Connecting Rivers, Landscapes, People

McDonalds Swamp
Environmental Water Management Plan

NORTH CENTRAL
Catchment Management Authority
Connecting Rivers, Landscapes, People

Department of Environment, Land, Water & Planning

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For further information on any of the information contained within this document contact:

North Central Catchment Management Authority
PO Box 18
Huntly Vic 3551
T: 03 5448 7124 F: 03 5448 7148
E: info@nccma.vic.gov.au
www.nccma.vic.gov.au

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EXECUTIVE SUMMARY

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

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

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

Hydrology and system operations

A key threat to the long-term health of McDonalds Swamp is the alterations that have been made to the watering regime over time. Historically McDonalds Swamp operated as an ephemeral wetland, experiencing periodic wetting and drying phases in response to high flow in the Piccaninny Creek. However, modifications to the catchment through land use changes have significantly altered its watering regime. In the 1960s, Piccaninny Creek was dredged and deepened, disconnecting McDonalds Swamp from natural flooding. The wetland received channel outfalls from the irrigation system, and also received rainfall rejection flows, irrigation drainage flows from adjacent land, and run-off from within the local catchment.

Due to increased efficiencies in irrigation infrastructure and practices, and declining regional rainfall volumes, the volume of channel outfalls decreased throughout the 1990s and early 2000s. The wetland's hydrology shifted again from an almost permanent watering regime to an annual wetting/drying regime, with the wetland drying out completely during 2006-07 and 2008-09 as a result of the drought (North Central CMA 2010). In response to the decreased availability of water, environmental water has been delivered intermittently to the wetland from 1998 onwards.

Water dependent values

McDonalds Swamp is a wetland of regional significance, largely due to the habitat values provided by the relative diversity of vegetation that it provides to numerous waterbirds (including threatened and migratory species), frogs and turtles. In particular, large numbers of waterbirds utilise the wetland for feeding and breeding including endangered species such as the Australasian Bittern (*Botaurus poiciloptilus*). The wetland also supports a number of important plants and vegetation communities including young River Red Gums (*Eucalyptus camaldulensis*), patches of lignum, and emergent and aquatic plants.

Ecological condition and threats

Although land use change has impacted on the duration, timing and frequency of inundation at McDonalds Swamp, the wetland is currently considered to be in good health. Waterbirds continue to opportunistically utilise the wetland during environmental watering events and localized rainfall events. Although the structure and composition of native vegetation has departed from its pre-European state, the vegetation as it exists now is considered to be in good health. Management focuses on providing conditions that facilitate River Red Gum growth and recruitment, and maintaining appropriate extents of diverse habitats.

Management objectives

A long-term management goal has been defined for McDonalds Swamp:

Management goal

Maintain McDonalds Swamp as a temporary freshwater marsh with a diversity of aquatic vegetation and habitat types to support feeding and breeding requirements for a range of native waterbirds (including colonial nesting and migratory species), frogs and turtles.

The ecological objectives and hydrological objectives that sit under the long-term management goal for McDonalds Swamp were informed by the *McDonalds Swamp Environmental Watering Plan 2010* and other technical investigations and were refined during the development of this EWMP.

Managing risks to achieving objectives

The threats to achieving the ecological objectives that are external to environmental water are identified by this EWMP. These include proliferation and encroachment of native species such as Cumbungi (*Typha spp.*) and Common Reed (*Phragmites australis*), as well as introduced species (i.e. foxes and rabbits).

Environmental water delivery infrastructure

It is recommended that a supply point is retained to continue the supply of environmental water to McDonalds Swamp. At present, only the western side of the wetland can be influenced with environmental water, and it is recommended that options for watering the eastern side be investigated as this area contains water-dependent vegetation communities.

Demonstrating outcomes

Monitoring is required to allow adaptive management of annual environmental watering (intervention monitoring). It is also required to enable the CMA and VEWH to demonstrate the long-term outcomes of the implementation of the McDonalds Swamp EWMP. As the State is currently developing the Wetlands Monitoring Assessment Program (WetMAP), the McDonalds Swamp EWMP recommends a suite of intervention and long-term monitoring activities that will meet the monitoring requirements.

Consultation

Key stakeholders, including DELWP, Parks Victoria and Goulburn Murray Water (GMW) were engaged during the development of this EWMP. The community involved in the consultation phase of the McDonalds Swamp EWMP also played a crucial role in advising the North Central CMA on its management of environmental water at the wetland. This group comprised of local community, private landholders, recreational, environmental and indigenous interest groups.

Knowledge gaps

The management actions in the McDonalds Swamp are based on the best available information. A number of knowledge gaps have been identified during the development of the EWMP, particularly around investigating options to enable delivery of environmental water to all areas of the wetland.

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The information contained in the McDonalds Swamp EWMP has been sourced from a variety of reports and field inspections and from individual knowledge and expertise. The North Central CMA acknowledges the assistance of the following people in preparing this EWMP:

- Suzanne Witteveen, Susan Watson, Mick Dedini, Department of Environment, Land, Water and Planning
- Ross Stanton, Goulburn-Murray Water
- Murray Thorson, Parks Victoria
- Damien Cook (Rakali Ecological Consulting)
- Charlie Gillingham (NRMC Member)
- Betty Waterson, Keith Stockwell (Birdlife Australia)
- Darryl Snowden and Mark Daley (Field and Game Australia)
- Ben Hall and Tuesday Browell (Community members)
- Emer Campbell, Michelle Maher, Bree Bisset, Louissa Rogers, Heidi Kleinert, and Phil Dyson (North Central CMA).

ACKNOWLEDGEMENT OF COUNTRY

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

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1. Introduction

Management of environmental water is planned and implemented through a framework of key documents. Figure 1 illustrates the strategies, scientific reports and operational documents required for environmental water management in Victoria. The North Central Catchment Management Authority (CMA) has recently developed the *North Central Waterway Strategy 2014-2022* (NCWS) which is an integrated strategy aimed at managing and improving the North Central CMA's waterways (rivers, streams and wetlands). The NCWS is guided by the *Victorian Waterway Management Strategy 2013* (VWMS) and the *North Central Regional Catchment Strategy 2012* (RCS). The NCWS sets priorities and outlines a regional works program to guide investment over the next eight years (North Central CMA 2014).

McDonalds Swamp is identified as a priority wetland in the NCWS, with the aim to influence long-term resource condition by:

- Improvement and maintenance of extent and condition of riparian vegetation at McDonalds Swamp by 2050 as measured by Index of Wetland Condition (IWC).
- Provision of a water regime that supports a diversity of flora and fauna typical of a temporary freshwater marsh, in particular providing key waterbird habitat including a mix of associated grasses and sedges, open water and mudflats.

These targets are reflected in the overall management goals and objectives described by this EWMP (section 6). In addition, a number of management activities are recommended to achieve these targets, including pest plant and animal control, appropriate delivery of environmental water, and ecological monitoring and assessments to improve knowledge of the wetland. These activities would be delivered by working with the CMA's partners, including Parks Victoria (PV), Goulburn Murray Water (GMW), the Victorian Environmental Water Holder (VEWH), the Department of Environment, Land, Water and Planning (DELWP) and local landholders.

The North Central CMA has received funding through the Department of Environment, Land, Water and Planning (DELWP) 'Victorian Basin Plan Environmental Water Management Plan Program' to prepare an EWMP for McDonalds Swamp. This EWMP aims to establish the long-term environmental water management goals for McDonalds Swamp to guide future management.

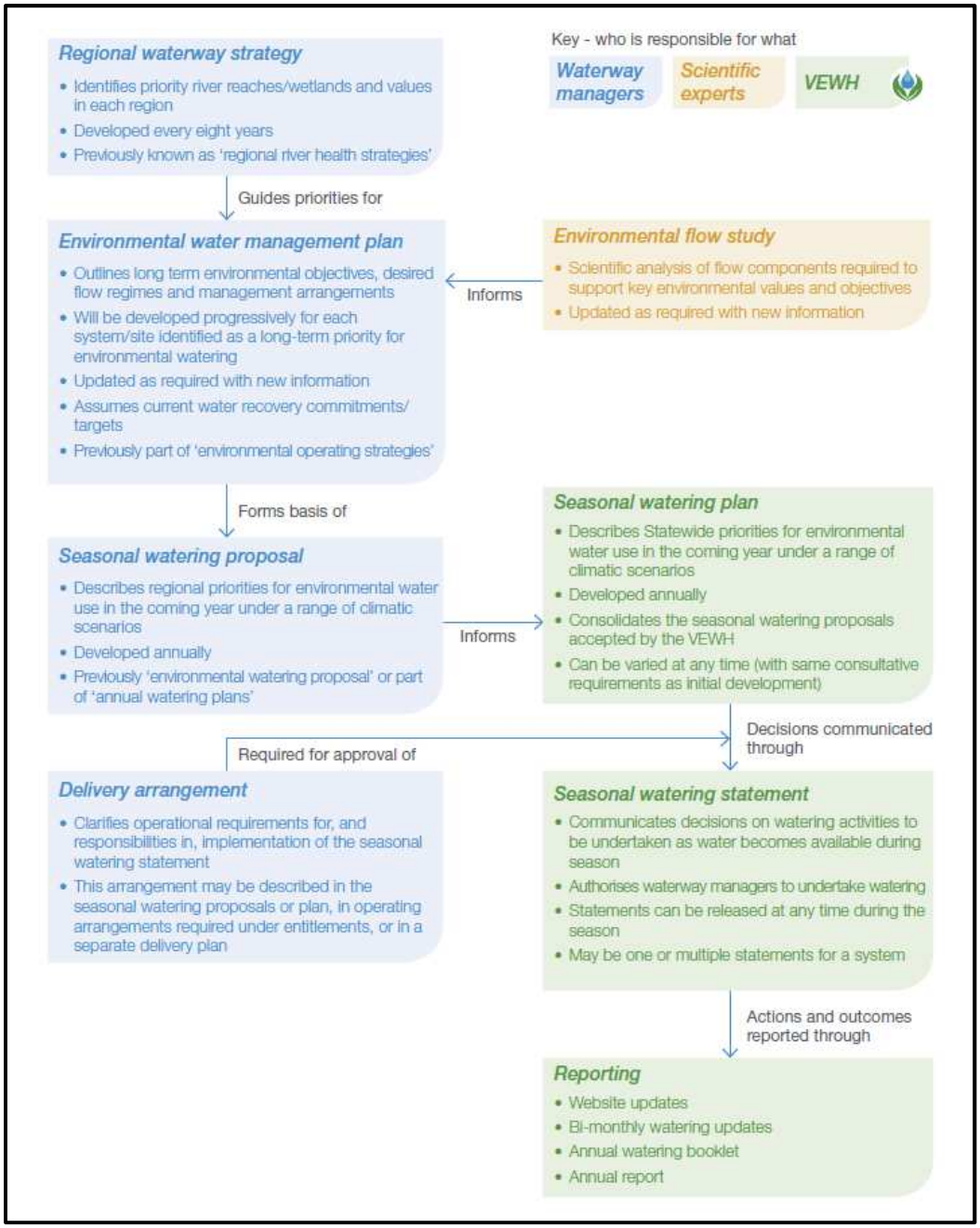

Figure 1. Planning framework for decisions about environmental water management in Victoria.

1.1. Purpose and scope

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

The key purposes of the EWMP are to:

- identify the long-term objectives and water requirements for the wetland;

- provide a vehicle for community consultation, including for the long-term objectives and water requirements of the wetland;
- inform the development of future SWPs and seasonal watering plans; and
- inform Long-term Watering Plans that will be developed by the State under the Basin Plan Chapter 8 (DEPI 2014a).

The scope of this EWMP is the western section of McDonalds Swamp currently managed by Parks Victoria as a State Wildlife Reserve. This area accounts for approximately 76 percent of the total area of the wetland. The remaining 24 percent, which runs along the eastern boundary of the Piccaninny-Barr Drain, is part of the Wildlife Reserve, but does not currently receive environmental water.

1.2. Development Process

McDonalds Swamp has an Environmental Watering Plan that was prepared by the North Central CMA under the Goulburn Murray Water Connections Project (formerly the Northern Victoria Irrigation Renewal Project). The development of the EWP was to establish a volume of mitigation water that Goulburn Murray Water Connections Project was required to set aside for Lake Murphy. The development process for the EWP established ecological objectives and a watering regime for McDonalds Swamp. The McDonalds Swamp EWMP is based on work undertaken for, and presented in, the *McDonalds Swamp Environmental Watering Plan 2010* (EWP), and was developed in collaboration with key stakeholders including DELWP, Parks Victoria, VEWH and Goulburn Murray Water (GMW). A number of tasks were undertaken to develop the EWMP including:

- **Scoping and collating information:** to understand the topography, current condition and threats to McDonalds Swamp the following surveys were undertaken at the onset of the EWMP project:
    - **Bathymetric survey and capacity table**; a bathymetric survey and associated ratings table for McDonalds Swamp area (including north of Lawrys Road) was produced in August 2014
    - **Vegetation survey, mapping and analysis**; baseline flora and fauna surveys including Ecological Vegetation Condition (EVC) mapping, IWC assessments and flora and fauna (incidental) surveys were undertaken in August 2014.
    - **Hydrogeological assessment**: a surface and groundwater assessment was undertaken in January-February 2015.
    - **Expert workshop**: a scientific team was engaged to provide technical review on the draft ecological and hydrological objectives.
    - **Community and stakeholder consultation**: The original community and stakeholder group was reconvened to provide input into the draft EWMP, particularly relating to the water management goal, ecological objectives and optimum watering regime. See Appendix 6 for further details.

The conversion of the McDonalds Swamp EWP to EWMP has been undertaken in collaboration with key stakeholders including DELWP, Parks Victoria, VEWH, GMW and local landholders. The most recent technical information including monitoring data, water delivery information and results of ecological investigations has been considered in the development of the McDonalds EWMP.

Information from the above tasks was analysed to provide justification and evidence for the following sections of the EWMP:

- **Water dependent values:** environmental values were derived from the baseline flora and fauna surveys, historical reports, DELWP databases and community and stakeholder accounts. Terrestrial species that, due to large-scale clearing of woodland

habitat throughout the catchment, are dependent on the vegetation surrounding the wetlands are also documented. Social values (cultural heritage, recreation and economic) are further described.

- **Ecological condition, condition trajectory and threats**: Available information, including IWC assessments, were used to describe the current condition and water related threats to McDonald Swamp. A "do-nothing" scenario is further considered to understand the condition trajectory if no action is undertaken.
- **Management objectives**: The water management goal and the ecological objectives for McDonalds Swamp are based on the water dependent values recorded for the wetland, the current condition and the condition trajectory. The objectives are also aligned with the broader environmental outcomes proposed in the *Basin Plan draft Environmental Watering Strategy 2014*.
- **Managing risks:** the risks to achieving the ecological objectives for McDonald Swamp are based on the best-available scientific and local knowledge. Management actions to mitigate each risk have been recommended and residual risk (assuming full adoption of management action) identified.
- **Environmental water delivery infrastructure:** Current constraints to delivery of environmental water are identified as well as recommendations to allow future environmental water delivery.
- **Demonstrating outcomes**: monitoring to adaptively manage the delivery of environmental water and to demonstrate the outcomes against the ecological objectives are based on best available science monitoring method. Justification for a suite of long term and intervention monitoring recommendations are given.
- **Knowledge gaps and recommendations:** a number of knowledge gaps were identified during the process of developing the ecological objectives, management actions and risk analysis sections. A series of recommended activities as well as a priority ranking is given for each knowledge gap.

2. Site overview

2.1. Site location

McDonalds Swamp is located approximately thirteen kilometres east of Kerang and ten kilometres west of the Murray River (Figure 2). The Piccaninny-Barr Drain transects the wetland, separating it into McDonalds Swamp East and McDonalds Swamp West (Appendix 2). Only McDonalds Swamp West currently has the appropriate infrastructure for delivery of environmental water.

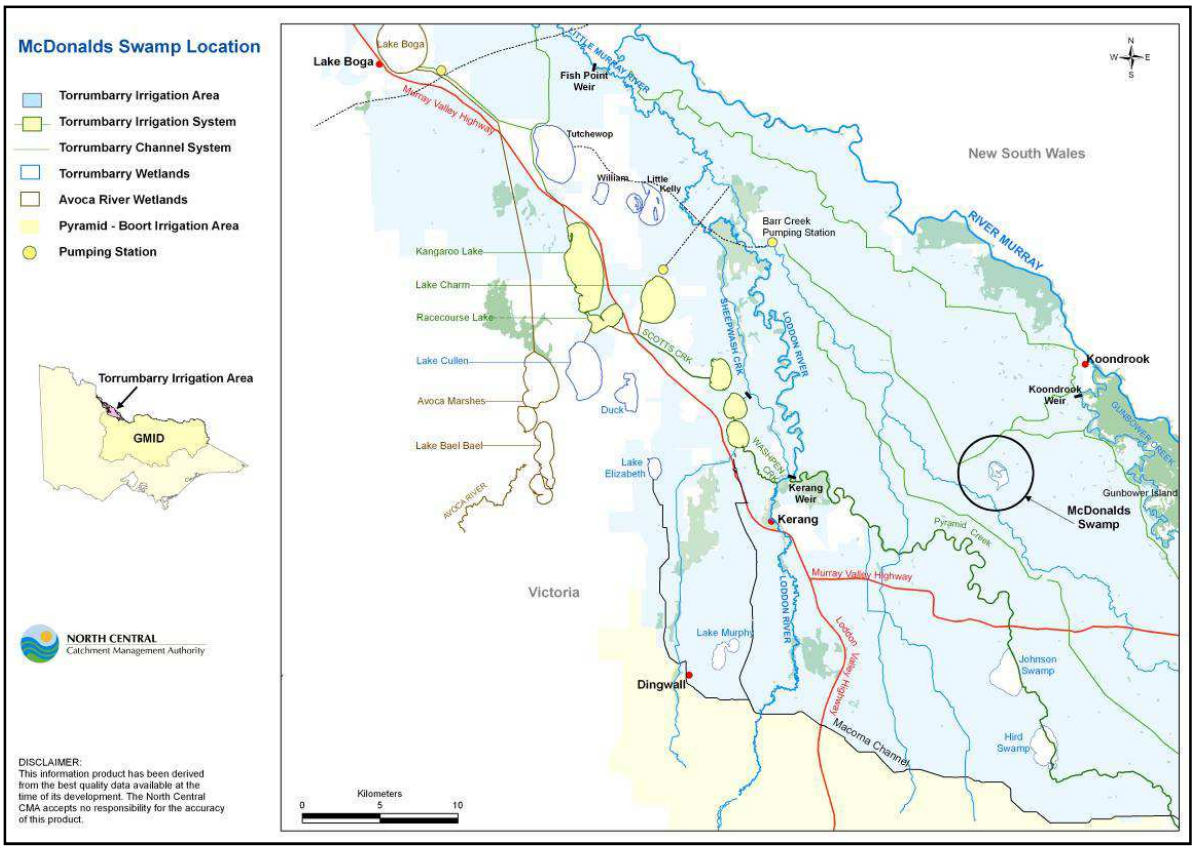

Figure 2. Location of McDonalds Swamp

2.2. Catchment setting

Climate

Climate data were obtained from the Bureau of Meteorology (BOM) for the Kerang meteorological station. Rainfall in the Kerang region averages 377 mm/year, with May to October being significantly wetter than November to April (Macumber 2002). Maximum average temperatures range from 31.6°C in January to 14.1°C in July, with minimum temperatures rarely below zero (BOM 2015). Evaporation rates from the 'Kerang Model Farm' shows pan evaporation (Class A Pan) rates of approximately 1,384.1 mm ranging from 32.8 mm in June to up to 233.3 mm in January between 1991 and 2013 (data supplied by R & E Jones, 2013). Since there is only at most 80mm available for evaporation at McDonalds Swamp, this means the wetland dries relatively quickly (SKM 2001).

Hydro-physical characteristics

McDonalds Swamp is located in the Barr Creek sub-catchment on the floodplains of the Loddon and Murray rivers. It is situated within the Murray Fans bioregion, an area that is characterised by a flat to gently undulating landscape on recent unconsolidated sediments, with evidence of former braided stream channels and river meanders, and broad floodplain areas (DEPI 2014d). These ancient rivers and streams deposited alluvial sediments that have resulted in a thick layer of mixed

clay and sand, known as the Shepparton Formation, which can extend up to 40 metres below the surface and overlies Parilla Sand and Renmark Group sediments (SKM 2001). The local catchment area is low-lying and prone to flooding, resulting in surface sediments that are rich in clay and of low permeability. Flood events and surface water movement, rather than groundwater, generally dominate wetlands formed in this area (SKM 2001).

McDonalds Swamp forms part of the broader 'Central Murray Wetland' complex that occurs within the Loddon-Murray region, and includes the Kerang Wetlands Ramsar site (although McDonalds is unlisted). These wetlands include freshwater lagoons, permanent open freshwater lakes, deep freshwater marches, saline and hypersaline wetlands (DSE 2004). Figure 3 shows the natural topography of the area and the location of McDonalds Swamp within the broader wetland complex of the area.

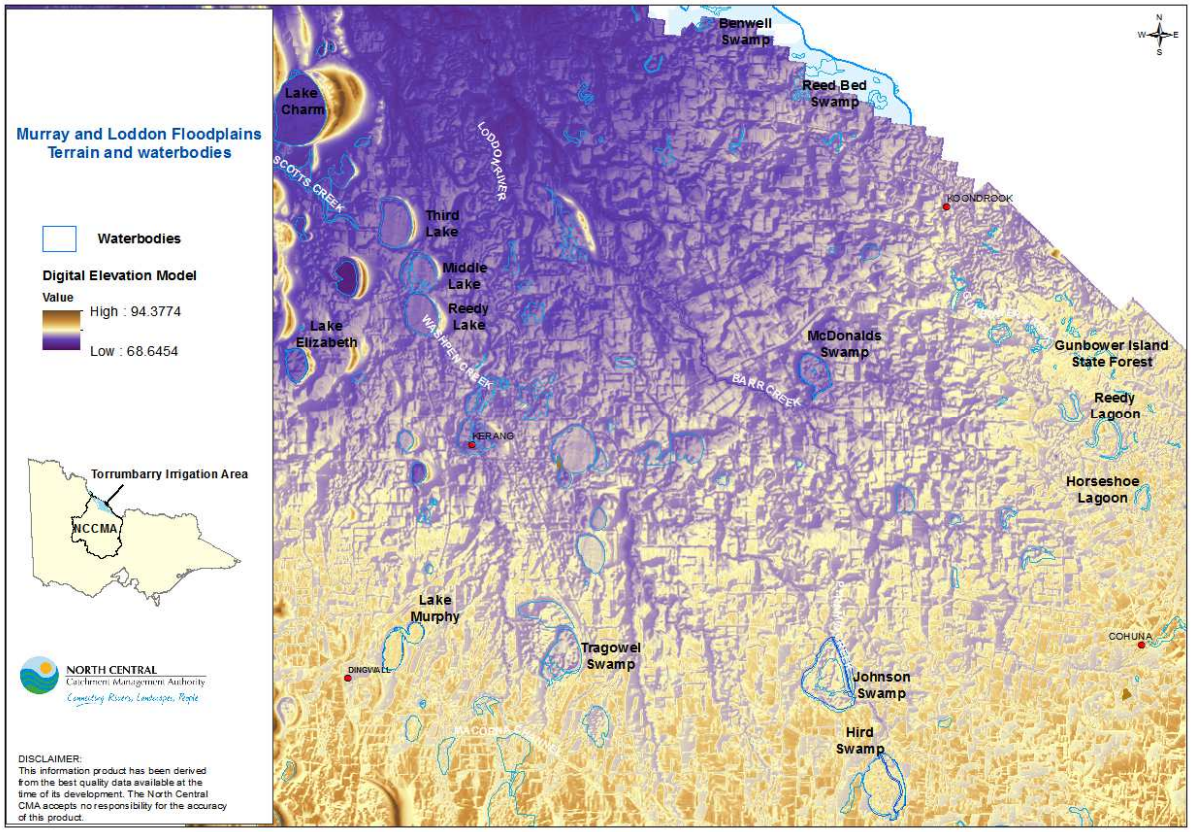

Figure 3. Terrain of the Murray and Loddon River Floodplains

2.3. Land status and management

Land use

Land use around the wetland has changed over time. Once surrounded by dairy farms, adjacent land use now consists primarily of broadacre dryland agriculture (O'Brien, R, 2009, personal communication [DPI], 19 November) and some annual and perennial pasture (SKM 2001, Campbell et al. 2009). Nearby land is salt-affected (Bartley Consulting 2009), and there is a greater possibility that this will negatively impact the wetland through pasture irrigation practices, rather than flooding of the wetland impacting on surrounding land (SKM 2001). McDonalds Swamp is located within the Torrumbarry Irrigation Area.

Land tenure

McDonalds Swamp occupies approximately 164 ha of a 215 ha Crown land reserve (Archards Irrigation 2010). The wetland is listed as a State Wildlife Reserve under the *Crown Land (Reserves) Act 1978* and is managed by Parks Victoria under the *Wildlife Act 1975*.

In 2009, the Victorian government endorsed (with amendments) the Victorian Environment Assessment Council (VEAC) recommendations for public land management. McDonalds Swamp remains as a wildlife reserve under the 'state game reserve' classification. Wildlife reserves are managed to conserve and protect species, communities or habitats of indigenous animals and plants while permitting recreational (including hunting in season as specified by the land manager) and educational use (VEAC 2008; DSE 2009c).

There are several agencies directly involved in environmental water management in Victoria. Other agencies, such as public land managers, play an important role in facilitating the delivery of environmental watering outcomes. Table 1 describes the key stakeholders that have involvement in the management of McDonalds Swamp.

Complementary works to environmental watering have been undertaken by the North Central CMA at McDonalds Swamp, including revegetation works around the wetland fringe, weed control and rabbit and fox control.

Table 1. Roles and responsibilities for environmental water in McDonalds Swamp

Agency/group	Responsibilities/involvement
Department of Environment, Land, Water and Planning (DELWP)	- Manage the water allocation and entitlements framework - Develop state policy on water resource management and waterway management approved by the Minister for Environment, Climate Change and Water - Develop state policy for the management of environmental water in regulated and unregulated systems - Act on behalf of the Minister for Environment, Climate Change and Water to maintain oversight of the VEWH and waterway managers (in their role as environmental water managers) - Legislative responsibilities for the management of flora and fauna - Provides approval of EWMPs and endorsement of SWPs.
Victorian Environmental Water Holder(VEWH)	- Make decisions about the most effective use of the Water Holdings, including use, trade and carryover - Authorise waterway managers to implement watering decisions - Liaise with other water holders to ensure coordinated use of all sources of environmental water - Publicly communicate environmental watering decisions and outcomes - Author of the Statewide Seasonal Watering Plan - Provides final endorsement of SWPs - Approves delivery of environmental water (Seasonal Watering Statement) and funds environmental water related monitoring.
Commonwealth Environmental Water Holder (CEWH)	- Make decisions about the use of Commonwealth water holdings, including providing water to the VEWH for use in Victoria. - Liaise with the VEWH to ensure coordinated use of environmental water in Victoria - Report on management of Commonwealth water holdings.

Agency/group	Responsibilities/involvement
Murray-Darling Basin Authority (MDBA)	- Implementation of the Murray-Darling Basin Plan - the Basin Plan sets legal limits on the amount of surface water and groundwater that can be taken from the Basin from 1 July 2019 onwards - Integration of Basin wide water resource management - Manager of The Living Murray water entitlements
North Central Catchment Authority (North Central CMA)	- Waterway Manager - Identify regional priorities for environmental water management in regional waterway strategies - In consultation with the community assess water regime requirements of priority rivers and wetlands to identify environmental watering needs to meet agreed objectives identify opportunities for, and implement, environmental works to use environmental water more efficiently - Propose annual environmental watering actions to the VEWH and implement the VEWH environmental watering decisions - Provide critical input to management of other types of environmental water (passing flows management, above cap water) report on environmental water management activities undertaken.
Goulburn Murray Water (GMW)	- Water Corporation – Storage Manager and Resource Manager - Work with the VEWH and waterway managers in planning for the delivery of environmental water to maximise environmental outcomes - Operate water supply infrastructure such as dams and irrigation distribution systems to deliver environmental water - Ensure the provision of passing flows and compliance with management of diversion limits in unregulated and groundwater systems - Provides endorsement of SWP and facilitates on-ground delivery.
Parks Victoria	- Land Manager - Implement the relevant components of EWMPs. - Operate, maintain and replace, as agreed, the infrastructure required for delivery of environmental water, where the infrastructure is not part of the GMW irrigation delivery system. - Where agreed, participate in the periodic review of relevant EWMPs and provides endorsement of SWPs - Manage and report on other relevant catchment management and risk management actions required due to the implementation of environmental water.
Input, advice and interest in environmental watering	
Barapa Barapa Nation Aboriginal Corporation	- Traditional owners of the area encompassing McDonalds Swamp. - The delivery of environmental water is likely to provide other benefits that depend on the condition of our waterways, such as supporting social and cultural values.
Central Murray Wetlands Environmental Water Advisory Group (EWAG)	- Stakeholder and community groups developed to provide advice on the best use of environmental water in the Central Murray Wetland Complex, including McDonalds Swamp - Members are represented by GMW, DELWP, Parks Victoria, VEWH, North Central CMA, Gannawarra Shire Council, Swan Hill Shire Council, Campaspe Shire Council, Birdlife Australia, Field and Game Australia, and local community.

2.4. Wetland characteristics

Victoria's wetland classification and inventory was updated in 2013 and replaces the system developed by Corrick and Norman. The updated classification is based on the Australian National Aquatic Ecosystem (ANAE) Classification Framework (the Framework) with data on wetlands and their classification attributes converted into spatial Geographic Information System (GIS) layers.

The Framework structure produces 37 wetland types. Categories were adopted to distinguish naturally-occurring from human-made wetlands in the first level of the classification hierarchy. Aquatic ecosystem habitats: palustrine, lacustrine and estuarine distinguish wetlands in the second level of the classification hierarchy and wetland attributes: water regime, salinity, landscape context, soils and wetland vegetation distinguish wetlands in the third level of the hierarchy (DEPI 2014b).

Under Corrick and Norman, the pre-European classification (1750 Classification) for McDonalds Swamp identified it as a shallow freshwater marsh. Due to extensive irrigation outfalls throughout the 20th century, it was re-classified as a deep freshwater marsh (1994 Classification). Based on the new classification system, McDonalds Swamp is a naturally occurring temporary freshwater marsh[1] (DEPI 2014b). An overview of the wetland characteristics is provided in Table 2.

[1] Under the 2013 Victorian wetland classification layer, the wetland type for McDonalds Swamp is 'unknown'. However, based on the criteria for each wetland type, McDonalds Swamp has been classified by the North Central CMA as a temporary freshwater marsh.

Table 2. Wetland characteristics of McDonalds Swamp

Characteristics	Description	
Name	McDonalds Swamp	
Mapping ID (Corrick)	7726 344450	
Area (ha)	Reserve	215 hectares
	Wetland (McDonalds Swamp West)	164 hectares
Bioregion	Murray Fans	
Conservation status	Regionally significant wetland	
Land status	Wildlife Reserve (126 ha), under the *Wildlife Act 1975*	
Land manager	Parks Victoria	
Surrounding land use	Broadacre dryland agriculture	
Water supply	• Historical: Piccaninny Creek • Current: Torrumbarry Irrigation System Channel Outfall (2/3) • 300 EC • Capacity of 30 ML/day • Average delivery rate 21 ML/day (approx. 42 days to FSL)	
1788 wetland category (Corrick and Norman)	Shallow freshwater marsh (<8 months duration, <0.5m depth)	
1994 wetland category (Corrick and Norman)	Category: Deep freshwater marsh Sub-category: Dead timber	
2013 Victorian wetland classification (DEPI 2014b)	*Wetland ID: 45216* *Aquatic System:* Palustrine *Salinity Regime:* Fresh *Water regime:* Periodically inundated- seasonal or episodic *Water Source – Tidal:* Non-tidal *Water Source – River:* Very high *Water Src – Groundwater:* Moderate *Source – Artificial:* Artificial *Wetland Origin:* Naturally occurring *Wetland Type:* Temporary freshwater marsh[1]	
Wetland capacity	872 ML at *FSL 75.50 m AHD*[2] however due to potential to inundate private land, FSL is more likely 75.4m AHD	
Wetland depth at capacity	0.8 maximum depth[3]	
Source: [2]Archards Irrigation 2010; [3]Chislett 2010 in Maher 2010		

2.5. Environmental water sources

The environmental water that is available for use at McDonalds Swamp is derived from a number of sources, described below and in Table 3. Water shares are classed by their reliability and there are two types in Victoria:

- High-reliability water shares (HRWS), which is a legally recognised, secure entitlement to a defined share of water.
- Low reliability water shares (LRWS) which are water shares with a relatively low reliability of supply. Allocations are made to high-reliability water shares before low-reliability shares (DEPI 2014c).

Water availability can vary from season to season according to climatic conditions, volumes held in storages and carryover entitlements.

Bulk Entitlement (River Murray Flora and Fauna) Conversion Order 1999

The Victorian River Murray Flora and Fauna Bulk Entitlement provides 27,600 ML HRWS in the Murray System. It is held by the VEWH for the purpose of providing for flora and fauna needs. It has been used in a range of wetlands including Gunbower Forest (Living Murray icon site) and the Kerang Ramsar wetlands, including McDonalds Swamp. It can also be traded on the water market on

an annual basis. The use of this water in McDonalds Swamp is not guaranteed and is at the discretion of the VEWH (VEWH 2012).

Commonwealth Water Holdings

Commonwealth water holdings are the direct result of government purchases of entitlements and a substantial investment in more efficient water infrastructure in the Murray Darling Basin. As at 25 March 2015, the Commonwealth environmental water holdings totaled 3,397 ML for the Loddon River system and 310,217 ML for the Murray River system. The use of this water for wetlands in the North Central CMA region is not guaranteed and is at the discretion of the CEWH (CEWH 2015).

GMW Connections Project – Environmental Entitlement (Murray System)

The Goulburn-Murray Water Connections Project is an irrigation modernisation project developing an improved water delivery network across northern Victoria. While improving irrigation efficiency, the Connections Project will reduce outfall volumes to wetlands, including McDonalds Swamp. 'Mitigation water' will therefore be delivered to ensure there is no net impact on high environmental values. Mitigation water is the volume of water required to offset the impact of the Connections Project. Calculation of mitigation water is detailed in the *McDonalds Swamp Environmental Watering Plan 2010*.

Table 3. Environmental water sources for McDonalds Swamp

Water entitlement	Volume	Flexibility of management	Conditions on availability and use	Responsible agency
Bulk Entitlement (River Murray – Flora and Fauna) Conservation Order 1999	28,750 ML (high reliability) 3,893 ML (low reliability) Carryover determined by VEWH	Fully flexible management	Can be used across multiple systems, within relevant trade protocols	VEWH
	40,000 ML (unregulated flows)	Flexible management in declared periods only	Only available for use during declared periods of unregulated flows on the Murray system	VEWH
Environmental Entitlement (Murray System - NVIRP Stage 1) 2012	136 ML for McDonalds Swamp	Can only be used in wetlands that have an approved Environmental Watering Plan with mitigation water recommended, such as McDonalds Swamp.		VEWH
Commonwealth Water Holdings	Determined by CEWH	Agreement is required with the CEWH	Can be used across multiple systems, within relevant trade protocols	CEWH (facilitated through VEWH)

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

There are a range of international treaties, conventions and initiatives, as well as National and Victorian State Acts, policies and strategies that direct management of wetlands within Victoria. Those that may have particular relevance to the management of the environmental and cultural values at McDonalds Swamp are listed below. The function and major elements of each can be sourced from Appendix 1.

International treaties, conventions and initiatives:

- Japan Australia Migratory Birds Agreement (JAMBA) 1974 - 7 of the species listed under this agreement have been recorded at McDonalds Swamp.
- China Australia Migratory Birds Agreement (CAMBA) 1986 - 8 of the species listed under this agreement have been recorded at McDonalds Swamp.

- Republic of Korea Australia Migratory Birds Agreement (ROKAMBA) 2002 - 5 of the species listed under this agreement have been recorded at McDonalds Swamp.
- Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) 1979 – 6 of the species listed under this convention have been recorded at McDonalds Swamp.

Commonwealth legislation and policy:

- Aboriginal and Torres Strait Islander Heritage Protection Act 1984 (Part IIA) – McDonalds Swamp is an area of cultural sensitivity.
- Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) - 1 migratory species listed under this Act have been recorded at McDonalds Swamp.
- Water Act 2007 – to provide for the protection of ecological values at McDonalds Swamp through appropriate management of Murray-Darling Basin water resources.

Victorian legislation:

- Aboriginal Heritage Act 2006 – McDonalds Swamp is an area of cultural sensitivity.
- Catchment and Land Protection Act 1994 - governs the management of land surrounding McDonalds Swamp e.g. pest plant and animal control.
- Water Act 1989 - provides a formal means for the integrated management of water in Victoria.
- Wildlife Act 1975 - Parks Victoria manages McDonalds Swamp in accordance with this Act.
- Flora and Fauna Guarantee Act 1988 (FFG Act) - 10 fauna species and 2 flora species listed under this Act have been recorded at McDonalds Swamp.

National policies and strategies:

- The National Cultural Flows Research Project – this project is investigating indigenous water values and uses to form the basis for cultural flow water entitlements. These would be legally and beneficially owned by the Indigenous Nations and are of a sufficient and adequate quantity and quality to improve the spiritual, cultural, environmental, social and economic conditions of those Indigenous Nations. The cultural flows framework is under development but may influence McDonalds Swamp as it is an area of cultural sensitivity.

Victorian policy and strategies:

- Victorian threatened flora and fauna species (DEPI advisory lists) – 24 fauna species and 8 flora species on the DEPI advisory lists have been recorded at McDonalds Swamp.
- Victorian Waterway Management Strategy (VWMS) – this strategy outlines the direction for the Victorian Government's investment over an eight year period (beginning in 2012-13). The overarching management objective is to maintain or improve the environmental condition of waterways to support environmental, social, cultural and economic values (DEPI 2013a).

Regional strategies and plans:

- North Central Regional Catchment Strategy (RSC) (North Central CMA 2012) – this strategy (2013-2019) sets regional priorities for the management of natural assets, and sets overall direction for investment and coordination of effort by landholders, partner organisations and the wider community. The Central Murray Wetlands Complex is identified as a key priority wetland asset in the RCS that supports highly depleted wetland types and significant threatened flora and fauna speices.

- North Central Waterway Strategy (NCWS) (North Central CMA 2014) – this regional strategy is an action out of the Victorian Waterway Management Strategy and provides the framework for managing rivers and wetlands with the community over the next eight years. It delivers key elements of the VWMS including developing work programs to maintain or improve the environmental condition of waterways in the north central region. McDonalds Swamp is a priority wetland for this eight year planning period.

3. Hydrology and system operations

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

3.1. Wetland hydrology, water management and delivery

3.1.1. Pre-regulation

The geology of the area indicates that prior to European settlement McDonalds Swamp would have been part of a larger wetland in association with the adjacent Red Gum Swamp, shown in Figure 4 (Bartley Consulting 2009). The wetland functioned as an intermittent shallow marsh wetland that would have experienced periodic flooding during moderate to large flood events in the River Murray (Hall, G, 2010, personal communication, [previous NCCMA flood manager], 25 January). Water flowing into Gunbower Creek from the River Murray would have subsequently travelled northwest via the Picaninny Creek, a 27km tributary of Barr Creek. Flood water would first inundate Red Gum Swamp, and then flow approximately 500m south-east via the creek into McDonalds Swamp before re-connecting to Barr Creek.

Based on the ecological and hydrological characteristics of the wetland and Picaninny Creek, it is likely that McDonalds Swamp received inflows up to seven years in ten during winter and spring, and drawing down by the following autumn mainly through evaporation (Australian Ecosystems 2012). The wetland supported a River Red Gum (*Eucalyptus camaldulensis*) vegetation community that would tolerate intermittent flooding.

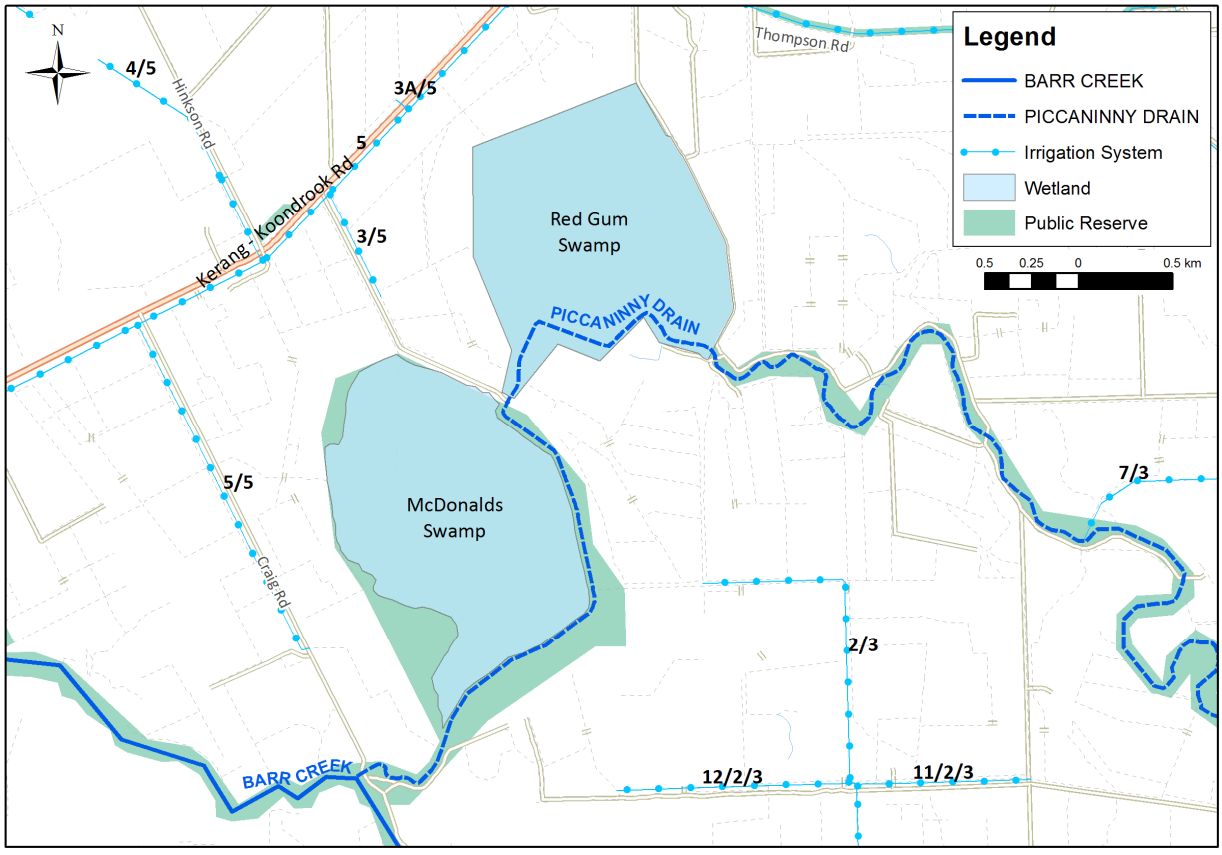

Figure 4. McDonalds Swamp in the landscape

3.1.2. Post-regulation

The establishment of the Torrumbarry Irrigation System in the 1920s, construction of levees across the floodplain and the dredging of the Piccaninny Creek in the 1960s have resulted in significant changes to the hydrology of McDonalds Swamp. The wetland is now disconnected from its natural flow path, rarely receiving water from the Piccaninny Creek, which has been deepened to become a drain (Bartley Consulting 2009). Since the dredging, the water level in the Picaninny Drain is rarely high enough to flow into the wetland (Hydro Environmental 2009).

With the advent of irrigation in the area, McDonalds Swamp was connected to the Torrumbarry Irrigation System and has historically received the following sources of water:

- channel outfalls during and at the end of irrigation season via channel 2/3, sometimes in excess of 40% of the wetland's capacity in any one year;
- rainfall rejection flows;
- irrigation drainage flows from adjacent land; and
- run-off from a small area to the west of McDonalds Swamp (~100ha) that constitutes the wetland's local catchment area and is drained by a small drain (channel 8/1/1 that off-takes from channel 5/5 at Craig Road).

The combination of these inflows represented a departure from the wetland's natural watering regime, resulting in almost permanent inundation (SKM 2001).

Due to increased efficiencies in irrigation infrastructure and practices, the volume of channel outfalls decreased throughout the 1990s and early 2000s. The wetland's hydrology shifted again from an almost permanent watering regime to an annual wetting/drying regime, with the wetland drying out completely in 2006-07 and 2008-09 during the drought (North Central CMA 2010). In response to the decreased availability of water, environmental water was delivered intermittently to the wetland from 1998 onwards. Table 4 demonstrates the watering history of McDonalds Swamp over the last twenty years.

Table 4. McDonalds Swamp wetting/drying calendar (Source: Seasonal Watering Proposal for the Central Murray Wetland Complex 2015-16)

Recommended watering regime	Watering History	Season									
		1995 - 1996	**1996 - 1997**	**1997 - 1998**	**1998 - 1999**	**1999 - 2000**	**2000 – 2001**	**2001 - 2002**	**2002 - 2003**	**2003 - 2004**	**2004 - 2005**
One event every year (i.e. wet and dry cycle every year) (duration of ~8mths)	Status[1]	W	W	D	W	W	W	W	W	W	W
	Water source[2]	U	U	-	E/C	C	E/C	E/C	E/C	E/C	E/C
		2005 - 2006	**2006 - 2007**	**2007 - 2008**	**2008 - 2009**	**2009 - 2010**	**2010 - 2011**	**2011 - 2012**	**2012 - 2013**	**2013 - 2014**	**2014 - 2015**
	Status[1]	W-D	D	D	W	W	W	W-D	D-W-D	D-W-D	W
	Water source[2]	-	-	-	E	E	E/F/I	-	E	E	E

[1] Water present / dry wetland
[2] Environmental water allocation / Flood mitigation / Unknown / Channel outfall / Surplus flows / Flood Inundation/Irrigation Tailwater

As a consequence of regulation in the local area, surface water connectivity between McDonalds Swamp and Red Gum Swamp, Picaninny and Barr Creek has been reduced. An outlet structure to the

south of McDonalds Swamp could allow for some drainage or throughflow into the Picaninny Creek which runs a short distance before connecting to Barr Creek (Figure 8).

3.1.3. Groundwater/surface water interactions

As McDonalds Swamp would naturally have been intermittently filled and flushed by floodwaters it would have been a temporary source of groundwater recharge once the local groundwater levels receded following flood events. Groundwater levels are estimated to have been 10 to 20 metres below the surface prior to European settlement, and had less influence on the flooding regime of the wetland (SKM 2001). However, following development of the irrigation system, groundwater levels within the Kerang region rose dramatically to within 80 cm of the surface in some areas (Bartley Consulting 2009, SKM 2001).

Groundwater monitoring at McDonalds Swamp is conducted by DELWP and local volunteers. DELWP collect groundwater data from regional bores in the State Observation Bore Network whilst data is collected from other bores within the vicinity by both DELWP and volunteers. Only one bore (6613) has long-term data available. Figure 5 shows the locations of groundwater bores in the vicinity of McDonalds Swamp.

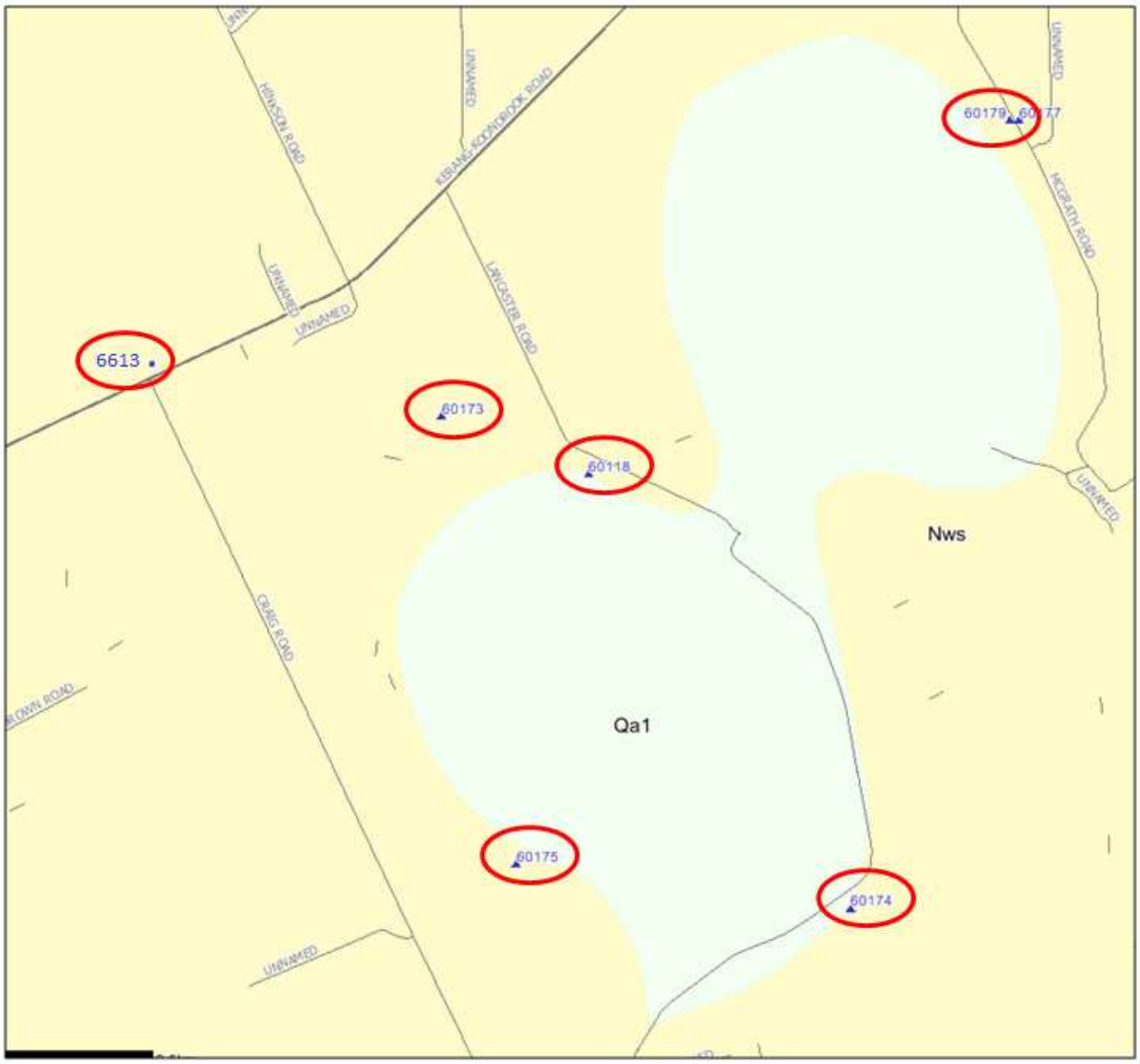

Figure 5. Groundwater bores in the vicinity of McDonalds Swamp

In the past, regional groundwater levels have been extremely shallow (SKM 2001); however they have been declining since the 1990s in response to a period of below average rainfall. Figure 6 illustrates groundwater behaviour from bores adjacent to McDonalds Swamp (60173, 60174, and 60175) and in the wider vicinity (6613 and 60179). Groundwater levels in the area have fluctuated over time. In the 1990s, the groundwater levels were higher than the wetland bed (74.70 m AHD), nearing the surface water level. The data also illustrates seasonal fluctuations in response to recharge and evapotranspiration. From the early 2000s, groundwater levels declined markedly to more than two metres below the wetland bed during the drought (Bartley Consulting 2009). The 2010-11 floods saw a sharp increase in regional groundwater levels, but they have declined in the following years. At the time of writing, no recent data is available for the bores closest to McDonalds Swamp, but using 6613 as a proxy, it is likely that groundwater levels are approximately now 2-3m below the wetland bed.

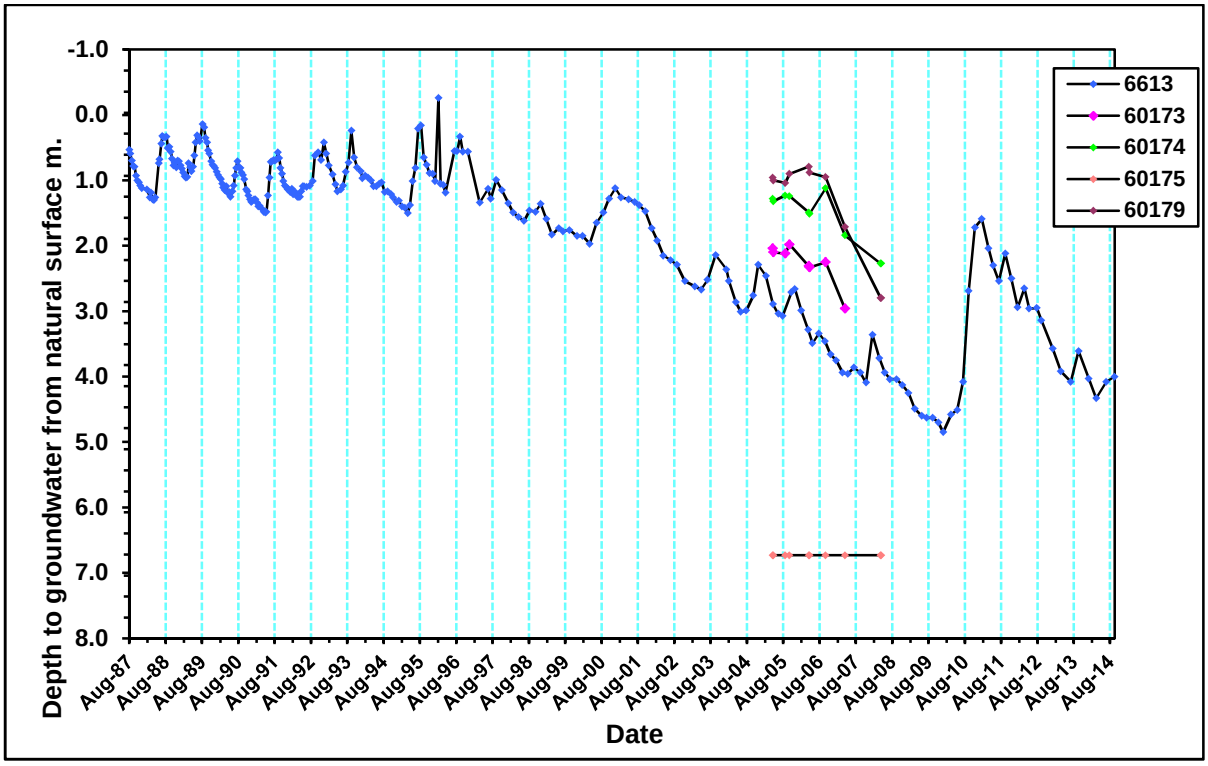

Figure 6. Groundwater levels in bores near McDonalds Swamp

Data from bores within the vicinity of McDonalds Swamp show extremely high, fluctuating EC levels in excess of 40,000 µS/cm. Although a slight declining trend is evident, surface water EC levels are highly variable (section 3.1.4). The data suggests that as the water levels decline in McDonalds Swamp salinity increases through evapoconcentration[2] (Figure 4).

Based on current groundwater levels (Bartley Consulting 2009):

- Intermittent watering of McDonalds Swamp is likely to result in localised groundwater mounding which would fluctuate in response to changing surface water levels. Monitoring of local groundwater bores is critical and in the case of rising groundwater tables, delivery of environmental water to the wetland will need to be adaptively managed and the target supply level adjusted accordingly.
- Inundation while groundwater levels are so low increases the opportunity for salts to move down the profile into the groundwater.

[2] Concentration of salts by evaporation

- There would be a small risk of saline groundwater discharge to low-lying areas on neighbouring land and drainage lines if McDonalds Swamp was permanently inundated. The risk would increase if regional groundwater levels were to rise.

If regional groundwater levels rise and McDonalds Swamp is dry, there is a risk of saline groundwater discharge into the wetland.

3.1.4. Water Quality

Regular monitoring of surface water and electrical conductivity commenced in 1990 and is also undertaken by DELWP. Salinity in McDonald Swamp has fluctuated markedly since 1990 (between 395 and 12,700 EC). These fluctuations are associated with the wetting and drying regime of McDonald Swamp, with the highest salinity values observed just prior to the dry periods. Figure 7 exemplifies this relationship using data collected from 1997 to 2007. The typical salinities, measured either as the mean salinity value of 2,381 EC or the median of 1,910 EC, are adequately high to be a potential cause of environmental stress to plants and animals.

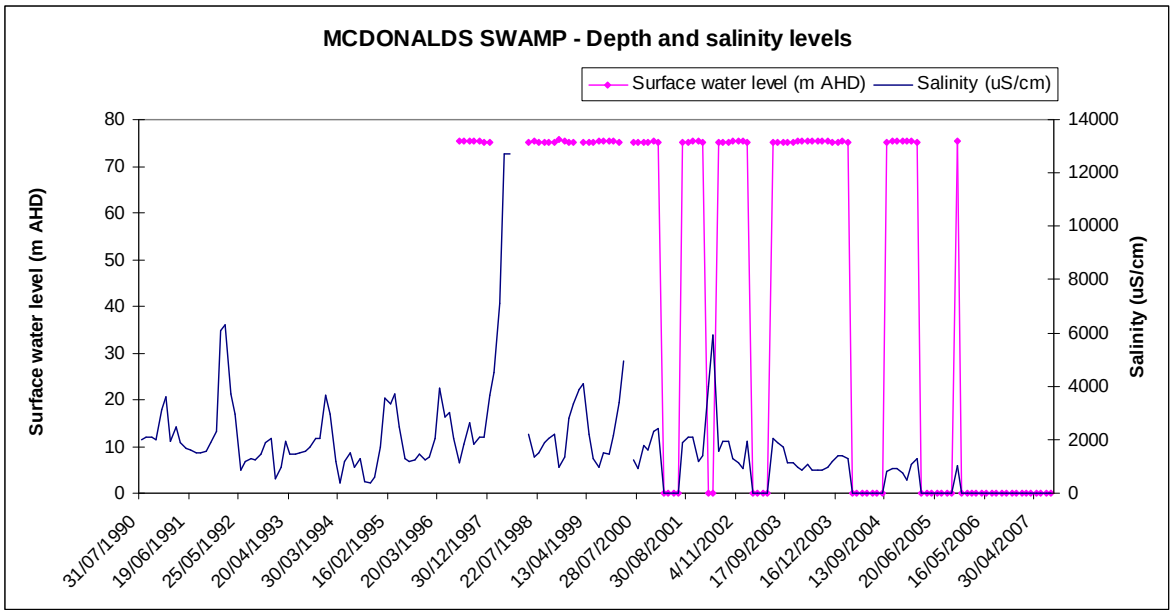

Figure 7. Surface water and salinity levels within McDonalds Swamp as recorded by DPI between 1990 and 2007 (North Central CMA 2010)

The pH levels are generally acceptable, as most of the observed values occur within the pH objective of 6.0-9.0 of Waters of Victoria (Environment Protection Authority [EPA] 1988). However in some periods, pH values of up to 11.1 have occurred, though are unlikely to be deleterious to biota (SKM 2001).

Dissolved oxygen data are restricted to daylight hours when higher values typically occur due to photosynthesis. Therefore, nightime sampling may detect instances of lower dissolved oxygen which are important for fish distributions and release/uptake of nutrients from wetland sediments. Nevertheless, mean dissolved oxygen values are satisfactory. Although the minimum value observed (3.7 mg/l) would be stressful to most organisms, all other values exceed 6.0 mg/l (SKM 2001).

Turbidity is relatively high, with data collected by SKM (2001) showing a mean of 30.1NTU and median of 13 NTU. The high mean was largely due to a very high value of 180 NTU recorded early in 1996, but a number of recordings greater than 20 NTU were also recorded. Higher turbidity levels limit light penetration, which adversely affects the photosynthesis of algae and submerged aquatic plants. Monitoring during the 2014-15 watering event showed that water became more turbid during drawdown (North Central CMA 2015).

Temperature illustrated a wide range, on average about 23°C but occasionally reaching higher extremes in the 30s. Temperature naturally fluctuates in wetlands between seasons and water depths. Water temperature and depth can have an impact on different vegetation types; for example, shallow, warmer water inhibits the growth of young River Red Gums, but is conducive to the exponential growth of Cumbungi and Common Reed.

Although nutrient data are restricted to between 4 and 6 sampling events, the data indicates high nutrient concentrations, with high mean concentrations of reactive phosphate, total phosphates and TKN. The highest value recorded for TKN (13.8 mg/L) is extreme (SKM 2001). Elevated nutrient levels may have a substantial impact on the structure and function of biotic communities through promoting macrophte or algal growth (SKM 2001).

3.1.5. Environmental watering

Following establishment of the irrigation system McDonalds Swamp received significant volumes of outfall water, rarely drying out (O'Brien, R, 2010, personal communication, [DPI], 8 February). In more recent times channel outfalls reduced dramatically and there was a requirement to utilise environmental water. Since 1998, McDonalds Swamp has received significant volumes of environmental water largely to compensate for declining outfalls resulting from increased irrigation efficiencies and declining regional rainfall volumes (Table 4).

The Northern Victoria Irrigation Renewal Project (NVIRP), now integrated into the GMW Connections Project, sought to upgrade ageing irrigation infrastructure across the Goulburn Murray Irrigation District (GMID) and to save water lost through leakage, seepage, evaporation and system inefficiencies (North Central CMA 2010). It was recognised that some of these 'losses' provided incidental benefits to environmental assets, and McDonalds Swamp was classified as a priority wetland that would be heavily impacted by the reduction in channel outfalls associated with increased efficiencies (SKM 2008). To mitigate these impacts, a volume of environmental water was calculated that could be used to sustain the existing ecological character of the wetland (North Central CMA 2010). In addition, other environmental water has been made available to use at the wetland. The *Environmental Watering Plan* produced in 2010 identified the values present at the site and an optimal watering regime was developed to maintain and improve the condition of the wetland. The North Central CMA has provided environmental water to McDonalds Swamp since 2010 in accordance with the EWP and seasonal watering plans.

Table 4 demonstrates the recent history of environmental watering at McDonalds Swamp since 1995. Environmental water was delivered to the wetland from 1998 to 2005, maintaining an annual seasonal regime. The following years at the height of the Millenium Drought saw the wetland dry out completely. Environmental water was again delivered from 2008-2011. In 2010-11, there was widespread flooding across the region, and no environmental water was required until 2012. Since then, the wetland has been again managed as a seasonal, shallow freshwater marsh.

4. Values

4.1. Environmental values

4.1.1. Listings

McDonalds Swamp is a wetland of regional significance, which is defined as a wetland that is not listed in the Directory of Important Wetlands but still provides significant values (Heron & Joyce 2008). At McDonalds Swamp, this largely due to the habitat values provided by the relative diversity of vegetation that it provides to numerous waterbirds (including threatened and migratory species), frogs and turtles (SKM 2008). In particular, large numbers of waterbirds utilise the wetland for feeding and breeding including vulnerable species such as Hardhead (*Aythya australis*) and the near-threatened migratory species, Glossy Ibis (*Plegadis falcinellus*).

Table 5 details the legislation, agreement and conventions and listings that are relevant to McDonalds Swamp. As shown, management of the wetland falls within four international listings (JAMBA, CAMBA, ROKAMBA and the Bonn Convention), one national listing (EPBC Act) and two Victorian State listings. A full list of flora and fauna recorded at McDonalds Swamp is shown in Appendix 3.

Table 5. Significance of McDonalds Swamp and its associated species

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

4.1.2. Water-dependent fauna

McDonalds Swamp provides a diverse array of habitat types including mudflats, open water, reeds, and dead River Red Gums which in turn attract a range of both water-dependent and terrestrial fauna species. One hundred and nine species of birds have been recorded, 23 of which are species of conservation significance at an international, national or state level (Table 7). Sixty are considered water-dependent.

The 60 water dependent waterbirds can be categorised into a diversity of feeding guilds, including large waders such as the Brolga (*Grus rubicundus*), which feed in the deeper parts of the wetland; piscivorous birds such as the Intermediate Egret (*Ardea intermedia*) and Caspian Tern (*Hydroprogne caspia*); and dabbling ducks such as the Freckled Duck (*Stictonetta naevosa*) which also utilise the Tangled Lignum (*Duma florulenta*) habitat on the wetland fringe. These species are all listed in the *Flora and Fauna Guarantee Act 1998* (FFG Act 1998). McDonalds Swamp is also important for other feeding guilds that include more common species such as shoreline foragers and small waders that feed in the shallows or probe damp mud on the fringe of the wetland, deep water foraging birds that forage in shallow or deep open water and on mudflats, and grazing waterfowl that forage amongst

fringing vegetation. Species such as the Australasian Bittern (*Botaurus poiciloptilus*), listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act 1999), utilise the fringing reedy vegetation for foraging and feeding platforms. Foraging raptors such as the FFG-listed White-bellied Sea Eagle (*Haliaeetus leucogaster*) use the dead River Red Gums as vantage points (Rakali Ecological Consulting 2014b).

McDonalds Swamp provides important open water and mudflat habitat for migratory waders (Australian Ecosystems 2012). The wetland, in conjunction with Johnson Swamp, Hirds Swamp and Lake Murphy, offers extensive mudflat habitat that is not offered by the more permanent lakes within the Kerang region (North Central CMA 2010). A number of species have been recorded at McDonalds Swamp that are protected under international migratory bird agreements, including the Common Greenshank (*Tringa nebularia*), the Marsh Sandpiper (*Tringa stagnatilis*) and the Wood Sandpiper (*Tringa glareola*), the latter two which are listed as vulnerable in Victoria (DEPI 2013b).

The wetland is highly productive for waterbird use and breeding, with regular nesting reported over time (SKM 2001). For example, numerous Black Swans (*Cygnus atratus*) were observed to have bred and Grey Teal (*Anas gracilis*) were observed in their thousands following watering events in the late 2000s (David, P, 2010, personal communication, [Landholder], 11 January). Tree hollows situated within the wetland also provide important breeding habitat for a variety of species. Eighteen species have been recorded nesting at McDonalds Swamp (Table 6), including the Hardhead (*Aythya australis*) (listed as vulnerable in Victoria), Purple Swamphen (*Porphyrio porphyrio*) and Black-winged Stilt (*Himantopus himantopus*). The migratory Glossy Ibis (*Plegadis falcinellus*), protected under the Bonn Convention and CAMBA treaty, has also been recorded breeding at McDonalds Swamp (DELWP 2015a).

Table 6. Most recent bird breeding events at McDonalds Swamp (species of conservation significance are in bold)

Common Name	Scientific Name	Source	Most recent recorded event
Australasian Grebe	*Tachybaptus novaehollandiae*	Dedini 2015	2011
Australian Reed-Warbler	*Acrocephalus australis*	Dedini 2015	2013
Australian Shelduck	*Tadorna tadornoides*	Dedini 2015	2011
Australian Spotted Crake	*Porzana fluminea*	DEWLP 2015a	2015
Black Swan	*Cygnus atratus*	DEWLP 2015a	1999
Black-fronted Dotterel	*Elseyornis melanops*	Dedini 2015	2011
Black-winged Stilt	*Himantopus himantopus*	Dedini 2015	2011
Common Starling	*Sturnus vulgaris*	DEWLP 2015a	1999
Eastern Rosella	*Platycercus eximius*	Dedini 2015	2011
Galah	*Eolophus roseicapillus*	DEWLP 2015a	1999
Glossy Ibis	***Plegadis falcinellus***	DEWLP 2015a	**1999**
Grey Teal	*Anas gracilis*	Dedini 2015	2011
Hardhead	***Aythya australis***	Dedini 2015	**2011**
House Sparrow	*Passer domesticus*	DEWLP 2015a	1999
Pacific Black Duck	*Anas superciliosa*	Dedini 2015	2013
Pink-eared Duck	*Malacorhynchus membranaceus*	Dedini 2015	2010
Purple Swamphen	*Porphyrio porphyrio*	Dedini 2015	2011
Red-kneed Dotterel	*Erythrogonys cinctus*	DEWLP 2015a	1999

McDonalds Swamp also supports four recorded amphibian and five recorded reptile species, though the wetland provides highly suitable habitat and it is likely that with increased survey effort, more species would be found. The Spotted Marsh Frog (*Limnodynastes tasmaniensis*) and Barking Marsh

Frog (*Limnodynastes fletcheri*) both readily colonise seasonal wetlands with longer hydroperiods (>3 months). The Common Froglet (*Crinia signifera*) and Plains Froglet (*Crinia parinsignifera*) are highly adaptable and less sensitive to changes in wetland hydrology. The Eastern Long-necked Turtle (*Chelodina longicollis*) has also been recorded at McDonalds Swamp, as it prefers ephemeral water bodies where there is reduced competition from other reptiles.

Table 7. Significant water dependent fauna species recorded at McDonalds Swamp

Common name	Scientific name	Last record	International status	EPBC status	FFG status	Victorian status
Australasian Bittern	*Botaurus poiciloptilus*	2004		EN	L	e
Australasian Shoveler	*Anas rhynchotis*	2012				v
Australian Pratincole	*Stiltia isabella*	1982				nt
Brolga	*Grus rubicunda*	2014			L	v
Caspian Tern	*Hydroprogne caspia*	2009	C, J		L	nt
Common Greenshank	*Tringa nebularia*	2002	B, C, J, R			v
Eastern Great Egret	*Ardea modesta*	2012	C, J,		L	v
Eastern Long-necked Turtle	*Chelodina longicollis*	2014				dd
Freckled Duck	*Stictonetta naevosa*	2012			L	e
Glossy Ibis[1]	*Plegadis falcinellus*	2014	B, C			nt
Gull-billed Tern	*Gelochelidon nilotica macrotarsa*	1982			L	e
Hardhead[1]	*Aythya australis*	2012				v
Intermediate Egret	*Ardea intermedia*	2012			L	e
Little Egret	*Egretta garzetta nigripes*	2015			L	e
Marsh Sandpiper	*Tringa stagnatilis*	2009	B, C, J, R			v
Musk Duck	*Biziura lobata*	2012				v
Nankeen Night Heron	*Nycticorax caledonicus*	2012				nt
Pectoral Sandpiper	*Calidris melanotos*	2009	B, J, R			nt
Pied Cormorant	*Phalacrocorax varius*	2014				nt
Royal Spoonbill	*Platalea regia*	2014				nt
Whiskered Tern	*Chlidonias hybridus*	2012				nt
Sharp-tailed Sandpiper	*Calidris acuminata*	2014	B, C, J, R			
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	2014	C		L	v
Wood Sandpiper	*Tringa glareola*	2014	B, C, J, R			v

Key:
International Status: C = CAMBA, J = JAMBA, R = ROKAMBA
EPBC: M = migratory species list, EN = Endangered
FFG Status: L = Listed as threatened, N = Nominated
DELWP Status: e = endangered, vu = vulnerable, nt = near threatened, dd = data deficient
[1]breeding recorded
Source: DELWP (2015a); DEPI (2013b); Rakali Ecological Consulting (2014)

4.1.1. Terrestrial fauna

In addition to supporting a multitude of waterbirds, 49 terrestrial bird species have also been recorded at McDonalds Swamp. This includes the FFG-listed Grey-crowned Babbler (*Pomatostomus temporalis*), likely to be part of one of the strongest remaining populations in Victoria around the Kerang region. Overall this species has declined by about 90 per cent since pre-European settlement (Tzaros et al. 2014). Land use surrounding the wetland has seen the clearance of River Red Gum and Black Box woodlands that would have previously supported woodland bird species. Now, terrestrial

birds utilise the remaining trees and the Tangled Lignum habitat on the wetland fringe (Australian Ecosystems 2012).

Terrestrial reptiles that have been recorded include the Boulenger's Skink (*Morethia boulengeri*), Stumpy-tailed Lizard (*Tiliqua rugosa*), Eastern Brown Snake (*Pseudonaja textilis*) and the Tiger Snake (*Notechis scutatus*). One native mammal has been recorded historically, the Water Rat (*Hydromys chrysogaster*).

4.1.2. Vegetation communities and flora

The Murray Fans bioregion falls between the margins of six drainage basins: the Broken River, Goulburn River, Campaspe River, Loddon River, Avoca River and the Mallee. The area is characterised by a flat to gently undulating landscape of broad floodplain areas and braided old river meanders (DEPI 2013d).

As a result of anthropogenic changes to the hydrology of the wetland, and associated changes in salinity, native vegetation has been significantly altered from its pre-European state. Surveys in 2014 identified five wetland Ecological Vegetation Classes (EVCs) (Rakali Ecological Consulting 2014), three of which are depleted or endangered in Victoria (Table 8). Aquatic Herbland (EVC 653) is dominated by herbaceous aquatic species (typically with rootstocks tolerant of dry periods) such as Red Milfoil (*Myriophyllum verrucosum*) and Eel Grass (*Vallisneria americana*) and occurs mostly in the open, deeper parts of the wetland. In dry phases, this EVC becomes more representative of Lake Bed Herbland, which supports species such as Pale Knotweed (*Persicaria* lapathifolia). The large number of dead River Red Gums that remain standing provide habitat to roosting ibis, ducks, spoonbills, cormorants, darters and bats (Rakali Ecological Consulting 2014a).

Small pockets of Aquatic Sedgeland are present in areas that transition from Aquatic Herbland to Tall Marsh. The Aquatic Sedgeland EVC is very species-poor, dominated by Tall Spike-sedge (*Eleocharis sphacelata*). Tall Marsh (EVC 821) covers more than one third of the wetland, occurring in both closed patches and in a mosaic with Aquatic Herbland (Rakali Ecological Consulting 2014a; 2014b). Remnants of its pre-European state, a number of dead River Red Gums are dispersed throughout this EVC. In McDonalds Swamp, Tall Marsh is dominated by Cumbungi (*Typha spp.*) and Common Reed (*Phragmites australis*), which have been advantaged by the hydrological changes and become extremely abundant. The current extent of these species has been mapped and can be seen in Appendix 5.

Intermittent Swampy Woodland is characterised by some live River Red Gums, and is dominated by Common Spike-sedge, Tall Spike-sedge and Water Couch (*Paspalum distichum*), as well as other sedges (Rakali Ecological Consulting 2014a). The terrestrial Pale Plover-daisy (*Leiocarpa leptolepis*), listed in the *FFG Act 1998* and endangered in Victoria, was recorded in this EVC (Appendix 3).

Small patches of Tangled Lignum are present on the western and northern boundaries of the wetland on slightly higher ground.

Riverine Chenopod Woodland is present along the south-eastern boundary of wetland, adjacent to a larger patch of Intermittent Swampy Woodland on the other side of the Picanniny-Barr Drain. This is a more elevated part of the wetland and would have once been prone to irregular shallow flooding. At McDonalds Swamp it is dominated by Black Box (*Eucalyptus largiflorens*) and would support less water-dependent species such as Berry Saltbush (*Atriplex semibaccata*) and Spider Grass (*Enteropogon acicularis*). The Black Box trees provide hollows, fallen branches and shading for habitat (e.g. White-bellied Sea Eagle and Grey-crowned Babbler), and are a source of seed for recruitment. Although both EVCs in this area are considered water-dependent, at present they are unable to be influenced though environmental watering due to a lack of infrastructure.

The current EVCs and bioregional conservation status for McDonalds Swamp are presented in Table 8.

Table 8. Conservation status of EVCs at McDonalds Swamp

EVC no.	EVC name	Bioregional Conservation Status
653	Aquatic Herbland	Depleted
308	Aquatic Sedgeland	N/A
813	Intermittent Swampy Woodland	Depleted
821	Tall Marsh	Least Concern
103	Riverine Chenopod Woodland	Endangered
Source: DEPI (2014d); Rakali Ecological Consulting (2014)		

Native and threatened flora

Ninety-seven native species have been recorded at McDonalds Swamp, including 54 that are considered water-dependent. Eight Victorian rare or threatened flora species (VROTS) have been recorded at McDonalds Swamp (Table 9 and Appendix 3). Of these, three are considered water-dependent species: Flat Spike-sedge (*Eleocharis plana*) that is vulnerable in Victoria, Spiny Lignum (*Muehlenbeckia horrida subsp. horrida*) that is rare, and the poorly known Eel Grass (*Vallisneria americana*) (DEPI 2014e).

Recorded flora species also include 43 terrestrial species, including two listed under the FFG Act 1998, Weeping Myall (*Acacia pendula*) and Pale Plover-daisy. Weeping Myall was planted at McDonalds Swamp in a trial to improve diversity and augment the seedbank which is thought to be depleted. Other species that are threatened in Victoria include the rare Floodplain Fireweed (*Senecio camplyocarpus*) and Branching Groundsel (*Senecio cunninghami var. cunninghammii*), and the poorly known Black Roly-poly (*Sclerolaena muricata var. muricata*).

Table 9. Listed water dependent flora recorded at McDonalds Swamp

Common name	Scientific name	Last Record	FFG Status	DELWP Status	Type
Black Roly-poly	*Sclerolaena muricata*	2012		k	T
Branching Groundsel	*Senecio cunninghamii var. cunninghamii*	2009		r	T
Eel Grass	*Vallisneria americana*	2014			W
Flat Spike-sedge	*Eleocharis plana*	2010		v	W
Floodplain Fireweed	*Senecio campylocarpus*	2014		k	T
Pale Plover-daisy	*Leiocarpa leptolepis*	2014	L	e	T
Spiny Lignum	*Muehlenbeckia horrida subsp. horrida*	2014		r	W
Weeping Myall	*Acacia pendula*	2014	L	r	T

4.1.3. Wetland depletion and rarity

Victoria's wetland classification system was recently updated to align with the ANAE national framework for aquatic ecosystems (see Section 2.4). The depletion and rarity of both classifications in Victoria, the North Central CMA region, the Loddon River catchment and Victoria Riverina bioregion are discussed below.

Shallow freshwater marsh (Corrick and Norman Classification)

According to the Corrick and Norman Classification, the pre-European classification of McDonalds Swamp was a shallow freshwater marsh. However, under the 1994 layer, the wetland is currently classified as a deep freshwater marsh (DEPI 2014g; DEPI 2014f) due to changes in hydrology from modifications to the catchment. However, given that it has a maximum depth of only 80 cm and holds water for less than eight months, it is considered to more appropriately represent a shallow freshwater marsh. Shallow freshwater marshes are often degraded as a result of agricultural activities, including grazing or cropping, and have subsequently decreased in extent across the landscape. The area of shallow freshwater marshes across Victoria is estimated to have decreased by approximately 60% since European settlement (DNRE 1997). Although McDonalds Swamp represents only a small proportion of shallow freshwater marshes across Victoria, it accounts for approximately 15 per cent within the Murray Fans bioregion (Table 10).

Temporary freshwater marsh (Victorian Wetland Classification)

As previously mentioned, under the 2013 Victorian Wetland Classification framework, the classification for McDonalds Swamp is unknown. However, based on the criteria for wetland types, the wetland is considered to represent a temporary freshwater marsh, as it is dominated by non-woody emergent and submergent vegetation, and is between the 0.5-2 metres depth range for this wetland type (Brooks et al. 2013). McDonalds Swamp represents less than 0.3% of this classification in all of the Victoria, North Central CMA region, Loddon and Murray Fans bioregion landscapes (Table 10). A comparison of percentage reduction since European settlement could not be undertaken as the system does not include a comprehensive update of the WETLAND_1788 layer to meet the new wetland classification categories.

Table 10. Area, depletion and rarity of wetland classifications in the region

Region	Corrick and Norman classification Shallow freshwater marsh				Current classification Temporary freshwater marsh	
	Pre-European area (ha)	Current area (ha)	Reduction (%)	McDonalds Swamp contribution to current area (%)	Current area (ha)	McDonalds Swamp contribution to current area (%)
Victoria	125,942	54,537	57	0.3	224,456	0.02
North Central catchment	11,774	4,811	41	3.4	153,024	0.04
Loddon catchment	8,576	2,880	34	5.7	114,083	0.05
Murray Fans bioregion	3,141	1,074	34	15.2	42,589	0.3

4.1.4. Ecosystem function

'Ecosystem function' is a term used to describe the biological, geochemical and physical processes and components that take place or occur within an ecosystem. These functions relate to the structural components of an ecosystem (e.g. vegetation, water, soil, atmosphere and biota) and how

they interact with each other, both at a local (i.e. site specific) and regional (i.e. complex) scale. This include processes that are essential for maintaining life such as storage, transport and nutrient cycling as well as the provision of resources that support biodiversity such as habitat, food and shelter.

From a landscape context, McDonalds Swamp is considered of high value as it represents a depleted wetland type, and supports a diversity of threatened flora and fauna species and communities that are important for maintaining biological diversity in the biogeographic region. The wetland is particularly important for breeding waterfowl and some migratory species listed under international conventions and bilateral agreements. These values contribute not only to the wider Central Murray Wetlands complex but the North Central CMA region as a whole. McDonalds Swamp accounts for more than 15 per cent of shallow freshwater marshes in the Murray Fans bioregion, and is in close proximity to both the Kerang Wetlands Ramsar Site (9km to the west) and to the Gunbower Forest Ramsar Site (8km to the east).

McDonalds Swamp shares numerous habitat types with other wetlands in the region (e.g. Hirds Swamp), particularly the marshy habitats that support cryptic waterbirds such as the Australasian Bittern. A recommendation from the community during the consultation phase was to manage the wetting and drying phases with consideration of the watering status of nearby Hirds Swamp (Appendix 6). While the two wetlands require different watering regimes, maintaining water in one while the other is in a drying phase would ensure that these habitat types are available throughout the region in most years when practicable.

Table 11 broadly shows the ecosystem functions provided by McDonalds Swamp from a local and regional perspective.

Table 11. Ecosystem function of McDonalds Swamp from a local and regional scale

Local ecosystem functions	Regional ecosystem functions
• **Convert matter to energy for uptake by biota** - this includes substrate surfaces (i.e. rocks, woody debris, gravel) for biofilms and plant matter and interactions between primary producers and consumers such as the breakdown of carbon and nutrients by zooplankton and macroinvertebrates for higher order consumers. • **Provide shade and shelter for biota** - this includes amelioration of extremes in temperature, sunlight exposure and wind as well as protection from predators. The interrelationship of tree, shrub, forb and grass species with compatible geology, soil type, slope aspect, elevation, moisture availability and temperature range characteristics are the main ecosystem components supporting this function. • **Provision of water for consumption** - retention and storage of water for use by biota to enhance growth and development and to ensure survival and reproduction. • **Reproduction** - recruitment of new individuals requires sufficient shelter from predators, food for growth, resources for nest building and cues for breeding (i.e. water level changes, temperature, rainfall etc.). Adequate resources to support newly fledged individuals are also required, including shelter, food and provision of water for consumption. Plants also require specific germination and growth conditions (including flood cues, follow up flooding, drying etc.) to ensure successful recruitment.	• **Movement/ dispersal** - movement of individuals is linked to food web functions (see local ecosystem functions) and is a requirement for the life cycle of some species (i.e. migration). It is also assists with maintaining genetic diversity within the landscape and reduces the risk of local species extinction. The movement of mobile species through the landscape further supports the dispersal of seeds/progapules in the landscape providing a source for colonisation. • **Cycle nutrients and store carbon** - important for essential ecological processes such as evapotranspiration, respiration, groundwater and carbon sequestration etc. • **Population persistance** - a number of species require specific habitat requirements to breed. With a dramatic reduction in the area of temporary freshwater marsh in the landscape, the population of species such as Brolga are aging, which results in reduced fecundity and recruitment. • **Biological diversity** - the provision of a sufficient number and range of habitat types in the landscape supports a diversity of native species. This in turn assists to safe guard the region from the impacts of local catastrophic events (i.e. loss of habitat through fire and clearing) due to there being sufficient alternative habitats available. This supports the maintenance of genetic and species diversity in the region.
Note: The above ecosystem services are particularly important for species with low or restricted mobility.	

4.2. Social values

4.2.1. Cultural heritage

The traditional owner group of the land that encompasses McDonalds Swamp includes the Wamba Wamba, Barapa Barapa and Wadi Wadi Peoples Native Title Claimants (VC00/5). There are no Registered Aboriginal Parties (RAPs) in the McDonalds Swamp area.

The Kerang Lakes area is known to be one of the most archaeologically significant areas within Victoria. Numerous large cooking mounds once fringed the wetland however many were scalped off and removed during early European settlement (O'Brien R 2010, personal communication, [DPI], 8 February cited in North Central CMA 2010). Five mounds have been recorded in the Red Gum Swamp/McDonalds Swamp area and are registered with Aboriginal Affairs Victoria (AAV). Further information can be obtained from AAV.

4.2.2. Recreation

McDonalds Swamp is a valuable wetland for recreation within the Kerang Lakes area. As a productive area for waterbird feeding and breeding, McDonalds Swamp draws visitors who appreciate its aesthetic value and participate in passive recreational activities, particularly bird watching (SKM 2001).

Under the McDonalds Swamp's status as a State Wildlife Reserve, in-season recreational hunting has historically been popular at the site, particularly for waterfowl (O'Brien, R, 2000, personal communication, April). However, under the more recent watering regime, the wetland is often dry by the commencement of duck hunting season, reducing this value.

4.3. Economic

Historically, McDonalds Swamp provided economic value through duck hunting and domestic stock grazing. Whilst duck hunting continues when conditions are suitable, grazing was phased out in the mid-2000s (North Central CMA 2010).

In addition to direct economic values of the site, McDonalds Swamp also provides a number of indirect economically valuable functions such as flood protections, providing refuges for rare and threatened species, trapping sediments, nutrient assimilation and recycling and providing hydrological stability between surface and ground water in catchments (Gillespie Economics 2008 cited in VEAC 2008)

4.4. Conceptualisation of the site

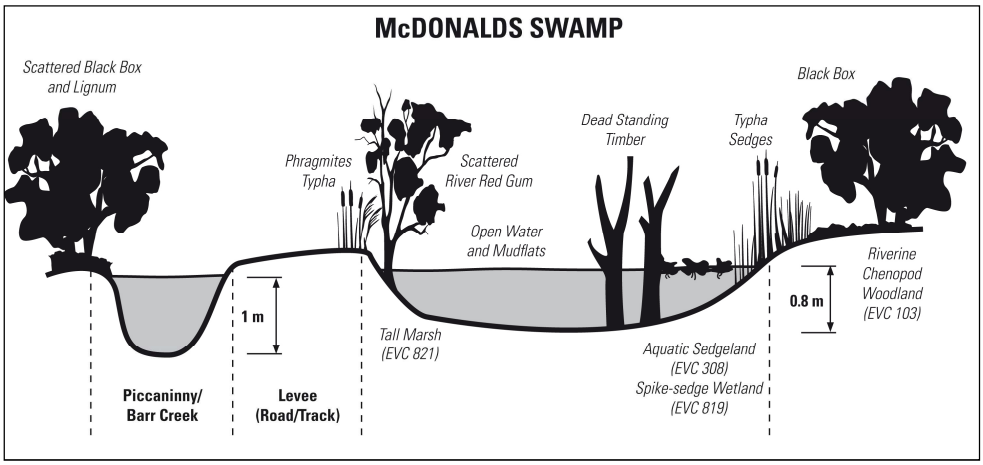

Figure 8. Schematic of wetland areas to be targeted (not to scale)

4.5. Significance

McDonalds Swamp is considered a regionally significant wetland, distinctive for its size (over 100 hectares) and highly diverse habitat that supports over sixty water-dependent species. The wetland occupies 164 hectares which is considered large in comparison to other wetlands within the North Central region (North Central CMA 2010). Only 6% of wetlands within the region are greater than 100 ha in size (North Central CMA 2005).

The wetland is situated in close proximity to two Ramsar-listed sites, acting as an important ecological and biodiversity linkage in a region and landscape that is otherwise highly modified. Habitat values include open water and mudflats, marshland, reed bed and Herbland vegetation, and fringing River Red Gum and Black Box. Open water provides drought refuge during dry spells, while marsh and reed bed habitat provide important nesting substrate and material. Both the dead River Red Gums and new recruits around the wetland fringe provide roosting, nesting and vantage points for birds, bats, reptiles and mammals. The frequent wetting and drying cycle of the wetland stimulates a highly productive environment, rich in nutrients and supportive of food webs.

McDonalds Swamp supports fauna and flora of national and state conservation significance, and migratory waterbirds protected under international agreements. The wetland is an important breeding ground particularly for waterfowl, but also provides roosts and food sources to colonial nesting species, as well as species of high conservation significance such as the Australasian Bittern and the Brolga, both of which were recently recorded there.

Although McDonalds Swamp has suffered from significant tree mortality, it continues to support depleted and endangered vegetation communities and is one of the few River Red Gum and Black Box dominated swamps left in the North Central CMA region.

5. Ecological condition and threats

5.1. Context

Long-term hydrological changes to McDonalds Swamp over the last 150 years (see Section 3.1.2) have altered the wetland substantially, to the detriment of some flora and fauna species and the benefit of others. The current condition has also been impacted by the extreme climatic events of the Millennium Drought (1995-2009) and the large floods that occurred in January 2011. The vegetation structure and composition has changed markedly, with the mortality of River Red Gums throughout the swamp and the proliferation of Cumbungi and Common Reed amongst the most influential factors. The following section describes the results of a number of monitoring measures used to describe the current condition of McDonalds Swamp.

5.2. Current condition

Displacement of wetland vegetation communities

Many of the pre-European wetland EVCs have been displaced as a result of the altered hydrological regime. The dominant pre-1750 wetland EVC was most likely Intermittent Swampy Woodland (EVC 813), indicated by the numerous dead River Red Gums throughout the wetland (Australian Ecosystems 2012; Rakali Ecological Consulting, 2014a). The density of the trees would have varied from very open woodland in the deeper parts of the wetland to open woodland in shallower parts (Rakali Ecological Consulting 2014a) that would have occurred as a complex with Aquatic Herbland (EVC 653) when wet and Lake Bed Herbland (EVC 107) when dry (Rakali Ecological Consulting 2014b). Shallower areas of this EVC would have supported an open shrub-layer of Tangled Lignum in association with more water-dependent species such as Common Spike-Sedge (*Eleocharis acuta*) and Common Nardoo (*Marsilea drummondii*).

As a result of anthropogenic changes to the hydrology of the wetland, and associated changes in salinity, native vegetation has been significantly altered from its pre-European state. Areas that once would have been Intermittent Swampy Woodland are now, due to a loss of understorey and canopy species, more representative of Aquatic Herbland, Aquatic Sedgeland and Tall Marsh. Some species have been advantaged by the altered hydrological conditions, particularly the dominant Cumbungi (*Typha spp.*) and Common Reed (*Phragmites australis*) that have become extremely abundant to the detriment of species diversity in these areas. While these species provide valuable protection and nesting habitat for wetland birds, they also form dense canopies of leaves which heavily shade the area beneath them, inhibiting the growth of other species. The warm, wet conditions that have generally occurred from October to March in McDonalds Swamp are highly conducive to rapid growth, which can lead to the displacement of open habitat and other aquatic species that are important for many fauna species (Rakali Ecological Consulting 2014a). The current extent of these species has been mapped and can be seen in Appendix 5.

Index of Wetland Condition

The Index of Wetland Condition (IWC) compares the current condition of a wetland against a benchmark that reflects the presumed characteristics of the same wetland type prior to European settlement. The IWC defines wetland condition as a state of the biological, physical and chemical components of the wetland ecosystem and their interactions. Sub-indices measured to inform the overall IWC condition score include physical form, hydrology, water properties, soil and biota (see the Index of Wetland Condition Assessment Procedure (DSE 2013) for more information). An assessment of the vegetation condition of McDonalds Swamp using only the biota sub-index component of the IWC was undertaken in 2012 and again in 2014.

The initial IWC biota assessment completed in 2012 compared the condition of the wetland EVC present at McDonalds Swamp (Intermittent Swampy Woodland) against the pre-European

benchmark. This assessment scored the overall biota score for Intermittent Swampy Woodland as 5.88 (Table 11), indicating that it was in very poor condition (Australian Ecosystems 2012). In 2014, a similar assessment was carried out, indicating a marginal increase in score to 6.23, which is still very poor (Rakali Ecological Consulting 2014a). The increase can be attributed to a slight improvement in the diversity and cover of indigenous species and an associated lower cover of weeds. The overall low scores for Intermittent Swampy Woodland are largely because there are few natural components of this EVC remaining, as the River Red Gum canopy has mostly died and the understorey has been invaded by sedge and rush species that are tolerant of prolonged inundation. In particular, Cumbungi and Common Reed species have been advantaged and are extremely abundant in areas of Intermittent Swampy Woodland, having displaced more diverse assemblages of indigenous wetland species (Rakali Ecological Consulting 2014a).

Table 12. IWC assessments for wetland EVCs at McDonalds Swamp against benchmark

Intermittent Swampy Woodland (EVC 813)	2012 IWC Biota Sub-Index Scores	2014 IWC Biota Sub-Index Scores
Critical lifeforms (F)	9.38	10.9
Weeds (G)	10.00	11.5
Indicators of altered processes (H)	10.00	8.75
Vegetation structure and health (I)	0.00	0.00
EVC Score (F+G+H+I/5)	5.88	6.23
Proportion of wetland	1	1
Result (EVC Score x Proportion of wetland)	5.88	6.23

An additional, non-standard assessment was carried out in recognition of the acquired value that the modified vegetation communities that are present now may provide. This non-standard assessment showed that the overall biota score was assessed as 15.5, indicating that the current condition is moderate (Rakali Ecological Consulting 2014b). Given the alternative method used to derive this score, the results of this non-standard assessment cannot be compared to the assessments of original wetland EVCs in Table 11.

The assessment indicated that Aquatic Herbland has a diverse field-layer and a relatively high cover of indigenous species, and a low cover of weeds. Aquatic Sedgeland is strongly dominated by Tall Spike-rush, and lacks diversity. Tall Marsh is strongly dominated by Cumbungi and Common Reed, and is relatively species poor. Apart from the mortality of all trees, vegetation health in each EVC is considered to be relatively good. Intermittent Swampy Woodland was separated into two apparent zones of varying condition on either side of the Piccaninny-Barr Drain (Zone 1 and Zone 2). In both zones, most River Red Gums are dead, although there are some young trees that have recruited. Zone 1 supports a diverse field-layer with a relatively high cover of indigenous species, while in Zone 2 this layer is degraded and invaded by terrestrial species due to a lack of regular flooding. The mapped results of this assessment can be seen in Appendix 4.

Tree condition

A tree condition assessment was completed in 2012 for twenty living River Red Gums in McDonalds Swamp, using the *Protocol for The Living Murray Tree Condition Assessment of River Red Gum and Black Box* (Souter et al. 2010) methodology (Australian Ecosystems 2012). A high number of standing dead River Red Gums are scattered throughout the wetland, but some young trees have recruited on the wetland fringe. Attributes that were assessed include crown extent and density, bark cracking, mistletoe, leaf die-off, new tip growth, epicormic growth and reproduction.

The assessment found that 95% of the sampled trees were classified within the medium to major range for both crown extent and crown density. Ninety percent of the trees were observed with flowering and fruiting buds/capsules either commonly or in abundance. Epicormic growth was either absent or scarce in 80% of sampled trees, while new tip growth was entirely absent throughout the

study area. Over 50 seedlings or saplings were also observed. Tree attributes that are indicative of poor tree health were largely absent from the trees sampled, showing no leaf die-off; supporting intact bark and no mistletoes visible (Australian Ecosystems 2012).

Changes to fauna species diversity and composition

In the short-term, DELWP bird monitoring surveys have indicated that McDonalds Swamp is capable of supporting bird species in the thousands. In 2009 it supported over 3,528 individuals, which may have been a product of the extreme drought conditions and lack of open water in the landscape, but it also supported more than 4,100 individuals during the 2011 floods. The wetland has consistently seen over 1,000 individuals each year since. The changes to the vegetation that have resulted from the altered hydrology in the wetland have seen the provision of habitat that may not have been present in pre-European times, but now provides important habitat for crakes, bitterns, swamphens and other secretive wetland species, including some that are threatened (Rakali Ecological Consulting 2014a). In addition, while Brolga have not been recorded breeding at McDonalds Swamp, it could provide suitable breeding habitat for these species if the extent of open water is maintained (Dedini, M, 2015, personal communication, [DELWP], 11 June).

Records indicate that almost all of the recorded threatened species have been observed within the last 15 years (Table 7), a number of which were observed during drought conditions (including the nationally endangered Australasian Bittern).

5.3. Condition trajectory – do nothing

Since European settlement, McDonalds Swamp has received natural flooding and additional amounts of excess water from the irrigation system, resulting in a more permanent ecology. However, dredging of the Piccaninny Creek has ensured that the wetland rarely receives natural flooding. The modernisation of the irrigation system has also reduced outfall water, except in periods of very heavy rainfall, and then only if the storage is required. In the last decade, environmental water has been the primary source of water to McDonalds Swamp.

As a complementary action to the RCS, the North Central CMA is developing the *North Central Climate Change Adaptation and Mitigation Plan* (in dev.), which predicts the long term impacts of climate change under a range of scenarios. Although the scale of impacts (e.g. severity, timeframe) differs accordingly for each scenario, the following impacts are expected to occur across all scenarios:

- Increased average temperatures in all seasons
- More hot days and less very cold days
- Decrease in winter rainfall
- Possible increase in summer rainfall
- Increase intensity of extreme rainfall
- Continued rainfall variability
- Increased frequency and severity of bushfire and flood events.

Under these predictions, McDonalds Swamp is likely to experience less natural rainfall over the winter period, coupled with higher spring and summer temperatures and increased evaporation during summer.

Although significantly altered from its pre-European state, the acquired vegetation values of the wetland are considered to be in reasonably good health, having recovered from the Millennium Drought following the 2010-11 floods. The wetland supports a high diversity of waterbirds that feed and breed there on an annual basis, including threatened and migratory species. Howver, it should

be noted that there is a notable absence of canopy trees and associated understorey species, and the extent of Cumbungi and Common Reed is disproportionate to benchmark recommendations.

In the absence of the delivery of environmental water, these water-dependent values will diminish. This will be further exacerbated by drier climatic scenarios. There would be a significant loss of diverse habitat and refuge for waterbirds and other wetland fauna species, reducing opportunities for breeding and recruitment in the landscape. The young River Red Gums would die, as well as other wetland flora species.

6. Management objectives

6.1. Management goal

The long term management goal takes into account the values the wetland supports, the current wetland condition and potential risks that need to be managed and is reflective of the management goal that was previously developed for the *McDonalds Swamp Environmental Watering Plan 2010*.

McDonalds Swamp Long-term Management Goal

Maintain McDonalds Swamp as a temporary freshwater marsh with a diversity of aquatic vegetation and habitat types to support feeding and breeding requirements for a range of native waterbirds (including colonial nesting and migratory species), frogs and turtles.

6.2. Ecological objectives

Ecological objectives describe the intended outcomes of environmental water delivery. They contribute towards achieving the long term management goal. The ecological objectives for McDonald Swamp are based on the key water-dependent values of the wetland. Where appropriate, these are expressed as the target condition or functionality for each key value, using one of the following trajectories:

- restore – recover a value that has been damaged, degraded or destroyed and return it to its original condition.
- rehabilitate – repair a value that has been damaged, degraded or destroyed but not to the extent of its original condition.
- maintain – maintain the current condition of a value.

Ecological objectives are presented as primary objectives and as secondary objectives. Primary objectives are related to the key values of McDonalds Swamp and summarise the overall objectives for those values. Secondary objectives either support the primary objectives (e.g. macroinvertebrates are a food source for fish) or are objectives for values for which little baseline information is known (e.g. frogs). If the monitoring budget in future years is restricted it is anticipated that the North Central CMA will prioritise monitoring of primary objectives.

The ecological objectives for McDonalds Swamp and the justification for each are shown in Table 13.

Table 13. Ecological objectives and their justifications for McDonalds Swamp

Objective	Justification
1. Primary Objective – species	
1.1 Maintain foraging and feeding areas for a diversity of waterbirds.	McDonalds Swamp is an important feeding ground for a multitude of waterbird feeding guilds i.e. fish-eating, grazing waterfowl, shoreline foragers, dabbling ducks, deep-water foragers. Linked to habitat objectives 3.1 and 3.2. The wetting and drying cycles stimulate a highly productive environment of micro- and macro-invertebrates and plant species that form the base of the food web in these systems. In turn, these support a range of higher-order fauna species such as waterbirds.
1.2 Support opportunistic breeding events for waterbirds.	A number of waterfowl species are known to breed at McDonalds Swamp, such as ducks and waders (see Table 6 for most recent bird breeding events) whose preferential breeding habitat is fringing dense vegetation and wetlands that are inundated for up to 9 months. McDonalds Swamp is also a productive feeding site for Brolga, and could potentially be a breeding site with the rehabilitation of appropriate habitat (such as aquatic understorey species found in Intermittent Swampy Woodland (EVC 813)). Linked to habitat objectives 3.1-3.4, as providing a variety of habitat types and high productivity of micro and macro-invertebrates and plant species through a wetting and drying cycle should enable breeding opportunities.
2. Secondary Objectives – species	
2.1 Maintain a diverse frog community by providing access to suitable habitat and food sources.	McDonalds Swamp supports a number of frog species that will utilise water bodies of short to long duration (<3 to >6 months) watering cycles. Frogs fulfil a role in the food web by providing a food resource for terrestrial and water-dependent birds, reptiles, and mammals. Linked to native bird objective 1.1 (waterbird feeding).
3. Secondary Objectives - habitat	
3.1 Maintain open water and mudflat habitat, and associated herbaceous aquatic and amphibious species in sections of the wetland.	Areas of this habitat type (e.g. Aquatic Herbland (EVC 653)) within McDonalds Swamp support a good diversity and relatively high cover of native herbaceous aquatic flora species. These species provide a diversity of habitat and food sources for macro- and micro-invertebrates, frogs, turtles and waterbirds.
3.2 Maintain marsh habitat and associated sedges, rushes and reeds, keeping the extent of *Typha* and *Phragmites* to no more than 40% of the wetland extent.	Sedges, rushes and reeds ((e.g. Tall Marsh (EVC 821) and Aquatic Sedgeland (EVC 821)) provide critical protection, nesting habitat and substrate for a number of waterbirds such as bitterns, crakes, reed warblers, ducks and swamp hens. However, some of these flora species are highly competitive and quickly proliferate under favourable conditions, creating large mono-specific patches throughout the wetland. This reduces the diversity of other

Objective	Justification
	species and the habitat opportunities that they provide. In McDonalds Swamp, *Typha* and *Phragmites* currently cover 38% of the wetland, which is just below the recommended target of no more than 40% (Rakali 2014). Maintaining an appropriate extent of these species will provide habitat value for waterbirds while reducing impacts on other habitat types.
3.3 Rehabilitate the extent of River Red Gum canopy and associated understorey (appropriate for Intermittent Swampy Woodland) • Maintain canopy health of existing trees • Provide opportunities for recruitment of River Red Gum and understorey species	Due to decades of permanent inundation there is a high number of standing dead River Red Gums throughout the wetland. These trees are rotting and collapsing. A survey of the few remaining live trees indicated that the majority of trees surveyed are in moderate to very good health. River Red Gum trees provide habitat, shelter and nesting substrate for waterbirds, terrestrial birds, reptiles and mammals. They provide hollows and structural habitat features (i.e. snags); moderate temperature through shading; reduce wind erosion; and maintain soil stability. Mature Red Gums also provide a source of seed and nectar for recruitment and as food sources to some fauna. Restoring the distribution of River Red Gums throughout the swamp is critical to ensure that fauna continue to have access to this important resource even as the dead standing trees are reduced. River Red Gums are one component of the Intermittent Swampy Woodland EVC at McDonalds Swamp. Managing the wetland to support this EVC would assist in maintaining or restoring the distribution of a number of characteristic understorey species such as Tangled Lignum and Canegrass. A small extent of Tangled Lignum is present on the south-eastern fringe of the wetland, while Canegrass is not present, but would likely have been in pre-European times. Tangled Lignum provides habitat for woodland and waterbirds e.g. Whiskered Tern, Freckled Duck. Brolga are known to use Canegrass as nesting material.

6.3. Hydrological requirements

A series of hydrological requirements based on the ecological objectives detailed in Section 6.2 have been developed for McDonalds Swamp. The information provided in Table 14 is a summary of this information.

Table 14. Hydrological requirements for McDonalds Swamp

Ecological Objectives	Water management area	Hydrological Objectives										
		Recommended number of events in 10 years			Tolerable interval between events once wetland is dry (months)			Duration of ponding (months)			Preferred timing of inflows	Depth (m)*
		Min	Opt	Max	Min	Opt	Max	Min	Opt	Max		
1. Primary objectives												
1.1 Maintain foraging and feeding areas for a diversity of waterbird feeding guilds.	Bed/fringe	3	5-10	10	4	4-6	-	4	6	12	Winter to summer	Variable
1.2 Maintain breeding habitat for waterbird species known to breed at McDonalds Swamp.	Bed/fringe	2	5-10	10	-	1-3	-	3-5	5-9	9-12	Early winter to summer	Variable (but >0.2m)
2. Secondary objectives – species												
2.1 Maintain a healthy frog community by providing access to suitable habitat and food sources.	Bed/fringe	Prefer ephemeral or semi-permanent water bodies but will retreat to permanent water bodies in drought conditions						3	3-6	12	Spring/summer	Variable
3. Secondary objectives – habitat												
3.1 Maintain open water and mudflat habitat, and associated herbaceous aquatic species in sections of the wetland.	Bed	5	6-8	8	3-4	7-17	60	1	6-8	11	Late winter/ spring	0.4-1m
3.2 Maintain marsh habitat and associated sedges, rushes and reeds, keeping the extent of Typha and Phragmites to no more than 40% of the wetland extent.	Bed	5	6-8	8	6	7-17	24-36	<1	6-8	11	Autumn to spring	0.25-0.4m
3.3 Restore the distribution of River Red Gum and associated understorey • Maintain health of few existing trees • Provide opportunities for recruitment of trees and understorey species	Bed/fringe	2	5	8	3	7	12-24	2	4	6	Not critical, but more growth achieved if flooded during spring-summer	Not critical for RRG; <1m for lignum

Source: Fitzsimons et al. 2011, Roberts and Marston 2011, Rogers and Ralph 2011, Butcher et al. 2015

6.4. Watering regime

The wetland watering regime for McDonalds Swamp has been derived from the ecological objectives and hydrological requirements detailed in Section 6.2 and 6.3, and considers the range of needs and tolerances of different characteristic species in each objective. 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 volume needed for any given year will need to be undertaken by the environmental water manager when watering is planned.

Due to the potential to flood private property, full supply level (FSL) for the purposes of environmental watering is 75.4m AHD.

Minimum watering regime

Fringe and wetland target years (5 events in 10 years): Fill wetland to 75.4m AHD (0.7m depth) between autumn and early spring (variable timing recommended) to inundate higher elevations around the wetland fringe. Provide top-ups if required to maintain depth of 0.5m to support waterbird breeding event.

In years when inflow occurs in autumn, allow wetland to recede before summer. In years when inflow occurs later (winter/early spring) allow wetland to recede during summer.

Allow wetland to dry for up to two consecutive years.

Optimum watering regime

Fringe and wetland target years (5 events in 10 years): Fill wetland to 75.4m AHD (0.7m depth) between autumn and early spring (variable timing recommended) to inundate higher elevations around the wetland fringe. Provide top-ups if required to maintain depth of 0.5m to support waterbird breeding event.

Wetland only target years (an additional 3 events in 10 years): Fill wetland to 75.10m AHD (0.4m depth) or less between autumn and early spring (variable timing recommended). Provide top-ups to an appropriate depth if required to support waterbird breeding event.

In years when inflow occurs in autumn, allow wetland to recede before summer. In years when inflow occurs later (winter/early spring) allow wetland to recede during summer.

Dry years (2 events in 10 years): Allow wetland to remain dry for up to two consecutive years.

Maximum watering regime

Fringe and wetland target years (5 events in 10 years): Fill wetland to 75.4m AHD (0.7m depth) between autumn and early spring (variable timing recommended) to inundate higher elevations around the wetland fringe. Provide top-ups if required to maintain depth of 0.5m to support waterbird breeding event.

Wetland only target years (an additional 5 events in 10 years): Fill wetland to 75.10m AHD (0.4m depth) or less between autumn and early spring (variable timing recommended). Provide top-ups to an appropriate depth if required to support waterbird breeding event.

In years when inflow occurs in autumn, allow wetland to recede before summer. In years when inflow occurs later (winter/early spring) allow wetland to recede during summer.

Allow wetland to remain dry for a minimum of 3 months.

7. Risk Assessment

A qualitative risk assessment has been undertaken for McDonalds Swamp to assign the level of long-term risk associated with:

- delivery of environmental water; and
- achieving set ecological objectives (i.e. factors outside delivery of environmental water inhibiting ability to achieve objective)

As shown in Table 15, the relationship between likelihood (probability of occurrence) and the severity (severity of the impact) provide the basis for evaluating the level of risk.

Table 15. Risk Matrix

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

The results from the McDonalds Swamp risk assessment are presented in Table 16, adapted from the *McDonalds Swamp Environmental Watering Plan 2010*. Management measures relevant for the moderate to high level risks are recommended and the residual risk is then recalculated using the same risk matrix. Please note that short-term operational risks (e.g. environmental releases causes flooding of private land) are assessed as part of the development of the *Central Murray Wetlands Seasonal Watering Proposal* which includes McDonalds Swamp.

Table 16. Possible risks and mitigation measures associated with environmental water delivery to McDonalds Swamp

Risk No.	Threat	Outcome	Relevant objective	Likelihood	Severity	Risk rating	Management Measure	Residual Risk rating
1	**Threats from environmental water**							
1.1	Encroachment or dominance of native flora species	• Monoculture of Typha sp. and Phragmites sp. • Loss in species diversity • Habitat loss (i.e. open water) • Watering events prove unproductive for waterbirds	1.1, 1.2, 3.1, 3.2, 3.3	Probable	Major	High	• The recommended watering regime has been developed with consideration of preferred growing periods and conditions for dominant native species (*Typha spp. and Phragmites australis*). Allowing the wetland to periodically dry out, and not maintaining water in the wetland over consecutive summer periods targets management of these species. • Active management (spraying, slashing, crash grazing etc) • Regular monitoring and adaptive management of water regime.	Low
1.2	Poor water quality (i.e. temperature fluctuations, blackwater events, high turbidity, salinity and nutrient levels)	• Reduced primary production (turbid water), limiting food resources for aquatic invertebrates and waterbirds. • Encroachment of nutrient tolerant vegetation Typha sp. and Phragmites sp. • Excessive algal growth • Potential fish kills	All	Possible	Moderate	Moderate	• Monitoring of groundwater levels, salinity and nutrient inputs in conjunction with a regular water quality monitoring program. • Adaptively manage water regime and delivery. Environmental water could be used to provide 'freshening' flows.	Moderate
1.3	Groundwater intrusion or discharge to low-lying surrounding area resulting from elevated groundwater levels[3]	• Poor vegetation health • Limited regeneration and dominance of salt tolerant species • Unsuitable habitat for waterbirds and food sources	All	Possible	Moderate	Moderate	• Monitoring of groundwater levels and salinity within wetland and surrounding area to evaluate the threat. • Adaptive management of water regime to minimise impacts on groundwater levels.	Low

[3] Under current conditions of low groundwater levels, this is unlikely. However, if conditions where to change and groundwater levels rose there would be a risk of saline groundwater intrusion into the wetland or discharge onto low-lying adjacent land (Bartley Consulting 2009).

Risk No.	Threat	Outcome	Relevant objective	Likelihood	Severity	Risk rating	Management Measure	Residual Risk rating
2	**Threats to achieving ecological objectives**							
2.1	Loss of standing timber habitat	• Dead River Red Gums are unstable and falling over, with limited regeneration is occurring to replace the dead trees. • Reduced availability of nesting and roosting habitat for birds, bats, mammals.	1.2, 3.3	Probable	Moderate	High	• The recommended watering regime has been developed to provide appropriate hydrological requirements for growth and recruitment of River Red Gums. • Undertake complementary works to plant and protect young River Red Gums. • Regular monitoring of tree health and condition will be undertaken to inform adaptive management of the wetland. • Residual risk rating is low in consideration that an appropriate watering regime will assist in recruitment of River Red Gums.	Low
2.2	Introduced species – fish	• European Carp and Gambusia are possibly present in McDonalds Swamp during inundation events, as they are likely to be present in the irrigation system. A high abundance of these species may limit the establishment of aquatic plants, predate on frogs (food sources for waterbirds) and reduce water quality. However they may also provide a source of food for piscivorous waterbirds.	2.1, 3.1	Possible	Moderate	Moderate	• Annual drying (as per recommended regime) will manage population. • Investigate options to prevent Carp access to wetland during fill events (carp screen). • A broad scale method for carp control is identified as a knowledge gap across the entire Murray-Darling Basin.	Low
2.3	Introduced species – foxes	• Foxes have been observed at McDonalds Swamp. Impacts include predation of juvenile waterbirds, turtles and mammals.	1.1, 1.2	Probable	Moderate	High	• Continued fox control program required • Residual risk reduced to reflect water and target fox control management	Moderate

Risk No.	Threat	Outcome	Relevant objective	Likelihood	Severity	Risk rating	Management Measure	Residual Risk rating
2.4	Introduced species – rabbits	• Herbivory of emergent vegetation as well as recruited understorey and overstorey (i.e. River Red Gums) impacts on the health and extent of native vegetation. The presence of warrens may also disrupt sites of cultural heritage and impact on soil structure.	1.1, 1.2, 3.1, 3.3	Probable	Moderate	High	• Continued rabbit control program required • Active revegetation (including use of plant guards) may be required in heavily impacted areas • Residual risk reduced to reflect active management	Moderate
2.5	Lack of seedbank viability of species not currently present	• Monoculture of Typha sp. and Phragmites sp. • Emergence of unexpected native or exotic species • Restricted regeneration • Lower species diversity	All	Possible	Moderate	Moderate	• The recommended watering regime has been developed with consideration of hydrological requirements to enable plants to complete their life cycles, which includes contribution to the seed bank. • Monitoring (e.g. IWC) and adaptive management. • Fluctuation of water levels will be required to support River Red Gum germination. Consider seeding if necessary.	Low
2.6	Re-location of delivery inlet	• Under the GMW Connections Project, the delivery point may be relocated as the current channel 2/3 may be rationalised. • Flow paths through the wetland may alter and potentially adversely impact vegetation communities (i.e. pond too long or not reach FSL)	3.1, 3.2, 3.3	Possible	Moderate	Moderate	• Determine whether delivery point is to be relocated. • Investigate flow paths of water delivery from new inlet, with consideration of vegetation communities and their hydrological requirements. • Residual risk remains moderate as impacts are expected to be detrimental to at least some vegetation (see North Central CMA 2010 where some investigation has been done for alternative delivery points).	Moderate
2.7	Recreational pressures e.g. hunting increases in response to water event	• Loss of non-game species • Damage to vegetation • Loss of woody debris	1.2	Possible	Moderate	Moderate	• Monitoring of waterbird numbers and diversity. Reporting of information between relevant bodies including Field and Game Australia and DELWP (particularly the occurrence of listed species prior to opening of the hunting season).	Low

Risk No.	Threat	Outcome	Relevant objective	Likelihood	Severity	Risk rating	Management Measure	Residual Risk rating
2.8	Fire	• Habitat and resource loss (e.g. standing timber) • Water quality may deteriorate.	All	Possible	Major	High	• Active management, monitoring (e.g. IWC) and adaptive management.	Moderate
2.9	Chytrid fungus	Chytrid fungus is an infectious amphibian disease that impairs osmoregulation of most species. Although there has been no testing for the disease at McDonalds Swamp, it is considered widespread in Victoria. Mortality rates of up to 100% are common, with adults more vulnerable than tadpoles.	2.1	Possible	Moderate	Moderate	• undertake zoospore counts to identify presence of disease- N.B. the disease is not as prevalent in semi-arid regions (vivacity linked to wet and cold conditions). • No change to residual risk due to limited control measures available.	Moderate

8. Environmental water delivery infrastructure

McDonalds Swamp receives outfalls from channel 2/3 via an automated regulating structure and delivery channel (~600 m) that enters the wetland to the east (Figure 8). A 900 mm siphon passes water beneath the Piccaninny-Barr drain that runs along the eastern side of McDonalds Swamp. The inlet capacity is reported to be 50 ML/day however the siphon has a capacity of 30 ML/day (Stanton, R 2010, personal communication, [G-MW], 18 May) (SKM 2001). The maximum delivered in the past was 38 ML in one day (Velik-Lord, B 2009, personal communication, [North Central CMA], 23 December).

An outlet structure exists in the southern corner of McDonalds Swamp. The outlet drains water into the Piccaninny-Barr Drain where it flows into Barr Creek and then into the Loddon River.

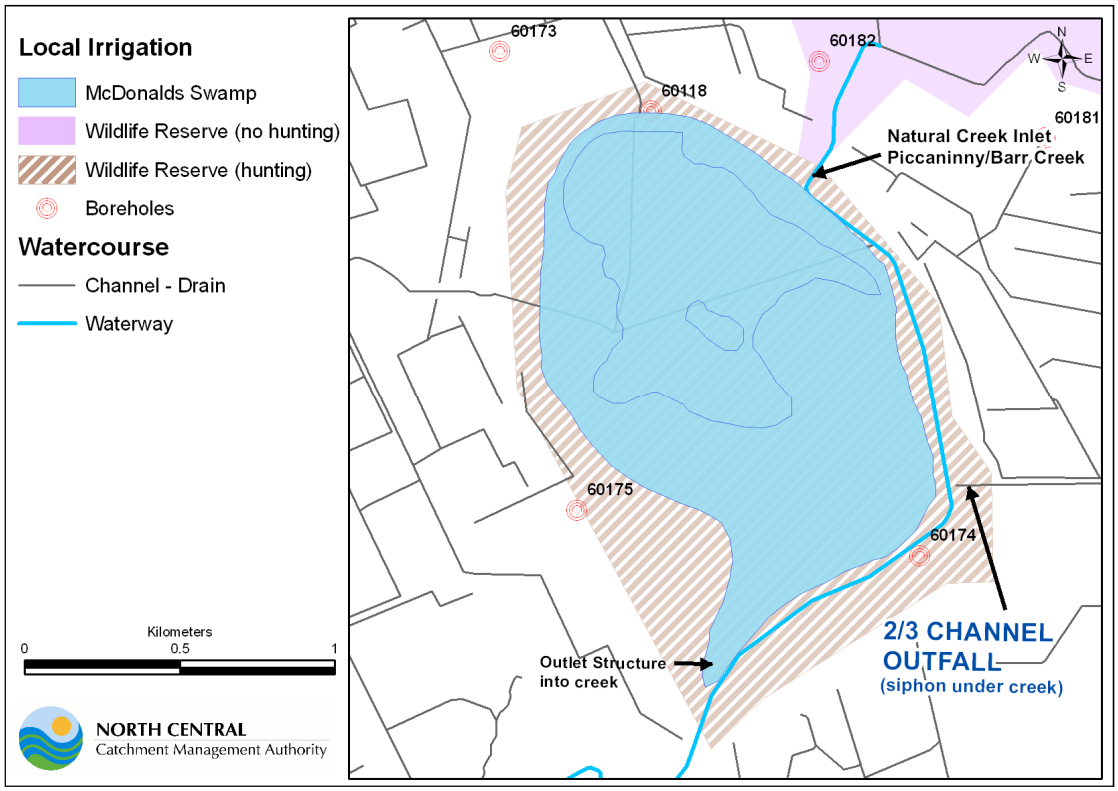

Figure 8. Inflow points at McDonalds Swamp

8.1. Proposed changes to existing infrastructure

The Goulburn-Murray Water Connections Project (GMWCP) includes delivering an automated backbone for the water distribution system, rationalising spur channels, connecting farm water supply to the backbone and upgrading metering on up to 50% of customer supply points in the GMID.

The Torrumbarry No. 5 channel is the backbone within the vicinity of McDonalds Swamp, situated to the north. The GMWCP is currently considering rationalising approximately 9 km of the channel 2/3 and providing a new delivery point to McDonalds Swamp. GMWCP will be required to provide an alternative supply point with the equivalent capacity of existing infrastructure or an agreed delivery rate in order to deliver the desired water regime (35 ML/day is recommended).

Alternative options under consideration are (North Central CMA 2010):

1. providing a new supply point to the west of the wetland. A small drain (8/1/1) with a capacity of 8-10 ML off-takes from channel 5/5 at Craig Road. This drain outfalls into the wetland to the west.

2. providing a new supply point to the northeast of the wetland along Lancaster Road (channel 3/5).

A change to the supply point will change the way water enters and flows through the wetland. It therefore has the potential to change the habitat structure currently in place. Consideration of these impacts has been described in the *McDonalds Swamp Environmental Watering Plan 2010*, with the recommendation that if required, the more appropriate alternative supply point would be the second option, placed in the northeast of McDonalds Swamp with a delivery rate of 35 ML/day.

Detailed costs for an alternative supply option are yet to be investigated.

8.2. Infrastructure constraints

There is currently infrastructure for delivery of environmental water to the western section of McDonalds Swamp. However, there remains a 50 hectare area to the east of the Piccaninny-Barr Drain that is unable to be influenced by environmental water due to a lack of infrastructure. The vegetation communities in this area require less frequent flooding than on the western side, but nevertheless are still water-dependent. Providing water to this area would increase the availability of healthy wetland vegetation to support the primary ecological objectives. Investigations into infrastructure options and costings have been recommended in Section 11.

8.3. Operation constraints

Annual maintenance works are required at the outlet (i.e. slashing of Typha) to ensure the maximum delivery rate of 30 ML/day can be achieved.

The FSL at McDonalds Swamp is 75.5m AHD. However, recent observations during delivery of environmental water show that water begins to encroach on private land at the north-west boundary of the wetland. Subsequent deliveries have instead targeted a lower level of 75.4m AHD to reduce this risk. To enable delivery of environmental water to reach FSL, one of two options would be required:

- An agreement can be made between the VEWH, the North Central CMA and the private landholder, enabling a small section of private land to be flooded during filling events; or
- Construction of a levee would obstruct the flow of water from reaching private land.

Delivering to FSL would enable flooding of the wetland fringe and provide greater support for the ecological objectives.

8.4. Infrastructure recommendations

Additional works to improve the ability to deliver environmental water to McDonalds, as outlined in sections 8.1, 8.2 and 8.3, are recommended below:

- It is recommended that the channel 2/3 is retained to ensure McDonalds Swamp is able to receive environmental water until suitable alternative supply arrangements are agreed upon, if required. If a new supply point is proposed, a more in-depth investigation will be required to understand impacts on wetland vegetation.
- It is recommended that options for delivering water to the eastern part of the wetland are investigated to maintain the availability and diversity of habitat available to fauna.
- It is recommended that options that would enable flooding of adjacent private land so that FSL (75.5m AHD) can be reached are investigated and discussed with the landholder.

9. Complementary actions

Implementation of the recommended watering regime for McDonalds Swamp will generate benefits to the environmental values of the wetland. Some objectives require complementary actions in order to be realised. These are directly related to the risk section, i.e. risk of not achieving objectives (Table 17).

Table 17. Complementary actions to enhance the benefits of environmental watering

Activity	Rationale
Typha spp. and *Phragmites australis* management	These two species have been advantaged by altered hydrology in the wetland and have formed large mono-specific patches throughout the wetland. This results in reduced species diversity and loss of important habitat for wetland species (i.e. open water and mudflats). Active management such as spraying, mowing and slashing, in conjunction with an appropriate watering regime, will assist in controlling the extent of these species.
Revegetation works	McDonalds Swamp has seen a loss in standing timber habitat, with many of the dead River Red Gums beginning to rot and collapse. While there is limited natural recruitment occurring, active revegetation of canopy trees (River Red Gum and Black Box on the wetland fringe) would augment this and provide further opportunities for ecological objectives (i.e. 1.2, 3.3). This could be done by planting tube stock or larger, or trialling direct seeding on the outer fringes of the wetland. These areas are Crown land. In addition, the cover and diversity of indigenous understorey, aquatic and amphibious plants could be improved through species enrichment planting. A diversity of species should be trialled to determine which species would be most suited to prevailing environmental conditions (Rakali Ecological Consulting 2014b).
Exotic flora control	Thirty two percent of species recorded at McDonald Swamp are noted to be exotic. These plant species have the potential to disturb the function of native vegetation through displacement and competition. Exotic plants also impact on primary production within a system, which in turn feeds into all other food web interactions that take place within a system. Weed control such as manual removal and chemical application should target high threat terrestrial and amphibious weeds. This activity is also a complementary activity to revegetation programs.
Fox control	Foxes are commonly observed at McDonalds Swamp. Impacts include predation on juvenile waterbirds, turtles, mammals and terrestrial birds. Fox control measures include baiting and interactive fox drives, and should be intensified during wet phases, particularly if bird breeding occurs.
Protection of turtle nests	Turtle nests are often predated upon by foxes. Using mesh, turtles nests that are identified in the area can be protected.
Rabbit control	Impacts of rabbits are evident at and around McDonalds Swamp with the presence of warrens, scatters and grazed vegetation. The presence of rabbits inhibits recruitment of native vegetation. Rabbit control measures include baiting, warren fumigation or destruction, and education interactive activities such as rabbit buster.

10. Demonstrating outcomes

Monitoring programs enable water managers to justify the application of environmental water by demonstrating that environmental outcomes are being achieved. Monitoring is undertaken to assist with determining the success of managed watering events, and to inform adaptive management of McDonalds Swamp.

DELWP is currently developing WetMAP (Wetlands Monitoring and Assessment Program), which will be a long-term monitoring program aimed at assessing the effect of environmental water on Victorian wetlands. This program is currently in its early stages of development. Currently monitoring is undertaken by DELWP and North Central CMA staff in McDonalds Swamp. The monitoring program described in the McDonalds Swamp EWMP should be revised once the statewide monitoring program has been established.

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

- Intervention monitoring
- Long-term condition monitoring

It is essential that analysis of monitoring results is regularly undertaken in order to develop an understanding of changes occurring at the wetland so that water managers can manage accordingly.

10.1. Intervention monitoring

Intervention monitoring will assess the responses of key environmental values to the changes in the water regime (intervention) and informs the achievement of ecological objectives e.g. to increase the occurrence of waterbird breeding events. Intervention monitoring may include monitoring of water quality, vegetation and biota (i.e. native waterbirds).

Monitoring the response to a watering event will be important to provide feedback on how the system is responding and whether any amendments need to be made to the operational management or determine if any risk management actions need to be enacted.

Current intervention monitoring

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

The internal CMA monitoring program currently includes waterbird monitoring, water quality parameters and short-term changes to wetland condition. This program does not adequately cover the suite of ecological objectives and their response to flows.

Required intervention monitoring

Further intervention monitoring is required so that the CMA is able to adaptively manage McDonalds Swamp over the next ten years to ensure that the delivery of environmental water is achieving the ecological objectives. The proposed intervention monitoring program and the objective that is being monitored is shown in Table 20.

Table 18. Required intervention monitoring for the implementation of the McDonalds Swamp EWMP

Ecological objective		Monitoring question	When	Method
1.1.	Maintain foraging and feeding areas for a diversity of waterbird feeding guilds.	Are waterbirds responding to the watering regime?	Throughout watering event	Visual monitoring as well as the use of monitoring cameras in key areas of the wetland (i.e. in trees over water) Water height monitoring
1.2	Maintain breeding habitat for waterbird species known to breed at McDonalds Swamp.			
2.1	Maintain a healthy frog community by providing access to suitable habitat and food sources.	Are frogs responding to the watering regime	Throughout watering event	Call-back and visual surveys Swabbing for Chytrid Fungus
3.1	Maintain open water and mudflat habitat, and associated herbaceous aquatic and amphibious species in sections of the wetland.	Is the diversity of amphibious and aquatic flora species being maintained or improving under the watering regime?	Annually (only during watering years)	Photopoint and rapid condition assessment monitoring
3.2	Maintain marsh habitat and associated sedges, rushes and reeds, keeping the extent of Typha and Phragmites to no more than 40% of the wetland extent.	Is the diversity and extent of marsh habitat being maintained under the watering regime?	Annually (only during watering years)	
3.3	Restore distribution and cover of River Red Gum canopy and associated understorey (appropriate for Intermittent Swampy Woodland)	Are River Red Gum trees recruiting after flooding?	Approx. one year after environmental watering or natural event.	Photopoint and rapid condition assessment monitoring
Risk		**Monitoring question**	**When**	**Method**
1.1	Encroachment or dominance of native flora species	Is the watering regime causing excessive growth of *Typha spp.* and *Phragmites australis*?	Every two weeks during watering event	Photopoint monitoring
			1 to 3 months after the end of wetting cycle	Comparison of 2014 mapping to aerial imagery[1]
1.2	Poor water quality	Are water quality parameters maintained at acceptable levels during watering events?	Two to three times during a watering event	Measurement of electrical conductivity, pH, turbidity, dissolved oxygen, nutrients.
1.3	Groundwater intrusion or discharge to low-lying surrounding area resulting from elevated groundwater levels	Is the watering regime causing elevated groundwater levels?	Annually	Monitoring of groundwater levels and salinity within wetland and surrounding area[2]

[1]Subject to availability of regularly updated imagery.
[2]See Bartley 2009 for further detail of recommended groundwater monitoring.

10.2. Long term monitoring

Long-term condition monitoring will provide information on whether the watering regime (and other factors) is causing a change in, or maintaining, the overall condition of the wetland (trend over time). As there is currently no formal long-term condition monitoring program in place, Table 19 details monitoring required to demonstrate change in condition over time specifically focusing on the long-term outcomes of the McDonalds Swamp EWMP.

It should be noted that condition monitoring is recommended to be conducted in conjunction with intervention monitoring to comprehensively evaluate any changes to McDonalds Swamp.

Recommendations have been made below for variables to be monitored in order to assess the response to the provision of the desired water regime and inform its adaptive management.

Table 19. Required long-term condition monitoring for McDonalds Swamp

Ecological Objective	Objective No.[1]	Method	When
Specifically relating to ecological objectives			
Maintain foraging and feeding areas for a diversity of waterbird feeding guilds.	1.1	Comprehensive waterbird monitoring including indication of age distribution, movement, abundance, diversity and breeding in the wider population.	Ideally annually with no more than two years between surveys
Maintain breeding habitat for waterbird species known to breed at McDonalds Swamp.	1.2		
Maintain open water and mudflat habitat, and associated herbaceous aquatic and amphibious species in sections of the wetland.	3.1	Comprehensive vegetation condition surveys including tree health, IWC, EVC condition, species presence and abundance and weediness	Ideally annually with no more than two years between surveys
Maintain marsh habitat and associated sedges, rushes and reeds, keeping the extent of Typha and Phragmites to no more than 40% of the wetland extent.	3.2		
Restore distribution and cover of River Red Gum canopy and associated understorey	3.3		
Risks	**Risk No.**	**Method**	**When**
Groundwater intrusion or discharge to low-lying surrounding area resulting from elevated groundwater levels.	1.3	Review groundwater-related aspects of the site, including environmental risks and impact of adopted watering regime. Subject to data availability, this should include an appraisal of the movement of the wetting front and salt, impacts on surrounding groundwater levels and neighbouring land, and a water budget that includes estimates of accessions to groundwater.	At least every 7 years or sooner if regional groundwater levels rise.

11. Knowledge gaps and recommendations

The McDonalds Swamp EWMP has been developed using the best available information. However, a number of information and knowledge gaps exist which may impact on recommendations and/or information presented in the EWMP. These are summarised below with priority status in Table 20.

Table 20. Knowledge gaps and recommendations for McDonalds Swamp

Knowledge Gap	Objective/ Risk	Recommendation	Who	Priority
Objectives				
Determine whether the wetland has suitable breeding habitat for Brolgas (coupled with adaptive management). While Brolgas are not known to have bred at McDonalds Swamp, it may be suitable habitat for them. If this was the case, objectives could be updated to reflect Brolga breeding requirements.	1.1, 1.2	Investigate breeding requirements of Brolga compared to what vegetation types are or could be available at McDonalds Swamp. This could be done through observations at other wetlands where Brolga are known to breed.	CMA or consultant/research body on behalf of CMA	Moderate
Current status of freshwater turtles, particularly the Eastern Long-necked Turtle, at McDonalds Swamp	1.1	Turtle surveys	CMA or research body on behalf of CMA	Moderate
Determine the presence and structure of fish populations at McDonalds Swamp.	1.1	Fish surveys have not been undertaken at McDonalds Swamp as the site is not permanent. However, fish are possibly present in the irrigation system, and could make their way into the wetland while the wetland is filling. Methods include electrofishing, bait trapping, seine and fyke netting.	CMA or consultant on behalf of CMA	Low
Determine the structure of macroinvertebrate, frog and turtle populations at McDonalds Swamp.	1.1	Targeted surveys of macroinvertebrates, frogs and turtles have not been recently undertaken at McDonalds Swamp. Methods include sweep netting or Rapid Bioassessment protocol (macros); Wildlife Acoustic Song Meters (audio) and visual surveys (frogs) and cathedral traps/ fyke nets (turtles). Swabbing for Taqman real-time PCR assay analysis is also recommended to determine presence of Chytrid fungus in frogs.	CMA or consultant on behalf of CMA	High
To facilitate the restoration of Intermittent Swampy Woodland and Riverine Chenopod Woodland, investigate infrastructure options for delivering water to the eastern side of the Piccaninny Drain.	3.3	Assess the benefit of providing environmental water to the eastern part, and infrastructure options and costs.	CMA or consultant on behalf of CMA	High

Investigate options for enabling delivery of water to reach FSL (75.5m AHD).	3.3	Investigate options for constructing a levee or reaching an agreement with the private landholder to flood private land.	CMA	High
To improve connectivity within the landscape, investigate options for installing connections between McDonalds Swamp and Red Gum Swamp to the north-east.	All	Delivery of environmental water to Red Gum Swamp has been proposed under the the North Central CMA Works and Measures program. Prior to European settlement, McDonalds Swamp was connected to Red Gum Swamp during floods to form a larger wetland complex. Now, water by-passes Red Gum Swamp. Investigation into restoring connectivity between the two sites will increase the area of available habitat for flora and fauna, providing greater opportunities for breeding and feeding.	CMA or consultant on behalf of CMA	Moderate
Risks				
Determine impacts from pest fish in McDonalds Swamp.	2.2	Determine presence and abundance of exotic fish species in McDonalds Swamp, and investigate impacts on aquatic flora and fauna.	CMA or consultant/research body on behalf of CMA	Moderate
Determine potential impacts on vegetation communities of re-locating the delivery point, as may occur through the GMW Connections Project.	2.6	Work with GMW to determine if a new delivery point is required as a result of the GMW Connections Project. If so, investigate flow paths and potential behaviour of water to determine ecological impacts to the wetland.	GMW Connections Project	Subject to Connections Project Works Program
To maintain an appropriate extent of *Typha spp.* and *Phragmites australis*, determine best practices for management in McDonalds Swamp.	1.1	Further investigation and monitoring of ecological responses from *Typha spp.* and *Phragmites australis*, trials and consultation/collaboration with other environmental managers can inform better management of this risk.	CMA and consultant/research body on behalf of CMA	Moderate
Determine levels of nutrients in McDonalds Swamp and possible sources.	1.2	Undertake testing for Total Nitrogen and Total Phosphorus at McDonalds Swamp, and if consistently high, investigate possible sources and mitigation measures.	CMA	Moderate
The response of Giant Rush (*Juncus ingens*) to the drying regime is uncertain. If it proliferates, it could contribute to the fire risk as it is highly flammable.	2.8	Monitor response of Giant Rush to the drying regime during vegetation surveys. If it proliferates extensively, management actions may need to be considered.	CMA	Moderate

12. References

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13. Abbreviations and acronyms

BE	Bulk Entitlement
Bonn	The Convention on the Conservation of Migratory Species of Wild Animals (also known as the Bonn Convention or CMS)
CAMBA	China-Australia Migratory Bird Agreement
CEWH	Commonwealth Environmental Water Holder
CMA	Catchment Management Authority
DELWP	Department of Environment, Land, Water and Planning
DEPI	Department of Environment and Primary Industries (Now an amalgamation DELWP in 2015)
DPI	Department of Primary Industries (Now an amalgamation DELWP in 2015)
DSE	Department of Sustainability and Environment (Now DELWP in 2015)
EPBC	Environment Protection and Biodiversity Conservation Act 1999 (Cth)
EVC	Ecological Vegetation Class
EWMP	Environmental Water Management Plan
FFG	Flora and Fauna Guarantee Act 1988 (Vic)
FSL	Full supply level
GIS	Geographical Information System
GMW	Goulburn Murray Water
GMWCP	Goulburn Murray Water Connections Project
HRWS	High Reliability Water Share
JAMBA	Japan-Australia Migratory Bird Agreement
LRWS	Low Reliability Water Share
MEWAG	Central Murray Wetlands Environmental Water Advisory Group
MDBA	Murray-Darling Basin Authority (formerly Murray-Darling Basin Commission, MDBC)
ML	Megalitre (one million litres)
ML/d	Megalitres per day
NCWS	North Central Waterway Strategy
ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement
RCS	Regional Catchment Strategy
SWP	Seasonal Watering Proposal
VEWH	Victorian Environmental Water Holder
VWMS	Victorian Waterway Management Strategy

Appendix 1. 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".

World Heritage Sites

Heritage includes places, values, traditions, events and experiences that capture where we've come from, where we are now and gives context to where we are headed as a community. The World Heritage Convention aims to promote cooperation among nations to protect heritage from around the world that is of such outstanding universal value that its conservation is important for current and future generations. It is intended that, unlike the seven wonders of the ancient world, properties on the World Heritage List will be conserved for all time (DEWHA ~2008a).

East Asian-Australasian Flyway Sites

Australia provides critical non-breeding habitat for millions of migratory waterbirds each year. Migratory waterbirds include species such as plovers, sandpipers, stints and curlews. The corridor through which these waterbirds migrate is known as the East Asian-Australasian Flyway.

To ensure their conservation, the Australian Government has fostered international cooperation through the recently launched East Asian-Australasian Flyway Partnership. Under the Flyway Partnership, the site network for shorebirds has been combined into a single network, referred to as the East Asian–Australasian Flyway Site Network.

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.

Nationally Important Wetlands

Victoria has a number of waterways of National importance as described in A Directory of Important Wetlands in Australia (Environment Australia, 2001).

There are 159 wetlands in Victoria listed in the Directory.

Living Murray Icon Sites

The Living Murray was established in 2002 in response to evidence that the health of the River Murray system is in decline. The Living Murray's first stage focuses on improving the environment at six 'icon sites' along the River:

- Barmah-Millewa Forest;
- Gunbower-Koondrook-Perricoota Forest;
- Hattah Lakes;
- Chowilla Floodplain and Lindsay-Wallpolla Islands;
- Lower Lakes, Coorong and Murray Mouth; and
- River Murray Channel.

The sites were chosen for their high ecological value—most are listed as internationally significant wetlands under the Ramsar convention—and also their cultural significance to Indigenous people and the broader community (MDBC, 2006).

HEVAE

Through National Water Initiative (NWI) commitments, a toolkit for identifying high ecological value aquatic ecosystems (HEVAE) has been developed so that national consistency may be applied. Five core criteria are used to develop HEVAE sites across a range of scales and ecosystems:

- Diversity
- Distinctiveness
- Vital habitat
- Naturalness
- Representativeness.

The HEVAE toolkit is saved at http://www.environment.gov.au/resource/aquatic-ecosystems-toolkit-module-3-guidelines-identifying-high-ecological-value-aquatic

National Heritage Sites

The National Heritage List has been established to list places of outstanding heritage significance to Australia. It includes natural, historic and Indigenous places that are of outstanding national heritage value to the Australian nation (DEWHA ~2008).

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
- Advisory List of Threatened Invertebrate Fauna in Victoria - 2009

Environmental Effects Act 1978

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

Planning and Environment Act 1987

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

Water Act 1989 (Victorian Water Act)

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

Aboriginal Heritage Act 2006

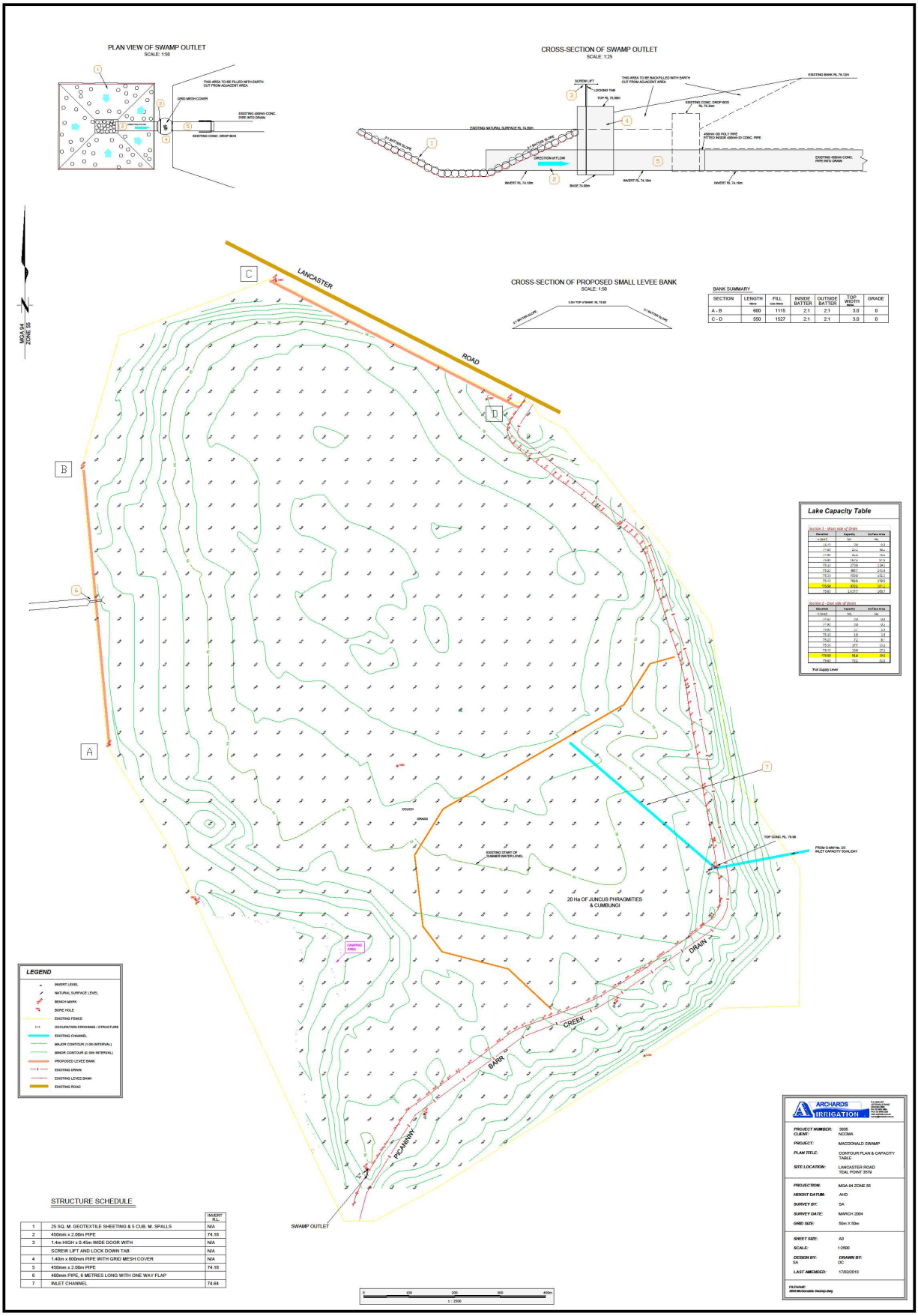
All Aboriginal places, objects and human remains in Victoria are protected under this Act.

Other relevant legislation

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

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

Appendix 2. Contour Map and Capacity Table



Appendix 3. Species lists

Table 21. Fauna species recorded within 1km buffer zone of McDonalds Swamp.

Common name	Scientific name	Date of last record	Source
Amphibians			
Barking Marsh Frog	*Limnodynastes fletcheri*	2014	Rakali 2014b
Common Froglet	*Crinia signifera*	1982	DELWP 2015a
Plains Froglet	*Crinia parinsignifera*	1982	DELWP 2015a
Spotted Marsh Frog	*Limnodynastes tasmaniensis*	2014	Rakali 2014b
Mammals			
Water Rat	*Hydromys chrysogaster*	1968	DELWP 2015a
House Mouse*	*Mus musculus*	1982	DELWP 2015a
Red Fox*	*Vulpes Vulpes*	1982	DELWP 2015a
Reptiles			
Boulenger's Skink	*Morethia boulengeri*	1982	DELWP 2015a
Eastern Brown Snake	*Pseudonaja textilis*	1982	DELWP 2015a
Eastern Long-necked Turtle	*Chelodina longicollis*	2014	Rakali 2014b
Stumpy-tailed Lizard	*Tiliqua rugosa*	1982	DELWP 2015a
Tiger snake	*Notechis scutatus*	2014	Rakali 2014b
Water-dependent birds			
Australasian Bittern	***Botaurus poiciloptilus***	***2004***	Birdlife Australia 2015
Australasian Darter	*Anhinga novaehollandiae*	*2010*	Birdlife Australia 2015
Australasian Grebe	*Tachybaptus novaehollandiae*	*2003*	Birdlife Australia 2015
Australasian Shoveler	***Anas rhynchotis***	***2012***	Australian Ecosystems 2012
Australian Pelican	*Pelecanus conspicillatus*	*2010*	Birdlife Australia 2015
Australian Pratincole	***Stiltia isabella***	***1982***	DELWP 2015a
Australian Reed-Warbler	*Acrocephalus australis*	*2014*	Rakali 2014a
Australian Shelduck	*Tadorna tadornoides*	*2015*	Dedini 2015
Australian Spotted Crake	*Porzana fluminea*	*2015*	Dedini 2015
Australian White Ibis	*Threskiornis molucca*	*2014*	Rakali 2014a
Australian Wood Duck	*Chenonetta jubata*	*2010*	Birdlife Australia 2015
Black Swan	*Cygnus atratus*	*2014*	Dedini 2015
Black-fronted Dotterel	*Elseyornis melanops*	*2014*	Rakali 2014a
Black-tailed Native-hen	*Tribonyx ventralis*	*2014*	Rakali 2014a
Black-winged Stilt	*Himantopus himantopus*	*2014*	Rakali 2014a
Brolga	***Grus rubicunda***	***2014***	Rakali 2014a
Caspian Tern	***Hydroprogne caspia***	***2009***	Dedini 2015
Chestnut Teal	*Anas castanea*	*2015*	Dedini 2015
Common Greenshank	***Tringa nebularia***	***2002***	DELWP 2015a
Dusky Moorhen	*Gallinula tenebrosa*	*2004*	DELWP 2015a
Eastern Great Egret	***Ardea modesta***	***2012***	Australian Ecosystems 2012
Eurasian Coot	*Fulica atra*	*2014*	Dedini 2015
Freckled Duck	***Stictonetta naevosa***	***2012***	Australian Ecosystems 2012
Glossy Ibis	***Plegadis falcinellus***	***2014***	Rakali 2014a
Great Cormorant	*Phalacrocorax carbo*	*1999*	DELWP 2015a
Great crested Grebe	*Podiceps cristatus*	*2011*	Dedini 2015
Grey Teal	*Anas gracilis*	*2014*	Rakali 2014a
Gull-billed Tern	***Gelochelidon nilotica macrotarsa***	***1982***	DELWP 2015a
Hardhead	***Aythya australis***	***2012***	Australian Ecosystems 2012

Common name	Scientific name	Date of last record	Source
Hoary-headed Grebe	*Poliocephalus poliocephalus*	*2010*	Birdlife Australia 2015
Intermediate Egret	***Ardea intermedia***	***2012***	Australian Ecosystems 2012
Little Black Cormorant	*Phalacrocorax sulcirostris*	*1999*	DELWP 2015a
Little Egret	***Egretta garzetta***	***2011***	Dedini 2015
Little Pied Cormorant	*Microcarbo melanoleucos*	*2010*	Birdlife Australia 2015
Marsh Sandpiper	***Tringa stagnatilis***	***2009***	Birdlife Australia 2015
Masked Lapwing	*Vanellus miles*	*2014*	Rakali 2014a
Musk Duck	***Biziura lobata***	***2012***	Australian Ecosystems 2012
Nankeen Night Heron	***Nycticorax caledonicus***	***2012***	Australian Ecosystems 2012
Pacific Black Duck	*Anas superciliosa*	*2014*	Rakali 2014a
Pacific Heron	*Cracticus nigrogularis*	*2001*	DELWP 2015a
Pectoral Sandpiper	***Calidris melanotos***	***2009***	Birdlife Australia 2015
Pied Cormorant	***Phalacrocorax varius***	***2014***	Dedini 2015
Pink-eared Duck	*Malacorhynchus membranaceus*	*2010*	Birdlife Australia 2015
Plumed Whistling-Duck	*Dendrocygna eytoni*	*1993*	DELWP 2015a
Purple Swamphen	*Porphyrio porphyrio*	*2014*	Rakali 2014a
Red capped Plover	*Charadrius ruficapillus*	*2013*	Dedini 2015
Red necked avocet	*Recurvirostra novaehollandiae*	*2014*	Dedini 2015
Red-kneed Dotterel	*Erythrogonys cinctus*	*2014*	Rakali 2014a
Royal Spoonbill	***Platalea regia***	***2014***	Rakali 2014a
Sacred Kingfisher	*Todiramphus sanctus*	*2004*	Birdlife Australia 2015
Sharp-tailed Sandpiper	***Calidris acuminata***	***2014***	Rakali 2014a
Silver Gull	*Chroicocephalus novaehollandiae*	*2010*	Birdlife Australia 2015
Straw-necked Ibis	*Threskiornis spinicollis*	*2014*	Rakali 2014a
Swamp Harrier	*Circus approximans*	*2005*	Birdlife Australia 2015
Whiskered Tern	***Chlidonias hybridus***	***2012***	Australian Ecosystems 2012
White-bellied Sea-Eagle	***Haliaeetus leucogaster***	***2014***	Rakali 2014a
White-faced Heron	*Egretta novaehollandiae*	*2010*	Birdlife Australia 2015
White-necked Heron	*Ardea pacifica*	*2014*	Rakali 2014a
Wood Sandpiper	***Tringa glareola***	***2014***	Rakali 2014a
Yellow-billed Spoonbill	*Platalea flavipes*	*2014*	Rakali 2014a
Terrestrial birds			
Australasian Pipit	Anthus novaeseelandiae	2001	DELWP 2015a
Australian Magpie	*Cracticus tibicen*	*2014*	Rakali 2014a
Australian Raven	*Corvus coronoides*	*2010*	Birdlife Australia 2015
Black Kite	*Milvus migrans*	*2001*	DELWP 2015a
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	*2001*	DELWP 2015a
Black-shouldered Kite	*Elanus axillaris*	*2012*	Australian Ecosystems 2012
Blue-faced Honeyeater	*Entomyzon cyanotis*	*2000*	DELWP 2015a
Brown Falcon	*Falco berigora*	*2009*	Birdlife Australia 2015
Brown Quail	*Coturnix ypsilophora*	*2014*	Rakali 2014a
Cockatiel	*Nymphicus hollandicus*	*1999*	DELWP 2015a
Collared Sparrowhawk	*Accipiter cirrhocephalus*	*2000*	DELWP 2015a
Common Starling	*Sturnus vulgaris*	*2014*	Rakali 2014a
Crested Pigeon	*Ocyphaps lophotes*	*2014*	Rakali 2014a
Crimson Rosella	*Platycercus elegans*	*2001*	DELWP 2015a
Eastern Rosella	*Platycercus eximius*	*2014*	Rakali 2014a
Galah	*Eolophus roseicapillus*	*2014*	Rakali 2014a

Common name	Scientific name	Date of last record	Source
Golden-headed Cisticola	*Cisticola exilis*	*1999*	DELWP 2015a
Grey-crowned Babbler	***Pomatostomus temporalis***	***2012***	Australian Ecosystems 2012
House Sparrow	*Passer domesticus*	*2000*	DELWP 2015a
Laughing Kookaburra	*Dacelo novaeguineae*	*2010*	Birdlife Australia 2015
Little Corella	*Megalurus gramineus*	*2005*	Birdlife Australia 2015
Little Grassbird	*Megalurus gramineus*	*2005*	Birdlife Australia 2015
Little Raven	*Corvus mellori*	*2009*	Birdlife Australia 2015
Magpie-lark	*Grallina cyanoleuca*	*2014*	Rakali 2014a
Marsh Harrier	*Falco cenchroides*	*1982*	DELWP 2015a
Mistletoebird	*Dicaeum hirundinaceum*	*2001*	DELWP 2015a
Nankeen Kestrel	*Falco cenchroides*	*2005*	Birdlife Australia 2015
Noisy Miner	*Manorina melanocephala*	*2014*	Rakali 2014a
Peregrine Falcon	*Falco peregrinus*	*2014*	Rakali 2014a
Pied Butcherbird	*Cracticus nigrogularis*	*2004*	Birdlife Australia 2015
Red-rumped Parrot	*Psephotus haematonotus*	*2014*	Rakali 2014a
Red Wattlebird	*Anthochaera carunculata*	*2012*	Australian Ecosystems 2012
Singing Honeyeater	*Lichenostomus virescens*	*2001*	DELWP 2015a
Southern Boobook	*Ninox novaeseelandiae*	*2012*	Australian Ecosystems 2012
Striated Pardalote	*Pardalotus striatus*	*2005*	Birdlife Australia 2015
Superb Fairy-wren	*Malurus cyaneus*	*2009*	Birdlife Australia 2015
Tree Martin	*Petrochelidon nigricans*	*2005*	Birdlife Australia 2015
Wedge-tailed Eagle	*Aquila audax*	*2000*	DELWP 2015a
Welcome Swallow	*Hirundo neoxena*	*2014*	Rakali 2014a
Whistling Kite	*Haliastur sphenurus*	*2014*	Rakali 2014a
White-breasted Woodswallow	*Artamus leucorynchus*	*2014*	Rakali 2014a
White-fronted chat	*Epthianura albifrons*	*2005*	Birdlife Australia 2015
White-plumed Honeyeater	*Lichenostomus penicillatus*	*2014*	Rakali 2014a
White-winged Fairy-wren	*Malurus leucopterus*	*2014*	Rakali 2014a
White-winged Triller	*Lalage sueurii*	*2003*	Birdlife Australia 2015
Willie Wagtail	*Rhipidura leucophrys*	*2014*	Rakali 2014a
Yellow Thornbill	*Acanthiza nana*	*1999*	DELWP 2015a
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	*2001*	DELWP 2015a
Zebra Finch	*Taeniopygia guttata*	*2004*	Birdlife Australia 2015

Table 22. Flora species recorded within 1km buffer zone of McDonalds Swamp.

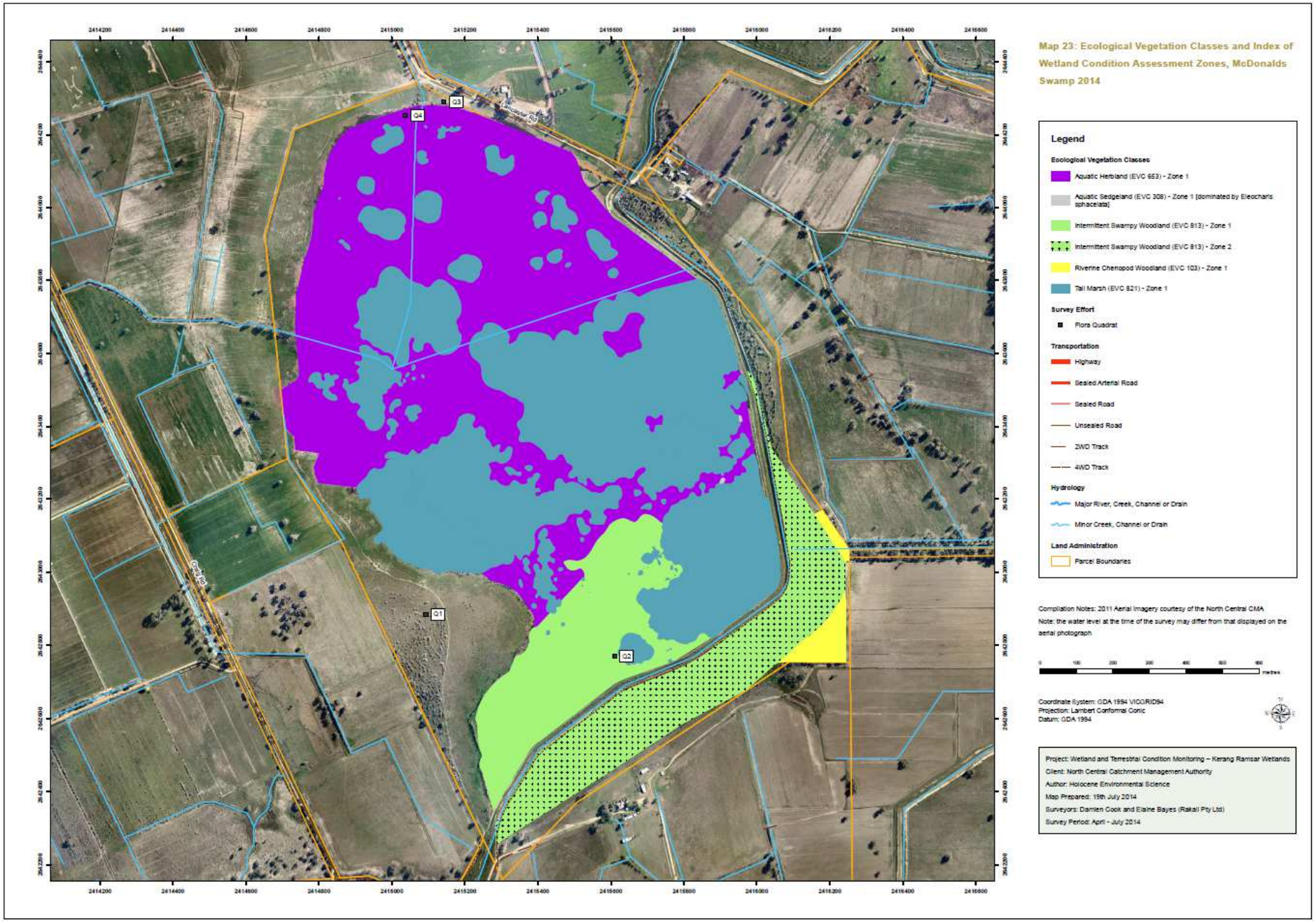
Common name	Scientific name	Date of last record	Source
Water-dependent species			
Annual Cudweed	*Euchiton sphaericus*	2012	Australian Ecosystems 2012
Blackseed Glasswort	*Tecticornia pergranulata subsp. pergranulata*	2014	Rakali 2014a
Bonefruit	*Osteocarpum salsuginosum*	2012	Australian Ecosystems 2012
Broad-leaf Cumbungi	*Typha orientalis*	2014	Rakali 2014a
Brown-back Wallaby-grass	*Rytidosperma duttonianum*	2014	Rakali 2014a
Clammy Goosefoot	*Chenopodium pumilio*	2014	Rakali 2014a
Clay Plantain	*Plantago cunninghamii*	2014	Rakali 2014a
Clove-strip	*Ludwigia peploides subsp. montevidensis*	2012	Australian Ecosystems 2012
Coarse Water-milfoil	*Myriophyllum caput-medusae*	2014	Rakali 2014a
Common Blown-grass	*Lachnagrostis filiformis var. 1*	2014	Rakali 2014a
Common Duckweed	*Lemna minor s.l.*	2014	Rakali 2014a
Common Nardoo	*Marsilea drummondii*	2012	Australian Ecosystems 2012
Common Reed	*Phragmites australis*	2014	Rakali 2014a
Common Sneezeweed	*Centipeda cunninghamii*	2012	Australian Ecosystems 2012
Common Spike-sedge	*Eleocharis acuta*	2014	Rakali 2014a
Common Swamp Wallaby-grass	*Amphibromus nervosus*	2014	Rakali 2014a
Eel Grass	***Vallisneria americana***	**2014**	**Rakali 2014a**
Eumong	*Acacia stenophylla*	2012	Australian Ecosystems 2012
Fennel Pondweed	*Potamogeton pectinatus*	unknown	EWP 2010
Finger Rush	*Juncus subsecundus*	unknown	EWP 2010
Flat Spike-sedge	***Eleocharis plana***	**unknown**	**EWP 2010**
Flat Spurge	*Chamaesyce drummondii*	2012	Australian Ecosystems 2012
Floodplain Fireweed	***Senecio campylocarpus***	**2014**	**Rakali 2014a**
Giant Rush	*Juncus ingens*	2012	Australian Ecosystems 2012
Gold Rush	*Juncus flavidus*	2014	Rakali 2014a
Grey Germander	*Teucrium racemosum s.l.*	1986	DELWP 2015b
Hairy Willow-herb	*Epilobium hirtigerum*	2012	Australian Ecosystems 2012
Knob Sedge	*Carex inversa*	1995	DELWP 2015b
Lesser Joyweed	*Alternanthera denticulata s.l.*	2014	Rakali 2014a
Lesser Sea-spurrey	*Spergularia marina s.s.*	2012	Australian Ecosystems 2012
Marsh Club-sedge	*Bolboschoenus medianus*	2014	Rakali 2014a
Narrow-leaf Cumbungi	*Typha domingensis*	2014	Rakali 2014a
Narrow-leaf Dock	*Rumex tenax*	1995	DELWP 2015b
Nitre Goosefoot	*Chenopodium nitrariaceum*	1986	DELWP 2015b
Pacific Azolla	*Azolla filiculoides*	2014	Rakali 2014a
Pale Knotweed	*Persicaria lapathifolia*	2014	Rakali 2014a
Poison Pratia	*Lobelia concolor*	2014	Rakali 2014b
Red Water-milfoil	*Myriophyllum verrucosum*	2014	Rakali 2014a
Rigid Panic	*Walwhalleya proluta*	2012	Australian Ecosystems 2012
River Club-sedge	*Schoenoplectus tabernaemontani*	2012	Australian Ecosystems 2012
River Red-gum	*Eucalyptus camaldulensis*	2014	Rakali 2014a
Robust Water-milfoil	*Myriophyllum pappilosum*	2014	Rakali 2014b

Common name	Scientific name	Date of last record	Source
Rosinweed	*Cressa australis*	2014	Rakali 2014a
Salt Club-sedge	*Bolboschoenus caldwellii*	2012	Australian Ecosystems 2012
Slender Knotweed	*Persicaria decipiens*	2012	Australian Ecosystems 2012
Small Loosestrife	*Lythrum hyssopifolia*	2014	Rakali 2014a
Spiny Lignum	***Duma horrida subsp. horrida***	**2014**	**Rakali 2014a**
Star Bluebush	*Stelligera endecaspinis*	2014	Rakali 2014a
Tall Fireweed	*Senecio runcinifolius*	2014	Rakali 2014a
Tall Spike-sedge	*Eleocharis sphacelata*	2014	Rakali 2014a
Tangled Lignum	*Duma florulenta*	2014	Rakali 2014a
Thin Duckweed	*Landoltia punctata*	2014	Rakali 2014a
Tussock Rush	*Juncus aridicola*	2012	Australian Ecosystems 2012
Upright Water-milfoil	*Myriophyllum crispatum*		Rakali 2014b
Terrestrial species			
Berry Saltbush	*Atriplex semibaccata*	2014	Rakali 2014a
Black Box	*Eucalyptus largiflorens*	2014	Rakali 2014a
Black Cotton-bush	*Maireana decalvans*	2014	Rakali 2014a
Black Roly-poly	***Sclerolaena muricata var. muricata***	**2012**	**Australian Ecosystems 2012**
Branching Groundsel	***Senecio cunninghamii var. cunninghamii***	**2009**	**Campbell et al. 2009**
Bristly Wallaby-grass	*Rytidosperma setaceum*	2014	Rakali 2014a
Common Cudweed	*Euchiton involucratus s.l.*	1995	DELWP 2015b
Common Purslane	*Portulaca oleracea*	2012	Australian Ecosystems 2012
Common Wallaby-grass	*Austrodanthonia caespitosa*	2009	Campbell et al. 2009
Corky Saltbush	*Atriplex lindleyi subsp. inflata*	2012	Australian Ecosystems 2012
Cotton Fireweed	*Senecio quadridentatus*	2014	Rakali 2014a
Dense Crassula	*Crassula colorata*	1995	DELWP 2015b
Fuzzy New Holland Daisy	*Vittadinia cuneata*	2012	Australian Ecosystems 2012
Grassland Wood-sorrel	*Oxalis perennans*	2012	Australian Ecosystems 2012
Grey Copperburr	*Sclerolaena diacantha*	2012	Australian Ecosystems 2012
Grey Roly-poly	*Sclerolaena muricata var. villosa*	2014	Rakali 2014a
Hairy Bluebush	*Maireana pentagona*	2014	Rakali 2014a
Hedge Saltbush	*Rhagodia spinescens*	2014	Rakali 2014a
Jersey Cudweed	*Pseudognaphalium luteoalbum*	2012	Australian Ecosystems 2012
Lemon Beauty-heads	*Calocephalus citreus*	1995	DELWP 2015b
Moonah	*Melaleuca lanceolata subsp. lanceolata*	2014	Rakali 2014a
Native Sea-spurrey	*Spergularia sp. 1*	2014	Rakali 2014a
Nitre-bush	*Nitraria billardierei*	2014	Rakali 2014a
Nodding Saltbush	*Einadia nutans subsp. nutans*	2014	Rakali 2014a
Pale Goodenia	*Goodenia glauca*	1995	DELWP 2015b
Pale Plover-daisy	***Leiocarpa leptolepis***	**2014**	**Rakali 2014a**
Prickly Saltwort	*Salsola tragus subsp. tragus*	2014	Rakali 2014a
Quena	*Solanum esuriale*	2012	Australian Ecosystems 2012
Ringed Wallaby-grass	*Rytidosperma caespitosum*	2014	Rakali 2014a
Ruby Salt-bush	*Enchylaena tomentosa var. tomentosa*	2014	Rakali 2014a
Short-leaf Bluebush	*Maireana brevifolia*	2012	Australian Ecosystems 2012
Sieber Crassula	*Crassula sieberiana*	1995	DELWP 2015b
Slender-fruit Saltbush	*Atriplex leptocarpa*	2014	Rakali 2014a
Small Knotweed	*Polygonum plebeium*	2009	Campbell et al. 2009

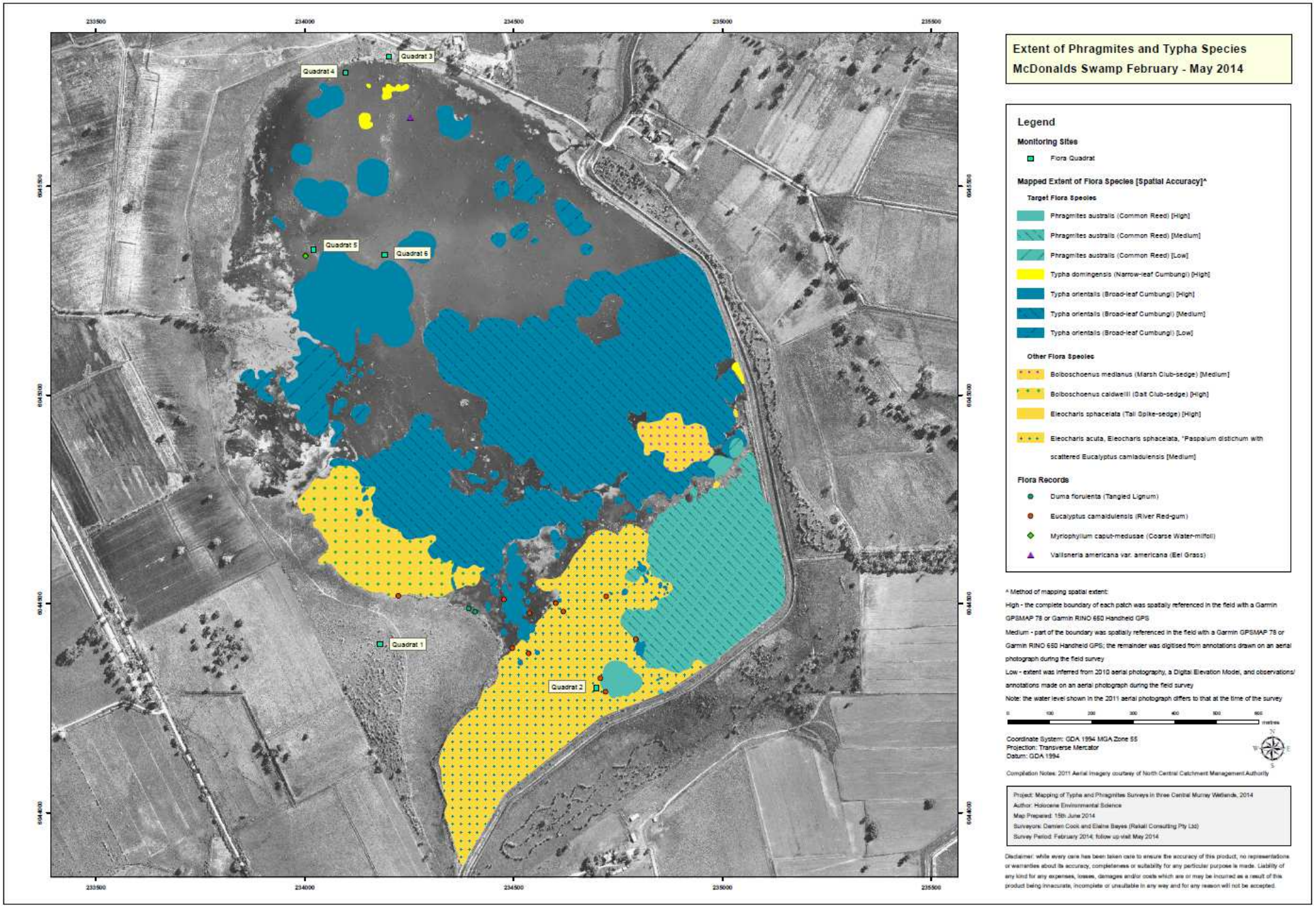
Common name	Scientific name	Date of last record	Source
Spider-grass	*Enteropogon acicularis*	2014	Rakali 2014a
Sprawling Saltbush	*Atriplex suberecta*	2014	Rakali 2014a
Star Cudweed	*Euchiton involucratus s.l.*	uknown	EWP 2010
Turkey Bush	*Eromophila sp.*	2012	Australian Ecosystems 2012
Variable Sida	*Sida corrugata*	2014	Rakali 2014a
Weeping Myall	***Acacia pendula***	**2014**	**Rakali 2014a**
Weeping Pittosporum	*Pittosporum angustifolium (P)*	2014	Rakali 2014a
Windmill Grass	*Chloris truncata*	1995	DELWP 2015b
Woolly Buttons	*Leiocarpa panaetioides*	2012	Australian Ecosystems 2012
Woolly New Holland Daisy	*Vittadinia gracilis*	2014	Rakali 2014a
Exotic water-dependent species			
Annual Beard-grass	*Polypogon monspeliensis*	2014	Rakali 2014a
Aster-weed	*Aster subulatus*	2014	Rakali 2014a
Barnyard Grass	*Echinochloa crus-galli*	2014	Rakali 2014a
Bathurst Burr	*Xanthium spinosum*	2012	Australian Ecosystems 2012
Berry Seablite	*Suaeda baccifera*	2012	Australian Ecosystems 2012
Celery Buttercup	*Ranunculus sceleratus subsp. sceleratus*	2012	Australian Ecosystems 2012
Clustered Dock	*Rumex conglomeratus*	1986	DELWP 2015b
Creeping Heliotrope	*Heliotropium supinum*	2014	Rakali 2014a
Curled Dock	*Rumex crispus*	2014	Rakali 2014a
Drain Flat-sedge	*Cyperus eragrostis*	2014	Rakali 2014a
Ferny Cotula	*Cotula bipinnata*	2012	Australian Ecosystems 2012
Hastate Orache	*Atriplex prostrata*	2012	Australian Ecosystems 2012
Jointed Rush	*Juncus articulatus subsp. articulatus*	1974	DELWP 2015b
Lesser Canary-grass	*Phalaris minor*	2014	Rakali 2014a
Noogoora Burr	*Xanthium occidentale*	2014	Rakali 2014a
Paspalum	*Paspalum dilatatum*	1986	DELWP 2015b
Slender Bard-grass	*Parapholis strigosa*	2012	Australian Ecosystems 2012
Sowbane	*Chenopodium murale*	2014	Rakali 2014a
Spiny Rush	*Juncus acutus subsp. acutus*	1986	DELWP 2015b
Water Buttons	*Cotula coronopifolia*	1986	DELWP 2015b
Water Couch	*Paspalum distichum*	2014	Rakali 2014a
Water-pepper	*Persicaria hydropiper*	unknown	EWP 2010
Exotic terrestrial species			
African Box-thorn	*Lycium ferocissimum*	2012	Australian Ecosystems 2012
Barley-grass	*Hordeum leporinum*	2014	Rakali 2014a
Bearded Oat	*Avena barbata*	2012	Australian Ecosystems 2012
Black Nightshade	*Solanum nigrum s.l.*	2012	Australian Ecosystems 2012
Burr Medic	*Medicago polymorpha*	2014	Rakali 2014a
Chickweed	*Stellaria media*	2012	Australian Ecosystems 2012
Common Heron's-bill	*Erodium cicutarium*	2012	Australian Ecosystems 2012
Common Peppercress	*Lepidium africanum*	2014	Rakali 2014a
Common Sow-thistle	*Sonchus oleraceus*	2014	Rakali 2014a
Dog Rose	*Rosa canina*	2012	Australian Ecosystems 2012
Great Brome	*Bromus diandrus*	1986	DELWP 2015b
Horehound	*Marrubium vulgare*	2012	Australian Ecosystems 2012

Common name	Scientific name	Date of last record	Source
Knotted Clover	*Trifolium striatum*	2014	Rakali 2014a
London Rocket	*Sisymbrium irio*	2014	Rakali 2014a
Onion Weed	*Asphodelus fistulosus*	2009	Campbell et al. 2009
Ox-tongue	*Helminthotheca echioides*	2014	Rakali 2014a
Paterson's Curse	*Echium plantagineum*	2012	Australian Ecosystems 2012
Perennial Ryegrass	*Lolium perenne*	2009	Campbell et al. 2009
Prickly Lettuce	*Lactuca serriola*	2014	Rakali 2014a
Prostrate Knotweed	*Polygonum aviculare s.l.*	2014	Rakali 2014a
Rat's-tail Fescue	*Vulpia myuros*	1995	DELWP 2015b
Red Sand-spurrey	*Spergularia rubra s.s.*	2012	Australian Ecosystems 2012
Rough Sow-thistle	*Sonchus asper s.s.*	2014	Rakali 2014a
Scorzonera	*Scorzonera laciniata*	2014	Rakali 2014a
Sea Barley-grass	*Hordeum marinum*	2012	Australian Ecosystems 2012
Sheep Sorrel	*Acetosella vulgaris*	2014	Rakali 2014a
Shepherd's Purse	*Capsella bursa-pastoris*	2012	Australian Ecosystems 2012
Small Ice-plant	*Mesembryanthemum nodiflorum*	2014	Rakali 2014a
Small-flower Mallow	*Malva parviflora*	2012	Australian Ecosystems 2012
Smooth Mustard	*Sisymbrium erysimoides*	2012	Australian Ecosystems 2012
Spear Thistle	*Cirsium vulgare*	2014	Rakali 2014a
Strawberry Clover	*Trifolium fragiferum var. fragiferum*	1986	DELWP 2015b
Sweet Briar	*Rosa rubiginosa*	2009	Campbell et al. 2009
Toowoomba Canary-grass	*Phalaris aquatica*	1995	DELWP 2015b
Variable Plantain	*Plantago varia*	2012	Australian Ecosystems 2012
Variegated Thistle	*Silybum marianum*	2012	Australian Ecosystems 2012
Wild Oat	*Avena fatua*	1986	DELWP 2015b
Wimmera Rye-grass	*Lolium rigidum*	2014	Rakali 2014a
Winged Slender-thistle	*Carduus tenuiflorus*	2012	Australian Ecosystems 2012
Wireweed	*Polygonum arenastrum*	2009	Campbell et al. 2009

Appendix 4. Ecological Vegetation Class Mapping



Appendix 5. Extent of Typha spp. and Phragmites australis distribution in McDonalds Swamp



Appendix 6. Community and stakeholder engagement

Consultation was undertaken for the Environmental Watering Plan in 2010, which captured information provided by members of the community, interest groups and agency stakeholders. Building on this, consultation was undertaken for the *McDonalds Swamp EWMP* to especially discuss changes to the proposed watering regime, and to confirm ecological values and objectives. As the EWP was written prior to the floods, consultation focused on changes that were observed at the wetland during the floods and in the years since.

Consultation involved a site visit at McDonalds Swamp on the 26th May 2015, as well as a questionnaire and phone interviews with additional people.

Below is a summary of the discussions and information that was received as part of the consultation. Comments have been combined so that they are not referred back to individuals.

Values and wetland condition

- Bird feeding and breeding was widely agreed to be the primary objective for McDonalds Swamp, with management of the Cumbungi and Common Reed, and fox control, required to assist in this.
- McDonald Swamp has suitable habitat for Bitterns, Rails, Crakes and Brolga. Enhancing the current ecological objectives to include Brolga was discussed. For the last 15 years they have been observed at the tall dead tree on the north-east side. The habitat is suitable for Brolga breeding, though maintaining the open water habitat is important for feeding. It is possible though that the wetland is too small, and also is in a heavily modified landscape near main roads and with sheep and cattle surrounding, as opposed to grasslands.
- Cumbungi and Common Reed are not the normal habitat at McDonalds Swamp, but birds are still utilising it so it is still important.
- Birdlife Australia recorded an Australasian Bittern at McDonalds Swamp on 18th November 2014.
- McDonalds Swamp is not a good Swan wetland – after the floods they breed, however the cygnets did not survive. There is good breeding habitat though, especially for ducks.
- Non-migratory birds also need to be considered in the region, need to have drought refuge areas for them to nest and feed on.
- Agreement with the objective to support the regeneration of River Red Gums in the wetland, as the dead timber is unattractive. Revegetation projects should be considered to faciliate this around the wetland fringe, particularly at the northern end.
- A focus on improving tree health to bring it back to the swampy woodland that it once was would assist in
- Adjacent landholders support revegetation/regeneration of trees to make the wetland more attractive – at present it reduces the aesthetic value of surround landscape with the dead timber and reeds.
- Tree regeneration would be the best indicator of swamp rehabilitation – larger trees would assist with controlling the cumbungi and common reed, and improve the appearance of the wetland and diversity of wildlife. It was once a swampy woodland and it would be good to see it returned to that.
- Anecdotally, Black Box trees to the south of the wetland (outside watering footprint) never received water until the Piccaninny Creek was dredged. It is also suggested that these were planted by DSE about 15 years ago.
- Field and Game Australia also undertake restoration work at wetlands. There is a network of 17,000 people, with many residing in Bendigo. There is an opportunity for this group to assist with

Revegetation work and Typha/Reed removal. A group of 20 people could get a lot done in isolated areas.

Threats

- Foxes were noted as a key threat to the wetland, predating on young chicks and turtles eggs. Three foxes were observed at the site visit at the wetland. Feral cats and rabbits are also an issue at this wetland. Walking out into the wetland approximately one hole was observed every four metres. The foxes hide in the cumbungi, and fox drives in previous years have had success. Fox drives need to be organised properly though, as normally shooting feral animals on a State Wildlife reserve is illegal.
- Management of pest animals is a key threat and needs to occur in a coordinated way, including conservation groups, shooting and baiting (especially in the shallow mudflat areas).
    - 10/80 baits for a couple of weeks, shooting follow up
    - Ensure that this work is not implemented when turtles are breeding.
- One threat to waterbird breeding is the extent of Typha/Phragmites at the wetland, because it decreases diversity of habitats. Maintaining the open water is important.
- Trial works to slash the Typha/Phragmites in the wetland have been undertaken at the wetland. Discussion on how it will grow back: the group was concerned by how much the wetland was overrun with these species.
- There is general agreement that keeping the extent of Typha/Phragmites to 40% is an appropriate target.
- Mosquitoes are an issue at the wetland, and disturb cattle on the adjacent farms.

Social and economic values

- Cultural heritage should be considered when planning for the wetland, including indigenous management practices i.e. controlled burns, which may help to manage the Cumbungi and Common Reed.
- Social values of the wetland are mainly bird-watching and duck hunting. No fishing or places to picnic – could work with the Shire to put a table there? Rarely see other people at the wetland.
- Local landholders are ok with hunting, but expect that those who participate will treat the area with respect and behave appropriately.

Wetlands changes

- Phragmites and Typha extent has increased.
- River Red Gums have grown, especially in the south-east corner of the wetland.
- There have always been good birds in the wetland in response to watering, however there used to be a lot more open water. Egrets, Herons, Sea Eagles and Falcons are always here.
- During the 2011 floods, there was a huge abundance of birds at the wetland, it stayed full for a long time and when Red Gum Swamp was flooded, it was very good for the birds.
- Abundance, diversity and even presence of species fluctuates every year and is dependent on a few things, including food availablity and where water is in the landscape i.e. if there's more water in other parts of Australia, birds will go there; if the landscape is relatively dry, birds will congregate where there is water. Depends on the wetting and drying at the wetland – dry phases help with productivity so there is often more food available in a wetting phase after the wetland's been dry.
- Changes to feeding guilds are largely on an annual basis – ducks when there is deeper water, small and large waders as the water recedes.

Wetland watering

- The wetland has been managed wetter than other wetlands in the region.
- The site visit group agreed that watering the wetland every year was too much.
- Flood events usually occur (naturally) in winter/spring to coincide with snow melt, typically the wetlands are dry in Autumn.
- The allocation of environmental water for Barr Creek should be investigated. It is salty at Koondrook Rd.
- Barr Creek was once a healthy creek, anecdotally 80 to 90 years ago it had vegetated banks. It has since been neglected and left as a drain.
- During the flood event of 2010/2011 water backed up from the Barr Creek. Consideration of two weirs to be installed downstream of McDonalds Swamp was raised. A study into the hydrology of the system is recommended.
- Historically the wetland received channel outfalls in May at the end of irrigation season and dried out by December. Anecdotally, issues with cumbungi and typha were lessened during this type of watering regime.

Watering regime

- The 8 in 10 year watering regime seems reasonable, however some still thought the wetland could have more dry phases. They also questioned how effective watering in Autumn would be.
- Dry phases are important to allow dead matter to accumulate and break down, which is what creates the big boost of productivity when watered again.
- Autumn watering may help to control Cumbungi and Common Reed, but could be ineffective for birds. There would be some productivity, and waterbirds would probably come at least initially, but probably would not get the same boom as watering in spring and summer. Conversely, watering too late in spring has had an impact on bird breeding in the last two years.
- Partial fills in autumn could be good to provide water over winter, but drying over summer is important for the cumbungi and phragmites and for the red gums.
- If there is water over summer, this could be very detrimental to the young red gums, which would essentialy have a ring-barking effect from the shallow, hot water.
- There should be water in the wetland in September and October as this is when migratory birds arrive. This is a good time for the wetland to be productive as they need the food sources to breed.
- A good recommendation of initiating a drying phase at McDonalds Swamp when Hird Swamp is having a wet phase, as they provide similar habitat that would then be constantly available for waterbirds. There is wide support for this recommendation.

Photos taken at site visit

Photo 1: Having a look at the trial slashing of Typha and Phragmites

Photo 2: The River Red Gums regenerating in the south-east corner of the wetland

Photo 3: Barr Creek (south of the wetland)

Appendix 7. Assessment against the Murray Darling Basin Plan Criteria for Identifying an Environmental Asset

Table 23. McDonalds Swamp assessed against the Murray Darling Basin Plan criteria for identifying an environmental asset

Item	Criteria	Meets criteria	Justification
Criterion 1: The water-dependent ecosystem is formally recognised in international agreements or, with environmental watering, is capable of supporting species listed in those agreements			
1	Assessment indicator: A water-dependent ecosystem is an environmental asset that requires environmental watering if it is:		
	(a) a declared Ramsar wetland; or		
	(b) with environmental watering, capable of supporting a species listed in or under the JAMBA, CAMBA, ROKAMBA or the Bonn Convention.	✓	Refer to Table 7, McDonalds Swamp has supported species listed under all of the international agreements – JAMBA, CAMBA, ROKAMBA or the Bonn Convention
Criterion 2: The water-dependent ecosystem is natural or near-natural, rare or unique			
2	Assessment indicator: A water-dependent ecosystem is an environmental asset that requires environmental watering if it:		
	(a) represents a natural or near-natural example of a particular type of water-dependent ecosystem as evidenced by a relative lack of post-1788 human induced hydrologic disturbance or adverse impacts on ecological character; or		
	(b) represents the only example of a particular type of water-dependent ecosystem in the Murray-Darling Basin; or		
	(c) represents a rare example of a particular type of water-dependent ecosystem in the Murray-Darling Basin.		
Criterion 3: The water-dependent ecosystem provides vital habitat			
3	Assessment indicator: A water-dependent ecosystem is an environmental asset that requires environmental watering if it:		
	(a) provides vital habitat, including: (i) a refuge for native water-dependent biota during dry spells and drought; or	✓	McDonalds Swamp provides a valuable drought refuge function when conditions are dry and has supported a range of waterbird species during previous environmental water delivery events
	(ii) pathways for the dispersal, migration and movements of native water-dependent biota; or		
	(iii) important feeding, breeding and nursery sites for native water-dependent biota; or	✓	McDonalds Swamp provides extensive mudflat habitat that is not offered by the more permanent lakes within the Kerang region, this habitat is critical for migratory waders
	(b) is essential for maintaining, and preventing declines of, native water-dependent biota.	✓	McDonalds Swamp provides important habitat for water dependent fauna in the area, particularly waterbirds

Item	Criteria	Meets criteria	Justification
Criterion 4: Water-dependent ecosystems that support Commonwealth, State or Territory listed threatened species or communities			
4	Assessment indicator: A water-dependent ecosystem is an environmental asset that requires environmental watering if it:		
	(a) supports a listed threatened ecological community or listed threatened species; or Note: See the definitions of ***listed threatened ecological community*** and ***listed threatened species*** in section 1.07. (Listed under the EPBC Act 1999)	✓	McDonalds Swamp provides habitat for the Australasian Bittern as well as five migratory waterbirds.
	(b) supports water-dependent ecosystems treated as threatened or endangered (however described) under State or Territory law; or	✓	McDonalds Swamp supports two endangered and two vulnerable EVCs within the Murray Fans Bioregion.
	(c) supports one or more native water-dependent species treated as threatened or endangered (however described) under State or Territory law.	✓	Other than the nationally threatened species listed above McDonalds Swamp supports an additional six state listed fauna species.
Criterion 5: The water-dependent ecosystem supports, or with environmental watering is capable of supporting, significant biodiversity			
5	Assessment indicator: A water-dependent ecosystem is an environmental asset that requires environmental watering if it supports, or with environmental watering is capable of supporting, significant biological diversity. This includes a water-dependent ecosystem that:		
	(a) supports, or with environmental watering is capable of supporting, significant numbers of individuals of native water-dependent species; or	✓	McDonalds Swamp provides wetland habitat for a number of protected species
	(b) supports, or with environmental watering is capable of supporting, significant levels of native biodiversity at the genus or family taxonomic level, or at the ecological community level.		

Appendix 8. Criteria and assessment indicators for McDonalds Swamp ecosystem functions

Item	Criteria	Meets criteria	Description for McDonalds Swamp
Criterion 1: The ecosystem function supports the creation and maintenance of vital habitats and populations			
1	**Assessment indicator:** An ecosystem function requires environmental watering to sustain it if it provides vital habitat including:		
	(a) a refugium for native water-dependent biota during dry periods and drought; or	✓	Waterbirds would opportunistically use McDonalds Swmap as a feeding site if in a wet phase (e.g. open water and exposed mudflats)
	(b) pathways for the dispersal, migration and movement of native water-dependent biota; or	✓	McDonalds Swamp acts as a stepping stone between two Ramsar-listed sites, Gunbower Forest and the Kerang Wetlands.
	(c) a diversity of important feeding, breeding and nursery sites for native water-dependent biota; or	✓	McDonalds Swamp provides diverse habitats that support a range of waterbirds.
	(d) a diversity of aquatic environments including pools, rifle and run environments; or	X	
	(e) a vital habitat that is essential for preventing the decline of native water-dependent biota.	X	
Criterion 2: The ecosystem function supports the transportation and dilution of nutrients, organic matter and sediment			
2	**Assessment indicator:** An ecosystem function requires environmental watering to sustain it if it provides for the transportation and dilution of nutrients, organic matter and sediment, including:		
	(a) pathways for the dispersal and movement of organic and inorganic sediment, delivery to downstream reaches and to the ocean, and to and from the floodplain; or	X	
	(b) the dilution of carbon and nutrients from the floodplain to the river systems.	X	
Criterion 3: The ecosystem function provides connections along a watercourse (longitudinal connections)			
3	**Assessment indicator:** An ecosystem function requires environmental watering to sustain it if it provides connections along a watercourse or to the ocean, including longitudinal connections:		
	(a) for dispersal and re-colonisation of native water-dependent communities; or	X	
	(b) for migration to fulfil requirements of life history stages; or	X	
	(c) For in-stream primary production.	X	

Item	Criteria	Meets criteria	Description for McDonalds Swamp
Criterion 4: The ecosystem function provides connections across floodplains, adjacent wetlands and billabongs (lateral connections)			
4	**Assessment indicator:** An ecosystem function requires environmental watering to sustain it if it provides connections across floodplains, adjacent wetlands and billabongs, including:		
	(a) lateral connections for foraging, migration and re-colonisation of native water-dependent species and communities; or	X	
	(b) lateral connections for off-stream primary production.	X	