Environmental Water Managemement Plan

Heywood Lake

mallee
catchment management authority

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Acknowledgement of Country

Mallee Catchment Management Authority (CMA) acknowledges and respects Traditional Owners, Aboriginal communities and organisations. We recognise the diversity of their cultures and the deep connections they have with Victoria's lands and waters. We value partnerships with them for the health of people and Country.

Mallee CMA Board, management and staff pay their respects to Elders past, present and emerging and recognise the primacy of Traditional Owners' obligations, rights and responsibilities to use and care for their traditional lands and waters.

Abbreviations and acronyms

ACHRIS	Aboriginal Cultural Heritage Register and Information System
AHD	Australian Height Datum
AM	Adaptive Management
AVIRA	Aquatic Value Identification and Risk Assessment
BWS	Basin Wide Environmental Watering Strategy
CAMBA	China-Australia Migratory Bird Agreement
CEWH	Commonwealth Environmental Water Holder
CMA	Catchment Management Authority
Ctf	Commence to flow
DCCEEW	Department of Climate Change, Energy, the Environment and Water (C'wth)
DEECA	Department of Energy, Environment and Climate Action (Victorian)
DELWP	Department of Environment, Land, Water and Planning (now DEECA)
EDBL	Ephemeral Deflation Basin Lake
EPBC	Environment Protection and Biodiversity Conservation
EVC	Ecological Vegetation Class
EWMP	Environmental Water Management Plan
EWP	Environmental Watering Plan
EWR	Environmental Water Reserve
FFG	Flora and Fauna Guarantee
IAP2	International Association of Public Participation
IWC	Index of Wetland Condition
JAMBA	Japan-Australia Migratory Bird Agreement
MDBA	Murray-Darling Basin Authority
LTWP	Long Term Watering Plan
RAP	Registered Aboriginal Party
ROKAMBA	Republic of Korea – Australia Migratory Bird Agreement
SMART	Specific, Measurable, Achievable, Relevant, Time-bound
SWP	Seasonal Watering Proposal
VBA	Victorian Biodiversity Atlas
VEWH	Victorian Environmental Water Holder
VWMS	Victorian Waterway Management Strategy
WMU	Waterway Management Unit
WRIG	Water Regime Indicator Group

Executive Summary

Environmental Water Management Plans (EWMPs) have been developed for key sites in the Mallee region. The Mallee Waterway Strategy 2014-22 (Mallee CMA, 2014) identified 23 Waterway Management Units (WMU) from 216 targeted waterways in the Mallee. The hydrological interconnectedness and commonality of threats impacting on the waterway values were used to group them into planning units. This EWMP has been developed for the Heywood Lake Floodplain Management Unit (FMU) of the Heywood WMU. The EWMP will help to guide future environmental watering activities for this area.

Heywood Lake is situated on the River Murray floodplain between Swan Hill and Robinvale, southeast of Boundary Bend and is approximately 1600 hectares in area. Heywood Lake includes a Wildlife Reserve (State Game Reserve), areas of private land, River Murray Park and River Murray Reserve. Adjacent to the north east of Heywood Lake is Little Heywood Lake. The target area for this EWMP is Heywood Lake and Little Heywood Lake and the channel linking the Heywood Lake to the River Murray.

Heywood Lake and Little Heywood Lake are ephemeral deflation basin lakes (EDBLs). EDBLs are naturally dynamic lowland river floodplain environments which fluctuate between terrestrial and aquatic states (Scholz et. al., 2002).

Heywood Lake is a nationally important wetland listed in the Directory of Important Wetlands for its cultural significance. 104 bird species have been recorded at Heywood Lake between 2012 and 2023, with over 15,000 observations recorded at the site over that time. Dynamic responses to environmental watering have been observed. For example, over 6,000 individual birds were recorded at Heywood Lake after environmental watering in 2013/2014 while the lake was full, while nearly 2,500 individual birds were counted as the environmental water receded and exposed the littoral fringe of the lake in early 2015.

23 listed species (birds, fish and amphibians) including 16 that are water dependent, and six that are indirectly water dependent have previously been found. Heywood Lake and Little Heywood Lake are both listed as high priority wetlands in the Mallee Waterway Strategy (Mallee CMA, 2014).

The combination of black box woodlands, mudflats, semi-emergent macrophyte beds and open water habitat found within the target area provide a great diversity of feeding, breeding and nursery sites for native water-dependent biota.

Index of Wetland Condition assessments of Heywood Lake and Little Heywood Lake in 2009 indicate that all sub-indices are in moderate to excellent condition, with the exception of hydrology. An appropriate water regime consisting of natural flooding events and supplementary environmental watering will therefore improve the site's condition and support its significant ecological values.

The long-term management goal for the Heywood Lake EWMP is to restore Heywood Lake to an intermittently flooded deep water wetland that sustains resident aquatic fauna while flooded and supports breeding waterbirds.

To achieve this, ecological and hydrological objectives have been defined to provide an appropriate environmental watering regime. The ecological objectives are based on the values that the Heywood Lake EWMP target area is likely to support. They are:

HeL1: By 2030, improve condition and maintain extent from baseline (2006) levels of black box (*Eucalyptus largiflorens*) to sustain communities and processes reliant of such communities at Heywood Lake and Little Heywood Lake

HeL2: By 2030, improve vital habitat at Heywood Lake by increasing the diversity of aquatic macrophytes present across a range of Water Regime Indicators Groups.

HeL3: By 2030, maintain representative populations of shallow-water and deep-water feeding guilds of waterbird (F2 and F3, respectively, after Jaensch 2002) at Heywood Lake, by maintaining a mixture of shallow and deep-water habitats.

HeL4: By 2030, maintain nesting and recruitment of non-colonial waterbirds (N1, N2, N3 and N4, after Jaensch 2002) at Heywood Lake and Little Heywood Lake, by maintaining a mixture of trees, low vegetation/shrubs, and ground/islet nesting habitat.

The optimal water regimes for Heywood Lake and Little Heywood Lake are provided below.

Heywood Lake:
Fill Heywood Lake to 56.8 mAHD to inundate the fringing Intermittent Swampy Woodland community every eight years during winter/spring. Allow the water level to decrease slowly over summer to create a range of depth-duration habitats and expose mud flats. The draw-down will meet the environmental water requirements of fringing vegetation and create habitat for macrophyte guilds. To ensure open water habitat is sustained a top up in the second year to 54 mAHD may be required to suppress persistence or colonisation of the lake bed by long-lived vegetation. Following the two years of available open water habitat, allow Heywood Lake to enter a drying phase.

Little Heywood Lake:
Inundate Little Heywood Lake every eight years to 56.8 mAHD for up to four months during winter/spring.

Environmental water is currently delivered to Heywood Lake by temporary pumping via a culvert with a temporary flange. Further investigation is required to determine the most efficient means of delivering water to Heywood Lake and Little Heywood Lake.

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1. Introduction

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

The Heywood Lake EWMP was first developed in 2016 and was updated in 2017, 2018 and 2020. This document is a full revision of the EWMP, to update content and to align the EWMP with version 6 of the EWMP Guidelines for rivers and wetlands released by the Department of Energy, Environment and Climate Action (DEECA, formerly DELWP) in 2022 (DELWP 2022).

1.1 PURPOSE AND SCOPE OF AN EWMP

An EWMP is a management plan for a wetland, wetland complex or river system that sets out the environmental watering goals and objectives, and the water regime required to meet the set objectives. An EWMP describes the:

- consultation undertaken for EWMP preparation and implementation
- asset overview and characteristics
- water-dependent environmental values present
- water-related threats to the environmental values
- management goals for the asset
- environmental objectives, targets and values that environmental watering of the asset will support or improve
- watering requirements needed to meet environmental objectives
- environmental water delivery infrastructure, management and constraints
- risks associated with environmental water delivery
- outcomes intended to be demonstrated through monitoring and assessment, and
- knowledge gaps to address

Further information on the purposes of EWMPs and how they relate to other plans, strategies and policies is provided in Appendix 1.

1.2 POLICY CONTEXT

Management of environmental water in Victoria is a statewide partnership between the Victorian Environmental Water Holder (VEWH), catchment management authorities (including Melbourne Water), DEECA, land managers including Parks Victoria and local councils, water corporations, Traditional Owner groups, and interstate agencies including the Commonwealth Environmental Water Holder (CEWH) and the Murray–Darling Basin Authority (MDBA).

Environmental watering in Victoria has historically been supported by management plans such as EWMPs, that document key information including the watering requirements of an asset, predicted ecological responses and water delivery arrangements. These plans support annual decisions about which sites should receive water and help managers evaluate how well those assets responded to the water they received or what could be done better.

A range of international treaties, conventions and initiatives, as well as National and State Acts, policies and strategies determine management of the target area. Those with particular relevance to Heywood Lake and the management of its environmental values are listed in Table 1.

Table 1. Legislation, conventions, and listings relevant to the target area

Legislation, Agreement or Convention	Jurisdiction
Environment Protection and Biodiversity Conservation Act 1999 (EPBC)	National
China - Australia Migratory Bird Agreement (CAMBA) Japan - Australia Migratory Bird Agreement (JAMBA) Republic of Korea - Australia Migratory Bird Agreement (ROKAMBA)	National (relevant international agreements administered under the EPBC Act)
Flora and Fauna Guarantee Act 1988 (FFG)	State

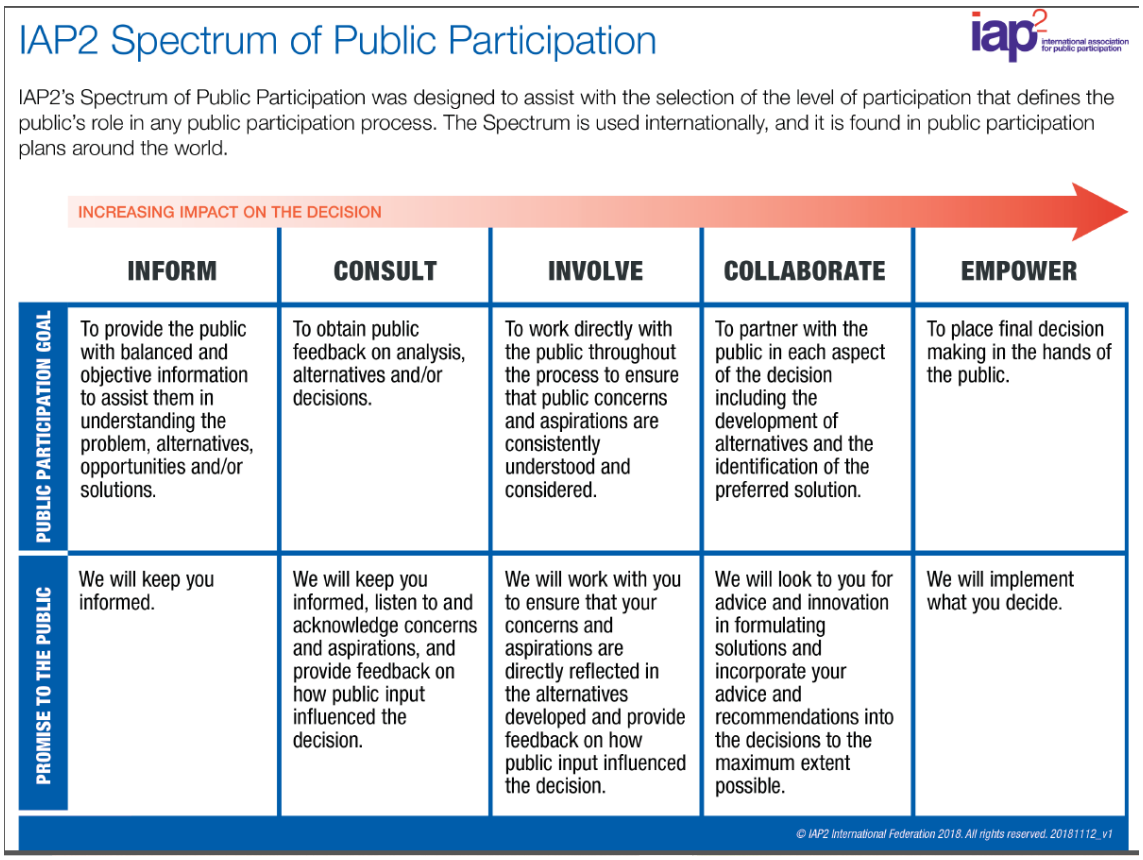
A regional context document (North, 2014) has been prepared to compliment the Mallee CMA EWMPs and should be read in conjunction with this document.

2. Partnership and Consultation

2.1 TARGET AUDIENCE

This section identifies the target audience and modes of consultation necessary to manage environmental water delivery, report against stated objectives and targets, and promote adaptive management over the life of the EWMP.

Engagement with different stakeholder groups is based on the International Association of Public Participation (IAP2) spectrum (Figure 1). The spectrum allows for a tailored approach based on stakeholder groups and their needs.



IAP2 Spectrum of Public Participation

IAP2's Spectrum of Public Participation was designed to assist with the selection of the level of participation that defines the public's role in any public participation process. The Spectrum is used internationally, and it is found in public participation plans around the world.

INCREASING IMPACT ON THE DECISION

	INFORM	CONSULT	INVOLVE	COLLABORATE	EMPOWER
PUBLIC PARTICIPATION GOAL	To provide the public with balanced and objective information to assist them in understanding the problem, alternatives, opportunities and/or solutions.	To obtain public feedback on analysis, alternatives and/or decisions.	To work directly with the public throughout the process to ensure that public concerns and aspirations are consistently understood and considered.	To partner with the public in each aspect of the decision including the development of alternatives and the identification of the preferred solution.	To place final decision making in the hands of the public.
PROMISE TO THE PUBLIC	We will keep you informed.	We will keep you informed, listen to and acknowledge concerns and aspirations, and provide feedback on how public input influenced the decision.	We will work with you to ensure that your concerns and aspirations are directly reflected in the alternatives developed and provide feedback on how public input influenced the decision.	We will look to you for advice and innovation in formulating solutions and incorporate your advice and recommendations into the decisions to the maximum extent possible.	We will implement what you decide.

Figure 1. IAP2 Spectrum (Source: (c) International Association for Public Participation www.iap2.org)

Table 2 lists the main stakeholder groups with an interest in environmental water based on their needs and interests and level of engagement required. To read more about the role of specific stakeholders in environmental water at Heywood Lake, refer to Sections 3.2 and 3.4.

Mallee CMA develops a communication and engagement plan each year that covers environmental watering events for the entire Mallee CMA region, including Heywood Lake. This ensures that all stakeholders and community members are aware of the Heywood Lake environmental watering operations.

Table 2. Stakeholder groups with an interest in environmental water at Heywood Lake

Stakeholder groups	Stakeholders	Needs and interests	IAP2 level	Consultation modes
Public land managers	Parks Victoria	Managing impacts from watering such as access, State-level environmental management	Collaborate	Monthly Meetings
	Department of Energy, Environment and Climate Action	State level environmental management planning, land manager, threatened species manager	Collaborate	Monthly Meetings
	Mallee CMA	Regional waterway and environmental management	N/A	N/A
River operators	Goulburn Murray Water	Manage Water Storage	Collaborate	Formal Meetings
Local government	Swan Hill Rural City Council	Access during watering events.	Involve	Meetings, phone calls, correspondence.
Aboriginal Stakeholders	See also Section 2.4: Traditional Owners	Ongoing connection to Country and protection of cultural heritage and values. Environmental impacts and benefits. Environmental watering regimes and how these may be timed to support/promote cultural values. Assistance in planning and implementation of programs.	Involve	Ongoing engagement with Mallee CMA's Aboriginal engagement team. Engagement is largely undertaken in-person and, where possible, on Country.
Environmental Water Holders	Victorian Environmental Water Holder	Decision-making around annual environmental water usage.	Collaborate	Formal Meetings
Private landholders	Local landholders	Assistance in planning and implementation of programs	Inform	
Community representatives	• Birdwatchers (Mildura BirdLife) • Mid-Murray field Naturalists	Watering benefits and impacts on local communities, such as access to parks and river during watering events.	Consult	Existing groups such as the Mallee CMA Land and Water Committee. Mallee CMA social media and news

2.2 DEVELOPING/UPDATING THE EWMP

In the development of this EWMP, Mallee CMA carried out community consultation in the following ways:

- Discussions with the Mallee CMA Land and Water Advisory Committee
- Workshops and on-Country engagement with Traditional Owners (see Section 2.4)
- Meetings with agency stakeholders
- Meetings with landholders
- Online surveys
- In-person engagement at local events such as markets and environmental group meetings
- Social media platforms.

2.2.1 Verifying asset values

Asset values at Heywood Lake have been established through environmental assessments and the development of previous versions of this EWMP. Consultation has been a key part of these processes with Traditional Owners, community members and technical specialists. Mallee CMA has continued to engage on asset values throughout the development of the EWMP, particularly with Traditional Owners and private and public landholders.

2.2.2 Informing proposed management objectives, targets and approaches

Mallee CMA has an established working relationship with those who have an extensive knowledge of Heywood Lake and floodplain ecosystems. This work has been central to providing a basis for local knowledge and expertise.

Combined with the Seasonal Watering Proposal, the data and knowledge from the proposed monitoring activities will guide future watering events, as part of the adaptive management approach.

2.2.3 Promoting adaptive management

Mallee CMA and other partners will take an adaptive management approach considering both varying seasonal conditions and lessons learned from previous events.

After the annual adaptive management checkpoint, Mallee CMA will adapt the EWMP if needed, which would then go through consultation, giving stakeholders the opportunity to see any updates.

2.3 COMMUNITY ENGAGEMENT

To inform the EMWP update community stakeholders were engaged in-person during local events such as the Red Cliffs and Swan Hill Markets and local environmental group meetings. This engagement included a 'Pins in Maps' activity,

where the community provided information on uses and values at specific locations at the site.

Community stakeholders were also engaged via an online survey, which was hosted on the Mallee CMA website in December 2023 – January 2024. The survey was designed to enable community, landholders, recreational users, environmental groups, and other interested parties to provide input to the plans. Through both engagement activities, stakeholders were asked to identify the values/uses at specific sites.

The survey and engagement supplements earlier community engagement about the Heywood Lake EWMP, and annual community engagement that informs the Seasonal Watering Proposal (SWP). Community consultation occurs at the IAP2 level of CONSULT. Community engagement activities are summarised in Appendix 2.

2.4 TRADITIONAL OWNERS

Engagement with Traditional Owners was conducted in a group setting at the INVOLVE level of the IAP2 framework, with the level of interest and involvement self-determined by the group.

Mallee CMA held discussions with Traditional Owners Culpra Milli Aboriginal Corporation, Gilbie Aboriginal Corporation Munatunga Elders, Tati Tati Land and Water Indigenous Corporation, Wadi Wadi Nation, Tati Tati Wadi Wadi Land and Water Indigenous Corporation and Dadi Dadi Weki Weki Aboriginal Corporation representatives on Country at Heywood Lake in October 2023. Through this engagement activity, Traditional Owner stakeholders were asked to identify the values/uses at specific sites by placing pins on a map where these uses and values occurred. Information from this consultation has informed cultural site use and values incorporated into this EWMP. In-line with EWMP guidelines, consultation with Traditional Owners is ongoing.

3. Asset Overview

The Mallee CMA region is situated in the north-west of Victoria. The area of responsibility is close to 39,000 km2 (3.9 million ha) and has a regional population estimated to be 67,000. Population centres include Mildura, Birchip, Sea Lake, Ouyen, Robinvale, Red Cliffs and Merbein. The boundaries of the Mallee CMA region cover almost one fifth of Victoria, making it the largest area managed by a CMA in the state.

Approximately 40% of the land area within the Mallee CMA boundary is public land, consisting mainly of national parks, reserves, wilderness, and large areas of riverine and dryland forests. The other 60% is predominantly dryland crops, but there is also a significant investment in irrigated horticulture including grapes, citrus, almonds, olives and vegetables along the River Murray corridor. Irrigated crops contribute over 40% of the value of agricultural production for the region.

The site for this plan is the Heywood Lake subunit of the Heywood WMU, hereafter referred to as Heywood Lake. Heywood Lake is located within the Heywood WMU, south east of Boundary Bend on the River Murray floodplain (Figure 1). To the immediate west of Heywood Lake are the Murrumbidgee Junction wetlands of the Boundary Bend WMU (covered by the Murrumbidgee Junction EWMP). Neighbouring to the east are the Piambie wetlands of the Heywood WMU (covered by the Piambie EWMP).

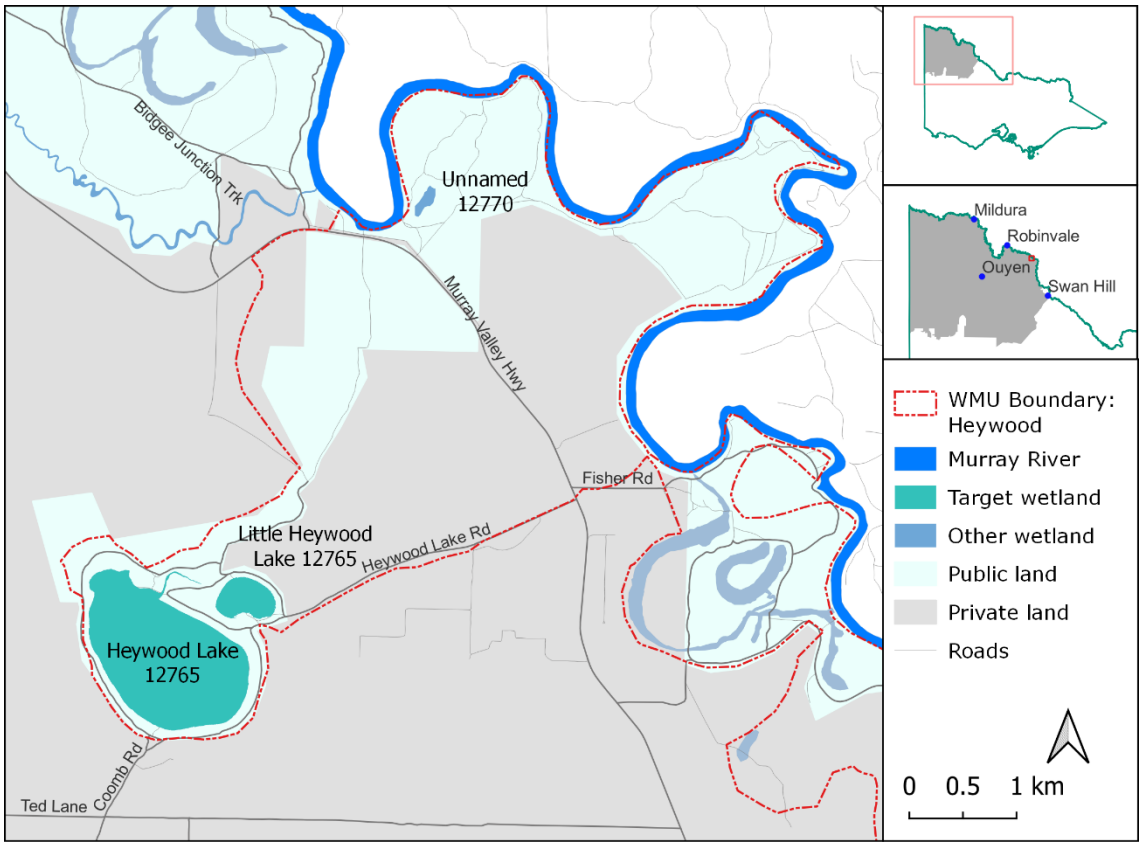


Figure 2. Heywood Lake and Little Heywood Lake, located within the Heywood WMU

3.1 CATCHMENT SETTING

Heywood Lake is located within the Murray Fans bioregion within the Mallee CMA region. The Murray Fans bioregion is characterised by a flat to gently undulating landscape on recent unconsolidated sediments with evidence of former stream channels, braided old river meanders and paleochannels and broad floodplain areas associated with major river systems and prior streams (DEECA, 2023a). The vegetation is a mosaic of Plains Grassy Woodland, Pine Box Woodland, Riverina Plains Grassy Woodland and Riverina Grassy Woodland ecosystems (DEECA, 2023a).

Heywood Lake is in proximity to a range of interconnected floodplain lakes (i.e. Yanga Lake, Kia Lake and Tala Lake of the NSW Murrumbidgee Floodplain, and Lake Poon Boon in the Wakool Creek system, NSW) and the Lower Bidgee Floodplain.

3.2 LAND STATUS AND MANAGEMENT

Several agencies and individuals are involved in managing the land and water at Heywood Lake (Table 3). Land management boundaries are shown in **Figure 3**.

The land tenure of Heywood Lake consists of the Heywood Lake Wildlife Reserve (immediately surrounding Heywood Lake), River Murray Reserve and proposed River Murray Park managed by Parks Victoria, significant areas of private land, and State Forest managed by DEECA.

The Heywood Lake Wildlife Reserve is a State Game Reserve. VEAC (2008) recommended that Heywood Lake remain a Wildlife Reserve (State Game Reserve):

- To conserve and protect species, communities or habitats of indigenous animals and plants; and
- For public recreation (including hunting in season and as specified by the land manager) and education, where this does not conflict with the primary objective.

Table 3. Land and water managers at Heywood Lake

Organisation	Management Role
Department Energy, Environment, and Climate Action (DEECA) - Minister for Water (Victoria)	• Oversee Victoria's environmental water management policy framework, and its implementation. • Administer the broader water allocation and entitlements framework and the Water Act 1989 (Vic).
Mallee CMA	• The waterway manager that plans and identifies environmental water needs across the Mallee region Water Act 1989 (Vic). • Approves and manages delivery of environmental water and monitoring and reporting of outcomes, in accordance with environmental objectives.
Parks Victoria	• The land manager for the Crown land under the National Parks Act 1975 (Vic) and Crown Land (Reserves) Act 1978 (Vic) • Manages pests and specific environmental impacts. • Supports watering on public land and manages any impacts, for example by engaging with site visitors about environmental water-related matters and managing public access during and after an event.
Victorian Environmental Water Holder	• Manager of Victoria's environmental water entitlements
Private Landholders	• Land managers of a significant portion of the Heywood WMU sub-unit

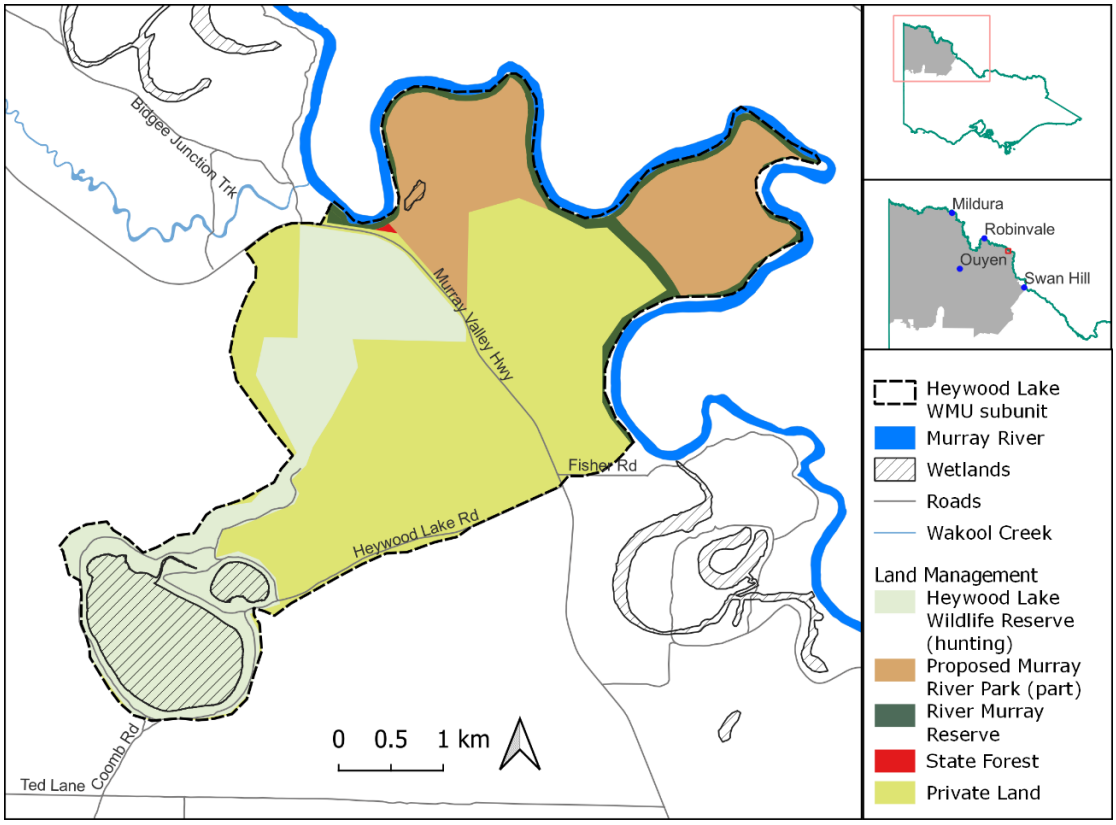


Figure 3. Land management boundaries at Heywood Lake

3.3 ASSET CHARACTERISTICS

A brief overview of the main characteristics of the wetlands at Heywood Lake is provided in Table 4.

Table 4. Wetland Characteristics at Heywood Lake

Characteristics	Description
Name	Heywood Lake
Mapping ID (Wetland Current layer)	Heywood Lake (12765) Little Heywood Lake (12765) Unnamed Wetland (12770)
Area of wetlands in target area	Heywood Lake, ID 12765: 147.06 ha Little Heywood Lake, ID 12765: 16.15 ha (Unnamed wetland 12770: 2.58 ha, outside the target area)
Bioregion	Most of the site is within the Murray Fans bioregion, while a small section falls within Murray Mallee bioregion
Conservation status	Heywood lake is in the Directory of Important Wetlands in Australia (Heywoods Lake), Reference code VIC009. Areas of EVCs listed as endangered, vulnerable, and depleted in the Murray Fans and Murray Mallee bioregions
Land status	State Wildlife Reserve (State Game Reserve), River Murray Park, Proposed River Murray Park, State Forest, and private land
Land manager	DEECA, Parks Victoria, and Private Landholders
Surrounding land use	Nature conservation, grazing, cropping, irrigated agriculture

Characteristics	Description
Water supply	Natural inflows from River Murray
Wetland category (Wetland Current layer)	Heywood Lake, ID 12765: Deep Freshwater Marsh Little Heywood Lake, ID 12765: Freshwater Meadow Unnamed wetland 12770: Shallow Freshwater Marsh
Wetland depth at capacity	Heywood Lake: 4 - 5 metres Little Heywood Lake: <2 metres Unnamed wetland 12770: unknown

Wetland types at Heywood Lake are shown in Figure 4.

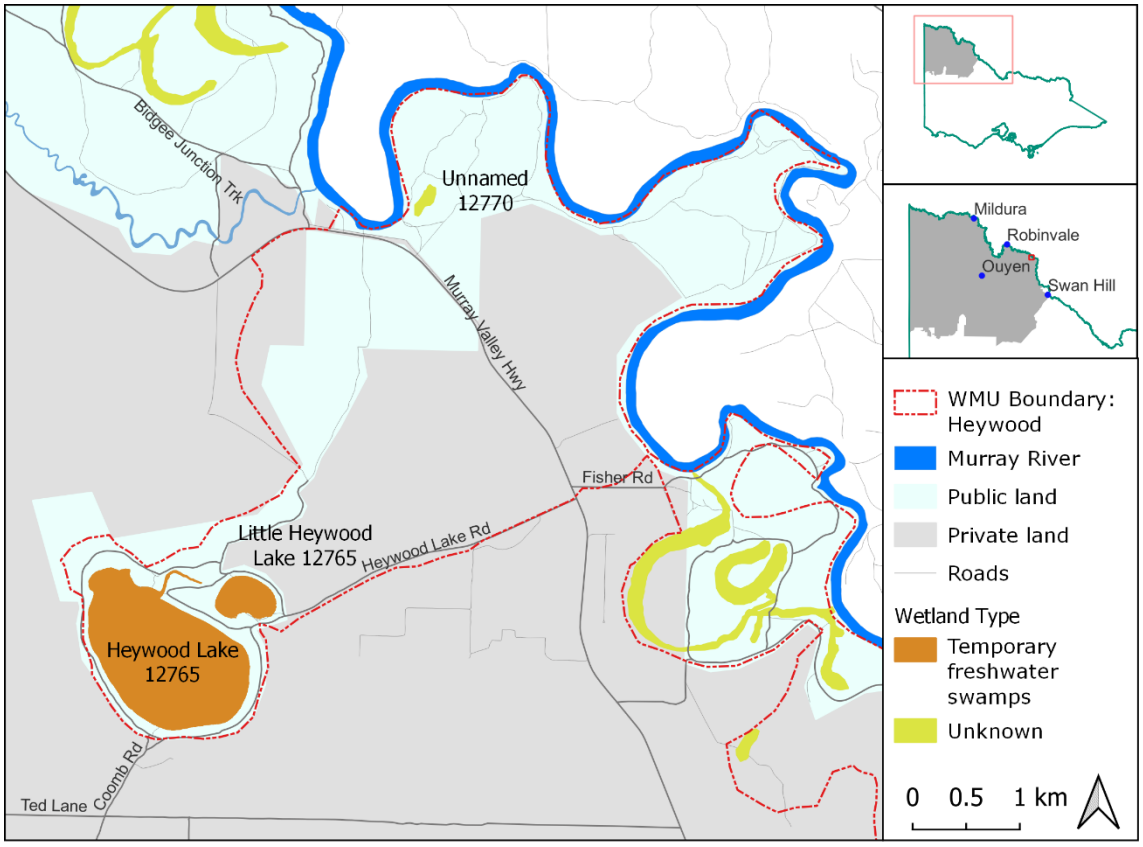


Figure 4. Wetland types (according to the Wetland Current spatial data layer)

The focus of this plan is restricted to the target area within Heywood Lake of 319 ha, shown as the maximum inundation extent in Figure 5.

This target area, consisting of Heywood Lake (the lake itself) and Little Heywood Lake, the channel between the River Murray and Heywood Lake and an area of Lignum Swampy Woodland abutting the channel, is the area that could conceivably be managed with environmental water.

Unnamed wetland #12770 has been excluded from the target area as the wetland sill is poorly defined and unable to be regulated.

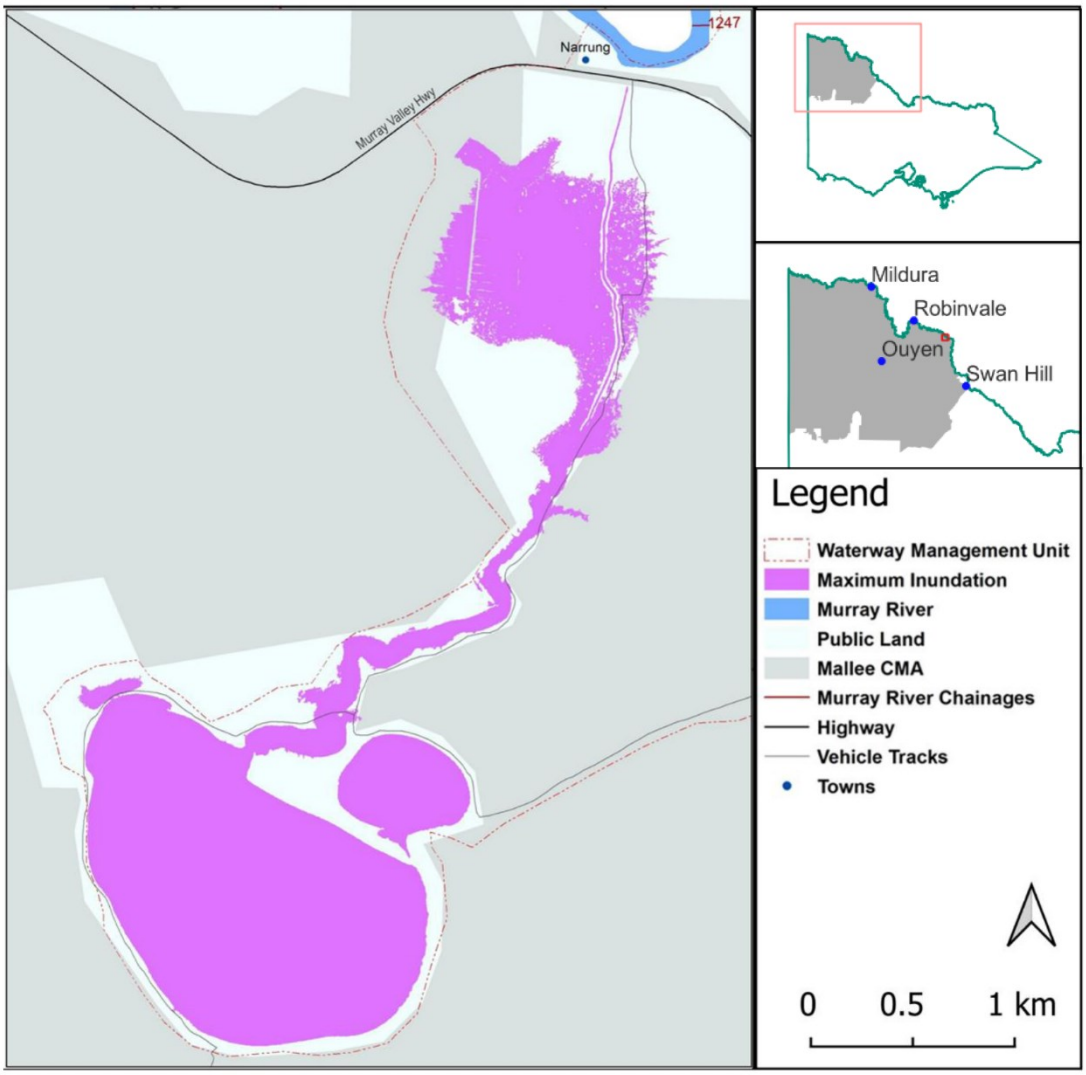


Figure 5. Maximum inundation extent of the Heywood Lake target area

Several specific studies have incorporated Heywood Lake. Heywood Lake was one of the areas investigated in the Mallee Wetland Operational Plans (SKM, 2002a) as well as the Investigation of Water Management Options for the River Murray – Nyah to Robinvale (Ecological Associates 2006).

A Cultural Heritage Assessment was carried out (SKM, 2002b) into the cultural sites and values which may have been impacted upon by a proposed nearby almond plantation expansion. This development has not been implemented, but the study provided important Indigenous cultural heritage context for this EWMP.

Heywood Lake has also been included in the Index of Wetland Condition (IWC) monitoring. Results from this monitoring are described and considered in this EWMP. Waterbird monitoring has taken place at Heywood Lake since 2012.

3.3.1 Conceptualisation of the site

Heywood Lake has been represented in a conceptual model. This is a visual representation of processes and components within the target area that are discussed throughout this EWMP.

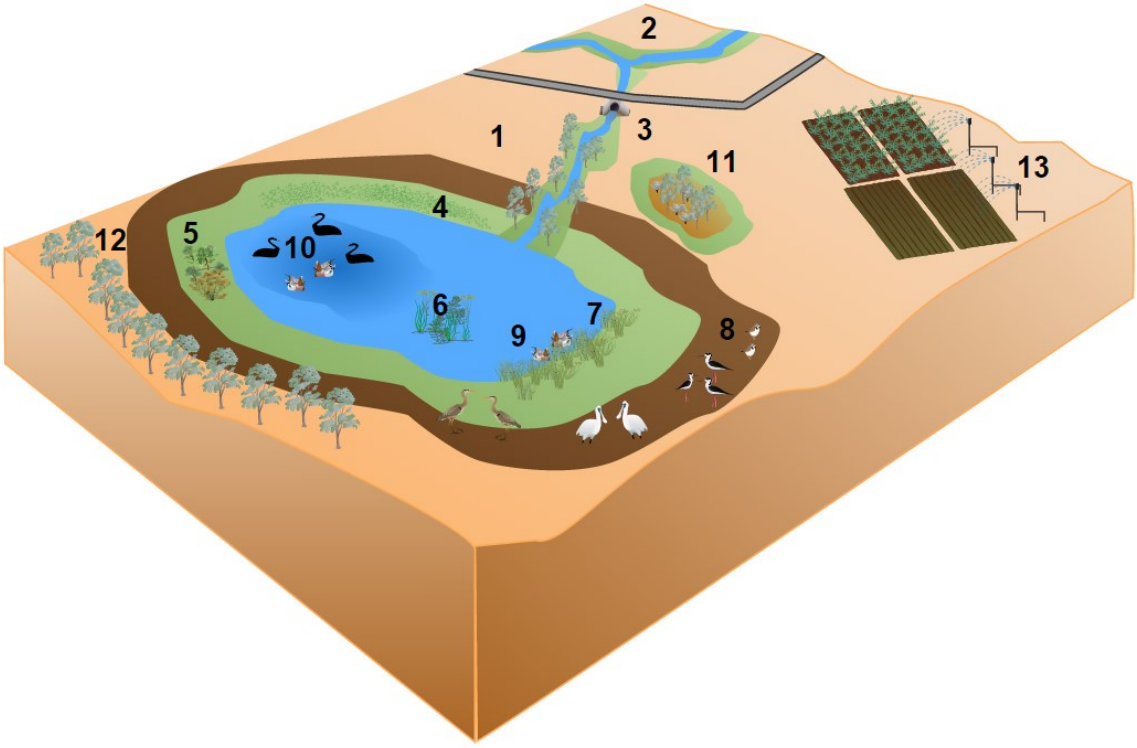


Figure 6. Conceptual Model

1) Heywood Lake is an ephemeral deflation basin lake, located high on the River Murray floodplain upon the quaternary aeolian sediments of the Woorinen Formation. It connects to the River Murray only during times of high river flow (92,700 ML/day) (Ecological Associates, 2006), via a combination of a constructed channel and natural flow path.
2) Natural inundation of Heywood Lake has been affected by River Murray regulation and modification of flow paths at the site. EDBLs are naturally subjected to episodes of rapid flooding, followed by periods of evaporative drying.
3) Heywood Lake was originally filled approximately every 10 – 15 years (flood thresholds of 155,700 – 166,700 ML/d) via a natural channel along the eastern side of the site. This channel was completely blocked following floods in 1956, preventing floods up to 181,900 ML/d (Gippel, 2006) until the construction of a spoon drain and culvert in the early 1990's lowered the wetland sill level and allowed more frequent inflows.
4) The lake takes several years to dry. When flooded it supports a mosaic of vegetation communities, carbon and nutrient cycling as well as a range of waterbird guilds.
5) During the drying phase the lake supports Lake Bed Herbland (Ecological Vegetation Class (EVC) 107). Following maturation and seeding, seeds are stored in the sediment, or plants die back to tuber-like rootstocks, waiting for the next inundation.
6) During prolonged inundation semi-emergent macrophytes flourish in the still water, supporting algae and biofilm communities and providing important refuge for small native fish and frogs.
7) Inundation of the shallow edges of the lake in spring followed by a gradual drawdown over late spring and summer will support an increased diversity and abundance of aquatic macrophytes.

8) Gradual drawdown of the lake will provide shallow water and exposed mudflats, providing feeding opportunities for large and small wading birds (royal spoonbill, straw-necked ibis, yellow-billed spoonbill, black-winged stilt, and black-fronted dotterel)

9) Dabbling ducks (Australasian shoveler, chestnut and grey teal, freckled duck, Pacific black duck, and pink-eared duck) feed in the fringing macrophyte habitat.

10) Deep-water foragers (black swan, blue-billed duck, Eurasian coot, hardhead, and musk duck) feed in open water habitat in deeper areas of lake.

11) Northeast of Heywood Lake a smaller lake (Little Heywood Lake) is perched slightly higher on the floodplain. It is rarely inundated and is dominated by a less flood-tolerant species assemblage of black box woodland with an understorey of cottony saltbush. Watering of this lake could be provided during prolonged dry conditions, to ensure the survival of the black box (*Eucalyptus largiflorens*) trees.

12) Low terraces around Heywood Lake and the channel support Intermittent Swampy Woodland (EVC 813), and at slightly higher levels, Riverine Chenopod Woodland (EVC 103) that are naturally subject to infrequent flooding.

13) A narrow buffer between agricultural land and the Heywood Lake reserve may be insufficient to protect ecological values in the reserve from land use impacts.

Additionally, Scholz and Gawne (2004) developed a conceptual model for EDBL function which is applicable to Heywood Lake. The authors note that there may be parts of the model that may be inappropriate to some EDBLs; however, the model provides a useful guide to identifying management targets and the likely outcomes of management actions. The model is presented below:

Conceptual model for Ephemeral Deflation Basin Lake function (Scholz and Gawne, 2004)

1. The first phase occurs as a dry or partially dried lake floods. This initial flooding phase is characterised by high habitat abundance and diversity provided primarily by inundated terrestrial vegetation, such as grasses, and by high productivity fuelled by the inflow of nutrients and organic matter with the floodwaters and by releases from the sediments and the decomposition of inundated terrestrial vegetation. Changes in primary and secondary production following wetland inundation tend to follow a predictable successional sequence.

2. During the late flood phase, fish populations increase due to both immigration and local recruitment, and provide increasing top-down pressure on secondary production. As water levels continue to increase, the inundation of the littoral fringe vegetation, such as lignum, black box and red gum provides additional aquatic habitat, although at this time also much of the habitat structure and complexity across the lakebed provided by inundated grasses and herbs begins to decline as they decompose.

3. During the late wet phase, fish populations are established, the productive pulse fuelled by nutrient releases from the sediments and decomposing vegetation subsides, and habitat structure/complexity is restricted to the littoral fringe.

4. During the drying phase the lake contracts, littoral habitat is exposed, water quality changes (elevated salt, nitrogen and phosphorous concentrations) and become less buffered to daily fluctuations in temperature. During this period aquatic organisms become concentrated and once the lake becomes too shallow to offer fish refuge, avian predation of fish increases. These processes impact on trophic interactions. This process continues until physical conditions become too harsh and the lake ultimately dries.

5. Finally, once the lakebed has been exposed it becomes an important terrestrial habitat for a range of plants and animals.

3.4 ENVIRONMENTAL WATER SOURCES

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

The VEWH is responsible for holding and managing Victoria's environmental water entitlements and sourcing water from the Victorian Murray system for delivery to Heywood Lake and Little Heywood Lake. This could include water held by the VEWH or CEWH. Details of the VEWH's environmental water entitlements are available at: https://www.vewh.vic.gov.au/watering-program/how-much-water-is-available

4. Current/Historical Hydrological Regime and System Operations

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

Ecological Associates (2006) suggest that the hydrology at Heywood Lake is best described using the MSM Bigmod Gauge 414200 River Murray @ downstream of Wakool Junction.

Historical hydrological regime

Prior to river regulation in this reach of the River Murray, the floodplain experienced inundation more frequently and for longer periods.

Under pre-regulation conditions, ephemeral deflation basin lakes (EDBLs) such as Heywood Lake were subjected to episodes of rapid flooding, followed by more protracted periods of evaporative drying. Heywood Lake was originally filled via a natural channel that diverted water from the River Murray at chainage 1258.3. McKane (1992) estimated that prior to European settlement, this channel provided inflow events every 10 – 15 years, indicating an inundation threshold of between 155,700 to 166,700 ML/day (Gippel, 2006).

Little Heywood Lake would have flooded following the filling of Heywood Lake. The high sill (approximately 57 mAHD) between the two wetlands blocks all but the highest flows and results in a reduced frequency of inundation for Little Heywood Lake.

Current hydrological regime

River regulation has not significantly changed the seasonality of flows in this section of the River Murray with high winter and lower summer flows still existing (Figure 4). However, the overall volume of winter flows has been reduced and there has been a reduction in the frequency of small to medium flood events (Maheshwari, Walker and McMahon, 1993). This, combined with the location of Heywood Lake high on the floodplain, has reduced the frequency of inundation of Heywood Lake significantly.

Ecological Associates (2006) reported that Heywood Lake filled in November 1992 and 1993, with the 1993 overflowing from Heywood Lake to inundate lignum shrubland and cultivated land to the north east. Heywood Lake also received water in 1996 to a depth of 60-90 cm, but did not fill (Ecological Associates, 2006). Prior to these events the Lake had not received floodwaters since 1956. Following the 1956 flood, the channel entering the floodplain at River Murray chainage 1258.3 was completely blocked; levees were constructed and other land management practices were enacted to prevent flooding (SKM, 2002c; Environment Australia, 2001). This prevented all inflows up to 181,900 ML/day reaching the Lake (Gippel, 2006).

The impact of river regulation has been offset by the excavation of a spoon drain in 1991, which has lowered the wetland sill level (Figure 7). It is estimated that

Heywood Lake is inundated at 92,700 ML/day flow in the River Murray (Table 5), which is now exceeded on average every eight years (Ecological Associates, 2006). The spoon drain is located on the northern side of Narrung Township Reserve and links to the natural inlet. A culvert was constructed in 1992 under the Murray Valley Highway which allows flow down the channel (SKM, 2002c, Figure 7). The commence to flow rate for inundation of Little Heywood Lake is unknown.

Table 5. Commence to flow rate for inundation of Heywood Lake

Wetland	Commence to flow rate (River Murray at Gauge 414200)
Heywood Lake	92,700 ML/day
Little Heywood Lake	153,000 – 163,000 ML/day

Figure 7. Culvert under the Murray Valley highway and the spoon drain which allows inundation of Heywood Lake either through flood event or pumping of environmental water.

4.1 GROUNDWATER AND SALINITY INTERACTIONS

Groundwater and salinity interactions at Heywood Lake are a knowledge gap.

4.2 ENVIRONMENTAL WATERING

Environmental watering has previously occurred at Heywood Lake on four occasions.

Table 6 below outlines the watering events. Estimation of the proportion of the lake inundated was made during waterbird counts undertaken during the watering periods (M. Dedini unpublished data, 2015). Little Heywood Lake received environmental water in 2017. These data are also presented in

Table **6**.

Table 6. A Summary of environmental watering at Heywood Lake

Water year	Waterbody	Time of inflow	Environmental Water Source	Total volume (ML)	Area (ha) inundated
2010/2011[1]	Heywood Lake	Autumn, Winter	VEWH	5,246.78	Unknown
2011/2012	Heywood Lake	Spring	VEWH Unregulated Flow	1999.104	Unknown
2013/2014[2]	Heywood Lake	Spring	VEWH River Murray Unregulated Flow	5,000.2	Unknown
2016/2017	Heywood Lake	Winter to Summer	Natural flows	Unknown	100%
2016/2017	Heywood Lake	Autumn to Winter	VEWH	3, 000.21	100%
2017/2018	Little Heywood Lake	Spring	Re-lifted from Heywood Lake	511.556	100%
2022/2023	Heywood Lake and Little Heywood Lake	Late Spring to early Summer	Natural flows	Unknown	Unknown

Temporary infrastructure in the form of a removable flange on the culvert under the Murray Valley Highway was installed to allow water to be pumped from the River Murray through the channel to Heywood Lake.

The area of inundation for the 2013 watering events is shown in Figure 8.

[1] In March 2011 Heywood Lake was dry.
[2] In September 2015 the lake the water level of the lake remained just below the level of the Intermittent Swampy Woodland.

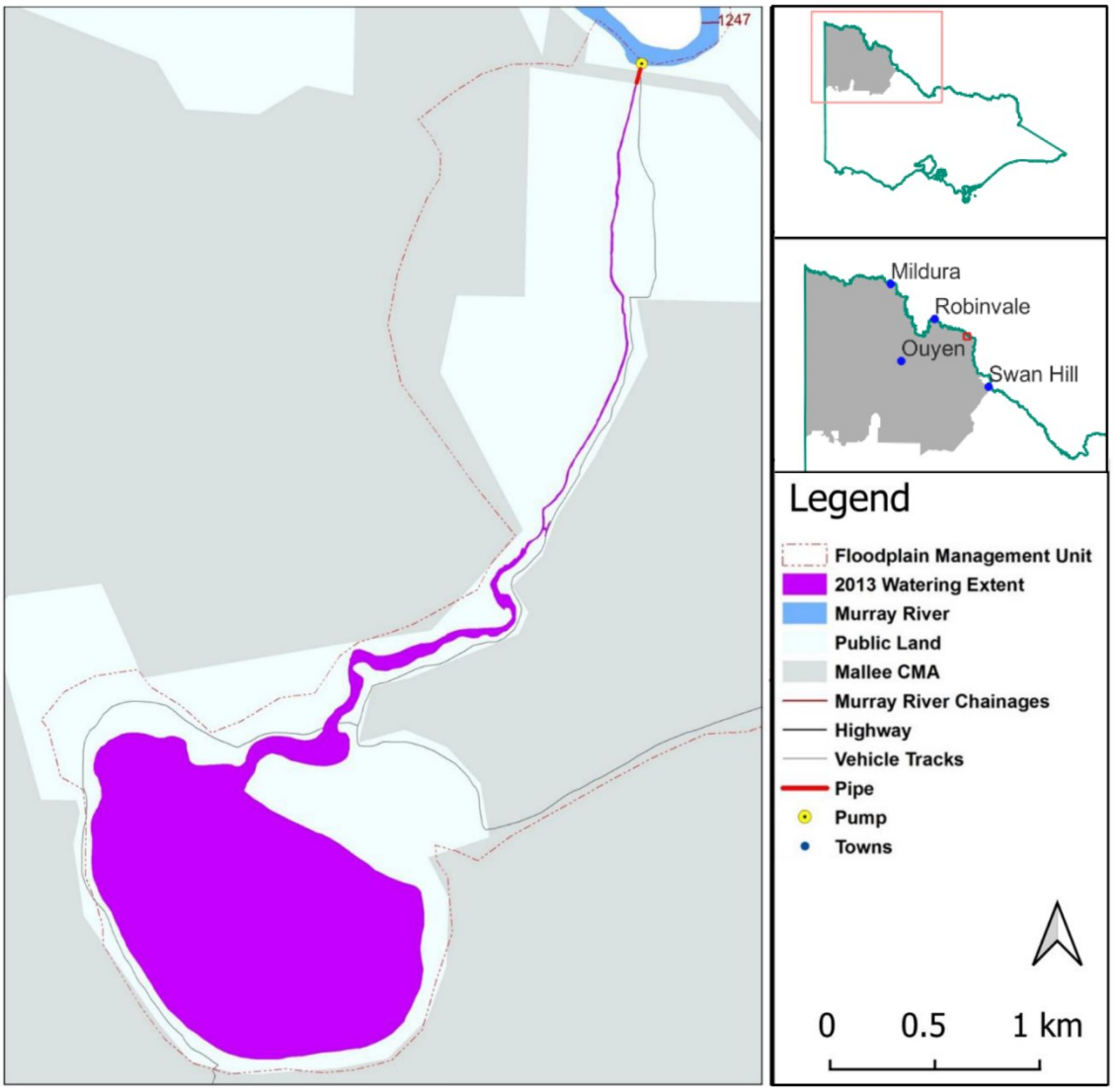


Figure 8. Inundation extent for the 2013 watering event

The objectives of the 2010/2011 environmental watering targeted improving the health of water stressed river red gum (*Eucalyptus camaldulensis*) and black box communities; and establishment of lakebed and fringing understorey providing habitat, food and breeding resources for wetland dependent species. Improved system productivity and the proliferation of invertebrates and frogs were also identified as targets (Mallee CMA, 2011). Figure 7 shows Heywood Lake in a dry state prior to the 2011/2012 environmental watering event.

The purpose of the 2011/2012 watering event was to top up the 2010/2011 watering to increase the inundation extent and maintain the depth of the inundation for a greater period (Mallee CMA, 2011).

The objectives for the 2013/2014 watering event focused on improving the health of the black box community and supporting the aquatic lake bed and fringing understorey vegetation that established following the previous watering (Mallee CMA, 2013). It also aimed to provide habitat, food sources and breeding resources for many wetland-dependent species (Mallee CMA, 2013).

In March 2017, environmental water was delivered to Lake Heywood to augment natural inflows and enable watering of Little Heywood Lake via re-lift in spring 2017.

Figure 9. Heywood Lake dry phase (March 2011)

Figure 10. Heywood Lake wet phase (date unspecified, source: Mallee CMA).

5. Water Dependent Values

Heywood Lake provides a range of shelter and food resources for indigenous fauna, flora and vegetation communities. The types of habitat provided, and consequently the species that utilise the site, change as water fills the lakes, channel and floodplain and then recedes.

The availability of flora and fauna data for Heywood Lake is limited. Flora and fauna lists are based on observations in the Victorian Biodiversity Atlas (VBA) (accessed via NatureKit, DEECA, 2023b), a Protected Matters Search (DCCEEW, 2024), and recent waterbird monitoring. It is recommended that further flora and fauna surveys, including fish and macrophyte surveys are undertaken to improve knowledge of the site's ecological values.

5.1 ENVIRONMENTAL VALUES

5.1.1 Ecosystem type and function

Wetland ecosystems support distinctive communities of plants and animals and provide numerous ecosystem services to the community (DSE, 2005b). Floodplain wetlands perform important functions necessary to maintain the hydrological, physical and ecological health of river systems.

Four key ecosystem functions have been identified for Heywood Lake. Each function is interlinked and must be supported in order for the ecosystem to flourish. The functions are briefly described below.

Connections across floodplains, adjacent wetlands and billabongs (lateral)

The connections between rivers and their floodplains (lateral connectivity) creates important habitat and supports key ecological functions essential for healthy and resilient ecosystems (BWS). Waterbirds are critically dependent on floodplain habitats for foraging roosting and breeding habitat. There are also many species of fish, frog, turtle and other reptiles dependent on wetland habitats.

Diversity of habitat for feeding, breeding and nursery

Seasonal fluctuations in the water levels increase the availability of specific habitat niches for feeding, breeding and nursery areas. The higher water levels proposed in spring and summer will provide a source of food, refuge from predators and nesting sites and materials (Kingsford and Norman, 2002). Receding water levels will expose mudflats required by small waders (Rogers and Ralph, 2011, Roshier, Robertson and Kingsford, 2002).

Inundation of the wetlands and woodlands will provide roosting and nesting habitat for species such as Darter (Vestjen, 1975) and Cormorant (Loyn, Lumsden and Ward, 2002), while the increase in macrophyte diversity and abundance will increase habitat values for waterbirds and small fish.

Productivity, nutrient and carbon cycling.

Lateral connectivity is associated with the transport of large amounts of nutrients, organic matter and sediment that increase productivity. Food webs subsequently convert the productivity into food resources for top predators such as fish and birds. The productivity increases can be through primary producers such as algae, macrophytes and woody vegetation or through decomposition of existing organic matter, with the latter being associated with blackwater risks.

Lateral connectivity creates a dynamic mosaic of habitat types that change through time in ways that affect both the animals produced and also their availability as prey for predators. This means that for some species, an asset may be important through the inundation and drying cycle and they have adaptations to deal with changes in habitat characteristics. For other species, such as birds, they seek out habitats that suit their food and foraging needs. For example, wading birds need shallow water while small waders require mud flats.

5.1.2 Flora and Fauna Values

Ecological Vegetation Classes (EVCs)

Heywood Lake is positioned at the edge of Murray Fans bioregion, with a small portion of the target area (the lunette to the southeast of the lake) falling within the Murray Mallee bioregion. Soil colour changes are visible onsite at this transition point. Six EVCs are modelled as present in the Heywood Lake target area (Figure 8) and one additional EVC had been identified in the 2009 Index of Wetland Condition (IWC) field assessments (DELWP, 2015b).

Table 7 provides a list of the EVCs within the target area, and their conservation status within the Murray Fans and Murray Mallee bioregions. Detailed descriptions of the EVCs are provided in Appendix 3.

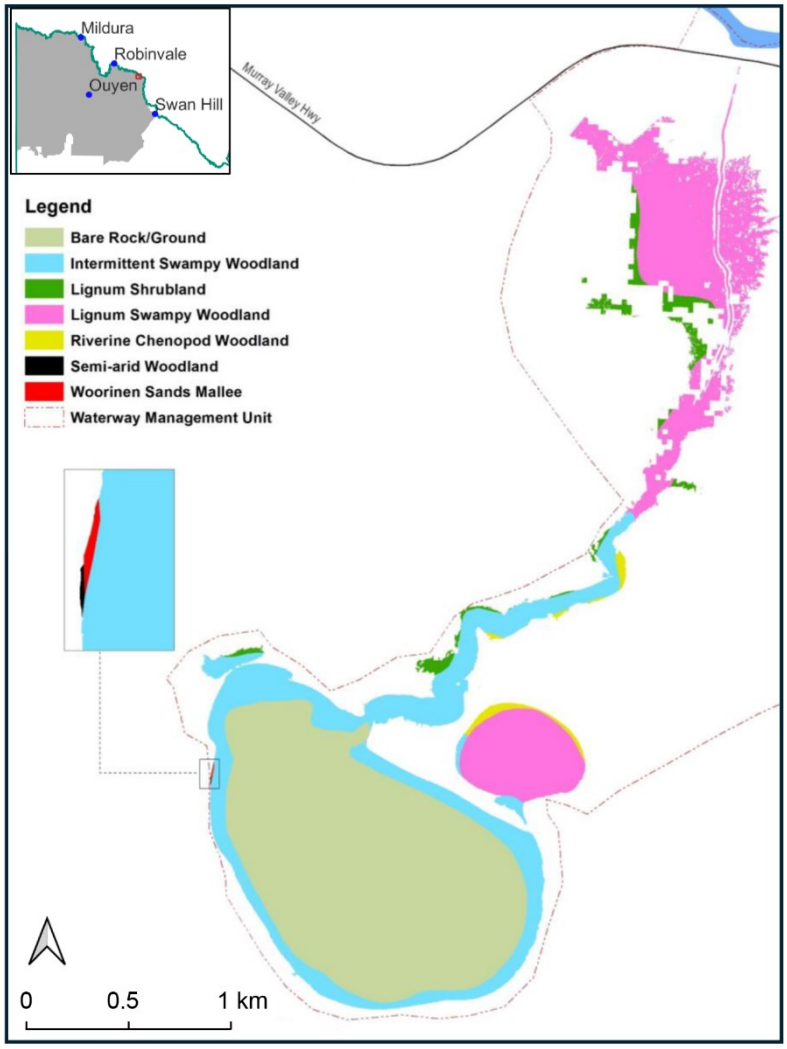


Figure 11. Spatial distribution of EVCs in the Heywood Lake target area

Table 7. EVCs modelled as present within the Heywood Lake target area

EVC Number	EVC Name	Area modelled as present within the target area (ha)	Bioregional Conservation Status	
			Murray Fans	Murray Mallee
107	Lake Bed Herbland *(note that this was modelled as Bare rock/ground)*	142.20	Vulnerable	Depleted
813	Intermittent Swampy Woodland	60.80	Depleted	Vulnerable
823	Lignum Swampy Woodland	60.80	Vulnerable	Vulnerable
808	Lignum Shrubland	7.50	Vulnerable	Least Concern
103	Riverine Chenopod Woodland	2.60	Endangered	Depleted
86	Woorinen Sands Mallee	0.05	Depleted	Depleted
97	Semi-arid Woodland	0.01	Vulnerable	Vulnerable

Lake Bed Herbland (Figure 12) can be shrub or herb dominated and is present when the wetland is in a dry or drying phase. It is dominated by species that are adapted to drying mud within lake beds (either through tuber-like rootstocks or as seed) (DSE, 2012, 2005a). Lake Bed Herbland is found during the dry phase at Heywood Lake in the area modelled as bare rock/ground as shown in Figure 11.

Figure 12. Lake Bed Herbland at Heywood Lake in 2009 (Source: IWC website)

Intermittent Swampy Woodland (EVC 813) surrounds Heywood Lake itself as well as the channel that leads to the River Murray (Figure 13a). It is a black box dominated woodland to 15m tall with a shrubby to rhizomatous sedgy understorey and patches of Tangled lignum (*Duma florulenta*) (DSE, 2012, 2005a). The maximum inundation duration for this EVC is one to six months (Frood, 2012).

Ecological Associates (2006) described this area as black box woodland, with associated species including Moonah (*Melaleuca lanceolata*), Hedge saltbush (*Rhagodia spinescens*) and Ruby saltbush (*Enchylaena tomentosa*). Black box provides essential habitat and foraging opportunities for a range of species including ground foraging and hollow-nesting birds, bacteria and fungi. Black box Woodlands are particularly important to the endangered Regent parrot which has been recorded using black box hollows for breeding (Baker-Gabb and Hurley, 2011) and the EPBC-listed Brown treecreeper (*Climacteris picumnus victoriae*) (Cheal, Lucas and Macaulay, 2011), which has been recorded at this site (see Appendices 4, 5 and 6 for fauna observations).

Figure 13. (a) Left, Intermittent Swampy Woodland and (b) Right, Riverine Chenopod Woodland at the transition between Heywood and Little Heywood Lakes (Sept 2015)

Little Heywood Lake is dominated by Riverine Chenopod Woodland. Riverine Chenopod Woodland (EVC 103) is a eucalypt woodland to 15m tall with a shrubby and grassy understorey, found on the most elevated of flood-prone riverine terraces and subject to only infrequent shallow flooding (DSE, 2012, 2005a) (Figure 13b and Figure 14).

Figure 14. Riverine Chenopod Woodland at Little Heywood Lake (September 2015)

Lignum Swampy Woodland (EVC 823) is also found at Little Heywood Lake on the northern side. Lignum Swampy Woodland is a black box dominated woodland with river coobah (*Acacia stenophylla*) and an often-dense shrub layer of tangled lignum. It is associated with seasonal drainage lines and their accompanying swamps and requires both wet and dry periods (DSE, 2012, 2005a). Lignum Swampy Woodland is present within Little Heywood Lake and along the channel and floodplain closer to the river (Figure 15).

Figure 15. Lignum Swampy Woodland present in and along the channel between the River Murray and Heywood Lake (September 2015).

Lignum dominated EVCs are present in shallow floodplain depressions that are intermittently inundated (Roberts and Marston, 2011). These range from the treeless Lignum Swamp (EVC 104) to a mix of lignum and eucalypt or acacia woodland (Lignum Swampy Woodland and Intermittent Swampy Woodland, EVC 813). When flooded these areas can provide nesting habitat for platform building birds as well as productive fish habitat (Ecological Associates, 2006). Tangled lignum has particular ecological value as waterbird breeding habitat (Rogers and Ralph, 2011) making it especially significant at this site. Wetland birds that breed over water, such as egrets, use flooded lignum shrublands (Ecological Associates, 2007) for resting and the hardhead duck uses lignum for nesting (Rogers and Ralph, 2011).

Small areas of Lignum Shrubland (EVC 808) are located on slightly higher land, adjacent to Intermittent and Lignum Swampy Woodland.

In elevated positions along the lunette to the south of Heywood Lake that are dependent on rainfall for moisture (rather than groundwater or flooding), small areas of Woorinen Sands Mallee (EVC 86) and Semi-arid Woodland (EVC 97) are present.

Figure 16. The transition from Mallee vegetation (left hand side of image) to woodland (right hand side) occurs as one moves to lower elevations from the lunette to Heywood Lake (September 2015)

Wetland depletion and rarity

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

The Heywood Lake target area contains two main wetland types under the Corrick classification: Deep Freshwater Marsh (Heywood Lake) and Freshwater Meadow (Little Heywood Lake). These are significant in the Victorian context due to the widespread loss of these types of wetlands and are also listed under the Directory of Important Wetlands in Australia (ANCA, 1996).

A large proportion of these wetland types have been lost in Victoria. Forty-five per cent of freshwater meadow area has been lost across the state (80% in Mallee CMA region) and seventy per cent of deep freshwater marsh (45% in Mallee CMA region) (Table 8).

Table 8. Regional change in area of wetland type

Corrick category	Wetland name	Total area (ha)	Percentage change in wetland area from 1788 to 1994		
			Change in Victoria	Change in Mallee CMA	Change in Murray Fans bioregion
Deep freshwater marsh	Heywood Lake	162.84 ha	-70%	-45%	-6%
Freshwater meadow	Little Heywood Lake	24.98 ha	-45%	-80%	-63%

The Wetland Current layer (DELWP, 2022b) has combined Heywood Lake and Little Heywood Lake into one single wetland listing (ID 12765) and has listed the wetland type as Temporary Freshwater Swamp (see Figure 4). Site investigations and modelling of EVCs at the site (see Figure 11) have determined that the two lakes have sufficiently different vegetation assemblages to warrant managing their water regimes separately.

Fauna

137 native fauna species have been recorded at Heywood Lake. Of special interest and management responsibility are the 23 fauna species listed in legislation and international agreements (Table 9). Heywood Lake supports species listed under the China-Australia Migratory Bird Agreement (CAMBA), the Japan-Australia Migratory Bird Agreement (JAMBA), the Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA), the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), Victoria's *Flora and Fauna Guarantee Act 1988* (FFG Act). A full fauna species list is included in Appendix 4.

Table 9. Listed species recorded at Heywood Lake

Scientific Name	Common Name	FFG Act	EPBC Act Status	International agreement
Spatula rhynchotis	Australasian Shoveler	Vulnerable	n/a	n/a
Oxyura australis	Blue-billed Duck	Vulnerable	n/a	n/a
Climacteris picumnus	Brown Treecreeper	n/a	Vulnerable	n/a
Hydroprogne caspia	Caspian Tern	Vulnerable	n/a	CAMBA
Tringa nebularia	Common Greenshank	Endangered	n/a	JAMBA, ROKAMBA
Calidris ferruginea	Curlew Sandpiper	Critically Endangered	Critically Endangered	CAMBA, JAMBA, ROKAMBA
Ardea alba modesta	Eastern Great Egret	Vulnerable	n/a	n/a
Sminthopsis crassicaudata	Fat-tailed Dunnart	Vulnerable	n/a	n/a
Stictonetta naevosa	Freckled Duck	Endangered	n/a	n/a
Litoria raniformis	Growling Grass Frog	Vulnerable	Vulnerable	n/a
Aythya australis	Hardhead	Vulnerable	n/a	n/a
Melanodryas cucullata	Hooded Robin	Vulnerable	Endangered	n/a
Hieraaetus morphnoides	Little Eagle	Vulnerable	n/a	n/a
Egretta garzetta	Little Egret	Endangered	n/a	n/a
Lophochroa leadbeateri	Major Mitchell's Cockatoo	Critically Endangered	Endangered	n/a
Tringa stagnatilis	Marsh Sandpiper	Endangered	n/a	CAMBA, JAMBA
Biziura lobata	Musk Duck	Vulnerable	n/a	n/a
Ardea intermedia plumifera	Plumed Egret	Critically Endangered	n/a	n/a
Polytelis anthopeplus monarchoides	Regent Parrot	Vulnerable	Vulnerable	n/a
Calidris acuminata	Sharp-tailed Sandpiper	n/a	n/a	CAMBA, JAMBA, ROKAMBA
Aphelocephala leucopsis	Southern Whiteface	n/a	Vulnerable	n/a
Haliaeetus leucogaster	White-bellied Sea-Eagle	Endangered	n/a	CAMBA
Maccullochella peelii	Murray cod	Vulnerable	Endangered	n/a

FFG – *Flora and Fauna Guarantee Act 1988*
EPBC – *Environment Protection and Biodiversity Conservation Act 1999*
CAMBA – China – Australia Migratory Bird Agreement
JAMBA – Japan – Australia Migratory Bird Agreement
ROKAMBA – Republic of Korea – Australia Migratory Bird Agreement

104 bird species have been recorded at the site. Six of the listed bird species: Brown treecreeper (*Climacteris picumnus victoriae*), hooded robin (*Melanodryas cucullata*), little eagle (*Hieraaetus morphnoides)*, regent parrot (*Polytelis anthopeplus monarchoides*), Major Mitchell's cockatoo (*Lophocroa leadbeateri*), and

southern whiteface (*Aphelocephala leucopsis)* are considered indirectly water dependent due to habitat requirements (e.g. dependent on nesting hollows in riparian trees). The fat-tailed dunnart (*Sminthopsis crassicaudata)* is dependent on shelter provided by fallen logs (SWIFFT 2024). The 16 other listed species are directly dependent on water due to food, shelter or breeding requirements.

Fish

The deep open water habitat of Heywood Lake can support breeding by large native fish (Ecological Associates, 2006) and Murray cod (*Maccullochella peelii*) have been recorded at the site. Murray cod are considered main channel specialists as this is where they spawn and recruit, though juveniles may possibly be found in the floodplain and lakes (Rogers and Ralph, 2011). The Mallee Waterway Strategy (Mallee CMA, 2014) recommends the introduction of native and recreationally targeted fingerlings into Heywood Lake.

Amphibians

One listed amphibian, the growling grass frog (*Litoria raniformis*), has been recorded at the site. The non-listed barking marsh frog (*Limnodynastes fletcheri*) has also been observed at Heywood Lake. The growling grass frog is found in or around permanent or ephemeral wetlands and prefers wetlands with complex aquatic vegetation communities. Recruitment success is higher at wetlands that remain inundated over spring and summer (> 6 months) though the presence of common carp (*Cyprinus carpio*) can significantly reduce reproductive success. It has limited capacity to survive dry periods and will move to refugia in permanently inundated wetlands or river channels (Rogers and Ralph, 2011).

Waterbirds

104 bird species have been observed at Heywood Lake in dedicated bird surveys between 2012 and 2023, including 17 listed species. Bird survey observations at Heywood Lake over time are provided in Appendix 5. Bird survey observations at Little Heywood Lake are provided in Appendix 6. Waterbird diversity and abundance are influenced by wetland habitat diversity, with different species and feeding guilds using different habitats for breeding and foraging. Water depth in particular influences waterbird diversity due to the specific feeding behaviours of different species (Bancroft, Gawlick and Rutchey, 2002). Managing wetlands to provide diverse habitats such as variable water depth, mud flats, inundated vegetation and areas of deep water increases the likelihood of waterbird diversity (Taft, Colwell, Isola and Safran, 2002).

Wetlands such as Heywood Lake that are deep enough to provide open water habitat support diving and fish-eating waterbirds (such as cormorants, pelicans, grebes and terns) (Ecological Associates, 2006). Shallower areas of the lake (with a depth of 1-2m) support semi-emergent macrophytes which provide highly productive areas of habitat for macroinvertebrates, tadpoles and small or juvenile fish. These areas are frequented by waterfowl and dabbling ducks that graze on the vegetation, biofilms and macroinvertebrates (Ecological Associates, 2006).

Waterbird counts were undertaken annually at Heywood Lake between 2012 and 2015, and then periodically up to 2023. The counts indicated that the environmental watering had contributed to large numbers of a wide range of waterbird species and guilds using the lake. 34 bird species were recorded as using

Heywood Lake during the 2012-2015 surveys, including 32 waterbird species, with total counts ranging between 279 – 6194 birds. Individual species were recorded as flocking in numbers up to 3030 individuals (Eurasian Coot in 2013) and the listed species, Australian shoveler, freckled duck, blue-billed duck, little egret, musk duck and eastern great egret were recorded as present. 53 bird species were recorded at the site in a WetMap 2023 survey, including a flock of 1820 grey teals (*Anas gracilis*). See Appendix 5 and 6 for the full list of bird species sighted and number of individuals per species during each survey.

Table 10. Waterbird guilds found at Heywood Lake and their habitat and resource requirements.

Waterbird Group	Food Resource	Habitat Use	Breeding Strategy
Dabbling Ducks (e.g. Chestnut teal, Pink-eared duck, Freckled duck)	Generalists; plankton, small invertebrates, plant material	Shallow water	Solitary
Grazing Waterfowl (e.g. Shellduck, Wood Duck)	Plant material, seeds, invertebrates	Shallow water, littoral zone	Colonial or solitary
Fish Eaters (e.g. Pelican, Cormorant, Grebe, Darter, Egret)	Fish	Open and deep water	Colonial
Small Waders (e.g. Stilt, Plovers, Dotterels)	Small invertebrates, seeds	Littoral zone, mudflats	Solitary
Large Waders (e.g. Ibis, Spoonbill)	Macroinvertebrates, fish, amphibians	Littoral zone	Colonial or solitary
Deep Water Foragers (e.g. Black Swan and Hardhead)	Plant material, some molluscs, invertebrates	Open deep water, shallow water, littoral zone, mudflats	Colonial or solitary
Shoreline Foragers (e.g. Lapwings, Hens)	Plant material, seeds, invertebrates	Littoral zone, mudflats	Solitary or small groups

Flora

167 species for flora have been recorded at Heywood Lake (Appendix 7), including seven species listed under the *FFG Act 1988* (Table 11). Of the listed species, cane grass (*Eragrostis australasica)* and spiny lignum (*Duma horrida subsp. horrida*) both require inundation. Bushy groundsel (*Senecio cunninghamii var. cunninghamii*) is frequently found along the banks and floodplains of the River Murray, its tributaries and associated wetlands, although its water-dependence is currently unknown (eFlora SA 2007).

Table 11. Listed flora species recorded at the Heywood Lake WMU subunit.

Scientific Name	Common Name	FFG Act	EPBC Act Status
Senecio cunninghamii var. cunninghamii	Branching groundsel	Endangered	Not listed
Eragrostis australasica	Cane grass	Critically Endangered	Not listed
Cullen cinereum	Hoary scurf-pea	Endangered	Not listed
Austrobryonia micrantha	Mallee cucumber	Endangered	Not listed
Duma horrida subsp. horrida	Spiny lignum	Critically Endangered	Not listed
Sida intricata	Twiggy sida	Endangered	Not listed
Acacia oswaldii	Umbrella wattle	Critically Endangered	Not listed

5.1.3 Current Condition

The condition of Heywood Lake and Little Heywood Lake was assessed in 2009 using the Index of Wetland Condition. The IWC defines wetland condition as the state of the biological, physical, and chemical components of the wetland ecosystem and their interactions.

IWC assessments on Heywood Lake and Little Heywood Lake in 2009 indicated that all sub-indices (physical form, hydrology, water properties, soils and biota) except hydrology are in moderate to excellent condition, therefore that the management of a suitable water regime consisting of natural flooding events and supplemented with appropriately planned environmental watering will enhance the significant values and condition at the site.

In 2009 Heywood Lake was assessed as being in good condition, with a score of seven out of ten. Little Heywood Lake was also assessed as being in good condition, however, it had a slightly higher score of eight out of ten.

Heywood Lake and Little Heywood Lake have been inundated either naturally or with environmental water on six occasions since the 2010/11 water year (see

Table **6**). The target water regime is being met and the site is expected to be in a similar or improved condition to that determined in 2009.

5.2 SHARED BENEFITS

5.2.1 Traditional Owner Cultural Values

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

In Indigenous culture, water is inseparable from the land, air, plants and animals. Caring for, and healing, Country is an inherited cultural obligation that is reliant upon having water in the landscape in the right place, at the right time of year. Water creates and sustains life and is a living and cultural entity that connects Traditional Owners to Ancestors, Country, cultural practice and identity. Traditional Owners have an ongoing connection to the wetlands at Heywood Lake and community members are invested in the ecological health and sustainable management of water at the site.

Within the Mallee CMA region, the River Murray and its associated waterways continue to be culturally significant areas for many Aboriginal groups. The high number of Indigenous cultural heritage sites throughout the Murray floodplain is unique in Victoria because of their concentration and diversity. It is typical to find high densities of identified Indigenous cultural heritage sites located around, or close to, freshwater sources. The Aboriginal Heritage Regulations 2018 define "areas of cultural heritage sensitivity" which include land within 200 m of named waterways and land within 50 m of registered Aboriginal cultural heritage places. A review of the Aboriginal Cultural Heritage Register and Information System

(ACHRIS) confirms that Heywood Lake, Little Heywood Lake, Unnamed wetland 12770 and the River Murray are defined as areas of cultural heritage sensitivity.

Several Indigenous cultural sites have been documented through various archaeological investigations (McKane, 1992 and Ahmat, 1992), and described by representatives from Culpra Milli Aboriginal Corporation, Gilbie Aboriginal Corporation, Munatunga Elders, Tati Tati Land and Water Indigenous Corporation, Wadi Wadi Nation, Tati Tati Wadi Wadi Land and Water Indigenous Corporation and Dadi Dadi Weki Weki Aboriginal Corporation who attended on-Country engagements and participated in pins-in-maps exercises. Cultural heritage at the Heywood Lake includes scarred trees, hearths and burial sites, and the true extent of cultural heritage at the site is unknown. Mallee CMA will work with Traditional Owners to ensure that cultural heritage is protected before, during and after environmental watering.

Heywood Lake is of significant cultural activity value, with the area used for fishing, camping, hunting, and storytelling by representatives who attended on-Country consultations about the EWMP. fish and plants at the site are of high cultural value.

5.2.2 European Heritage Values

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

5.2.3 Recreational Values

Heywood Lake is a popular recreation area, with uses including fishing, swimming, picnicking, bird watching, boating and hunting (in the game reserve), particularly when the lake is full (ANCA, 1996).

5.2.4 Economic Values

Properties producing potatoes, almonds, citrus, honey, wool and dry land crops occupy the adjoining properties to Heywood Lake and contribute to the broader economic value of the region.

Significant numbers of visitors may visit Heywood Lake, while inundated, for licensed waterfowl hunting during prescribed seasons. This may contribute to the local economy on a seasonal basis. Significant numbers of the waterbirds counted during the 2012-2023 surveys were game species.

5.2.5 Education Values

A respondent to the 2024 community online survey stated that they use Heywood Lake for education purposes.

5.3 TRAJECTORY OF CHANGE

The extended dry period at Heywood Lake associated with infrastructure and land use prior to the early 1990's placed significant stress on the Heywood Lake ecosystem. The construction of the spoon drain and culverts in the early 1990's significantly enhanced the opportunity for Heywood Lake to experience a more suitable water regime, however low flows in the Murray system during the Millennium Drought meant that the system remained under significant hydrological stress prior to the environmental watering events described earlier.

Environmental watering and natural inundation events since 2011 have improved the conditions of the lake and have protected significant environmental values. Continued environmental watering in accordance with the hydrological regime set out in this EWMP will continue to maintain and enhance the water dependent values of Heywood Lake and Little Heywood Lake. Careful monitoring of the inundation duration of the fringing black box will need to be undertaken to ensure that the length of inundation does not exceed the threshold for black box.

Little Heywood Lake received environmental water for the first time in September-November 2017, prior to which the lake experienced prolonged dry periods (see Figure 17 for image of Little Heywood Lake during dry phase). Without this watering it is expected that the Black Box Chenopod Woodland and Lignum Swampy Woodland would eventually decline with prolonged dry conditions. Additionally, it is predicted that the diversity of fauna species using Little Heywood Lake would also decline over time due to corresponding decreases in habitat condition and diversity with prolonged dry conditions. Little Heywood Lake was also inundated during the 2022/2023 flood event (Figure 17).

Figure 17. Photopoint monitoring at Little Heywood Lake (left) in 2017 during a dry phase (right) on 16/04/2023, during a wet phase

6. Managing Water Related Threats

Water related threats occurring within the Heywood Lake target area and identified through the AVIRA database (identified by a score of 4 or 5) are:

- Invasive fauna (aquatic) – score 5 (Carp)
- Changed water regime – score 5

Changed water regime

Heywood Lake and Little Heywood Lake have received a score of 0 for the hydrology sub-index of the Index of Wetland Condition. The hydrology sub-index takes into account the impacts of regulation on the primary water source of the wetland (River Murray), which would include duration and frequency of connection. Other activities that may impact the wetlands water regime, include changes to the connection to the river and alterations to the local groundwater.

Introduced fauna (aquatic)

Common carp are prevalent in Heywood Lake when it is inundated from high River Murray flows. Carp have been found to contribute to the loss of aquatic vegetation and increased turbidity, resulting in loss of habitat for waterfowl (Purdey and Loyn, 2008) and native fish species. This species also competes with the native fish for habitat and food and has a detrimental effect on water quality (Mallee CMA, 2003).

Environmental watering will help mitigate the threat from a changed water regime, by enabling inundation of the target area in a seasonally appropriate manner (magnitude, timing and duration).

Managing water related threats

Management of water related threats at Heywood Lake is undertaken through maintaining the optimal watering regime. As part of this process, the wetlands will periodically be allowed to dry out, enabling the reduction of invasive aquatic species such as European carp. Drawdown and inundation of wetlands in line with the optimal watering regime will also manage invasive flora species not suited to natural water cycles.

ASSESSING RISK

Consideration of risk provides a link between recognition of system threats and key management processes, including decade and seasonal planning. Risk assessments are composed of both likelihood and consequence components. In this instance, likelihood is influenced by the probability that there will be sufficient environmental water to maintain flows and water levels.

From a seasonal watering perspective, prioritisation of watering actions will be based on consequence. While consequence for an individual wetland can be determined, environmental water allocations require consideration of the consequences at larger scales. For the Mallee CMA it is their region, for the VEWH it is Victoria and the CEWH it is the Murray Darling Basin.

Not all consequences can be identified as readily and so we have provided a process that can be followed in Appendix 8.

7. Management Goals, Objectives and Targets

7.1 MANAGEMENT GOAL

The management goal for the Heywood Lake target area is to:

Restore Heywood Lake to an intermittently flooded deep water wetland that sustains resident aquatic fauna while flooded and supports breeding waterbirds.

This goal is linked to the goals of the Mallee Waterway Strategy 2014-2022 (Mallee CMA 2014), which are to:

- maintain or improve habitat within waterways and on surrounding riparian land;
- manage all land tenures for water quality benefits and respond appropriately to threatening events (both natural and pollution based);
- restore appropriate water regimes and improve connectivity;
- protect the extent and condition of Cultural Heritage (Indigenous and non-Indigenous) sites associated with waterways; and
- increase community capacity for, awareness of and participation in waterway management.

The Mallee Waterway Strategy (Mallee CMA, 2014) identified Heywood Lake and Little Heywood Lake as high priority wetlands. Additionally, the strategy identifies several specific management activities for these wetlands. These activities are:

- Introduce fingerlings to the Heywood Lake system (threatened native species and recreational species) (Management activity number B2.1).
- Lower sill between Heywood Lake and Little Heywood Lake (Management activity number C1.3).
- Deliver water as per the EWMP (Management activity number C1.5).
- Assess cultural heritage values at Heywood Lake and Little Heywood Lake and consider recommendations in management plans (Management activity number E1.2).
- Review extent of Heywood EWMP (Management activity number F1.1).

The activities identified in the Mallee Waterway Strategy (Mallee CMA, 2014) have been considered in the development of this EWMP. Some recommendations may not be specifically supported, where up to date data or recommendations provide better options for the target area.

7.2 ENVIRONMENTAL OBJECTIVES AND TARGETS

Environmental objectives represent the desired environmental outcomes of the site based on the management goal, above, as well as the key values outlined in the Water Dependent Values section. It is intended that EWMP objectives will be described in terms of the primary environmental outcomes, in most cases ecological attributes. The focus of the objectives should be on the final ecological outcomes and not the drivers per se.

During 2020, the environmental objectives (formally ecological objectives) were analysed and refined with the intent of improving the specificity and measurability of the objectives through the development of targets, and to improve line of sight

to the Basin Plan. While the process attempted to maintain the intent and integrity of the original objectives, it provided an opportunity to reassess the suitability of these objectives for the asset. The rationalisation, assessment of SMARTness, mapping to Basin Plan and update of each objective for Heywood Lake can be found in Section 5.9.1 of Butcher et al. (2020), and in Appendix 9.

While every attempt has been made to make the following objectives and targets as complete as possible, gaps remain as critical information is not currently available. As such, baselines are not able to be set at this time. In the interests of moving forward, the objectives and targets have been written in a way (i.e. red highlighted text) that allows missing information to be included at a later stage as it becomes available.

Table 12. Environmental objectives and targets for Heywood Lake

EWMP Objective	Target
HeL1: By 2030, improve condition and maintain extent from baseline (2006) levels of black box (*Eucalyptus largiflorens*) to sustain communities and processes reliant of such communities at Heywood Lake and Little Heywood Lake	A positive trend in the condition score of black box dominated EVC benchmarks at 50% of sites over the 10 year period. OR By 2030, at stressed sites (see Wallace et al. 2020): in standardised transects that span the floodplain elevation gradient and existing spatial distribution, ≥70% of viable trees will have a Tree Condition Index Score (TCI) ≥ 10. Baseline condition of black box trees needs to be established to ensure TCI good is achievable – may need to rewrite target and adaptively manage this as condition improves.
HeL2: By 2030, improve vital habitat at Heywood Lake by increasing the diversity of aquatic macrophytes present across a range of Water Regime Indicators Groups.	By 2030, increase diversity of native of aquatic macrophytes at Heywood Lake with ≥2 species from each of the following Water Regime Indicator Groups present in 80% of years: • Aquatic (small floating) (Asf) (no species recorded) • Aquatic (obligate submerged) (Aos) (no species recorded) • Aquatic (submerged to partially emergent) (Ase) (no species recorded) • Aquatic graminoids (persistent) (Agp) (no species recorded) • Aquatic to semi-aquatic (persistent) (Asp) (no species recorded) • Seasonally immersed – low growing (Slg) (blue rod *Stemodia florulenta*) • Seasonally inundated – emergent non woody (Sen) (no species recorded) Target is not measurable at present as no macrophytes are listed in the EWMP that align to WRIGs
HeL3: By 2030, maintain representative populations of shallow-water and deep-water feeding guilds of waterbird (F2 and F3, respectively, after Jaensch 2002) at Heywood Lake, by maintaining a mixture of shallow and deep-water habitats.	By 2030, 80% of representative F2 and F3 species recorded at Heywood Lake in 8 years out of any 10-year period where conditions are suitable. • Representative F2 species include: Australian wood duck (*Chenonetta jubata*), Australasian grebe (*Tachybaptus novaehollandiae*), Pacific black duck (*Anas superciliosa*), white-faced heron (*Egretta novaehollandiae*), and yellow-billed spoonbill (*Platalea flavipes*). • Representative F3 species include: Australian darter (*Anhinga novaehollandiae*), little pied cormorant (*Microcarbo melanoleucos*), pied cormorant (*Phalacrocorax varius*) Feeding habitat defined as a mixture of deep feeding areas (water >1 m) and shallow feeding areas (<0.5 m depth and or drying mud) with intermittent inundation of densely vegetated shrublands (flooding of lignum habitat for 5-6 months every 2 years on average).

EWMP Objective	Target
HeL4: By 2030, maintain nesting and recruitment of non-colonial waterbirds (N1, N2, N3 and N4, after Jaensch 2002) at Heywood Lake and Little Heywood Lake, by maintaining a mixture of tree, low vegetation/shrubs, and ground/islet nesting habitat	There is a lack of data on species that breed at the site. The expectation is that the list of species commonly nesting at Heywood Lake will be confirmed over time. By 2030, at least two of the following species to be recorded as nesting and/or breeding at Heywood Lake and Little Heywood Lake in 7 out of any 10-year period in which nesting/breeding conditions are suitable: • Representative N1 and N2 species include: white-bellied sea-eagle (*Haliaeetus leucogaster*) • Representative N3 and N4 species include: Australasian grebe (*Tachybaptus novaehollandiae*), masked lapwing (*Vanellus miles*), Pacific black duck (*Anas supercilliosa*)

7.3 REGIONAL SIGNIFICANCE

Heywood Lake and Little Heywood Lakes are ephemeral deflation basin lakes (EDBLs). EDBLs are naturally dynamic lowland river floodplain environments which fluctuate between terrestrial and aquatic states (Scholz et. al., 2002) and thereby provide diverse and episodic habitat for diverse flora and fauna (Scholz and Gawne, 2004).

Heywood Lake is a nationally important wetland listed in the Directory of Important Wetlands for its cultural significance. Thirty-two species of waterbirds were recorded at Heywood Lake between 2012 and 2015 in response to environmental watering. Over 6,000 individual birds were recorded at that Lake in 2013 while the Lake was full, while nearly 2,500 individual birds were counted as the environmental water receded and exposed the littoral fringe of the Lake in early 2015.

Over 15,000 individual birds from 104 species have been recorded at Heywood Lake in monitoring between 2012 and 2023.

Twenty-three fauna species (birds, fish and an amphibian) of state, national and international conservation significance, including sixteen that are water dependent and six that are indirectly water dependent have previously been recorded at the site.

The combination of black box woodlands, mudflats, semi-emergent macrophyte beds and open water habitat found within the target area provide a great diversity of feeding, breeding and nursery sites for native water-dependent biota.

As noted above, the Mallee Waterway Strategy (Mallee CMA, 2014) identifies Heywood Lake and Little Heywood Lake as high priority wetlands in the Mallee Region for their environmental, social and cultural values.

7.4 ALIGNMENT TO BASIN PLAN

The primary environmental outcome of the Basin Plan is the protection and restoration of water-dependent ecosystems and ecosystem functions in the Murray-Darling Basin, with strengthened resilience to a changing climate. The MDBA is required to measure progress towards achieving the objectives of the Environmental Watering Plan (EWP) (Chapter 8 of the Basin Plan) by using the targets in Schedule 7 and having regard to the long-term average sustainable

diversion limits, ecological objectives and ecological targets. These are set out in Long-Term Watering Plans (LTWP), the Basin-wide Environmental Watering Strategy (BWS) and annual Basin environmental watering priorities.

Details on the alignment of the updated Heywood Lake EWMP environmental objectives to the Basin Plan are provided in **Table** 13. The mapping of objectives to Schedule 7 targets, the BWS and LTWP are provided by Butcher et al., 2020 in Appendix 9.

Table 13. Mapping of environmental objectives to the Basin Plan

EWMP Objective	Alignment with Basin Plan		
	8.05 Ecosystem and biodiversity	**8.06** Ecosystem function	**8.07** Ecosystem resilience
HeL1: By 2030, improve condition and maintain extent from baseline (2006) levels of black box (*Eucalyptus largiflorens*) to sustain communities and processes reliant of such communities at Heywood Lake and Little Heywood Lake	8.05, 3(b)	n/a	n/a
HeL2: By 2030, improve vital habitat at Heywood Lake by increasing the diversity of aquatic macrophytes present across a range of Water Regime Indicators Groups.	8.05, 3(b)	8.06, 6(b)	n/a
HeL3: By 2030, maintain representative populations of shallow-water and deep-water feeding guilds of waterbird (F2 and F3, respectively, after Jaensch 2002) at Heywood Lake, by maintaining a mixture of shallow and deep-water habitats.	8.05, 3(b)	n/a	n/a
HeL4: By 2030, maintain nesting and recruitment of non-colonial waterbirds (N1, N2, N3 and N4, after Jaensch 2002) at Heywood Lake and Little Heywood Lake, by maintaining a mixture of tree, low vegetation/shrubs, and ground/islet nesting habitat	n/a	8.06, 6(b)	n/a

8. Environmental Water Requirements and Intended Water Regime

8.1 WATERING REQUIREMENTS AND INTENDED WATERING REGIME

The conceptual model for ephemeral deflation basin lakes (Scholz and Gawne, 2004) highlights the significance of managing EDBLs such as Heywood Lake to ensure both wet and dry lake phases. The five states in the cycle of flooding and drying of EDBLs each have importance to ecosystem function as outlined in the conceptual model.

Hydrological objectives describe the components of the water regime required to achieve the environmental objectives for the target area. The hydrological requirements to achieve each of the environmental objectives are presented in Table 14.

Black box woodlands require flooding to occur every three to seven years with durations of two to six months. This species can tolerate shorter flood durations but plant vigour will suffer. Although timing of flood events is not crucial for black box it will affect understorey and other woodland biota. Black box trees may survive prolonged periods of 12 to 16 years with no flooding but tree health will suffer and the woodland will have low productivity (Roberts and Marston, 2011).

Flooding is unreliable but can cover extensive areas of Intermittent Swampy Woodland when it occurs (DSE, 2005c). Hydrological objectives for the Intermittent Swampy Woodland have been focussed around the water requirements of the black box as the dominant structural species within the EVC at this site.

Lignum can tolerate a wide range of wet and dry conditions as well as moderate salinity levels. Flood requirements vary with frequencies of one to three years needed to maintain large shrubs with vigorous canopy and flooding every three to five years for maintenance of healthy shrubs. Intervals of seven to ten years can be tolerated by small shrubs but growth will decline and plants in this state do not accommodate nesting by birds. Durations of three to seven months sustain vigorous canopy, but waterlogging is detrimental. Although timing of flooding is not crucial for lignum, following natural seasonality is encouraged to provide for understorey and wetland plants (Roberts and Marston, 2011).

Table 14. Hydrological objectives for Heywood Lake and Little Heywood Lake

Environmental Objectives	Hydrological Objectives											
	Mean frequency of events (No. per 10 years)			Tolerable interval between events		Duration of ponding (months)			Preferred timing of inflows	Target supply level (mAHD)	Volume to fill to TSL (ML)	Volume to maintain at TSL (ML)	Total volume per event (ML)
	Min.	Opt.	Max.	Min.	Max.	Min.	Opt.	Max					
HeL1: By 2030, improve condition and maintain extent from baseline (2006) levels of black box (*Eucalyptus largiflorens*) to sustain communities and processes reliant of such communities at Heywood Lake and Little Heywood Lake	1	2	3	3	10	2	4	6	Winter/ Spring	56.8* 57.0*	5,200**	2,000**	8,000
HeL2: By 2030, improve vital habitat at Heywood Lake by increasing the diversity of aquatic macrophytes present across a range of Water Regime Indicators Groups.	2	5	10	0	1	1	6	12	Spring/ Summer	53.5	Provided by natural drawdown/evaporative losses following watering to meet black box objective		
HeL3: By 2030, maintain representative populations of shallow-water and deep-water feeding guilds of waterbird (F2 and F3, respectively, after Jaensch 2002) at Heywood Lake, by maintaining a mixture of shallow and deep-water habitats.	2	3	3	-	8	24	-	-	n/a	54 – 56.8			
HeL4: By 2030, maintain nesting and recruitment of non-colonial waterbirds (N1, N2, N3 and N4, after Jaensch 2002) at Heywood Lake and Little Heywood Lake, by maintaining a mixture of tree, low vegetation/shrubs, and ground/islet nesting habitat***	Met through hydrological objectives HeL1-HeL3								-	54			

* Heywood Lake and Little Heywood Lake **Volumes provided based on watering events from 2010/11 (empty to full inundation) and 2011/12 (top up of previous event), ***Ecological objective met through other hydrological objectives. TSL = Target supply level. ML = Megalitres

A flooding regime dominated by spring rather than summer flooding promotes higher macrophyte diversity and abundance (Robertston, Bacon and Heagney, 2001). Semi-emergent macrophytes occupy shallower water that is generally flooded to a depth of one to two metres (Ecological Associates, 2006).

Flooding of wetland and floodplain vegetation in spring and summer provides a source of food, refuge and nesting sites and materials for waterbirds (Kingsford and Norman, 2002). Food availability is enhanced in wetlands that have been subjected to dry periods of one or more years prior to filling (Briggs, Thomas and Lawler, 1997). Receding waters levels over summer provide shallow open water and mudflats which are important foraging habitat for wading birds (Ecological Associates, 2013).

Whilst the watering requirements of individual species or communities found at Heywood Lake may indicate a higher watering frequency, the proposed watering regime of Heywood Lake is driven by the EDBL conceptual model and review of the system's pre-regulation hydrology.

Watering regime

The wetland watering regime has been derived from the ecological and hydrological objectives. To allow for adaptive and integrated management, the watering regime is framed using the seasonally adaptive approach. This means that a watering regime is identified for optimal conditions, as well as the maximum and minimum tolerable watering scenarios.

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

Optimal watering regime

Heywood Lake:
Fill Heywood Lake to 56.8 m AHD to inundate the fringing Intermittent Swampy Woodland community once every eight years during winter/spring. Allow the water level to decrease slowly over summer to create a range of depth-duration habitats and expose mud flats. The draw-down will meet the environmental water requirements of fringing vegetation and create habitat for macrophyte guilds. To ensure open water habitat is sustained a top up in the second year to 54 m AHD may be required to suppress persistence or colonisation of the lake bed by long-lived vegetation. Following the two years of available open water habitat, allow Heywood Lake to enter a drying phase.

Little Heywood Lake:
Inundate Little Heywood Lake every eight years to 56.8 m AHD for up to four months during winter/spring.

8.2 EXPECTED WATERING EFFECTS

This section aims to explicitly outline potential watering actions to achieve the stated environmental objective and expected watering effects.

Objective code	Environmental Objective	Potential Watering Action	Expected Watering Effect
HeL1	By 2030, improve condition and maintain extent from baseline (2006) levels of black box (*Eucalyptus largiflorens*) to sustain communities and processes reliant of such communities at Heywood Lake and Little Heywood Lake	Facilitate flooding to 56.8 m AHD every eight years, during winter/spring, with ponding for four months. Allow the water to recede over summer.	Condition and extent of black box is improved/maintained from baseline levels
HeL2	By 2030, improve vital habitat at Heywood Lake by increasing the diversity of aquatic macrophytes present across a range of Water Regime Indicators Groups.	Facilitate flooding to 53.5 m AHD in five of every 10 years, during Spring / Summer with ponding for up to six months. Allow the water to recede over summer.	Suitable conditions for germination, growth and reproduction are provided for a variety of aquatic macrophytes through variation in water levels.
HeL3	By 2030, maintain representative populations of shallow-water and deep-water feeding guilds of waterbird (F2 and F3, respectively, after Jaensch 2002) at Heywood Lake, by maintaining a mixture of shallow and deep-water habitats.	Facilitate flooding to 56.8 m AHD during winter/spring Allow the water to recede over summer and autumn Provide a top up to 54.0 m AHD in following year, and maintain open water habitat for at least two years. After two years of open water, allow Heywood Lake to enter a drying phase for the following two years.	Foraging habitat is provided for deep feeding guilds (>1.0m depth) while wetland is inundated to its maximum extent. Foraging habitat is provided for shallow feeding guilds (<0.5 m depth water and mudflats) as water recedes over summer and autumn.
HeL4	By 2030, maintain nesting and recruitment of non-colonial waterbirds (N1, N2, N3 and N4, after Jaensch 2002) at Heywood Lake and Little Heywood Lake, by maintaining a mixture of tree, low vegetation/shrubs, and ground/islet nesting habitat	Achieved through watering actions for other objectives.	Nesting habitat is provided for N1, N2, N3 and N4 waterbirds through by having water in the landscape (Nesting preferences: N1: inundated dead trees, N2: inundated live trees, N3: inundated shrubs / low vegetation N4: on ground next to water)

8.3 SEASONALLY ADAPTIVE APPROACH

To allow for adaptive and integrated management, the watering requirements have been framed using an adaptive approach which identifies priorities for environmental watering under different seasonal conditions. This means that a watering regime is identified for optimal conditions, as well as the maximum and minimum tolerable watering scenarios (refer to Table 14). The planning scenarios under different seasonal conditions for Heywood Lake are described in Figure

18. The example watering actions presented in Figure 18 are indicative of the actions that may be delivered under the various planning scenarios. Other factors such as the condition of the site, recent watering history and forecast water availability will also influence the watering actions that are delivered.

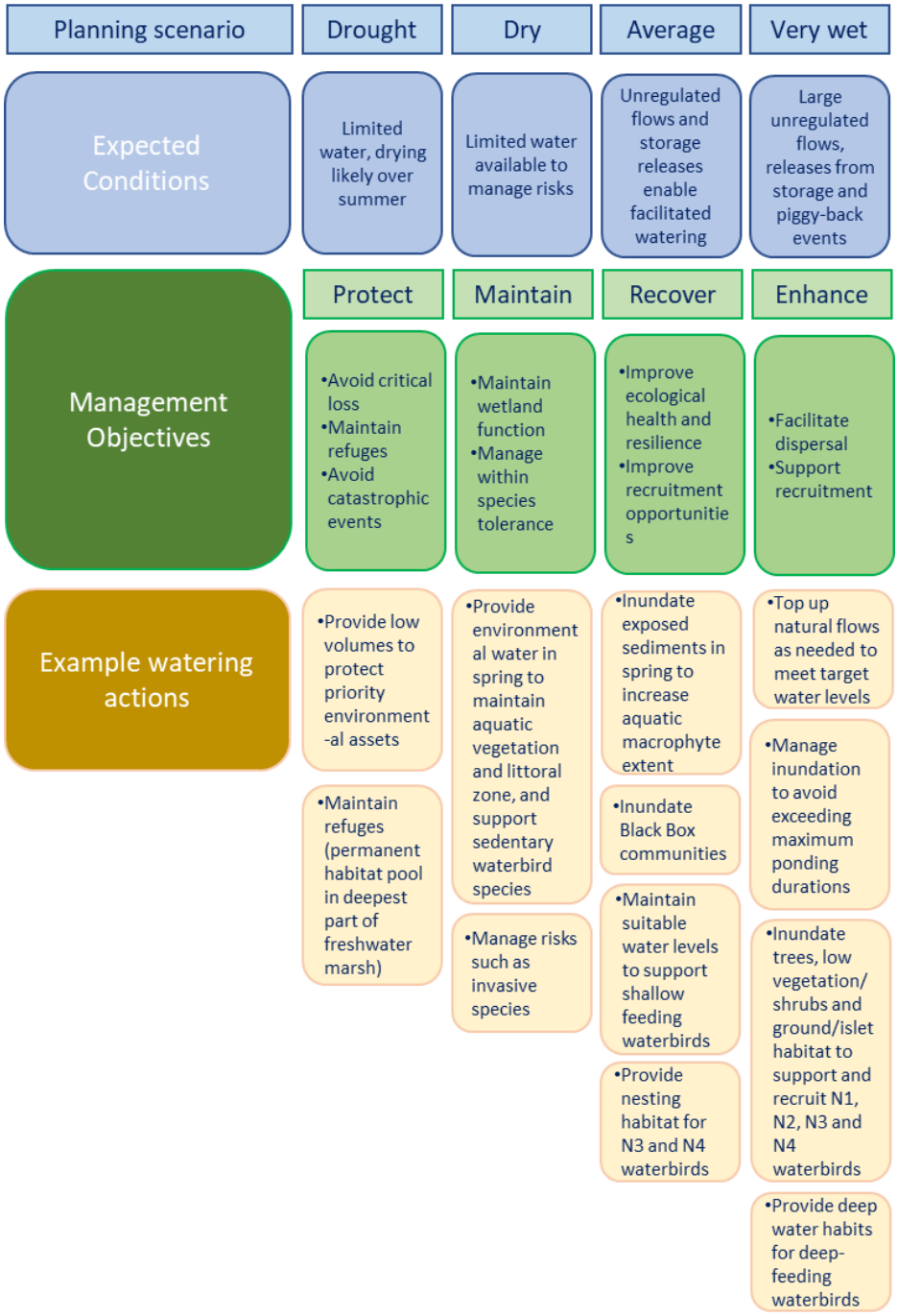


Figure 18. Indicative seasonally adaptive approach

9. Environmental Water Delivery Infrastructure

9.1 WATER DELIVERY INFRASTRUCTURE

Environmental water is currently delivered the Heywood Lake via a temporary flange on the culvert under the Murray Valley Highway.

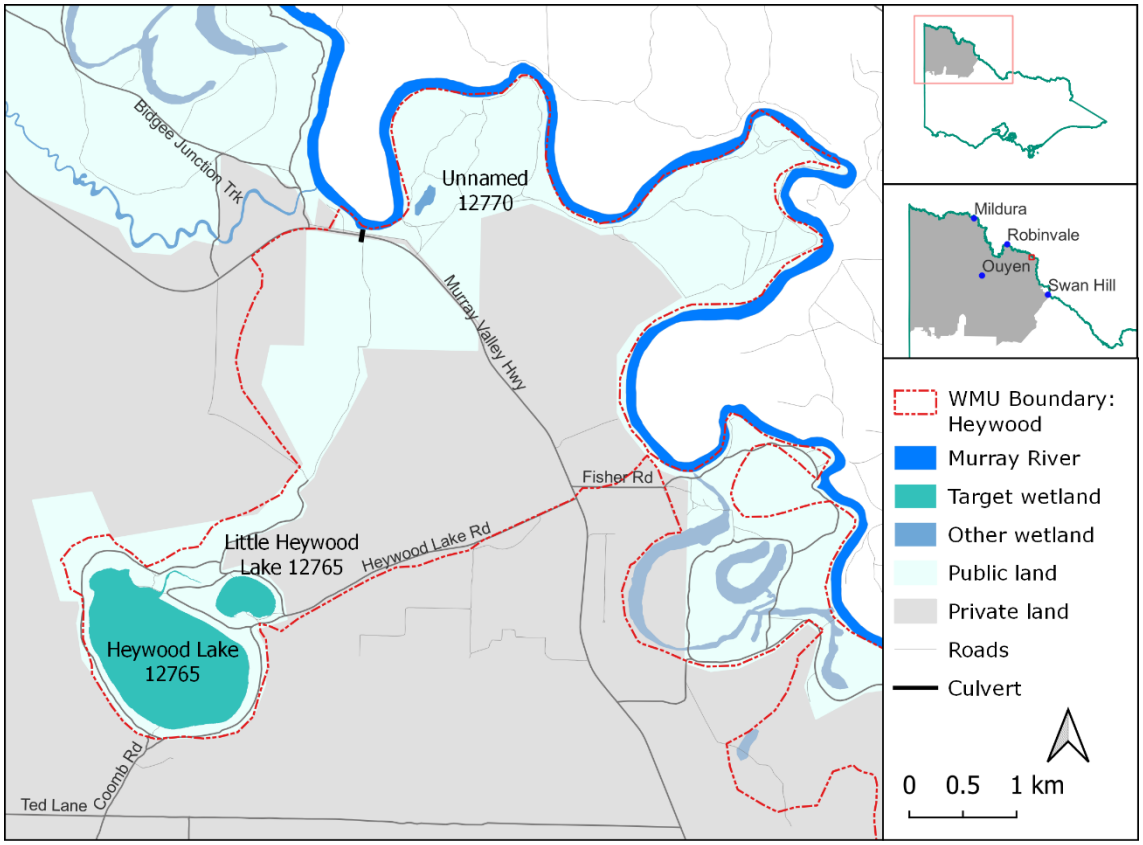


Figure 19. Infrastructure at Heywood Lake

9.2 CONSTRAINTS

The temporary flange limits the rate of pumping of environmental water, while suitable levels in the River Murray are required for pumping to occur. Pumping efficiency is greatest when River Murray flows are 40,000 ML/day. Up to 50 ML/day can be pumped through the culvert, as when deliveries exceed this rate the inlet channel is overtopped. Previous watering events have operated for up to 6 weeks. The spoon drain and natural channel between the River Murray and Heywood Lake runs for approximately 3 km.

The sill between Heywood Lake and Little Heywood Lake is high (approximately 57.0 m AHD) and constrains the watering of Little Heywood Lake via Heywood Lake using the proposed environmental watering regime.

The best options for faster pumping into Heywood Lake and for enabling environmental watering at Little Heywood Lake remain knowledge gaps. The Maximum inundation extent was shown earlier in Figure 5.

10. Demonstrating Outcomes

10.1 ENVIRONMENTAL MONITORING

The following monitoring activities have been proposed for the Heywood Lake target area (Table 15). These activities will enable environmental water managers to assess progress against targets and assist in the adaptive management of the target area to achieve the stated environmental objectives and outcomes. The link between stated objectives and monitoring priorities are described in Table 15.

Table 15. Environmental monitoring at the Heywood Lake target area

Objective	Monitoring Focus	Monitoring Question	Method	When
Overarching management goal	Waterbirds	See for HeL3 and HeL4	See for HeL3 and HeL4	See for HeL3 and HeL4
	Wetland condition	Has there been an overall improvement in the condition of the target area by 2030?	Undertake IWC method assessment.	Every five years
Water Regime	Volume	How much water has been delivered and retained in Lake	Lower Murray Water	Annually
	Inundation extent	Which components of Lake were inundated	Sentinel 2	Annually
	Maximum Depth (AHD & depth classes)	When filled, to what height (AHD) and what was area of key depth classes?	CSIRO, MDBA inundation products	Annually
	Minimum Depth (AHD & depth classes)	What was the minimum depth of the residual pool and what was its extent?	Sentinel 2	Annually

Objective	Monitoring Focus	Monitoring Question	Method	When
HeL1	Condition and extent of black box	Is the condition of black box improving? What is the extent of black box compared to the baseline? Are new trees being recruited into the forest and woodland populations?	TSC tool, field assessments. Evaluate survival of seedlings over a 15 year period, transect survey and Tree Condition Index (TCI) score assessments, photo point monitoring, remote sensing. Compare results against benchmark of initial survey.	Suitable time after delivery
HeL2	Diversity of aquatic macrophytes from across a range of Water Regime Indicators groups	What is the baseline diversity of aquatic macrophytes? By 2030 Are ≥2 species from each of the Water Regime Indicator groups present in 80% of years?	Undertake surveys of aquatic macrophytes at Heywood Lake (including species ID and extent). Compare results against benchmark of initial survey.	Based on existing and antecedent conditions, monitor against expected community.
HeL3	Abundance and diversity of populations of shallow-water and deep-water feeding guilds of waterbirds. Condition and extent of shallow and deep-water habitats	Is the condition or extent of shallow and deep water habitats improving with environmental watering? Are 80% of representative shallow-water and deep-water feeding waterbirds recorded at Heywood Lake in 8 of any 10 year period where conditions are suitable?	Undertake waterbird surveys.	Intervention monitoring at an appropriate time after watering.
HeL4	Nesting and recruitment of non-colonial waterbirds	Are at least two of the representative waterbird species recorded as nesting and/or breeding at Heywood Lake in 7 of any 10-year period in which conditions are suitable?	Undertake waterbird surveys.	Intervention monitoring at an appropriate time after watering.

10.2 MONITORING PRORITIES AT THE ASSET

The monitoring priorities that have been identified for the Murrumbidgee Target area and reason for their prioritisation are shown in Table 16.

Table 16. Monitoring priorities at Heywood Lake

Monitoring Priority	Reason for Priority
Water delivery	Adaptive management: water is managed to meet EWMP objectives.
Hydraulic outcomes	Depth, extent and duration of inundation in relation to EVCs.
Inundation extent	To ensure that black box community inundation thresholds are not exceeded, and that thresholds for creating open water habitat are reached. Informs adaptive management.
Telemetry on depth gauges	To continuously monitor depth through wetting and drying phases of the water regime, and inform adaptive management
Index of wetland condition assessments	These provide information on changes in hydrology and water quality that impact on flora and fauna
Black box stand condition and extent	To develop baselines to assist condition assessments. Key for assessing progress against objectives of the Basin Plan Environmental Watering Plan (EWP), Basin Plan Schedule 7 targets, Basin wide Environmental Watering strategy (BWS) and Victorian Murray Long Term Watering Plan. Black box stands are an important long-term indicator of the effectiveness of environmental water.
Diversity of aquatic macrophytes	Monitor macrophyte responses to watering with reference to EWMP objectives and expected outcomes. Key for assessing progress against objectives of the Basin Plan Environmental Watering Plan (EWP), Basin Plan Schedule 7 targets, Basin wide Environmental Watering Strategy (BWS) and Victorian Murray Long Term Watering Plan.
Monitoring of waterbird diversity, abundance and breeding within the target area	To develop baselines to assist condition assessments. Key for assessing progress against objectives of the Basin Plan Environmental Watering Plan (EWP), Basin Plan Schedule 7 targets, Basin wide Environmental Watering strategy (BWS) and Victorian Murray Long Term Watering Plan.

11. Adaptive Management

Mallee CMA uses an adaptive management approach in planning and managing environmental watering actions.

Adaptive management is the process of incorporating new scientific and operational information into the implementation of a project or plan to ensure that management actions are appropriate, effective and contribute to goals efficiently. It is a standard and well-established practice for environmental water management, recognising the inherent uncertainties and risks associated with the complex relationships between changes to hydrology and ecological responses, and the potential for a watering event to provide both positive and adverse outcomes. Figure 20 shows an illustration of the adaptive management cycle for environmental water delivery.

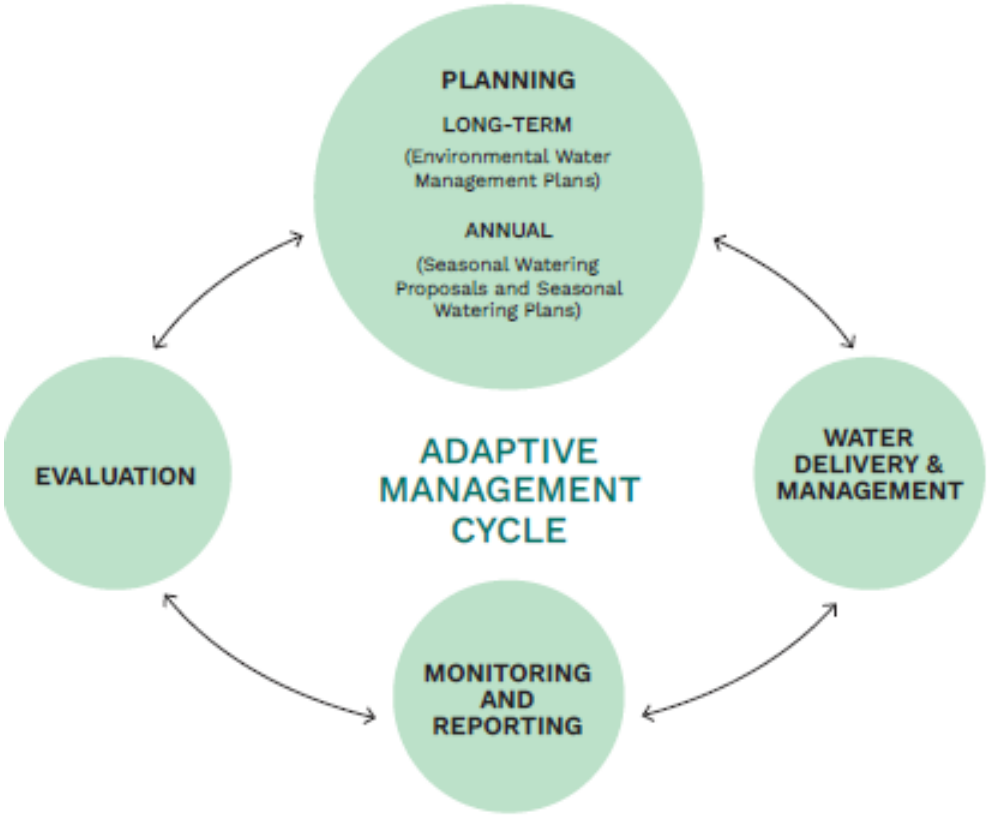


Figure 20. The adaptive management cycle for environmental water delivery and management

Mallee CMA uses three main pathways to identify inputs to the adaptive management process (also referred to as lessons):

- monitoring to detect differences between what was planned and the outcomes at the environmental watering site.
- incidental observations by managers, operators or other observers that identify opportunities to reduce risk or improve outcomes.
- research or investigations into hydraulic or ecological management practices that could improve the conceptual models on which operations are based.

Mallee CMA formally documents lessons to strengthen organisational memory and provide transparency in continual improvement measures. Recording of lessons is crucial for both annual environmental watering actions and long-term planning. Demonstrating continual improvement provides the justification for monitoring programs and confirms that assets are being managed responsibly.

An adaptive management framework has several components that work together to build lessons learned from environmental watering actions and program partners into the environmental water program. This produces iterative improvements in the way environmental watering is undertaken using the best available evidence.

The EWMP will be constantly refined to incorporate learnings from ecological monitoring as well as feedback from community consultation.

Land managers and river operators are included in the operational planning cycle which include adaptive management processes to incorporate learnings and risk management.

Figure 21. Heywood Lake, 2013. Source: Mallee CMA.

12. Knowledge Gaps and Recommendations

This plan is based on best information at the time of writing. In some cases, information is scarce or outdated. Further investigation and information collection will continue, and the results of this further work will continue to build a better picture of the site and add rigor to future planning. A comprehensive review of the Heywood Lake management goal, environmental objectives, hydrological objectives, and watering actions is strongly recommended for better alignment with the site's natural hydrology as an ephemeral deflation basin lake.

Some areas where further knowledge would be beneficial are outlined in Table 17. Any future monitoring plan could include a number of these recommendations.

Table 17. Knowledge gaps and recommendations for Heywood Lake

Knowledge and data gap	Action recommended	Responsibility
Wetland condition	Heywood Lake and Little Heywood Lake should be incorporated into the five-yearly Index of Wetland Condition assessments.	Implementation of any of these recommendations would be dependent on investment from Victorian and Australian Government funding sources as projects managed through the Mallee CMA.
Mechanism to achieve optimal pumping into Heywood Lake	Explore mechanisms to achieve maximum inundation of the target area, such as infrastructure or the relaxation of constraints. A concept design report is required to scope the infrastructure requirements at Heywood Lake.	
Best options for watering of Little Heywood Lake	Scoping of requirements and detailed design of options for watering of Little Heywood Lake, including an investigation of connection points, required sill levels and height of Heywood Lake inundation required to allow connection to Little Heywood Lake. Investigations should examine whether inundation duration thresholds for black box would be exceeded at the Heywood Lake levels required to overtop the sill.	
Land use impacts	Assess whether surrounding land use is impacting the water dependent values within the target area. Impacts could include: • Spray drift from cropping activities impacting water quality or vegetation health. • Sediment input into the wetland associated with cropping and grazing activities. • Altered drainage or local runoff associated with channels and levees.	
Spells analysis and inundation thresholds for Heywood Lake and Little Heywood Lake, based on the Swan Hill gauge.	Undertake spells analysis for inundation thresholds from Swan Hill gauge – investigations should consider the pre-regulation wetland sill, and the sill created by the spoon drain.	
Condition and extent of black box and aquatic macrophytes	Undertake methods identified in Table 15.	
Cultural Heritage and Values Assessments	Traditional Owners to carry out cultural heritage and values assessment at site to understand cultural constraints to watering.	

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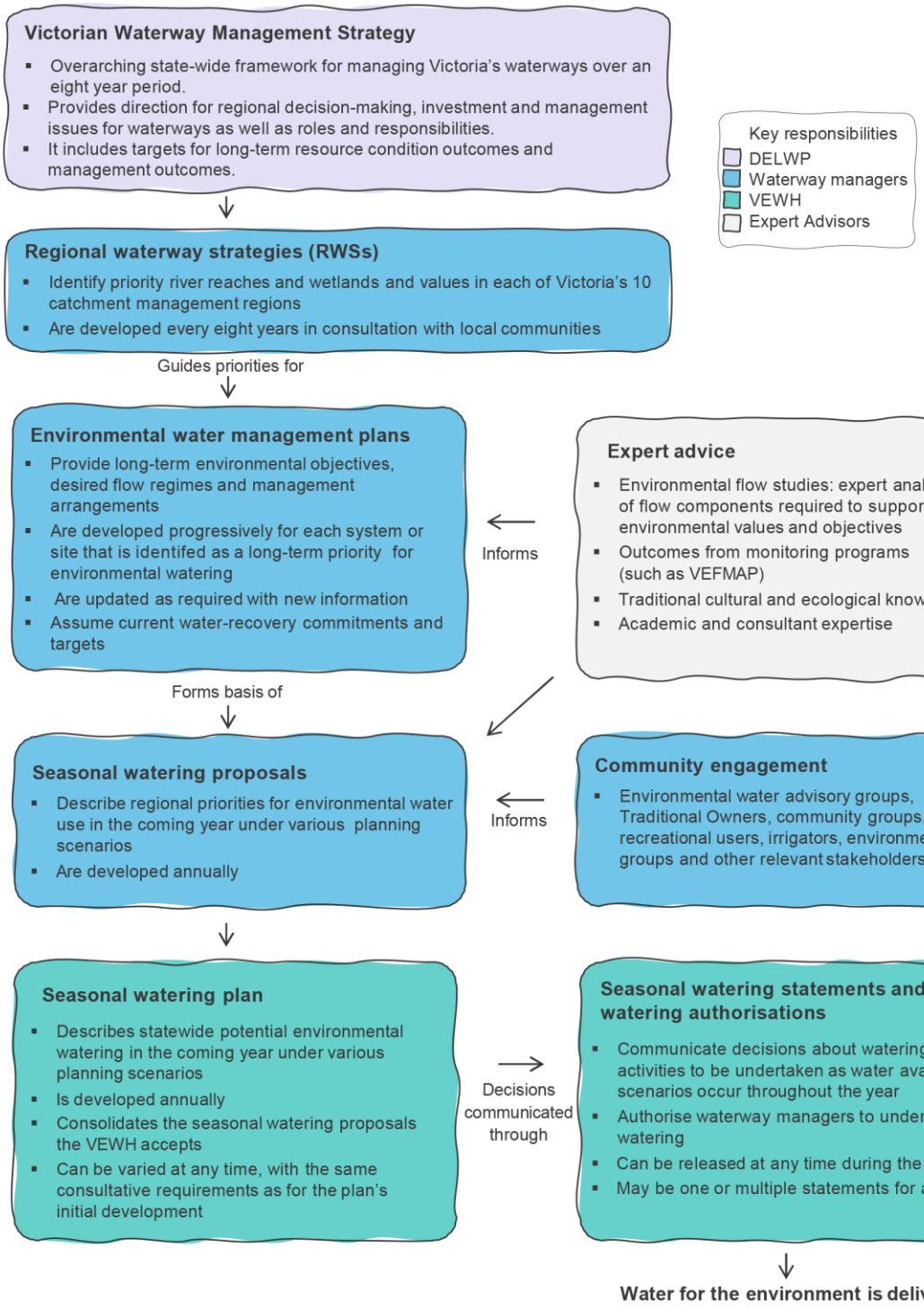
APPENDIX 1. Environmental Water Management Plan Context

Environmental water in Victoria is managed as an integral part of the Victorian Waterway Management Program. The state-level Victorian Waterway Management Strategy (VWMS) provides the overarching framework for environmental water management (see accompanying figure). The Mallee Waterway Strategy (2014-22) drives implementation of the VWMS at the regional level. Information from the Mallee Waterway Strategy is a key input to environmental water planning arrangements, including the selection of eligible assets to receive environmental water. Environmental water management plans are site-specific plans developed for a wetland or wetland complex deemed a priority to receive environmental water through the Mallee Waterway Strategy development process. This document is the Environmental Water Management Plan (EWMP) for Heywood Lake in the Mallee Catchment Management region.

Environmental watering in the Mallee Region has historically been supported by management plans such as this one, that document key information including the watering requirements of an asset, predicted ecological responses and water delivery arrangements. These plans support annual decisions about which sites should receive water and assist managers to evaluate how well those assets respond to the water they receive or what could be done better. Environmental water management at Heywood Lake is further underpinned by the Murray-Darling Basin Plan 2012 (Commonwealth) and the associated Basin-wide environmental watering strategy. In accordance with Basin Plan requirements, Victoria has also developed the Victorian Murray Water Resource Plan and Victorian Murray Long-Term Watering Plan, which apply at Heywood Lake.

Mallee Catchment Management Authority (MCMA), the Victorian Department of Energy, Environment and Climate Action (DEECA), the Victorian Environmental Water Holder (VEWH) and Traditional Owner groups have worked together to develop several EWMPs for watered assets throughout the Mallee region. These plans are continually updated through an adaptive management process. A primary purpose of EWMPs is to provide a consistent set of documents that support seasonal watering proposals to be submitted by asset managers to the VEWH annually.



EWMP Policy Context

APPENDIX 2.

COMMUNITY AND AGENCY ENGAGEMENT 2024

Community stakeholders were engaged on the update of this and other EWMPs in person at several local events, including local markets (Mildura Market, Red Cliffs Market, Swan Hill Market), local environmental group meetings (Mildura Birdlife meeting, Greening Mildura meeting, Cabarita Inc. day and an environmental volunteer event), and a drop in event at Nangiloc. In-person engagements were designed to enable community input to the plans, and included a 'Pins in Maps' exercise, where stakeholders identified locations of water-dependent values at sites within Heywood Lake and other WMU subunits.

Community stakeholders were also engaged on the update of the Heywood Lake EWMP via an online survey, which was hosted on the Mallee CMA website in December 2023 – January 2024. The survey and in-person engagements supplement earlier community engagement about the Heywood Lake EWMP, and annual community engagement that informs the Seasonal Watering Proposal (SWP). Community consultation occurs at the IAP2 level of CONSULT.

In-person community engagement:

Community stakeholders provided information about Heywood Lake at in-person meetings with Mildura Birdlife, and in an environmental volunteer event. These stakeholders had specific interests in birds and water values at the site.

Online survey:

The online survey was completed by one respondent, who was a visitor to the region. The respondent visited during winter for birdwatching, nature appreciation and education purposes. The respondent agreed with natural watering cycles returning to the area.

Traditional Owner engagement on Country:

Traditional Owner representatives were engaged on the Heywood Lake EWMP at an in-person meeting on-Country at Heywood Lake in October 2023. Representatives from Culpra Milli Aboriginal Corporation, Munatunga Elders, Gilbie Aboriginal Corporation, Tati Tati Land and Water Indigenous Corporation, Wadi Wadi Nation, Tati Tati Wadi Wadi Land and Water Indigenous Cooperation, and Dadi Dadi Weki Weki Aboriginal Cooperation attended the meeting. A 'pins in maps' exercise was also completed at this meeting. Traditional Owners identified water-dependent values, flora and fauna values (goannas and swans), recreational values (fishing, camping and hunting), and other cultural values across Heywood Lake. Traditional Owners noted the cultural heritage at Heywood Lake, including hearths, scarred trees and burial sites. The true extent of cultural heritage at Heywood Lake is unknown. Heywood Lake is an important site for storytelling.

Agency Engagement:

Mallee CMA met with representatives from agency stakeholders Parks Victoria, Lower Murray Water and Mildura Rural City Council in February 2024. Discussions regarding Heywood Lake centred on the need for cultural heritage inspections, and planned control of pest animal and plant species.

Nearby private pump infrastructure, the repair/maintenance of the culvert and road maintenance were also discussed.

APPENDIX 3.

ECOLOGICAL VEGETATION CLASSES

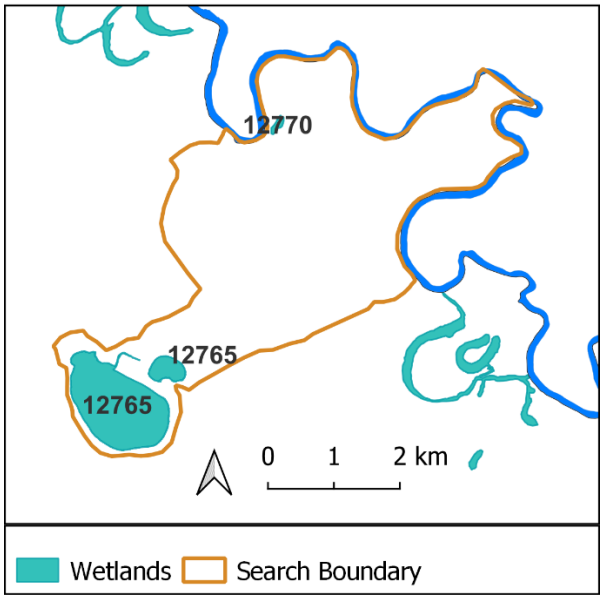
EVC no.	EVC name	Bioregional Conservation Status		Description
		Murray Fans	Murray Mallee	
86	Woorinen Sands Mallee	n/a	Depleted	Mallee shrubland to 7 m tall, typically supporting a hummock grass (Triodia spp.) dominated understorey. This EVC could be considered intermediate between the heavier soil mallee woodlands and the lighter sandy soil mallee vegetation predominant on Lowan (siliceous) sand.
97	Semi-arid Woodland	Vulnerable	Vulnerable	Non-eucalypt woodland or open forest to 12 m tall, of low rainfall areas. Occurs in a range of somewhat elevated positions not subject to flooding or inundation. The surface soils are typically light textured loamy sands or sandy loams.
103	Riverine Chenopod Woodland	Endangered	n/a	Eucalypt woodland to 15 m tall with a diverse shrubby and grassy understorey occurring on most elevated riverine terraces. Confined to heavy clay soils on higher level terraces within or on the margins of riverine floodplains (or former floodplains), naturally subject to only extremely infrequent incidental shallow flooding from major events if at all flooded.
107	Lake Bed Herbland	Vulnerable	Depleted	Herbland or shrubland to 0.5 m tall dominated by species adapted to drying mud within lake beds. Some evade periods of prolonged inundation as seed, others as dormant tuber-like rootstocks. Occupies drying deep-cracking mud of lakes on floodplains. Floods are intermittent but water may be retained for several seasons leading to active growth at the 'drying mud stage'.
808	Lignum Shrubland	Vulnerable	n/a	Relatively open shrubland of species of divaricate growth form. The ground-layer is typically herbaceous or a turf grassland, rich in annual/ephemeral herbs and small chenopods. Characterised the open and even distribution of relatively small Lignum shrubs. Occupies heavy soil plains along River Murray, low-lying areas on higher-level (but still potentially flood-prone) terraces.
813	Intermittent Swampy Woodland	Depleted	Vulnerable	Eucalypt woodland to 15 m tall with a variously shrubby and rhizomatous sedgy – turf grass understorey, at best development dominated by flood stimulated species in association with flora tolerant of inundation. Flooding is unreliable but extensive when it happens. Occupies low elevation areas on river terraces (mostly at the rear of point-bar deposits or adjacent to major floodways) and lacustrine verges (where sometimes localised to narrow

EVC no.	EVC name	Bioregional Conservation Status		Description
		Murray Fans	Murray Mallee	
				transitional bands). Soils often have a shallow sand layer over heavy and frequently slightly brackish soils.
823	Lignum Swampy Woodland	Vulnerable	n/a	Understorey dominated by Lignum, typically of robust character and relatively dense (at least in patches), in association with allow Eucalypt and/or Acacia woodland to 15 m tall. The ground layer includes a component of obligate wetland flora that is able to persist even if dormant over dry periods.

DEECA 2023a, DSE 2004, 2005c

APPENDIX 4.

FAUNA SPECIES LIST. – COMBINED NATUREKIT, BIRD OBSERVATIONS AND PROTECTED MATTERS SEARCHES.



Scientific Name	Common Name	FFG Act Status	EPBC Act Status
Acanthagenys rufogularis	Spiny-cheeked honeyeater		
Acanthiza chrysorrhoa	Yellow-rumped thornbill		
Acanthiza uropygialis	Chestnut-rumped thornbill		
Acrobates spp.	Feather-tailed glider species		
Aegotheles cristatus	Australian owlet-nightjar		
Anas castanea	Chestnut teal		
Anas gracilis	Grey teal		
Anas superciliosa	Pacific black duck		
Anhinga novaehollandiae	Australasian darter		
Anthus australis	Australian pipit		
Aphelocephala leucopsis	Southern whiteface		Vulnerable
Apus pacificus	Fork-tailed swift		
Aquila audax	Wedge-tailed eagle		
Ardea alba	Great egret		
Ardea alba modesta	Eastern great egret	Vulnerable	
Ardea intermedia plumifera	Plumed egret	Critically Endangered	Critically Endangered
Ardea pacifica	White-necked heron		
Artamus superciliosus	White-browed woodswallow		
Aythya australis	Hardhead	Vulnerable	
Barnardius zonarius	Australian ringneck		
Barnardius zonarius barnardi	Mallee ringneck		
Biziura lobata	Musk duck	Vulnerable	

Scientific Name	Common Name	FFG Act Status	EPBC Act Status
Cacatua galerita	Sulphur-crested cockatoo		
Cacatua sanguinea	Little corella		
Cacomantis pallidus	Pallid cuckoo		
Calidris acuminata	Sharp-tailed sandpiper		
Calidris ferruginea	Curlew sandpiper	Critically Endangered	Critically Endangered
Calidris ruficollis	Red-necked stint		
Certhionyx variegatus	Pied honeyeater		
Charadrius bicinctus	Double-banded plover		
Charadrius ruficapillus	Red-capped plover		
Chenonetta jubata	Australian wood duck		
Cheramoeca leucosterna	White-backed swallow		
Chlidonias hybrida	Whiskered tern		
Chroicocephalus novaehollandiae	Silver gull		
Cincloramphus cruralis	Brown songlark		
Cincloramphus mathewsi	Rufous songlark		
Circus approximans	Swamp harrier		
Climacteris picumnus	Brown treecreeper		Vulnerable
Colluricincla harmonica	Grey shrike-thrush		
Coracina novaehollandiae	Black-faced cuckoo-shrike		
Corvus coronoides	Australian raven		
Corvus mellori	Little raven		
Cracticus nigrogularis	Pied butcherbird		
Cracticus torquatus	Grey butcherbird		
Cygnus atratus	Black swan		
Cyprinus carpio	Common carp*		
Delma australis	Southern legless lizard		
Dromaius novaehollandiae	Emu		
Egretta garzetta	Little egret	Endangered	Endangered, Overfly marine
Egretta novaehollandiae	White-faced heron		
Elanus axillaris	Black-shouldered kite		
Elseyornis melanops	Black-fronted dotterel		
Eolophus roseicapilla	Galah		
Epthianura albifrons	White-fronted chat		
Erythrogonys cinctus	Red-kneed dotterel		
Falco cenchroides	Nankeen kestrel		
Falco longipennis	Australian hobby		
Fulica atra	Eurasian coot		
Gallinula tenebrosa	Dusky moorhen		
Gavicalis virescens	Singing honeyeater		
Geopelia placida	Peaceful dove		
Grallina cyanoleuca	Magpie-lark		
Gymnorhina tibicen	Australian magpie		

Scientific Name	Common Name	FFG Act Status	EPBC Act Status
Haliaeetus leucogaster	White-bellied sea-eagle	Endangered	
Haliastur sphenurus	Whistling kite		
Hieraaetus morphnoides	Little eagle	Vulnerable	
Himantopus himantopus	Black-winged stilt		
Himantopus leucocephalus	Pied stilt		
Hirundo neoxena	Welcome swallow		
Hydroprogne caspia	Caspian tern	Vulnerable	
Lalage tricolor	White-winged triller		
Lialis burtonis	Burton's snake-lizard		
Limnodynastes fletcheri	Barking marsh frog		
Litoria raniformis	Growling grass Frog	Vulnerable	Vulnerable
Lophochroa leadbeateri	Major Mitchell's cockatoo	Critically Endangered	Endangered
Maccullochella peelii	Murray cod	Endangered	Vulnerable
Malacorhynchus membranaceus	Pink-eared duck		
Malurus assimilis	Purple-backed fairywren		
Malurus cyaneus	Superb fairy-wren		
Malurus lamberti	Variegated fairy-wren		
Malurus leucopterus	White-winged Fairy-wren		
Manorina flavigula	Yellow-throated miner		
Manorina melanocephala	Noisy miner		
Melanodryas cucullata	Hooded robin	Vulnerable	Endangered
Melithreptus brevirostris	Brown-headed honeyeater		
Merops ornatus	Rainbow bee-eater		
Microcarbo melanoleucos	Little pied cormorant		
Milvus migrans	Black kite		
Myiagra inquieta	Restless flycatcher		
N/A	Black-winged stilt		
Northiella haematogaster	Blue bonnet		
Nycticorax caledonicus	Nankeen night-heron		Overfly Marine
Ocyphaps lophotes	Crested pigeon		
Oxyura australis	Blue-billed duck	Vulnerable	
Pachycephala rufiventris	Rufous whistler		
Pardalotus striatus	Striated pardalote		
Pelecanus conspicillatus	Australian pelican		
Petrochelidon ariel	Fairy martin		
Petrochelidon nigricans	Tree martin		
Petroica goodenovii	Red-capped robin		
Phalacrocorax carbo	Great cormorant		
Phalacrocorax sulcirostris	Little Black cormorant		
Phalacrocorax varius	Pied cormorant		
Phaps chalcoptera	Common bronzewing		
Platalea flavipes	Yellow-billed spoonbill		

Scientific Name	Common Name	FFG Act Status	EPBC Act Status
Platalea regia	Royal spoonbill		
Platycercus elegans	Crimson rosella		
Platycercus elegans flaveolus	Yellow rosella		
Plectorhyncha lanceolata	Striped honeyeater		
Podiceps cristatus	Great crested grebe		
Poliocephalus poliocephalus	Hoary-headed grebe		
Polytelis anthopeplus monarchoides	Regent parrot	Vulnerable	Vulnerable
Pomatostomus ruficeps	Chestnut-crowned babbler		
Pomatostomus superciliosus	White-browed babbler		
Psephotellus varius	Mulga parrot		
Psephotus haematonotus	Red-rumped parrot		
Ptilotula penicillata	White-plumed honeyeater		
Recurvirostra novaehollandiae	Red-necked avocet		
Rhipidura albiscapa	Grey fantail		
Rhipidura leucophrys	Willie wagtail		
Smicrornis brevirostris	Weebill		
Sminthopsis crassicaudata	Fat-tailed dunnart	Vulnerable	
Spatula rhynchotis	Australasian shoveler	Vulnerable	
Stictonetta naevosa	Freckled duck	Endangered	
*Sturnus vulgaris**	Common starling		
Tachybaptus novaehollandiae	Australasian grebe		
Tadorna tadornoides	Australian shelduck		
Threskiornis molucca	Australian white ibis		
Threskiornis spinicollis	Straw-necked ibis		
Todiramphus sanctus	Sacred kingfisher		
Tribonyx ventralis	Black-tailed native-hen		
Tringa nebularia	Common greenshank	Endangered	
Tringa stagnatilis	Marsh sandpiper	Endangered	
Vanellus miles	Masked lapwing		
Vanellus tricolor	Banded lapwing		
Wallabia bicolor	Black-tailed wallaby		
Zosterops lateralis	Silvereye		

* Indicates introduced species

DEECA 2023b, DCCEEW 2024

APPENDIX 5. BIRD OBSERVATIONS – HEYWOOD LAKE

Proportion of lake inundated		80%	70%	100%	60%	Unknown	Unknown	Unknown	100%	
Source		EWMP	EWMP	EWMP	EWMP	WetMap	WetMap	WetMap	Birdata	
Common name	Scientific name	2012	2013	2014	2015	2018	2019	2023 wetmap	2023 birdata	FFG Act Status
Australasian Darter	*Anhinga novaehollandiae*	0	2	6	0	0	0	11	8	
Australasian Grebe	*Tachybaptus novaehollandiae*	125	240	2	85	0	0	28	9	
Australasian Shoveler	*Spatula rhynchotis*	0	55	0	41	0	25	0	0	Vulnerable
Australian Hobby	*Falco longipennis*	0	0	0	0	0	0	0	0	
Australian Magpie	*Gymnorhina tibicen*	0	0	0	0	0	14	0	9	
Australian Pelican	*Pelecanus conspicillatus*	0	0	0	250	0	232	0	1	
Australian Raven	*Corvus coronoides*	0	0	0	0	0	30	0	3	
Australian Ringneck	*Barnardius zonarius*	0	0	0	0	0	0	0	5	
Australian Shelduck	*Tadorna tadornoides*	0	8	2	0	0	74	0	0	
Australian White Ibis	*Threskiornis molucca*	0	0	0	0	0	0	32	0	
Australian Wood Duck	*Chenonetta jubata*	708	179	68	23	0	713	0	54	
Black Kite	*Milvus migrans*	0	0	0	0	0	2	0	0	
Black Swan	*Cygnus atratus*	0	152	0	70	14	0	0	0	
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	0	0	0	0	6	0	0	4	
Black-fronted Dotterel	*Elseyornis melanops*	0	32	0	0	0	14	0	0	
Black-shouldered Kite	*Elanus axillaris*	0	0	0	0	0	0	0	2	
Black-tailed Native-hen	*Tribonyx ventralis*	0	540	0	0	27	0	0	60	
Black-winged Stilt	*Himantopus himantopus*	0	22	0	0	0	25	0	0	
Blue Bonnet	*Northiella haematogaster*	0	0	0	0	2	0	0	8	
Blue-billed Duck	*Oxyura australis*	6	32	0	7	0	0	0	0	Vulnerable
Brown Treecreeper	*Climacteris picumnus*	0	0	0	0	2	0	0	2	

Proportion of lake inundated		80%	70%	100%	60%	Unknown	Unknown	Unknown	100%	
Source		EWMP	EWMP	EWMP	EWMP	WetMap	WetMap	WetMap	Birdata	
Common name	Scientific name	2012	2013	2014	2015	2018	2019	2023 wetmap	2023 birdata	FFG Act Status
Caspian Tern	*Hydroprogne caspia*	0	0	0	0	1	0	0	0	Vulnerable
Chestnut Teal	*Anas castanea*	0	0	0	0	2	0	0	0	
Chestnut-crowned Babbler	*Pomatostomus ruficeps*	0	0	0	0	20	0	0	0	
Chestnut-rumped Thornbill	*Acanthiza uropygialis*	0	0	0	0	0	3	0	7	
Common Bronzewing	*Phaps chalcoptera*	0	0	0	0	0	0	0	1	
Common Greenshank	*Tringa nebularia*	0	0	0	0	0	1	0	0	Endangered
Common Starling	*Sturnus vulgaris*	0	0	0	0	1	0	0	0	
Crested Pigeon	*Ocyphaps lophotes*	0	0	0	0	0	8	0	6	
Crimson Rosella	*Platycercus elegans*	0	0	0	0	0	0	0	2	
Curlew Sandpiper	*Calidris ferruginea*	0	0	0	0	0	3	0	0	Critically Endangered
Double-banded Plover	*Charadrius bicinctus*	0	0	0	0	0	2	0	0	
Dusky Moorhen	*Gallinula tenebrosa*	0	0	0	0	0	0	13	2	
Eastern Great Egret	*Ardea alba modesta*	0	1	0	2	0	0	0	0	Vulnerable
Emu	*Dromaius novaehollandiae*	0	0	0	0	3	0	0	0	
Eurasian Coot	*Fulica atra*	15	3030	6	360	87	0	0	19	
Fairy Martin	*Petrochelidon ariel*	0	0	0	0	0	0	0	6	
Freckled Duck	*Stictonetta naevosa*	0	5	0	5	0	0	0	0	Endangered
Great Cormorant	*Phalacrocorax carbo*	0	3	34	710	178	0	0	3	
Great Crested Grebe	*Podiceps cristatus*	2	0	0	8	0	0	7	0	
Grey Butcherbird	*Cracticus torquatus*	0	0	0	0	1	0	0	0	
Grey Fantail	*Rhipidura albiscapa*	0	0	0	0	1	0	0	7	
Grey Shrike-thrush	*Colluricincla harmonica*	0	0	0	0	1	0	0	0	
Grey Teal	*Anas gracilis*	120	944	72	510	0	0	1820	4	

Proportion of lake inundated		80%	70%	100%	60%	Unknown	Unknown	Unknown	100%	
Source		EWMP	EWMP	EWMP	EWMP	WetMap	WetMap	WetMap	Birdata	
Common name	Scientific name	2012	2013	2014	2015	2018	2019	2023 wetmap	2023 birdata	FFG Act Status
Hardhead	*Aythya australis*	0	27	0	31	0	0	0	0	Vulnerable
Hoary-headed Grebe	*Poliocephalus poliocephalus*	15	207	0	12	0	0	0	4	
Little Black Cormorant	*Phalacrocorax sulcirostris*	0	0	32	60	0	0	0	6	
Little Eagle	*Hieraaetus morphnoides*	0	0	0	0	0	0	0	0	Vulnerable
Little Egret	*Egretta garzetta*	0	0	0	1	0	0	0	0	Endangered
Little Pied Cormorant	*Microcarbo melanoleucos*	0	0	31	0	0	0	130	11	
Magpie-lark	*Grallina cyanoleuca*	0	0	0	0	0	21	0	13	
Mallee Ringneck	*Barnardius zonarius barnardi*	0	0	0	0	0	0	0	0	
Marsh Sandpiper	*Tringa stagnatilis*	0	0	0	0	0	1	0	0	Endangered
Masked Lapwing	*Vanellus miles*	0	3	0	21	0	42	0	0	
Mulga Parrot	*Psephotellus varius*	0	0	0	0	0	1	0	0	
Musk Duck	*Biziura lobata*	4	12	0	4	0	0	11	0	Vulnerable
Nankeen Night-Heron	*Nycticorax caledonicus*	0	0	0	0	0	0	19	7	
Noisy Miner	*Manorina melanocephala*	0	0	0	0	0	0	0	0	
Pacific Black Duck	*Anas superciliosa*	106	505	3	41	0	0	180	0	
Peaceful Dove	*Geopelia placida*	0	0	0	0	0	2	0	0	
Pied Butcherbird	*Cracticus nigrogularis*	0	0	0	0	0	0	0	1	
Pied Cormorant	*Phalacrocorax varius*	0	0	2	30	0	0	0	0	
Pied Honeyeater	*Certhionyx variegatus*	0	0	0	0	0	1	0	0	
Pink-eared Duck	*Malacorhynchus membranaceus*	0	190	0	45	0	24	0	2	
Plumed Egret	*Ardea intermedia plumifera*	0	0	0	0	0	0	0	5	Critically Endangered
Rainbow Bee-eater	*Merops ornatus*	0	0	0	0	0	0	0	0	

Proportion of lake inundated		80%	70%	100%	60%	Unknown	Unknown	Unknown	100%	
Source		EWMP	EWMP	EWMP	EWMP	WetMap	WetMap	WetMap	Birdata	
Common name	Scientific name	2012	2013	2014	2015	2018	2019	2023 wetmap	2023 birdata	FFG Act Status
Red-capped Plover	*Charadrius ruficapillus*	0	0	0	0	0	49	0	0	
Red-capped Robin	*Petroica goodenovii*	0	0	0	0	0	0	0	2	
Red-kneed Dotterel	*Erythrogonys cinctus*	0	0	0	0	4	0	0	1	
Red-necked Avocet	*Recurvirostra novaehollandiae*	0	0	0	0	21	0	0	0	
Red-necked Stint	*Calidris ruficollis*	0	0	0	0	0	60	0	0	
Red-rumped Parrot	*Psephotus haematonotus*	0	0	0	0	0	0	0	2	
Regent Parrot	*Polytelis anthopeplus monarchoides*	0	0	0	0	0	13	0	0	Vulnerable
Royal Spoonbill	*Platalea regia*	0	0	0	7	0	6	0	0	
Rufous Whistler	*Pachycephala rufiventris*	0	0	0	0	0	0	0	3	
Sacred Kingfisher	*Todiramphus sanctus*	0	0	0	0	0	0	0	3	
Sharp-tailed Sandpiper	*Calidris acuminata*	0	0	0	0	0	16	0	0	
Silver Gull	*Chroicocephalus novaehollandiae*	0	0	0	0	0	26	0	0	
Silvereye	*Zosterops lateralis*	0	0	0	0	0	0	0	1	
Singing Honeyeater	*Gavicalis virescens*	0	0	0	0	0	2	0	6	
Southern Whiteface	*Aphelocephala leucopsis*	0	0	0	0	0	0	0	10	
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*	0	0	0	0	0	4	0	10	
Straw-necked Ibis	*Threskiornis spinicollis*	0	0	0	0	0	0	47	0	
Striated Pardalote	*Pardalotus striatus*	0	0	0	0	1	0	0	9	
Striped Honeyeater	*Plectorhyncha lanceolata*	0	0	0	0	2	0	0	0	
Superb Fairy-wren	*Malurus cyaneus*	0	0	0	0	4	0	0	0	
Swamp Harrier	*Circus approximans*	0	2	3	0	0	0	0	0	
Tree Martin	*Petrochelidon nigricans*	0	0	0	0	0	100	0	25	

Proportion of lake inundated		80%	70%	100%	60%	Unknown	Unknown	Unknown	100%	
Source		EWMP	EWMP	EWMP	EWMP	WetMap	WetMap	WetMap	Birdata	
Common name	Scientific name	2012	2013	2014	2015	2018	2019	2023 wetmap	2023 birdata	FFG Act Status
Variegated Fairy-wren	*Malurus lamberti*	0	0	0	0	1	0	0	5	
Weebill	*Smicrornis brevirostris*	0	0	0	0	10	0	0	10	
Welcome Swallow	*Hirundo neoxena*	0	0	0	0	0	405	0	4	
Whiskered Tern	*Chlidonias hybrida*	0	0	0	0	33	0	0	0	
Whistling Kite	*Haliastur sphenurus*	0	0	11	0	0	46	0	2	
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	0	0	0	0	0	3	0	3	Endangered
White-browed Babbler	*Pomatostomus superciliosus*	0	0	0	0	0	0	0	7	
White-faced Heron	*Egretta novaehollandiae*	0	2	7	4	0	0	0	6	
White-fronted Chat	*Epthianura albifrons*	0	0	0	0	15	0	0	0	
White-necked Heron	*Ardea pacifica*	0	1	0	0	0	0	46	0	
White-plumed Honeyeater	*Ptilotula penicillata*	0	0	0	0	5	0	0	11	
White-winged Fairy-wren	*Malurus leucopterus*	0	0	0	0	2	0	0	2	
Willie Wagtail	*Rhipidura leucophrys*	0	0	0	0	0	0	0	15	
Yellow-billed Spoonbill	*Platalea flavipes*	0	0	0	4	0	16	0	0	
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	0	0	0	0	0	0	0	13	
Yellow-throated Miner	*Manorina flavigula*	0	0	0	0	1	0	0	9	

APPENDIX 6. WETMAP BIRD COUNTS AT LITTLE HEYWOOD LAKE

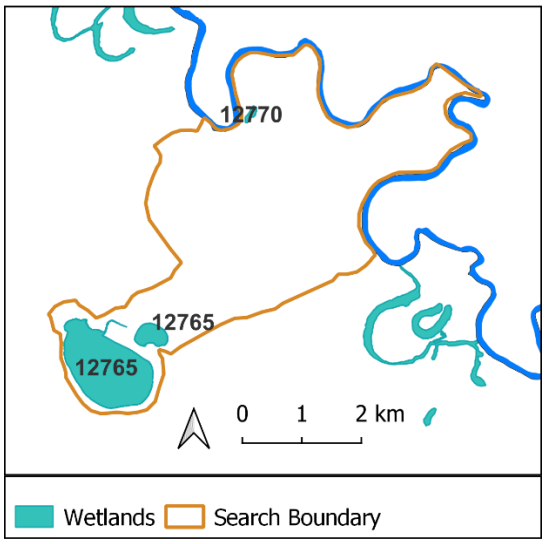
Scientific Name	Common Name	Waterbird count in survey year	
		2022	2023
Acanthiza chrysorrhoa	Yellow-rumped Thornbill	10	0
Acanthiza uropygialis	Chestnut-rumped Thornbill	100	0
Aphelocephala leucopsis	Southern Whiteface	1	0
Ardea pacifica	White-necked Heron	0	13
Barnardius zonarius barnardi	Mallee Ringneck	7	0
Colluricincla harmonica	Grey Shrike-thrush	1	0
Cracticus torquatus	Grey Butcherbird	1	0
Gavicalis virescens	Singing Honeyeater	5	0
Gymnorhina tibicen	Australian Magpie	4	0
Malurus cyaneus	Superb Fairy-wren	4	0
Nycticorax caledonicus	Nankeen Night Heron	0	27
Pachycephala rufiventris	Rufous Whistler	2	0
Phaps chalcoptera	Common Bronzewing	2	0
Ptilotula penicillata	White-plumed Honeyeater	4	0
Smicrornis brevirostris	Weebill	5	0
Threskiornis spinicollis	Straw-necked Ibis	80	0

Source: Wetland Monitoring and Assessment Program (WetMAP) – Arthur Rylah Institute, accessed 28 Nov 2023

APPENDIX 7.

FLORA SPECIES LIST

A Heywood Lake flora species list was generated through combining results of a NatureKit (DEECA 2024) Victorian Biodiversity Atlas observation search using the input boundary below, with results of a WetMAP flora survey (WetMAP 2024) conducted at Little Heywood Lake.



Scientific Name	Common Name	FFG Act Status	EPBC Act Status
Abutilon theophrasti	Chingma Lantern*		
Acacia oswaldii	Umbrella Wattle	Critically Endangered	
Acacia stenophylla	River Coobah		
Actinobole uliginosum	Flannel Cudweed		
Alectryon oleifolius subsp. canescens	Cattle Bush		
Alternanthera denticulata s.s.	Lesser Joyweed		
Alternanthera nodiflora	Common Joyweed		
Amaranthus grandiflorus	Large-flower Amaranth		
Amyema miquelii	Box Mistletoe		
Arabidella nasturtium	Yellow Cress		
Arctotheca calendula	Cape weed*		
Asparagus asparagoides	Bridal Creeper*		
Atriplex eardleyae	Small Saltbush		
Atriplex leptocarpa	Slender-fruit Saltbush		
Atriplex lindleyi	Flat-top Saltbush		
Atriplex lindleyi subsp. inflata	Corky Saltbush		
Atriplex lindleyi subsp. lindleyi	Flat-top Saltbush		
Atriplex nummularia	Old-man Saltbush		
Atriplex prostrata	Hastate Orache*		
Atriplex semibaccata	Berry Saltbush		

Scientific Name	Common Name	FFG Act Status	EPBC Act Status
Atriplex suberecta	Sprawling Saltbush^		
Austrobryonia micrantha	Mallee Cucumber	Endangered	
Austrostipa scabra subsp. falcata	Rough Spear-grass		
Brachyscome ciliaris var. ciliaris	Variable Daisy		
Brachyscome lineariloba	Hard-head Daisy		
Bryophytes/Lichens	Bryophytes/Lichens		
Bulbine alata	Desert Leek-lily		
Bulbine semibarbata	Leek Lily		
Calandrinia eremaea	Small Purslane		
Calotis hispidula	Hairy Burr-daisy		
Carex inversa	Knob Sedge^		
Centipeda crateriformis subsp. crateriformis	Lagoon Sneezeweed		
Centipeda cunninghamii	Common Sneezeweed		
Centipeda minima subsp. minima s.s.	Spreading Sneezeweed		
Centipeda spp.	Sneezeweed		
Chenopodiaceae spp.	Chenopod		
Chenopodium album	Fat Hen*		
Chenopodium curvispicatum	Cottony Saltbush		
Chenopodium desertorum subsp. microphyllum	Small-leaf Goosefoot		
Chenopodium nitrariaceum	Nitre Goosefoot		
Chenopodium sp.	Goosefoot*		
Chondrilla juncea	Skeleton Weed*		
Cirsium vulgare	Spear Thistle*		
Convolvulus erubescens s.l.	Pink Bindweed		
Convolvulus remotus	Grass Bindweed		
Convolvulus wimmerensis	Wimmera Bindweed		
Cotula australis	Common Cotula		
Cotula bipinnata	Ferny Cotula*		
Crassula colorata	Dense Crassula		
Crassula sieberiana s.l.	Sieber Crassula		
Crassula sieberiana s.s.	Sieber Crassula		
Cullen cinereum	Hoary Scurf-pea	Endangered	
Cuscuta campestris	Field Dodder*		
Dodonaea viscosa subsp. cuneata	Wedge-leaf Hop-bush		
Duma florulenta	Tangled Lignum		
Duma horrida subsp. horrida	Spiny Lignum	Critically Endangered	
Duma spp.	Lignum		
Dysphania pumilio	Clammy Goosefoot^		
Echinochloa microstachya	Prickly Barnyard-grass*		
Einadia nutans	Nodding Saltbush		

Scientific Name	Common Name	FFG Act Status	EPBC Act Status
Einadia nutans subsp. nutans (s.s.)	Nodding Saltbush		
Enchylaena tomentosa var. tomentosa	Ruby Saltbush		
Enteropogon acicularis	Spider Grass		
Epilobium billardiereanum	Variable Willow-herb		
Epilobium hirtigerum	Hairy Willow-herb		
Eragrostis australasica	Cane Grass	Critically Endangered	
Eragrostis dielsii	Mallee Love-grass		
Eragrostis setifolia	Bristly Love-grass		
Erigeron bonariensis	Flaxleaf Fleabane*		
Erigeron sp.	Fleabane*		
Erodium sp.	Heron's Bill*		
Eucalyptus largiflorens	Black Box		
Eucalyptus microcarpa	Grey Box		
Euphorbia drummondii s.l.	Flat Spurge^		
Exocarpos sparteus	Broom Ballart		
Geococcus pusillus	Earth Cress		
Glinus lotoides	Hairy Carpet-weed		
Glycyrrhiza acanthocarpa	Southern Liquorice		
Hakea leucoptera subsp. leucoptera	Silver Needlewood		
Heliotropium curassavicum	Smooth Heliotrope		
Heliotropium europaeum	Common Heliotrope*		
Heliotropium supinum	Creeping Heliotrope*		
Hordeum leporinum	Barley Grass*		
Hordeum spp.	Barley Grass*		
Hypochaeris radicata	Flatweed*		
Juncus amabilis	Hollow Rush		
Lachnagrostis filiformis s.s.	Common Blown-grass		
Lactuca serriola	Prickly Lettuce*		
Laphangium luteoalbum	Jersey Cudweed		
Liliaceae sp. (sensu lato)	Lily		
Lolium rigidum	Wimmera Rye-grass*		
Maireana brevifolia	Short-leaf Bluebush		
Maireana decalvans s.s.	Black Cotton-bush		
Maireana turbinata	Satiny Bluebush		
Malva parviflora	Small-flower Mallow*		
Malva preissiana s.l.	Australian Hollyhock		
Medicago minima	Little Medic*		
Medicago polymorpha	Burr Medic*		
Medicago spp.	Medic*		
Melaleuca lanceolata	Moonah		
Mesembryanthemum nodiflorum	Small Ice-plant*		

Scientific Name	Common Name	FFG Act Status	EPBC Act Status
Mesembryanthemum spp.	Ice Plant*		
Myriophyllum verrucosum	Red Water-milfoil		
Nicotiana glauca	Tree Tobacco*		
Nicotiana velutina	Velvet Tobacco		
Oxalis perennans	Grassland Wood-sorrel		
Paspalidium constrictum	Knottybutt Grass		
Persicaria lapathifolia	Pale Knotweed^		
Persicaria prostrata	Creeping Knotweed		
Pittosporum angustifolium	Weeping Pittosporum		
Plagiobothrys elachanthus	Hairy Forget-me-not		
Plantago cunninghamii	Clay Plantain		
Poa fordeana	Forde Poa		
Polycalymma stuartii	Poached-eggs Daisy		
Polycarpon tetraphyllum	Four-leaved Allseed*		
Polygonum aviculare s.s.	Hogweed*		
Polygonum plebeium	Small Knotweed		
Rhagodia spinescens	Hedge Saltbush^		
Riccia spp.	Crystalwort		
Rorippa palustris	Marsh Yellow-cress*		
Rumex brownii	Slender Dock		
Rumex tenax	Narrow-leaf Dock		
Rytidosperma caespitosum	Common Wallaby-grass		
Rytidosperma setaceum var. setaceum	Bristly Wallaby-grass		
Salsola tragus	Prickly Saltwort		
Salsola tragus subsp. tragus	Prickly Saltwort		
Sclerolaena diacantha	Grey Copperburr		
Sclerolaena muricata var. muricata	Black Roly-poly		
Sclerolaena muricata var. villosa	Grey Roly-poly		
Sclerolaena obliquicuspis	Limestone Copperburr		
Sclerolaena stelligera	Star Bluebush		
Sclerolaena tricuspis	Streaked Copperburr		
Senecio cunninghamii var. cunninghamii	Branching Groundsel	Endangered	
Senecio glossanthus s.l.	Slender Groundsel		
Senecio quadridentatus	Cotton Fireweed		
Senecio runcinifolius	Tall Fireweed		
Senna artemisioides subsp. coriacea	Broad-leaf Desert Cassia		
Sida corrugata	Variable Sida		
Sida intricata	Twiggy Sida	Endangered	
Silene apetala var. apetala	Mallee Catchfly*		
Sisymbrium erysimoides	Smooth Mustard*		
Solanum esuriale	Quena		

Scientific Name	Common Name	FFG Act Status	EPBC Act Status
Solanum nigrum s.s.	Black Nightshade*		
Solanum simile	Oondoroo		
Solanum spp.	Nightshade		
Sonchus asper s.l.	Rough Sow-thistle*		
Sonchus asper subsp. asper	Rough Sow-thistle*		
Sonchus oleraceus	Common Sow-thistle*		
Spergularia rubra s.l.	Red Sand-spurrey*		
Spergularia sp.	Sand Spurrey		
Sporobolus mitchellii	Rat-tail Couch		
Stelligera endecaspinis	Star Bluebush		
Stemodia florulenta	Blue Rod		
Stemodia glabella s.l.	Blue Rod		
Symphyotrichum subulatum	Aster-weed*		
Tetragonia moorei	Annual Spinach		
Teucrium racemosum s.s.	Grey Germander		
Tribulus terrestris	Caltrop		
Triglochin isingiana	Spurred Arrowgrass		
Verbena supina	Trailing Verbena*		
Verbena supina var. supina	Trailing Verbena*		
Vicia sp.	Vetch*		
Vittadinia cervicularis	Annual New Holland Daisy		
Vittadinia dissecta var. hirta	Dissected New Holland Daisy		
Vulpia myuros f. myuros	Rat's-tail Fescue*		
Vulpia spp.	Fescue*		
Xanthium occidentale	Noogoora Burr*		

* indicates introduced species

^ indicates native, but some stands may be alien.

Naturekit DEECA 2023b, WetMAP 2024 (Vegetation, little Heywood Lake)

APPENDIX 8. Assessing risk

Assessing Risk - Consequence

Prioritising wetland watering is often difficult because there is no framework by which the fate of different species can be compared. To support prioritization, this guide seeks to put each wetland and its associated species within a regional context. The process can also be used when communicating the rationale behind decisions or support engagement by providing a framework for discussion.

The process is presented in Figure A1, with a more detailed explanation provided in Tables A1 and A2.

Table A1.

Row	Question	Rationale	Response	Risk	Go To
1	Will the species persist *in situ*?	If the species will survive without intervention, it becomes a lower priority	Yes	Low	
			No		Row 2
2	Will the species persist in a connected refuge?	If the species has the capacity (its own capability and appropriate connectivity) to survive, it becomes a lower priority	Yes		Table A2
			No		Row 3
3	Is the species common?	If a species is common then there may be other populations that are more likely or easier to protect than the ones in the wetland.	Yes	Med	
			No	High	

Table A2.

Row	Question	Rationale	Response	Risk	Go To
1	Is the species short or long lived?	Long-lived species often have greater capacity to endure periods of hardship, whereas short lived species are programmed to die.	Long	Med	
			Short		Row 2
2	Does the species need the wetland to recruit?	If the species requires the wetland to recruit then sustaining will require protection of wetland condition.	No	Med	
			Yes		Row 3
3	Is the species common?	If a species is common then there may be other populations that are more likely or easier to protect than the ones in the wetland.	Yes	Mod	
			No	High	

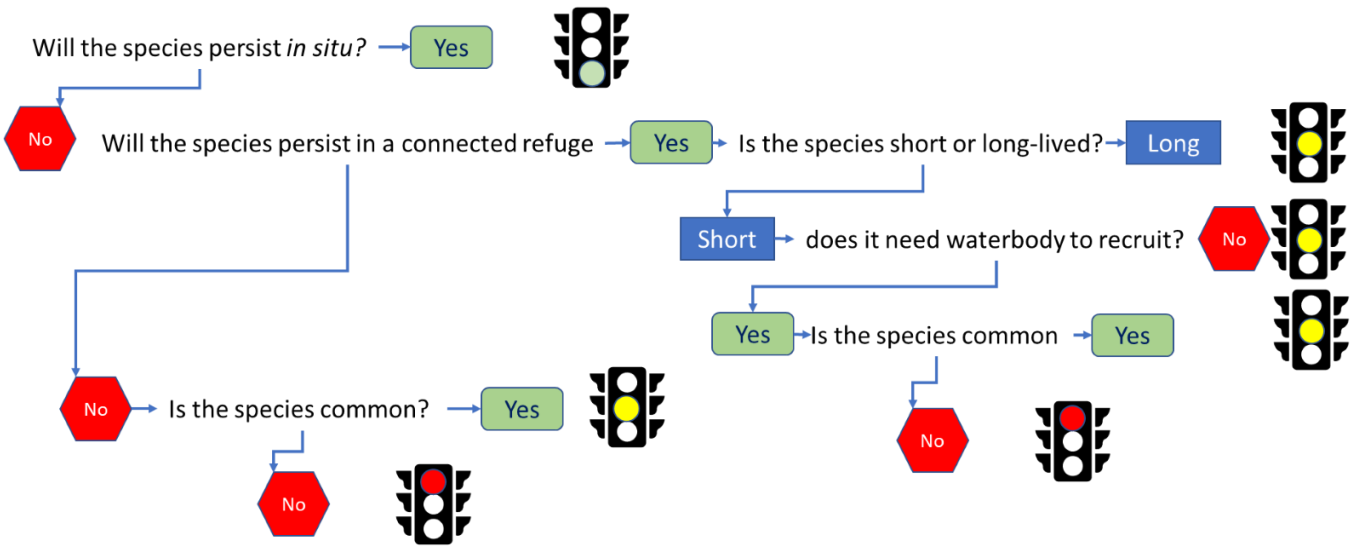


Figure A1 – Decision tree for assessing risk

APPENDIX 9.

EWMP UPDATED ENVIRONMENTAL OBJECTIVES, FURTHER INFORMATION (FROM BUTCHER ET AL. 2020)

5.9 Heywood's Lake

5.9.1 SMARTness and rationalisation

Site-specific environmental objectives for the Heywood's Lake EWMP (Riverness 2015a).

EWMP objectives
HeL1: Maintain Black Box Woodland diversity and productivity (EVCs 103 and 813)
HeL2: Promote diverse aquatic macrophyte zones
HeL3: Provide open water habitat to encourage diversity and abundance of deep water foraging and piscivorous waterbirds

EWMP objectives
HeL4: Provide shallow water habitat that supports foraging, nesting and recruitment of dabbling ducks and large and small waders
HeL5: Encourage a productive aquatic ecosystem through the release of nutrients and organic matter from the sediments and decomposition of inundated terrestrial vegetation through inundation of the wetlands following a dry phase

Assessment of SMARTness of current Heywood's Lake EWMP objectives. Scoring: 1 is criterion met, 0 is criterion not met, and 0.5 is partially met

	Specific		Measurable			Achievable		Relevant		Timely	
Objective	Magnitude clearly specified	Location and scale detailed	Indicators available or easily developed	Can be analysed using accepted statistical practices	Capacity to collect data exists	Under river operating constraints and current climate variability	Considered feasible by knowledgeable stakeholders	Matters driven by environmental watering and/or works and measures	Linked to BP objectives	Absolute date or time period specified	Considers likely lags in response
HeL1	0	0	1	1	1	0.5	1	1	1	0	0
HeL2	0	0	1	1	1	0.5	1	1	1	0	0
HeL3	0	0	1	1	1	0.5	1	1	1	0	0
HeL4	0	0	1	1	1	0.5	1	1	1	0	0
HeL5	0	0	1	0.5	1	0.5	1	1	1	0	0

Rationalised environmental objectives for the Heywood's EWMP (Riverness 2015).

Objective	Issue	Outcome
HeL1	Incudes multiple aspects of biodiversity (diversity) and function (productivity) Options are to split or consolidate to a measure of condition.	Rationalised to align with LTWP objectives – change to be about condition with the assumption that if condition is improved this incorporates diversity and productivity
HeL2	No issue with objective other than its not fully SMART and no baseline data.	Objective updated to align with Basin Plan language.
HeL3	No issue with objective other than its not fully SMART and no baseline data	Objective updated to align with Basin Plan language.
HeL4		Split and move, Combine foraging with HeL3, separate breeding
HeL5	Not considered viable at the asset by MCMA. Productivity objectives were included in EWMPs as a fundamental ecological function; however this is not a specific value of the site and water is not delivered solely for productivity outcomes at this wetland; it will be an outcome achieved by the delivery of water for the other objectives at the asset	Deleted

5.9.2 Mapping to Basin Plan

Basin Plan Schedule 8 and 9 criteria.

Schedule 8 criteria met	Schedule 9 criteria met
From DELWP (2015a)	
1: CAMBA **4:** FFG Act, EPBC act, DSE Listed **5:** Flows into the creek and wetlands of the floodplain are less frequent. 103 Riverine Chenopod Woodland – Endangered^	**1:** Supports the creation and maintenance of vital habitats and populations **2:** water quality - ecosystem processes support the transportation and dilution of nutrients, organic matter and sediment; supports the dilution of carbon and nutrients from the floodplain to the river system **4:** lateral connectivity - (between floodplains, anabranches and wetlands)
Updated assessment	
3(a)iii Vital habitat - feeding, breeding, nursery sites **3(b)** Prevents declines in native biota	**1(c):** Vital habitat - feeding, breeding, nursery sites

^ Mapping PEA criteria 5 to EVC is not appropriate

Mapping Heywood's Lake EWMP objectives to Basin Plan EWP objectives, Schedule 7 targets, BWS QEEO, and LTWP Vic Murray objective.

EWMP objectives	Relevant Basin Plan EWP objective	Relevant Schedule 7 target	Relevant BWS QEEO	LTWP objective
HeL1: Maintain Black Box Woodland diversity and productivity (EVCs 103 and 813)	8.05,3(b) 8.06,6(b)	Condition of priority asset - prevention of decline in native biota Condition of native water dependent vegetation Condition of priority ecosystem functions - creation of vital habitat - habitat for prevention of decline in native species	B2.8	LTWPVM6
HeL2: Promote diverse aquatic macrophyte zones	8.05,3(b) 8.06,6(b)	Condition of priority asset - prevention of decline in native biota Diversity of native water dependent vegetation Condition of priority ecosystem functions - creation of vital habitat - habitat for prevention of decline in native species	B2.11	LTWPVM2
HeL3: Provide open water habitat to encourage diversity and abundance of deep water foraging and piscivorous waterbirds	8.05,3(b)	Condition of priority asset - Vital habitat - feeding, breeding, nursery	B3.2	LTWPVM12 LTWPVM13
HeL4: Provide shallow water habitat that supports foraging, nesting and recruitment of dabbling ducks and large and small waders	8.05,3(b)	Condition of priority asset - Vital habitat - feeding, breeding, nursery	B3.2	LTWPVM12 LTWPVM13
HeL5: Encourage a productive aquatic ecosystem through the release of nutrients and organic matter from the sediments and decomposition of inundated terrestrial vegetation through inundation of the wetlands following a dry phase	8.06,7	Condition of priority ecosystem functions – connectivity – off-stream productivity	None specified	None specified

5.9.3 Updated objectives for Heywood's Lake

Current objective	HeL1: Maintain Black Box Woodland diversity and productivity (EVCs 103 and 813)
Comments	Rationalised to align with LTWP objectives – change to be about condition with the assumption that if condition is improved this incorporates diversity and productivity

EWP objective(s)	8.05,3(b)
Schedule 7 targets	Condition of priority asset - prevention of decline in native biota Condition of native water dependent vegetation Condition of water-dependent vegetation
PEA/PEF criteria met	PEA 3(b) Prevents declines in native biota
BEWS QEEO	B2.8 By 2024 improve condition of Black Box and river red gum
LTWP objective	LTWPVM6 Improve the condition of Black Box dominated EVCs
LTWP target	A positive trend in the condition score of Black Box dominated EVC benchmarks at 50% of sites over the 10 year period to 2025
2020 Objective:	By 2030, improve condition and maintain extent from baseline (2006) levels of Black Box (*Eucalyptus largiflorens*) to sustain communities and processes reliant of such communities at Heywood's Lake and Little Heywood's Lake
2020 Targets:	A positive trend in the condition score of Black Box dominated EVC benchmarks at 50% of sites over the 10 year period. OR By 2030, at stressed sites (see Wallace et al. 2020): in standardised transects that span the floodplain elevation gradient and existing spatial distribution,≥70% of viable trees will have a Tree Condition Index Score (TCI) ≥ 10. Baseline condition of Black Box trees needs to be established to ensure TCI good is achievable - may need to rewrite target and adaptively manage this as condition improves.

Current objective	HeL2: Promote diverse aquatic macrophyte zones
Comments	Adopted WRIGs developed by DELWP. Some species need to be identified as currently not all aquatic WRIGs represented in the flora lists in the EWMP.
EWP objective(s)	8.05,3(b) 8.06,6(b)
Schedule 7 targets	Condition of priority asset - prevention of decline in native biota Diversity of native water dependent vegetation Condition of priority ecosystem functions - creation of vital habitat - habitat for prevention of decline in native species
PEA/PEF criteria met	PEA 3(b) Prevents declines in native biota PEF 1(e) Vital habitat - preventing decline of native biota
BWS QEEO	B2.11 To maintain the current extent of non-woody vegetation
LTWP objective	LTWPVM2 Improve the species richness of aquatic vegetation in wetlands
LTWP target	None specified for non-woody vegetation
2020 Objective:	By 2030, improve vital habitat at Heywood's Lake by increasing the diversity of aquatic macrophytes present across a range of Water Regime

	Indicators Groups.
2020 Targets:	By 2030, increase diversity of native of aquatic macrophytes at Heywood's Lake with ≥2 species from each of the following Water Regime Indicator Groups present in 80% of years: • Aquatic (small floating) (Asf) (no species recorded) • Aquatic (obligate submerged) (Aos) (no species recorded) • Aquatic (submerged to partially emergent) (Ase) (no species recorded) • Aquatic graminoids (persistent) (Agp) (no species recorded) • Aquatic to semi-aquatic (persistent) (Asp) (no species recorded) • Seasonally immersed – low growing (Slg) (Blue Rod *Stemodia florulenta*) • Seasonally inundated – emergent non woody (Sen) (no species recorded) Target not measurable at present a no macrophytes listed in EWMP that align to WRIGs

Current objective	**HeL3: Provide open water habitat to encourage diversity and abundance of deep water foraging and piscivorous waterbirds**
Comments	
EWP objective(s)	8.05,3(b)
Schedule 7 targets	Condition of priority asset - Vital habitat - feeding, breeding, nursery
PEA/PEF criteria met	PEA 3(a) iii Vital habitat - feeding, breeding, nursery sites PEF 1 (c) Vital habitat - feeding, breeding, nursery sites
BEWS QEEO	B3.2 A significant improvement in waterbird populations in the order of 20 to 25% over the baseline scenario, with increases in all waterbird functional groups
LTWP objective	LTWPVM12: Improve habitat for waterbirds LTWPVM13: Improve feeding areas for waterbirds
LTWP target	Appropriate water regime to support feeding and habitat areas for guilds of waterbirds delivered at 50% of sites, 8 years in 10
2020 Objective:	By 2030, maintain representative populations of shallow-water and deep-water feeding guilds of waterbird (F2 and F3, respectively, after Jaensch 2002) at Heywood's Lake, by maintaining a mixture of shallow and deep-water habitats.
2020 Targets:	By 2030, 80% of representative F2 and F3 species recorded at Heywood's Lake in 8 years out of any 10-year period where conditions are suitable. • Representative F2 species include: Australian Wood Duck (*Chenonetta jubata*), Australasian Grebe (*Tachybaptus novaehollandiae*), Pacific Black Duck (*Anas superciliosa*), White-faced Heron (*Egretta novaehollandiae*), and Yellow-billed Spoonbill (*Platalea flavipes*). • Representative F3 species include: Australian Darter (*Anhinga novaehollandiae*), Little Pied Cormorant (*Microcarbo melanoleucos*), Pied Cormorant (*Phalacrocorax varius*)

	• Feeding habitat defined as a mixture of deep feeding areas (water >1 m) and shallow feeding areas (<0.5 m depth and or drying mud) with intermittent inundation of densely vegetated shrublands (flooding of lignum habitat for 5-6 months every 2 years on average).

Current objective	HeL4: Provide shallow water habitat that supports foraging, nesting and recruitment of dabbling ducks and large and small waders
Comments	Combined feeding element with HeL3
EWP objective(s)	8.06,6(b)
Schedule 7 targets	Recruitment and populations of native water-dependent birds
PEA/PEF criteria met	PEA 3(a) iii Vital habitat - feeding, breeding, nursery sites PEF 1 (c) Vital habitat - feeding, breeding, nursery sites
BEWS QEEO	B3.4 Breeding abundance (nests and broods) for all of the other functional groups to increase by 30-40% compared to the baseline scenario, especially in locations where the Basin Plan improves over bank flows
LTWP objective	LTWPVM11: Improve breeding opportunities for waterbirds
LTWP target	No targets specified for non-colonial breeding species
2020 Objective:	By 2030, maintain nesting and recruitment of non-colonial waterbirds (N1, N2, N3 and N4, after Jaensch 2002) at Heywood's Lake and Little Heywood's Lake, by maintaining a mixture of tree, low vegetation/shrubs, and ground/islet nesting habitat.
2020 Targets:	There is a lack of data on species that breed at the site. The expectation is that the list of species commonly nesting at Heywood's Lake will be confirmed over time. By 2030, at least two of the following species to be recorded as nesting and/or breeding at Heywood's Lake and Little Heywood's Lake in 7 out of any 10-year period in which nesting/breeding conditions are suitable: • Representative N1 and N2 species include: White-bellied Sea Eagle (*Haliaeetus leucogaster*), • Representative N3 and N4 species include: Australasian Grebe (*Tachybaptus novaehollandiae*), Masked Lapwing (*Vanellus miles*), Pacific Black Duck (*Anas supercilliosa*)

Current objective	HeL5: Encourage a productive aquatic ecosystem through the release of nutrients and organic matter from the sediments and decomposition of inundated terrestrial vegetation through inundation of the wetlands following a dry phase
Comments	Deleted

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