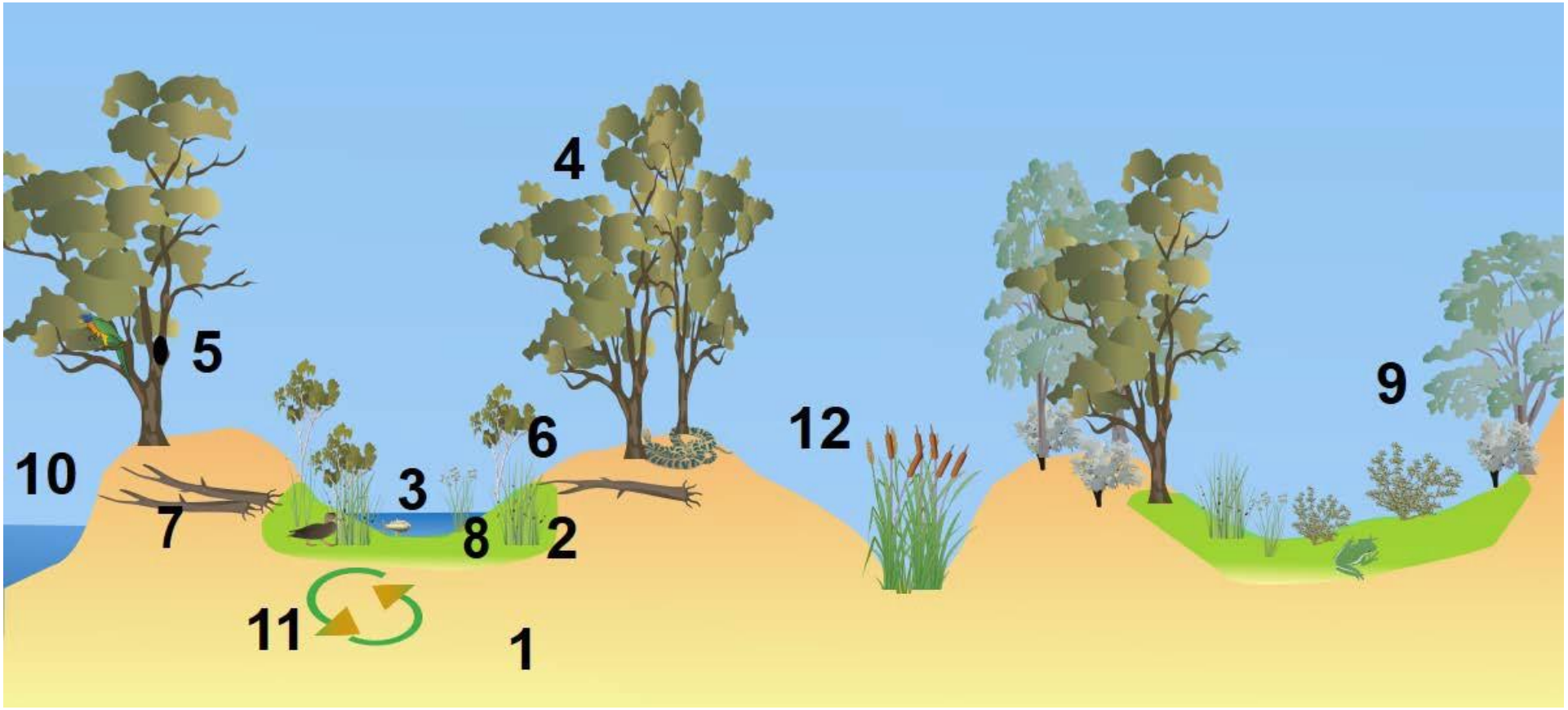
Carina Bend is situated on the Murray River floodplain, 25km south west of Robinvale, between the townships of Wemen and Happy Valley. The Carina Bend FMU features a lagoon system nearly 5km in length (Carina Bend Wetland) as well as two smaller, unnamed wetlands and low meander scroll complexes that support River Red Gum woodland vegetation communities. The central floodplain supports higher terraces with Black Box and lignum vegetation communities (Ecological Associates, 2007c).

Until recently, wetlands that comprise the south western end of Carina Bend Wetland (from the entry point at 1081.5 river km) have been used to hold irrigation water (Ecological Associates, 2007c).

2.4 Conceptualisation of the site

Carina Bend is represented by a conceptual model which is a visual representation of the processes and components within the target area that are discussed throughout this EWMP.

Carina Bend



Carina Bend WMU sub-unit is located between 1081 and 1096 river kilometres. It is 25km south west of Robinvale and 24km downstream of Euston weir.

1. The Carina Bend Wetland is comprised of a series of wetlands nearly 5km long that can join up during high flows. The deepest points are approximately 3 metres.
2. Prior to river regulation parts of these wetlands would have been inundated annually during winter flows. Water levels would have dropped over the summer and autumn exposing the wetland edges and encouraging macrophyte growth.
3. Watering to support semi-permanent water in the channel will provide habitat for small bodied fish such as Gudgeon species and reliable aquatic habitat for waterfowl.
4. Mature, hollow bearing River Red Gum line the wetlands and Murray River frontage. Watering Carina Bend wetland will result in improved tree health for significant areas of River Red Gums along the channel.
5. Hollows in mature River Red Gum provide important habitat for fauna including Regent Parrot and Carpet Python which have been recorded breeding at the site.
6. The northern end of Carina Bend Wetland spreads out into areas of shallow water and sandy benches. During and following inundation, the Lignum Swampy Woodland and Intermittent Swampy Woodland will support a complex habitat structure of macrophyte beds, overhanging River Red Gum branches, shrubs and lignum. These areas will provide excellent frog habitat.
7. Fallen woody debris provides feeding sites for the Brown Tree-creeper as they forage for insects from the ground to the canopy. Appropriate inundation frequencies will support tree health and the long-term supply of woody debris.
8. Carina Bend Wetland supports Floodway Pond Herbland in the channel fringed by Intermittent Swampy Woodland.
9. Lignum Swampy Woodland, Lignum Swamp and Riverine Chenopod Woodland are present in adjacent, higher areas of the floodplain. Other terraces, wetlands and channels also host areas of Shallow Freshwater Marsh, Grassy Riverine Forest and Shrubby Riverine Woodland.
10. River regulation and water extraction for irrigation have reduced the frequency, duration and magnitude of inundation of floodplain wetlands in this section of the Murray River.
11. The floodplain is currently only inundated during very high river flows. Reduced floodplain and wetland inundation have contributed to reductions in the diversity and productivity of riparian and floodplain vegetation communities and a reduction in habitat availability and structural complexity for aquatic and terrestrial fauna. Channels and wetlands are lined with juvenile River Red Gums that germinated following previous inundation events.
12. Some channels at the site have been modified and deepened for irrigation supply, reducing the width and complexity of the littoral zone.

2.6 Land status and management

Several agencies and individuals are involved in managing the land and water at Carina Bend (Table 1). Land management boundaries are shown in Figure 2.

Carina Bend is subject to three public land classifications: Murray River Park, Murray River Reserve and Carina Bend Riverine Forest. Parks Victoria is the public land manager at Carina Bend. There is also an area of private land within Carina Bend.

Table 1 - Stakeholders for the Carina Bend EWMP

Group	Role
Parks Victoria	Land Manager
Mallee CMA	Regional waterway and environmental management
Department of Environment, Land, Water and Planning (DELWP)	State level environmental management planning, land manager, threatened species manager
Victorian Environmental Water Holder (VEWH)	Manager of Victoria's environmental water entitlements
Robinvale Claimant Group Tati Tati community representatives Latji Latji community representatives	Indigenous representation
Wemen Progress Association	Local community representation

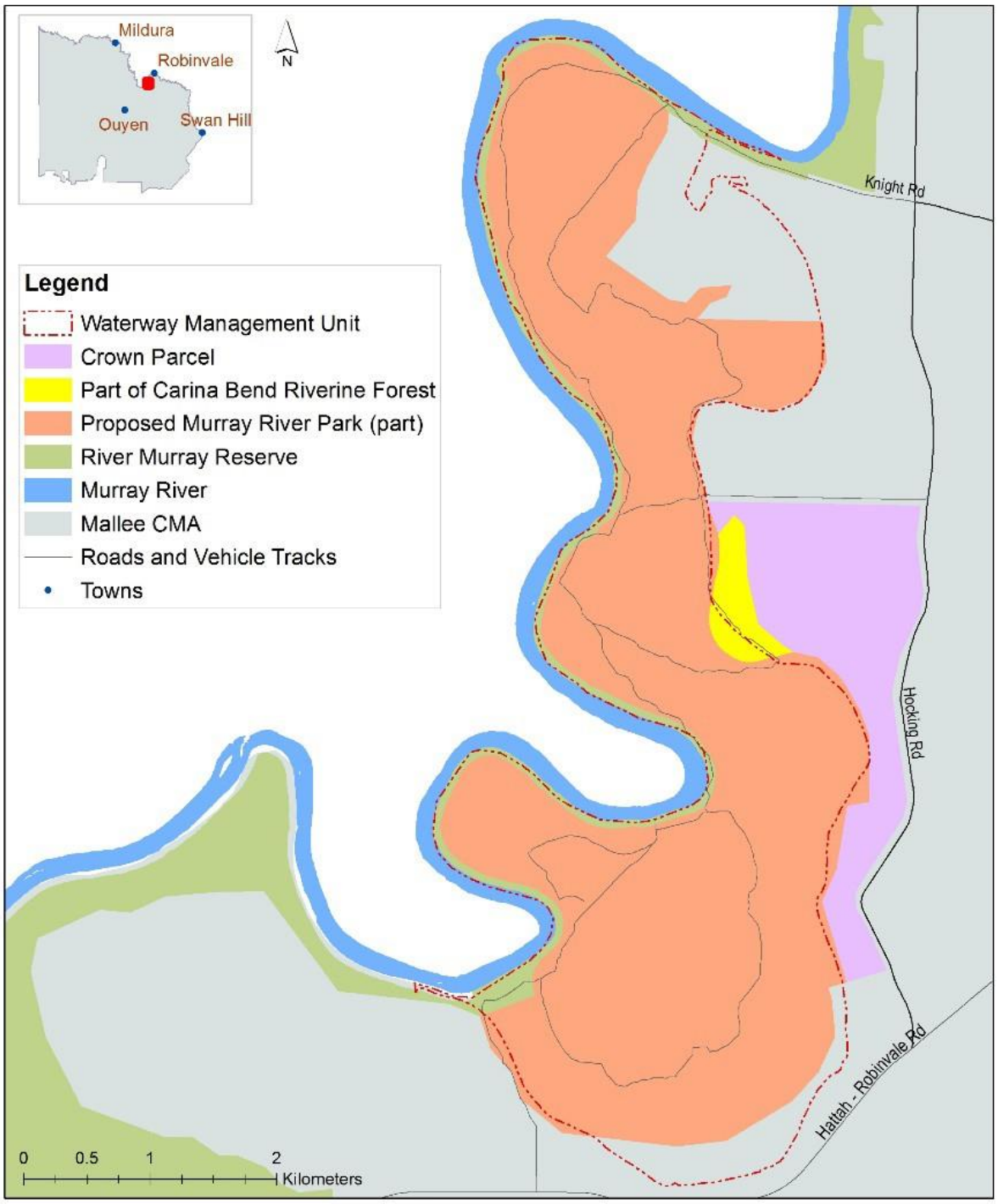


Figure 2 - Land management boundaries within Carina Bend

2.8 Wetland characteristics

A brief overview of the main characteristics of the wetlands at Carina Bend is provided in Table 2. Wetland types found within Carina Bend are shown in Figure 3.

Table 2 - Wetland characteristics at Carina Bend

Characteristics	Description
Name	Carina Bend
Mapping ID (Wetland Current layer)	**Carina Bend Wetland:** 12238 **Unnamed wetland:** 12170 **Unnamed wetland:** 12174
Area of wetlands in target area	93.6 ha
Bioregion	Robinvale Plains
Conservation status	Bioregion conservation status: areas of EVCs listed as Vulnerable, Depleted and Least Concern
Land status	Public land: Proposed Murray River Park, River Murray Reserve, Carina Bend Riverine Forest/Crown land; private land
Land manager	Parks Victoria, DELWP
Surrounding land use	Dryland cropping, irrigation agriculture (almonds, grapes and oranges), town of Happy Valley
Water supply	Natural inflows from the Murray River and local catchment runoff
Wetland category (Wetland Current layer)	**Carina Bend Wetland:** Deep Marsh **Unnamed wetland #12170:** Shallow Marsh **Unnamed wetland #12174:** Deep Marsh
Wetland depth at capacity	**Carina Bend Wetland:** approximately 3 m at the deepest points

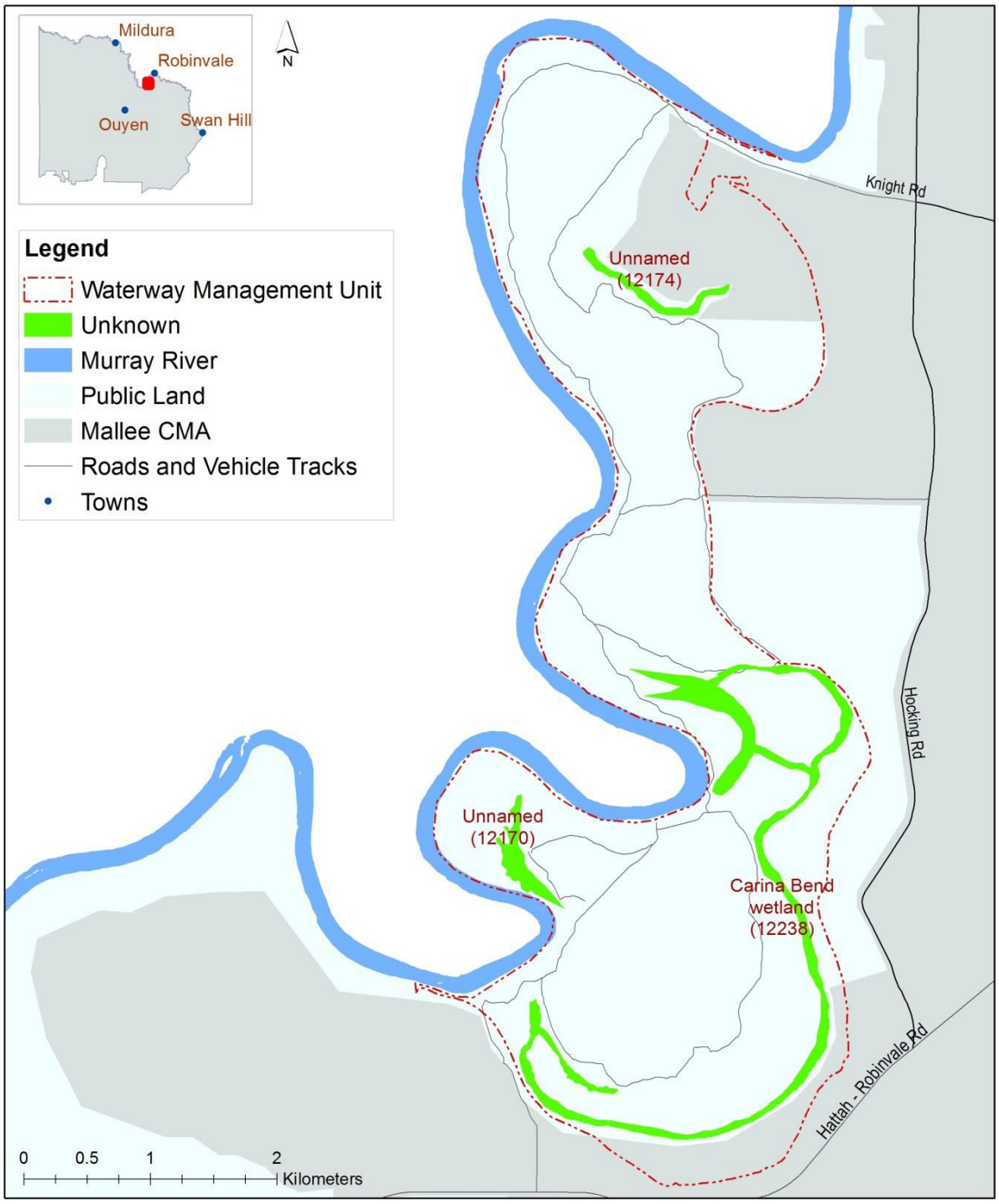


Figure 3 - Wetland types at Carina Bend

2.9 Management scale

The whole of Carina Bend has a water requirement as a floodplain complex, but the focus of this plan is the area of the floodplain where environmental water can be managed, following the construction of the infrastructure proposed in this plan. This target area consists of Carina Bend Wetland and an area of Grassy Riverine Forest / Floodway Pond Herbland Complex and Intermittent Swampy Woodland. The target area is 135.9 ha, as shown as the inundation extent at 46.7 m AHD in Figure 4.

Unnamed wetlands #12174 and #12170 are excluded from the target area. Expansion of the target area is possible only with significant alterations to Murray River operations such as large releases from storage. This is beyond the scope of this plan but is being addressed at the Murray-Darling Basin scale.

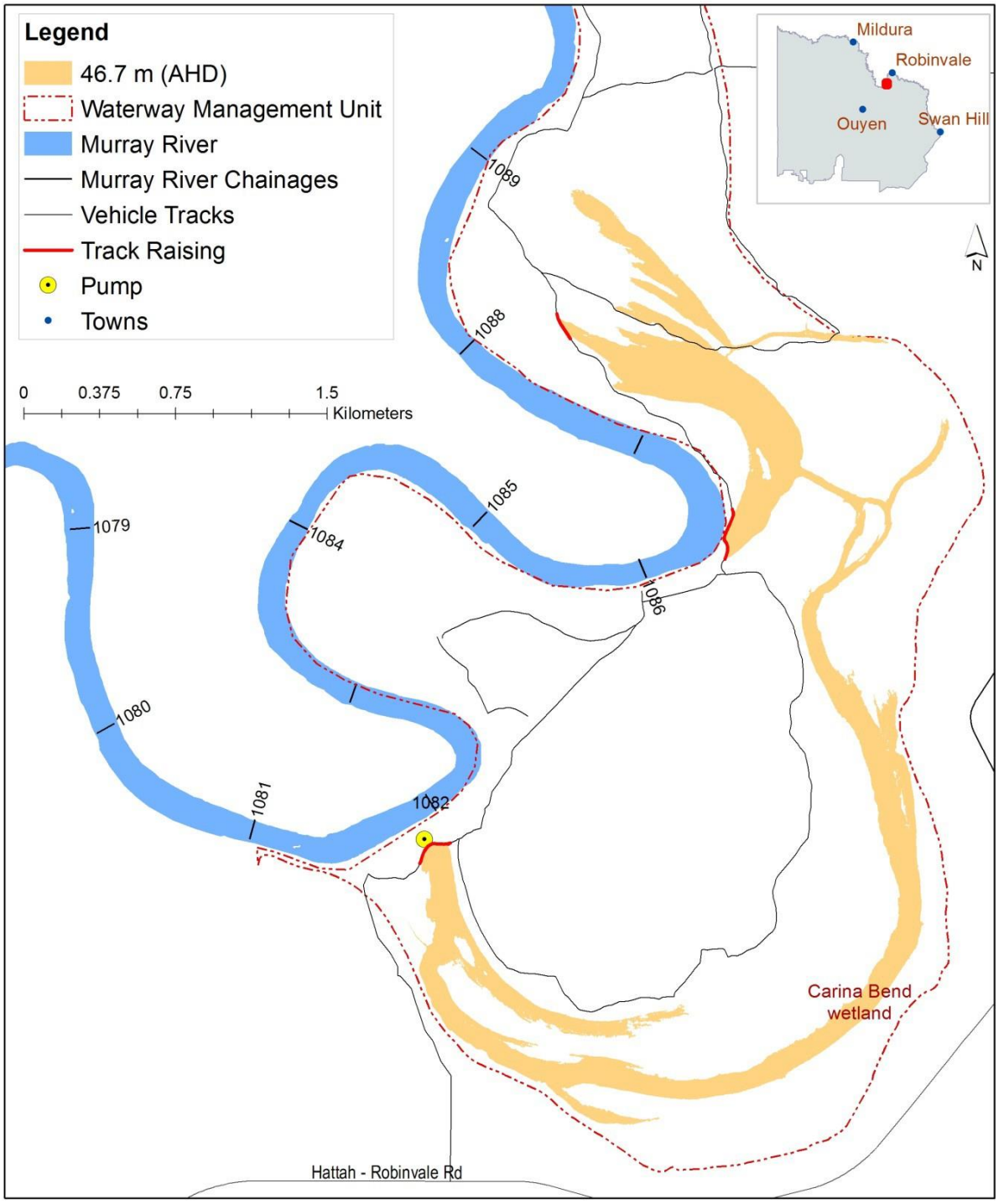


Figure 4 - Target area for the Carina Bend EWMP consisting of the areas of Carina Bend Wetland inundated at a level of 46.7m (AHD).

2.11 Environmental water sources

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

The Victorian Environmental Water Holder (VEWH) is responsible for holding and managing Victoria's environmental water entitlements.

Environmental water for the target area may be sourced from the water entitlements listed in Table 3 and further explained in the Regional Context Document (North, 2014a). Previous environmental watering at Carina Bend is outlined in the Environmental Watering section of this EWMP.

Table 3 - Summary of environmental water sources available to Carina Bend

Water entitlement	Responsible agency
Murray River unregulated flows Murray River surplus flows	Murray-Darling Basin Authority
Victorian Murray River Flora and Fauna Bulk Entitlement	Victorian Environmental Water Holder
Commonwealth water	Commonwealth Environmental Water Holder
Donated water	Victorian Environmental Water Holder

Source: (Commonwealth Department of the Environment, 2016; DELWP, 2016a)

2.12 Related agreements, policy, plans and activities

There is a range of National and State Acts, policies and strategies that direct management of the target area. Those with particular relevance to the site and the management of its environmental values are listed in Table 4. For the functions and major elements of each refer to the Regional Context Document (North, 2014b).

Table 4 - National and state legislation relevant to management of the target area

Jurisdiction	Legislation, agreement or convention
National	Environment Protection and Biodiversity Conservation Act 1999
State	Flora and Fauna Guarantee Act 1988
State	DELWP Advisory List of Threatened Vertebrate Fauna

The Carina Bend EWMP was first developed in 2012. This document is a full revision of the 2012 EWMP.

The Mallee Waterway Strategy (2014) identifies Carina Bend Wetland as a medium priority wetland in the Mallee CMA region.

The Strategy identifies the need to review EWMPs across the WMU that includes Carina Bend (Management Action F1.1). This updated Carina Bend EWMP contributes to this action.

A number of earlier investigations into the Murray River floodplain are relevant to Carina Bend and have been considered in the development of this EWMP. These include salinity management plans, flow studies, and an investigation into River Red Gum health by the Land Conservation Council (LCC, 1989) and the Victorian Environmental Assessment Council (VEAC, 2008).

Carina Bend was also one of the areas included in the Investigation of Water Management Options for the Murray River – Robinvale to Wallpolla (Ecological Associates, 2007c).

3 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. A wetland's hydrology is determined by the physical form of the wetland, surface and groundwater inflows and outflows in addition to precipitation and evapotranspiration. Duration, frequency and seasonality (timing) are the main components of the hydrological regime for wetlands and rivers.

Hydrology at Carina Bend is best described using gauge #414203 (Murray River @ downstream of Euston Weir).

3.1 Wetland hydrology

Murray River hydrology

Murray River hydrology has been altered significantly by regulation and diversion upstream. Storages in Victoria and New South Wales are managed to capture water in winter and spring and to deliver this water at manageable flow rates to consumers (primarily irrigators) during the summer. The impact on river hydrology has been a reduction in large winter and spring flow peaks and enhancement of low summer flows.

The ecologically significant effects of these hydrological changes have been to:

- largely eliminate flowing water habitat under normal regulated flows;
- reduce the frequency and duration of floods that reach higher-level wetlands and floodplain areas.

The hydrology of the river at Carina Bend has been characterised by analysing the MSM_Bigmod daily flow series for Natural and Current (Baseline scenarios, using data from 1891 to 2009 (Figure 5).

The river now spends more time fluctuating at very low flows, less than 10,000 ML/d, than under natural conditions as indicated by higher than natural spell frequency but much shorter spell duration. Events that inundate low-lying wetlands, up to 30,000 ML/d, now occur at 40% the frequency of natural conditions. The duration of these events, when they do occur, has also been reduced by almost 40%. The impact on floodplain inundation is also significant. While the duration of spells exceeding 70,000 ML/d under current conditions is similar to natural, the frequency of these events has declined to as much as 50% of natural. This has resulted in a major increase in the interval between spells for very high flows.

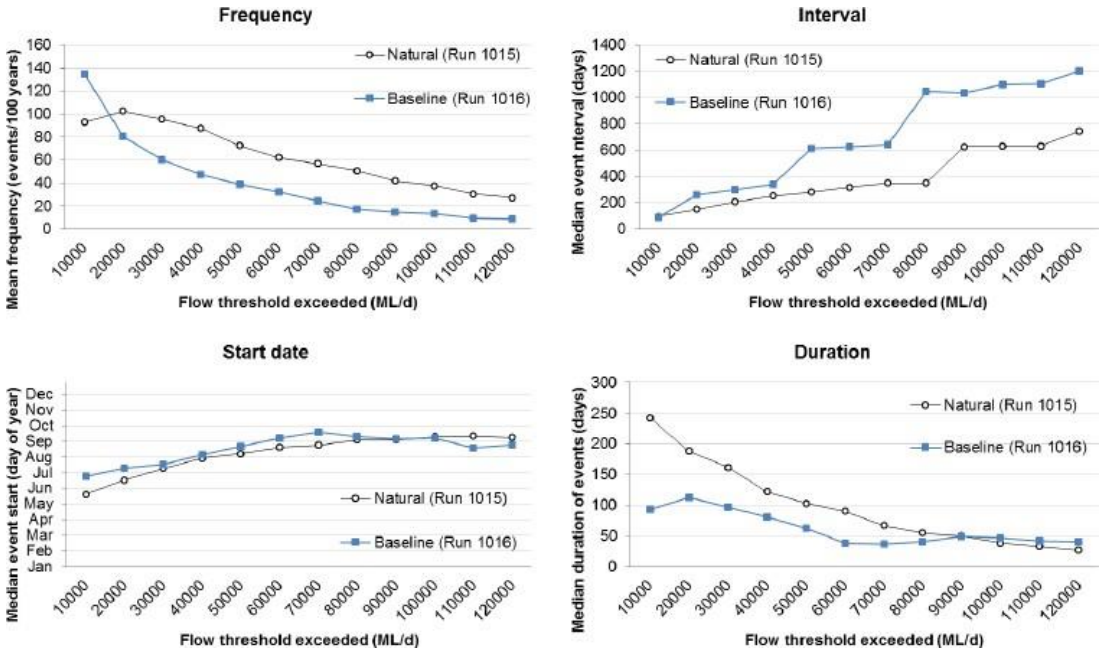


Figure 5. Spells analysis for River Murray flows upstream of Lock 11 (using data from Euston DS) for Natural and Baseline scenarios over a 114-year modelled period (Gippel, 2014).

Mean annual flows at Euston have been reduced by 49 per cent from natural levels, although seasonality of mean monthly flows is largely unaltered (Maheshwari, Walker and McMahon, 1993; Ecological Associates, 2006) as shown in Figure 6.

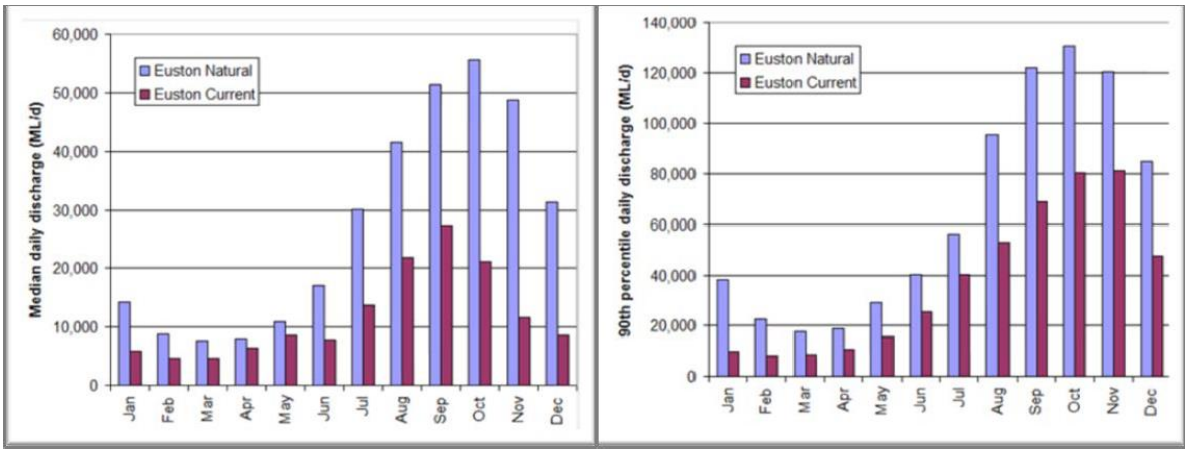


Figure 6 - Distribution of median flows and 90th percentile flows for each month in the Murray River through Euston Weir for pre-regulated and regulated (current) conditions (Ecological Associates, 2006).

Wetland hydrology and system operations

Water first enters the system at a former pump station at 1086 river km at flows of <25,000 ML/day (P.Goldring pers.comm. 17/01/07:cited in (Ecological Associates, 2007b). Following this water backs into Carina Bend wetland via an excavated channel to the north and south. As river levels increase water continues to fill Carina Bend wetland. When fully connected, Carina Bend wetland is over 5 km long. Until recently, water was pumped into Carina Bend wetland for relifting for irrigation. This ceased in 2008, when irrigation pumps were taken off the anabranches and relocated to the main channel.

The wetland is effectively full when river levels reach 46.7 m AHD, which corresponds to a flow of approximately 55,000 ML/d (Gippel 2008). Under pre-regulation condition Carina Bend wetland would have filled on average 67.5 times in 100 years and post-regulation this has reduced by almost 50%. The event duration has also reduced from 98 days by almost 50%.

Under pre-regulation conditions the wetland would have commenced to fill at flows of 25,000 ML/day on average 97.4 times per 100 years compared with 70.2 times per 100 years post-regulation. The median duration of inundation events has been reduced from 177 days to 100 days since river regulation (Gippel, 2014).

Environmental watering

Environmental watering has been provided at Carina Bend wetland in 05-06, 09-10, 17-18, and 19-20; details are presented in Table 5. The water was pumped onto the floodplain using temporary earth banks and mobile pumps.

Table 5 - A summary of environmental watering at Carina Bend

Water year	Time of inflow	Environmental Water Source	Source volume (ML)	Total volume (ML)	Area (ha) inundated
2005	Spring	Surplus flows EWA	340 128	468	80
2006	Autumn	Donated	695	695	100
09-10	Autumn-Winter	EWR	1013	1013	74
10-11	Summer	Natural flows	n/a	n/a	n/a
16-17	Spring	Natural flows	n/a	n/a	n/a
17-18	Spring-Summer	VEWH	800	800	74
19-20	Spring	VEWH	878	878	74

Initial environmental watering was an ‘emergency response’ to assist the vegetation during the prolonged dry conditions which had resulted in a decline in River Red Gum health. The environmental watering flooded the whole of Carina Bend wetland, but it did not reach the broader floodplain. It was effective in improving the health of trees lining the creeks and wetlands in the target area, and had the added benefit of providing some drought refuge for waterbirds. Along with increased foliage vigour, it was reported that many of the larger River Red Gum and Black Box have since flowered and seeded with the bands of young seedlings now forming in and around the wetted-up margins. Wetland plants such as Moira Grass (*Pseudoraphis spinescens*), Spike Sedge (*Eleocharis microcarpa*), Marsh Clubrush (*Bolboschoenus medianus*) were present. Floodplain fauna that benefited from the watering events include frogs, turtles and invertebrates (Sunraysia Environmental, 2008).

4 Water dependent values

Wetlands and waterways on the floodplain are a vital component of the landscape. The habitat provided by vegetation communities around wetlands is essential to a range of fauna. 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 services are maintained.

Carina Bend provides a range of shelter and food resources for indigenous fauna, flora and vegetation communities. The types of habitat provided, and consequently the species that utilise the site, change as water fills the wetlands and floodplain and recedes again.

Flora and fauna data for the site is very limited. While data from the Victorian Biodiversity Atlas (DELWP, 2016b) and previous site studies (GHD, 2010) have been referenced, it is recommended that flora and fauna surveys are undertaken at the site to improve knowledge of the site's ecological values.

4.1 Environmental values

Listings and significance

Fauna

Forty-nine fauna species have been recorded at Carina Bend, three of which are introduced. Of special interest and management responsibility are the five water dependent fauna species listed in legislation, agreements or conventions.

Carina Bend supports species listed under the *Commonwealth Environment Protection and Biodiversity Conservation Act (EPBC Act), Victoria's Flora and Fauna Guarantee Act (FFG Act), and* the Advisory List of Threatened Fauna in Victoria (VROT advisory list) (Table 6). A full list of fauna recorded at the site is presented in Appendix 1.

Despite only a limited number of listed fauna being identified in VBA records, it is fair to assume that more listed species are likely to occur due to the availability of habitat and nearby sightings.

Table 6 - Listed water dependent fauna recorded at Carina Bend

Common name	Scientific name	Type	International agreements	EPBC threatened fauna status	FFG status	VROT advisory list status
White-browed Treecreeper*	*Climacteris affinis*	B	-	-	Listed	Vulnerable
Brown Treecreeper* (SE ssp.)	*Climacteris picumnus victoriae*	B	-	-	-	Near threatened
Hooded Robin*	*Melanodryas cucullata cucullata*	B	-	-	Listed	Near threatened
Carpet Python*	*Morelia spilota metcalfei*	R	-	-	Listed	Endangered
Regent Parrot*	*Polytelis anthopeplus monarchoides*	B	-	Vulnerable	Listed	Vulnerable

Legend: Lifeform type: Amphibian, Bird, Fish, Invertebrate, Reptile, Mammal

*Species are included as water dependent due to habitat requirements

All five listed water dependent species at the site are considered indirectly water dependent due to habitat requirements (e.g. dependent on nesting hollows in riparian trees).

The White-browed Treecreeper (*Climacteris affinis)* feeds on insects and invertebrates on the rough bark of living or dead trees and amongst logs and leaf litter on the ground in forests and woodlands. They are considered vulnerable in Victoria with populations declining due to habitat loss, fragmentation and degradation (GHD, 2010).

The Brown Tree-creeper (south-eastern spp.) (*Climacteris picumnus victoriae*) forages for insects on tree trunks and amongst fallen woody debris on the ground. The majority of their diet is comprised of ants, but also includes other insects such as spiders, moths and larvae as well as sap. Hollows in trees (dead or alive) or tree stumps are essential for nest sites (Office of Environment & Heritage, n.d.). Appropriate inundation regimes will support a healthy and productive forest ecosystem and continued supply of habitat resources such as food, hollows and woody debris.

The Hooded Robin (*Melanodryas cucullata cucullata*) forages on tree trunks, on the ground and in the air, consuming invertebrates, small lizards and frogs and seeds. The amount of tree and shrub cover, woody debris and leaf litter is a key factor in species habitat preference and survival (Office of Environment & Heritage, n.d.).

The Regent Parrot (*Polytelis anthopeplus monarchoides*) is listed as nationally vulnerable under the EPBC Act, with estimates of only 2,900 birds left in the wild. This species has quite specific habitat requirements. It breeds almost exclusively in River Red Gum (*Eucalyptus camaldulensis*) forest and woodland, typically nesting in large, old and healthy hollow-bearing trees close to water (Figure 7). They require trees that are a minimum of 160 years old (Baker-Gabb and Hurley, 2011). Regent Parrots have also been known to breed in Black Box (*Eucalyptus largiflorens*). They mostly feed in large blocks of intact Mallee woodlands usually within 5-10km (maximum 20km) of nest sites, but also consume flower buds of River Red Gum, Black Box and Buloke (*Allocasuarina leuhmanii*) (Baker-Gabb and Hurley, 2011). Regent Parrots are reluctant to fly through open areas and require corridors of vegetation between nesting and foraging sites.

Figure 7 - Large River Red Gum provide nesting hollows and habitat for birds such as the Regent Parrot and Carpet Python (February 2016)

Carpet Pythons rely on habitat provided by River Red Gum forests along major watercourses and benefit from the vertebrate prey species that live in productive wetlands and floodplains. Trees and logs with large hollows, or large rock outcrops, plus thick litter or shrub cover close to (within 100m of) riparian zones, are essential to the existence of Carpet Pythons. Black Box woodlands with hollows further away from waterways are often used for hibernation (Robertson and Hurley, 2001; DSE, 2003).

Major threats to the Carpet Python habitat include the removal of fallen timber for firewood collection, fox predation, timber harvesting, grazing and rabbit warren fumigation (as Carpet Pythons are known to shelter in rabbit warrens) (Robertson and Hurley, 2001).

Vegetation communities

Eleven Ecological Vegetation Classes (EVCs) and one EVC complex are modelled as present within the target area.

Table 7 provides a list of these EVCs, along with their bioregional conservation status, Figure 8 displays the spatial arrangement of the EVCs, and Appendix 2 provides detailed descriptions of the EVCs.

Table 7 - Ecological Vegetation Classes modelled as present within the Carina Bend target area

EVC no.	EVC name	Area modelled as present within target area (ha)	Bioregional conservation status
98	Semi-arid Chenopod Woodland	0.2	Vulnerable
103	Riverine Chenopod Woodland	0.2	Depleted
104	Lignum Swamp	2.0	Vulnerable
106	Grassy Riverine Forest	0.9	Depleted
	Grassy Riverine Forest/Floodway Pond Herbland Complex	30.7	
200	Shallow Freshwater Marsh	4.0	Vulnerable
295	Riverine Grassy Woodland	0.1	Depleted
808	Lignum Shrubland	0.4	Least concern
810	Floodway Pond Herbland	40.8	Depleted
813	Intermittent Swampy Woodland	42.9	Depleted
818	Shrubby Riverine Woodland	1.9	Least concern
823	Lignum Swampy Woodland	11.8	Depleted

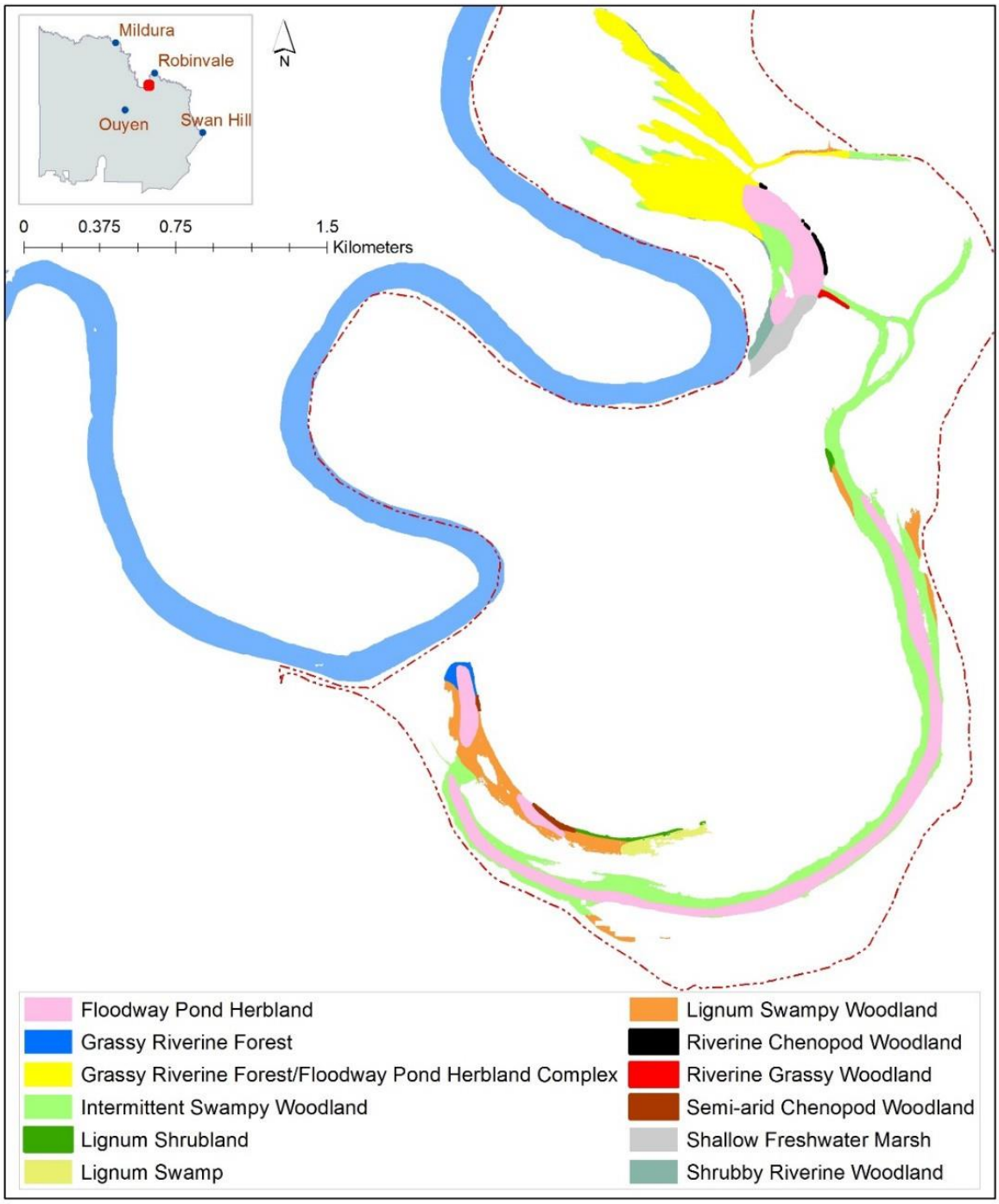


Figure 8 - Ecological Vegetation Classes present in the Carina Bend target area

Low meander scrolls on the floodplain adjacent to the Murray support vegetation communities dominated by River Red Gum such as Grassy Riverine Forest (EVC 106) and Intermittent Swampy Woodland (EVC 813) (Ecological Associates, 2007b). At its northern end, Carina Bend Wetland spreads out into areas of shallow water and sandy benches, supporting Grassy Riverine Forest/Floodway Pond Herbland Complex and then (slightly higher up) Intermittent Swampy Woodland on the floodplain.

Grassy Riverine Forest is a River Red Gum forest to 25m tall with an understorey of Eumong (*Acacia stenophylla*), Tangled Lignum (*Muehlenbeckia florulenta*) and a range of tussock grasses and occasional tall shrubs (Figure 9).

Figure 9 - Riverine Grassy Forest in the flow path that feeds wetland #12174 from the north (February 2016)

Intermittent Swampy Woodland is comprised of an overstorey of River Red Gum and Black Box to roughly 15m tall, with an understorey of Eumong, scattered shrubs such as Tangled Lignum and a range of grasses and sedges. With frequent inundation it is dominated by flood stimulated species in association with inundation-tolerant flora (Figure 10 and Figure 11).

Figure 10 – Intermittent Swampy Woodland in the drainage line that connects Carina Bend Wetland to the Murray River in the south (February 2016)

Ideal flooding for River Red Gum recruitment is late spring to early summer (Johns and et al., 2009), while ideal flood timing for River Red Gum maintenance and survival is winter to spring following the natural flooding pattern (Dalton, 1990).

Higher terraces on the central floodplain support Black Box woodlands and Lignum wetlands (Ecological Associates, 2007c). Black Box provides essential habitat and foraging opportunities for a range of species including mammals and reptiles and supports a high proportion of ground foraging and hollow-nesting birds. Black Box can tolerate a range of moisture and salinity conditions (Roberts and Marston, 2011), however recruitment and establishment is linked to the elevated and continued

soil moisture associated with flood events. Under extended periods of dry conditions Black Box is likely to decline and eventually die (Ecological Associates, 2007a).

Figure 11 - Intermittent Swampy Woodland is present on the terraces above Carina Bend Wetland (February 2016)

Lignum Swampy Woodland (EVC 823) and Lignum Swamp (EVC 104) are present on terraces adjacent to Carina Bend Wetland. Lignum Swampy Woodland has an overstorey of 15m tall Black Box and River Red Gum and an understorey dominated by Lignum, along with Eumong and a mix of chenopod shrubs, grasses and sedges that can survive extended dry periods. Lignum Swamp is typically treeless, subject to only infrequent inundation and dominated by Lignum, with a range of chenopod shrubs, herbs and grasses.

During and after inundation, the bed of Carina Bend Wetland will host Floodway Pond Herbland (EVC 810) (Figure 12). Floodway Pond Herbland is up to 30cm tall, has a large component of ephemeral grass, sedge and herb species, and is associated with floodway systems with a regular wetting and drying cycle.

Figure 12 - Carina Bend Wetland's wide flat channels are lined with River Red Gum dominated Intermittent Swampy Woodland. During and after inundation, Floodway Pond Herbland would be present within the channel bed, currently in a dry phase (February 2016)

Flora

Twenty-five species of flora have been recorded at Carina Bend (a full list of flora can be found in Appendix 3). None of these are listed under the FFG Act and/or the Advisory List of Rare or Threatened Flora in Victoria. Seven introduced flora species have also been recorded at the site. It is likely that a larger range of flora are present at the site but that flora surveys have been limited to date.

Other fauna

Waterbirds

Waterbird diversity and abundance are influenced by wetland habitat diversity, with different species and feeding guilds using different habitats for breeding and foraging (Haig, Mehlman and Oring, 1998). Water depth in particular influences waterbird diversity due to the specific feeding behaviours of different species (Bancroft, Gawlick and Rutchey, 2002). Managing wetlands to provide diverse habitats such as variable water depth, mud flats, inundated vegetation and areas of deep water increases the likelihood of waterbird diversity (Taft, Colwell, Isola and Safran, 2002).

Recommendations within this EWMP will be directed toward providing the habitat through a watering regime appropriate to providing key habitat needs of the waterbird guilds listed in Table 8. This is based on the habitat types available at the site.

Table 8 - Waterbird functional feeding groups (Roshier, Robertston and Kingsford, 2002) and their resource use

Waterbird Group	Food Resource	Habitat Use	Waterbird Group
Grazing Waterfowl (e.g. Australian Wood Duck)	Plant material, seeds, invertebrates	Shallow Water, littoral zone	Colonial or solitary
Shoreline Foragers (e.g. Lapwings, Hens)	Plant material, seeds, invertebrates,	Littoral zone, mudflats	Solitary or small groups

Providing appropriate water requirements to support the vegetation communities will support habitat for birds that have adapted to the required flooding and drying cycle (Scott, 1997). With an appropriate water regime, waterbirds will utilise areas of shallow water, mudflats and the littoral zone in floodplain channels and wetlands.

Wetland depletion and rarity

The conservation significance of Victorian wetland types has been determined by comparing the estimated extent prior to European settlement with the remaining extent.

Carina Bend contains three wetland types under the Corrick classification:

- Permanent Open Freshwater,
- Shallow Freshwater Marsh and
- Deep Freshwater Marsh.

Since European settlement, Permanent Open Freshwater has suffered a slight loss across the state (-6%) and has gained area in Mallee CMA (+5%), possibly due to raised weir levels along the Murray River permanently inundating wetlands that would previously have been only inundated seasonally. Within the Robinvale Plains Bioregion it has reduced in extent (-1%). Shallow Freshwater Marsh and Deep Freshwater Marsh have declined to a much greater extent across the state, (-60% and -70% respectively); within the Mallee CMA (-6% and -45% respectively) and within the Robinvale Plains Bioregion (-4% and -37% respectively) (Table 9).

Table 9 – Regional changes in the area of the wetland type (Corrick classification) represented within the Carina Bend target area. Source: (Mallee CMA, 2006; DELWP, 2016a)

Corrick category	Wetland name	Total area (ha)	Percentage change in wetland area from 1788 to 1994		
			Change in Victoria	Change in Mallee CMA	Change in Robinvale Plains bioregion
Permanent Open Freshwater	Carina Bend wetland (part)	25.6 ha	-6%	+5%	-1%
Shallow Freshwater Marsh	Unnamed wetland #12170	10.9 ha	-60%	-6%	-4%
	Carina Bend wetland (part)	11.7 ha			
Deep Freshwater Marsh	Unnamed wetland #12174	8.5 ha	-70%	-45%	-37%
	Carina Bend wetland (part)	14.4 ha			

Ecosystem functions

Wetland ecosystems support distinctive communities of plants and animals and support numerous ecosystem functions. Floodplain wetlands perform important functions necessary to maintain the hydrological, physical and ecological health of river systems.

Three key broad ecosystem functions have been identified for the Carina Bend EWMP. Each function is interlinked and must be supported in order for the ecosystem to flourish. The functions are briefly described below.

Connections across floodplains, adjacent wetlands and billabongs (lateral)

Inundating the length of Carina Bend Wetland will provide a range of habitat types: deep pools, shallow benches for macrophyte beds and flooded areas of lignum. During drawdown the wetland will separate into pools joined by Floodway Pond Herbland and mud flats.

Water levels that engage flood channels, wetlands and floodplain surfaces will promote nutrient and carbon cycling and return organic material to the river for further processing (Robertston, Bacon and Heagney, 2001a).

Waterbird groups also access a variety of habitat types such as mud flats, flooded lignum and shallow aquatic vegetation which only become available following inundation.

Diversity of habitat for feeding, breeding and nursery

Wetland filling and water recession will increase the extent and species diversity of the band of sedges, rushes and semi-aquatic forbs surrounding wetlands and areas of deeper, semi-permanent water will support submerged aquatic macrophytes. This inundation cycle will promote high levels of aquatic productivity and increased habitat complexity for frogs, small native fish, and waterbirds. When flooded, the ephemeral flora component of Lignum Swampy Woodland and Lignum Swamp will germinate or expand, providing habitat for frogs, aquatic invertebrates and small native fish and the water birds that prey on these species. Fringing macrophytes will provide a source of food, refuge from predators and nesting sites and materials (Kingsford and Norman, 2002).

River Red Gum and Black Box within or adjacent to inundated areas will have increased growth and vigour, ensuring that they can continue to provide hollows for nesting, perch sites, input of leaves and coarse woody debris into the wetlands and floodplain.

Transportation and dilution of nutrients and organic matter and increase in macroinvertebrate productivity and biofilm diversity

Wetland inundation will transport nutrients and carbon into the water column, which will become available for consumption by bacteria, algae, macrophytes and macroinvertebrates.

Drying of wetlands, particularly during summer and autumn, exposes sediments and facilitates decomposition and processing of organic matter. The microbial decay of plant material is an important route for energy and nutrients to enter the food chain (Young, 2001).
Fluctuations in water levels allow exposure of substrates such as large wood and plant stems through a drying cycle, supporting a mosaic of biofilm species that offer a range of food resources for macroinvertebrates and fish. Macroinvertebrates with an adult, terrestrial life stage will provide a food source for insectivorous woodland birds.

4.2 Social values

Cultural value

The Mallee region 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 Mallee's natural landscapes.

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 densities 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 concentration and diversity. They include large numbers of burial and hunting sites and middens.

In the south of the region, waterways were focal points for the region's traditional owners, with many lakes being the site for large gatherings of social clan groups that afforded trade and cultural exchanges. 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.

Cultural heritage

Carina Bend Wetlands are an important indigenous cultural heritage site and contain burial sites, middens and ovens. Indigenous representation for Carina Bend includes the Robinvale Claimant Group, Tati Tati and Latji Latji (DSE, 2012), however currently there is no Registered Aboriginal Party (RAP) for the area nor any applications for RAP status (DPC, 2016).

A historical pumping station is also present at Carina Bend and is covered by a Heritage Overlay under the Swan Hill planning scheme.

4.3 Recreation

Carina Bend provides opportunities for nature-based recreation for residents of Robinvale, 25km away. Recreation opportunities include walking, trail bike riding, four wheeling driving, picnicking, camping, fishing and swimming. VEAC recommendations (2008) continue to allow camping and campfires in the area.

4.4 Economic values

Carina Bend has previously been used for grazing and firewood collection. Surrounding land uses include irrigated agriculture (almonds, grapes and oranges) and dryland cropping.

4.5 Significance

Carina Bend supports populations of the listed Regent Parrot, Brown Tree-creeper and White-browed Tree-creeper and Carpet Python. These species rely on the health of large mature River Red Gums, which are prevalent with the target area. Carina Bend wetland is 5 km long providing a significant wetland habitat off the Murray when inundated. The wetland can provide excellent seasonal habitat for fish, frogs and waterfowl.

5 Ecological condition and threats

5.1 Current condition

The condition of wetlands at Carina Bend has not been assessed using the state-wide Index of Wetland Condition. The condition information described below is based on brief field observations and limited existing literature. It should be considered a high priority to undertake a condition assessment of wetlands at Carina Bend using the Index of Wetland Condition.

Field inspections undertaken in December 2019 found wetlands at Carina Bend to be in a drawdown phase following a spring water delivery. Healthy mature River Red Gums line the Murray River frontage and Carina Bend Wetland and new recruitment was observed within the wetland (Figures 13a/b). Aquatic grass (Moira spp. nc) was also seen growing along the margins of the inundated area (Figure 14). In contrast, River Red Gum on high terraces outside the main Carina Bend Wetland channel continue to show evidence of poorer health. Continuation of watering at Carina Bend wetland will result in improved tree health for significant areas of River Red Gums along the considerable length of the wetland channel.

Figure 13a – Healthy mature River Red Gum line the edges of Carina Bend Wetland. (December 2019)

Figure 13b – River Red Gum recruitment is occurring within the wetland bed (below). (December 2019)

Figure 14 – Aquatic grass (Moira spp. n.c.) growing along the margins of the inundated area of Carina Bend Wetland (December 2019)

5.2 Water related threats

The Aquatic Value Identification and Risk Assessment (AVIRA) database is an on-line tool used by Victorian waterway managers to store data about the values, threats and risks to waterway health in their region. The database evaluates threats for a range of sub-indices including water regime, invasive fauna and acid sulphate soils (Peters, 2009).

Invasive fauna aquatic

Although no aquatic species records are available for the site, wetlands on site are likely to support Common Carp (*Cyprinus carpio*). Carp have been found to contribute to the loss of aquatic vegetation and increased turbidity, degrading the habitat for waterfowl (Purdey and Loyn, 2008) and native fish. Common Carp also competes with the native fish for habitat and food (Mallee CMA, 2003).

Invasive fauna terrestrial

Introduced species recorded at the site include Red Fox (*Vulpes vulpes*) and Common Starling (*Sturnus vulgaris*). European Rabbit (*Oryctolagus cuniculus*) and Cat (*Felis catus*) are also likely to be present.

Foxes and Cats predate on native birds and mammals and both are listed as potentially threatening processes under the *Flora and Fauna Guarantee Act 1988* (DSE, 2002, 2004a). Foxes are known to predate on young Hooded Robins (NSW Scientific Committee, 2008) and on Carpet Pythons (Robertson and Hurley, 2001).

Rabbits can over-browse flora species and reduce survival and recruitment success, cause erosion, compete with native herbivores for food and burrows and support high populations of introduced predators such as foxes and cats (Office of Environment & Heritage, 2015). Fumigation of Rabbit warrens has been known to cause the death of Carpet Pythons as they occasionally use warrens for shelter (Robertson and Hurley, 2001).

Invasive flora wetland

Agricultural and other weeds are an ongoing threat on the Murray River floodplain and have been recorded at Carina Bend. A full list of introduced flora is presented in Appendix 3.

Overland flow is occurring from privately held irrigation land within the WMU sub-unit. These flows could act as a vector for weed propagules and favour weed species by increasing nutrient levels at the site.

An irrigation channel located on private land at Carina Bend is completely choked by Cumbungi (*Typha* sp.) due to stable shallow flooding during summer.

Changed water regime

As discussed in the hydrology section of this EWMP, the hydrology of the target area has been greatly impacted by the regulation of the Murray River. The proposed water regime assessment takes into account the impacts of regulation of the primary water source of the wetland (Murray River), other activities which may impact the wetland water regimes, impacts to seasonality, duration and frequency of the water regime and the severity of the effects of these activities.

6 Management objectives

6.1 Management goal

The management goal for Carina Bend is:

“To provide a water regime that will support the health of fringing mature River Red Gum and provide seasonal habitat for native fish, frogs and waterfowl.”

6.2 Ecological objectives

Ecological objectives represent the desired ecological outcomes of the site based on the management goal which has been framed around the key values outlined in the Water Dependent Values section of this EWMP. In line with policy in the Victorian Waterway Management Strategy (VWMS) the ecological objectives are expressed as the target condition or functionality of each key value.

The ecological objectives for Carina Bend Wetland are:

Carina Bend wetland

- Support the health of mature River Red Gum trees along the wetland perimeter
- Provide seasonal aquatic habitat that supports a diverse population of native fish and frogs
- Reliable nesting and feeding habitat for waterfowl in winter and spring
- Healthy Lignum vegetation that provides productive habitat for small fish and frogs when flooded and shelter and foraging habitat for terrestrial fauna when dry

Table 10 - Ecological objectives for Carina Bend

Ecological objective	Justification
Support the health of mature River Red Gum trees along the wetland perimeter	Mature River Red Gum provides nesting hollows and roosting sites for the Regent Parrot, Brown Tree-creeper, White-browed Tree-creeper and Carpet Python which are all listed species found within the target area.
Provide seasonal aquatic habitat that supports a diverse population of native fish and frogs	As well as the intrinsic value of native fish presence, small- bodied native fish also provide an important food source for piscivorous waterbirds and some large-bodied native fish species.
Reliable nesting and feeding habitat for waterfowl in winter and spring	Waterfowl nest in reed beds and flooded Lignum or River Red Gum through winter and spring. Waterfowl will use the littoral zone and shallow water areas of Carina Bend wetland for feeding as the water levels recede through late summer/autumn.
Diverse macrophyte and frog population supported by healthy Lignum Swampy Woodland vegetation	Inundation of Lignum woodlands will allow colonisation by native fish including Gudgeon and Murray-Darling Rainbowfish. Shelter and feeding habitat for frogs will also expand from the fringing wetland areas to the refuge of the deeper wetland areas. Healthy Lignum can also provide shelter and feeding sites for Carpet Python and Woodland birds such as Brown Tree- creeper.

6.3 Hydrological objectives

Hydrological objectives describe the components of the water regime required to achieve the ecological objectives for the target area. The hydrological requirements to achieve each of the ecological objectives are presented in Table 11 and described below.

River Red Gum woodlands require flooding every two to four years with durations of two to four months. Flood events may differ and a variation in ponding duration around the mean requirement for this species is encouraged. Although the timing of flooding is not vital for River Red Gum, spring-summer flooding encourages greater growth. Timing is however important for understorey plant communities – flooding in spring encourages a diversity of emergent macrophytes while flooding in summer tends to promote Common Reed and Cumbungi. The critical interval for River Red Gum woodland inundation is five to seven years to prevent deterioration of tree condition (Roberts and Marston, 2011).

Lignum can tolerate a wide range of wet and dry conditions as well as moderate salinity levels. Frequencies of one to three years are needed to maintain large shrubs with vigorous canopy while flooding every three to five years for maintenance of healthy shrubs. Intervals of seven to ten years can be tolerated by small shrubs but these are not suitable as nesting platforms. Durations of three to seven months sustain vigorous canopy, but waterlogging is detrimental. Although the timing of flooding is not crucial for Lignum, following natural seasonality is encouraged to provide for understorey and wetland plants (Roberts and Marston, 2011).
Flooding of wetland and floodplain vegetation in spring and summer provides a source of food, refuge and nesting sites and materials for waterbirds (Kingsford and Norman, 2002).

Hydrological objectives for Carina Bend are presented in Table 11.

Table 11- Hydrological objectives for Carina Bend

Level	Zone	Frequency	Duration	Timing
44.7	Expose wetland bed	1:1	1-6	Late summer/early autumn
45.5	Littoral zone	1:1	4-6 months	Late winter/early summer
46	Fringing River Red Gum	1:2	2-4 months	Late winter/early spring
46.7	Lignum wetlands	1:4	3-7 months	Early spring/late summer

6.4 Watering regime

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

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

The watering regime has been derived following review of the pre-regulation hydrology data.

Optimal watering regime

The optimal watering regime is to maintain Carina Bend Wetland as a semi-permanent freshwater wetland, with a seasonally inundated fringe. Fill Carina Bend Wetland every second year in late winter/early spring to 46m AHD, with water levels falling naturally by seepage and evaporation over summer and autumn. In every fourth year, fill wetland to 46.7m AHD to inundate the Lignum communities in September, with water levels falling naturally by seepage and evaporation over summer and autumn.

Minimum watering regime

Fill Carina Bend Wetland every second year to 46m AHD to maintain fringing River Red Gum health, with water levels falling naturally by seepage and evaporation over summer and autumn to expose the wetland bed.

Maximum watering regime

The optimal watering regime is to maintain Carina Bend Wetland as a permanent freshwater wetland, with a seasonally inundated fringe. Fill Carina Bend Wetland every second year in late winter/early spring to 46.7m AHD, with water levels falling naturally by seepage and evaporation over summer and autumn. Top up when water levels fall below 45.5m AHD in summer to maintain inundation of the littoral zone. In every fourth year allow water levels to fall naturally through seepage and evaporation over summer and autumn, allowing exposure of the wetland bed.

7 Managing risks to achieving objectives

Threat	Likelihood	Consequence	Risk – H, M, L (likelihood x consequence)	Management measure	Residual risk
Failure to meet ecological objectives	Possible	High	H	Monitoring program in place. Adaptive approach.	L
Species, communities or ecological functions have been overlooked in water regime due to lack of data	Possible	High	H	Review ecological survey results and update objectives if significant gaps are found.	L
Inundation duration too long or too short	Possible	High	H	Monitoring program in place. Adaptive approach as additional baseline and monitoring outcome data is available.	L
Flooding of private land	Possible	Moderate	M	Observe long range weather forecasts, monitor Murray River flows, and manage delivery. Communication in place with private landholders.	L
Criminal damage or theft of water delivery infrastructure	Possible	Moderate	M	Utilise appropriate security devices on equipment and proactively engage with the community prior to watering event to gain support for the program.	L
Damage to infrastructure, particularly pumps or regulators leading to loss of water from target area	Likely	Moderate	M	Appropriate engagement and site management in place. Regular monitoring and staff presence during watering events.	L

Threat	Likelihood	Consequence	Risk – H, M, L (likelihood x consequence)	Management measure	Residual risk
Maintenance required to delivery infrastructure (pump/channel etc.) during proposed watering event	Likely	High	VH	Include maintenance of channel on annual inspection checklist. Ensure pump contractors are appropriately qualified and have appropriate quality assurance processes in place.	L
Monitoring program is unable to detect improvement in short to medium term	Possible	High	H	Engagement with key stakeholders confirming expected outcomes, timeframes and assumptions.	L
Damage to cultural heritage sites through construction of temporary infrastructure and equipment	Possible	High	H	Site risk assessments undertaken and mitigations in place prior to any works occurring. Cultural Heritage Management Plans in place.	L

8 Environmental water delivery infrastructure

8.1 Constraints

The infrastructure to allow inundation of the target area needs to be planned and implemented. Carina Bend is currently able to be watered to a level of 44.8m AHD. The area that is able to be inundated without the proposed infrastructure is shown in Figure 16. Full inundation of the target area is not possible without the infrastructure and works recommendations listed below.

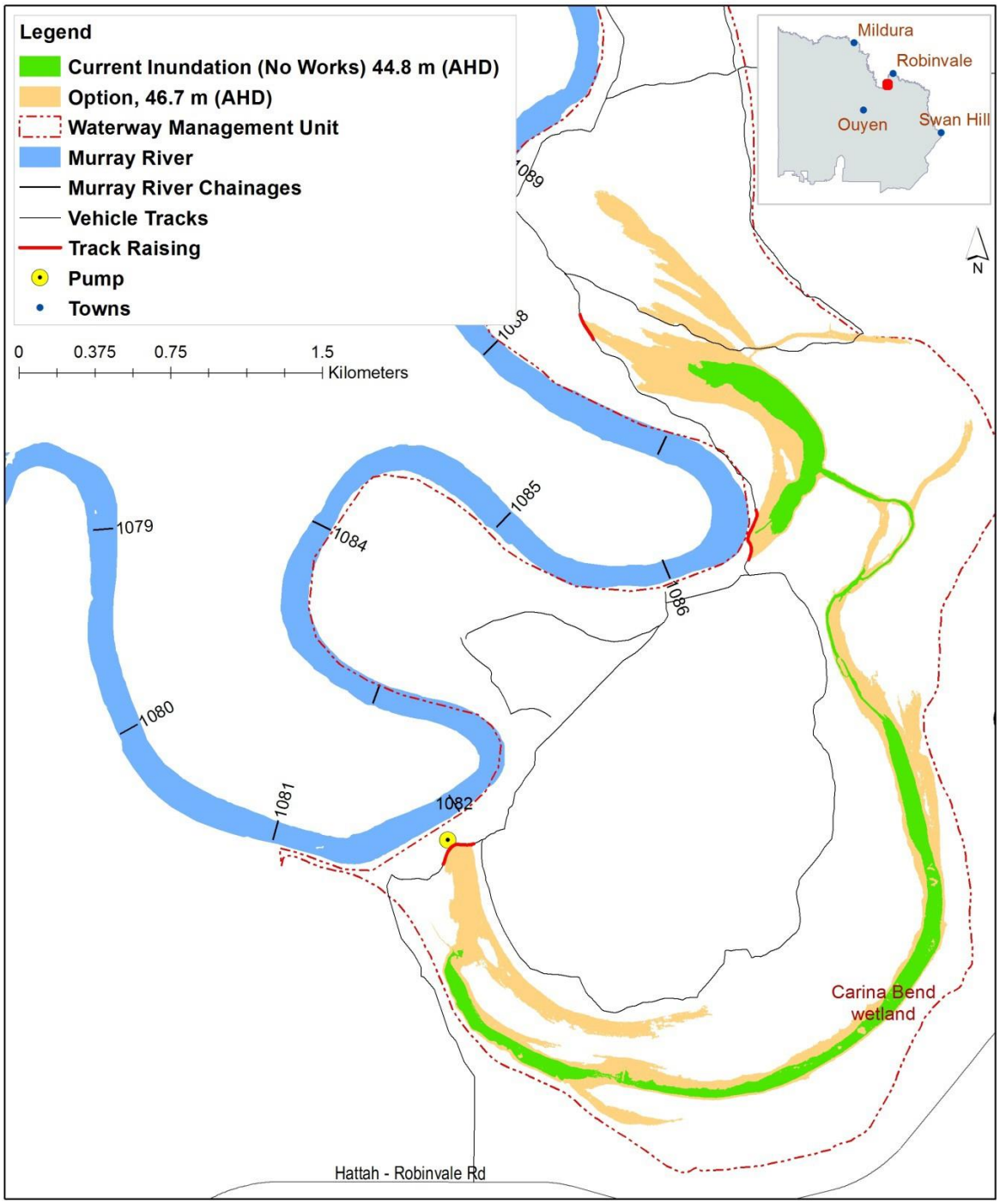


Figure 16 - Current inundation extent without proposed infrastructure

In addition to infrastructure requirements to enable delivery of environmental water, access roads must be maintained to ensure continued access to the target area by management vehicles and visitors.

8.2 Infrastructure or complementary works recommendations

It is recommended that track raising is undertaken in three locations, as shown in Figure 16. The road raising ensures that environmental water pumped into the Carina Bend Wetland is not unintentionally lost back to the river via the floodplain channels. Conceptual designs would need to be developed to confirm the works required to implement the recommendations in this plan. Cultural heritage investigations would be required. Filling of the wetland would be undertaken using a temporary pump located near the road raising at river km 1082.

10 Demonstrating outcomes

10.1 Monitoring priorities at the site

The following priorities for monitoring have been identified for the Carina Bend target area:

- IWC monitoring should be undertaken at Carina Bend Wetland and wetlands #12174 and #12170 on a five-yearly basis.
- Photo point monitoring of tree health within the woodlands should be undertaken.

11 Consultation

This Plan was developed in collaboration with key stakeholders namely Parks Victoria, the Department of Environment, Land, Water and Planning, and local interest groups.

Table 12 - Consultation for development of Carina Bend EWMP

Meeting Date	Stakeholders	Details
Sept 2012	Parks Victoria	Present initial concept and contents of draft plan and seek feedback
October 2012	Wemen Progress Association	
May 2016	Parks Victoria	Presentation of plan
June 2016	Wemen Progress Association	Presentation of plan
June 2016	Mildura BirdLife	Presentation of plan
June 2016	Murray Lower Darling Rivers Indigenous Nations	Presentation of plan
June 2016	Department of Environment Land Water and Planning	Presentation of plan

12 Knowledge gaps and recommendations

Concept design report for infrastructure

A concept design report is required to scope the infrastructure requirements at three sites at Carina Bend. It is likely that that road raising will be required, although a single regulator at river km 1082 should also be investigated.

Index of Wetland Condition assessment

The target area wetlands should be incorporated into the five-yearly Index of Wetland Condition assessments.

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Abbreviations and acronyms

CMAs	Catchment Management Authorities
DELWP	Department of Environment, Land, Water and Planning
EVC	Ecological Vegetation Class
EWMP	Environmental Water Management Plan
FSL	Full Supply Level
MDBA	Murray-Darling Basin Authority (formally Murray-Darling Basin Commission, MDBC)
TSL	Targeted Supply Level
VEWH	Victorian Environmental Water Holder

Appendix 1 – Fauna species list

Common name	Scientific name	Type
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	B
Grey Teal	*Anas gracilis*	B
Pacific Black Duck	*Anas superciliosa*	B
Southern Whiteface	*Aphelocephala leucopsis*	B
Dusky Woodswallow	*Artamus cyanopterus*	B
Sulphur-crested Cockatoo	*Cacatua galerita*	B
Little Corella	*Cacatua sanguinea*	B
Australian Wood Duck	*Chenonetta jubata*	B
Horsfield's Bronze-Cuckoo	*Chrysococcyx basalis*	B
White-browed Treecreeper	*Climacteris affinis*	B
Brown Treecreeper (south-eastern ssp.)	*Climacteris picumnus victoriae*	B
Grey Shrike-thrush	*Colluricincla harmonica*	B
White-winged Chough	*Corcorax melanorhamphos*	B
Australian Raven	*Corvus coronoides*	B
Little Raven	*Corvus mellori*	B
Laughing Kookaburra	*Dacelo novaeguineae*	B
Varied Sittella	*Daphoenositta chrysoptera*	B
White-faced Heron	*Egretta novaehollandiae*	B
Black-fronted Dotterel	*Elseyornis melanops*	B
Galah	*Eolophus roseicapilla*	B
Eurasian Coot	*Fulica atra*	B
Peaceful Dove	*Geopelia striata*	B
Magpie-lark	*Grallina cyanoleuca*	B
Australian Magpie	*Gymnorhina tibicen*	B
White-plumed Honeyeater	*Lichenostomus penicillatus*	B
Variegated Fairy-wren	*Malurus lamberti*	B
Splendid Fairy-wren	*Malurus splendens*	B
Noisy Miner	*Manorina melanocephala*	B
Hooded Robin	*Melanodryas cucullata cucullata*	B
Rufous Whistler	*Pachycephala rufiventris*	B

Common name	Scientific name	Type
Striated Pardalote	*Pardalotus striatus*	B
Australian Pelican	*Pelecanus conspicillatus*	B
Welcome Swallow	*Petrochelidon neoxena*	B
Tree Martin	*Petrochelidon nigricans*	B
Red-capped Robin	*Petroica goodenovii*	B
Little Black Cormorant	*Phalacrocorax sulcirostris*	B
Little Friarbird	*Philemon citreogularis*	B
Yellow Rosella	*Platycercus elegans flaveolus*	B
Regent Parrot	*Polytelis anthopeplus monarchoides*	B
Red-rumped Parrot	*Psephotus haematonotus*	B
Willie Wagtail	*Rhipidura leucophrys*	B
Apostlebird	*Struthidea cinerea*	B
Common Starling*	*Sturnus vulgaris*	B
Australasian Grebe	*Tachybaptus novaehollandiae*	B
Straw-necked Ibis	*Threskiornis spinicollis*	B
Western Grey Kangaroo	*Macropus fuliginosus*	M
European Rabbit*	*Oryctolagus cuniculus*	M
Red Fox*	*Vulpes vulpes*	M
Carpet Python	*Morelia spilota metcalfei*	R

*Introduced species
Lifeform type: Invertebrate (I), Fish (F), Amphibian (A), Reptile (R), Bird (B), Mammal (M)
Source: (DELWP, 2016b)

Appendix 2 – Ecological Vegetation Classes

EVC no.	EVC name	Bioregional conservation status	Description
98	Semi-arid Chenopod Woodland	Vulnerable	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	Depleted	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 ground layer dominated by tussock-forming graminoids. Occasional tall shrubs present.
200	Shallow Freshwater Marsh	Vulnerable	Wetland type
295	Riverine Grassy Woodland	Depleted	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 ground layer dominated by graminoids and sometimes lightly shrubby or with chenopod shrubs.
808	Lignum Shrubland	Least concern	Relatively open shrubland of species of divaricate growth form. The ground-layer is typically herbaceous or a turf grassland, rich in annual/ephemeral herbs and small chenopods. Characterised the open and even distribution of relatively small Lignum shrubs. Occupies heavy soil plains along Murray River, low-lying areas on higher-level (but still potentially flood-prone) terraces.
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.
813	Intermittent Swampy Woodland	Depleted	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 of 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
818	Shrubby Riverine Woodland	Least concern	Eucalypt woodland to open forest to 15 m tall of less flood-prone (riverine) watercourse fringes, principally on levees and higher sections of point-bar deposits. The understorey includes a range of species shared with drier floodplain habitats with a sparse shrub component, ground-layer patchily dominated by various life-forms. A range of large dicot herbs (mostly herbaceous perennial, several with a growth-form approaching that of small shrub) are often conspicuous.
823	Lignum Swampy Woodland	Depleted	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.

Source: (DELWP, 2016a; DSE, 2004b)

Appendix 3 – Flora species list

Common name	Scientific name
Eumong	*Acacia stenophylla*
Cattle Bush	*Alectryon oleifolius* subsp. *canescens*
Spear Grass	*Austrostipa* spp.
Belah	*Casuarina pauper*
Spear Thistle*	*Cirsium vulgare*
Couch	*Cynodon dactylon*
Tangled Lignum	*Duma florulenta*
Nodding Saltbush	*Einadia nutans*
River Red-gum	*Eucalyptus camaldulensis*
Black Box	*Eucalyptus largiflorens*
Spurge	*Euphorbia* spp.
Rough Raspwort	*Haloragis aspera*
Smooth Cat's-ear*	*Hypochaeris glabra*
Prickly Lettuce*	*Lactuca serriola*
Poison Pratia	*Lobelia concolor*
Wimmera Rye-grass*	*Lolium rigidum*
Grassland Wood-sorrel	*Oxalis perennans*
Warrego Summer-grass	*Paspalidium jubiflorum*
Prickly Fan-flower	*Scaevola spinescens*
Variable Sida	*Sida corrugata*
Mallee Catchfly*	*Silene apetala* var. *apetala*
Common Sow-thistle*	*Sonchus oleraceus*
Blue Rod	*Stemodia glabella* s.l.
Grey Germander	*Teucrium racemosum* s.l.
Cumbungi*	*Typha* spp.

*Introduced species
Source: (DELWP, 2016b)