Connecting Rivers, Landscapes, People

Round Lake
Environmental Water Management Plan

NORTH CENTRAL
Catchment Management Authority
Connecting Rivers, Landscapes, People

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EXECUTIVE SUMMARY

The Round Lake Environmental Water Management Plan (EWMP) sets out the long-term objectives for the priority environmental values of Round Lake, in the Kerang Lakes 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 Round Lake 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 Round Lake EWMP. The main conclusions to facilitate appropriate environmental water management into the future are summarised below.

Hydrology and system operations

Round Lake is a natural wetland depression on the edge of the Mallee and northern floodplains. It historically received variable flood flows from the combined Avoca and Little Murray floodplain systems.
The lake has been dramatically altered since European settlement, owing to shallow saline groundwater intrusion following the construction of the Torrumbarry Irrigation System in the 1920s and from water received indirectly from the Tresco horticultural catchment to the south. Round Lake is currently managed as a permanent saline lake, and has received environmental water since 2004 via the 1/9 irrigation channel to support the endangered Murray Hardyhead (*Craterocephalus fluviatilis*).

Water dependent values

Round Lake is a wetland of regional significance as it supports one of less than ten remaining populations of the endangered Murray Hardyhead. Additionally, large numbers of waterbirds, including 15 species of conservation significance, use the lake for feeding. Round Lake also supports populations of submerged aquatic plants including Large-fruit Tassel (*Ruppia megacarpa*) and Charophytes. These plants provide critical habitat for Murray Hardyhead and various waterbirds.

Ecological condition and threats

Recent index of wetland condition assessments indicate that Round Lake is in good health. Observations in 2016 indicate that the lake continues to support populations of the endangered Murray Hardyhead. Surveys in 2015 also indicate that Round Lake supports a high abundance and diversity of waterbirds (including several listed species) that use the lake during environmental watering events.

Management objectives

The long-term management goal for Round Lake is to:

Maintain Round Lake as a permanent, saline lake that provides suitable habitat for the threatened Murray Hardyhead and submerged aquatic vegetation, particularly Large-fruit Tassel and charophytes (macroscopic algae).

The ecological objectives and hydrological objectives that sit under the long-term management goal for Round Lake were informed by the *Round Lake Environmental Watering Plan 2015* (North Central CMA 2015a) and other technical investigations and were refined during the development of this EWMP.

Managing risks to achieving objectives

The main risk to achieving the objectives is water quality as Murray Hardyhead requires a permanently saline environment and is potentially susceptible to sudden or frequent fluctuations in salinity. It is imperative that the water regime is managed adaptively to incorporate new knowledge of the requirements of Murray Hardyhead.

Environmental water delivery infrastructure

Round Lake is maintained as a permanent saline lake, with top-ups provided via the irrigation system at a rate of 10 ML/day, a rate considered appropriate for delivering fresh inflows in spring and top-ups as required, to maintain suitable habitat and salinity levels for Murray Hardyhead. The capacity of the current water delivery infrastructure is considered adequate, although the infrastructure could be upgraded to improve safety and system efficiency.

Upgrading the existing drop-board outfall structure with an automated regulator would minimise losses (bar leakage), enhance safety and allow greater operational control. Replacing the earthen embankments that separate Round Lake from Golf Course Lake and Long Lake with automated regulator structures would improve operational control and allow future connectivity between the three Tresco lakes.

Demonstrating outcomes

Intervention and condition monitoring are required to assess the effect of annual environmental watering events, demonstrate the long-term outcomes of the Round Lake EWMP and adaptively manage future environmental water delivery to the site. Specific monitoring recommendations outlined in the EWMP include fish surveys, a water quality monitoring program, and longer term condition monitoring through vegetation surveys and the index of wetland condition (IWC) assessment.

Consultation

Key stakeholders, including DELWP, Parks Victoria and Goulburn Murray Water (GMW) were engaged during the development of this EWMP. Community consultation for the EWMP consisted of phone conversations with the community members originally consulted for the EWP, specifically focussing on changes to the Lake over the last 5 years.

Knowledge gaps

The management actions in the Round Lake EWMP are based on the best available information, but there is a degree of uncertainty associated with the recommendations. The main knowledge gaps include:

- The salinity tolerances of some key submerged aquatic vegetation (Charopyhte species).
- The salinity tolerances of eggs and larvae of the Murray Hardyhead.
- Potential impacts that construction works associated with the GMW Connections Project will have on Round Lake and its surrounds.

ACKNOWLEDGEMENTS

The information contained in the Pig 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 and previous Round Lake EWPs, which the EWMP was largely based on:

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- Geoff Sainty (Sainty Associates)
- Jon Bartley (Bartley Consulting)
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- Shelley Heron (Kellogg Brown and Root)
- Dustin Chislett (Archards Irrigation)
- Mark Reid (DPI Primary Industries Research Victoria)
- Andrea Joyce (Department of Sustainability and Environment)
- Mark Tscharke (Parks Victoria)
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- Pat Feehan (Feehan Consulting)
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- NVIRP Technical Advisory Committee
- Wetland workshop attendees
- Tom Lowe, John Jobson, Barry Free, Peter Koestveld (Landholders and community members)
- Bridie Velik-Lord, Rebecca Horsburgh, Peter McRostie, Lyndall Rowley (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

Round Lake is a saline wetland located at the south-western side of the township of Lake Boga in northern Victoria. The lake is located at the junction of the Avoca River and Murray River floodplains, and was originally flooded by high flows in either of these systems. The lake was incorporated into the Torrumbarry Irrigation System and developed a permanent and saline water regime under the influence of elevated groundwater levels and saline irrigation drainage inflows. These conditions have provided habitat for the nationally Endangered Murray Hardyhead, a small fish which benefits from the Large-fruit Tassell and charophyte vegetation growing on the wetland bed. The lake also provides habitat for migratory wading birds.

Following improvements in irrigation practices and water delivery, Round Lake no longer receives either irrigation drainage water or outfall water. To preserve the important conservation values that have developed at the lake, this Environmental Water Management Plan sets out long term ecological objectives and hydrological targets.

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 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 up until 2022 (North Central CMA 2014).

Round Lake is identified as a priority wetland in the NCWS and the main management aim for the site is to:

- Maintain populations of endangered Murray Hardyhead through appropriate environmental water regime and provide suitable waterbird habitat.

These targets are reflected in the overall management goals and objectives described in this EWMP (Section 6). The EWMP recommends a number of management activities 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. It is intended that these activities will be delivered in collaboration with the CMAs 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 Round Lake. This EWMP aims to establish the long-term environmental water management goals for Round Lake to guide future management.

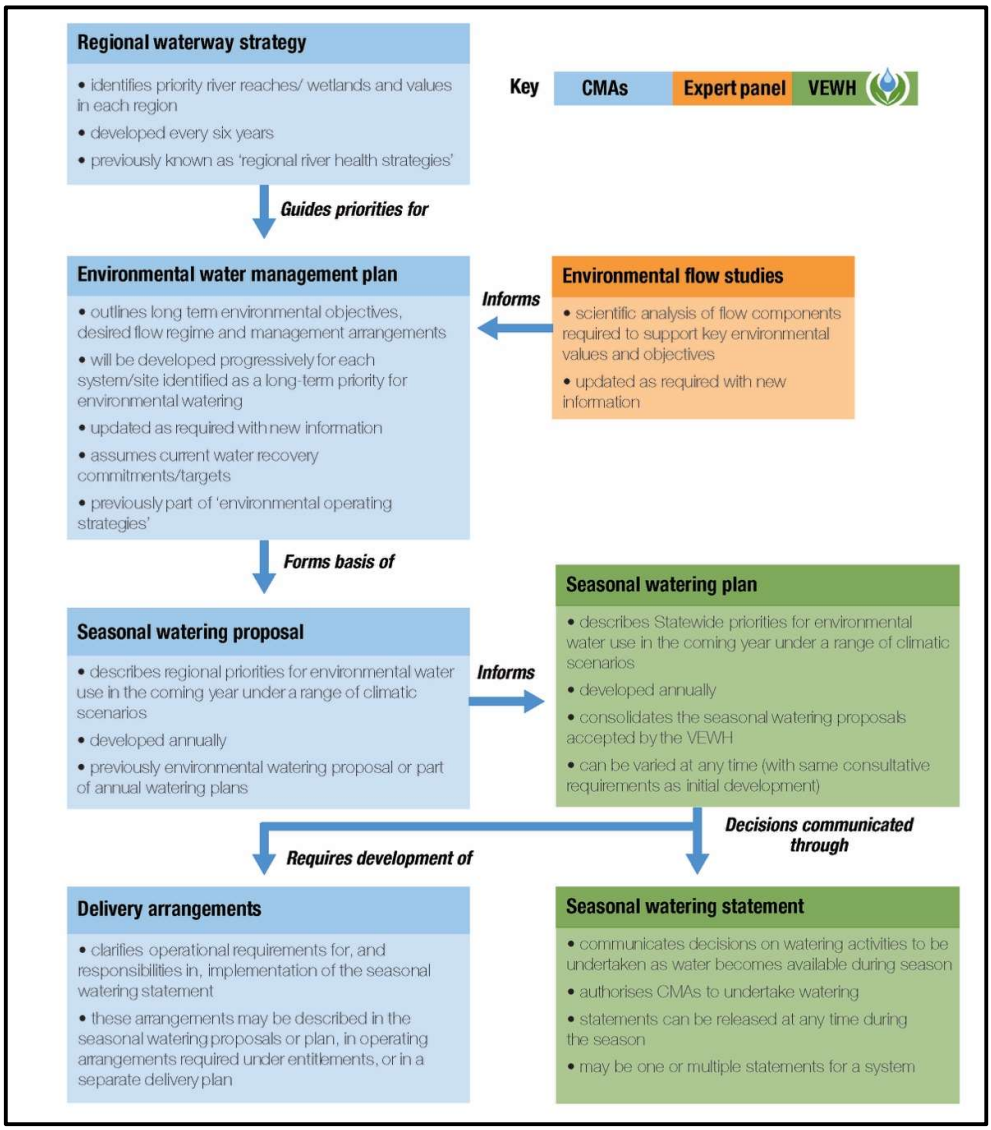


Figure 1. Planning framework for decisions about environmental water management in Victoria (VEWH, 2016).

1.1. Purpose and scope

The Round Lake EWMP is a ten year management plan that describes the ecological values present, the long-term goal for the wetland, priority ecological objectives and the watering regime required to achieve these objectives. It is based on both scientific information and stakeholder consultation and will be used by the North Central CMA inform the development of future seasonal watering proposals (SWPs) and seasonal watering plans; and inform Long-term Watering Plans that will be developed by the State under Chapter 8 of the Murray-Darling Basin Plan (DEPI 2014a). DELWP and the VEWH will also use the EWMP to inform short and longer-term environmental water planning across the state (DEPI 2014a). The scope of this EWMP is the Round Lake section (40ha) of the Long Lake and Round Lake Water Reserve, which occupies approximately 186 ha.

1.2. Development Process

Round Lake 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) (North Central CMA 2015a). The purpose of the EWP was to establish a volume of mitigation

water that Goulburn Murray Water Connections Project was required to set aside for Round Lake. The EWP established ecological objectives and a watering regime for Round Lake, which have been largely retained in this EWMP.

Specific tasks undertaken to develop the EWMP included:

- **Update information on condition**: Ecological Vegetation Condition (EVC) mapping, IWC assessments and flora and fauna (incidental) surveys were undertaken in August 2014.
- **Collation of flora and fauna records:** Species lists and status were updated with new records from relevant databases and surveys.
- **Collation of water quality data**
- **Community and stakeholder consultation**: Members of the original community group, where available, were consulted via telephone to provide input into the draft EWMP, particularly relating to the water management goal, ecological objectives and optimum watering regime. See Appendix 5 for further details

The most recent technical information including monitoring data, water delivery information and results of ecological investigations has been considered in the development of the Round Lake 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 Round Lake. 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 Round Lake 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 Round Lake 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 on the delivery of environmental water are identified and recommendations are made to improve environmental water delivery in the future.
- **Demonstrating outcomes**: A suite of long-term and intervention monitoring activities are recommended to adaptively manage the delivery of environmental water and to demonstrate the outcomes against the ecological objectives.

- **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.

2. Site overview

2.1. Site location

Round Lake is a permanent saline lake located immediately south-west of Lake Boga (Figure 2). The lake is approximately 40 ha (Archards Irrigation 2010) and forms part of the Long Lake and Round Lake Water Reserve, which occupies approximately 186 ha (DSE 2009a). It also forms a component of the Tresco Lakes, which is a series of three relatively deep wetlands that comprises (from south to north) Golf Course Lake, Round Lake and Long Lake (Figure 3).

Round Lake is an important refuge for Murray Hardyhead (*Craterocephalus fluviatilis*), a small native fish which lives for a maximum of 18 months in the wild. The species is listed as endangered under the International Union for the Conservation of Nature (IUCN) Red List, endangered under the Federal Environment Protection Biodiversity Conservation (EPBC) Act 1999 and is listed under Victorian Flora and Fauna Guarantee (FFG) Act 1988. Murray Hardyhead is endemic to Australia and the population in Round Lake is one of less than ten known remaining populations. The Murray Hardyhead population in Round Lake is the only viable population in the Kerang area (A Keleher [DELWP] pers. comm., 27 Nov 2014).

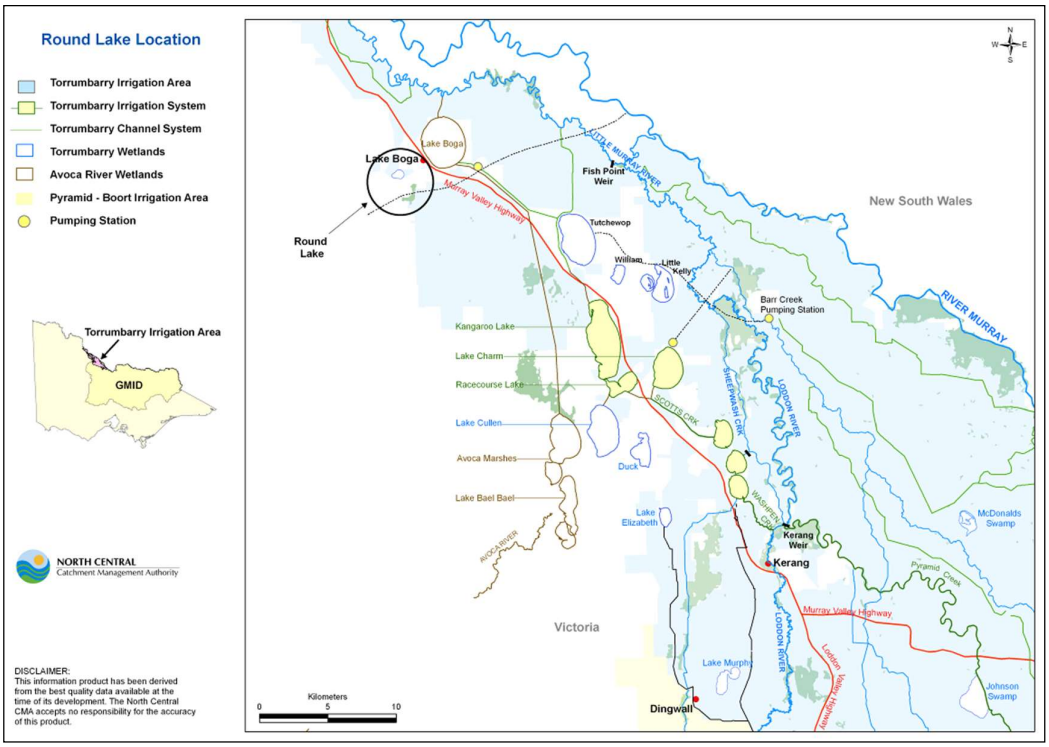


Figure 2. Location of Round Lake

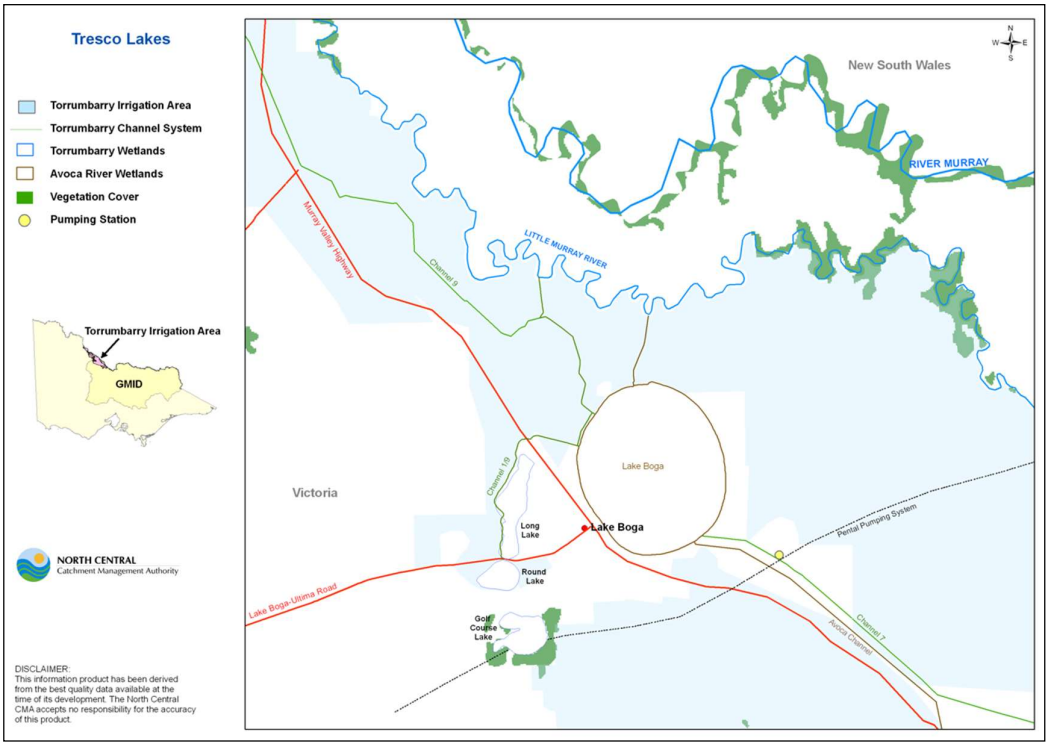


Figure 3. Tresco Lakes landscape map

2.2. Catchment setting

Climate

Between 1903 and 2008, the annual average rainfall recorded at nearby Lake Boga was 334 mm/year, with the months May to October being significantly wetter than November to April (Macumber 2009). An annual average of 312 mm fell during the prolonged drought conditions experienced between 1997 and 2009 (Macumber 2009). The drought broke in 2010 and was followed immediately by wet years in both 2010 and 2011. Since 2011, annual rainfall has been slightly below average, with 2015 being a particularly dry year (225mm) (Bureau of Meteorology 2016). Maximum average daily temperatures within the Kerang region range from 31.5°C in January to 14°C in July, with minimum average daily temperatures falling to 4°C in July (Bureau of Meteorology 2015).

Hydro-physical characteristics

Round Lake is located in the Kerang Lakes sub-catchment on the floodplains of the Loddon and Murray rivers. It is situated within the Murray Mallee bioregion, an area that is characterised by broad undulating sandy plains associated with linear, east-west aligned, low sand dunes with intervening heavier textured swales developed from alluvial, aeolian and swampy deposits, which have been laid down in the current Cainozoic era (DEPI 2014d). The plains, drainage lines and groundwater discharge landscapes are interspersed with salt lakes and gypsum flats, with lakes usually having lunettes on their eastern margins (DEPI, 2014d).

Round Lake is part of the broader wetland complex that occurs within the Loddon-Murray region, which includes the Kerang Wetlands Ramsar site. These wetlands include freshwater lagoons, permanent open freshwater lakes, deep freshwater marshes, saline wetlands and hypersaline wetlands (DSE 2004). Round Lake is not one of the Ramsar site wetlands. Lake Boga, which

influences the groundwater of Round Lake, is operated by GMW as a Victorian Mid Murray Storage lake as part of the Torrumbary Irrigation District. Figure 4 shows the natural topography of the area and the location of Round Lake within the broader wetland complex.

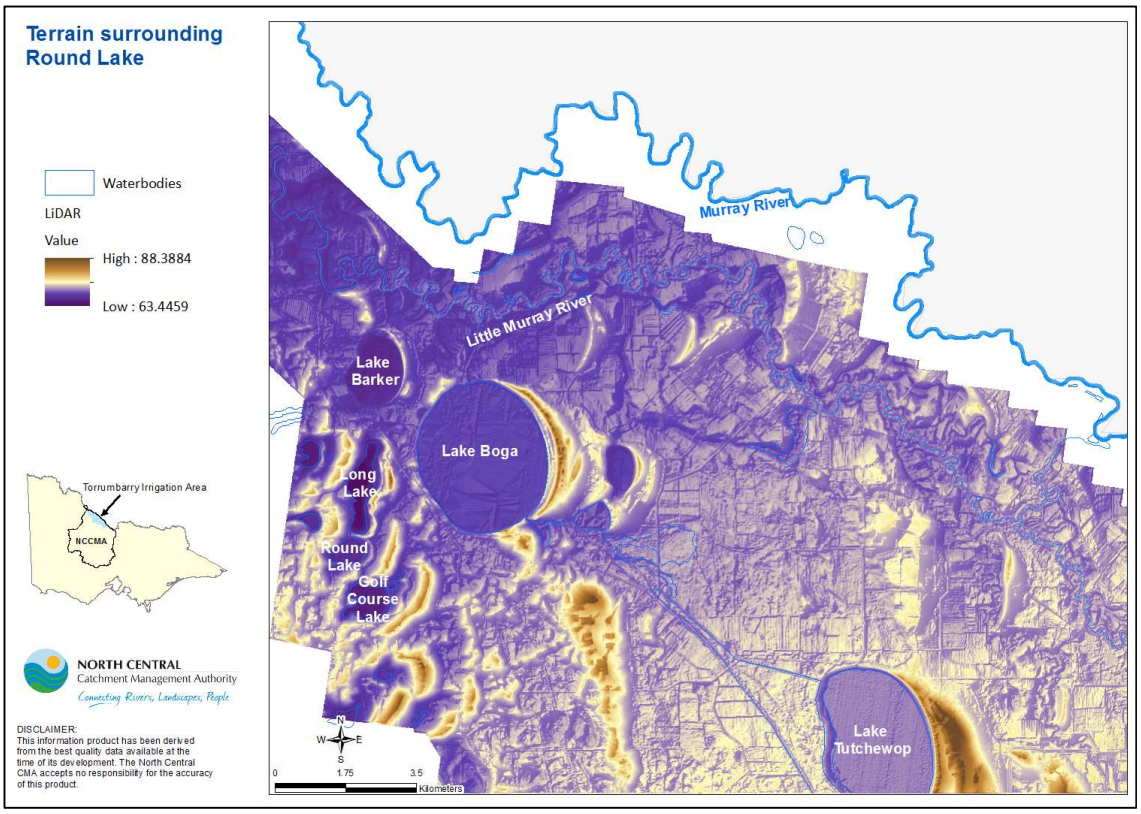


Figure 4. Terrain surrounding Round Lake

2.3. Land status and management

Land use

Round Lake is surrounded by the Tresco horticultural area. Land use on the south-western side of the lake is horticulture (irrigated vine fruits); to the north of the lake is the Tresco Bushland Reserve, and to the east is the township of Lake Boga. The broader surrounding land uses are horticulture and dry land cropping and grazing.

Land tenure

Round Lake is Crown Land classified for Water Supply, Regulation and Drainage use under Section 4 of the Crown Land (Reserves) Act 1978 and is managed by GMW (DSE 2009a). This designation requires that the lake is managed for the storage and distribution of irrigation and domestic water, flood mitigation, and disposal of drainage water. Nature conservation and recreation activities are permitted to an extent consistent with the primary purpose (LCC 1988).

There are several agencies directly involved in environmental water management in Victoria. Table 1 describes the key stakeholders involved in managing or providing input into environmental water delivery at Round Lake.

Table 1. Roles and responsibilities for environmental water in Round Lake

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 for approval 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 - Review and approve EWMPs and endorse 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 State-wide Seasonal Watering Plan - Provide final endorsement of SWPs - Approve 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.
Murray-Darling Basin Authority (MDBA)	- Implement the Murray-Darling Basin Plan, which sets legal limits on the amount of surface water and groundwater that can be taken from the Basin from 1 July 2019 onwards - Integrate Basin wide water resource management - Manage of The Living Murray (TLM) 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 environmental water requirements of priority rivers and wetlands to meet agreed objectives and implement environmental works to use environmental water 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) and report on environmental water management activities undertaken.

Agency/group	Responsibilities/involvement
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 within the constraints of the water supply system and needs of other entitlement holders. - 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 - Provide endorsement of SWP and facilitate 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 endorse 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	
Wamba Wamba, Barapa Barapa and Wadi Wadi Peoples Native Title Claimants	- Traditional owners of the area encompassing Round Lake.
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 Round Lake - 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 based on a hierarchical classification. The first classification level distinguishes between naturally-occurring and human-made wetlands. The second classification level distinguishes between aquatic ecosystem habitats: palustrine, lacustrine and estuarine wetlands. The third classification level distinguishes wetlands based on the following attributes: water regime, salinity, landscape context, soils and wetland vegetation (DEPI 2014b).

Under Corrick and Norman, the pre-European classification (1750 Classification) for Round Lake identified it as a deep freshwater marsh. Due to extensive irrigation outfalls throughout the 20th century, it was re-classified as a permanent saline wetland (subcategory: shallow <5m) (1994 classification). Round Lake is classified as a permenant saline lake under the ANAE system. The lake has a maximum depth of 3.2m and the lake floor is 64.6 m AHD (Macumber 2009). An overview of the wetland characteristics is provided in Table 2.

Table 2. Wetland characteristics of Round Lake

Characteristics	Description	
Name	Round Lake	
Mapping ID (Corrick)	43609	
Area (ha)	Reserve	186 hectares
	Wetland	40 hectares
Bioregion	Murray Mallee	
Conservation status	Bioregionally Important Wetland	
Land status	Crown land	
Land manager	GMW	
Surrounding land use	Dryland cropping and grazing	
Water supply	Natural: Backed-up Murray River flood flows Current: Channel outfalls (1/9) • 300 EC • Channel capacity of 40 ML/day • Outfall regulating structure capacity 30 ML/day	
1788 wetland category (Corrick and Norman)	Deep freshwater marsh	
1994 wetland category (Corrick and Norman)	Category: Permanent saline wetland Sub-category: Shallow (<5m)	
2013 Victorian wetland classification (DEPI 2014b)	*Wetland ID:* 43609 *Aquatic System:* Palustrine or Lacustrine (unknown) *Salinity Regime:* Saline *Water regime:* Permanent *Water Source – Tidal:* Non-tidal *Water Source – River:* Very low *Water Source – Groundwater:* Very high *Source – Artificial:* Artificial *Wetland Origin:* Naturally occurring *Wetland Type:* Unknown	
Wetland capacity	820 ML, FSL 67.4 m AHD[1]	
Wetland depth at capacity	3.2 m maximum depth[1]	
Source: [1]Archards Irrigation 2010		

2.5. Environmental water sources

The environmental water that is available for use at Round Lake 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) are water shares with a relatively low reliability of supply.

Water availability can vary from season to season according to climatic conditions, volumes held in storages and carryover entitlements. Water allocations are made to high-reliability water shares before low-reliability shares when water availability is limited (DEPI 2014c).

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 can also be traded on the water market on an annual basis. The use of this water in Round Lake 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 30 Nov 2015, the Commonwealth environmental water holdings totaled 3,883 ML for the Loddon River system and 344,660 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 Commonwealth Environmental Water Holder (CEWH 2015).

The Water Act 2007 provides that "the Commonwealth Environmental Water Holder must perform its functions for the purpose of protecting or restoring environmental assets so as to give effect to relevant international agreements". Round Lake is a refuge for species listed under other international conventions. It is also one of less than ten remaining wetlands that supports the federally listed Murray Hardyhead. As such, a case could be made to use Commonwealth environmental water in Round Lake.

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 some wetlands, including Round Lake. 'Mitigation water' will be provided to wetlands to ensure there is no net impact on high environmental values. More details on the justification for mitigation water and specific calculations for the mitigation volume for Round Lake are presented in NCCMA (2015).

Table 3. Environmental water sources for Round Lake

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 'mitigation water'	262 ML for Round Lake	Can only be used in wetlands that have an approved Environmental Watering Plan with mitigation water recommended, such as Round Lake.		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 is a range of international treaties, conventions and initiatives, as well as National and Victorian State Acts, policies and strategies that direct the management of wetlands within Victoria. Those that have particular relevance to the management of the environmental and cultural values at Round Lake are listed below. The function and major elements of each agreement is provided in Appendix 1.

International treaties, conventions and initiatives:

- Japan Australia Migratory Birds Agreement (JAMBA) 1974 - Seven species listed under this agreement have been recorded at Round Lake.

- China Australia Migratory Birds Agreement (CAMBA) 1986 - Six species listed under this agreement have been recorded at Round Lake.
- Republic of Korea Australia Migratory Birds Agreement (ROKAMBA) 2002 - Four species listed under this agreement have been recorded at Round Lake.
- Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) 1979 – Five species listed under this convention have been recorded at Round Lake.

Commonwealth legislation and policy:

- Aboriginal and Torres Strait Islander Heritage Protection Act 1984 (Part IIA) – Round Lake is an area of cultural sensitivity.
- Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) - One species listed under this Act has been recorded at Round Lake. This act also covers international migratratory conventions.
- Water Act 2007 – to provide for the protection of ecological values at Round Lake through appropriate management of Murray-Darling Basin water resources.

Victorian legislation:

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

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 sufficient 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 Round Lake as it is an area of cultural sensitivity.

Victorian policies and strategies:

- Victorian threatened flora and fauna species (DELWP advisory lists) – 13 fauna species and eight flora species on the DEPI advisory lists have been recorded at Round Lake.
- 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 (RCS) (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. Round Lake is a part of the Central Murray Wetland Complex, which is identified as a 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. Round Lake is a priority wetland for this eight year planning period.

3. Hydrology and system operations

Wetland hydrology is the most important determinant 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.

At full supply level (FSL) (67.4 m AHD); Round Lake has a storage capacity of 820 ML (Archards Irrigation 2010) and a maximum depth of 3.2 m. Refer to Appendix 2 for the contour plan prepared for Round Lake by Archards Irrigation (2010).

3.1. Wetland hydrology, water management and delivery

3.1.1. Pre-regulation

Round Lake is located approximately 6 km south of the Little Murray River. Its natural water supply would have been floodwater from the Little Murray River system and/or the Avoca River system (Appendix 5). Prior to regulation, Round Lake would have been inundated mainly in winter and spring, with draw-down resulting from evaporation and seepage over the warm low-rainfall months of summer and autumn. Round Lake and Long Lake both received floodwaters, however anecdotal evidence suggests that there was no connectivity with Golf Course Lake to the south (**Figure 5**; Appendix 5).

Lake Boga would have naturally filled and spilled as a result of high flows in the Murray River, which would in turn flood the Little Murray River. Water would flow from Lake Boga into Lake Baker, Long Lake, and then into Round Lake. If the Avoca River flooded at the same time, water would have flowed northward from the Avoca Marshes, through the Mystic Park area via a wide and shallow waterway into Lake Mannoar and Lake Boga (**Figure 5**; Appendix 5).

3.1.2. Post-regulation

Construction of the Torrumbarry Irrigation System and development of the adjacent Tresco horticultural catchment resulted in significant hydrological changes that turned Round Lake from an intermittent wetland into a permanent lake. Until 2003, Round Lake received significant volumes of drainage water indirectly from the Tresco horticultural catchment to the south. Tile drains constructed in the 1950s/1960s contributed irrigation drainage water. Surface run-off which entered Golf Course Lake to the south would, in wetter periods, flow into Round Lake via a pipe connecting the two. Round Lake then overflowed into Long Lake via a deep connecting channel (Macumber 2009).

Round Lake has also received fluctuating volumes of outfall water from channel 1/9 which enters the lake to from the north (Figure 6). Between 1999 and 2015, water levels in Round Lake have fluctuated between 66.4 m AHD and 67.3 m AHD (Figure 7). Low water levels in February 2002 corresponded with a period of very high salinity, reaching above 40,000 EC (Macumber 2009 and Figure 6).

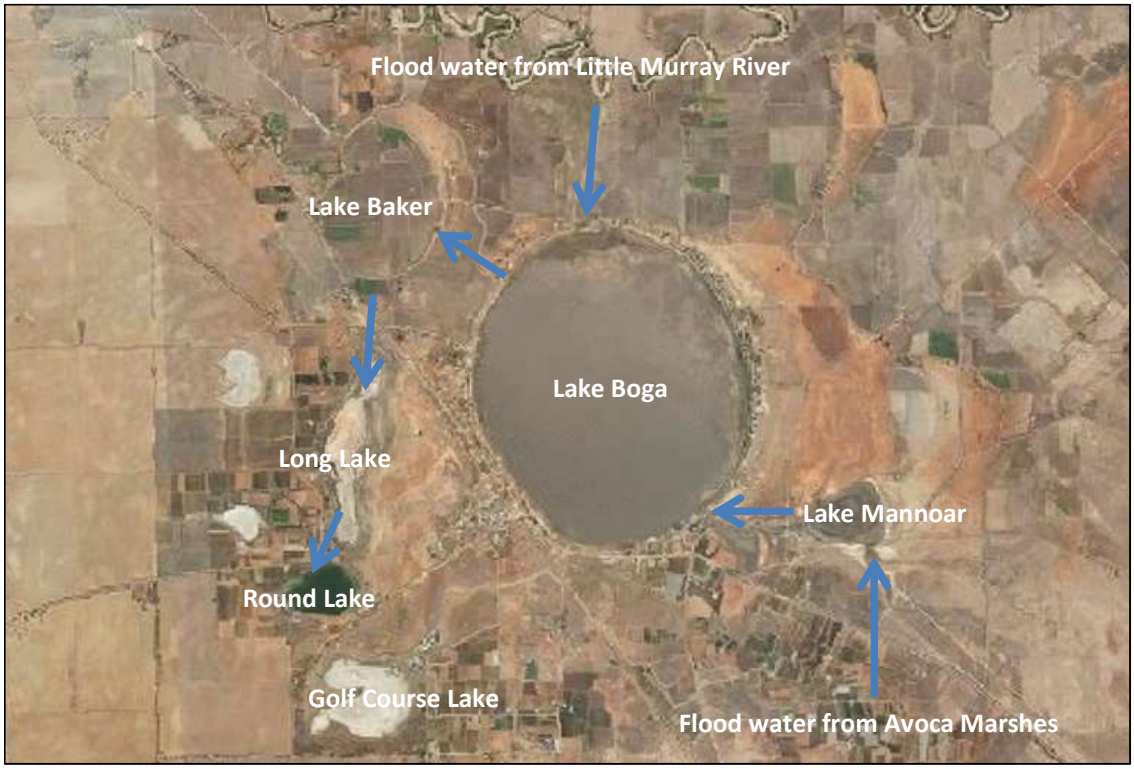


Figure 5. Natural flooding flow path to Round Lake from the Little Murray River and the Avoca Marshes.

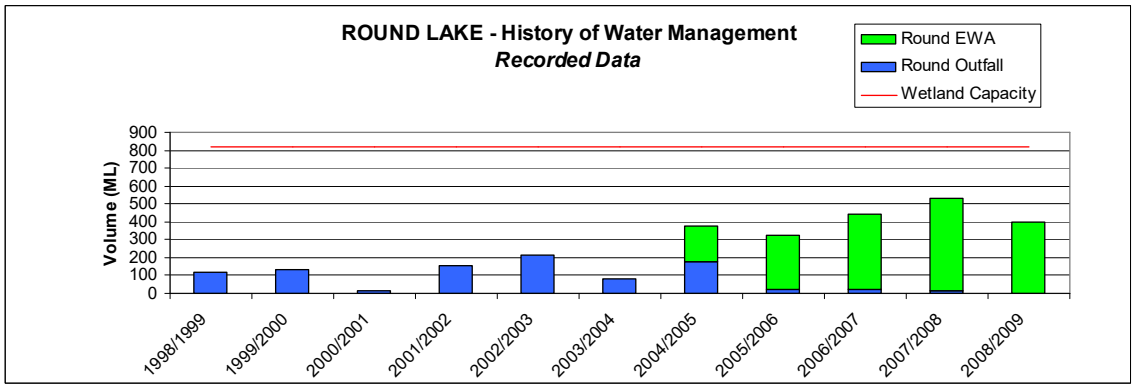


Figure 6. Recorded volumes received by Round Lake from outfalls and environmental allocations (EWA)

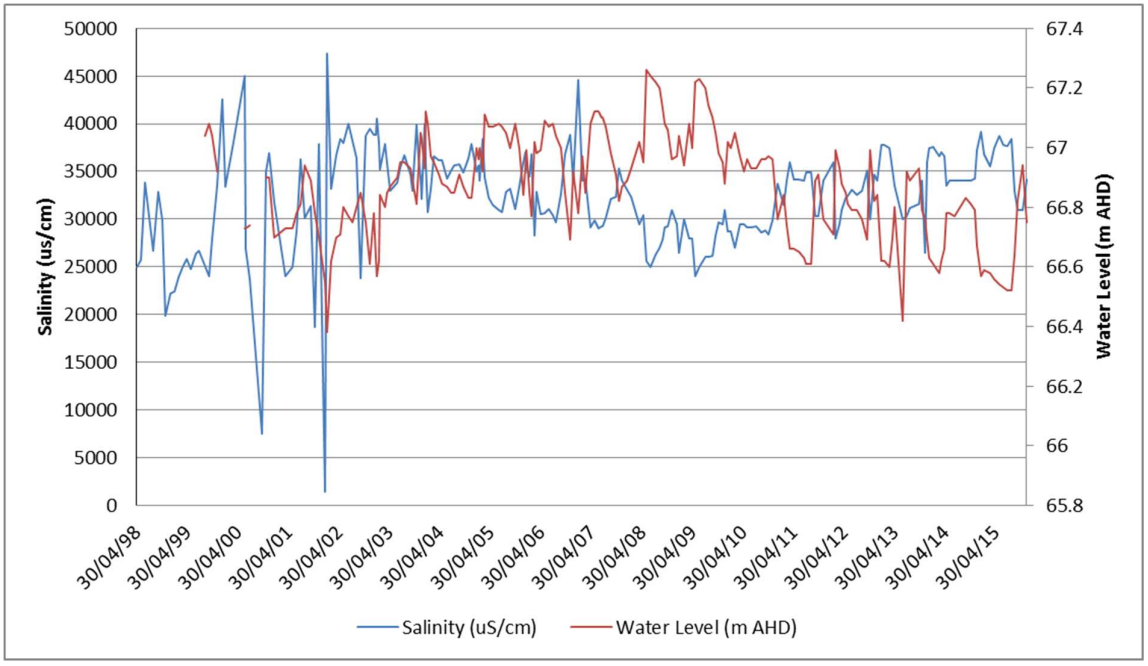


Figure 7. Depth and salinity levels within Round Lake between 1999 and 2015 as recorded by DEDJTR (and previously DPI)

From around 2003, drainage into Golf Course Lake, and subsequent inflows into Round Lake, reduced in response to increased irrigation efficiencies and prolonged drought conditions (Macumber 2009). Attempts were made to deliver freshwater into Golf Course Lake to protect its environmental values. Fresh channel water was delivered to Round Lake to increase its water level and drive water through the existing pipeline into Golf Course Lake. This approach was not efficient and eventually Golf Course Lake salinity levels rose and almost all of the previous environmental values were lost (Appendix 5).

GMW constructed earthen embankments at the north and south ends of Round Lake to prevent flows passing into Golf Course Lake and Long Lake (date unknown). These embankments mean Round Lake is now managed in relative isolation from the adjacent wetlands (Appendix 5).

Since 2004/05, Round Lake has received environmental water allocations to counteract declining outfall and drainage volumes in order to maintain salinity levels and provide suitable habitat for Murray Hardyhead (Figure 6). The lake requires around 475 ML of fresh water inflows to maintain levels and salinity in an average year (Macumber 2009). Water level fluctuations from late 2004 have reduced to 60 cm between 66.7 m AHD and 67.3 m AHD (Figure 7). Inflows have generally occurred in late winter-early spring prior to the Murray Hardyhead peak breeding season, and have continued over the summer and autumn months with the highest water levels experienced in winter (Macumber 2009).

Table 4 demonstrates the watering history of Round Lake over the last twenty years.

Table 4. Round Lake 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	W	W	W	W	W	W	W	W
	Water source[2]	U	U	U	C	C	C	C	C	C	C/E
		2005 - 2006	**2006 - 2007**	**2007 - 2008**	**2008 - 2009**	**2009 - 2010**	**2010 - 2011**	**2011 - 2012**	**2012 - 2013**	**2013 - 2014**	**2014 - 2015**
	Status[1]	W	W	W	W	W	W	W	W	W	W
	Water source[2]	C/E	C/E	C/E	E	E	E	E	E	E	E

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

3.1.3. Groundwater/surface water interactions

Each of the wetlands in the Tresco Lakes, including Round Lake, is bound to the east by a lunette, created by wind-blown sediments from the saline lake floor during times when the lakes were dry (Macumber, 2009). The Tresco Lakes traverse the boundary between the Parilla Sand and Shepparton formation.

Groundwater behaviour in the vicinity of Tresco Lakes is highly dependent on the status of nearby Lake Boga. When Lake Boga is full (ranging from 68 m AHD to 70 m AHD) a hydraulic gradient causes groundwater to move from Lake Boga into Round Lake. These groundwater flows affect salinity levels within Round Lake and its groundwater inflow and outflow potential. When Lake Boga is empty, groundwater movement is towards the northwest and Round Lake no longer receives groundwater from Lake Boga (Figure 8, Figure 9).

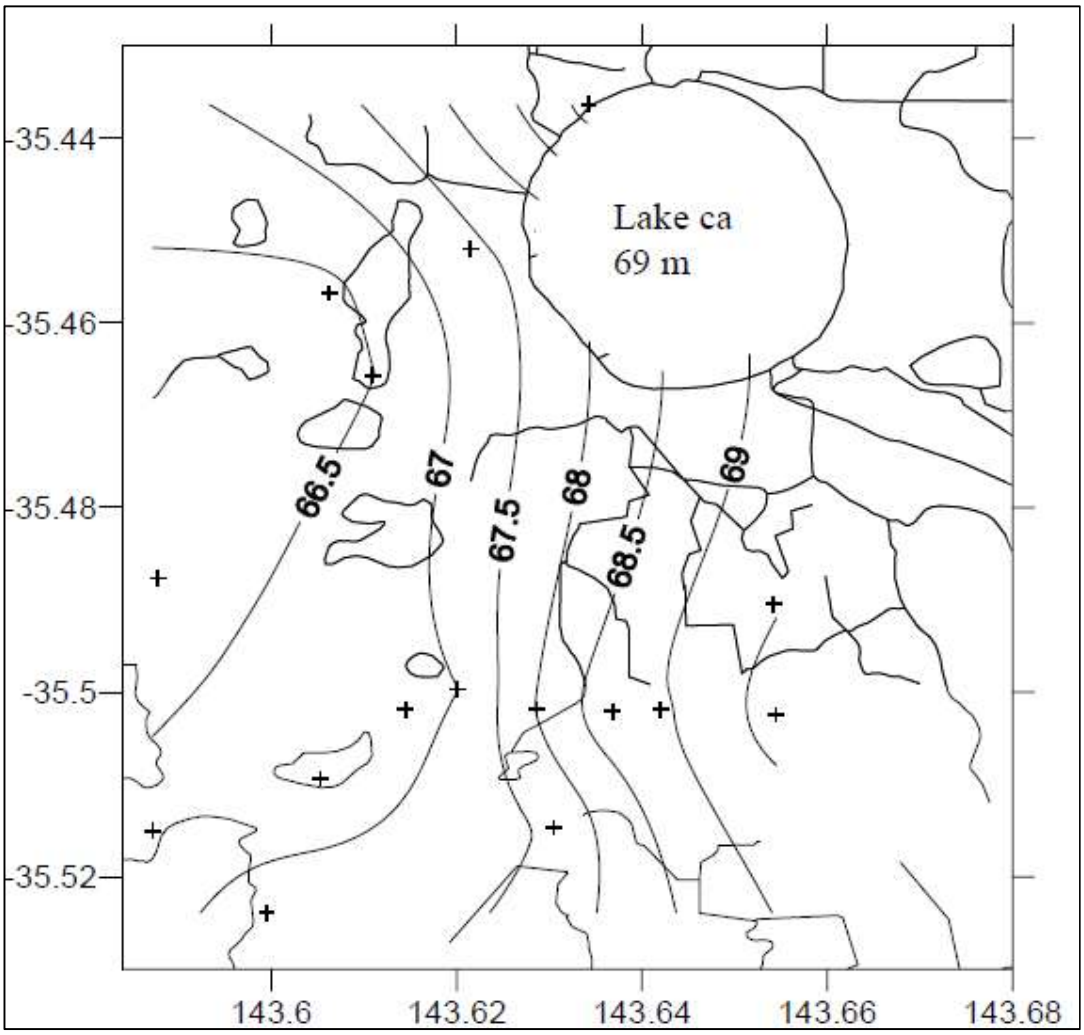


Figure 8. Potentiometric surface in the vicinity of the Tresco Lakes in spring (October-November) 1996 when Lake Boga was full (Source: Macumber 2009).

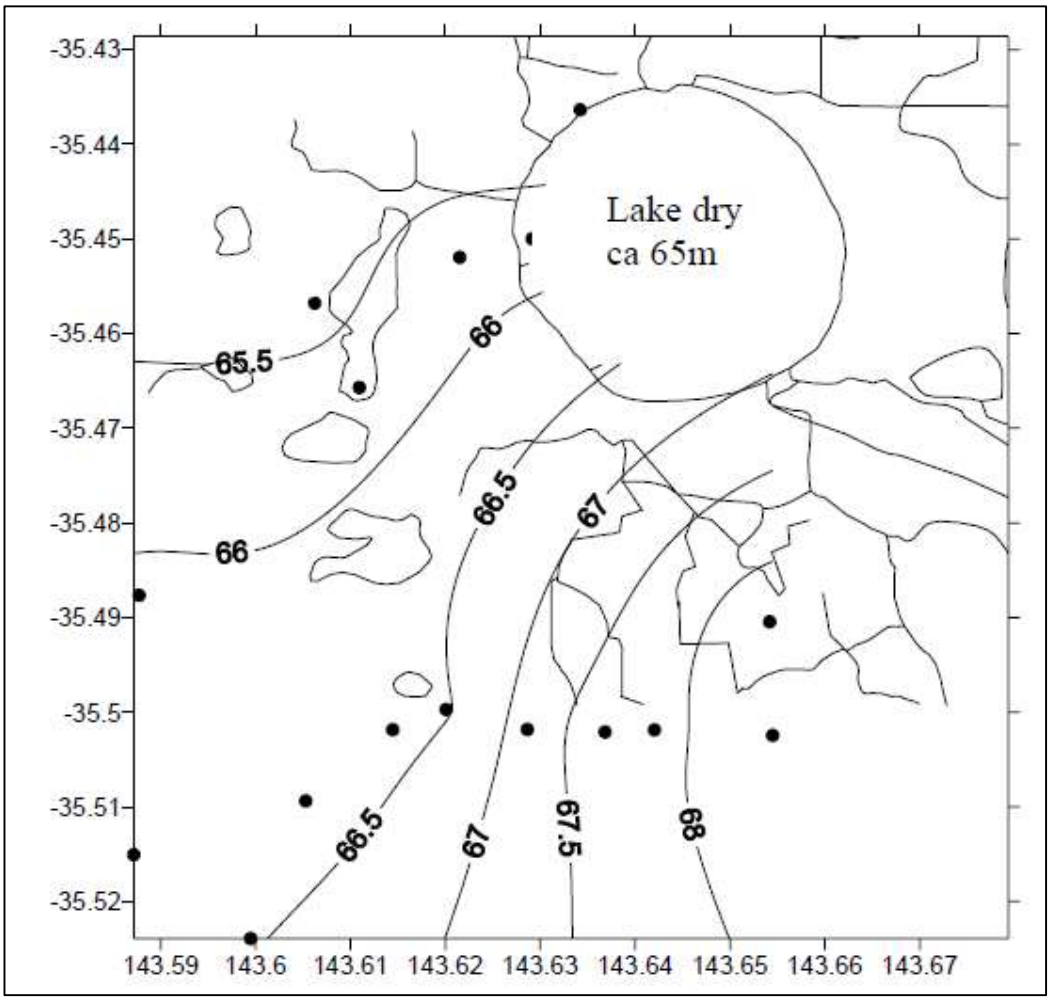


Figure 9. Potentiometric surface in the vicinity of the Tresco Lakes in winter (July-August) 2007 when Lake Boga was dry (Source: Macumber 2009).

Following construction of the Torrumbarry Irrigation System in the 1920s, groundwater levels began to rise dramatically (Appendix 5). Consequently, low lying depressions and wetlands became susceptible to shallow saline groundwater levels (Appendix 5). The bed of Long Lake is approximately 3 m below the managed surface water levels at Round Lake, which means Long Lake has become a groundwater discharge zone. There is a strong downward hydraulic gradient beneath Round Lake, which has increased in strength in conjunction with regional groundwater declines and high manipulated surface water levels.

A freshwater lens (approximately 36 m in depth) has developed beneath Lake Boga. Therefore, higher groundwater salinities are prevalent to the east of Lake Boga (58,594 µS/cm to 70,313 µS/cm) than in areas adjacent to it, which are impacted by groundwater movement (e.g. 2,344 µS/cm to 6,094 µS/cm) at the northern end of the lake. The monitoring record shows salinity levels of 6,825 µS/cm and 11,770 µS/cm occurring between Lake Boga and Round Lake, illustrating localised groundwater recharge (Refer to

Table 5, Figure 10 and Figure 11).

Table 5. Groundwater salinity in bores adjacent to Lake Boga and the Tresco Lakes (Source: Macumber 2009)

Location	Bore (nests)	Screen (m)	Salinity	
			(mg/L)	µS/cm
Lake Boga	73481	13 to 16	1277	1995
Lake Boga	73480	36 to 39	3213	5020
North of Round Lake	73490	5 to 7	7533	11,770
North of Round Lake	73489	25 to 28	19,053	29,770
North of Round Lake	73488	34 to 37	37,669	58,858
West of Lake Boga	73487	40 to 43	4176	6478
West of Lake Boga	73486	46 to 49	17,238	26,934
West of Long Lake	73485	12 to 15	12,825	20,039
West of Long Lake	73484	31 to 34	58,490	91,391

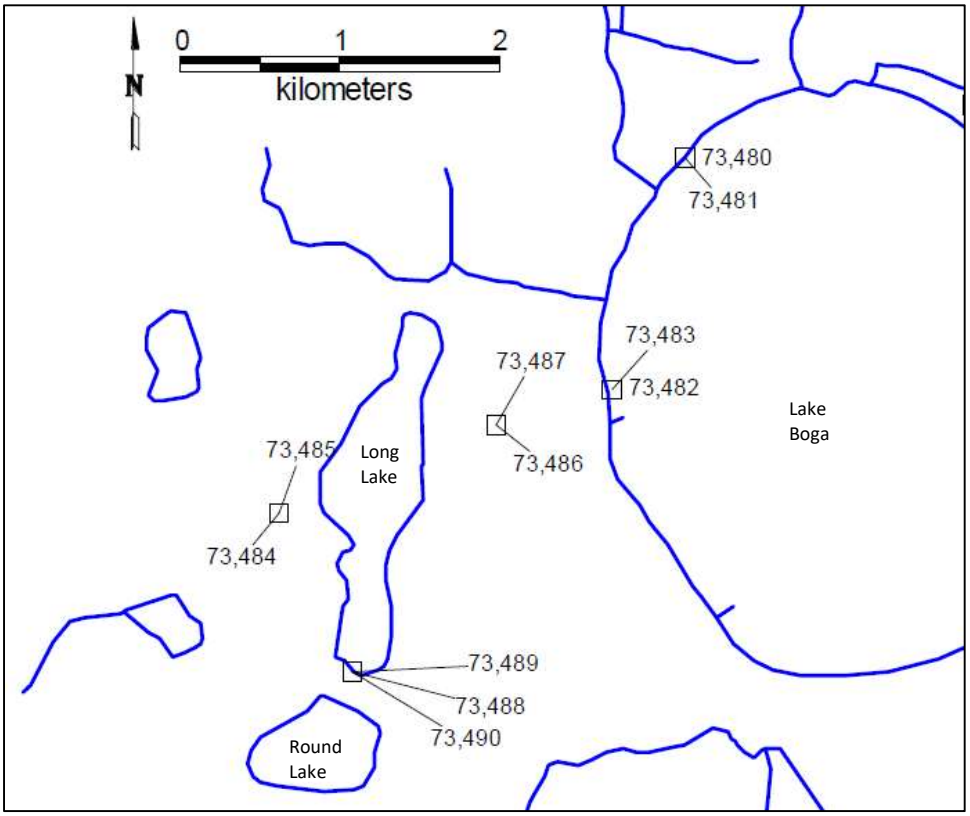


Figure 10. Location of groundwater bores nearby Round Lake (Source: Macumber 2009)

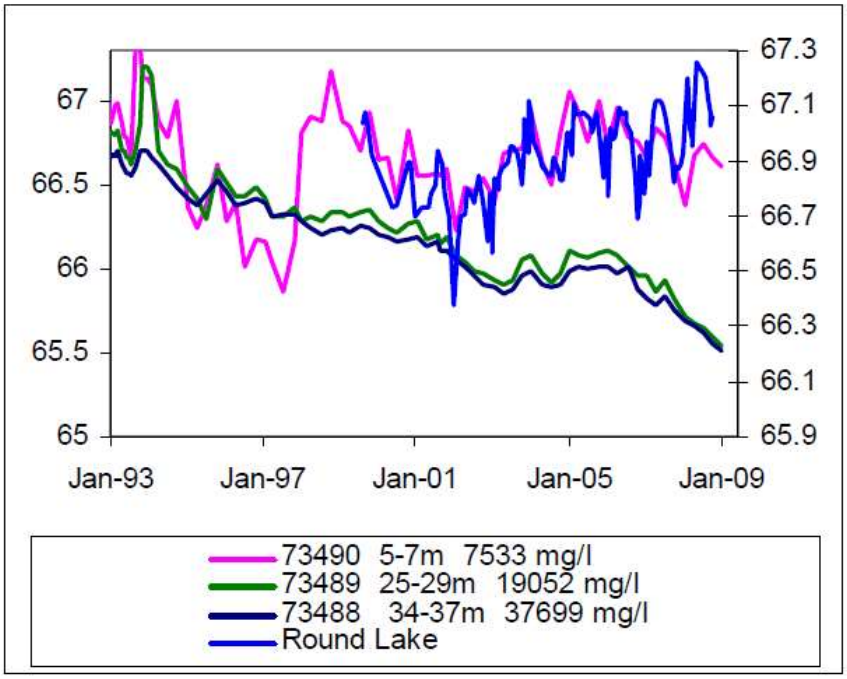


Figure 11. Hydrographs of the 73488-90 piezometer nest and Round Lake surface water levels for the period between 1993 and 2009. This figure illustrates the clear relationship in levels between the fresher water in the shallow bore (73490) and that of the surface water within Round Lake. (Source: Macumber 2009)

Macumber (2009) reports that when Round Lake is flooded, groundwater seepage flushes salt to the aquifer, and that this is sufficient to counter the salt gain from surface water inflows. This process is promoted by the high water levels in Round Lake and low regional groundwater levels. The area has since flooded during the 2010 and 2011 floods. Table 6 provides an estimate of annual salt and water loss from Round Lake resulting from groundwater flushing. This estimate is based on a 400ML/year environmental water allocation of channel water with a salinity of 250EC.

Table 6: Annual salt (tonne) and seepage (ML) loss from Round Lake (2004-2009) (Source: Macumber 2009)

Lake depth (m)	Net salt loss tonne/yr	Salt 'in'	Salt 'out' (seepage)	Seepage volume at 21 gm/L (ML/yr)
		tonne		
1.5	291	60	351	17
2.0	457	60	517	24
2.5	623	60	683	32
3.0	790	60	850	41

3.1.4. Water Quality

Monthly monitoring of surface water quality has been undertaken by DEDJTR and its predecessors since 1998. Round Lake would be classified as a terminal shallow lake using the environmental quality guidelines for Victorian lakes, and as such has no corresponding water quality guidelines (Environment Protection Authority [EPA] 2010). Salinity during this time has fluctuated between 18,700 and 47,000 EC, but has not exceeded 40,000 EC since 2007. The typical salinities, measured either as the mean salinity value of 32,552 EC or the median of 33,100 EC, are within the range preferred by Murray Hardyhead and typical of wetlands supporting saline aquatic vegetation such as Large-fruit Tassel.

Salinity within Round Lake is inversely correlated to surface water levels (Figure 7). Prior to 2003, salinity levels and the salt load within the lake rose steadily, peaking in 2003 at over 40,000 EC (Macumber 2009). This reflects the more saline nature of inflows received from Golf Course Lake. Water delivered via channel 1/9, which largely replaced inflows from Golf Course Lake, is less than 300 EC. Consequently, salinity levels within the lake have fallen since 2003 and monthly water quality samples taken between 2011 and 2014 indicate that the salinity range in the lake is between 27,000 to 39,300 EC. The annual rate of decline in salinity between 2003 and 2008 was approximately 1,500 EC/yr (Macumber 2009), however, since this time salinity has increased back to 2003 levels.

The pH was on average 8.9, ranging from 5.7 -10.7 although rarely recorded below 7. The range of pH recorded in Round Lake are unlikely to cause deleterious effects to aquatic biota.

Dissolved oxygen (DO) data are restricted to daylight hours when higher values typically occur due to photosynthesis. Therefore, sampling at night may detect instances of lower dissolved oxygen which are important for fish distributions and release/uptake of nutrients from wetland sediments. DO levels for Round Lake are generally acceptable (mean value of 6.9 mg/L); however, a few very low values have been recorded (e.g. 1.1 mg/L in March 2006), which would be stressful to most aquatic fauna. Low DO levels tend to occur around late summer/early autumn, under still conditions (B Mathers [DEDJTR] 2016, pers. comm., Jan). Ellis et al. (2013) report that Murray Hardyhead can tolerate variable DO conditions, ranging from 3.5 to 25 mg/L.

Recorded water temperatures at Round Lake range between 5.5 and 30.3 degrees Celsius. Murray Hardyhead has previously been recorded in water bodies at 34 degrees (Ellis et al. 2013).

Turbidity levels are generally acceptable (median of 2.5 NTU). However, in recent years, turbidity levels appear to have increased (e.g. median turbidity of 35 NTU since 2013), although the reasons for this are unclear. Higher turbidity levels limit light penetration, which adversely affects the photosynthesis of algae and submerged aquatic plants. Rakali (2014) reported that the lake was reasonably turbid during IWC assessment in 2014 and recommended that when the lake is topped up with environmental water it should be done gradually, with low turbidity water.

Nutrient levels at Round Lake are not routinely monitored by DEDJTR. Bradbury (2013) reported that phosphorus levels in Round Lake were within ANZECC guidelines (<0.5 mg/L), but nitrate concentrations did exceed the ANZECC guidelines.

3.1.5. Environmental watering

Round Lake has received environmental water allocations since 2004/05 to counteract declining outfall and drainage volumes, maintain salinity levels and provide suitable habitat for Murray Hardyhead (Figure 6). The lake requires around 475 ML of fresh water inflows to maintain levels and salinity in an average year (North Central CMA 2015a).

4. Values

4.1. Environmental values

4.1.1. Listings

Round Lake 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). The most significant values in Round Lake include a population of the endangered Murray Hardyhead and extensive beds of submerged aquatic vegetation that supports numerous waterbirds, including threatened and migratory species.

Many flora and fauna species recorded at Round Lake are formally listed under one or more international treaties, national and state legislation or agreements (see Table 7). A full list of flora and fauna recorded at Round Lake is available in Appendix 3.

Table 7. Legislation and agreements that relate to the management of Round Lake

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

Round Lake has previously supported three native fish species Murray Hardyhead (*Craterocephalus fluviatilis*), Bony Bream (*Nematalosa erebi*), and Flat-headed Gudgeon (*Philypnodon grandiceps*). Murray Hardyhead was first officially identified in Round Lake in 1999, but may have been present for prior to this. Five exotic species have previously been recorded; Carp *(Cyprinus carpio*), Tench (*Tinca tinca*), Goldfish (*Carassius auratus*), Redfin (*Perca fluviatilis*) and Gambusia (*Gambusia holbrooki*). On the basis of recent surveys, Gambusia is the only exotic species still present, and in very low abundance (Stoessel 2012). Other exotic species have likely been exluded becuase of the high salinity levels at the lake.

The Round Lake population of the endangered Murray hardyhead is critically important as it is one of less than ten known remaining populations, and is one of only a few remaining natural sites where the species is predicted to survive in the medium term (Backhouse 2008a). The exact size and stability of the population is difficult to accurately ascertain because the species is difficult to sample and populations tend to undergo natural boom and bust cycles.

Murray hardyhead have an affinity with slow flowing waterbodies, billabongs and lakes with elevated salinity (Backhouse 2008a). The true salinity tolerance of Murray Hardyhead is unknown as tolerance levels of populations may differ significantly due to genetic and non-genetic adaptations. In addition, tolerance levels may differ throughout the life cycle (i.e. between egg, larvae and adult

stages). Although adults have been recorded in waters with salinity greater than 40,000 EC (Backhouse et al. 2008a; Backhouse et al. 2008b), little is known about the salinity tolerance of eggs and larvae (Ellis and Kavanagh 2014). Given Murray Hardyhead do not migrate into or out of Round Lake, the salinity tolerance of their most sensitive life history stage will determine whether the species is able to survive and breed in the lake. Key threats to Murray hardyhead at Round Lake are the loss of habitat for spawning and food production (e.g. Large-fruit tassel), high salinity levels that exceed the species tolerance, and proliferation of exotic fish species, namely Carp and Gambusia.

Submerged aquatic vegetation (especially Large-fruit Tassel) attracts Black Swans (*Cygnus atratus*) to Round Lake. Various migratory waders including species protected by international agreements e.g. Common Greenshank (*Tringa nebularia*) and Marsh Sandpiper (*Tringa stagnatilis*) are also attracted to Round Lake as the water level draws down and exposes parts of the bed. In total, 49 water dependent bird species have been recorded at Round Lake, with 15 being of conservation significance at an international, national and/or state level (Table 8 and Appendix 3).

Four common species of frogs, Common Spadefoot Toad (*Neobatrachus sudeli*), Pobblebonk (*Limnodynastes dumereli*), Spotted Marsh Frog (*Limnodynastes tasmaniensis*) and Common Froglet (*Crinia signifera*) have been recorded at Round Lake.

Table 8. Significant water dependent fauna species recorded at Round Lake

Common name	Scientific name	Last record	International status	EPBC status	FFG status	Victorian status
Australasian Shoveler	*Anas rhynchotis*	2015				v
Caspian Tern	*Hydroprogne caspia*	2014	C, J		L	nt
Clamorous Reed Warbler	*Acrocephalus stentoreus*	2001	B			
Common Greenshank	*Tringa nebularia*	2000	B, C, J, R			vu
Eastern Great Egret	*Ardea modesta*	2000	C, J		L	vu
Freckled Duck	*Stictonetta naevosa*	2015			L	e
Gull-billed Tern	*Gelochelidon nilotica macrotarsa*	-			L	e
Hardhead[1]	*Aythya australis*	2015				vu
Intermediate Egret	*Ardea intermedia*	-			L	e
Marsh Sandpiper	*Tringa stagnatilis*	2015	B, C, J, R			vu
Murray Hardyhead	*Craterocephalus fluviatilis*	2016[1]		EN	L	ce
Musk Duck	*Biziura lobata*	2015				vu
Red Necked Stint	*Calidris ruficollis*	2015	B, C, J, R			
Royal Spoonbill	*Platalea regia*	2015				nt
Whiskered Tern	*Chlidonias hybridus*	2014				nt
Sharp-tailed Sandpiper	*Calidris acuminata*	2015	B, C, J, R			

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: ce = critically endangered, e = endangered, vu = vulnerable, nt = near threatened, dd = data deficient
[1]Observed (M. Dedini [DELWP] 2016, pers. comm., Feb)
Source: DELWP (2015a); DEPI (2013b); DEPI (2014e); Rakali Ecological Consulting (2014)

4.1.1. Terrestrial fauna

The Victorian Biodiversity database shows that 57 native terrestrial bird species including the Rainbow Bee-eater (*Merops ornatus*) which is listed under the JAMBA treaty have been recorded

within 1 km of Round Lake (Appendix 3). Stumpy-tailed Lizard (*Tiliqua rugosa*) and Eastern grey Kangaroo (*Macropus giganteus*) have also been observed in the vicinity of Round Lake.

4.1.2. Vegetation communities and flora

DSE's pre-1750 Ecological Vegetation Class (EVC) mapping suggests that prior to European settlement Round Lake was dominated by Samphire Shrubland (EVC 101) vegetation and surrounded by Woorinen Mallee (EVC 824) and Semi-arid Woodland (EVC 97) vegetation (DSE 2009b). Samphire Shrubland EVC is described as:

"Low open shrub layer to 0.5 m of succulent chenopods on saline clay pans. Found in association with the various halite salinas that have developed within evaporative basins". (DSE 2009c)

DSE's 2005 EVC mapping suggests that all of the original EVCs are still present at Round Lake; however the extent of the Woorinen Mallee and Semi-arid Woodland EVCs has diminished (DSE 2009c). This is likely due to land clearing around the lake.

Rakali (2014) surveyed vegetation at Round Lake and found the lake is characterised by Brackish Aquatic Herbland (EVC 537); Brackish Herbland (EVC 538); Brackish Herbland (EVC 538)/Tall Marsh (EVC 821) Complex and Woorinen Mallee (EVC 824). The 2014 field survey is likely to provide a more reliable assessment of vegetation communities at Round Lake than DSE's state-wide EVC mapping layer, which was based on a mix of aerial photographs, biophysical data and limited ground-truthing. Therefore, the EVCs identified by Rakali (2014) are adopted for the EWMP. The current EVCs for Round Lake are presented in Table 9.

Sharp Rush (*Juncus acutus* subsp. *acutus)* is a notable exotic species at Round Lake that has dense stands around majority of lake fringe.

Table 9. Conservation status of EVCs at Round Lake

EVC no.	EVC name	Bioregional Conservation Status
537	Brackish Aquatic Herbland	n/a
538	Brackish Herbland	n/a
821	Tall Marsh	Least Concern
824	Woorinen Mallee	Vulnerable

Native and threatened flora

Ninety three native plant species have been recorded at Round Lake, which is a very high level of plant diversity. Twenty eight of these species are considered water-dependent. Eight Victorian rare or threatened flora species (VROTS) have been recorded (Table 10 and Appendix 3). Of these, only the FFG listed Salt Paperbark (*Melaleuca halmaturorum subsp. halmaturorum*) is considered a water-dependent species. Other significant flora includes Large-fruit Tassel (*Ruppia megacarpa*), Fennel Pondweed (*Potamogeton pectinatus*), Water-mat (*Lepilaena sp.*) and Charophytes, which provide key habitat for Murray Hardyhead as well as large numbers of waterbirds. In particular, Large-fruit tassel is commonly associated with Murray Hardyhead populations, and some micro-crusteans, which are a food source for Murray Hardyhead, rely on Large-fruit Tassel for habitat.

Table 10. Flora of high conservation status recorded at Round Lake

Common name	Scientific name	Last Record	FFG Status	DELWP Status	Type
Salt Paperbark	*Melaleuca halmaturorum subsp. halmaturorum*	2014	L	v	W
Dwarf Myall	*Acacia ancistrophylla var. lissophylla*	1963		r	T
Flat-top Saltbush	*Atriplex lindleyi subsp. Lindleyi*	2014		k	T
Knotted Poa	*Poa drummondiana*	1903		r	T
Mealy Saltbush	*Atriplex pseudocampanulata*	Unknown		r	T
Salt Lawrencia	*Lawrencia spicata*	2014		r	T
Small Burr-grass	*Tragus australianus*	2014		r	T
Warty Peppercress	*Lepidium papillosum*	1903		k	T

Key:
FFG Status: L = Listed as threatened, N = Nominated
DELWP Status: e = endangered, v = vulnerable, r=rare, k = poorly known
Type: W = water dependant; T - Terrestrial
Source: DELWP (2015a); DEPI (2013c); DEPI (2014e); Rakali (2014)

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.

Permanent saline wetland (Corrick and Norman Classification)

According to the Corrick and Norman Classification, prior to 1750 Round Lake was a deep freshwater marsh, although given the pre-1750 samphire vegetation mapped at the site, it was more likely brackish than freshwater. The 1994 classification designates Round Lake as a permanent saline wetland (DEPI 2014g; DEPI 2014f) due to changes in hydrology from modifications to the catchment. Round Lake represents only a small proportion of permanent saline wetland across Victoria, but it accounts for approximately 37 per cent within the Murray Mallee bioregion and is therefore regionally significant (Table 11).

Permanent saline lake (Victorian Wetland Classification)

Round Lake has not been formally classified under the 2013 Victorian Wetland Classification framework, but it fits the criteria for a permanent saline lake. Round Lake represents less than 0.06% of permanent saline lakes in Victoria, 5.5% in the North Central CMA region and the Loddon Catchment and 15.6% in the Murray Mallee bioregion (Table 11). 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 11. Area, depletion and rarity of wetland classifications in the region

Region	Corrick and Norman classification Permanent saline wetland				Current classification Permanent saline lake	
	Pre-European area (ha)	Current area (ha)	Change in area	Round Lake contribution to current area (%)	Current area (ha)	Round Lake contribution to current area (%)
Victoria	4,402,808	638,026	86% reduction	0.001	65,998	0.06
North Central catchment	1,384	2,363	71% increase	1.7	755	5.5
Loddon catchment	1,384	2,078	50% increase	2.0	755	5.5
Murray Mallee bioregion	0	114	NA	37	267	15.6

4.1.4. Ecosystem function

The term 'ecosystem function' is 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. Ecosystem functions include processes that are essential for maintaining life such as storage, transport of carbon, nutrient cycling and the provision of resources that support biodiversity such as habitat, food and shelter.

Table 12 broadly shows the ecosystem functions provided by Round Lake from a local and regional perspective.

Table 12. Ecosystem function of Round Lake from a local and regional scale

Local ecosystem functions	Regional ecosystem functions
• **Convert matter to energy for uptake by biota** - woody debris within the lake provide a substrate for primary producers such as biofilms and plant matter to grow on. These in turn provide food and energy for zooplankton, macroinvertebrates and higher order consumers. • **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.). 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 required for specific life cycle stages of some species (i.e. migration). Movement 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. • **Population persistance** - a number of species require specific habitat requirements to breed. • **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.
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 groups of the land that encompasses Round Lake includes the Wamba Wamba, Barapa Barapa and Wadi Wadi Peoples Native Title Claimants (VC00/5). There are no Registered Aboriginal Parties (RAPs) in the Round Lake area.

The Kerang Lakes area is known to be one of the most archaeologically significant areas within Victoria. To date however, no Aboriginal cultural heritage sites have been identified at Round Lake and registered with Aboriginal Affairs Victoria (AAV).

4.2.2. Recreation

Recreational opportunities at Round Lake are limited. However, it is a valuable wetland for bird watching. Swan Hill Shire Council has recently discussed erecting interpretive signs and hides to support bird watching (D White [North Central CMA] 2016, pers. comm., Jan). Local duck hunting has occurred within the Tresco Drainage Lakes during duck hunting seasons. The native vegetation surrounding Round Lake is poor and extensive fringing Spiny Rush (*Juncus acutus* subsp. *acutus*) is relatively unattractive.

4.3. Economic

Round Lake does not provide any significant direct economic values. Indirect economic benefits include flood protection, providing refuge for rare and threatened species, trapping sediments, nutrient assimilation and recycling (Gillespie Economics 2008 cited in VEAC 2008).

4.4. Conceptualisation of the site

Round Lake has simple bowl-shaped bathymetry with a broad margin of brackish herbland and brackish herbland/tall marsh complex near the outfall; and aquatic meadow vegetation in the centre of the lake. The areas of Round Lake to be targeted by environmental watering are shown in Figure 12. These include the *Ruppia megacarpa*, charophytes and Saline Aquatic Meadow vegetation community (EVC842), which provide key habitat for Murray Hardyhead. Flows delivered in late winter/early spring following a period of drawdown drive an increase in productivity through emergence of zooplankton and aquatic vegetation at the lake margins, which provides a food pulse that coincides with the peak Murray Hardyhead spawning season, as well as food and habitat for waterbirds. The influx of fresh water during this time is also thought to be a trigger for Murray Hardyhead spawning. The rates of rise and fall should be kept to a minimum to allow vegetation germination and fish movement in or out of the draw-down or fill zones.

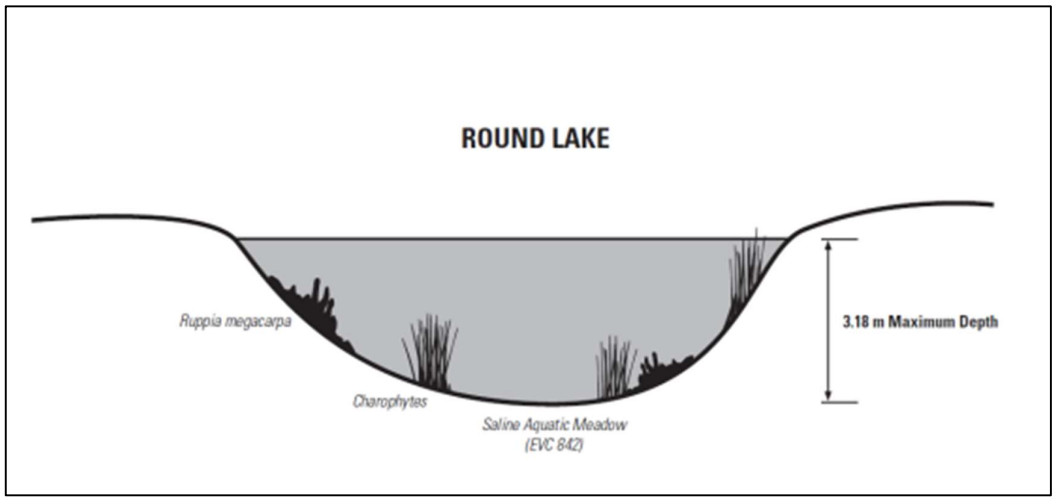


Figure 12. Schematic of wetland areas to be targeted (not to scale)

4.5. Significance

Round Lake satisfies four of the five of the criteria used to identify environmental assets for purposes of environmental watering, as per Schedule 8 of the Basin Plan (Appendix 6). These include sustaining fauna and flora of national and state conservation significance, and sustaining migratory waterbirds protected under international agreements. Further, the lake sustains a permanent refuge for native water-dependent biota during dry spells and drought, particularly water birds and Murray Hardyhead.

Round Lake supports a number of threatened flora and fauna species that are important for maintaining biological diversity in the biogeographic region. The wetland is critically important habitat for Murray Hardyhead, and also important for waterbirds and some migratory species listed under international conventions and bilateral agreements. These values contribute not only to biodiversity of the wider Central Murray Wetlands complex but the North Central CMA region as a whole.

5. Ecological condition and threats

5.1. Context

Hydrological changes over the last 150 years (see Section 3.1.2) have substantially altered Round Lake, to the detriment of some flora and fauna species and the benefit of others. The shift from a deep freshwater marsh to a permanent saline wetland would have caused obligate aquatic species that are intolerant of saline conditions to be replaced by plants and animals that either tolerate or prefer high salt concentrations. The following section describes the results of a number of monitoring measures used to describe the current condition of Round Lake.

5.2. Current condition

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 (i.e brackish EVC benchmarks). 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). A full IWC assessment of Round Lake was undertaken in 2014 (Rakali 2014).

The IWC assessment rated Round Lake as being in good condition (Table 13), scoring well for physical form, soils and biota sub-indices. However, the wetland catchment score was very low, due to horticulture and grazing pressures on the land surrounding the lake. The majority of Round Lake is dominated by Brackish Aquatic Herbland (EVC 537) which scored well for vegetation structure and health, had no aquatic weeds or indication of altered processes (Table 14). The remaining EVCs located on the lake margins had markedly lower scores owing to the presence of weeds (e.g. Spiny Rush; *Juncus acutus* subsp. *acutus*), indicators of altered processes and very poor vegetation structure and health. The mapped results of this assessment can be seen in Appendix 4.

Table 13. Overall IWC scores for Round Lake (Rakali 2014)

Sub index Name	Wetland catchment	Physical form	Hydrology	Water properties	Soils	Biota	Total
Sub Index Score	2	20	10	10	20	16.1	78.1
Weighting	0.26	0.08	0.31	0.47	0.07	0.73	
Weight adjusted score	5.2	0.8	3.1	4.7	1.4	11.8	27
Condition Category	Very poor	Excellent	Moderate	Moderate	Excellent	Good	Good

Table 14. IWC assessments for wetland EVCs at Round Lake against benchmark

	Brackish Aquatic Herbland (EVC 537) - Zone 1	Brackish Herbland (EVC 538) - Zone 1	Brackish Herbland (EVC 538)/Tall Marsh (EVC 821) Complex - Zone 1
Critical lifeforms (F)	12.5	25	25
Weeds (G)	25	15	15
Indicators of altered processes (H)	25	10	10
Vegetation structure and health (I)	25	0	0
EVC Score (F+G+H+I/5)	17.5	10	10
Proportion of wetland	0.8129	0.1201	0.067
Result (EVC Score x Proportion of wetland)	14.23	1.2	0.67
Total Score – 16.1			

Changes to fauna species diversity and composition

Round lake has historically supported a population of Murray Hardyhead in spawning condition. Murray Hardyhead surveys undertaken in November 2015 resulted in a zero catch of individuals, however, approximately 15 individuals were observed in the lake near the inlet in January 2016 (M. Dedini [DELWP] 2016, pers. comm., 03 Feb). Large discrepancies in catch rates between surveys is not uncommon because (1) Murray Hardyhead populations often exhibit natural boom and bust cycles (North Central CMA, 2015) and (2) they are a schooling species which can lead to inconsistent catches.

Monthly waterbird surveys have been undertaken by DELWP between October and March since 2013. Both abundance and diversity of waterbirds was higher in 2013/14 and 2014/15 than in 2015/16; although it is difficult to directly attribute this to the water regime at Round Lake, as metapopulations of waterbirds respond to climatic conditions and the arrangement of inundated habitats over large spatial scales. Surveys recorded over 2600 in January 2015, highlighting that Round Lake is highly productive for waterbirds. A total of 28 different species were recorded, including a number of significant species such as the FFG-listed Caspian Tern (*Sterna caspia*) and a high number of Blue-billed Duck (*Oxyura australis*) (435 individuals recorded in January 2015).

5.3. Condition trajectory – do nothing

Since European settlement, Round Lake has received natural flooding, saline groundwater intrusion and additional water via tile drainage from the Tresco horticultural district, resulting in a more permanent water regime.

As a complementary action to the RCS, the North Central CMA is developing the North Central Climate Change Adaptation and Mitigation Plan (North Central CMA 2015b), which predicts the long term impacts of climate change under a range of scenarios. Although the scale of impacts (e.g. severity, timeframe) differs for each scenario, the following impacts are expected to occur across all scenarios:

- Reduced and more variable rainfall
- Decrease in winter rainfall
- Increased temperatures, and extreme heat
- Increased intensity of extreme rainfall
- Increased frequency and severity of bushfire and flood events

Under these predictions, Round Lake is likely to experience less natural rainfall during winter and higher temperatures and evaporation in spring and summer. In the absence of the delivery of environmental water, Round Lake would become an ephemeral saline lake drying over the hotter

months similar to the situation which presently occurs in Long Lake and Golf Course Lake (Macumber 2009), resulting in the loss of the few remaining populations of Murray Hardyhead.

6. Management Objectives

6.1. Management goal

The long term management goal for Round Lake takes into account the values the wetland supports, the current wetland condition and potential risks that need to be managed. The goal reflects the management goal that was previously developed for the *Round Lake Environmental Watering Plan 2015*.

Round Lake Long-term Management Goal

Maintain Round Lake as a permanent, saline lake that provides suitable habitat for the threatened Murray Hardyhead and submerged aquatic vegetation, particularly Large-fruit Tassel and Charophytes (macroscopic algae).

6.2. Ecological objectives

Ecological objectives describe the intended outcomes of environmental water delivery that contribute to the long term management goal. The ecological objectives for Round Lake 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 Round Lake and summarise the overall objectives for those values. Secondary objectives either support the primary objectives (e.g. habitat to support fish) or are objectives for values for which little baseline information is known. 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 Round Lake and the justification for each are shown in Table 15.

Table 15. Ecological objectives and their justifications for Round Lake

Objective	Justification
1. Primary Objective – species	
1.1 Maintain and support breeding of Murray Hardyhead	▪ A Federal and State listed threatened species ▪ Maintaining genetic diversity amongst remaining populations
1.2 Maintain populations of Large-fruit Tassel (*Ruppia megacarpa*) associated with Brackish Herbland (EVC 538)	▪ Key aquatic species in saline lakes where Murray Hardyhead occurs. ▪ Murray Hardyhead are known to spawn amongst vegetation (Stoessel 2010) ▪ Food for waterbirds (e.g. swans, coots, ducks and waders) ▪ Key primary producer ▪ Contributes to macroinvertebrate productivity ▪ Contributes to the diversity of vegetation in regional wetlands
1.3 Maintain Charophytes (macroscopic algae) persisting in the lake	▪ Stabilise sediment and reduce turbidity ▪ Contributes to macroinvertebrate productivity ▪ Food source for waterbirds (e.g. swans) Source: Sainty and Jacobs (2003)

6.3. Hydrological requirements

A series of hydrological requirements based on the ecological objectives detailed in Section 6.2 have been developed for Round Lake. The information provided in Table 16 is a summary of this information. The hydrological requirements are primarily based on the general requirements of Murray Hardyhead (Figure 13). Fresh inflows in early spring promote vegetation and zooplankton growth which are important to Murray Hardyhead breeding success (I Ellis [MDFRC] 2009, pers. comm., Nov), and are also likely to trigger the onset of spawning (Stoessel 2010). Water levels are maintained at depths required to ensure salinity is between 25,000EC and 35,000EC during the spawning and breeding period (Sept-Feb) and between 25,0000EC and 40,000EC at other times of the year. The salinity regime is based on reccomendations in Stoessel (2010).

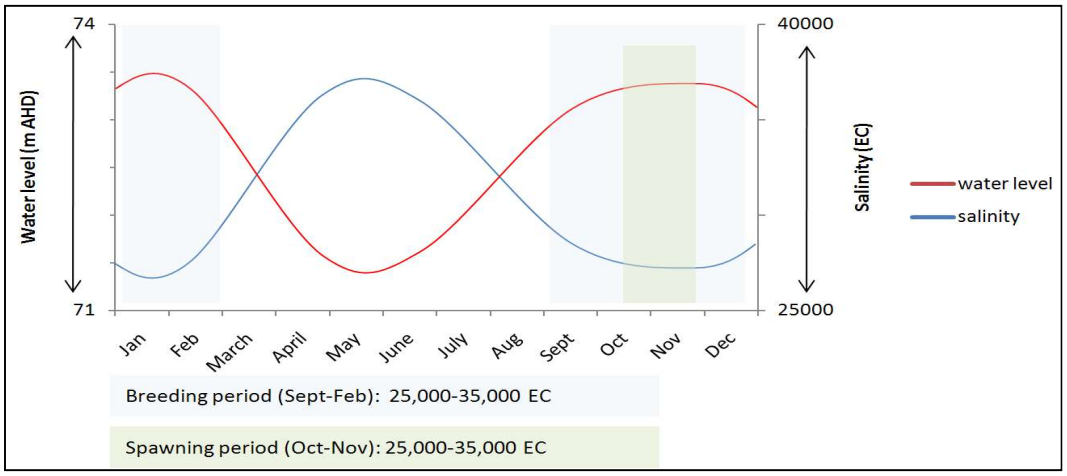


Figure 13. Preferred hydrograph for Murray Hardyhead (based on D Stoessel [MDFRC] 2013, pers. comm.)

Table 16. Hydrological requirements for Round Lake

Ecological Objectives	Water management area	Hydrological requirements	Preferred timing of inflows
1.1 Maintain and support breeding of Murray Hardyhead	Within wetland	Permanent inundation is required. Water levels should be maintained above 66.8 m AHD (2.58 m) and below 67.2 m AHD (2.98 m) to keep salinity levels between 25,000 and 34,000 EC hich aligns with the recommended optimal range of 25,000 and 35,000 EC for Murray Hardyhead breeding.	Winter – early spring (September) to freshen conditions during peak spawning
1.2 Maintain populations of Large-fruit Tassel (*Ruppia megacarpa*) associated with Brackish Herbland (EVC 538).	Bed and fringe	Frequency of 3 innundation events per 10 years is ideal, however can persist in permanent conditions	Winter – early spring (September)
1.3 Maintain Charophytes (macroscopic algae) persisting in the lake	Bed and fringe	Frequency 3 innundation events per 10 years is ideal, however can persist in permanent conditions	Winter – early spring (September)

6.4. Watering regime

The watering regime for Round Lake has been derived from the ecological objectives and hydrological requirements detailed in Sections 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.

The proposed regime closely aligns with the more recent management of Round Lake which maintained it as a permanent saline lake. This regime is based on maintaining suitable habitat for the threatened Murray Hardyhead and submerged aquatic vegetation (particularly Large-fruit Tassel) for which Round Lake is highly valued. The minimum watering regime prescribes maintaining EC below 40,000EC. While Murray Hardyhead has been known to spawn and recruit at this salinity, it is recommended that EC maintained at between 25,000 and 35,0000 (to align with optimal breeding range) at least every second year in a dry phase, as Murray Hardyhead are heavily dependent on annual recruitment (Ellis and Kavanagh 2015).

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 to provide optimal salinity levels any given year will need to be undertaken by the environmental water manager when watering is planned.

Minimum watering regime

Provide environmental water to maintain a permanent regime with salinity levels below 40,000 EC (i.e. minimum level 66.6 m AHD; depth of 2.38 m), to ensure survival of Murray Hardyhead. The rates of rise and fall should be kept to a minimum to allow vegetation germination and fish movement in or out of the draw-down or fill zones. A rate of 10 ML/day over four days, equating to a 10 cm rise is considered an appropriate rate of delivery.

Note – the minimum water regime should not be provided in consecutive years. The optimum water regime should be provided at least every second year to restrict salinity levels between 25,000 and 35,000 EC during the breeding season to ensure that Murray Hardyhead, which only live for 18 months can have a successful breeding event at least once each generation.

Optimum watering regime

Provide fresh inflows to maintain water levels between 66.8 m AHD (depth 2.58 m) and 67.2 m AHD (depth 2.98 m) to regulate salinity levels between 25,000 and 35,000 EC during early spring (September) to coincide with the peak breeding season of Murray Hardyhead and to support germination of submerged macrophytes. Allow the lake to drawdown to a minimum level of 66.6 m AHD via evaporation over autumn/winter. Additional top ups may be needed at times to prevent water levels dropping below the recommended minimum level or to prevent salinity increasing above 40,000 EC.

The rates of rise and fall should be kept to a minimum to allow vegetation and fish movement in or out of the draw-down or fill zones. A rate of 10 ML/day over four days, equating to a 10 cm rise is considered an appropriate rate of delivery.

Maximum watering regime

Provide environmental water to maintain a permanent regime.

Manage inflows as required to maintain a maximum level of 67.2 m AHD (depth 2.98 m) to maintain salinity above 25,000 EC.

The rates of rise and fall should be kept to a minimum to allow vegetation and fish movement in or out of the draw-down or fill zones. A rate of 10 ML/day over four days, equating to a 10 cm rise is considered an appropriate rate of delivery.

7. Risk Assessment

A qualitative risk assessment has been undertaken for Round Lake 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 17, the relationship between likelihood (probability of occurrence) and the severity (severity of the impact) provide the basis for evaluating the level of risk.

Table 17. Risk Matrix

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

The results from the Round Lake risk assessment are presented in Table 18, adapted from the *Round Lake Environmental Watering Plan 2015*. Management measures to mitigate 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 Round Lake.

Table 18. Possible risks and mitigation measures associated with environmental water delivery to Round Lake

Risk No.	Threat	Outcome	Relevant objective	Likelihood	Severity	Risk rating	Management Measure	Residual Risk rating
1	**Threats from environmental water**							
1.1	Limited water availability (i.e. no environmental water allocation to provide the desired water regime)	• Failure to achieve identified objectives and overall water management goal. Decline or loss of Murray Hardyhead population.	All	Possible	Major	High	• Ensure sufficient information is collected for prioritisation in environmental allocation processes. • Re-model volumes required in light of changing climatic conditions.	Low
1.2	Climatic variability, specifically drought conditions	• Failure to achieve identified objectives and overall water management goal. Decline or loss of Murray Hardyhead population.	All	Probable	Major	High	• Adaptive management of watering regime and delivery options. • Re-model volumes required in light of changing climatic conditions and wetland phase.	Moderate
1.3	Inappropriate water regime	• No successful Murray Hardyhead breeding events • Regime unsuitable for submerged aquatic vegetation	All	Improbable	Major	Moderate	• Seasonal water delivery, regular monitoring (i.e. Murray Hardyhead Recovery team) and adaptive management of watering regime. • Review recommendations in light of emerging information on the requirements and status of the Murray Hardyhead in Round Lake.	Low
2	**Threats to achieving ecological objectives**							

Risk No.	Threat	Outcome	Relevant objective	Likelihood	Severity	Risk rating	Management Measure	Residual Risk rating
2.1	The inlet infrastructure capacity is too low to release water at required rate. (e.g. salinity spike requires water to be delivered at a greater capacity)	• Inflow rates to low to maintain salinity in target range. Decline or loss of Murray Hardyhead population	1.2	Improbable	Major	Moderate	• Upgrade the existing drop-board outfall structure with an automated regulator to allow improved operational management and capacity at Round Lake.	Low
2.2	Introduced species – fish	• Invasion with European Carp or increase in the Gambusia population to an unaacceptble levels	All	Possible	Major	High	• Maintain salinity levels above 25,000 EC to exclude carp, and provide unfavourable conditions for Gambusia.	Low
2.3	Deliver water contaminated by blue green algae	• Rapid breakdown of blue green algal bloom may lead to very low DO levels, which could lead to loss of Murray Hardyhead	All	Possible	Major	High	• Monitor blue green levels in the supply channel system and adapt timing and rate of environmental water delivery to minimise the quantity of blue green contaminated water delivered to the lake. For example, in March 2016, water delivered earlier than planned.	Moderate
2.4	Increased rate of groundwater discharge to Round Lake due to management of Lake Boga	• Increases salinity in Round Lake beyond Murray Hardyhead breeding threshold.	All	Possible	Moderate	Moderate	• Monitor salinity in Round Lake and provide top-ups as required	Low
2.5	Freshening of lake due to falling groundwater levels and fresh channel inflows	• Proliferation of alien fish species, namely Gambusia and Carp • Competition, habitat destruction, and predation leading to a loss of Murray Hardyhead.	All	Possible	Major	High	• Monitor groundwater levels and salinity in Round Lake and provide top-ups as required • As a fallback, extend the drawdown period and manage the lake at a lower level (Macumber, 2009).	Moderate

8. Environmental water delivery infrastructure

Round Lake receives outfalls from the 1/9 channel via a drop-board outfall structure and short delivery channel approximately 60 m in length (Figure 14). The reported capacity of channel 1/9 is 40 ML/day. The outfall structure has a maximum capacity of 30 ML/day (R Stanton [GMW] 2009, pers. comm., 22 March) while the capacity of the delivery channel is unknown. A 450 mm pipe passes water beneath Lake Boga-Ultima Road.

At present, Round Lake is operated as a terminal system with earthen embankments preventing flows between Golf Course Lake to the south (bank approximately 1.08 m high) and Long Lake to the north (bank approximately 1.8 m high). FSL is at 67.40 m AHD (Archards Irrigation 2010).

Delivery of environmental water in 2009 to maintain water and salinity levels occurred at a rate of 8-10 ML/day. A delivery rate of 10 ML/day equates to a 10 cm rise in four days which is considered a suitable rate of delivery.

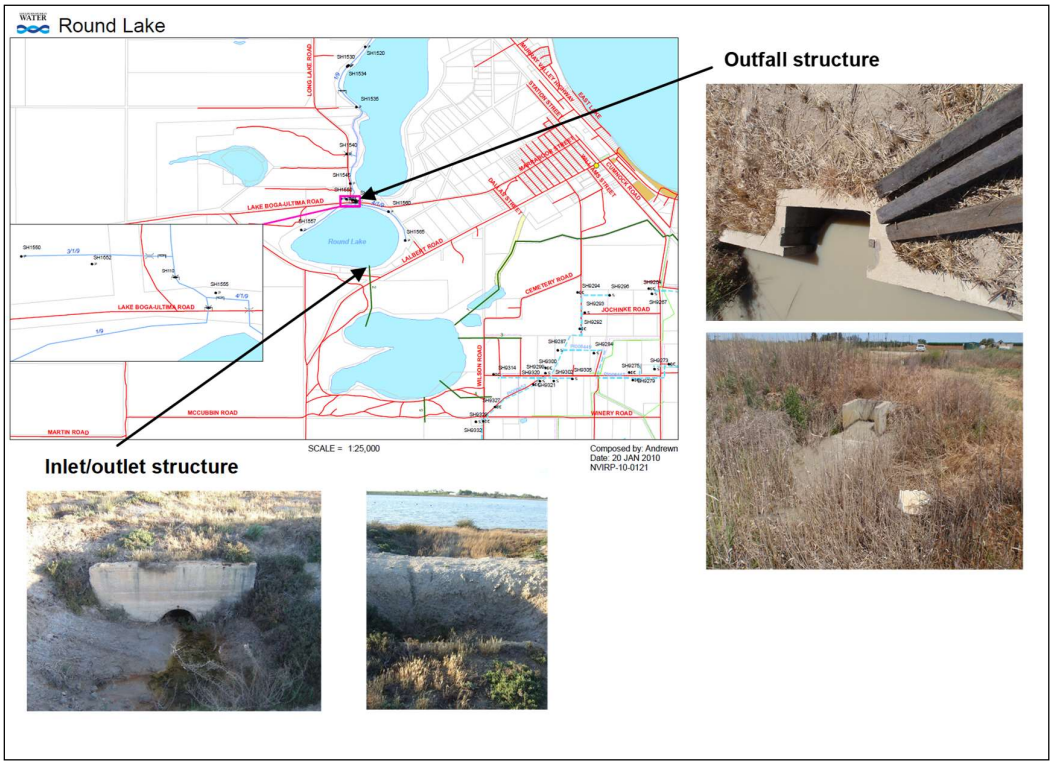


Figure 14. Water delivery infrastructure at Round Lake

8.1. Proposed changes to existing infrastructure

The Stage 1 GMW Connections Project works program 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.

Within the immediate vicinity of Round Lake channel 1/9, on which the Round Lake outfall structure is located, is not part of the automated backbone. Approximately 5 km (to the north-western margin of Lake Boga) of the channel may be rationalised as part of the GMW Connections Project. It is recommended that the 1/9 channel is retained to ensure Round Lake is able to receive environmental water. Otherwise alternative supply arrangements will be required.

GMW Connections Project is responsible for "retain(ing) infrastructure and improving where practicable, where it will be required for delivering environmental water…." (GMW 2013). A review of

the infrastructure requirements and supply arrangements will need to be undertaken if channel 1/9 is considered for rationalisation. Similarly, the potential impact of providing a new supply point will need to be investigated if the current supply point is likely to alter.

8.2. Infrastructure and operational constraints

The infrastructure servicing Round Lake should be retained to ensure environmental water delivery is possible. Therefore, the immediate infrastructure and channel system servicing should not be rationalised as part of the GMW Connections Project works.

At present, Round Lake is maintained as a permanent saline lake, with top-ups provided via the irrigation system at a rate of 10 ML/day, a rate considered appropriate for maintaining suitable habitat for Murray Hardyhead. The current delivery infrastructure is considered adequate to deliver these smaller flows.

8.3. Infrastructure recommendations

Additional upgrade options to improve operational management of Round Lake delivery infrastructure could be undertaken.

- Unrecorded outfalls were received by Round Lake between 2000 and 2003 and have been quantified (Macumber 2009). It is recommended that the existing drop-board outfall structure is upgraded with an automated regulator. This will improve operational management by minimising losses (bar leakage) and enhancing safety and useability. Allowing more operational control over flows delivered to Round Lake is particularly important as maintaining suitable habitat for Murray Hardyhead is an ecological objective.
- Replacement of the earthen embankments prohibiting flows to Golf Course and Long Lake with automated regulating structures would improve operational control and potential future connectivity between the three wetlands.

9. Complementary actions

Implementation of the recommended watering regime for Round Lake will generate benefits to the environmental values of the wetland. Table 19 outlines complementary actions that will enhance these benefits.

Table 19. Complementary actions to enhance the benefits of environmental watering

Activity	Rationale
Exotic flora control and Revegetation works	The native vegetation surrounding Round Lake is in poor condition, and the lake margins are dominated by the introduced Spiny Rush. Exotic 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. North Central CMA has recently undertaken works to control spiny rush and plant native species on the southeastern section of the lake..
Fox control	Foxes are common in the Round Lake area. Impacts of foxes include predation on juvenile waterbirds, 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.
Rabbit control	Impacts of rabbits are evident at and around Round Lake. The presence of rabbits inhibits recruitment of native vegetation. Rabbit control measures include baiting, warren fumigation or destruction, and interactive education activities such as rabbit buster.

10. Demonstrating outcomes

Monitoring programs enable water managers to demonstrate 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 Round Lake.

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 monitoring results are reviesed regularly 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 watering events, and informs the achievement of ecological objectives. Intervention monitoring may include monitoring of water quality, vegetation and biota (i.e. native waterbirds).

Monitoring the watering event provides feedback on how the system is responding and whether management needs to change. Required intervention monitoring is detailed in Table 20.

Table 20. Required intervention monitoring for the implementation of the Round Lake EWMP

Ecological objective		Monitoring question	When	Method
1.1	Maintain and support breeding of Murray Hardyhead	Are Murray Hardyhead populations breeding and recruiting?	Biannually, in March and November	Fish survey using bait traps and fyke nets, and seine nets using the protocol established by the Murray Hardyhead Recovery Team. Surveys are carried out by DELWP
1.2	Maintain and support breeding of Murray Hardyhead	Is the watering remige providing food sources to support Murray Hardyhead recruitment?	Anually in Spring	Replicated zooplankton trawls to quanitify abundance/emergence of zooplankton from late winter/spring flows.
1.3	Maintain populations of Large-fruit Tassel (*Ruppia megacarpa*) associated with Brackish Herbland (EVC 538)	Has the extent of Large-fruit Tassel cover changed?	Annual	Distribution mapping of Large-fruit Tassel cover across the lake as part of IWC monitoring. Establish quadrats to determine changes in abundance over time.
1.4	Maintain Charophytes (macroscopic algae) persisting in the lake	Has the extent of Charophytes changed?	Annual	Distribution mapping of Charophyte cover across the lake as part of IWC monitoring. Establish quadrats to determine changes in abundance.
Risk		**Monitoring question**	**When**	**Method**
2.1	Poor water quality	Are water quality parameters maintained at acceptable levels for Murray Hardyhead survival and breeding?	Monthly; EC continuous	Measurement of electrical conductivity, pH, turbidity, dissolved oxygen and lake level. This is currently undertaken by DELWP. EC is to be continuously monitored and telemetered to allow rapid management responses if needed. Include monitoring of nutrient levels (total nitrogen, nitrate/nitrite and total phosphorus) as part of the monitoring program.
2.2	Introduced species – fish	Have introduced fish species such as *Gambusia* or carp established significant populations in the lake?	Biannual	Fish surveys (as previously described, undertaken by DELWP); surveillance/observations during other monitoring (e.g. IWC, water quality monitoring)
2.3	Algal blooms	Are algal blooms occurring? What is the magnitude of the algal bloom? Are algal blooms causing large diel DO fluctuations?	As required	Inspection of the lake during routine water quality monitoring Algal sampling to determine algal cell counts and species composition Installation of DO logger to measure diel fluctuations in DO

10.2. Long term monitoring

Long-term condition monitoring will provide information on whether the watering regime (and other factors) affect the overall condition of the wetland (trend over time). As there is currently no formal long-term condition monitoring program in place,

Table 21 details monitoring required to demonstrate change in condition over time specifically focusing on the long-term outcomes of the Round Lake EWMP.

Condition monitoring should be conducted in conjunction with intervention monitoring.

Table 21. Required long-term condition monitoring for Round Lake

Ecological Objective	Objective No.[1]	Method	When
Specifically relating to ecological objectives			
Maintain populations of Large-fruit Tassel (*Ruppia megacarpa*) associated with Brackish Herbland (EVC 538)	2.1	Comprehensive vegetation condition surveys including IWC, EVC condition, species presence and abundance and weediness; and photopoint monitoring.	Ideally annually with no more than two years between surveys
Risks	**Risk No.**	**Method**	**When**
Changes in EC of Round Lake owing to changes in groundwater contributions from nearby wetlands (e.g. inundation of Lake Boga)	2.6	Continue monitoring of groundwater movement (currently undertaken by DEDJTR and local community volunteers). Ensure monthly monitoring results are provided by DEDJTR to the North Central CMA and/ or the land manager to facilitate data analysis and inform adaptive management	Monthly

11. Knowledge gaps and recommendations

The Round Lake 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 (Table 22).

Table 22 Knowledge gaps and recommendations for Round Lake

Knowledge Gap	Objective/ Risk	Recommendation	Who	Priority
The Channel 1/9 will be considered for rationalisation and any alternative supply arrangements Dertermine if the current supply point is likely to be altered and details of any potential alternative supply points	All	Liaise with GMW connections to determine whether the Channel 1/9 will be rationalised, and details of any alternative supply points if required.	CMA, GMW Connections	High
The salinity tolerance, particularly eggs and larvae, and spawning habitat requirements of Murray Hardyhead	1.1	Keep abreast with latest scientific information on Murray Hardyhead and adaptively manage watering as required.	Researchers	High
The genus of Charophytes occurring at Round Lake and its salinity tolerance levels are currently unknown.	1.3, 2.1	Confirm the identification and salinity tolerance of the Charophytes at Round Lake; adaptively manage watering as required.	Consultant/Researcher on behalf of CMA	Medium

12. References

Archards Irrigation 2010, *Round Lake Contour Plan and Capacity Table,* Prepared for the North Central Catchment Management Authority, Archards Irrigation, Cohuna, Victoria

Backhouse, G Lyon, J & Cant, B, 2008a, *National Recovery Plan for the Murray Hardyhead Craterocephalus fluviatilis*, Department of Sustainability and Environment, Melbourne

Backhouse, G., Lyon, J. & Cant, B, 2008b, *Background and Implementation Information for the Murray Hardyhead Craterocephalus fluviatilis National Recovery Plan,* Department of Sustainability and Environment, Melbourne

Bradbury, S, 2013, *Resilience of Biota in wetlands of intermediate salinity,* PhD Thesis, Deakin university

Bureau of Meterology, 2009, *Climate Statistics for Australian Locations*, viewed November 2009, <http://www.bom.gov.au/climate/averages/tables/ca_vic_names.shtml>

Commonwealth Environmental Water Holder (CEWH) 2015, *Environmental water holdings*, viewed February 2015, <http://www.environment.gov.au/water/cewo/about/water-holdings>

Dedini, M. 2015, Wetland waterbird monitoring in the Kerang region, unpublished raw data collected for North Central Catchment Management Authority, Huntly, Victoria.

DELWP 2016, Bioregional Conservation Status for each BioEVC, viewed February 2016, <http://www.depi.vic.gov.au/environment-and-wildlife/biodiversity/evc-benchmarks>

Department of Environment and Primary Industries (DEPI) 2014a, *Guidelines: Wetland Environmental Water Management Plans*, Department of Environment and Primary Industries, Melbourne, Victoria.

DEPI 2014b, *The Victorian wetland classification framework 2014,* Department of Environment and Primary Industries, East Melbourne, Victoria.

DEPI 2014c, *Water Dictionary*, viewed 31 October 2014, <http://waterregister.vic.gov.au/water-dictionary>.

DEPI ,2014d, *EVC Benchmarks – Murray Mallee Bioregion*, viewed 25 March 2015 <http://www.depi.vic.gov.au/environment-and-wildlife/biodiversity/evc-benchmarks>.

DEPI 2014e, *Advisory List of Rare or Threatened Plants in Victoria*, Department of Environment and Primary Industries, Melbourne, Victoria.

DEPI 2014f, *'WETLAND_1994'*, The State of Victoria, Department of Environment and Primary Industries, viewed 10 February 2015, < http://mapshare2.dse.vic.gov.au/MapShare2EXT/imf.jsp?site=iwc>.

DEPI 2014g, *'WETLAND_1788',* The State of Victoria, Department of Environment and Primary Industries, viewed 10 February 2015, < http://mapshare2.dse.vic.gov.au/MapShare2EXT/imf.jsp?site=iwc>.

DEPI 2013a, *Victorian Waterway Management Strategy*, Department of Environment and Primary Industries, Melbourne, Victoria.

DEPI (2013b). *Advisory List of Threatened Vertebrate Fauna,* Department of Environment and Primary Industries, Melbourne, Vcitoria.

DEPI 2013c, *Flora and Fauna Guarantee Act 1988 Protected Flora List* May 2014, The Department of Environment and Primary Industries, Melbourne.

DEWHA 2008, *Water Requirements of Important Wetlands in the Murray-Darling Basin –Initial Overview Assessment,* Final Report, Compiled by Fluvial Systems and Lloyd Environmental, Canberra.

Department of Sustainability and Environment (DSE) 2013, Index of Wetland Condition methods manual Version 14, unpublished report, Department of Sustainability and Environment, Heidelberg, Victoria.

DSE 2009a, *Biodiversity Interactive Map*. Department of Sustainability and Environment, viewed November 2009, <http://mapshare2.dse.vic.gov.au/MapShare2EXT/imf.jsp?site=bim>

DSE 2009b, *EVC/Bioregion Benchmark for Vegetation Quality Assessment Murray Mallee Bioregion EVC 101: Samphire Shrubland*, Department of Sustainability and Environment, Melbourne.

DSE 2009c, Data Source: '2005_EVC', © The State of Victoria, Department of Sustainability and Environment. The contribution of the Royal Botanical Gardens Melbourne to the data is acknowledged. Accessed: January 2009.

Ellis, I. & Kavanagh, M. 2014, *A review of the biology and status of the endangered Murray Hardyhead: streamlining recovery processes*. Final Report prepared for the Murray-Darling Basin Authority by The Murray-Darling Freshwater Research Centre, MDFRC Publication 19/2014.

Ellis, IM, Stoessel, D, Hammer, MP, Wedderburn, SD, Suitor, L, & Hall, A, 2013, Conservation of an inauspicious endangered freshwater fish, Murray hardyhead (*Craterocephalus fluviatilis*), during drought and competing water demands in the Murray–Darling Basin, Australia. Marine and Freshwater Research, 64(9), 792-806.

EPA 2010, *Environmental quality guidelines for Victorian lakes*. Environment Protection Authority Victoria, viewed February 2016, <http://www.epa.vic.gov.au/our-work/publications/publication/2010/february/1302>

GMW 2013, *Water Change Management Framework*, Version 3, Goulburn-Murray Water Connections Project, Tatura, Victoria

Heron, S & Joyce A, 2008, *Northern Victorian Wetlands: water requirements and impacts of climate change on the 27.6 GL Flora and Fauna Entitlement and dependant wetlands.* Report prepared for Department of Sustainability and Environment, Heidelberg, Victoria.

LCC 1988, *Statewide Assessment of Public Land Use*, Land Conservation Council, July, Melbourne, Victoria

Macumber, PG, 2009, *The Hydrogeology, Hydrology and Management of Round Lake*, Phillip Macumber Consulting Services, Donvale, Victoria

Mitsch, W & Gosselink, J, 2000, *Wetlands*, John Wiley and Sons, New York.

North Central CMA 2015a, *Round Lake Environmental Watering Plan Version 9, Prepared for the Goulburn-Murray Water Connections Project*, North Central Catchment Management Authority, Huntly, Victoria.

North Central CMA 2015b, *North Central Climate Change Adaptation and Mitigation Plan 2015-2018*, North Central Catchment Management Authority, Huntly, Victoria.

North Central CMA 2014, *North Central Waterway Strategy 2014-22*, North Central Catchment Management Authority, Huntly, Victoria.

North Central CMA 2012, *North Central Regional Catchment Strategy 2013-19*, North Central Catchment Management Authority, Huntly, Victoria.

Rakali Ecological Consulting 2014, *Kerang Ramsar and other significant wetlands monitoring project 2014*, report prepared for North Central Catchment Management Authority by Rakali Ecological Consulting.

Sainty, GR & Jacobs, SWL, 2003, *Waterplants in Australia A Field Guide: 4th Edition*, Sainty and Associates Pty Ltd, Potts Point, NSW

Stoessel, D, 2010, *Review of biological and environmental data for Murray Hardyhead (Craterocephalus fluviatilis) within two lakes near Swan Hill - DRAFT*. A report prepared for the Department of Sustainability and Environment, Statewide Services. Department of Sustainability and Environment, Heidelberg, Victoria (Unpublished).

Stoessel, D, 2009, *Assessment of the status of Murray Hardyhead (Craterocephalus fluviatilis) populations within Round and Woorinen North Lake in north-central Victoria*, 2008 - 2009. Arthur Rylah Institute for Environmental Research. Department of Sustainability and Environment, Heidelberg, Victoria (Unpublished).

Stoessel, D, Ellis, I & Ingram, B, 2008a, *A summary of progress and direction of the Murray Hardyhead (Craterocephalus fluviatilis) captive maintenance and breeding program*. Arthur Rylah Institute for Environmental Research. Department of Sustainability and Environment, Heidelberg, Victoria.

Stoessel, D, 2008b, *Assessment of the status of Murray Hardyhead (Craterocephalus fluviatilis) populations within Round and Woorinen North Lake in north-central Victoria – interim report December 2008.* Arthur Rylah Institute for Environmental Research. Department of Sustainability and Environment, Heidelberg, Victoria (Unpublished).

Stoessel, D, 2007, *Assessment of the status of Murray Hardyhead (Craterocephalus fluviatilis) populations within Round, Woorinen North and Elizabeth Lakes – interim report*. Arthur Rylah Institute for Environmental Research (Department of Sustainability and Environment: Heidelberg).

VEAC 2008, *River Red Gum Forests Investigation*, Final report, Victorian Environmental Assessment Council, July, Melbourne.

Victorian Environmental Water Holder (VEWH) 2016, *Environmental water planning*, available at http://www.vewh.vic.gov.au/managing-the-water-holdings/planning [accessed February 2016].

Victorian Environmental Water Holder (VEWH) 2012, *Water Holdings*, available at <http://www.vewh.vic.gov.au/managing-the-water-holdings> [accessed February 2016].

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
DEDJTR	Department of Economic Development, Jobs, Transport and Resources
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 DEDJTR and 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 2008).

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

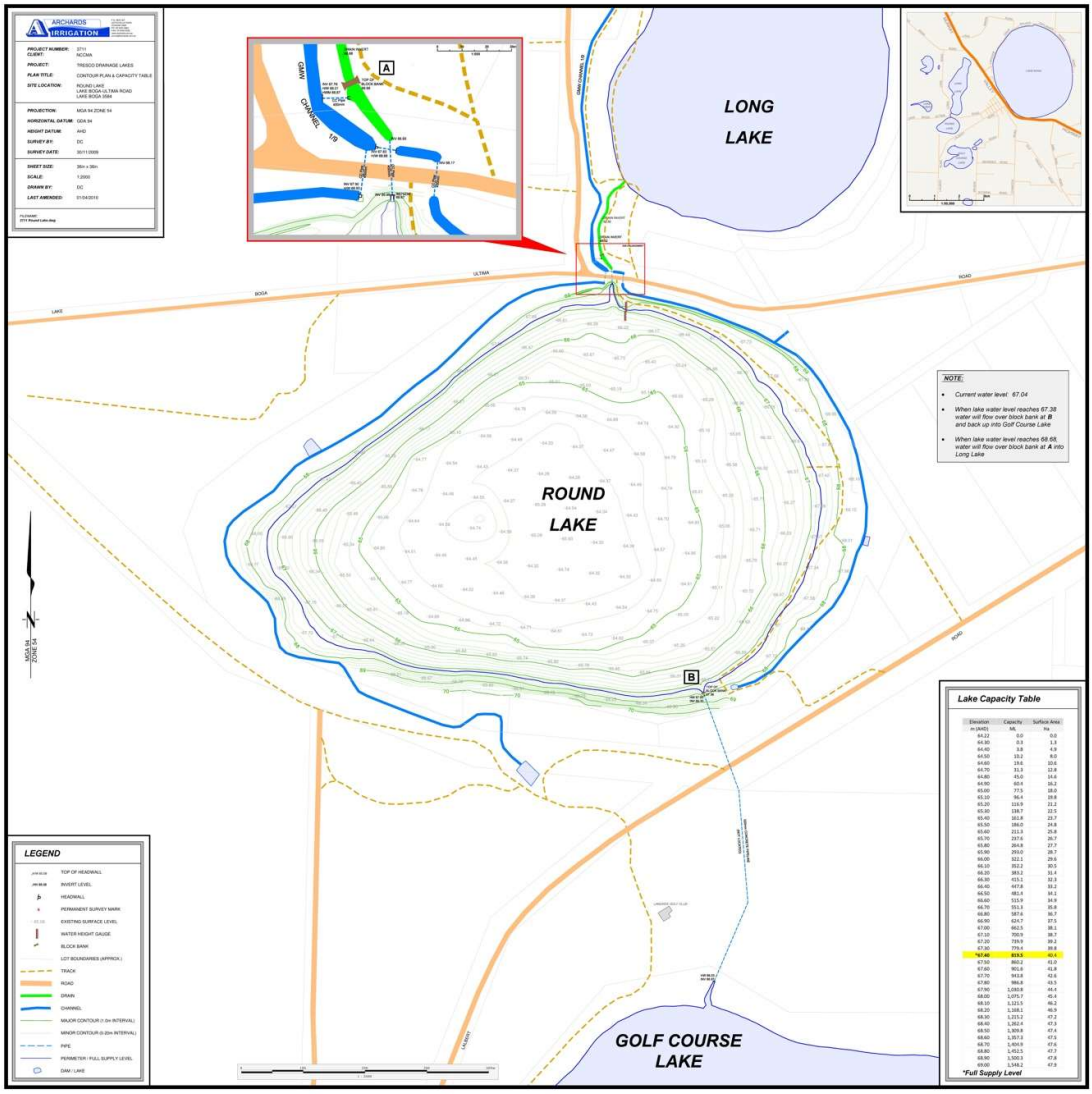
All Aboriginal places, objects and human remains in Victoria are protected under this Act.

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



Source: Archards Irrigation (2010)

Appendix 3. Species lists

Table 23. Fauna species recorded within 1km buffer zone of Round Lake.

Common name	Scientific name	Date of last record	Source
Amphibians			
Common Spadefoot Toad	*Neobatrachus sudeli*	2014	Rakali (2014)
Pobblebonk	*Limnodynastes dumereli*	2014	Rakali (2014)
Spotted Marsh Frog	*Limnodynastes tasmaniensis*	2014	Rakali (2014)
Common Froglet	*Crinia signifera*	2000	DELWP (2015)
Mammals			
Eastern Grey Kangaroo	*Macropus giganteus*	2014	Rakali (2014)
European Rabbit*	*Oryctolagus cuniculus*	2014	Rakali (2014)
Red Fox*	*Vulpes vulpes*	2014	Rakali (2014)
Reptiles			
Stumpy-tailed Lizard	*Tiliqua rugosa*	2014	Rakali (2014)
Fish			
Bony Bream	*Nematalosa erebi*	2012	Stoessel (2012)
Eastern Gambusia*	*Gambusia holbrooki*	2012	Stoessel (2012)
European Carp*	*Cyprinus carpio*	1981	DELWP (2015)
Flat-headed Gudgeon	*Philypnodon grandiceps*	Unknown	North Central CMA (2015a)
Goldfish*	*Carassius auratus*	1981	DELWP (2015)
Murray Hardyhead	*Craterocephalus fluviatilis*	2016	Dendini, M. (pers. comm)
Redfin*	*Perca fluviatilis*	1981	DELWP (2015)
Tench*	*Tinca tinca*	1981	DELWP (2015)
Water-dependent birds			
Australasian Grebe	*Tachybaptus novaehollandiae*	2015	Dendini (2015)
Australasian Shoveler	***Anas rhynchotis***	**2015**	Dendini (2015)
Australian Pelican	*Pelecanus conspicillatus*	2014	Dendini (2015)
Australian Reed-Warbler	*Acrocephalus australis*	Unknown	North Central CMA (2015a)
Australian Shelduck	*Tadorna tadornoides*	2015	Dendini (2015)
Australian White Ibis	*Threskiornis molucca*	Unknown	North Central CMA (2015a)
Australian Wood Duck	*Chenonetta jubata*	2015	Dendini (2015)
Black Swan	*Cygnus atratus*	2015	Dendini (2015)
Black-fronted Dotterel	*Elseyornis melanops*	2014	Dendini (2015)
Black-tailed Native-hen	*Gallinula ventralis*	2000	DELWP (2015)
Black-winged Stilt	*Himantopus himantopus*	2015	Dendini (2015)
Blue-billed Duck	***Oxyura australis***	**2015**	Dendini (2015)
Caspian Tern	***Sterna caspia***	**2014**	**Dendini (2015)**
Chestnut Teal	*Anas castanea*	2015	Dendini (2015)
Clamorous Reed Warbler	*Acrocephalus stentoreus*	2001	DELWP (2015)
Common Greenshank	***Tringa nebularia***	**2000**	DELWP (2015)
Darter	*Anhinga melanogaster*	2015	Dendini (2015)
Dusky Moorhen	*Gallinula tenebrosa*	2001	DELWP (2015)
Eastern Great Egret	***Ardea modesta***	**2000**	DELWP (2015)
Eurasian Coot	*Fulica atra*	2015	Dendini (2015)
Freckled Duck	***Stictonetta naevosa***	**2015**	Dendini (2015)
Great Cormorant	*Phalacrocorax carbo*	Unknown	North Central CMA (2015a)
Great Crested Grebe	*Podiceps cristatus*	2002	DELWP (2015)
Great Egret	*Ardea alba*	Unknown	North Central CMA (2015a)

Common name	Scientific name	Date of last record	Source
Grey Teal	*Anas gracilis*	2015	Dendini (2015)
Gull-billed Tern	*Gelochelidon nilotica*	Unknown	North Central CMA (2015a)
Hardhead	***Aythya australis***	**2015**	Dendini (2015)
Hoary-headed Grebe	*Poliocephalus poliocephalus*	2015	Dendini (2015)
Intermediate Egret	***Ardea intermedia***	Unknown	North Central CMA (2015a)
Little Black Cormorant	*Phalacrocorax sulcirostris*	2000	DELWP (2015)
Little Pied Cormorant	*Microcarbo melanoleucos*	2014	Dendini (2015)
Marsh Sandpiper	***Tringa stagnatilis***	**2015**	Dendini (2015)
Musk Duck	***Biziura lobata***	**2015**	Dendini (2015)
Pacific Black Duck	*Anas superciliosa*	2015	Dendini (2015)
Pink-eared Duck	*Malacorhynchus membranaceus*	2015	Dendini (2015)
Purple Swamphen	*Porphyrio porphyrio*	1999	DELWP (2015)
Red-capped Plover	*Charadrius ruficapillus*	2015	Dendini (2015)
Red-kneed Dotterel	*Erythrogonys cinctus*	2015	Dendini (2015)
Red-necked Avocet	*Recurvirostra novaehollandiae*	2015	Dendini (2015)
Red-necked stint	***Calidris ruficollis***	**2015**	Dendini (2015)
Royal Spoonbill	***Platalea regia***	**2014**	Dendini (2015)
Sacred Kingfisher	*Todiramphus sanctus*	1999	DELWP (2015)
Sharp tailed sandpiper	***Calidris acuminata***	**2015**	Dendini (2015)
Silver Gull	*Chroicocephalus novaehollandiae*	2015	Dendini (2015)
Straw-necked Ibis	*Threskiornis spinicollis*	2000	DELWP (2015)
Whiskered Tern	***Chlidonias hybridus javanicus***	**2014**	Dendini (2015)
White-faced Heron	*Egretta novaehollandiae*	2014	Dendini (2015)
White-necked Heron	*Ardea pacifica*	2015	Dendini (2015)
Yellow billed spoonbill	*Platalea flavipes*	2015	Dendini (2015)
Terrestrial birds			
Australian Hobby	*Falco longipennis*	2014	Rakali (2014)
Australian Magpie	*Cracticus tibicen*	2014	Rakali (2014)
Australian Raven	*Corvus coronoides*	2000	DELWP (2015)
Black Honeyeater	*Sugamel niger*	2012	DELWP (2015)
Black Kite	*Milvus migrans*	2000	DELWP (2015)
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	2014	Rakali (2014)
Black-shouldered Kite	*Elanus axillaris*	1999	DELWP (2015)
Blue Bonnet	*Northiella haematogaster*	2014	Rakali (2014)
Blue-faced Honeyeater	*Entomyzon cyanotis*	2014	Rakali (2014)
Brown Falcon	*Falco berigora*	2000	DELWP (2015)
Brown Goshawk	*Accipiter fasciatus*	2000	DELWP (2015)
Brown Songlark	*Cincloramphus cruralis*	2000	DELWP (2015)
Budgerigar	*Melopsittacus undulatus*	2000	DELWP (2015)
Common Blackbird	*Turdus merula*	2012	DELWP (2015)
Common Starling*	*Sturnus vulgaris*	2014	Rakali (2014)
Crested Pigeon	*Ocyphaps lophotes*	2014	Rakali (2014)
Eastern Barn Owl	*Tyto javanica*	2014	Rakali (2014)
Eastern Rosella	*Platycercus eximius*	2014	Rakali (2014)
European Goldfinch*	*Carduelis carduelis*	2000	DELWP (2015)
Galah	*Eolophus roseicapilla*	2000	DELWP (2015)
Golden-headed Cisticola	*Cisticola exilis*	2014	Rakali (2014)
Grey Fantail	*Rhipidura albiscapa*	2014	Rakali (2014)

Common name	Scientific name	Date of last record	Source
Grey Shrike-thrush	*Colluricincla harmonica*	2014	Rakali (2014)
Horsfield's Bronze-Cuckoo	*Chrysococcyx basalis*	1999	DELWP (2015)
House Sparrow*	*Passer domesticus*	2014	Rakali (2014)
Little Eagle	*Hieraaetus morphnoides*	2000	DELWP (2015)
Little Grassbird	*Megalurus gramineus*	2014	Rakali (2014)
Little Raven	*Corvus mellori*	2014	Rakali (2014)
Magpie-lark	*Grallina cyanoleuca*	2014	Rakali (2014)
Masked Lapwing	*Vanellus miles*	2015	Dendini (2015)
Musk Lorikeet	*Glossopsitta concinna*	2014	Rakali (2014)
Nankeen Kestrel	*Falco cenchroides*	2000	DELWP (2015)
Noisy Miner	*Manorina melanocephala*	2014	Rakali (2014)
Peaceful Dove	*Geopelia striata*	2014	Rakali (2014)
Pied Butcherbird	*Cracticus nigrogularis*	2014	Rakali (2014)
Rainbow Bee-eater	***Merops ornatus***	**2000**	DELWP (2015)
Red Wattlebird	*Anthochaera carunculata*	2014	Rakali (2014)
Red-rumped Parrot	*Psephotus haematonotus*	2000	DELWP (2015)
Rosella species	*Platycercus sp.*	1999	DELWP (2015)
Rufous Songlark	*Cincloramphus mathewsi*	2000	DELWP (2015)
Rufous Whistler	*Pachycephala rufiventris*	1999	DELWP (2015)
Silvereye	*Zosterops lateralis*	1999	DELWP (2015)
Singing Honeyeater	*Lichenostomus virescens*	2014	Rakali (2014)
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*	2014	Rakali (2014)
Spotted Pardalote	*Pardalotus punctatus*	2014	Rakali (2014)
Striped Honeyeater	*Plectorhyncha lanceolata*	1999	DELWP (2015)
Superb Fairy-wren	*Malurus cyaneus*	2014	Rakali (2014)
Swamp Harrier	*Circus approximans*	2000	DELWP (2015)
Tree Martin	*Petrochelidon nigricans*	2014	Rakali (2014)
Wedge-tailed Eagle	*Aquila audax*	2000	DELWP (2015)
Welcome Swallow	*Hirundo neoxena*	2014	Rakali (2014)
Welcome Swallow	*Petrochelidon neoxena*	2001	DELWP (2015)
Whistling Kite	*Haliastur sphenurus*	2000	DELWP (2015)
White-breasted Woodswallow	*Artamus leucorynchus*	1999	DELWP (2015)
White-browed Babbler	*Pomatostomus superciliosus*	2000	DELWP (2015)
White-fronted Chat	*Epthianura albifrons*	2012	DELWP (2015)
White-plumed Honeyeater	*Lichenostomus penicillatus*	2014	Rakali (2014)
White-winged Fairy-wren	*Malurus leucopterus*	2014	Rakali (2014)
Willie Wagtail	*Rhipidura leucophrys*	2014	Rakali (2014)
Zebra Finch	*Taeniopygia guttata*	2001	DELWP (2015)

* = introduced species

Table 24. Flora species recorded within 1km buffer zone of Round Lake.

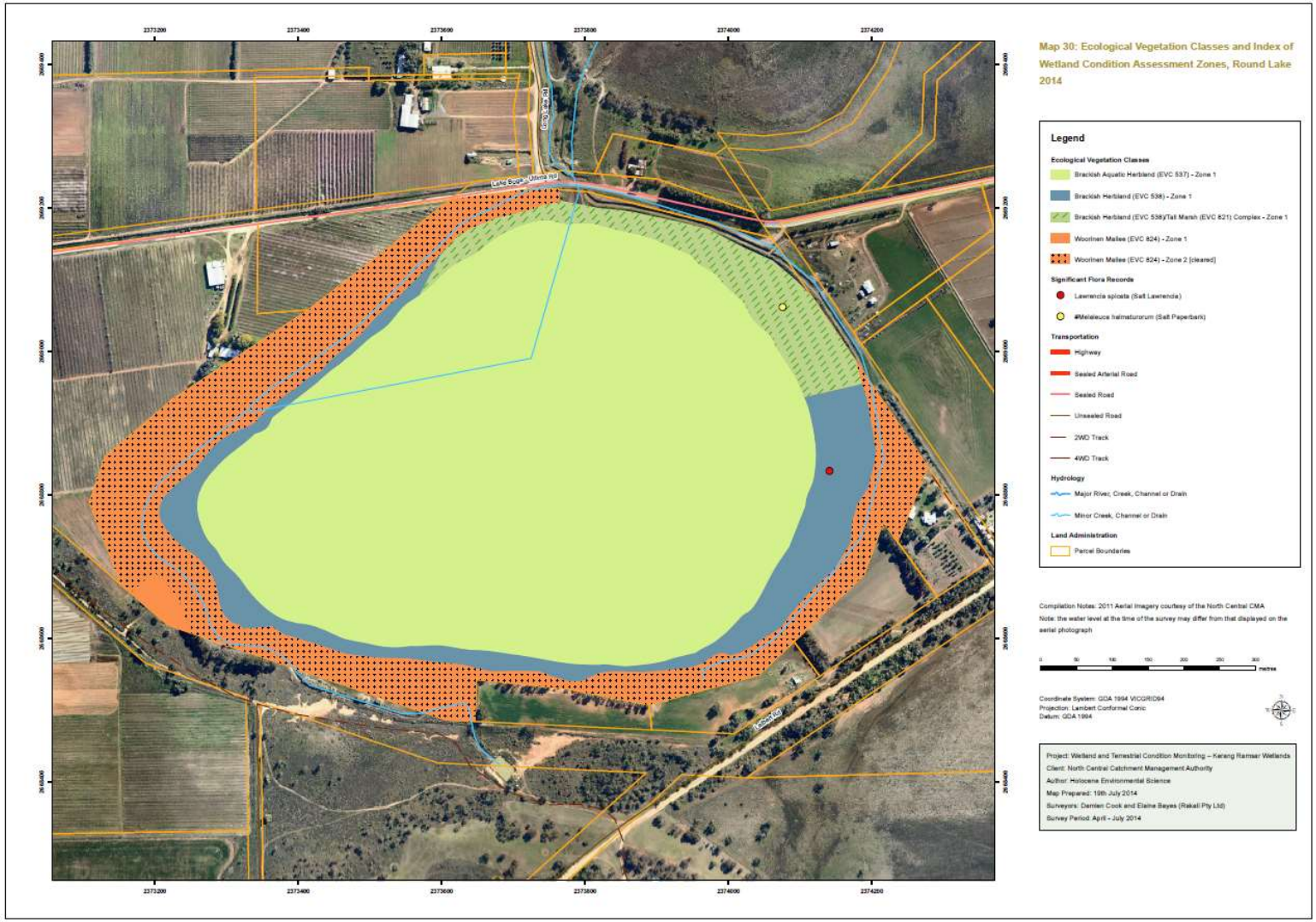
Common name	Scientific name	Date of last record	Source
Water-dependent species			
Australian Salt-grass	*Distichlis distichophylla*	2014	Rakali (2014)
Black Box	*Eucalyptus largiflorens*	2014	Rakali (2014)
Blackseed Glasswort	*Tecticornia pergranulata*	2014	Rakali (2014)
Charophyte	*Charophyte*	Unknown	NCCMA (2015a)
Clay Plantain	*Plantago cunninghamii*	2014	Rakali (2014)
Common Reed	*Phragmites australis*	2014	Rakali (2014)
Fennel Pondweed	*Potamogeton pectinatus*	2014	Rakali (2014)
Filamentous algae	*Filamentous algae*	Unknown	NCCMA (2015a)
Large-fruit Tassel	*Ruppia megacarpa*	Unknown	NCCMA (2015a)
Mallee Love-grass	*Eragrostis dielsii*	2014	Rakali (2014)
Narrow-leaf Cumbungi	*Typha domingensis*	2014	Rakali (2014)
Narrow-leaf Wilsonia	*Wilsonia backhousei*	2014	Rakali (2014)
Native Millet	*Panicum decompositum var. decompositum*	2014	Rakali (2014)
Native Sow-thistle	*Sonchus hydrophilus*	2014	Rakali (2014)
Quena	*Solanum esuriale*	2014	Rakali (2014)
River Red-gum	*Eucalyptus camaldulensis*	2014	Rakali (2014)
Rosinweed	*Cressa australis*	2014	Rakali (2014)
Round-leaf Wilsonia	*Wilsonia rotundifolia*	2014	Rakali (2014)
Salt Paperbark	***Melaleuca halmaturorum subsp. halmaturorum***	**2014**	Rakali (2014)
Salt Sand-spurrey	*Spergularia marina s.l.*	2014	Rakali (2014)
Sea Celery	*Apium aff. prostratum (Tyrendarra)*	2014	Rakali (2014)
Seablite	*Suaeda australis*	Unknown	NCCMA (2015a)
Slender Knotweed	*Persicaria decipiens*	2014	Rakali (2014)
Small Loosestrife	*Lythrum hyssopifolia*	Unknown	NCCMA (2015a)
Spider Grass	*Enteropogon acicularis*	2014	Rakali (2014)
Spiny Flat-sedge	*Cyperus gymnocaulos*	2014	Rakali (2014)
Water-mat	*Lepilaena sp.*	Unknown	NCCMA (2015a)
Willow Wattle	*Acacia salicina*	2014	Rakali (2014)
Australian Salt-grass	*Distichlis distichophylla*	2014	Rakali (2014)
Terrestrial species			
Berry Saltbush	*Atriplex semibaccata*	2014	Rakali (2014)
Blown Grass	*Agrostis avenacea*	Unknown	NCCMA (2015a)
Broad-leaf Millotia	*Millotia myosotidifolia*	1903	DELWP (2015a)
Burr Stickseed	*Omphalolappula concava*	1903	DELWP (2015a)
Caltrop	*Tribulus terrestris*	2014	Rakali (2014)
Common Bow-flower	*Millotia muelleri*	1898	DELWP (2015a)
Common Wallaby-grass	*Rytidosperma caespitosum*	2014	Rakali (2014)
Creeping Monkey Flower	*Mimulus repens*	Unknown	NCCMA (2015a)
Dark Bottle-washers	*Enneapogon nigricans*	2014	Rakali (2014)
Darnel	*Lolium temulentum*	Unknown	NCCMA (2015a)
Desert Cassia	*Senna artemisioides spp. agg.*	2014	Rakali (2014)
Dillon Bush	*Nitraria billardieri*	Unknown	NCCMA (2015a)
Dumosa Mallee	*Eucalyptus dumosa*	2014	Rakali (2014)
Dwarf Myall	***Acacia ancistrophylla var. lissophylla***	**1963**	DELWP (2015)
Flat-top Saltbush	***Atriplex lindleyi subsp. lindleyi***	**2014**	Rakali (2014)

Common name	Scientific name	Date of last record	Source
Fuzzy New Holland Daisy	*Vittadinia cuneata*	2014	Rakali (2014)
Grass Bindweed	*Convolvulus remotus*	2014	Rakali (2014)
Grey Copperburr	*Sclerolaena diacantha*	2014	Rakali (2014)
Hairy Burr-daisy	*Calotis hispidula*	1903	DELWP (2015)
Hairy Forget-me-not	*Plagiobothrys elachanthus*	1903	DELWP (2015)
Hairy Willow-herb	*Epilobium hirtigerum*	Unknown	NCCMA (2015a)
Hedge Saltbush	*Rhagodia spinescens*	2014	Rakali (2014)
Honey-myrtle	*Melaleuca sp. (planted)*	Unknown	NCCMA (2015a)
Inland Pigface	*Carpobrotus modestus*	2014	Rakali (2014)
Knotted Poa	***Poa drummondiana***	**1903**	DELWP (2015)
Knotty Spear-grass	*Austrostipa nodosa*	2014	Rakali (2014)
Knottybutt Grass	*Paspalidium constrictum*	2014	Rakali (2014)
Leafless Ballart	*Exocarpos aphyllus*	2014	Rakali (2014)
Mallee Rice-flower	*Pimelea microcephala subsp. microcephala*	2014	Rakali (2014)
May Smocks	*Harmsiodoxa blennodioides*	1903	DELWP (2015)
Mealy Saltbush	***Atriplex pseudocampanulata***	**Unknown**	NCCMA (2015a)
Nodding Saltbush	*Einadia nutans*	2014	Rakali (2014)
Pea Thread-petal	*Stenopetalum sphaerocarpum*	1898	DELWP (2015)
Pimelea Daisy-bush	*Olearia pimeleoides*	2014	Rakali (2014)
Prickly Saltwort	*Salsola tragus subsp. tragus*	2014	Rakali (2014)
Pussy Tails	*Ptilotus spathulatus*	1848	DELWP (2015)
Rough Raspwort	*Haloragis aspera*	1891	DELWP (2015)
Rough Spear-grass	*Austrostipa scabra*	2014	Rakali (2014)
Rounded Noon-flower	*Disphyma crassifolium subsp. clavellatum*	2014	Rakali (2014)
Ruby Saltbush	*Enchylaena tomentosa var. tomentosa*	2014	Rakali (2014)
Salt Lawrencia	***Lawrencia spicata***	**2014**	Rakali (2014)
Sandhill Goodenia	*Goodenia willisiana*	1898	DELWP (2015)
Short-leaf Bluebush	*Maireana brevifolia*	2014	Rakali (2014)
Slender Barb-grass	*Parapholis strigosa*	Unknown	NCCMA (2015a)
Slender Hop-bush	*Dodonaea viscosa subsp. angustissima*	2014	Rakali (2014)
Small Burr-grass	***Tragus australianus***	**2014**	Rakali (2014)
Small Cooba	*Acacia ligulata*	2014	Rakali (2014)
Smooth Halgania	*Halgania andromedifolia*	1770	DELWP (2015)
Starry Goosefoot	*Scleroblitum atriplicinum*	1891	DELWP (2015)
Sticky Boobialla	*Myoporum petiolatum*	1836	DELWP (2015)
Stiff Cup-flower	*Pogonolepis muelleriana*	1903	DELWP (2015)
Tamarisk	*Tamarix aphylla*	Unknown	NCCMA (2015a)
Thorny Lawrencia	*Lawrencia squamata*	2014	Rakali (2014)
Tree Tobacco	*Nicotiniana glauca*	Unknown	NCCMA (2015a)
Tufted Bluebell	*Wahlenbergia communis*	Unknown	NCCMA (2015a)
Umbrella Wattle	*Acacia oswaldii*	2014	Rakali (2014)
Variable Sida	*Sida corrugata*	2014	Rakali (2014)
Variable Spear Grass	*Austrostipa variabilis*	Unknown	NCCMA (2015a)
Wallaby Grass	*Austrodanthonia setacea*	Unknown	NCCMA (2015a)
Warty Peppercress	***Lepidium papillosum***	**1903**	DELWP (2015)
Wedge-leaf Hop-bush	*Dodonaea viscosa subsp. cuneata*	2014	Rakali (2014)

Common name	Scientific name	Date of last record	Source
Weeping Pittosporum	*Pittosporum angustifolium*	2014	Rakali (2014)
Windmill Grass	*Chloris truncata*	2014	Rakali (2014)
Wire-leaf Mistletoe	*Amyema preissii*	2014	Rakali (2014)
Woolly New Holland Daisy	*Vittadinia gracilis*	2014	Rakali (2014)
Exotic water-dependent species			
Aster-weed	*Aster subulatus*	2014	Rakali (2014)
Berry Seablite	*Suaeda baccifera*	2014	Rakali (2014)
Buck's-horn Plantain	*Plantago coronopus*	2014	Rakali (2014)
Coast Barb-grass	*Parapholis incurva*	2014	Rakali (2014)
Common Heliotrope	*Heliotropium europaeum*	2014	Rakali (2014)
Curled Dock	*Rumex crispus*	Unknown	NCCMA (2015a)
Hairy Hawkbit	*Leontodon taraxacoides subsp. taraxacoides*	2014	Rakali (2014)
Jointed Rush	*Juncus articulatus*	Unknown	NCCMA (2015a)
Paspalum	*Paspalum dilatatum*	2014	Rakali (2014)
River Oak	*Casuarina cunninghamiana subsp. cunninghamiana*	2014	Rakali (2014)
Spiny Rush	*Juncus acutus subsp. acutus*	2014	Rakali (2014)
Stinkwort	*Dittrichia graveolens*	2014	Rakali (2014)
Swamp Yate	*Eucalyptus occidentalis*	2014	Rakali (2014)
Weeping Willow	*Salix babylonica s.l.*	2014	Rakali (2014)
Exotic terrestrial species			
African Box-thorn	*Lycium ferocissimum*	2014	Rakali (2014)
Annual Beard-grass	*Polypogon monspeliensis*	Unknown	NCCMA (2015a)
Apricot	*Prunus armeniaca*	2014	Rakali (2014)
Asparagus	*Asparagus officinalis*	2014	Rakali (2014)
Barley Grass	*Hordeum sp.*	Unknown	NCCMA (2015a)
Blue Sow-thistle	*Sonchus asper ssp. glaucescens*	Unknown	NCCMA (2015a)
Bridal Creeper	*Asparagus asparagoides*	2014	Rakali (2014)
Brome	*Bromus sp.*	Unknown	NCCMA (2015a)
Buffalo Grass	*Stenotaphrum secundatum*	2014	Rakali (2014)
Camel Melon	*Citrullus lanatus*	2014	Rakali (2014)
Cape Weed	*Arctotheca calendula*	Unknown	NCCMA (2015a)
Cat's Ear	*Hypochoeris radicata*	Unknown	NCCMA (2015a)
Common Ice-plant	*Mesembryanthemum crystallinum*	2014	Rakali (2014)
Common Sow-thistle	*Sonchus oleraceus*	2014	Rakali (2014)
Couch	*Cynodon dactylon*	2014	Rakali (2014)
Flax-leaf Alyssum	*Alyssum linifolium*	1903	DELWP (2015)
Fleabane	*Conyza spp.*	2014	Rakali (2014)
Gazania	*Gazania spp.*	2014	Rakali (2014)
Grape	*Vitis vinifera*	2014	Rakali (2014)
Great Brome	*Bromus diandrus*	2014	Rakali (2014)
Horehound	*Marrubium vulgare*	2014	Rakali (2014)
Ice Plant	*Mesembryanthemum crystalinum*	Unknown	NCCMA (2015a)
kikuyu	*Pennisetum clandestinum*	2014	Rakali (2014)
Little Medic	*Medicago minima*	Unknown	NCCMA (2015a)
London Rocket	*Sisymbrium irio*	2014	Rakali (2014)
Maltese Cockspur	*Centauria melitensis*	Unknown	NCCMA (2015a)

Common name	Scientific name	Date of last record	Source
Mediterranean Barley-grass	*Hordeum hystrix*	2014	Rakali (2014)
Oat	*Avena sp.*	Unknown	NCCMA (2015a)
Olive	*Olea europaea*	2014	Rakali (2014)
Onion Weed	*Asphodelus fistulosus*	2014	Rakali (2014)
Ox-tongue	*Helminthotheca echioides*	2014	Rakali (2014)
Paradoxical Canary-grass	*Phalaris paradoxa*	Unknown	NCCMA (2015a)
Pepper Tree	*Schinus molle*	2014	Rakali (2014)
Persian Poppy	*Hypecoum pendulum*	1975	DELWP (2015)
Pine	*Pinus spp.*	2014	Rakali (2014)
Prickly Lettuce	*Lactuca serriola*	2014	Rakali (2014)
Prickly Pear	*Opuntia spp.*	2014	Rakali (2014)
Prickly Sow Thistle	*Sonchus asper*	Unknown	NCCMA (2015a)
Rats-tail Fescue	*Vulpia myuros*	Unknown	NCCMA (2015a)
Red Brome	*Bromus rubens*	2014	Rakali (2014)
Red Sandspurrey	*Spergularia rubra*	Unknown	NCCMA (2015a)
Rough Sow-thistle	*Sonchus asper s.l.*	2014	Rakali (2014)
Scarlet Pimpernal	*Anagallis arvensis*	Unknown	NCCMA (2015a)
Scarlet Pimpernel	*Anagallis arvensis var. arvensis*	2014	Rakali (2014)
Scotch Thistle	*Onopordum acanthium*	Unknown	NCCMA (2015a)
Skeleton Weed	*Chondrilla juncea*	2014	Rakali (2014)
Slender Vetch	*Vicia tetrasperma*	2014	Rakali (2014)
Small Ice-plant	*Mesembryanthemum nodiflorum*	2014	Rakali (2014)
Small-leaf Burr Medic	*Medicago praecox*	Unknown	NCCMA (2015a)
Soursob	*Oxalis pes-caprae*	2014	Rakali (2014)
Spear Thistle	*Cirsium vulgare*	2014	Rakali (2014)
Velvet Cotoneaster	*Cotoneaster pannosus*	2014	Rakali (2014)
White Fumitory	*Fumaria capreolata*	1975	DELWP (2015)
White Mustard	*Sinapis alba*	Unknown	NCCMA (2015a)
Wild Oat	*Avena fatua*	2014	Rakali (2014)
Wild Sage	*Salvia verbenaca*	2014	Rakali (2014)
Willow-leaf Lettuce	*Lactuca saligna*	2014	Rakali (2014)

Appendix 4. Ecological Vegetation Class Mapping



Appendix 5. Community and stakeholder engagement

Initial community consultation was undertaken for the Environmental Watering Plan in 2010, which captured information provided by members of the community, interest groups and agency stakeholders. Further consultation for the *Round Lake EWMP* was undertaken via phone consultation with available community members that were originally consulted as part of the EWP to discuss the proposed watering regime, and update ecological values and objectives. As the original 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. The following section is the information captured from the consultation for the development of the EWP in 2010.

Community Engagement purpose

An important component of the EWPs involves identifying the goal, underlying environmental objectives and wetland type for each of the wetlands being assessed for the GMW Connections Project. This requires an understanding of physical attributes, the history and the main biological processes associated with each of the wetlands.

In many cases, adjoining landholders have had a long association with a wetland and have developed a good understanding that is useful to include in the development of the EWPs. This is particularly important if only limited monitoring records exist.

Method

A targeted community/agency engagement process was developed for the first round of EWPs developed in early 2009. A list of people with a good technical understanding of each wetland was developed by the technical working group (DPI, DSE and North Central CMA representatives).

This list included key adjoining landholders that have had a long association with the wetland and proven interest in maintaining its environmental value. A minimum of 2 landholders were invited to provide input for each wetland.

Other community and agency people that can provide useful technical and historic information include G-MW water bailiffs, duck hunters (Field & Game Association), bird observers and field naturalists. These people often possess valuable information across several of the wetlands currently being studied.

The method of obtaining information was informal and occurred at the wetland (e.g. oral histories, interviews). The information has been captured in brief dot point form and only technical information and observations are to be noted that will add value to the development of the EWP.

A list of participants has been recorded however all the comments have been combined for each of the wetlands so individual comments are not referenced back to individuals.

List of community and agency participants (Round Lake)

- Tom Lowe (field naturalist)
- John Jobson (landholder)
- Barry Free (landholder)
- Peter Keostveld (G-MW)

Note: the results below document the comments received from the community members approached as part of the community engagement process. However, if new information comes to light this can be amended and redistributed accordingly.

Information provided to the community

It is important that the people approached for this information have a brief, straight summary of the purpose of the EWPs and type of information that will be useful to include in the planning process. Refer to summary below (adapted from Rob O'Brien, DPI 2009):

We are currently completing a study for NVIRP Northern Victoria Irrigation Renewal Project. It involves completing plans for Lake Leaghur, McDonalds Swamp, Little Lake Meran, Lake Meran, Little Lake Boort, Round Lake and Lake Yando.

As part of this it would be valuable to gather information that is broadly described below with a focus on the water regime and associated wetland values. It's recognised that these wetlands have been altered significantly since European settlement and the expansion of irrigated agriculture.

Providing information on these changes and how these influenced and altered the wetlands is important. It is particularly important to collate information or observations over more recent times, such as the last 30 - 50 years.

- *What was the original (pre-European settlement) condition of the wetland, including any details of the water regime and values (environmental, cultural)?*
- *What broad changes to the wetlands have occurred, particularly changed water regimes, as agricultural development influenced the floodplains and wetland?*
- *What connection does the wetland have to the floodplain to provide floodwater, or local catchment runoff?*
- *To what extent does the current irrigation supply channel have on the water regime over time?*
- *During more recent times (last 50yrs?) how did the productivity of the wetland vary with the altered water regimes?*
- *Describe the health of the wetland and notable plants and animals (both aquatic/terrestrial) associated with its water management.*
- *Comment on pest plants (boxthorn, willows, cumbungi etc)*
- *What influence has grazing domestic stock had on the reserve, both positive and negative effects?*
- *Given the history and current condition what type of water regime would be needed to achieve the best environmental results for the wetland?*
- *What other management practices could be adopted to improve the environmental value of the wetland?*

Pre European Settlement Condition

- Round Lake is located on the northern floodplains, which were influenced by the Avoca River, the Loddon River and the Murray River and Little Murray River systems. Floodwater behavior was dependent on the volume and timing of these interacting waterways, wetlands and floodplains.
- Round Lake is part of an interacting wetland system situated west of Lake Boga and adjoins Long Lake to the north.
- Another wetland, Gold Course Lake, is situated immediately south of Round Lake but is not hydrologically connected. Golf Course Lake never functioned as a lake but more a Mallee depression with no obvious water supply.
- Gold Course Lake has a Mallee and floodplain catchment area to the south and southeast that may have produced watershed during very wet periods.
- Round Lake is also situated on fringe Mallee and appears to be a Mallee depression with no obvious nearby catchment area.
- Round and Long Lakes would have received floodwater from Lake Baker to the north that was fed from the overflow of Lake Boga combined with the water that backed up from the Little Murray River system.
- Rainfall and flooding was highly variable in this section of the catchment under natural conditions.
- Lake Boga was well connected to the Little Murray River. As the water levels rose in the Murray River, the Little Murray would experience high flows delivering water into Lake Boga. If the Avoca River flooded at the same time, water would have flowed northward from the Avoca Marshes, through the Mystic Park area and onto Lake Manor and Lake Boga.
- The banks of the Little Murray River were almost treeless and this may have been due to the water regime not favoring Red Gum recruitment.

- The watercourse for Avoca water between the Mystic Park and Lake Boga was very wide and shallow and could spread 1 mile wide.
- Many of the inland lakes all joined together and could be boated between during flood times in a flat- bottom boat.
- The natural flooding of the northern floodplain was variable however normally filled, flushed and fell away quite quickly.
- Lake Kunett is a low-lying Mallee depression west of Long Lake. It was a natural salt lake prior to European settlement.
- The Tresco Drainage Lakes and nearby Lake Boga and Lake Kunett would have influenced each other via the groundwater system.

Changed Management

- The Tresco Drainage Lakes and other nearby wetlands would have contained a greater diversity of native plants and animals than what is present today.
- Round Lake and the other adjoining wetlands were dramatically impacted as part of European Settlement.
- The rivers that determined the flooding regime of the Tresco Drainage Lakes were manipulated to suit European Settlers and this changed natural water regime, which altered the character of the districts waterways and wetlands.
- Basic river regulation began in the mid 1800's, first to secure stock and domestic water, then later for irrigation use.
- The natural salt lakes, Lake Kunett, Lake Kelly and Spences Lake were important salt harvesting lakes and salt was transported by Paddle Steamers via the Murray River in the early years.
- There were plans to widen the waterway from the Little Murray River into Lake Boga to allow Paddle Streamers access into Lake Boga. This would allow the salt that was being harvested at Lake Kunett to be carted a much shorter distance, compared to carting it to Swan Hill, reducing freight costs.
- Long Lake was maintained as a freshwater storage lake and a pump located on the western side supplied water into a channel system that serviced dry land areas to the west.
- Groundwater level began to rise dramatically with the development of the irrigation supply system and irrigated agriculture.
- Low lying depressions and wetlands became susceptible to high saline groundwater levels and this increased salinity altered their character limiting the plants and animals that could exist there.
- Wetlands that have their water supply diminished or removed are susceptible to high saline groundwater conditions and usually deteriorate becoming increasing saline.
- Long Lake was removed from the irrigation and floodplain system and became increasingly saline. The GMW channel following the western side of the wetland leaked and seeped significantly, further salinising the adjoining Long Lake.
- The Tresco Horticultural district original irrigation supply system was very inefficient and resulted in huge amounts of water being lost causing groundwater levels to rise and significant salinity problems particularly on the majority of the low lying areas.
- The Tresco Horticultural area originally supported a significant citrus industry of over 1000 acres.
- Early furrow or flood irrigation systems in the Tresco horticultural district resulted in more water entering the already elevated groundwater system, further aggravating the salinity problem.
- Golf Course Lake was taken over by GMW to provide a drainage outfall for the Tresco Horticultural district.
- With the Tresco area being irrigated and supporting horticultural crops there was a need for improved drainage. The original drainage schemes commenced in the 1920's.
- Tough economic times for the districts farmers occurred in the 1940's and this was followed by a series of wet years in the 1950's further aggravating the salinity problems.

- In the 1950's and 1960's tile drainage systems where installed in conjunction with deepening the main drains system which provided relief from salinisation and resulted in significant drainage flows into Golf Course Lake and then onto Round Lake.
- Lake Boga has been managed primarily a deep freshwater lake for most of the last century and possibly accumulated a lot of silt over that time.
- Lake Boga dried in 1915 however was filled a few months later.
- A local history book by Grant Angus (Between the Rivers) provides a good description of the areas development.
- The GMW channel that follows the western side of Long Lake provides outfall flows into Round Lake. This has assisted in maintaining the water levels in the lake.
- There are no irrigation supply channels that can deliver fresh water into Golf Course Lake; only the drainage flows from the Tresco Horticultural district enter this wetland.
- A concrete pipe has been installed from the north end of Golf Course Lake to the southern end of Round Lake (1950's/60's?). This was to allow water to flow northward out of Golf Course Lake into Round (& Long) if the drainage flows overfilled Gold Course Lake.
- During the wet periods water did flow from Gold Course Lake into Long Lake however with changed irrigation practices and diminishing drainage flows it is believed the storage of Golf Course Lake alone, is sufficient to receive all of the drainage flows eventuating off the Tresco Horticultural district.
- There has been an enormous improvement in irrigated agriculture in the Tresco Horticultural district with most farm utilizing highly efficient systems that result in minimal drainage or exporting of nutrients.

Environmental Values

- In the 1960's Round Lake and Golf Course Lake supported a diverse range of waterbird species, a host of aquatic plants and associated invertebrates, and several fish species. Some of the waterbirds include Grey Teal, Hardhead Duck, Green Shanks, Dotterels, Stints, Sand Pipers, Marsh Terns, Silver Gulls, Marsh sandpipers, Blue Bill Ducks, Grebes.
- Long Lake was maintained as a deep freshwater lake in the mid 1900's and supported a significant fishery, particularly Murray Cod.
- Golf Course and Round Lakes did not appear to support large bodied fish.
- The waterbird diversity dropped in Golf Course Lake and Round Lake as the salinity of the wetlands increased.
- The salinity of these wetlands and many of the districts wetlands increased after the wet period in the 1970's.
- In the 1980's Golf Course Lake was considered to possess the highest environmental values of all the Tresco Drainage Lakes. Golf Course Lake appeared slighter fresher and there were healthy populations of the threatened salt tolerant native fish, Murray Hardyhead, and good waterbird numbers.
- In the late 1990's the drainage flows off the horticultural catchment reduced significantly and resulting in lower water levels in Golf Course Lake and increasing salinity levels. Increased salinity levels caused environmental decline particularly the loss of Murray Hardyhead but also reduced waterbird usage.
- Attempts were made to deliver freshwater into Golf Course Lake to protect the environmental values by injecting significant volumes of fresh channel water into Round Lake, elevating the lakes water level and forcing water through the pipeline into Golf Course Lake. This approach was not efficient and eventually Golf Course Lake salinity levels rose and almost all of the previous environmental values lost.
- Round Lake currently is considered to possess the highest environmental values of all of the Tresco Drainage Lakes. It supports the threatened Murray Hardyhead fish and good numbers of waterbirds.
- The volume of outfall have reduced over time into Round Lake and Environmental water has been delivered periodically to maintain the lake levels and keep the salinity levels within a range that can support key species, particularly Murray Hardyhead.
- Lake Boga needs to be recognized for the environmental values it possesses.

- Some of the local people value Round Lake as it currently supports good numbers of waterbirds however the small native salt tolerant fish, Murray Hardyhead, is not as well valued.
- During recent tough times, with water becoming increasingly scarce and valuable, some surrounding landholders view the water being delivered into Round Lake as wasteful, particularly when they are suffering lost production including the death of some of their permanent plantings.

Suggested Future Management

- Round lake could be managed as a permanent saline lake, with fluctuating water levels.
- There is no support for refilling Golf Course Lake to increase its environmental values as it compromises is primary use as providing drainage relief to the valuable horticultural district.
- The local community expressed a need to better communicate environmental water delivery and objectives using several communication methods.
- There is an increasing need to undertake pest plant and animal work, particularly rabbit control across all land tenures to protect both the environment and agricultural production.

Key Points

- Round Lake was originally a wetland depression, on the edge of the Mallee and northern floodplains that received variable flood flows from the combined Avoca and Little Murray floodplain systems.
- Round Lake has been dramatically altered over time since European settlement and is currently being managed as a permanent saline lake.
- The management of Round Lake needs to be considered in the context of the other nearby wetlands as they will influence each other (i.e. groundwater leakage).
- The views on the environmental value are quite varied however there is limited objection to maintain Round Lake it for waterbird usage. Murray Hardyhead is not as well valued.
- There would be significant objections to filling Golf Course Lake with environmental water as it would jeopardise its primary function of providing drainage relief for the Tresco Horticultural district.
- Community members expressed an interest in increasing the community and agency interaction in regards to the management of the Tresco Drainage Lakes and the delivery of environmental water allocations.

Additional information from the 2016 EWMP Consultation

- Golf Course lake originally a mallee depression, filled by irrigation drainage from Tresco area
- Round would originally fill from drainage line connecting the Little Murray River to Lake Boga, then overflow to Lake Barker, Long Lake and then Round Lake.
- A pipe was put in between Golf course and Round, now blocked off
- Bird populations are good, very fluid depending on season. Observations of large numbers of coots, ducks, and occasional pelican.
- Lake vegetation has improved over the last 15 years
- Suggested that Boxthorn is a currently a big problem in the Tresco area particularly around roadsides and easements, may be an issue at Round Lake that requires control
- Control of Sharp rush would be beneficial

Appendix 6. Assessment against the Murray Darling Basin Plan Criteria for Identifying an Environmental Asset

Table 25. Round Lake 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	X	
	(b) with environmental watering, capable of supporting a species listed in or under the JAMBA, CAMBA, ROKAMBA or the Bonn Convention.	✓	Refer to Table 8, Round Lake 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	X	
	(b) represents the only example of a particular type of water-dependent ecosystem in the Murray-Darling Basin; or	X	
	(c) represents a rare example of a particular type of water-dependent ecosystem in the Murray-Darling Basin.	X	
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	✓	Round Lake 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	X	
	(iii) important feeding, breeding and nursery sites for native water-dependent biota; or	✓	Round Lake provides vital feeding, breeding and nursery sites for Murray Hardyhead
	(b) is essential for maintaining, and preventing declines of, native water-dependent biota.	✓	Round Lake provides vital habitat for Murray Hardyhead and is known to support several listed waterbird species

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)	✓	Round Lake provides habitat for the EPBC listed threatened species, Murray Hardyhead.
	(b) supports water-dependent ecosystems treated as threatened or endangered (however described) under State or Territory law; or	X	
	(c) supports one or more native water-dependent species treated as threatened or endangered (however described) under State or Territory law.	✓	Round Lake supports an additional five 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	✓	Round Lake 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.	X	

Appendix 7. Criteria and assessment indicators for Round Lake ecosystem functions

Item	Criteria	Meets criteria	Description for Round Lake
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 Round Lake as a feeding site (e.g. open water and beds of *Ruppia* sp)
	(b) pathways for the dispersal, migration and movement of native water-dependent biota; or	X	
	(c) a diversity of important feeding, breeding and nursery sites for native water-dependent biota; or	X	
	(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.	✓	Round Lake is one of less than ten remaining locations supporting Murray Hardyhead
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 Round Lake
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	