Mildura Waterway Management Unit (Sandilong Creek) Environmental Water Management Plan

Mallee Catchment Management Authority

mallee catchment management authority

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Author(s)	Paula Robinson, Leonie North (Sunraysia Environmental Pty Ltd)
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For further information on any of the information contained within this document contact:
Louise Searle
Coordinator Waterways
Mallee Catchment Management Authority

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EXECUTIVE SUMMARY

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

The Mildura WMU is situated 5 km east of Mildura on the Murray River floodplain. This plan focuses on the target area of Sandilong Creek, and an associated billabong within the WMU, for environmental watering events and related infrastructure development to maximise the ecological benefits achieved through periodic inundation of a total area of 8.84 ha.

Sandilong Creek and billabong are located entirely within the grounds of the Riverside Golf Course. The creek was once a small anabranch of the nearby Murray River. It is now isolated from the river due to levee banks and is permanently inundated; the water level is maintained close to the pool level of the river. The billabong is isolated from the river by levees and experiences natural inundation only in extremely high river events or if a breach of the levee occurs.

Environmental values for the Mildura WMU include a diverse range of water dependent flora and fauna species including some listed under state, national and international treaties, conventions, Acts and initiatives. Within the target area, the Sandilong Creek is well known for its resident population of the state listed Freshwater Catfish (*Tandanus tandanus*). Records also exist for sightings of the state listed Inland Carpet Python (*Morelia spilota metcalfei*) and internationally listed migratory birds including the Caspian Tern (*Sterna caspia*) and Curlew Sandpiper (*Calidris ferruginea*). The area contains three depleted water dependent ecological vegetation classes and wetlands. Significant species within these EVCs are River Red Gum (*Eucalyptus camaldulensis*), Black Box (*Eucalyptus largiflorens*), and Tangled Lignum (*Muehlenbeckia florulenta*).

The target area has significant social values, in particular the Riverside Golf Club community, and the local indigenous community have connections to the area. The value which is central to the management of the site is the population of Freshwater Catfish. This plan has been prepared with the goal of maintaining or improving surrounding vegetation, thus indirectly supporting Freshwater Catfish. Management of environmental watering needs to merge the desire to maintain or improve the surrounding vegetation with the need to protect the Freshwater Catfish population, and also meet the ongoing business and community functions of the Golf Club.

Mildura waterway management unit management goal

To provide a watering regime that supports native aquatic and terrestrial fauna and supports productive native vegetation communities within the target area.

To achieve this objective, a long-term watering regime has been developed. The timing and pace of inundation and the recession of water should be managed so as to avoid potential impacts on the Catfish population.

Sandilong Creek

Minimum watering regime - Sandilong Creek

Provide two watering events every ten years.

Raise the level of the creek slowly in spring-summer by 1.2 m to 35.7 m AHD to inundate the surrounding low lying areas twice in ten years, with a maximum interval of seven years between events. Maintain the water on the floodplain for two months, allowing a slow recession from January-March.

Optimal watering regime – Sandilong Creek

Provide three watering events every ten years.

Raise the level of the creek slowly in spring-summer by 1.2 m to 35.7 m AHD to inundate the surrounding low lying areas three times in ten years, with a maximum interval of four years between events. Maintain the water on the floodplain for three months, allowing a slow recession from January-March.

Maximum watering regime – Sandilong Creek

Provide five watering events every ten years.

Raise the level of the creek slowly in spring-summer by 1.2 m to 35.7 m AHD to inundate the surrounding low lying areas five times in ten years, with a maximum interval of two years between events. Maintain the water on the floodplain for four months, allowing a slow recession from February-March.

Billabong

Optimal watering regime

Provide three watering events every ten years.

Inundate the billabong area in spring to 35.7 m AHD, three times in ten years, with a maximum interval of three years. Maintain the water in the billabong for three months.

Minimum watering regime

Provide two watering events every ten years.

Inundate the billabong area in spring-summer to 35.7 m AHD, twice in ten years, with a maximum interval of eight years. Maintain the water in the billabong for two months.

Maximum watering regime

Provide four watering events every ten years.

Inundate the billabong area in spring to 35.7 m AHD, four times in ten years, with a maximum interval of two years. Maintain the water in the billabong for six months.

The constraints on the current ability to water the target area within the Mildura WMU include land use, the limitations of the current water delivery structure, and lack of connectivity to the river. The current ability to water the billabong is constrained because it cannot be filled independently. The billabong is fed by a pipe from the creek and can only be filled when the creek is at sufficient depth (approximately 35 m AHD). The volume of water required to inundate the current extent possible is 150 ML.

Management of the Common Carp population and the breeding habits of Freshwater Catfish within the creek are the top two knowledge gaps for the site.

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ACKNOWLEDGEMENTS

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

ABBREVIATIONS, ACRONYMS AND TERMS

ANCA	Australian Nature Conservation Agency
AVIRA	Aquatic Value Identification and Risk Assessment
CAMBA	China-Australia Migratory Bird Agreement
Bonn	The Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animals Appendices I and II)
CAMBA	China-Australia Migratory Bird Agreement
CEWH	Commonwealth Environmental Water Holder
CMAs	Catchment Management Authorities
DEPI	Department of Environment and Primary Industries (formerly Department of Sustainability and Environment (DSE)
DEPI	Department of Environment and Primary Industries
DNRE	Department of Natural Resources and Environment
DSE	Department of Sustainability and Environment
EA	Ecological Associates
EPBC	Environment Protection and Biodiversity Conservation Act
EVC	Ecological Vegetation Class
EWR	Environmental Water Reserve
FFG	Flora Fauna Guarantee Act
FSL	Full Supply Level
G-MW	Goulburn-Murray Water
JAMBA	Japan-Australia Migratory Bird Agreement
MCMA	Mallee Catchment Management Authority
MDBA	Murray-Darling Basin Authority (formerly Murray-Darling Basin Commission, MDBC)
Ramsar	Global treaty adopted in the Iranian city of Ramsar in 1971 that focuses on the conservation of internationally important wetlands
RGC	Riverside Golf Club
RMUF	River Murray Unregulated Flows
ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement
TLM	The Living Murray Initiative
TSL	Targeted Supply Level
VAHR	Victorian Aboriginal Heritage Register
VEAC	Victorian Environmental Assessment Council
VEWH	Victorian Environmental Water Holder
WMU	Waterway Management Unit

1 INTRODUCTION

1.1 Background

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

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

1.2 Purpose

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

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

1.3 Site location

The Mallee CMA is situated in the north-west of Victoria. The area of responsibility is close to 39,000 km^2 (3.9 million ha), with a regional population estimated to be 65,000. Population centres include Mildura, Birchip, Sea Lake, Ouyen, Robinvale, Red Cliffs and Merbein (Figure 1).

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

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

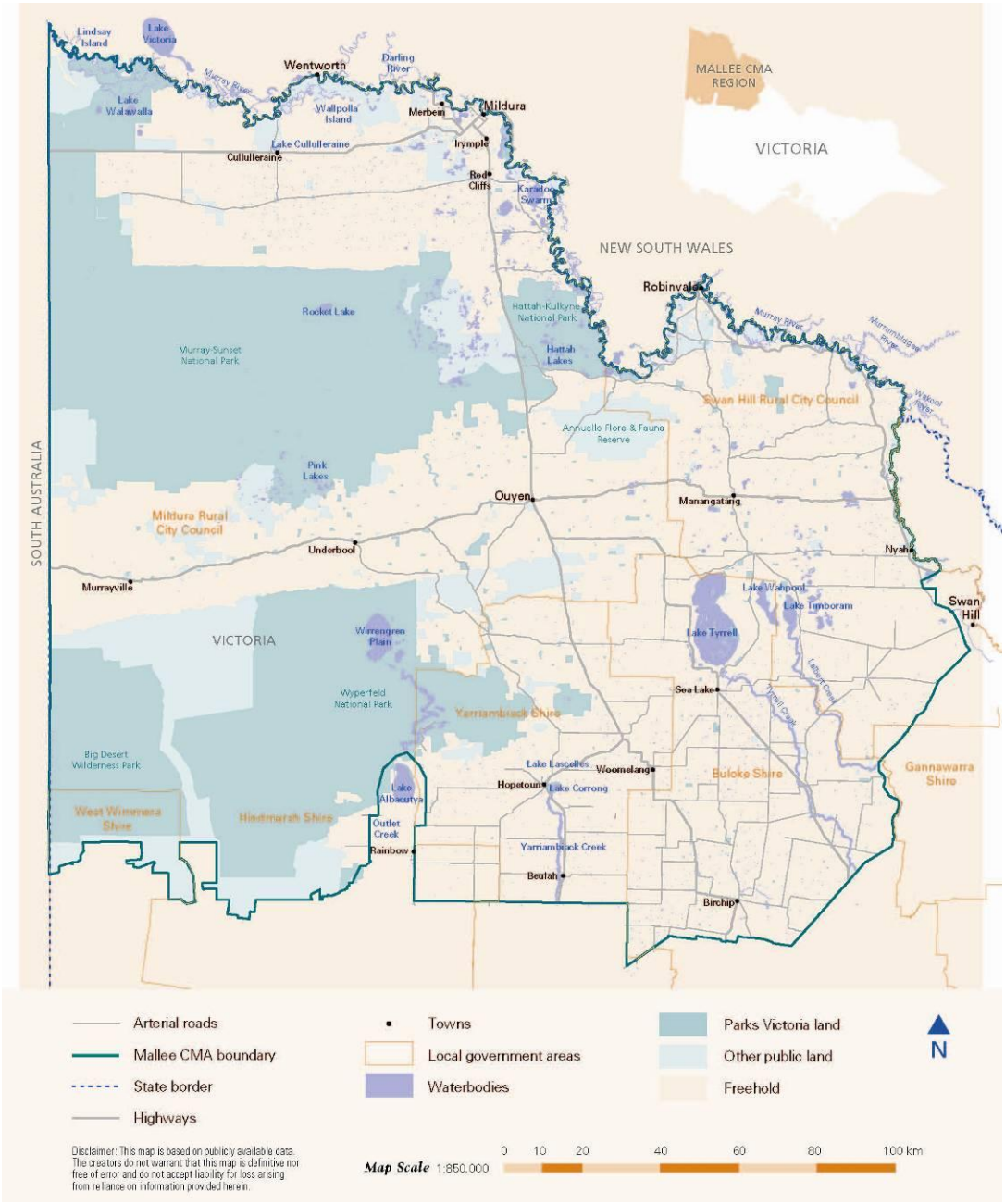


Figure 1 Map of the CMA Region

In 2006 the Mallee CMA engaged consultants, Ecological Associates, to investigate water management options for the Murray River floodplain from Robinvale to Wallpolla Island. One of the major outcomes of these investigations (EA 2006) was the development of a system of waterway management units (WMUs). These divide the floodplain into management units which are areas in which water regimes can be managed independently of another WMU but which are relatively consistent in their ecological values and land uses. The Mallee CMA has based its environmental water management plans on these WMUs to achieve more effective management of hydrologically connected systems.

The site for this plan is the Mildura WMU situated 5 km east of Mildura on the Murray River floodplain (Figure 2).

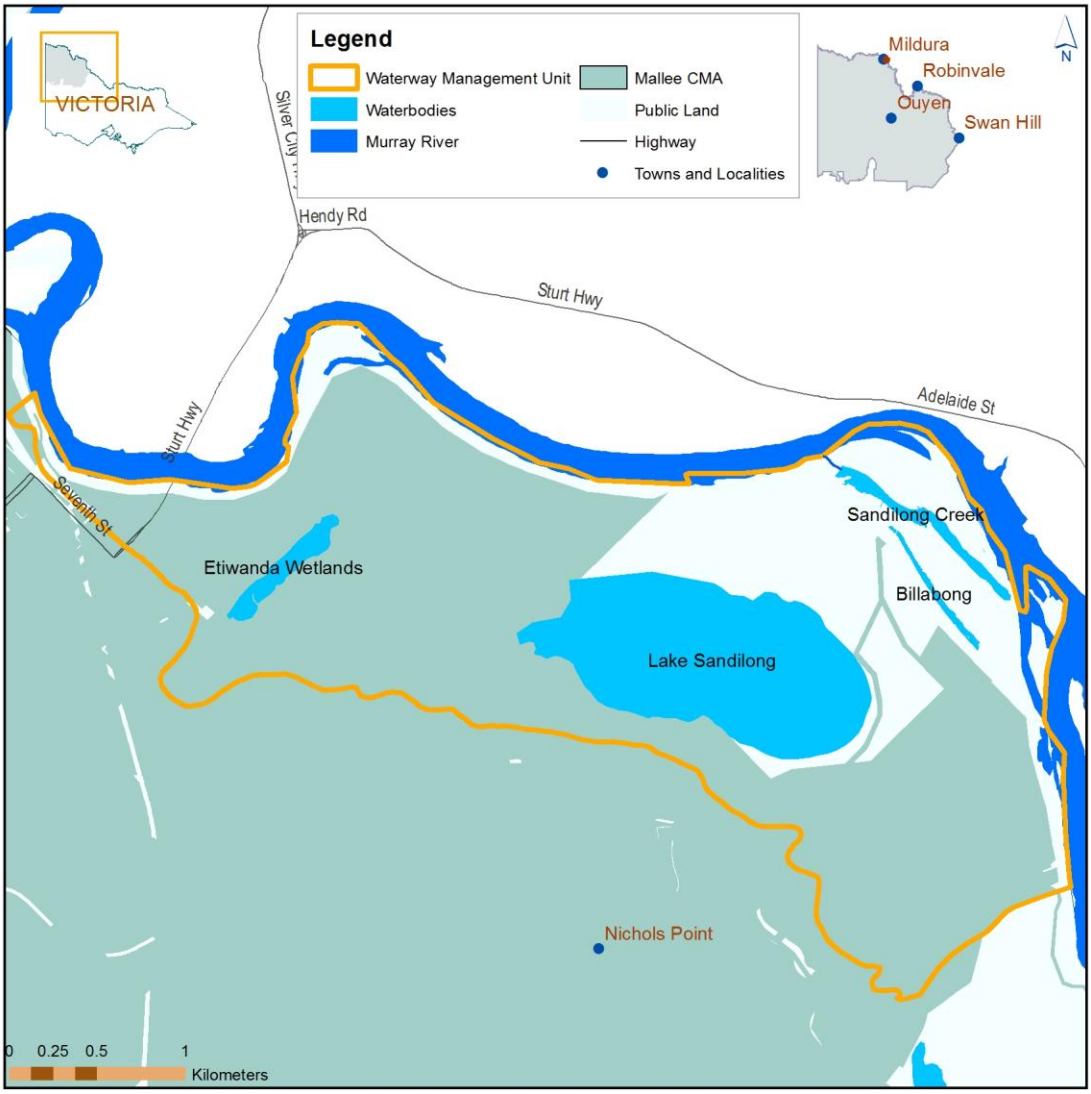


Figure 2 Map of the Mildura WMU

1.4 Information sources

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

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

This information was supplemented by discussions with people with an intimate knowledge of the study area, its environmental values and the management and operation of the Mildura waterway management unit.

1.5 Limitations

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

2 SITE OVERVIEW

2.1 Catchment Setting

The Waterway Management Unit boundary indicates the area for which water regimes can be managed largely independently of neighbouring Waterway Management Units. The Mildura Waterway Management Unit (Figure 2) is located in the Robinvale Plains bioregion within the Mallee CMA region, 5 km east of Mildura and 5 km upstream of the Mildura Weir. River levels at this location remain relatively static under the influence of the weir pool, with inundation of the floodplain and flood runners occurring only during extreme events (Thoms et al. 2000, p 106). The wetting and drying cycles of the floodplain environment are modified from that which would have existed prior to river regulation (EA 2007).

The Mildura WMU is bordered to the north by the Murray River. The land consists of riverine vegetation including River Red Gum (*Eucalyptus camaldulensis*), extending generally southwards to slightly higher elevations of Black Box (*E. largiflorens*) floodplain and associated flora species.

The WMU is part of the Murray River floodplain and is a high profile site presenting an excellent opportunity to conduct environmental watering for education, ecological and social purposes with significant environmental benefits. Situated within close proximity to the township, the area is subject to high levels of visitation. Aquatic activities including swimming, boating, fishing and skiing are popular. The Mildura WMU contains large areas of recreational land including a golf course, tennis courts, horse complex and a racecourse, as well as areas of native vegetation. A houseboat mooring site is located on the Murray River adjacent the Riverside Golf Course, and is used frequently to provide tourist access by boat to the golf course. Also within this WMU is the Mildura Cemetery, and areas of private land (Appendix 5).

The WMU forms a significant part of the river's local ecosystem. It is situated adjacent to the Kings Billabong Park, a nationally important wetland (Environment Australia 2001). Throughout the WMU Black Box and River Red Gum communities form significant corridors connecting the Park, and assisting the movement of terrestrial and avian fauna.

The target area for this plan includes Sandilong Creek and an associated billabong, which are described in Section 2.2. Several other wetlands exist within the WMU that are constrained in terms of delivery or need of environmental water. Etiwanda Wetlands (Figure 2) is a constructed permanent wetland, which filters up to two thirds of Mildura's stormwater prior to its eventual release to the river (MRCC 2011). Mildura Rural City Council (MRCC) manages Etiwanda Wetlands, and because the wetland accommodates large volumes of stormwater, its management through delivery of environmental water is not the subject of this plan.

Lake Sandilong (Figure 2) is classified as a Shallow Freshwater Marsh in the 1994 wetland layer (see Section 3.1.2) (DEPI 2014a), however due to river regulation, flood levees, and the constraints of surrounding land use, this wetland is only inundated through extremely high rainfall events or when a flood overtops the levee banks.

There is also a large diversity of terrestrial and aquatic flora and fauna species present in the WMU. Backwaters that are connected to the Murray River maintain relatively static water levels due to the influence of the Mildura Weir (EA 2008). Some of the Murray River backwaters are known to contain aquatic species including the state listed Murray-Darling Rainbowfish (*Melanotaenia fluviatilis*), the near-threatened Golden Perch (*Macquaria ambigua*) and the endangered Freshwater Catfish (*Tandanus Tandanus*), as well as Bony Herring (*Nematalosa erebi*) and Peron's Tree Frog (*Litoria peronii*) (Chapman, Ellis & Pyke 2009). These backwaters are separated from the target area by a levee, but add value to the system due to their proximity to Sandilong Creek and the diversity of fauna present.

2.2 Target Area

The whole of the Mildura WMU (Figure 2) has a water requirement as a floodplain complex, however due to the current uses of public land, the extent of existing flood levees designed to protect private land from flood, and the extent of private land within this WMU, an environmental watering regime is not planned for the floodplain.

The target area for this Plan is based on Sandilong Creek and an associated billabong (Figure 3), and the extent to which environmental water is able to be managed within the WMU with current infrastructure. Both the creek and the billabong are wholly within the Riverside Golf Course boundary (Figure 4).

Freshwater Catfish, Golden Perch and several species of state listed turtles have been recorded in the Sandilong Creek (Ellis & Wood 2012). For more detail, refer Section 3.1.1.

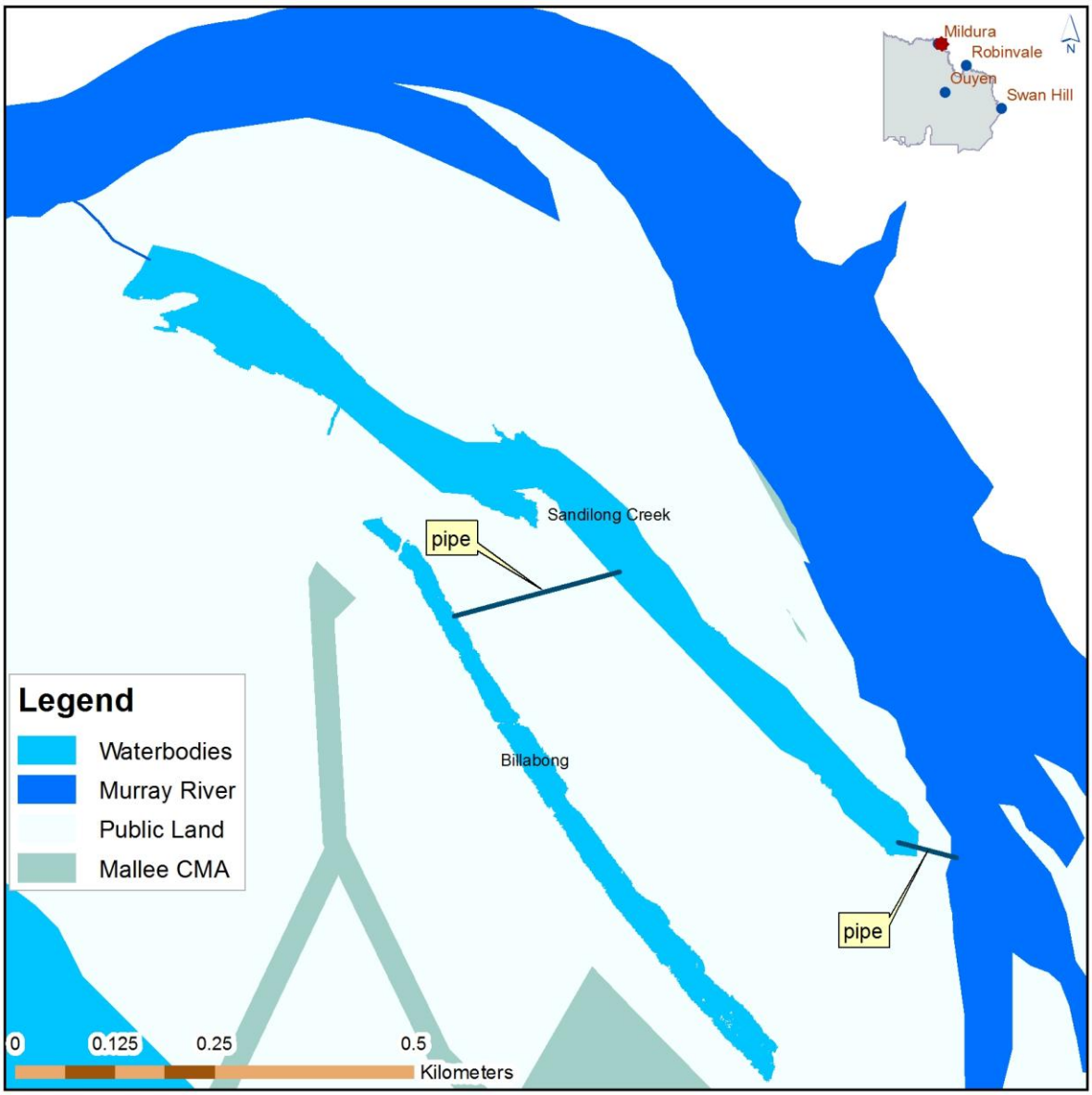


Figure 3 Map of wetlands in the Target Area of the Mildura Waterway Management Unit

2.3 Land status and management

The Mildura WMU area has a complex land tenure arrangement (Appendix 5). A number of parcels of private land exist on higher ground, outside the target area.

A large part of the WMU, including the target area, was historically managed by the Department of Environment and Primary Industries (DEPI) as State Forest under the Murray River Reserve. The reserve was reclassified in the 1930s as a recreation reserve to be managed by the Shire of Mildura (now Mildura Rural City Council, MRCC). The 1989 Land Conservation Council Final Recommendations (Land Conservation Council, 1989) recommended the land remain as Recreation Reserve, managed by MRCC. This classification remained unchanged after the River Red Gum Forests Investigation Final Report (VEAC 2008). Stakeholders with an interest in this plan are outlined in Table 1 (page 8).

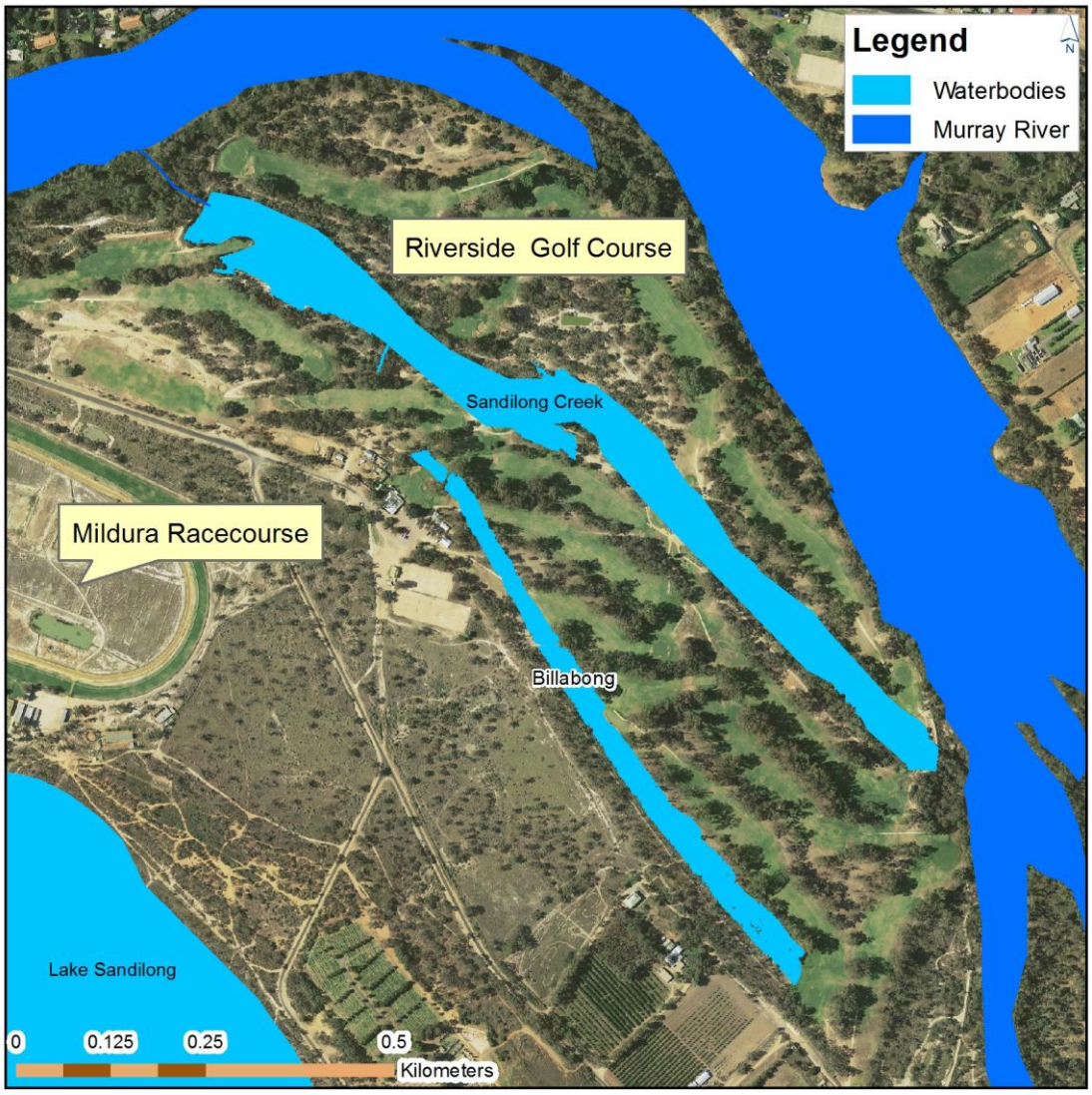


Figure 4 Riverside Golf Course surrounding the target area

Table 1 Stakeholders for the Mildura WMU Target Area

Group	Role
Mildura Rural City Council	Neighbouring Land Manager, Local Government
Mallee CMA	Regional environmental management
Department of Environment and Primary Industries	State level environmental management
Goulburn Murray Water	River Murray operations
Nyeri Nyeri and Latji Latji Community	Indigenous Representation
Riverside Golf Club	Committee of Management, Business operating within the WMU

Since at least 2002, the Golf Club has leased the golf course land directly from DEPI (Appendix 5). Council is land manager for the remaining land within the Recreation Reserve. The golf course surrounds the target area, and has been under the management of the Golf Club since 1935 (Riverside Golf Club, 2010). The land near both the creek and billabong predominantly has native vegetation over-storey, which is generally well-connected, however the understorey is not always connected via a natural shrub layer (Sunraysia Environmental 2008).

A section of land approximately 60 m in width (Appendix 5), between the golf course and the Murray River, falls under Parks Victoria management as part of the Murray River Public Purposes Reserve (Murray River Reserve). In practical terms, the Golf Club passively manages this area in keeping with the natural environment.

2.4 Wetland characteristics in the Target Area

Sandilong Creek

The Sandilong Creek is a permanently inundated former anabranch of the Murray River that has been isolated from the river by flood levees to protect the golf course (Figure 14, Figure 21 and Figure 22) constructed to 39 m AHD (EA 2008). The creek is currently maintained at weir pool level (34.5 m AHD), is approximately 1,190 m in length, less than 1 m deep at each end, and more than 2 m deep in several large holes (EA 2008).

The creek has some remnant fringing River Red Gum community with Eumong and chenopod understorey. In some locations the understorey is dominated by exotic grass and weed species, and further from the banks of the creek, understorey has been thinned or removed (Sunraysia Environmental 2008). The creek itself contains some aquatic vegetation dominated by Cumbungi (*Typha* spp.) and Common Reed (*Phragmites australis*) (EA 2008), and provides habitat for resident native fish populations including Freshwater Catfish (*Tandanus tandanus*) (Chapman, Ellis & Pyke 2009).

Whilst Sandilong Creek is isolated from the river by levees, it is connected by pipes with valves to control the water level (Figure 3). The creek has three causeways providing crossings for golfers and Golf Club machinery and staff, one of which was funded by the Mallee CMA and allows fish passage. The remaining two causeways limit movement of aquatic fauna within the creek (Figure 20, page 41).

The Billabong

The billabong is approximately 900 m long and 30 m wide (EA 2008) and is located to the south east of the golf course (Figure 4). It is located on the edge of a rise in the floodplain and would once have been classed a freshwater meadow or shallow freshwater marsh. In the past, the billabong received saline irrigation drainage water (EA 2008), although it is now generally dry, only filling naturally if a significant flood event were to occur that overtopped or breached the levee, or through a significant rainfall event. Surrounding vegetation includes River Red Gum in reasonable health and Black Box in poor health (EA 2008).

The billabong is fed artificially by a pipe leading from the Sandilong Creek (Figure 3), and can only be filled when the creek is at a sufficient depth (approximately 35 m AHD). To the east of the billabong is a narrow corridor of Red Gum and Black Box, and the golf course, and to the west is a narrow corridor of Black Box and private land.

This combined target area represents approximately 8.84 ha (Figure 3). Constraints and proposed infrastructure are discussed fully in Sections 4 and 8. Expansion of the target area would need careful consideration of the implications for the Golf Club and neighbouring landholders and land managers. Given the modified and irrigated environment of the target area, further ecological benefits arising from expansion of the inundation zone are unlikely.

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

Table 2 Summary of target area characteristics

Characteristics	***Description***
Name	Sandilong Creek and billabong
Mapping ID within area	No wetland id
Area	8.84 ha
Bioregion	Robinvale Plains
Conservation status	Bioregional Conservation Status: areas of EVC listed as depleted and least concern.
Land status	Recreation Reserve
Land manager	Riverside Golf Club for land leased from DEPI
Surrounding land use	Recreational, irrigated horticulture, Murray River floodplain, Murray River Reserve and Murray River
Water supply	Piped from Murray River, maintained close to weir pool level (no natural supply due to levees)
Wetland depth at capacity*	35.75 m AHD maximum at gauge point (34.5 m + 1.25 m AHD); depth approximately 2.5 m

Note: *Capacity is governed by golf course operations

2.5 Environmental water

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

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

Environmental Water for the target area may be sourced from the water entitlements and their agencies listed in Table 3 and further explained in Appendix 1. Recent environmental watering which has occurred at the Mildura site is outlined in section 4.1.3.

Table 3 Summary of environmental water sources available to the Mildura WMU

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

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

2.6 Legislative Policy Framework

There is a range of international treaties, conventions and initiatives, as well as National and State Acts, policies and strategies that determine management of the target area. 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 Appendix 2.

Table 4 Legislation, agreements, convention and listings relevant to the target area

Legislation, Agreement or Convention	Jurisdiction
EPBC Act 1999	National
Flora and Fauna Guarantee Act 1988	State
DEPI advisory lists	State
JAMBA	International
CAMBA	International
ROKAMBA	International

2.7 Related Plans and Activities

The Mildura WMU is situated on the Victorian floodplain of the Murray River which is, and has been the subject of a number of investigations. These include Salinity Management Plans, Flow studies and Land Conservation Council Reviews. The WMU is within the area covered by the Robinvale to Merbein Murray River Frontage Action Plan (FAP) (MCMA 2003). Through the FAP a number of projects have been carried out and the opportunity remains to attract future funding and implement further works through that Plan.

There have also been local investigations. In 2008, Mallee CMA engaged consultants Ecological Associates to investigate water management options for the target area. This investigation recommended a range of management options for the Sandilong Creek including removal of blockages to aquatic fauna, manipulating water levels, facilitating through flow, controlling carp, manipulating Lock 11 to raise and lower the river to expose low benches, regulating River Murray backwaters at the site and pumping water to the Billabong.

Also in 2008, Mallee CMA engaged consultants Sunraysia Environmental to conduct a review of management and usage of the river frontage in the target area. This review recommended a range of actions to improve ecological values, mitigate risk from ecological, and social threats, and improve public education. Recommended actions included installation of a rabbit/vermin proof fence, removal of pest plants including Willows, African Boxthorn and Prickly Pear, and removal of hard rubbish.

Following these recommendations the Golf Club in partnership with the Mallee CMA has contributed to significant investment of environmental works including:

- Installation of a vermin proof fence along the perimeter of the golf course;
- Pest plant and pest animal management (primarily rabbit and weed control and willow tree removal (Figure 5));
- Removal of hard rubbish occurring at a number of sites within the target area;
- Replacement of one causeway with a fish friendly structure, improving fish passage within part of the creek;
- Willow removal at the houseboat landing site on the Murray River and protection of the area surrounding the site by installation of bollards;
- Development of a community demonstration site to highlight river health management including informative signage and holding an education event at the creek - Catch a Carp Day; and
- Delivery of environmental water to the creek and billabong in 2011/12, 2012/13, and 2013/14 (prior to this the Golf Club delivered water from their own irrigation allocations during the most recent drought)

In 2010, as part of a wider study encompassing Sandilong Creek and Kings Billabong (Kings Billabong Wildlife Park), Mallee CMA engaged consultant, Landskape, to prepare a Cultural Heritage Management Plan for proposed works for regulator structures and bridges.

The Golf Club and/or Mildura Rural City Council have also undertaken significant works since 1935 to develop the Golf Course including:

- Further work on levee banks (1970s), possibly reconstruction;
- Construction of causeways (the first *circa* 1954);
- Pumps, channels (now replaced with pipes) and irrigation systems for the fairways and greens;
- Provision of water to the billabong (*circa* 1994); and
- Cleaning up an old tip site (*circa* 1994)

[Source: Riverside Golf Club 2010]

The Nichols Point Community Plan (MRCC 2012) promotes the preservation and maintenance of the area's natural waterways, which includes the target area of this WMU.

The Mildura WMU may be influenced by other programs such as the Murray Darling Basin Plan, and this Plan may need to be revised when the Basin Plan is implemented.

Figure 5 Willow Removal works, Sandilong Creek, August 2012
Image: Sunraysia Environmental Pty Ltd.

3 WATER DEPENDENT VALUES

3.1 Environmental

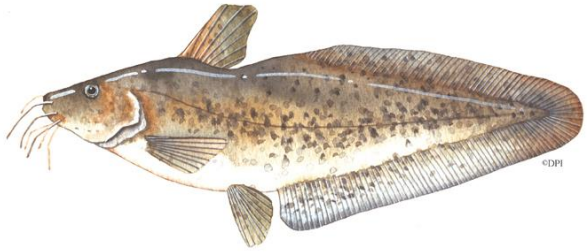
Wetlands and waterways on the floodplain are a vital component of the landscape. They support a vast array of flora and fauna which may vary greatly with the type of wetland/waterway system. The habitat provided by vegetation communities around wetlands is essential for maintaining populations of water dependent and other 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.

The wetland systems of the Mildura WMU support a wide range of flora and fauna, and a diversity of species are known to be present in the local area. The wetlands provide both a water source and food source for the array of terrestrial fauna occurring locally. Sandilong Creek and the billabong are vegetatively linked to the Kings Billabong Park and are therefore an important site for transiting native fauna.

3.1.1 Listings and significance

Fauna

A total of 88 species of native fauna have been recorded in the WMU, including 13 listed species. Water dependent species of conservation significance recorded in the Water Management Unit are listed in the Victorian Biodiversity Atlas (DEPI 2013a) and summarised in Table 5 (page 13). Aquatic species include the Growling Grass Frog (*Littoria raniformis*), Freshwater Catfish (Figure 6), and Murray-Darling Rainbowfish. Several wetland reptiles and birds have also been reported. Three of the listed species depend on hollows for shelter or breeding including the Inland Carpet Python (Figure 7), Red-backed Kingfisher (*Todiramphus pyrropygia*) and Major Mitchell's Cockatoo (*Cacatua leadbeateri leadbeateri*). River Red Gum and Black Box trees associated with the wetlands are the principal source of tree hollows in the region (EA, 2008).



Freshwater Catfish
(*Tandanus Tandanus*)

Habitat

The Freshwater Catfish prefers slow-flowing waterbodies and lakes. It is a benthic species, preferring to live and feed on or near the bottom.

Breeding

Adults are sexually mature at 3-5 years. Spawning is believed to be stimulated by water temperature (20-24^{0}C) and occurs in spring and summer. The male constructs a nest from sand or gravel, and may reconstruct another if it is exposed by a drop in water level. The male will stay with the eggs until hatched, protecting them from predation and fanning them to avoid deposition of silt. The nest may be used for multiple spawnings in the one season.

Food Sources

Freshwater Catfish generally consume shrimps and yabbies, aquatic insects, worms, snails and small fish. Juveniles feed on aquatic insects.

Threats

Exotic fish species including Common Carp and Redfin may pose a threat to Catfish populations. Change to natural water flow regimes, natural water temperature regimes, loss of aquatic vegetation, degradation of habitat and water quality, and saline water can impact on the Freshwater Catfish. Spawning can be inhibited if a nest is repeatedly exposed by receding water levels.

Species Trajectory

Freshwater Catfish have been stocked in a number of dams and lakes, however riverine populations have been in decline since the late 1970s/early 1980s. In 2005 it was believed that there were only four self-sustaining Freshwater Catfish populations in Victoria (DSE 2005b).

Source: Lintermans 2007, DSE 2005b; Image: DEPI 2013b

Figure 6 The Freshwater Catfish

Table 5 Water dependent Fauna of Conservation Significance reported in the Mildura Waterway Management Unit (Victorian Biodiversity Atlas)

Scientific Name	Common Name	Type	EPBC Status	FFG Status	DEPI Status	Migratory Bird Agreement[@]	Hollow Dependent
Ardea intermedia	Intermediate Egret	B	NL	L	EN		
Lerista timida	Dwarf Burrowing Skink	R	NL	L	EN		
Limosa limosa	Black-tailed Godwit	B	M		VU	B, J, C, R	
Litoria raniformis	Growling Grass Frog	A	NL	L	VU		
Cacatua leadbeateri leadbeateri	Major Mitchell's Cockatoo	B	NL	L	VU		*
Melanotaenia fluviatilis	Murray-Darling Rainbowfish	F	NL	L	VU		
Merops ornatus	Rainbow Bee-eater	B	M		NL	J	
Morelia spilota metcalfei	Inland Carpet Python	R	NL	L	EN		*
Ogyris subterrestris subterrestris	Mildura Ogyris	I	NL	L	VU		
Phalacrocorax varius	Pied Cormorant	B	NL		NT		
Tandanus tandanus	Freshwater Catfish	F	NL	L	EN		
Todiramphus pyrropygia	Red-backed Kingfisher	B	NL		NT		*
Tringa stagnatilis	Marsh Sandpiper	B	M		VU	B, J, C, R	

[@] *Source: Department of Environment 2012*

Legend:

Type - Invertebrate, Fish, Amphibian, Reptile, Bird, Mammal
EPBC status - Migratory, Not Listed *(Environment Protection & Biodiversity Conservation Act 1999)*
DEPI status - ENdangered, Vulnerable, Near Threatened, Not Listed
FFG – L: Listed species *(Flora and Fauna Guarantee Act 1988)*
CAMBA – C:species listed under the China-Australia Migratory Bird Agreement
JAMBA – J: species listed under the Japan-Australia Migratory Bird Agreement
ROKAMBA – R: species listed under the Republic of Korea-Australia Migratory Bird Agreement
Bonn – B: species listed under the Bonn Convention

The list provided in Table 5 includes a range of listed water dependent species which will benefit from the wetlands in the target area receiving water on a more regular basis. Species included in the list may forage or nest in or on water, inhabit, or breed in water, or require flooding to trigger breeding or fledging. The Inland Carpet Python is indirectly dependent on water, requiring riparian trees, vigorous ground cover and fallen timber as essential habitat (DSE 2003). The Freshwater Catfish, which is directly dependent on water, appears to have found suitable habitat in the creek system (Chapman, Ellis & Pyke 2009). In order to provide both habitat and breeding opportunities, elements within the WMU such as the Sandilong Creek and the surrounding ecosystem including the River Red Gum and Black Box communities must be maintained in good condition. A complete list of native species recorded in the WMU is appended(Appendix 3).

Several fish surveys have been conducted in the creek. Of particular note are surveys conducted to inform environmental watering programs, and to monitor impacts of inflows on fish movement. The results of these surveys are provided in Table 6.

Table 6 Fish species recorded during recent surveys of Sandilong Creek#

Scientific Name	Common Name	Type	EPBC Status	FFG Status	DEPI Status	2009 Survey	2012 Survey
Chelodina expansa	Broad-shelled Turtle	R	NL	L	EN		✓
Chelodina longicollis	Common Long-necked Turtle	R	NL		DD		✓
Craterocephalus stercusmuscarum fulvus	Fly-specked Hardyhead	F	NL				✓
Emydura macquarii	Murray River Turtle	R	NL		VU	✓	✓
Hypseleotris spp.	Carp Gudgeon	F	NL			✓	✓
Macquaria ambigua	Golden Perch	F	NL	I	NT		✓
Philypnodon grandiceps	Flat-headed Gudgeon	F	NL			✓	✓
Philypnodon macrostomus	Dwarf Flat-headed Gudgeon	F	NL			✓	✓
Retropinna semoni	Australian Smelt	F	NL				✓
Tandanus tandanus	Freshwater Catfish	F	NL	L	EN	✓	✓
*Cyprinus carpio**	Common Carp*	F*	NL				✓
Cyprinus carpio/Carassius auratus* hybrid*	Carp/Goldfish hybrid*	F*	NL				✓
*Gambusia holbrooki**	Gambusia (Mosquito Fish)*	F*	NL			✓	

Source: Chapman, Ellis & Pyke 2009; Ellis & Wood 2012.
Legend:
***** - Indicates exotic species
Type: Reptile, Fish
EPBC status - Migratory, Not Listed *(Environment Protection & Biodiversity Conservation Act 1999)*
FFG Status - L: Listed Species *(Flora and Fauna Guarantee Act 1988)*
DEPI Status – Endangered, VUlnerable, Near Threatened, Data Deficient, Ineligible or Invalid (nominated for listing but rejected)
It should be noted that the diversity of species identified during the 2012 survey was the result of an investigation into the movement of species upstream during slow- and fast-fill events, with the creek at a very low water level, whereas the 2009 survey was conducted at a selection of sampling sites with the creek at its permanent water level. By the very nature of each survey, the 2012 survey was likely to result in more species being trapped and identified than the 2009 survey.

The 2012 survey captured 17 Freshwater Catfish moving upstream during the fast fill event. Two size cohorts were found: 100 – 200 mm; and 300 – 400 mm, indicating that a breeding population is likely to exist within the creek. The results of the 2009 survey also revealed Catfish of multiple size classes indicating successful breeding (I. Ellis 2013, pers. comm., 12 Sept).

The Freshwater Catfish is directly dependent on a healthy wetland system in the Sandilong Creek. Preferring still or slow-flowing waters with abundant aquatic vegetation and submerged timber providing shelter and habitat, Catfish are sensitive to changes in natural flow regimes and water temperatures (DSE 2005b). Delivery of environmental watering under this plan will encourage diversity of aquatic vegetation, and improve riparian vegetation, which in turn may provide submerged habitat and increase the potential forage area and breeding sites for Catfish outside the creek banks. Watering events must be managed to ensure that drawdown or recession of floodwaters does not occur rapidly during the spawning season.

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 are important for incubation sites.

Species Trajectory
Once widespread in typical habitats in northern Victoria, numbers have been significantly reduced since human settlement and is now listed as Threatened under the FFG Act. In 2010 there were fewer than 200 confirmed records of occurrences in Victoria (DSE 2010).
Source: DSE 2003 & DSE 2010; DEPI 2013c

Figure 7 The Inland Carpet Python

The Inland Carpet Python (Figure 7) has been recorded within the Riverside Golf Course. In a healthy wetland environment, the areas lining both the creek and the billabong would provide suitable habitat and cover in the form of thick litter and shrubs, tree hollows and fallen timber, and also a range of food sources within that habitat.

The Inland Carpet Python is indirectly dependent on a healthy wetland system in the Sandilong Creek and billabong. 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 riparian 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.

Vegetation communities

Within the target area, the most extensive ecological vegetation classes (EVC) are Grassy Riverine Forest and Riverine Chenopod Woodland, which are classified as depleted within the Robinvale Plains bioregion (DEPI 2014b). Shrubby Riverine Woodland also occurs, listed as being of least concern. A very small area (Figure 8) of Grassy Riverine Forest/Floodway Pond Herbland Complex is also noted and is classified as depleted (DEPI 2014b).

The dominant tree species of these EVC are River Red Gum and Black Box (Table 7). The condition of Black Box can be dependent on the frequency of inundation events, which in turn can impact on bud size and abundance of flowering (Roberts & Marston 2011). River Red Gum need flooding to meet all their water requirements; without flooding, distribution and quality can be limited (Di Stephano 2001). Flowering of River Red Gum occurs in summer, with seed fall occurring in spring, which is aligned to spring flood events (Roberts & Marston 2011), and allows distribution and germination of seed, thereby promoting recruitment. Understorey species often flower at this time also, generating a diversity of flora on the floodplain (S. Erlandsen 2013, pers. comm., 18 Sept).

River Red Gum and Black Box trees provide habitat including feeding, breeding and refuge areas for fish, reptiles, mammals and birds (West n.d; DEC 2011). These trees can provide shelter for hollow-seeking native birds such as the Major Mitchell's Cockatoo, and provide perching sites for visiting birdlife. Fallen limbs can provide hollow logs as harbour and nesting sites for reptiles such as the Carpet Python. Healthy River Red Gums contribute to the wetland ecosystem by depositing organic material, and submerged fallen trees provide habitat (Roberts & Marston 2011) (Figure 18, page 33) for aquatic species such as the Freshwater Catfish. Healthy Black Box helps provide important vegetative corridors to other areas above the floodplain for a range of transient native fauna. Also important in Black Box communities and present in the target area are Lignum species (*Muehlenbeckia* spp.). Healthy Lignum provides shelter for a range of birdlife, nesting sites for smaller birds, and cover for frogs and reptiles.

To promote vigorous growth in River Red Gum forests, inundation every 1-3 years is needed. For Black Box, this interval is 3-7 years. Lignum requirements vary from 1-5 years (Roberts & Marston 2011).

A full list of EVCs within the entire WMU and details of each is appended (Appendix 4). The EVCs within the target area and their conservation status can be seen in Figure 8 and Table 7.

Table 7 Conservation status of water dependent EVCs in the target area

EVC no.	EVC name	Dominant Tree Species	Bioregional Conservation Status Robinvale Plains Bioregion	Ha within Target area
103	Riverine Chenopod Woodland	Black Box	Depleted	0.6988
106	Grassy Riverine Forest	*Eucalyptus* spp. (River Red Gum Forest)	Depleted	0.3035
818	Shrubby Riverine Woodland	Black Box, River Red Gum	Least concern	2.7087
811	Grassy Riverine Forest/ Floodway Pond Herbland Complex	*Eucalyptus* spp. (River Red Gum Forest)	Depleted	0.0007

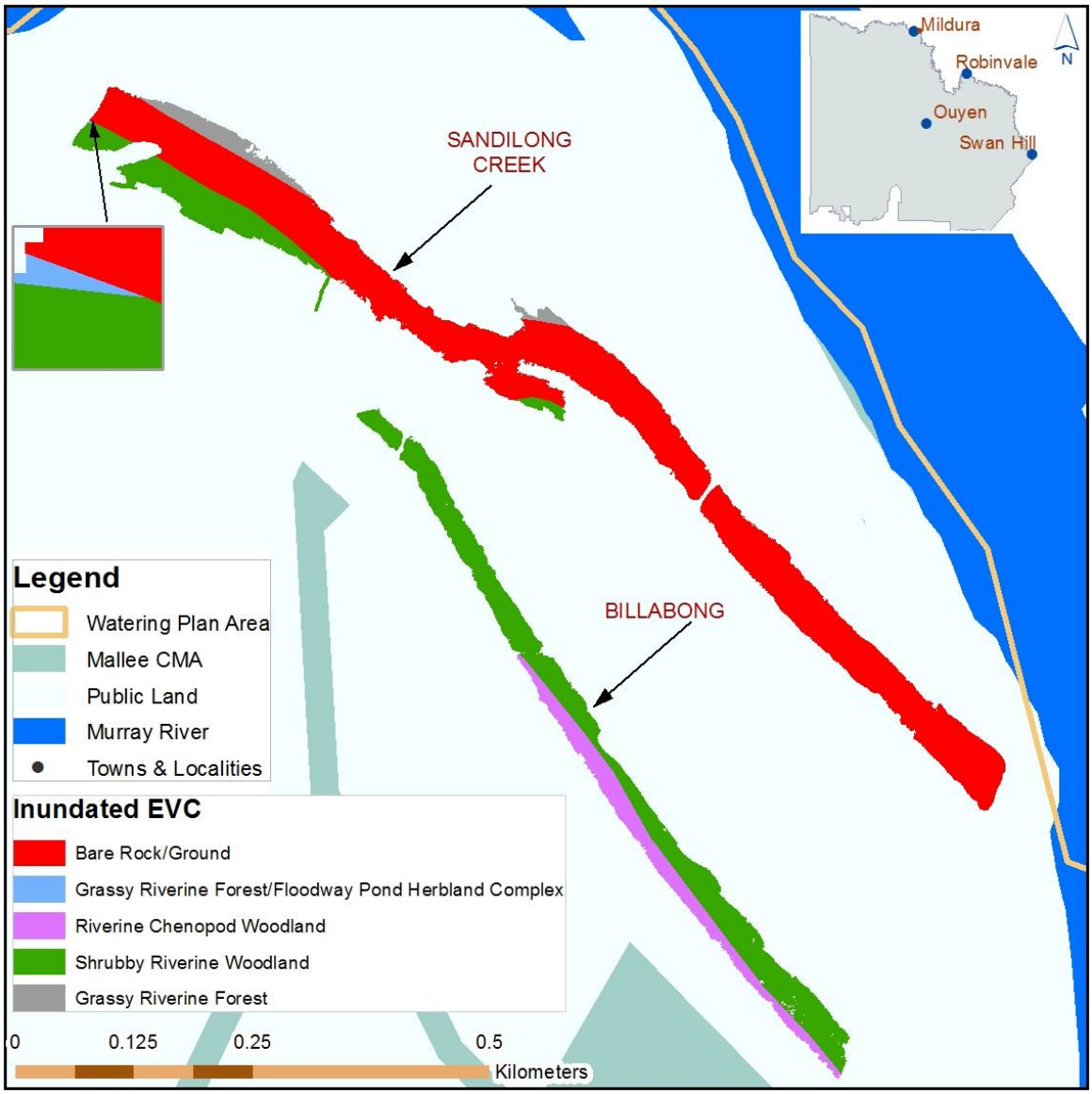


Figure 8 EVCs within the target area of the Mildura WMU

Flora

A total of 142 native flora species are recorded within the Mildura WMU, including 28 listed species (Table 8). The Victoria Biodiversity Atlas reports floodplain species of conservation significance including Cane Grass, Spiny Lignum and Slender Water-ribbons (EA 2008). A full list of flora recorded at the Sandilong Creek site is appended (Appendix 3).

The range of flora recorded within the WMU provides support for improving the quality and diversity of flora within the target area through environmental watering, which will in turn benefit a range of native fauna and contribute to a healthy wetland ecosystem.

Table 8 Plant species of Conservation Significance reported in the Mildura Waterway Management Unit - Victorian Biodiversity Atlas (DEPI 2013a)

Scientific Name	Common Name	EPBC Status	DEPI Advisory List	FFG
Abutilon otocarpum	Desert Lantern	NL	VU	
Acacia victoriae subsp. *victoriae*	Bramble Wattle	NL	R	
Atriplex limbata	Spreading Saltbush	NL	VU	L
Atriplex nummularia subsp. *omissa*	Dwarf Old-man Saltbush	NL	R	
Atriplex papillata	Coral Saltbush	NL	R	
Calandrinia volubilis	Twining Purslane	NL	R	
Calotis cuneifolia	Blue Burr-daisy	NL	R	
Cullen pallidum	Woolly Scurf-pea	NL	EN	L
Cynodon dactylon var. *pulchellus*	Native Couch	NL	PK	
Digitaria ammophila	Silky Umbrella-grass	NL	VU	
Dissocarpus biflorus var. *biflorus*	Twin-flower Saltbush	NL	R	
Eragrostis australasica	Cane Grass	NL	VU	
Eragrostis setifolia	Bristly Love-grass	NL	VU	
Eremophila divaricata subsp. *divaricata*	Spreading Emu-bush	NL	R	
Eremophila maculata subsp. *maculata*	Spotted Emu-bush	NL	R	
Frankenia serpyllifolia	Bristly Sea-heath	NL	R	
Leiocarpa leptolepis	Pale Plover-daisy	NL	EN	L
Malacocera tricornis	Goat Head	NL	R	
Muehlenbeckia horrida subsp. *horrida*	Spiny Lignum	NL	R	
Minuria cunninghamii	Bush Minuria	NL	R	
Minuria integerrima	Smooth Minuria	NL	R	
Picris squarrosa	Squat Picris	NL	R	
Ptilotus polystachyus	Long Tails	NL	EN	
Sarcozona praecox	Sarcozona	NL	R	
Sclerolaena muricata var. *muricata*	Black Roly-poly	NL	PK	
Sida ammophila	Sand Sida	NL	VU	
Triglochin dubia	Slender Water-ribbons	NL	R	
Zygophyllum angustifolium	Scrambling Twin-leaf	NL	R	

Legend:
EPBC status - Not Listed *(Environment Protection & Biodiversity Conservation Act 1999)*
FFG Status - L: Listed Species *(Flora and Fauna Guarantee Act 1988)*
DEPI Status – ENdangered, VUlnerable, Rare, Poorly Known

3.1.2 Wetland depletion and rarity

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

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

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

At the same time, an attempt was made to categorise and map wetland areas occupied prior to European settlement. This was largely interpretive work and uses only the primary category, based on water regime. This is known as the 1788 layer. It has been possible to determine the depletion of wetland types across the state using the primary category only, based on a comparison of wetland extent between the 1788 and 1994 wetland layers.

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

Across the state, the greatest decreases in original wetland area have been in the freshwater meadow (43 per cent decrease), shallow freshwater marsh (60 per cent decrease) and deep freshwater marsh (70 per cent decrease) categories (DNRE 1997). Within the Mildura WMU, one shallow freshwater marsh is identified in the 1788 wetland layer (Figure 2) (DEPI 2014); however this wetland site is constrained by surrounding land use and is not currently subject to inundation except in extreme conditions.

The target area within the Mildura WMU focuses on two wetlands. These wetlands have not been classified using the Corrick-Norman wetland classification system. They are subject to high visitation by golfers and walkers, which makes them ideal for demonstration sites of wetland management practices. Prior to the formation of the levees, the creek was an intermittent wetland. It has the potential to contribute to the ecology of the wider river system by providing refuge, habitat and food sources for many aquatic species and water dependent birdlife. The creek is significant because it is one of only "a small number of sites" in Victoria (DSE 2005b) that has a naturally occurring breeding population of Freshwater Catfish (I. Ellis 2013, pers. comm., 12 Sept).

The billabong was once an intermittent wetland filling during flood events and slowly drying. This area contributed to floodplain ecology through natural wetting and drying cycles and would have once provided habitat and food sources for a range of aquatic and terrestrial fauna. Through the formation of the levees to protect the golf course, this billabong has not been subject to natural inundation events, and was, for a time, inundated with saline irrigation drainage water (EA 2008). Recent improvements to irrigation efficiency has resulted in drying of the billabong bed (EA 2008) and decreasing vegetation quality in and around the bed.

3.1.3 Ecosystem functions

The Sandilong Creek and billabong ecosystems support distinctive communities of plants and animals and provide numerous ecosystem services to the community (DSE 2005a). When operating like floodplain wetlands, they perform important functions necessary to help maintain the hydrological, physical and ecological health of the Murray River system. These ecosystem functions include:

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

Modified riparian conditions and altered water regimes in the target area due to river regulation, altered land use, and installation of levees and causeways have resulted in a significant alteration to the water regime of the creek and billabong. Without human intervention, the creek and billabong are not able to absorb or release floodwaters during a flood event. Organic material typically remains within the creek system, and the billabong provides little in terms of feeding, breeding and refuge sites for flora and fauna.

However the environmental watering regime proposed in this plan may help restore the balance within these ecosystems and help the wider river system. A healthy wetland system in the creek and billabong helps promote primary production and nutrient cycling and helps maintain a balance between complex systems. Vegetation condition, extent and diversity can be enhanced when the wetland system is well maintained, in turn improving fauna condition, recruitment and shelter potential. Sound ecological diversity and effective water management may also provide a level of natural control of pest species including Common Carp and weeds, which are known to exist at the site from time to time. In addition, the local community gains significant awareness and appreciation of the value a healthy wetland (Figure 9).

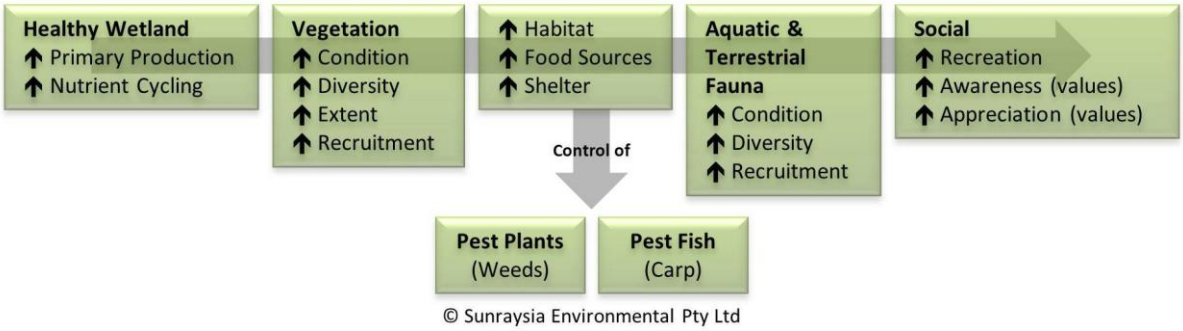


Figure 9 Benefits of a healthy wetland system

3.2 Social

3.2.1 Aboriginal Cultural heritage

As is the case for most of the Murray River floodplain and beyond, it is recognised that waterways and floodplains are highly significant for the indigenous culture but the true extent of the number and types of sites present is still unknown.

When undertaking planning for the installation of bridges and regulators on Sandilong Creek, Mallee CMA sponsored an Aboriginal Cultural Heritage Management Plan (CHMP), with Dr Matt Cupper engaged as Cultural Heritage Advisor. No Registered Aboriginal Party (RAP) is yet available for the activity area but representatives from each of the RAP applicants Mildura Aboriginal Corporation and Gilbie Aboriginal Corporation, and local Aboriginal community groups Latji Latji Mumthelang Aboriginal Corporation and Nyeri Nyeri People were consulted during the cultural heritage assessment.

The Aboriginal CHMP involved a desktop and standard assessment in accordance with the *Aboriginal Heritage Regulations 2007*. An archaeological ground survey was carried out on 15 and 17 December 2009 specifically for the Aboriginal CHMP. The background research and ground survey did not identify any Aboriginal cultural heritage items or places in the areas proposed for works (Cupper 2010).

Within the WMU, however, a listed place on the Victorian Aboriginal Heritage Register (VAHR) is the 'Gol Gol (Murray River) Camp' (VAHR site number 4.1-20) which is located at the site of the Sandilong Racecourse. At the end of the nineteenth century, Aboriginal people in the Mildura area resided at this camp, including the last traditional Latji Latji clan leader, Whorlong and members of his family. Many aboriginal members of the community are buried at the Mildura Cemetery (VAHR site number 9.3-27), which is also within the Mildura WMU (Cupper 2010). The location of this former camp highlights significant historical Aboriginal connection with this part of the river and the WMU.

Figure 10 Flood markers on a River Red Gum beside the 18th fairway
Image: Riverside Golf Club Incorporated.

3.2.2 European cultural heritage

European heritage reflects the pioneering history of the area. There was a Murray River crossing to Gol Gol (NSW) near the western end of Sandilong Creek from 1910, consisting of a punt, until a bridge was constructed downstream in 1927 (Cupper 2010). The Riverside Golf Club has a long association with the site, founded in 1935, and has experienced a number of Murray River flood events. There is a marker tree on the Golf Course which provides records of flood levels when the course was inundated in 1956, 1973, 1974 and 1975 (Figure 10), and historical records and photos exist providing insight into the Golf Club's past interaction with floodwaters. The club house is known to have existed on its current site since the 1940s. Other significant European footprints within the target area include the original Sandilong Park Swimming Pool (Figure 11) and remnants of an old swing bridge across the Sandilong Creek (circa 1940).

The club house of the Nichols Point Tennis Club, which is situated next door to the Golf Course, is believed to have once been part of the Migrant Camp Holding Centre. The building is believed to have been moved to its current site from the Mildura Aerodrome after the holding facility ceased operations (Riverside Golf Club 2010). The Mildura Cemetery is situated in the WMU, on a rise in the flood plain (VAHR site number 9.3-27) (Cupper 2010).

Figure 11 The former Sandilong Park Swimming Pool
Image: Sunraysia Environmental Pty Ltd.

3.3 Recreation

The main recreational activity within the target area of the Mildura WMU is golf. Sandilong Creek forms part of the Riverside Golf Course. The Club's members are passionate about the natural aspects of the course. Club members are engaged and positive about the watering plan, and there is significant opportunity for wider public education in wetland management and appreciation.

Adjoining the golf course is the Murray River which is popular for boating, camping, fishing, bushwalking and swimming. Houseboats often moor at the designated landing site adjacent the golf course and visitors decamp to play golf. On the floodplain within the WMU is a horse racing course and horse complex. Situated beside the Golf Course is the Nichols Point Tennis Club.

The Riverside Golf Club holds key events each year including:

- March: Catch a Carp Day;
- April: Opens;
- June: Ladies' Club Championships;
- July: Golf Week; and
- August: Men's Club Championships

The committee and management have expressed their preference to avoid receding waters during golfing events (as listed above); inundation to the maximum extent is ideal at these times to maximise course aesthetics. Conversely, lower water levels are preferred for the Catch a Carp Day (March).

Figure 12 Sandilong Creek during the 2013 inundation event.
Note the teeing ground (left background) is located above the water level.
Image: Sunraysia Environmental Pty Ltd.

3.4 Economic

The Mildura WMU contains large areas of publicly accessible recreational land including the previously mentioned recreation sites. The Golf Club, tennis club and horse complex each have associated buildings located on the floodplain. The Mildura Cemetery is situated on a rise in the floodplain.

The target area (Sandilong Creek and billabong) is within the Riverside Golf Course, which is run as a business by a committee. Any works or watering events at this site must be made with consideration to the golf course and its ability to continue to operate. The other economic assets mentioned are positioned above the 1:100 year flood level, and environmental watering is unlikely to impact upon them.

3.5 Significance

The outlined environmental, social and economic values indicate the significance of this site. The Mildura WMU is considered culturally significant to local Indigenous groups due to the location of the Gol Gol Camp, whilst there is European historical importance within the target area, with the Sandilong Creek public swimming pool in the Sandilong Creek and a long history of use by the Riverside Golf Club. It is a high profile site, close to the Mildura township, and receives high visitation. This also makes it significant for public education opportunities. These social and cultural values are important to the local community, and closely linked to these values is the health of the surrounding natural environment.

The riparian and floodplain communities of the Murray River are important to the functioning of the river system, and this site is an important component of that system. The Sandilong Creek was formerly an intermittent creek, however the static water levels maintained are not conducive to longer term wetland health. The billabong once filled from flood events, but now rarely receives natural flows. If the ecosystem is allowed to degrade, many key values and others would be at risk.

The area is rich in biodiversity, provides essential habitat for native species, and is a refuge for listed flora and fauna species. Of particular significance are two of the listed fauna recorded within the target area that rely on the health of the ecosystem for survival and protection: the Inland Carpet Python; and the population of Freshwater Catfish.

The Freshwater Catfish population in the Sandilong Creek presents this location as a site high in value for the conservation of this species. Providing some fluctuation to water levels is an important tool in improving aquatic vegetation diversity which may in turn support the population of Catfish (DSE 2005b). Inundation of part of the area surrounding the creek may provide additional forage areas, habitat and breeding sites, as well as improving the overall ecology of the target area through recruitment of key native species and reducing the prevalence of weeds.

Other important native aquatic species have been recorded in the creek including the Broad-shelled, Common Long-necked and Murray River Turtles, and Golden Perch, indicating the site is worthy of enhancement through environmental watering. The nearby billabong also presents as potential extended habitat for local turtle and frog populations through the delivery of environmental water intermittently to the billabong. At the eastern end of the billabong, a community of Tangled Lignum (*Muehlenbeckia florulenta*) offers shelter for a range of native fauna. The billabong may also be useful as a potential nursery site for the endangered Murray Hardyhead (*Craterocephalus fluviatilis*).

River Red Gum communities line the creek. Black Box communities occur higher on the floodplain, and surrounding the billabong. These communities can provide shelter and habitat in the form of tree hollows and hollow logs for fauna including the Inland Carpet Python and hollow-dependent birds. River Red Gum can provide snags that could be used as habitat by the Freshwater Catfish and other native large bodied fish. Healthy River Red Gums can also improve wetland health through moderating water temperatures by shading, and delivery of dissolved organic carbon (Roberts & Marston 2011). Lignum is an important understorey component in floodplain environments (Roberts & Marston 2011).

Therefore, the specific values within the target area for this plan that make this area a priority for protection, enhancement and education through environmental water management are the:

- Freshwater Catfish (*Tandanus Tandanus*);
- Inland Carpet Python (*Morelia spilota metcalfei*);
- River Red Gum (*Eucalyptus camaldulensis*); and
- Black Box (*Eucalyptus largiflorens*) and Tangled Lignum (*Muehlenbeckia florulenta*).

These values are interconnected:

- Healthy River Red Gum communities offer improved wetland health, contribute to primary production, and offer habitat for native fauna including the Freshwater Catfish (as snags) and the Inland Carpet Python (hollow logs);
- Healthy Black Box communities offer improved habitat for hollow dependent birds and reptiles, including providing hollow logs for the Carpet Python; and
- Healthy Lignum communities offer shelter for reptiles and smaller native birds.

Through environmental watering events, the quality, extent, reproduction and diversity of the surrounding EVCs may be improved. Improving the health of Black Box, Lignum and River Red Gum can help improve ecosystem functions within the WMU, which in turn can help provide habitat and food sources for the Freshwater Catfish, Inland Carpet Python and other native fauna (Figure 13).

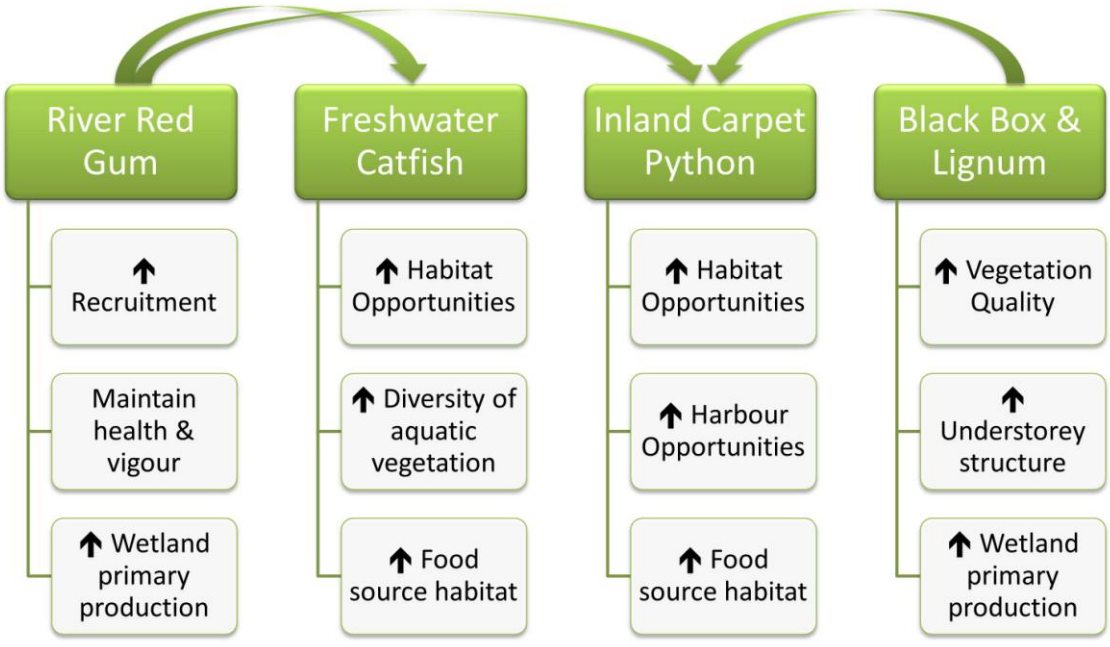


Figure 13 Interactions between values and benefits of environmental water delivery

4 HYDROLOGY AND SYSTEM OPERATIONS

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

The target area within the Mildura Waterway Management Unit is located on the Victorian floodplain of the Murray River (chainage 894 to 891 km). It is within the influence of the Mildura weir (Upstream river gauge # 414210). Sandilong Creek is isolated from the Murray River by levees; flow into the creek is managed by valves at either end of the creek which are functional under normal operating conditions of the Mildura weir pool. The creek is generally maintained at approximately 34.5 m AHD (weir pool height).

4.1 Water management and delivery

4.1.1 Pre-regulation

Prior to river regulation in the reach of the Murray River below Euston Weir, the floodplain experienced inundation more frequently and these events had a greater duration (EA 2007). Natural flows were highest in spring and lowest in autumn. The temporary wetlands of the floodplain experienced inundation during high flow periods punctuated with drying phases on a regular basis. The inundation allowed for recruitment and preservation of the floodplain flora species and offered more regular access to a wider range of habitat and food sources for aquatic species.

Sandilong Creek was once connected to the river to form a small anabranch and would have experienced both inundation and dry spells as water levels fluctuated in the main channel of the Murray. The billabong would have filled when the floodplain was inundated, and slowly dried after the floodwaters had receded.

4.1.2 Post-regulation

The Mildura weir along with others along the length of the Murray River were installed in the 1920's and 30's and has had a significant impact on the flow and flood regime in the river. Locks and weirs were completed at Mildura (downstream) in 1927 (G-MW 2013), and at Euston (upstream) in 1937 (MDBC [n.d.]). In this part of the Murray River, the frequency, duration and magnitude of all but the largest floods have been reduced due to effects of major storages in the Murray and its tributaries (Thoms et al. 2000).

High flows, except for the extreme flood events have been affected, which reduces the flooding of anabranches and floodplain habitats such as those within the Mildura WMU. A reduction in the frequency of inundation of these habitats was identified as a key threatening process in this reach by the River Murray Scientific Panel which was commissioned by the then Murray Darling Basin Commission (Thoms et al. 2000). Extreme low flow events have been removed, due to the requirement of minimum flows for irrigation and interstate agreements (SKM 2002).

The Mildura WMU is located 5 km upstream of the Mildura Weir and is within the influence of the weir pool which has meant that the water level has remained relatively constant for the past eighty years. Sandilong Creek is now isolated from the river by levees but has been maintained at or near weir pool level for the benefit of the Golf Club. Also within the levee, the billabong (Figure 15) was previously regularly inundated by irrigation drainage water, but now only fills through a breach in the levee during a flood significant flood event (>38.5 m AHD), or through an environmental watering event where the creek is filled to a sufficient level to allow water to be gravity fed to the billabong.

4.1.3 Environmental watering

Environmental watering began in Sandilong Creek in Spring 2011 to improve the health of the system by manipulating water levels. A partial drying phase (draw down) was implemented during the winter of 2012, followed by a slow fill event to return the creek to its former static level, and then a second watering event commenced in October 2012 (Figure 12). Watering recommenced in December 2013 intermittently, with subsequent fills commencing in January and April 2014.

The water for each of these events was obtained from various sources as outlined in Table 9.

Table 9 A summary of recent environmental watering events in Sandilong Creek

Water year	Time of inflow	Inflow source	Source volume (ML)	Total volume (ML)	Area (ha) Inundated
2011/12	Spring-Autumn	EWR	20.09	150	8.84
		RMUF	99.47		
		Internal diversion	30.44		
2012/13	Spring-Autumn	EWR	150.17	150	8.84
2013/14	Summer-Autumn	EWR	150.17	150	8.84

The aim of these environmental watering events and partial draw-downs was to introduce some variability to the level in Sandilong Creek and to return water to the billabong to improve vegetation health, which would in turn provide habitat, feeding and breeding opportunities to increase the abundance, distribution and diversity of native wetland species in the target area. Due to the high visitor numbers at the golf course, environmental watering at this location also provides an ideal demonstration site for raising community awareness of wetland management.

Since construction of flood levees (*circa* 1956), the creek and the billabong have lacked natural connectivity to the river. Currently, water levels in Sandilong Creek can be controlled through pipes with valves and carp screens at either end of the creek. Water has been pumped into the billabong site using temporary pumps and earthen levees to prevent back flow.

More recently the billabong has been filled by an existing pipe connecting to the creek. When the creek is at sufficient depth, water is gravity fed to the billabong. Each watering event inundated the target area to the maximum extent (8.84 ha, 35.75 m AHD) (Figure 14, page 28) and included both the creek and the billabong. The creek was then partially drawn down before refilling to the former static water level. A complete drying phase for the creek was not conducted due to the presence of Freshwater Catfish.

Anecdotal evidence suggests that the watering was effective in improving the health of trees lining the billabong in the target area in 2011/12. Other observations noted by the Mallee CMA include reduced dominance of Cumbungi (Figure 16, page 31), promotion of native fringing vegetation, zooplankton populations and improvement in bank stability. A study of fish movement within the creek was undertaken at commencement of the October 2012 watering event (Table 6, page 14), which suggested that a breeding population exists and is undergoing recruitment (Ellis & Wood 2012). During consultation with Riverside Golf Club, it was suggested that the number and diversity of birdlife surrounding the creek and billabong had dramatically increased since the watering program had commenced (RGC Committee 2013, pers. comm., 15 Oct)

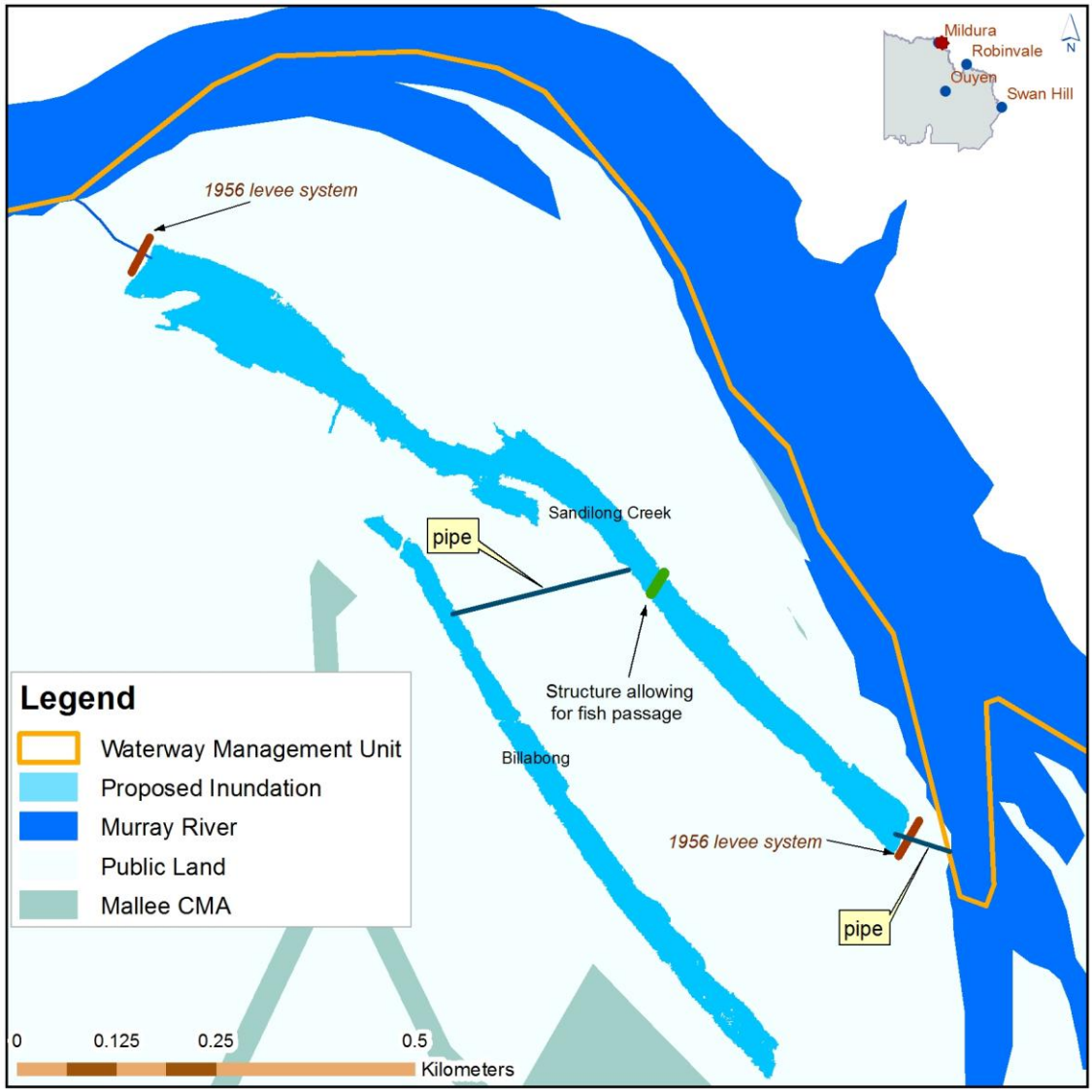


Figure 14 Current inundation extent of the target area

5 THREATS AND CONDITION

5.1 Water dependent threats

The values for the target area of the Mildura WMU are described in Section 3. Threats to these values are the result of such factors as human intervention and extreme climatic events. Some of the threats which may have an impact on the target area include:

- Changed water regime
- Loss or reduction of wetland connectivity
- In-stream structures which inhibit fish passage
- Reduced water quality
- Introduction/increase of exotic flora and fauna
- Reduction in biodiversity of native flora allowing some species to become dominant
- Loss of woody debris and native hollow-bearing trees

The regulation of the Murray River and the installation of levee banks to protect the golf course from significant flooding has seen the water regime throughout the Mildura WMU altered. Flow events of the magnitude required to allow flows into the creeks and wetlands of the floodplain are less frequent and of shorter duration (see section 4.1). This combined with dry conditions over the last decade affects the vigour of the vegetation and can place trees under stress, affecting the productivity and functioning of the floodplain ecosystem.

The almost static water level of Sandilong Creek has significantly altered the general ecology and diversity of the area, allowing some species of aquatic flora and fauna to flourish and reducing the capacity to support a more diverse ecosystem (e.g. dominance of Cumbungi (*Typha* spp.) and Common Reed (*Phragmites australis*)). Fluctuating water levels more closely mimicking natural flows can help restore balance.

The levees at either end of Sandilong Creek inhibit connectivity with the River, preventing natural flow through and variable water levels. Two causeways limit movement of aquatic fauna within the creek. The billabong has lost connectivity with the river through the construction of levees during the 20th century. These threats have reduced the functionality of the waterbodies and led to a loss of a range of habitat niches and reduction in the extent and quality of available habitat.

Common Carp infestation has been linked to increased turbidity and elevated nutrient levels, damage to aquatic plants and possibly algal blooms and bank erosion (Gehrke [n.d]). Carp infestation, combined with loss of flow through, may increase the possibility of water quality issues in the target area. Common Carp also spread disease and compete with native species for food sources and habitat (Gehrke [n.d]).

Rabbit infestation can impact on vegetation quality, extent and diversity and also on water quality through increased sediment entering the water bodies. Rabbits have been a problem in the past in the Mildura WMU, however a control program implemented by the Golf Course, with support from the Mallee CMA has helped to reduce rabbit density within the course. Only isolated areas remain, which contain relatively low numbers of rabbits.

Environmental weeds are an ongoing threat and management issue on the Murray River floodplain. These may pose an enhanced threat when water is applied. Of concern for this site are introduced grasses, several species of noxious weed, and garden escapees from neighbouring properties. A list of exotic flora species identified in the Mildura WMU are provided in Appendix 3.

The altered water regime is considered the major threat for the target area of the WMU and is the primary factor behind the development of this environmental water management plan.

5.2 Current condition

One method for assessing the current condition of a wetland is the Index of Wetland Condition (IWC) developed by DSE. The IWC defines wetland condition as the state of the biological, physical, and chemical components of the wetland ecosystem and their interactions. The two waterbodies in the target area have not been assessed using the IWC. This is noted as a knowledge gap to be addressed.

Sandilong Creek has lost its hydrologic connectivity to the river and has a stable water level limiting the range of habitats and diversity and restricting the flora and fauna communities within or near the creek. The billabong has also lost its connectivity and without environmental watering would remain dry unless significant rainfall and associated runoff caused it to fill.

The condition of the remnant vegetation varies across the site. The Red Gum and Black Box trees lining the creek and fairways have benefitted from the irrigation of the golf course fairways and greens, and the canopy is generally in good condition. Native vegetation along the billabong is in poorer condition. The understorey surrounding the billabong has limited diversity of native species and the overstorey of Black Box has suffered from recent dry years, exhibiting loss of canopy and in some cases tree loss (Figure 15, Figure 19). The understorey lining the creek represents one of the most intact riparian vegetation communities in the area. The aquatic environment within the creek has in the recent past been dominated by Cumbungi.

Native aquatic life at the site is limited by loss of connectivity to the river, blockages within the creek, stable water levels in the creek, prolific Cumbungi growth (Figure 16), sedimentation due to lack of flow through, and the carp population in the creek. The billabong vegetation is in poor health due to extended dry conditions and aquatic life has potentially been impacted by salinity and saline drainage water.

Figure 15 Recovering Black Box and Lignum understorey, eastern end of billabong, September 2013
Image: Sunraysia Environmental Pty Ltd.

5.3 Condition trajectory

Management intervention has already begun in Sandilong Creek with environmental watering events in 2011/12, 2012/13 and 2013/14, as outlined in section 4.1.3. There have also been works in and around the creek such as rubbish removal, carp removal, willow removal, and an improvement to fish passage. The Golf Club is supportive and has assisted with these works where possible. To continue to build on these works, and improve the health of the riparian vegetation and in-stream habitat, on-going intervention to improve the water regime is required.

Photographic and anecdotal evidence indicates an improvement in condition of the wetland following works and watering events. If intervention through watering is not continued, the benefits from these events are unlikely to be sustained.

If water levels are kept static in the creek, Cumbungi will again dominate the creek banks (Figure 16) limiting opportunistic germination of other species and subsequently limiting the recruitment of fauna species which require a variety of habitats and plants as food sources. Due to river regulation and existing levees, natural flood events alone would not be enough to limit Cumbungi growth and sustain these communities.

The billabong especially, without delivery of environmental water is likely to continue to degrade. Recent watering events have aided recovery (Figure 15), however the surrounding vegetation has suffered considerably in past years and both the overstorey and understorey will continue to decline without further watering events. This will impact on both water dependent and vegetation dependent bird life, and ground dwelling fauna including reptiles.

Figure 16 Sandilong Creek, December 2009 (prior to the first environmental water event) and February 2013 (after the second environmental water event).
Note the reduction in Cumbungi in the 2013 image (right). *Images: Mallee CMA*

6 MANAGEMENT OBJECTIVES

6.1 Seasonally adaptive approach

Victoria has adopted an adaptive and integrated approach to environmental management. A key component of this approach for environmental watering is the 'seasonally adaptive' approach, outlined in the Victorian Waterway Management Strategy.

The seasonally adaptive approach identifies the priorities for environmental watering, works and complementary measures, depending on the amount of water available in a given year. It is a flexible way to deal with short-term climatic variability and helps to guide annual priorities and manage droughts. The approach is outlined in Figure 17.

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

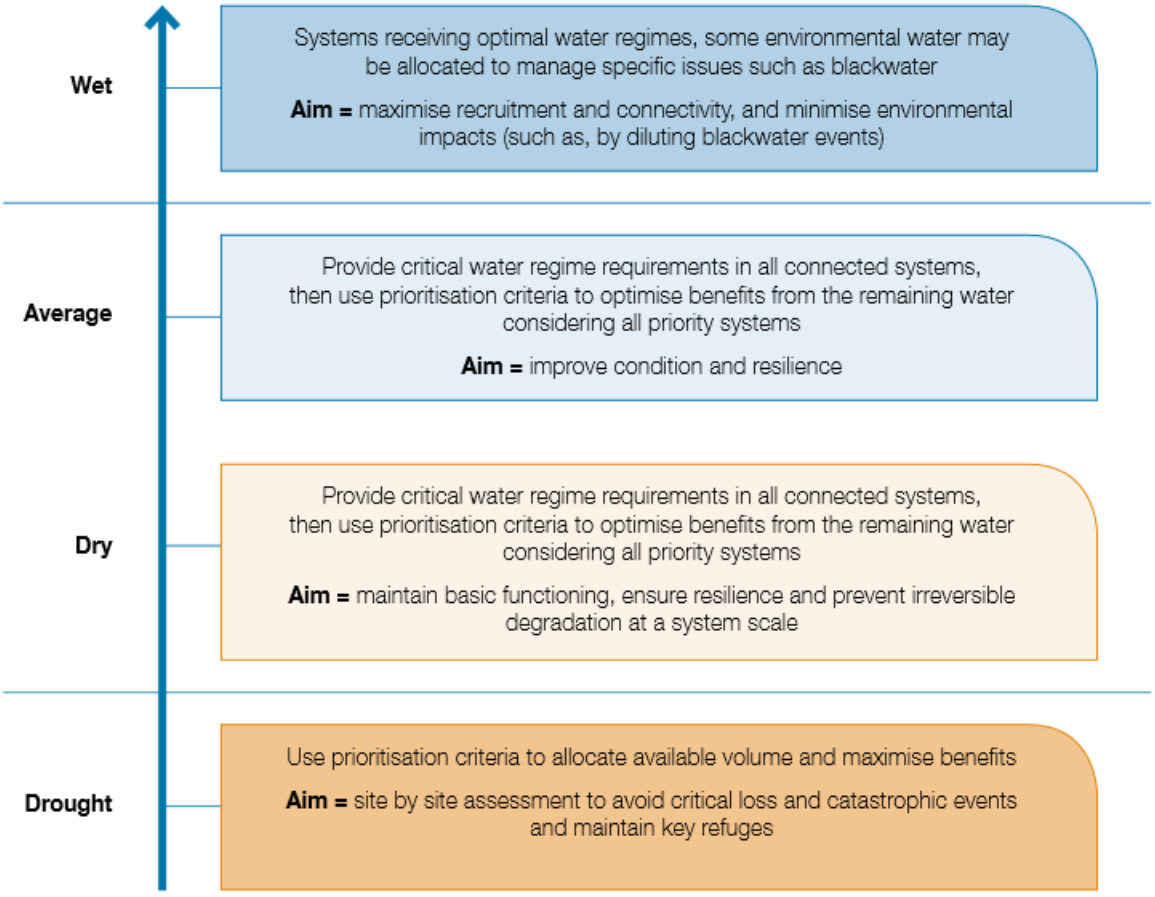


Figure 17 The seasonally adaptive approach to river and wetland management
Source: DEPI 2013

6.2 Management goal

The overall goal proposed for the Mildura waterway management unit target area has been developed through consultation with various experts and stakeholders including Parks Victoria, and Riverside Golf Club. The goal considers the values the wetland supports and the potential threats that need to be managed. This includes consideration of the values the wetland has historically supported and the likely values it could support into the future.

Mildura waterway management unit management goal

To provide a watering regime that supports native aquatic and terrestrial fauna and supports productive native vegetation communities within the target area.

6.3 Ecological and hydrological objectives

6.3.1 Ecological objectives

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

- Maintain;
- Improve;
- protect ; or
- re-instate

As with any healthy wetland ecosystem, ecological outcomes are interrelated. The objectives outlined in Table 10, if achieved, contribute to wetland productivity and improve the overall health of the system. Improving vegetation condition may provide access to additional feeding sites, breeding sites and habitat for key fauna species including the Freshwater Catfish and Inland Carpet Python.

Figure 18 The western end of Sandilong Creek during the 2012 draw-down phase.
Note the presence of fallen Red Gum which would provide structural submerged habitat.
Image: Sunraysia Environmental Pty Ltd.

Table 10 Ecological objectives for the target area

Wetland	Ecological objective	Justification (value based)
Sandilong Creek	Maintain the terrestrial vegetation structure	A healthy vegetation structure includes diversity of species and age classes. The vegetation lining the creek is in good condition structurally, however it is important to maintain this condition and to assist recruitment of the keystone River Red Gum. In turn, a healthy and diverse understorey may provide important habitat and refuge for terrestrial and aerial fauna. Wetland productivity may be improved through deposition of organic matter from all vegetation life forms present.
Billabong	Maintain health of Black Box & Lignum communities	Black Box and Lignum are keystone species and their health is essential to maintaining a functioning floodplain and river system. As the key ecological value for this site the downward trend in health must be stopped as a first priority.
Billabong	Improve health of Black Box & Lignum communities	An improvement in the health of the Black Box & Lignum communities is the next logical progression towards improvement of the broader ecological values of the site, including regeneration of a diverse understorey.

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. Maintaining the structure of terrestrial vegetation at the creek is also likely to provide habitat values for native fauna.

The current population of Freshwater Catfish in the Sandilong Creek appears to be self-sustaining (Chapman, Ellis & Pyke 2009), one of only a handful of sites in Victoria (DSE 2005b), thus it is important to manage the creek so as to not negatively impact on this population. Careful management of environmental water at this site has the potential provide the Catfish population with access to additional spawning sites if inundation expands the creek zone prior to the onset of the spawning season.

For the billabong, the objective is to firstly maintain the Black Box communities and the associated understorey (including Lignum), and to restrict any further decline due to lack of water. The second objective is more ambitious and aims to see an improvement in the health of the Black Box and Lignum communities. This is likely to provide habitat for native fauna including frogs, turtles, birds and terrestrial reptiles, as well encourage diversity of flora species in the understorey.

The Inland Carpet Python requires hollow logs for breeding, and uses understorey for shelter and cover. This species has been known to occur within the target area. Through environmental watering key habitat niches will potentially be maintained, recruitment of key flora species may assist over the longer term in the provision of hollows for the Carpet Python and other hollow-dependent fauna.

Attainment of the ecological objectives is anticipated to have wider benefits for the target area and is expected to result in many interrelated outcomes. These are outlined in Table 11 in terms of the ability of these broader benefits to impact on the key values identified in Section 3.5).

Table 11 Broader ecological benefits expected from achievement of ecological objectives

	Sandilong Creek		Billabong			
	River Red Gum	**Freshwater Catfish**	**Black Box**	**Inland Carpet Python**	**Lignum**	**Wider benefits**
Improving understorey productivity					✓	Improved habitat quality and extent for terrestrial fauna. Reduced incidence or control of exotic weeds in the inundated areas
Improving overstorey productivity	✓	✓	✓	✓		Improved habitat quality and extent for terrestrial fauna
Improving the quality of the tree canopy	✓		✓			Aiding flight-path connectivity for birdlife; improving perching and nesting opportunities
Reducing Cumbungi dominance in the creek		✓				Promoting greater diversity of aquatic vegetation
Reinstating submerged and semi emergent aquatic macrophytes		✓				Promoting greater diversity of native fish, frogs and turtles, and a broader food web; greater diversity of aquatic vegetation
Improved ecosystem services	✓	✓	✓	✓	✓	Increased organic matter; enhanced water quality; increased species diversity; recruitment; additional habitat, food sources, breeding sites

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

6.3.2 Hydrological objectives

Hydrological objectives describe the components of the water regime required to achieve the ecological objectives at this site. The ecological objectives at this site are centred on firstly maintaining the vegetation structure surrounding the creek and the Black Box communities surrounding the billabong, and then improving the health of the Black Box communities surrounding the billabong where possible. Lignum occurs in the eastern end of the billabong and has a watering requirement similar to Black Box. Watering activities related to Black Box objectives are likely to also benefit Lignum.

Hydrological objectives are proposed in Table 12 (page 37). The hydrological objectives are based on the assumption that maintenance of current health requires less frequent watering with longer intervals between events than for improving condition.

As this site requires pumping of water into the creek, and subsequently the billabong, over a number of weeks, the duration and volumes of the events remains the same in both scenarios in order to ensure complete inundation of the target area. In any given watering year, if the billabong was not to be filled, the inundation extent could be reduced, or the connecting pipe closed off. This would reduce the inundation area to that of the creek and surrounds and omit the billabong and its associated Black Box and Lignum communities.

Ecological Considerations and Constraints

A population of Freshwater Catfish is known to occur in the Sandilong Creek. Catfish prefer slow-flowing water bodies, however little is known about the response of this species to flood events. Hydrological objectives are therefore aimed at minimising disruption to the breeding patterns. Inundation of Sandilong Creek prior to commencement of the breeding season (spring & summer) may offer additional nesting sites. Rapid fill events should be avoided during this time to minimise turbidity, reduce the chance of silt settling on eggs, and to reduce the risk of a significant change in water temperature. Water levels should be maintained throughout the breeding season, with drawdown/recession only commencing afterwards to reduce the risk of exposing active nesting sites.

Consideration should be given to the likelihood or presence of Inland Carpet Python in the target area. If this species is observed, changes to the water regime may be required so as to not inundate the creek area during the egg-incubation season (December-March), with the aim of maximising potential habitat and nesting sites.

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

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

- Black Box stands occur in the two Woodland EVCs within the target area. They require 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 effect understorey and other woodland biota. 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 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 the Mildura WMU target area. As little information exists as to the flood requirements of the Freshwater Catfish, hydrological objectives have not been set for this species.

Table 12 Hydrological objectives for Mildura Waterway Management Unit target area

Ecological objective	Water management area	Hydrological objectives												
		Mean frequency of events (number per 10 years)			Tolerable interval between events (years)		Duration of ponding (months)			Preferred timing of inflows	Target supply level (TSL) (m AHD)	Volume to fill to TSL[1] (ML)	Volume to maintain at TSL[2] (ML)	Total volume per event[3] (ML)
		Min	Opt	Max	Min	Max	Min	Opt	Max					
Maintain the terrestrial vegetation structure	Sandilong Creek	2	3	5	2	7	2	3	4	Spring/Summer	35.75	150	20-50	170-200
Maintain health of Black Box & Lignum Communities	Billabong	2	2	3	3	8	2	3	6	Spring/Summer	35.75	150	20-50	170-200
Improve health of Black Box & Lignum communities		3	3	4	2	4	3	3	6	Spring/Summer	35.75	150	20-50	170-200

[1] Estimate based on filling from empty to the target supply level (TSL), assuming no inflows
[2] Estimate based on maintaining at target supply level (TSL) for optimum duration of ponding, assuming no inflows
[3] Sum of [1] and [2]

6.3.3 Watering regime

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

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

Because the billabong has a different water requirement to the creek, but cannot be watered without a creek fill, regimes are proposed for each zone separately. Watering of the creek could occur in isolation if the connecting pipe were closed off for the duration of the event. The billabong could be filled separately through the installation of a temporary pump.

For all watering regimes, recession of water should occur slowly, and not immediately after Catfish spawning is likely to have occurred, so as to minimise disturbance to nest sites.

Minimum watering regime - Sandilong Creek

Provide two watering events every ten years.

Raise the level of the creek slowly in spring-summer by 1.2 m to 35.7 m AHD to inundate the surrounding low lying areas twice in ten years, with a maximum interval of seven years between events. Maintain the water on the floodplain for two months, allowing a slow recession from January-March.

Maximum watering regime – Sandilong Creek

Provide five watering events every ten years.

Raise the level of the creek slowly in spring-summer by 1.2 m to 35.7 m AHD to inundate the surrounding low lying areas five times in ten years, with a maximum interval of two years between events. Maintain the water on the floodplain for four months, allowing a slow recession from February-March.

Optimal watering regime – Sandilong Creek

Provide three watering events every ten years.

Raise the level of the creek slowly in spring-summer by 1.2 m to 35.7 m AHD to inundate the surrounding low lying areas three times in ten years, with a maximum interval of four years between events. Maintain the water on the floodplain for three months, allowing a slow recession from January-March.

Minimum watering regime - Billabong

Provide two watering events every ten years.

Inundate the billabong area in spring-summer to 35.7 m AHD, twice in ten years, with a maximum interval of eight years. Maintain the water in the billabong for two months.

Maximum watering regime - Billabong

Provide four watering events every ten years.

Inundate the billabong area in spring to 35.7 m AHD, four times in ten years, with a maximum interval of two years. Maintain the water in the billabong for six months.

Optimal watering regime - Billabong

Provide three watering events every ten years.

Inundate the billabong area in spring to 35.7 m AHD, three times in ten years, with a maximum interval of three years. Maintain the water in the billabong for three months.

Figure 19 The western end of the billabong during the 2013 watering event.
Note the dead trees right of picture, and the recovering Black Box canopy behind.

7 POTENTIAL RISKS PARTICULAR TO THE MILDURA WMU

A list of potential risks and means for mitigating these is used as the basis for assessing the risk of environmental water delivery at this site (Table 13). Two of the risks associated with implementing this environmental watering plan (Risks 8 and 9) are related to specific knowledge gaps, which are discussed further in Section 9. The numbering of risks is not intended as any form of risk rating.

Table 13 Potential risks associated with the target area

Risk No	Description of Risk	Likelihood	Consequence	Mitigation Measure
1	Disruption to breeding cycle for Freshwater Catfish	4	5	Maintain overbank fill beyond spawning time + 1 week
2	Fill rate impacts on Freshwater Catfish eggs in nest	4	5	Avoid turbid slug: No fast-fill during spawning season, and utilise a rock runway at inlet pipe to reduce movement of sediment and subsequent silt settling on eggs
3	Genetic diversity of Catfish population limited due to lack of connectivity with the river	5	3	Consider relocating part of the population (e.g. to the Sandilong Backwater, which has full connectivity with the river)
4	Fluctuating water temperature pre-breeding season	3	4	Avoid cold water slug: No fast-fill during breeding season
5	Infrastructure works disrupt breeding season	3	5	Avoid undertaking in-stream works during and immediately after breeding season
6	Provision of good Carp spawning conditions	4	5	Monitor shallow benches during Carp spawning season; if carp spawning occurs, reduce water level by 20-50 cm to strand eggs and then refill (I. Ellis 2013, pers. comm., 12 Sept)
7	Risk of public taking Catfish (due to increased exposure & education of Catfish habitat)	4	5	Install signage at key points, further education
8	Loss of Cumbungi as habitat	3	3	Monitor whether impact is positive or negative on aquatic and terrestrial fauna and flora, adjust Plan accordingly
9	Impact on Turtle population	3	3	Monitor whether impact is positive or negative for Turtle population, adjust Plan accordingly

8 ENVIRONMENTAL WATER DELIVERY INFRASTRUCTURE

8.1 Constraints

The existing arrangements (Section 4.1) and surrounding land use limit the extent of area of floodplain which can be inundated by environmental watering in the Mildura WMU to 8.84 ha (Figure 20). The extent of inundation cannot be increased without interference to the operation of the golf course. Watering events can only occur via a pipe and valve through the levee (Figure 21).

The billabong cannot be watered without first inundating the creek to a sufficient depth (approximately 35 m AHD). Without closing off the fill pipe, the billabong will be watered during every event, in conjunction with the creek.

Within the creek, two causeways remain as impediments to fish passage. Besides impact on aquatic fauna, these two crossings are submerged during watering events, and a low level of damage is sustained to the crossing surface, which must be rebuilt after the water has receded. The submersion of these two crossings impedes golf course operations as they are used as machinery crossings as well as pedestrian crossings. The centre crossing is also used by golfers visiting from the river.

Figure 20 Proposed Infrastructure Sandilong Creek and the existing structure allowing for fish passage

8.2 Infrastructure recommendations

The water in Sandilong Creek is usually maintained at weir pool height. This means that any increase or decrease in water levels must be achieved through pumping, or opening the upstream valve during a natural rise in the Murray River, which could be augmented with pumping.

The inlet pipes are located within the creek bed at each end of the creek (Figure 14), and pass through the levee at each location. The levees (Figure 21 and Figure 22) are constructed to approximately 39 m AHD, which is around 5 m above creek level. Investigations could be undertaken to design and cost suitable structures. The likely impact of restoring connectivity on the Freshwater Catfish population should be investigated.

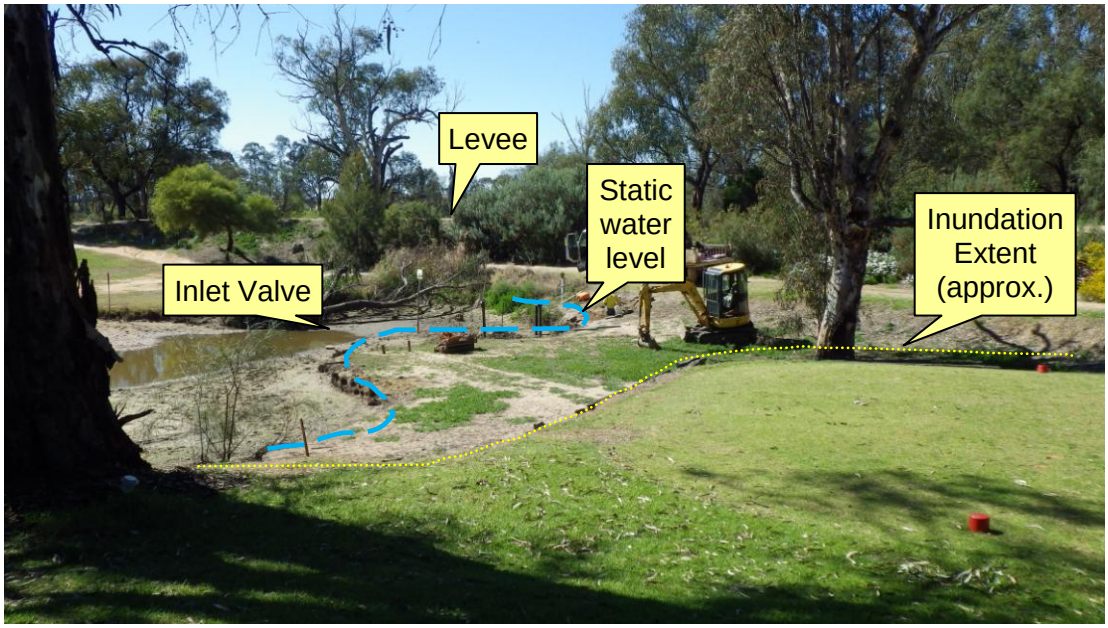


Figure 21 The upstream end of Sandilong Creek, during draw down
Key: Blue dashed line: Approximate static water level; Yellow dotted line: Approximate inundation extent. One of the Sandilong Backwaters is situated a short distance behind the levee bank.
Image: Sunraysia Environmental Pty Ltd.

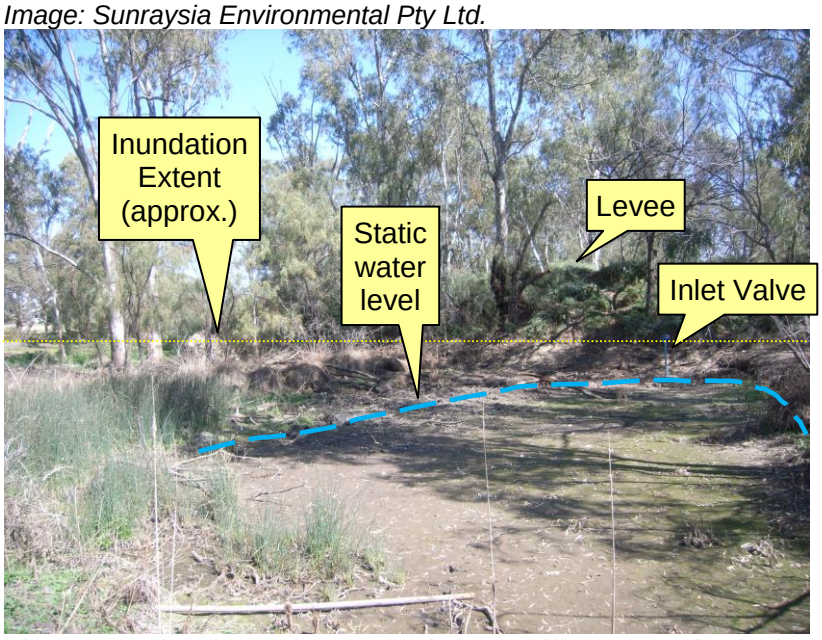


Figure 22 The downstream end of Sandilong Creek, during drawn down
Key: Blue dashed line: Approximate static water level; Yellow dotted line: Approximate inundation extent. The Murray River is situated a short distance behind the levee bank.
Image: Sunraysia Environmental Pty Ltd.

Fish passage within the creek is inhibited by two of the three causeways. A fish-friendly structure (Figure 14, Figure 23) was placed at the swing bridge causeway during 2010, however two obstructive causeways remain (Figure 20). It is recommended that these causeways be modified to enable fish passage and access by golfers, golf course staff and machinery. One of these crossings (nearest the clubhouse) would need to be constructed to a standard capable of supporting heavy machinery, as it is a high-use crossing for golf club machinery.

The proposed infrastructure would provide greater movement of fish and other aquatic species within the creek, provide further habitat, and help return the creek to a more natural structure.

In the longer term, investigations should be undertaken to determine options for the installation of regulator structures in the levee at either end of the creek. Modification of the existing levee, however, requires careful consideration of all potential risks and implications.

Figure 23 A fish friendly causeway installed near the swing bridge site in 2010

9 KNOWLEDGE GAPS AND RECOMMENDATIONS

This plan is based on best information at the time of writing. In some cases 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 14. Any future monitoring plan could include a number of these recommendations.

Table 14 Knowledge gaps and recommendations for the target area

Knowledge and data gaps	Action recommended	Responsibility
Conceptual and detail designs for management works	Engage consultants to carry out investigations and designs	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
Connectivity pros and cons	Investigate benefits and potential negative impacts on Catfish population in providing connectivity to the River	
Role of wetland on turtle and frog breeding and population	Annual fish surveys each spring to determine if: species diversity is maintained; varying size cohorts continue to occur; and exotic species are controlled. Assessment of spawning timings, durations, water depths, temperatures, etc. Assessment of Catfish population diversity and estimate sustainable population size; Catch-a-carp Days Annual turtle and frog surveys.	
Effects of watering program on carp breeding and populations		
Understanding Catfish population dynamics (e.g. spawning habits)		
Impact of watering program on littoral vegetation	Assessment of littoral vegetation extent and diversity before and after watering events	
Role of Cumbungi as habitat for aquatic and terrestrial fauna; its ability to recover from semi-regular inundation	Field surveys of reed-dwelling fauna (e.g. Clamorous Reed Warbler). Annual assessment of Cumbungi extent	
Impact on riparian vegetation condition and diversity	Annual vegetation assessments (including understorey diversity and condition)	
Impact on exotic weed species	Assessment of weed proliferation before and after watering event	
Accurate depth & volume measurements for wetland	Determination of depth/volume to commence to flow to billabong	
Index of wetland condition	Conduct assessment of creek and billabong separately	
Impacts of nearby irrigation on wetland health	Investigation of surface water, groundwater and irrigation water interaction	
Nesting habits of birds at the site	Survey of species and numbers	

10 CONSULTATION

This Plan has been developed in collaboration with key stakeholders, namely Parks Victoria, Riverside Golf Club and the Department of Environment and Primary Industries. The consultation has been ongoing with the Golf Club since 2007 when initial investigations for water and natural resource management took place.

Three meetings were held during the development phase of this Plan to seek input from the Golf Club and to gather information. At the time of writing, a second environmental watering program had been completed, and consultation focussed on the positive impacts of the program, on ways to minimise impact to the Golf Club community and the Club's operations, and on additional ways that the Golf Club could maintain involvement with the program outcomes (Table 15).

Table 15 Consultation process for development of Mildura WMU Environmental Water Management Plan

Meeting date	Stakeholders	Details
08 Oct 2013	RGC Greens Superintendent	Initial meeting to discuss issues, constraints, values.
15 Oct 2013	RGC Committee	Open forum at RGC committee meeting to discuss timing, issues, connectivity of creek to river, carp & catfish populations
08 Nov 2013	RGC Administration Manager	Meeting with Administration Manager to inform of Plan progress.

The formal consultation sessions were open discussions about the environmental watering program and its future direction. It was clear that the Golf Club values the creek and the billabong and, whilst the inundation causes some minor access issues, the watering program is strongly supported by the club and its patrons. Anecdotally, the committee has noticed an increase in the number and diversity of bird life inhabiting the areas surrounding the creek and billabong since the program commenced (RGC Committee 2013, pers. comm., 15 Oct). There is also significant interest in community opportunities arising from the ecological benefits to be gained from the watering program.

Key items identified during the consultation phase included:

- The requirement for notification to the club of intended watering (preferred minimum of two weeks);
- Watering that coincides with major tournaments is preferred (to add to the aesthetics of the course);
- Improving creek connectivity with the river (through the levee);
- Improving fish passage in creek (two causeways), one with larger carrying capacity to accommodate heavy machinery;
- Catch-a-carp days are best held during a low water event (to increase the chances of catching fish, thereby encouraging participation);
- Options for creating a wildlife sanctuary (for injured/recuperating native animals);
- Dislodged Cumbungi could potentially block some areas of the creek;
- Opportunities for restocking fish; and
- Education opportunities involving school groups (e.g. water quality monitoring, field trips, etc.).

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APPENDIX 1: ENVIRONMENTAL WATER SOURCES

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

Commonwealth Environmental Water Holder (CEWH)

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

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

Victorian Environmental Water Holder (VEWH)

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

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

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

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

The Living Murray Initiative (TLM)

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

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

Donations

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

River Murray Unregulated Flow (RMUF)

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

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

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

APPENDIX 2: LEGISLATIVE FRAMEWORK

International agreements and conventions

Ramsar Convention on Wetlands (Ramsar)

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

Bilateral migratory bird agreements

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

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

These agreements require that the parties protect migratory birds by:

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

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

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

Commonwealth legislation

Environment Protection and Biodiversity Conservation Act 1999 (EPBC)

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

Water Act 2007 (Commonwealth Water Act)

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

Aboriginal and Torres Strait Islander Heritage Protection Act 1984

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

State legislation and listings

Flora and Fauna Guarantee Act 1988 (FFG)

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

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

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

- Advisory List of Rare or Threatened Plants In Victoria – 2005
- Advisory List of Threatened Vertebrate Fauna in Victoria – 2007; and
- Advisory List of Threatened Invertebrate Fauna in Victoria – 2013

Environmental Effects Act 1978

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

Planning and Environment Act 1987

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

Water Act 1989 (Victorian Water Act)

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

Aboriginal Heritage Act 2006

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

Other relevant legislation

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

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

APPENDIX 3: FLORA AND FAUNA SPECIES LIST

Source: Victorian Biodiversity Atlas (DEPI 2013a).

Flora – Native species recorded in Mildura WMU

Scientific Name	Common Name	DEPI Advisory List Status
Abutilon otocarpum	Desert Lantern	Vulnerable
Acacia ligulata	Small Cooba	
Acacia oswaldii	Umbrella Wattle	
Acacia stenophylla	Eumong	
Acacia victoriae subsp. *victoriae*	Bramble Wattle	Rare
Alectryon oleifolius subsp. *canescens*	Cattle Bush	
Allocasuarina luehmannii	Buloke	
Amyema miquelii	Box Mistletoe	
Asperula conferta	Common Woodruff	
Atriplex eardleyae	Small Saltbush	
Atriplex leptocarpa	Slender-fruit Saltbush	
Atriplex limbata	Spreading Saltbush	Vulnerable
Atriplex lindleyi	Flat-top Saltbush	
Atriplex lindleyi subsp. *inflata*	Corky Saltbush	
Atriplex nummularia	Old-man Saltbush	
Atriplex nummularia subsp. *nummularia*	Old-man Saltbush	
Atriplex nummularia subsp. *omissa*	Dwarf Old-man Saltbush	Rare
Atriplex papillata	Coral Saltbush	Rare
Atriplex pumilio	Mat Saltbush	
Atriplex semibaccata	Berry Saltbush	
Atriplex spp.	Saltbush	
Atriplex vesicaria	Bladder Saltbush	
Austrostipa nitida	Balcarra Spear-Grass	
Austrostipa scabra	Rough Spear-grass	
Austrostipa scabra subsp. *falcata*	Rough Spear-grass	
Austrostipa spp.	Spear Grass	
Brachyscome ciliaris	Variable Daisy	
Brachyscome dentata	Lobe-seed Daisy	
Brachyscome lineariloba	Hard-head Daisy	
Calandrinia eremaea	Small Purslane	
Calandrinia volubilis	Twining Purslane	Rare
Callitris gracilis	Slender Cypress-pine	
Calotis cuneifolia	Blue Burr-daisy	Rare
Calotis hispidula	Hairy Burr-daisy	
Calotis scapigera	Tufted Burr-daisy	
Carpobrotus modestus	Inland Pigface	
Chenopodium desertorum subsp. *microphyllum*	Small-leaf Goosefoot	
Chenopodium nitrariaceum	Nitre Goosefoot	
Chloris spp.	Windmill Grass	

Chloris truncata	Windmill Grass	
Convolvulus remotus	Grass Bindweed	
Crassula colorata	Dense Crassula	
Crassula sieberiana s.l.	Sieber Crassula	
Crassula spp.	Crassula	
Cressa australis	Rosinweed	
Cullen pallidum	Woolly Scurf-pea	Endangered
Cynodon dactylon	Couch	
Cynodon dactylon var. *pulchellus*	Native Couch	Poorly known
Danthonia s.l. spp.	Wallaby Grass	
Dianella longifolia s.l.	Pale Flax-lily	
Dianella longifolia var. *longifolia s.l.*	Pale Flax-lily	
Digitaria ammophila	Silky Umbrella-grass	Vulnerable
Disphyma crassifolium subsp. *clavellatum*	Rounded Noon-flower	
Dissocarpus biflorus var. *biflorus*	Twin-flower Saltbush	Rare
Dissocarpus paradoxus	Hard-head Saltbush	
Dodonaea viscosa subsp. *angustissima*	Slender Hop-bush	
Duma florulenta	Tangled Lignum	
Duma horrida subsp. *horrida*	Spiny Lignum	Rare
Eclipta platyglossa subsp. *platyglossa*	Yellow Twin-heads	
Einadia nutans	Nodding Saltbush	
Enchylaena tomentosa var. *tomentosa*	Ruby Saltbush	
Enteropogon acicularis	Spider Grass	
Eragrostis australasica	Cane Grass	Vulnerable
Eragrostis dielsii	Mallee Love-grass	
Eragrostis infecunda	Southern Cane-grass	
Eragrostis setifolia	Bristly Love-grass	Vulnerable
Eremophila divaricata subsp. *divaricata*	Spreading Emu-bush	Rare
Eremophila longifolia	Berrigan	
Eremophila maculata subsp. *maculata*	Spotted Emu-bush	Rare
Eucalyptus camaldulensis	River Red-gum	
Eucalyptus largiflorens	Black Box	
Eucalyptus socialis	Grey Mallee	
Euchiton sphaericus	Annual Cudweed	
Eulalia aurea	Silky Browntop	
Exocarpos aphyllus	Leafless Ballart	
Frankenia serpyllifolia	Bristly Sea-heath	Rare
Glycyrrhiza acanthocarpa	Southern Liquorice	
Goodenia pusilliflora	Small-flower Goodenia	
Hakea tephrosperma	Hooked Needlewood	
Haloragis aspera	Rough Raspwort	
Heliotropium curassavicum	Smooth Heliotrope	
Lachnagrostis filiformis s.l.	Common Blown-grass	
Leiocarpa leptolepis	Pale Plover-daisy	Endangered
Leiocarpa websteri	Stalked Plover-daisy	
Leptochloa fusca subsp. *fusca*	Brown Beetle-grass	Rare

Lycium australe	Australian Box-thorn	
Lysiana exocarpi	Harlequin Mistletoe	
Maireana appressa	Grey Bluebush	
Maireana brevifolia	Short-leaf Bluebush	
Maireana decalvans s.l.	Black Cotton-bush	
Maireana pentagona	Hairy Bluebush	
Maireana pyramidata	Sago Bush	
Malacocera tricornis	Goat Head	Rare
Melaleuca lanceolata	Moonah	
Minuria cunninghamii	Bush Minuria	Rare
Minuria integerrima	Smooth Minuria	Rare
Osteocarpum acropterum var. *deminutum*	Babbagia	
Oxalis perennans	Grassland Wood-sorrel	
Oxalis spp.	Wood Sorrel	
Panicum effusum	Hairy Panic	
Paspalidium constrictum	Knottybutt Grass	
Phragmites australis	Common Reed	
Picris squarrosa	Squat Picris	Rare
Pittosporum angustifolium	Weeping Pittosporum	
Ptilotus polystachyus	Long Tails	Endangered
Rhagodia spinescens	Hedge Saltbush	
Rytidosperma caespitosum	Common Wallaby-grass	
Rytidosperma setaceum	Bristly Wallaby-grass	
Rytidosperma setaceum var. *setaceum*	Bristly Wallaby-grass	
Salsola tragus	Prickly Saltwort	
Salsola tragus subsp. *tragus*	Prickly Saltwort	
Sarcozona praecox	Sarcozona	Rare
Schoenoplectus tabernaemontani	River Club-sedge	
Sclerochlamys brachyptera	Short-wing Saltbush	
Sclerolaena diacantha	Grey Copperburr	
Sclerolaena muricata var. *muricata*	Black Roly-poly	Poorly known
Sclerolaena obliquicuspis	Limestone Copperburr	
Sclerolaena tricuspis	Streaked Copperburr	
Senecio glossanthus s.l.	Slender Groundsel	
Senna form taxon *'coriacea'*	Broad-leaf Desert Cassia	
Sida ammophila	Sand Sida	Vulnerable
Sida spp.	Sida	
Sida trichopoda	Narrow-leaf Sida	
Solanum esuriale	Quena	
Sporobolus mitchellii	Rat-tail Couch	
Stelligera endecaspinis	Star Bluebush	
Tecticornia indica	Brown-head Glasswort	
Tecticornia pergranulata	Blackseed Glasswort	
Tecticornia pruinosa	Bluish Glasswort	
Thysanotus baueri	Mallee Fringe-lily	
Tragus australianus	Small Burr-grass	Rare

Tribulus terrestris	Caltrop	
Triglochin dubia	Slender Water-ribbons	Rare
Triodia scariosa	Porcupine Grass	
Typha domingensis	Narrow-leaf Cumbungi	
Vittadinia cuneata	Fuzzy New Holland Daisy	
Vittadinia spp.	New Holland Daisy	
Wahlenbergia gracilenta s.l.	Annual Bluebell	
Zygophyllum ammophilum	Sand Twin-leaf	
Zygophyllum angustifolium	Scrambling Twin-leaf	Rare
Zygophyllum apiculatum	Pointed Twin-leaf	
Zygophyllum glaucum	Pale Twin-leaf	

Flora – Exotic species recorded in the Mildura WMU

Scientific Name	**Common Name**
Arctotheca calendula	Cape weed
Asparagus officinalis	Asparagus
Asphodelus fistulosus	Onion Weed
Aster subulatus	Aster-weed
Avena barbata	Bearded Oat
Avena fatua	Wild Oat
Avena spp.	Oat
Avena sterilis subsp. *ludoviciana*	Sterile Oat
Brassica tournefortii	Mediterranean Turnip
Bromus diandrus	Great Brome
Bromus rubens	Red Brome
Carrichtera annua	Ward's Weed
Cenchrus longisetus	Feathertop
Centaurea melitensis	Malta Thistle
Chondrilla juncea	Skeleton Weed
Cichorium intybus	Chicory
Cirsium vulgare	Spear Thistle
Conyza sumatrensis var. *sumatrensis*	Tall Fleabane
Dittrichia graveolens	Stinkwort
Echinochloa crus-galli	Barnyard Grass
Emex australis	Spiny Emex
Hordeum glaucum	Northern Barley-grass
Hordeum leporinum	Barley-grass
Hordeum murinum s.l.	Barley-grass
Hypochaeris glabra	Smooth Cat's-ear
Juncus acutus subsp. *acutus*	Spiny Rush
Lactuca saligna	Willow-leaf Lettuce
Lactuca serriola	Prickly Lettuce
Lamarckia aurea	Golden-top
Lepidium africanum	Common Peppercress
Lolium rigidum	Wimmera Rye-grass
Lycium ferocissimum	African Box-thorn

Marrubium vulgare	Horehound
Medicago minima	Little Medic
Medicago polymorpha	Burr Medic
Medicago sativa subsp. *sativa*	Lucerne
Melilotus albus	Bokhara Clover
Melilotus indicus	Sweet Melilot
Melilotus spp.	Melilot
Mesembryanthemum crystallinum	Common Ice-plant
Mesembryanthemum nodiflorum	Small Ice-plant
Monoculus monstrosus	Tripteris
Opuntia elata	Riverina Pear
Opuntia spp.	Prickly pear
Parapholis incurva	Coast Barb-grass
Phalaris minor	Lesser Canary-grass
Phoenix canariensis	Canary Island Date-palm
Phyla canescens	Fog-fruit
Plantago lanceolata	Ribwort
Polygonum aviculare s.l.	Prostrate Knotweed
Polypogon monspeliensis	Annual Beard-grass
Psilocaulon granulicaule	Wiry Noon-flower
Reichardia tingitana	False Sow-thistle
Rostraria pumila	Tiny Bristle-grass
Rumex conglomeratus	Clustered Dock
Salix babylonica s.l.	Weeping Willow
Salvia verbenaca	Wild Sage
Schismus barbatus	Arabian Grass
Silene apetala var. *apetala*	Mallee Catchfly
Sisymbrium erysimoides	Smooth Mustard
Sisymbrium irio	London Rocket
Sisymbrium orientale	Indian Hedge-mustard
Sonchus asper s.l.	Rough Sow-thistle
Sonchus oleraceus	Common Sow-thistle
Spergularia diandra	Lesser Sand-spurrey
Spergularia rubra s.l.	Red Sand-spurrey
Tragopogon porrifolius subsp. *porrifolius*	Salsify
Vicia sativa	Common Vetch
Vulpia bromoides	Squirrel-tail Fescue
Vulpia myuros	Rat's-tail Fescue
Washingtonia robusta	Mexican Fan-palm

Fauna – Native species recorded in the Mildura WMU

Scientific Name	Common Name	DSE Advisory List Status
Acrocephalus stentoreus	Clamorous Reed Warbler	
Anas gracilis	Grey Teal	
Anas superciliosa	Pacific Black Duck	
Anhinga novaehollandiae	Darter	
Ardea intermedia	Intermediate Egret	Endangered
Canis lupus	Dingo & Dog (feral)	
Chenonetta jubata	Australian Wood Duck	
Christinus marmoratus	Marbled Gecko	
Chroicocephalus novaehollandiae	Silver Gull	
Chrysococcyx basalis	Horsfield's Bronze-Cuckoo	
Coracina novaehollandiae	Black-faced Cuckoo-shrike	
Corvus coronoides	Australian Raven	
Corvus mellori	Little Raven	
Cracticus nigrogularis	Pied Butcherbird	
Craterocephalus stercusmuscarum fulvus	Fly-specked Hardyhead	
Cryptoblepharus pannosus	Carnaby's Wall Skink	
Ctenophorus pictus	Painted Dragon	
Ctenotus regius	Regal Striped Skink	
Cuculus pallidus	Pallid Cuckoo	
Cygnus atratus	Black Swan	
Dacelo novaeguineae	Laughing Kookaburra	
Egretta novaehollandiae	White-faced Heron	
Elanus axillaris	Black-shouldered Kite	
Entomyzon cyanotis	Blue-faced Honeyeater	
Eolophus roseicapilla	Galah	
Falco cenchroides	Nankeen Kestrel	
Gallinula tenebrosa	Dusky Moorhen	
Gallirallus philippensis	Buff-banded Rail	
Gehyra variegata	Tree Dtella	
Geopelia striata	Peaceful Dove	
Grallina cyanoleuca	Magpie-lark	
Gymnorhina tibicen	Australian Magpie	
Haliastur sphenurus	Whistling Kite	
Hieraaetus morphnoides	Little Eagle	
Lalage sueurii	White-winged Triller	
Lerista punctatovittata	Spotted Burrowing Skink	
Lerista timida	Dwarf Burrowing Skink	Endangered
Lichenostomus penicillatus	White-plumed Honeyeater	
Limnodynastes dumerilii dumerilii	Pobblebonk Frog	
Limnodynastes fletcheri	Barking Marsh Frog	
Limnodynastes tasmaniensis	Spotted Marsh Frog (race unknown)	
Limosa limosa	Black-tailed Godwit	Vulnerable

Litoria peronii	Peron's Tree Frog	
Litoria raniformis	Growling Grass Frog	Endangered
Lophocroa leadbeateri	Major Mitchell's Cockatoo	Vulnerable
Malurus cyaneus	Superb Fairy-wren	
Malurus lamberti	Variegated Fairy-wren	
Manorina melanocephala	Noisy Miner	
Melanotaenia fluviatilis	Murray-Darling Rainbowfish	Vulnerable
Merops ornatus	Rainbow Bee-eater	
Milvus migrans	Black Kite	
Morelia spilota metcalfei	Carpet Python	Endangered
Morethia boulengeri	Boulenger's Skink	
Ocyphaps lophotes	Crested Pigeon	
Ogyris subterrestris subterrestris	Mildura Ogyris	Vulnerable
Ornithorhynchus anatinus	Platypus	
Pardalotus striatus	Striated Pardalote	
Pelecanus conspicillatus	Australian Pelican	
Petrochelidon ariel	Fairy Martin	
Petrochelidon neoxena	Welcome Swallow	
Phalacrocorax sulcirostris	Little Black Cormorant	
Phalacrocorax varius	Pied Cormorant	Near threatened
Phaps chalcoptera	Common Bronzewing	
Phascolarctos cinereus	Koala	
Platycercus elegans	Crimson Rosella	
Platycercus elegans flaveolus	Yellow Rosella	
Pogona vitticeps	Central Bearded Dragon	
Pomatostomus ruficeps	Chestnut-crowned Babbler	
Porphyrio porphyrio	Purple Swamphen	
Psephotus haematonotus	Red-rumped Parrot	
Rhipidura leucophrys	Willie Wagtail	
Smicrornis brevirostris	Weebill	
Struthidea cinerea	Apostlebird	
Tachybaptus novaehollandiae	Australasian Grebe	
Tachyglossus aculeatus	Short-beaked Echidna	
Tandanus tandanus	Freshwater Catfish	Endangered
Threskiornis molucca	Australian White Ibis	
Todiramphus pyrropygia pyrropygia	Red-backed Kingfisher	Near threatened
Todiramphus sanctus	Sacred Kingfisher	
Trichosurus vulpecula	Common Brushtail Possum	
Tringa stagnatilis	Marsh Sandpiper	Vulnerable
Vanellus miles	Masked Lapwing	
Zosterops lateralis	Silvereye	

Fauna – Exotic

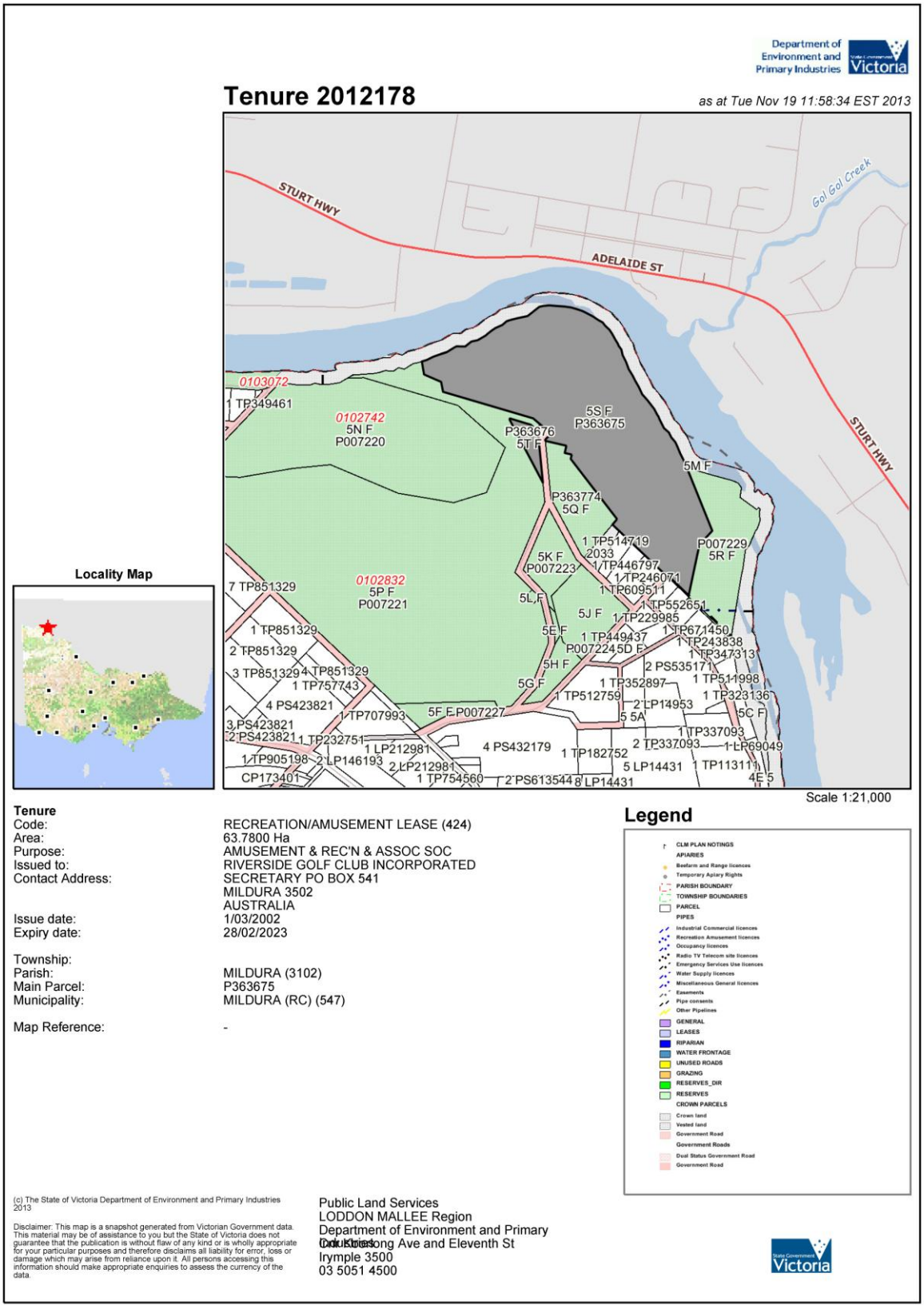
Scientific Name	Common Name
Columba livia	Rock Dove
Felis catus	Cat
Mus musculus	House Mouse
Oryctolagus cuniculus	European Rabbit
Passer domesticus	House Sparrow
Sturnus vulgaris	Common Starling
Turdus merula	Common Blackbird

APPENDIX 4: ECOLOGICAL VEGETATION CLASSES

Description of each EVC in the Mildura WMU target area

EVC no.	EVC name	Bioregional Conservation Status Robinvale Plains	Description
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.
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.
811	Grassy Riverine Forest/Floodway Pond Herbland Complex	Depleted	Combination of Grassy Riverine Forest (above) and 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 regular flooding and drying cycle.
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.

APPENDIX 5: LAND TENURE WITHIN TARGET AREA



Tenure

Code:	RECREATION/AMUSEMENT LEASE (424)
Area:	63.7800 Ha
Purpose:	AMUSEMENT & REC'N & ASSOC SOC
Issued to:	RIVERSIDE GOLF CLUB INCORPORATED
Contact Address:	SECRETARY PO BOX 541 MILDURA 3502 AUSTRALIA
Issue date:	1/03/2002
Expiry date:	28/02/2023
Township:	
Parish:	MILDURA (3102)
Main Parcel:	P363675
Municipality:	MILDURA (RC) (547)
Map Reference:	-

Public Land Services
LODDON MALLEE Region
Department of Environment and Primary Industries
Cnr Koorong Ave and Eleventh St
Irymple 3500
03 5051 4500