Environmental Water Management Plan

Photo: Bottle Bend Floodplain
Bottle Bend

Bottle Bend

mallee
catchment management authority

Version Number	Description	Issued To	Issue Date
1.	Working draft	S. Bates (Mallee CMA)	17/11/2014
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4.	Submission of draft to DELWP	S. Watson (DELWP)	01/06/2015
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6.	Submission of final	S. Saris (Mallee CMA)	02/11/2016
7.	Updated ecological objectives – Water's Edge Consulting	D. Wood (Mallee CMA)	16/12/2020
8.	Whole EWMP review and update to align with latest DEECA Guidelines 2022	Mallee CMA	30/06/2025

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

AHD	Australian Height Datum
AM	Adaptive Management
ANAE	Australian National Aquatic Ecosystem
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)
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
LTWMP	Long-Term Watering Plan
MDBA	Murray-Darling Basin Authority
LTWP	Long Term Watering Plan
RAP	Registered Aboriginal Party
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
WEL	Watering Event Lessons
WMU	Waterway Management Unit

Executive Summary

Environmental Water Management Plans (EWMPs) have been developed for key sites in the Mallee region. The Mallee Waterway Strategy 2014-22 (Mallee CMA, 2014) identified 23 Waterway Management Units (WMU) from 216 targeted waterways in the Mallee. The interconnectedness and commonality of threats impacting on the waterway values were used to group the WMUs into planning units. This EWMP has been developed for Bottle Bend, a sub-unit of the Karadoc WMU, hereafter referred to as Bottle Bend. The EWMP will help to guide future environmental watering activities for this area.

Bottle Bend is located in the Robinvale Plains bioregion within the Mallee CMA region 15 km south-east of Mildura and covers 1487.23 ha.

Environmental values for Bottle Bend include a diverse range of water dependant flora and fauna species including some listed under state, national and international treaties, conventions, Acts and initiatives including the Regent Parrot and Eastern Great Egret. Bottle Bend has significant social values for the local community and the local indigenous community has strong connections to the area.

Some wetlands within Bottle Bend are used as irrigation drainage disposal basins, which has led to extensive reed growth at Bottle Bend. The Mallee CMA recognises irrigation drainage will be one of the uses for the site going forward and understands that any ecological and hydrological objectives recommended herein should acknowledge this use. Wetland areas that are either an irrigation drainage basin or are on private land are excluded from the target area for this EWMP.

Bottle Bend covers a series of ten wetlands, however only the northern wetlands are included in the target area for this EWMP.

The long-term management goal of Bottle Bend EWMP is:

The target area of Bottle Bend will be managed to maintain the condition of fringing Riverine Chenopod Woodland and provide seasonal habitat for waterfowl, wading birds and frogs.

To achieve this, ecological and hydrological objectives have been developed to sustain the ecological components of the target area. The ecological objectives for Bottle Bend target area are to:

BB1a: By 2030, maintain representative populations of shallow-water and deep-water feeding guilds of waterbird (F2 and F3, respectively, after Jaensch 2002) at the Bottle Bend asset, by maintaining a mixture of shallow and deep-water habitats.

BB1b: By 2030, maintain nesting and recruitment of non-colonial waterbirds (N1, N2, N3 and N4, after Jaensch 2002) at the Bottle Bend asset, by maintaining a mixture of tree, low vegetation/shrubs, and ground/islet nesting habitat.

BB2: By 2030, improve vital habitat at the Bottle Bend asset by increasing the diversity of aquatic macrophytes present across a range of Water Regime Indicators Groups.

BB3: By 2030, protect and restore biodiversity by maintaining representative populations of frogs at the Bottle Bend asset.

BB4: 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 the Bottle Bend asset.

The optimal water regime for Bottle Bend Wetland Complex is provided below.

Fill wetland #11380 to 35.9m AHD every year in late spring to inundate littoral zone, allow water to recede naturally, gradually exposing the littoral zone and mudflats.

In every third year, fill the northern wetlands to 36.5m AHD late winter/spring to inundate surrounding Riverine Chenopod Woodland vegetation, allow water to recede naturally, gradually exposing the littoral zone and mudflats.

Minor infrastructure requirements are required at Bottle Bend to allow inundation of the target area.

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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 Bottle Bend.

The Bottle Bend EWMP was first developed in 2016 and ecological objectives updated in 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 following:

- 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 relevance to Bottle Bend 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
China-Australia Migratory Bird Agreement (CAMBA)	International agreement administered under the federal *Environment Protection and Biodiversity Conservation Act 1999.*
Japan-Australia Migratory Bird Agreement (JAMBA)	
Environment Protection and Biodiversity Conservation Act (1999) (EPBC)	National
Flora and Fauna Guarantee Act (FFG)	State
Department of Energy, Environment and Climate Action advisory lists (DEECA)	State

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 international association for 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: © 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 Bottle Bend, 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 Bottle Bend. This ensures that all stakeholders and community members are aware of the Bottle Bend environmental watering operations.

Table 2. Stakeholder groups with an interest in environmental water at Bottle Bend

Stakeholder groups	Stakeholders	Needs and interest	IAP2 level	Consultation modes
Public land/water managers	Parks Victoria	Managing impacts from watering such as access, State-level environmental management	Collaborate	Monthly meetings
	Mallee CMA	N/A	N/A	N/A
	Department of Energy, Environment and Climate Action (DEECA)	State level environmental management planning, land manager, threatened species manager	Collaborate	Monthly meetings
River operators	Goulburn Murray Water	Manage water storage	Collaborate	Formal meetings
Water Corporation	Lower Murray Water	Pump site register and drainage management	Collaborate	Formal meetings
Local government	Mildura Rural City Council	Access during watering events	Involve	Meetings, phone calls, correspondence.
First Nations People	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
	Commonwealth Environmental Water Holder	Decision-making around annual environmental water usage.	Collaborate	Formal meetings
Private landholders	Local landholders	Managing impacts from watering such as access. Provides assistance in planning and implementation of programs.	Collaborate	Directly affected landholders will be informed of watering proposals and asked to provide feedback if relevant.
Community representatives	• Birdwatchers (Mildura Birdlife) • General community	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 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
- Presentation at the Biodiversity-Water Catchment Partnership Committee
- In-person engagement event at local events such as markets and environmental group meetings
- Social media platforms

2.2.1 Verifying asset values

Asset values at Bottle Bend 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 Bottle Bend and floodplain ecosystems. This work has been central to providing a basis for local knowledge and expertise.

Combined with the Murray Wetlands 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.

Following seasonal review, 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 EWMP update community stakeholders were engaged in-person during local events such as the Red Cliffs Market and local community and environmental group events. This engagement included a 'Pins in Maps' activity, where the community provided information on uses and values at specific locations at the site.

This engagement supplements earlier community engagement about the Bottle Bend EWMP, and annual community engagement that informs the Seasonal Watering Proposal (SWP). Community consultation occurs at the IAPs 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 First People of the Millewa Mallee Aboriginal Corporation (FPMMAC) in person in October 2024. Through this engagement activity, Traditional Owner stakeholders were asked to identify the values/uses at specific sites by placing pins on a map where they occurred. Information from this consultation has informed cultural site uses and values incorporated into this EWMP. In-line with EWMP guideline, 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 Bottle Bend subunit of the Karadoc WMU, hereafter referred to as Bottle Bend. Bottle Bend is located in the Karadoc WMU, 15km south-east Mildura on the River Murray Floodplain (Figure 2). To the immediate southeast is Karadoc Swamp (covered by the Karadoc Swamp EWMP). Northwest of Bottle Bend is Kings Billabong of the Nichols Point WMU (covered by the Kings Billabong EWMP).

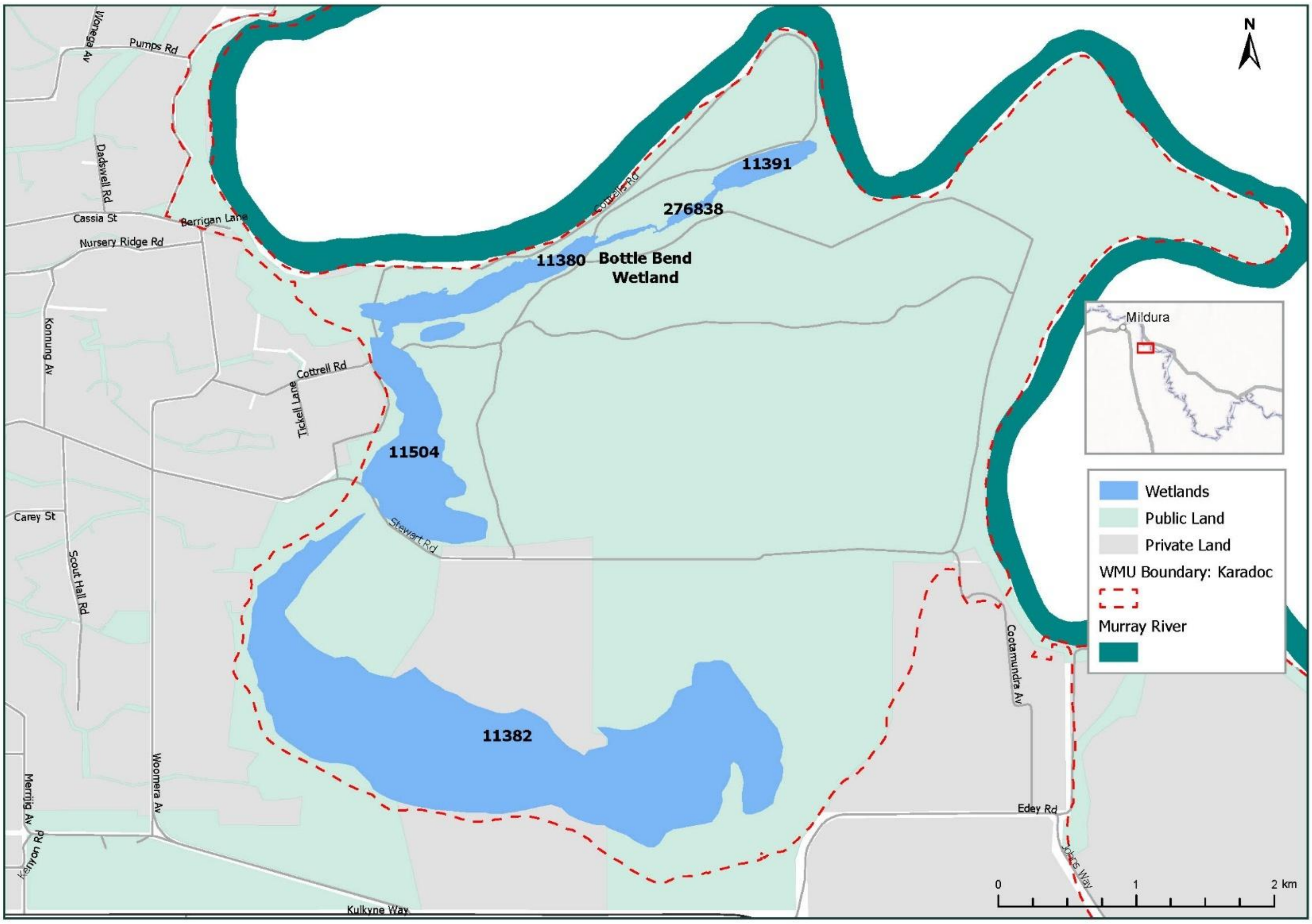


Figure 2. Bottle Bend wetlands overview located within the Bottle Bend

The figure above shows an overview of the wetlands located within the Bottle Bend sub-unit. Throughout this EWMP, wetlands #11380, #276838 and #11391 are collectively known as the northern wetlands. Wetland #11504 is known as central wetland and #11382 is known as the southern wetland.

Permanent inundation as a result of irrigation drainage to the southern wetlands (Figure 3) has created ideal conditions for flora such as Cumbungi (Typha spp.) and has led to large scale invasion of the wetlands by reed-bed vegetation, with approximately 37 ha of wetlands colonised in 2015 (Ecological Associates and Tonkin Consulting, 2016). The area colonised has shrunk from approximately 184 ha in 1992 (Bluml 1992), and 120 ha in 1997. This is likely to be due to reduced inflows from rainfall, groundwater and irrigation drainage and increased salinity (Ecological Associates and Tonkin Consulting, 2016). The irrigation drainage water from drains 10 and 8 that discharges into the southern wetlands have an average conductivity of 1,700 EC and 1,800 EC respectively (Ecological Associates and Tonkin Consulting, 2016). A combination of irrigation drainage and groundwater intrusion has led to an increase in salinity levels and degradation of local vegetation.

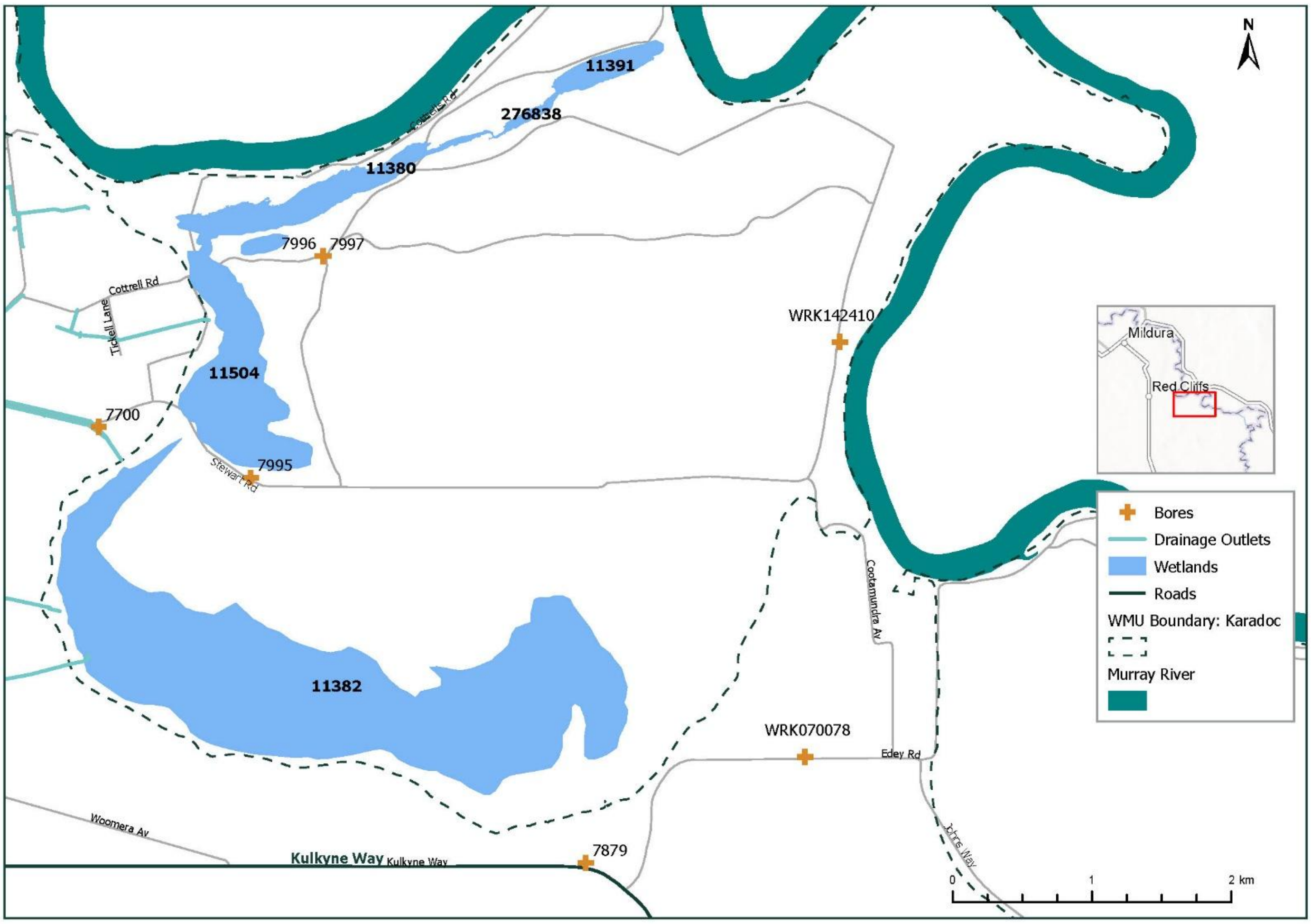


Figure 3. Bottle Bend irrigation drainage outlet points and bores in the area

3.1 CATCHMENT SETTING

Bottle Bend is located in the Robinvale Plains Bioregion within the Mallee CMA region (DEECA, 2024). The Robinvale Plains Bioregion is characterised by a narrow gorge confined by the cliffs along the Murray River, which is entrenched within older up-faulted Cainozoic sedimentary rocks. Alluvial deposits from the Cainozoic period gave rise to the red brown earths, cracking clays and texture contrast soils (Dermosols, Vertosols, Chromosols and Sodosols) this supports Riverine Grassy Forest and Riverine Grassy Chenopod Woodland ecosystems (DEPI 2011).

Bottle Bend covers 1487 hectares. The floodplain height is between 35 – 39m AHD and is bordered by the Murray River to the North and by higher land (roughly 50m AHD) to the south (Figure 2). The floodplain is located 34 km upstream of the Mildura Weir (Lock 11) which maintains a normal upstream water level of 34.4 m AHD (Ecological Associates and Tonkin Consulting, 2016).

The major stratigraphic units encountered on the floodplain within the study area, in order of increasing depth, include the Coonambidgal Clay (aquitard), Monoman Formation (floodplain aquifer), Parilla Sands (regional aquifer) and Lower Parilla Clay (aquitard).

The Coonambidgal Clay acts as an aquitard for the floodplain aquifer. The extent and thickness of the Coonambidgal Clay is likely to be a key factor on the interaction between the Bottle Bend wetlands and the underlying groundwater system and therefore the magnitude of potential salinity impacts from floodplain watering. Significant volumes of groundwater will be removed from this layer as a result of the shallow groundwater levels (<5m from surface) and higher capillary rise potential than the underlying aquifer.

The Monoman Formation is semi-confined by the Coonambidgal Clay and forms the floodplain aquifer. There is some evidence of connectivity between the Murray River floodplain and regional aquifer. The floodplain aquifer has been observed to correspond to high river flows and is variably connected to the regional aquifer, with a potential for downward flux.

The Parilla Sands form the regional aquifer occurring across both the highland and floodplain. They can be divided into upper and lower units. The regional aquifer is recharged by irrigation drainage water. Elevated groundwater levels have created a radial flow pattern away from the irrigation area, with groundwater contours suggesting a flow towards the Bottle Bend floodplain.

3.2 LAND STATUS AND MANAGAGEMENT

Bottle Bend largely consists of public land in the Murray River Park; a portion of the central floodplain and wetlands is privately owned and used for agriculture (Ecological Associates 2007b) (Figure 4).

The public land within Bottle Bend has historically been managed by the Department of Environment, Energy and Climate Change (DEECA) and its predecessors as State Forest under the Murray River Reserve (Parks Victoria 2012). The central floodplain is now incorporated into the Murray River Park as a result of the River Red Gum Forests Investigation (VEAC 2008) and is now managed by Parks Victoria. The target area falls within the Murray River Reserve.

Adjacent land to the west and south is managed for irrigated horticulture (Ecological Associates and Tonkin Consulting 2016).

Several agencies and individuals are involved in managing the land and water at Bottle Bend (Table 3). Land management boundaries are shown in Figure 4.

Table 3. Land and water managers at Bottle Bend.

Organisation	Management role
Department of Energy, Environment and Climate Action	• State level environmental management • Administer the broader water allocation and entitlements framework and the Water Act 1989 (Vic).
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 ecological 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.
Murray Darling Basin Authority	• Management and operation of the Murray River on behalf of the Basin States in accordance with the Water Act 2007 (Cth).
Victorian Environmental Water Holder	• Manager of Victoria's environmental water entitlements.
Commonwealth Environmental Water Holder	• Manager of Commonwealth environmental water entitlements
Private Landholders	• Land managers of a significant portion of the Bottle Bend WMU sub-unit.
First Nations Peoples	• Traditional Owner representation
Lower Murray Water	• Murray River operations and irrigation drainage.

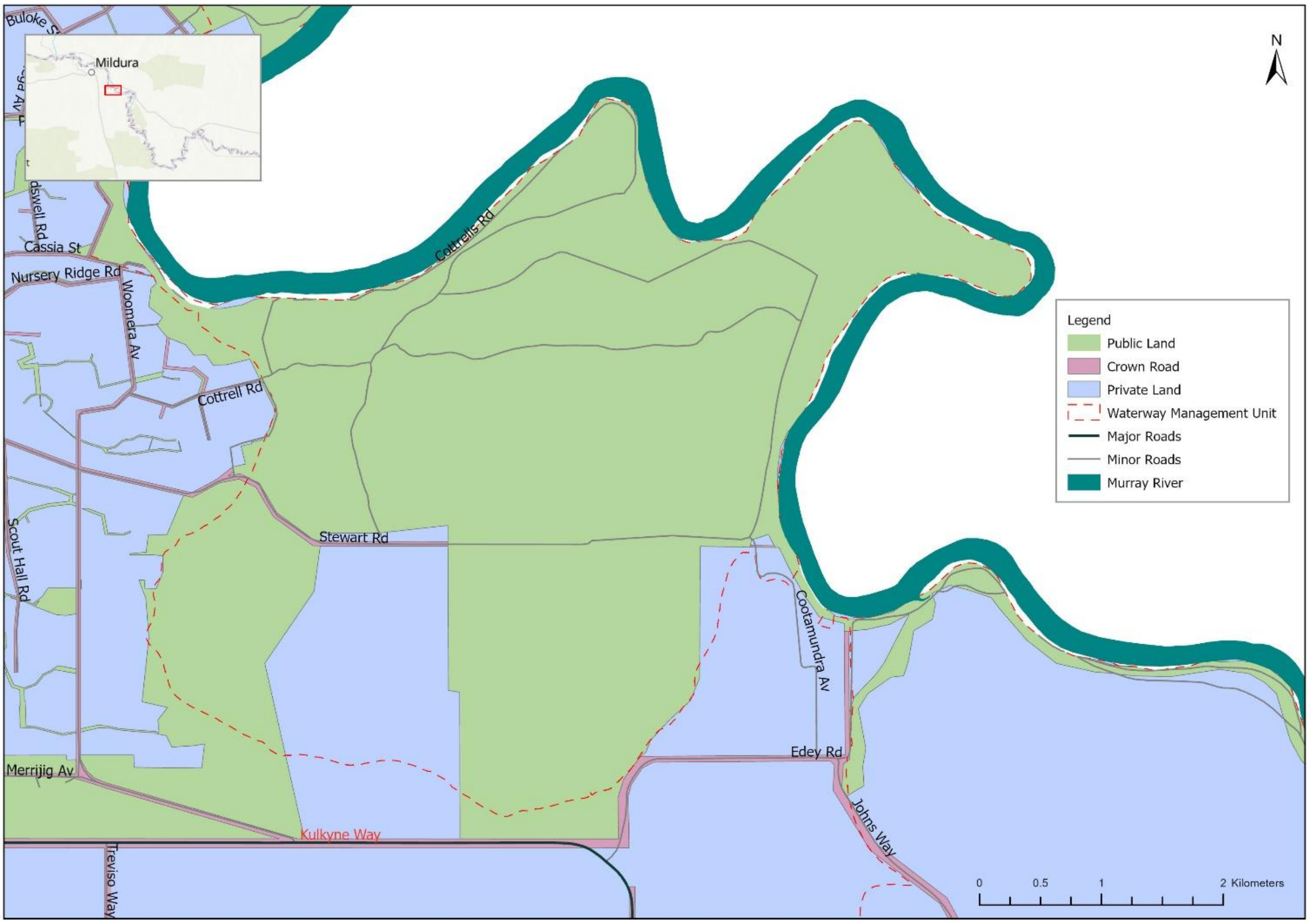


Figure 4. Bottle Bend land management boundaries

3.3 ASSET CHARACTERISTICS

The whole of Bottle Bend has a water requirement as a floodplain complex (Mallee CMA 2014). However, this EWMP focuses on the area that can be inundated through environmental watering, referred to as the target area. The target area is the maximum extent to which environmental water can be managed.

There are ten wetlands at Bottle Bend, only three of these wetlands, are in the target area for this EWMP. Wetlands not targeted in this EWMP may be considered in the future for environmental watering.

Table 4. Wetland Characteristics at Bottle Bend

Characteristics	Description
Name	Bottle Bend Wetland Complex
Mapping ID (Wetland Current layer)	Northern wetlands: 11380, 11391 & 276838
Area of wetlands in target area	Total area of WMU Sub-unit is 1487.23 ha Total area of wetlands at Bottle Bend is 395.13 ha Total of targeted wetlands is: 37.15 ha
Bioregion	Robinvale Plains
Conservation status	Vulnerable (Semi-arid Chenopod Woodland & Alluvial Plains Semi-arid Grassland); Depleted (Floodway Pond Herbland & Intermittent Swampy Woodland); Least Concern (Lignum Shrublands)
Land status	Murray River Park, Murray River Reserve, Scenic Reserve and private land
Land manager	Parks Victoria and Private Landholders
Surrounding land use	Agriculture
Water supply	Controlled irrigation drainage water release, Murray River
Wetland category (Wetland Current layer)	Shallow Freshwater Marsh - 11504 Deep Freshwater Marsh – 11391, 276868, 11382 Permanent Open Freshwater - 11380 Freshwater Meadow
Wetland depth at capacity	2.92

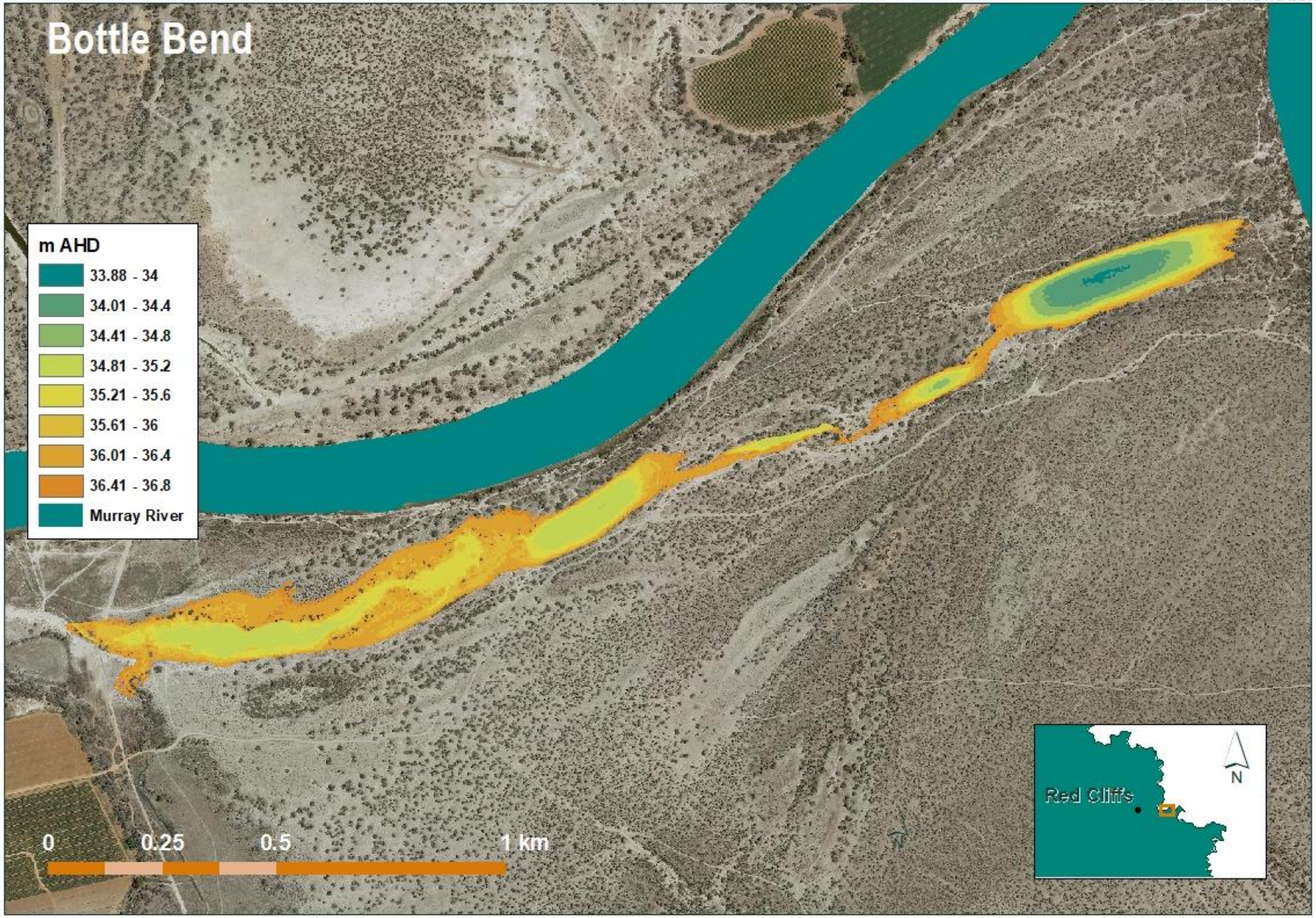


Figure 5. Target inundation extent of the Bottle Bend target area

Wetland types are shown below in Figure 6.

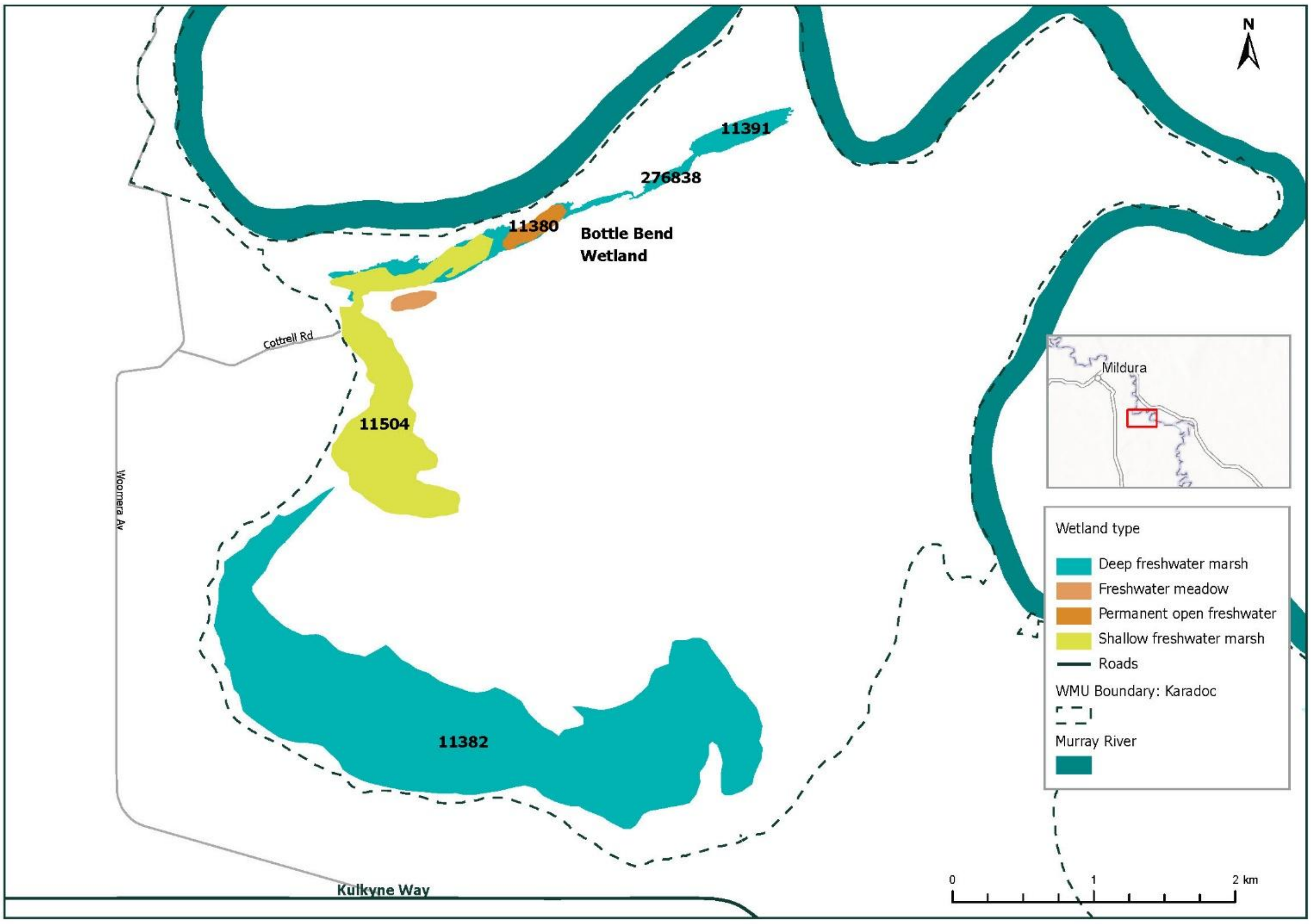
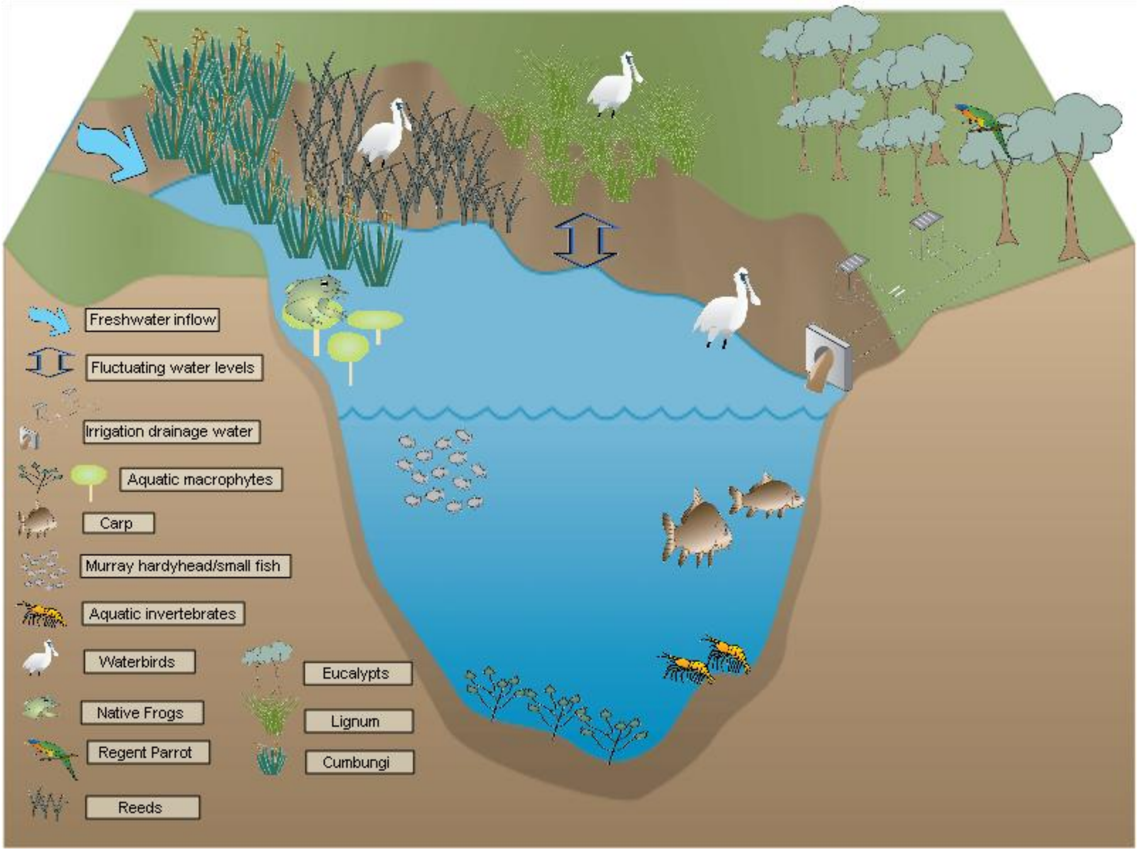


Figure 6. Wetland types (according to the Wetland Current spatial data layer)

3.3.1 Conceptualisation of the site

Bottle Bend 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 7).



Saline irrigation drainage and groundwater discharge enter the wetland, increasing salinity levels. **Freshwater inflows** to the system will be delivered as environmental water to provide **fluctuating water levels** and reduce salinity. This flooding leads to the rapid release of nutrients from the soils, germination of aquatic plants from the seed banks, and emergence of invertebrates. This pulse in aquatic macrophytes and invertebrates provides food for waterbirds, frogs and turtles. The wetland becomes more productive as surrounding emergent vegetation benefits from periodic inundation and water recession.

Figure 7. Conceptual model of Bottle Bend target areas

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 the target wetlands at Bottle Bend Wetland Complex. 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/our-watering-program/our-water-holdings .

4 Current/Historical Hydrological Regime and System Operations

4.1 ENVIRONMENTAL WATERING

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.

The target area within Bottle Bend is located on the Victorian floodplain of the River Murray (912 to 923 river km) between river gauges Euston (#414203C) and downstream Mildura Weir (#414216A).

Historical hydrological regime

Under natural conditions, flow is understood to have been strongly seasonal, with median daily discharge highest in late winter to spring and lowest in autumn (SKM, 2002). Prior to river regulation in this reach of the Murray River, the floodplain experienced inundation more frequently and for longer periods. To inundate low areas of floodplain and many wetlands, the flows would need to be 20,000 to 60,000 ML/d. These flow conditions would have occurred for longer duration than under the current base line conditions (Ecological Associates, 2007b) (Figure 8).

In this section of the Murray River, the frequency, duration and magnitude of all but the largest floods have been reduced due to effects of major storages in the Murray and its tributaries (Thoms et al, 2000). The seasonal distribution of flows in this section of the Murray River shows that despite a reduction in discharge, the river retains the same annual pattern of higher flows in winter and spring with lower flows in summer and autumn (Figure 8).

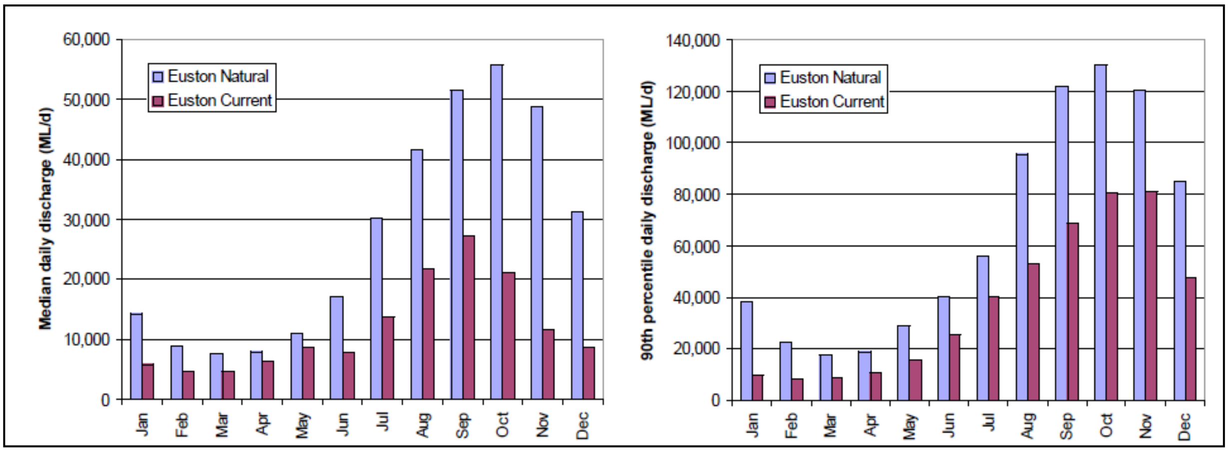


Figure 8. Distribution of median flows and 90th percentile flows for each month in the River Murray through Euston Weir for natural and current (benchmark) conditions. Data derived from MDBC MSM_Bigmod 109 year data (Ecological Associates, 2007b)

Current hydrological regime

Spells analysis shows that the events most affected are those generated by flows above approximately 15,000ML/d, which now occur less frequently. Floods generated by flows greater than 90,000ML/d now occur for shorter duration (Figure 9) (Gippel 2014). Commence to flow data suggests that the Northern Wetlands are inundated when river flows exceed 37,900ML/d (Table 5).

Table 5. Commence to flow rate for inundation of Bottle Bend

Wetland	Commence to flow rate (ML/day)
Northern Wetlands	37,900ML/d

The frequency of these events has reduced by almost 50 per cent since regulation Figure 9. Under current conditions water enters the wetland system from the Murray River at wetland #11380 and continues on to fill the remaining northern wetlands. Water then backs up into wetland central wetlands and on to the southern-most wetlands. The Southeast Drainage Basins are connected by an excavated channel. The inflow of drainage water to these wetlands has caused dense reed growth which impedes flows (Ecological Associates,2007b) (Figure 10.)

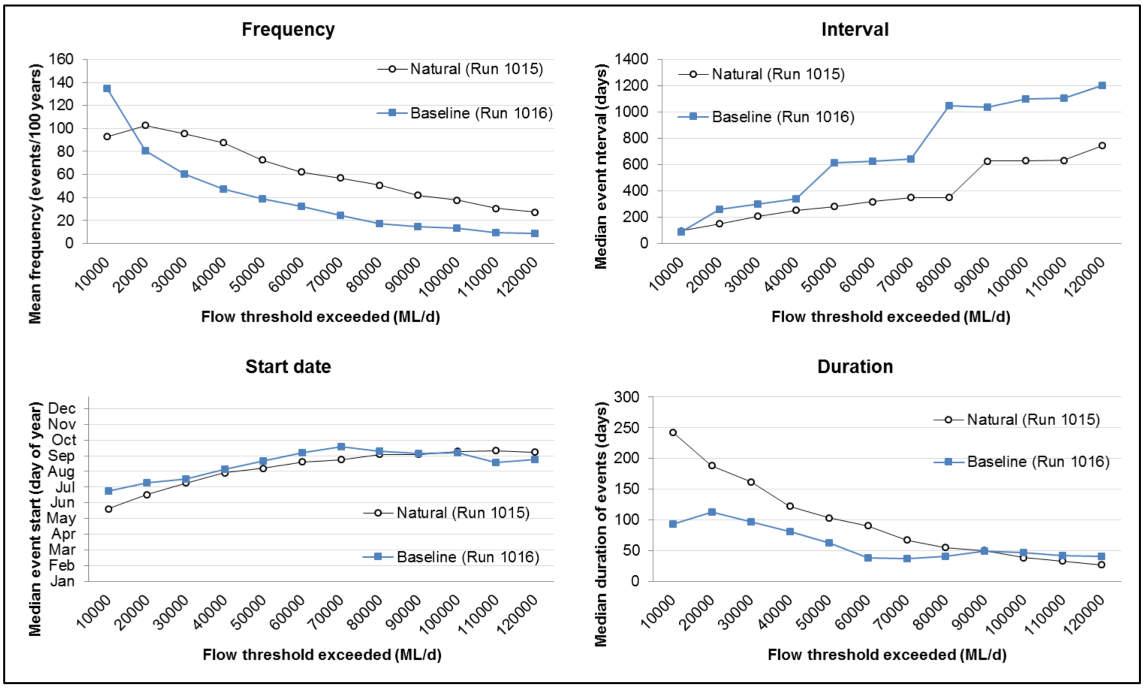


Figure 9. Comparison of Natural (pre-regulation) and Baseline Modelled Flow (post-regulation) scenarios for Euston Downstream (Gippel, 2014)

Figure 10. Common Reed growing in the southern-most wetland (Ecological Associates and Tonkin Consulting, 2016)

4.2 GROUNDWATER AND SALINITY INTERACTIONS

The Murray-Darling Basin Ministerial Council released the Basin Salinity Management 2030 (BSM 2030) in 2015. This document builds on the Basin Salinity Management Strategy of 2001-2015 (BSMS) and provides a program of salinity management across governments to meet the Basin Salinity Target of maintaining the salinity at Morgan at less than 800 EC for 95 per cent of the time. An accountable action under this plan is one that is assessed as causing a change in average daily salinity at Morgan of 0.1 EC or more by 2100.

Schedule B of the Water Act 2007 requires that, if an activity causes a significant salinity effect it be treated as an accountable action, triggering a detailed assessment and possible entry on either of the salinity Registers (A or B) (SKM, 2014). For example, if an event such as wetland flushing provides a reduction in salinity, then the Commonwealth may allocate credits to the Commission A Register to offset actions to provide environmental and social benefits (MDBA, 2001).

An assessment of proposed watering regimes and target areas for Bottle Bend was undertaken at the draft EWMP stage. A watering regime proposed for the northern wetlands was assessed to determine their potential impacts on salinity in the Murray River (Richardson and Currie, 2015) via the mobilisation of salt. The modelling identified the salinity pathways for these wetlands during environmental watering are:

- enhanced recharge to groundwater;
- rise in groundwater levels and an altered hydraulic gradient across the floodplain; and
- a resultant increase in groundwater flux (and salt load) to the river.

4.2.1 Groundwater levels and flow

Groundwater level contours reflect groundwater flow to the floodplain from highland irrigation areas to the west and south. The data on the floodplain itself is sparse but suggest a slight head gradient towards the river (34.4 mAHD). Hydrograph data for the Channel Sands indicate a general decline in groundwater levels on the floodplain since the early 2000s. This is likely due to below average rainfall and river flows, while groundwater elevations under some irrigated areas have remained relatively stable. Groundwater bores situated close to the Bottle Bend Wetland Complex show an increase in groundwater levels around 2010-2012, in response to receiving recharge from high river flows entering the floodplain, while bores situated further away do not display the same response (Richardson and Currie, 2015). Bore locations and IDs can be seen in Figure 3.

4.2.2 Groundwater salinity

Groundwater salinity data, while sparse, shows salinity in the Channel Sands aquifer ranges from <10,000 to 50,000 EC across the floodplain, with salinity generally increasing with distance from the irrigation area towards the river. Available data shows a rise in salinity that coincides with declining groundwater levels since the early 2000s (Richardson and Currie, 2015). An Airborne Electromagnetic (AEM) survey undertaken during low flows in 2007 suggests the presence of high salinity groundwater beneath the majority of Bottle Bend floodplain. Patches of low salinity water have been identified under sections of wetland which may reflect the Woorinen Sand and or an influence of lower salinity drainage water recharging the water table. Near River groundwater salinity is high and may have significant instream impacts if mobilised by floodplain inundation (Australian Water Environments, 2014). Another AEM survey was conducted in 2023, results from this survey are pending data inversion.

4.2.3 Surface water-groundwater interactions

Groundwater levels have declined on average in the region since the mid-1990s. This may be due to improved irrigation practices, low rainfall and/or river flow conditions. This has resulted in a reduction in the amount of recharge to the water table and reduced volumes of drainage water being disposed of on the Bottle Bend floodplain.

The water table below Bottle Bend is contained within the Coonambidgal Clay formation and lies between 0-10 m below the surface. Morphological studies suggest that Bottle Bend is a high terrace floodplain represented by the oldest and thickest clay sequences with a low vertical hydraulic conductivity of less than 10-3 m/d.

The measured groundwater elevation on the western side of wetlands #11504 and #11382 is approximately 2 m below the wetland bed elevation, indicating that the wetlands are disconnected from the groundwater system and are likely to experience losing conditions when filled. Closer to the River in northern wetlands, the groundwater elevation is approximately 35 mAHD indicating gaining conditions to the River are probable (Richardson and Currie, 2015). Groundwater level data suggest that there is some hydraulic separation between the Channel Sands and Parilla Sands aquifers and indicates a potential for downward fluxes (Australian Water Environments, 2014). Hydrographs show a rise in ground levels following the high River flows in 2010, indicating some connection between the floodplain aquifer and River Murray.

Overall, it is likely that the proposed height of ponded water from the inundation options will be higher than groundwater heads in the adjacent floodplain aquifer suggesting the potential for the discharge of environmental water to groundwater (Richardson and Currie, 2015).

4.3 ENVIRONMENTAL WATERING

Table 6 below outlines watering events for the Bottle Bend Wetland Complex. The wetlands have received environmental water in the past only via natural inundation, therefore total volume delivered, and area inundated are not known. Environmental water was proposed to be delivered in 2024/25 but was not able to be funded by VEWH. 350 ML was allocated to target an inundation height of 36.5m AHD.

Table 6. A summary of environmental watering at Bottle Bend

Water year	Waterbody	Time of inflow	Environmental Water Source	Total volume delivered (ML)	Area (ha) inundated
2010-11	Northern wetlands	Summer	Natural inundation	Unknown	Unknown
2016-17	Northern wetlands	Summer	Natural inundation	Unknown	Unknown
2022-23	Bottle Bend Complex	Spring - Summer	Natural inundation	Unknown	Unknown
2023-24	Northern wetlands	Spring	Natural inundation	Unknown	Unknown

5 Water Dependant Values

5.1 ENVIRONMENTAL VALUES

Wetlands and waterways on the floodplain are a vital component of the landscape supporting a large variety of flora and fauna which may vary greatly with the type of wetland/waterway system. The habitat provided by vegetation communities around wetlands is essential for maintaining populations of water dependent fauna. Other functions provided by floodplain complexes include water filtration, slowing surface water flow to reduce soil erosion, flood mitigation and reducing nutrient input into waterways. Protecting the ecological functioning of wetlands ensures these vital services are maintained.

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, 2005). Floodplain wetlands perform important functions necessary to maintain the hydrological, physical and ecological health of river systems. These ecosystem functions may include:

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

Productivity, nutrient and carbon cycling

Wetland inundation transports nutrients and carbon into the water column, which then becomes available for consumption by bacteria, algae and macroinvertebrates. On re-wetting, decomposition accelerates and becomes more efficient. Carbon and nutrients are released from the soil and enter the water and are available for aquatic plants and animals. The release of energy and nutrients results in increased productivity, with an increase in bacteria and invertebrates (Ecological Associates, 2013).

Wetting and drying cycles

Drying of wetlands, particularly during summer and autumn, exposes sediments and facilitates decomposition and processing of organic matter. The microbial decay of plant material is an important route for energy and nutrients to enter the riverine food chain (Young, 2001).

Fluctuations in water levels allows exposure of substrates such as large wood and plant stems through a drying cycle, which increases the diversity of the biofilms grazed by macroinvertebrates and fish.

Seasonal fluctuation in water levels in the wetlands increase the availability of the specific habitat niches for feeding, breeding and nursey areas. Permanent and semi-permanent water bodies provide a source of food, refuge from predators and nesting sites and materials (Kingsford and Norman, 2002). Receding water levels expose mudflats required by small waders (Roshier, Robertson and Kingsford, 2002).

Wetland filling and water recession increases the extent of the band of sedges, rushes and semi-aquatic forbs surrounding wetlands. Areas of deeper water support submerged aquatic macrophytes and promote high levels of aquatic productivity and high habitat value for frogs, fish and waterbirds.

Altered water regimes in the target area due to river regulation and dry conditions have seen a decrease in the frequency of inundation in the floodplain wetlands including the northern wetlands and therefore a subsequent decrease in the ability for these wetlands to perform these valuable ecosystem functions.

5.1.2 Flora and Fauna Values

Ecological Vegetation Classes (EVCs)

Ecological Vegetation Classes (EVCs) were developed by the state of Victoria in 1994 and have been utilised since for mapping floristic biodiversity. Vegetation communities are grouped based on structural, floristic and ecological features. DEECA has defined all of the EVCs within Victoria.

The EVCs modelled as present within the Bottle Bend target area are Floodway Pond Herbland, Intermittent Swampy Woodland and Alluvial Plains Semi-arid Grassland along the floor of the channel, surrounded by Lignum Shrubland and Riverine Chenopod Woodland along the less frequently inundated edges.

Floodway Pond Herbland and Alluvial Plains Semi-arid Grassland are comprised of low vegetation of up to 0.3 m tall with occasional emergent plants, dominated by herbs and herbs or grasses respectively. Alluvial Plains Semi-arid grassland also has a variety of shrub species including Tangled Lignum (Muehlenbeckia florulenta). Both EVCs are present in areas that experience episodic floods and consequently have a high proportion of ephemeral plants that germinate and grow in response to inundation.

Riverine Chenopod Woodland is a Eucalypt Woodland to 15 m tall, with an overstorey of Black Box with an understorey of River Coobah (Acacia stenophylla), and chenopods. Intermittent Swampy Woodland is also a Eucalypt Woodland to 15 m, with an overstorey of River Red-gum and Black Box and understorey of Lignum and other small to large shrubs.

Black Box provides essential habitat and foraging opportunities for a range of species including mammals and reptiles and supports a high proportion of ground foraging and hollow-nesting birds, Black Box can tolerate a range of conditions from wet to dry and saline to fresh (Roberts & Marston, 2011). However, under extended periods of dry conditions trees will suffer a decline in health and eventually death (Ecological Associates, 2007a). Black Box woodlands provide strong habitat links to the surrounding Mallee landscape in this region. They can support rich bird diversity, with both riverine and woodland species utilising these EVCs (Ecological Associates, 2007a).

For a full list of EVCs within Bottle Bend and details on each see Appendix 3. The EVCs within the target area and their conservation status can be seen in Figure 11 and Table 7.

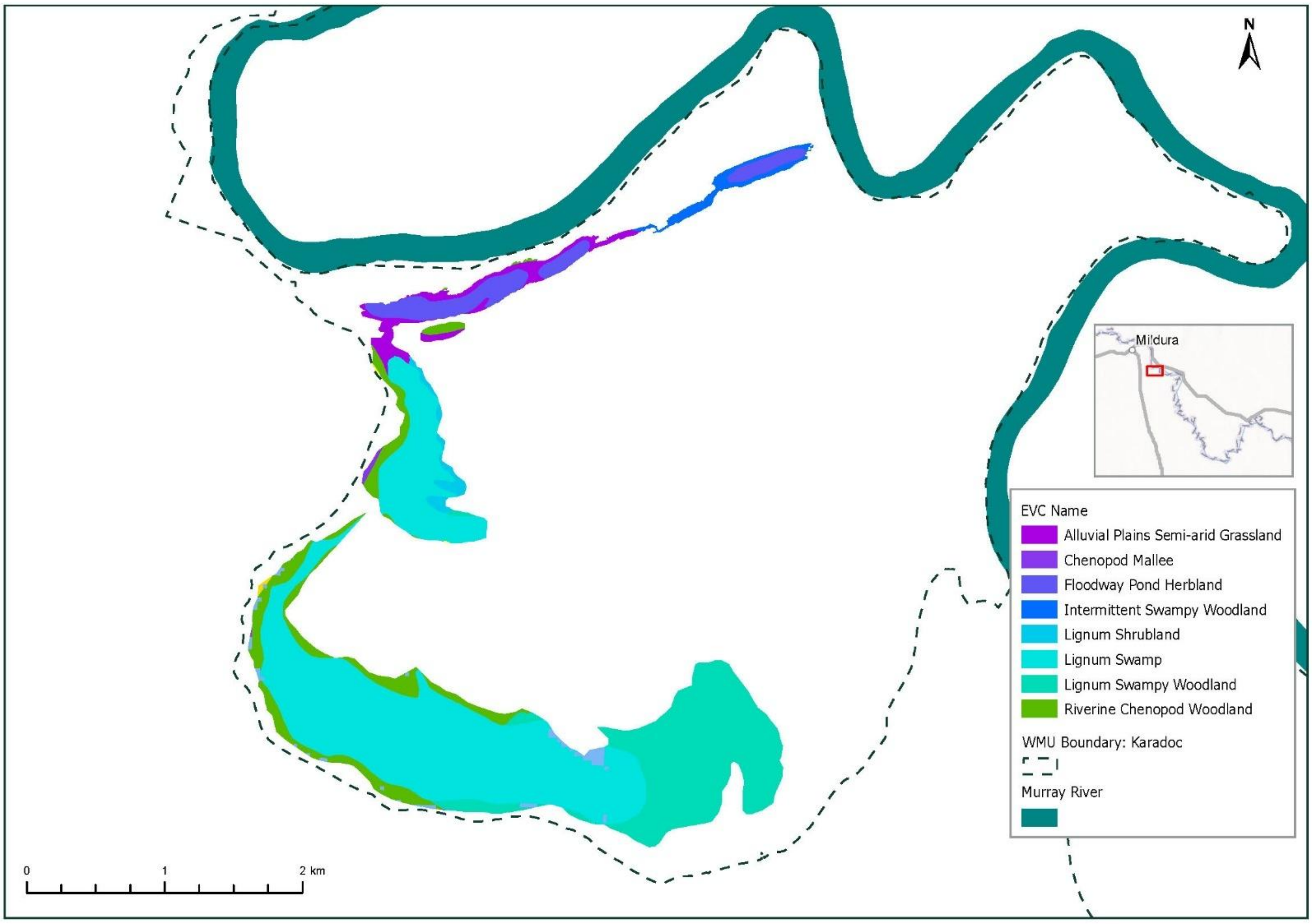


Figure 11. Ecological Vegetation Classes (EVCs) present within the Bottle Bend target area

Table 7. Ecological Vegetation Classes modelled as present within the Bottle Bend target area

EVC Number	EVC Name	Bioregional Conservation Status
810	Floodway Pond Herbland	Depleted
103	Riverine Chenopod Woodland	Depleted
806	Alluvial Plains Semi-arid Grassland	Vulnerable
813	Intermittent Swampy Woodland	Depleted
808	Lignum Shrubland	Least concerned

*Source: NatureKit 2024

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.

Victoria's wetlands are mapped and are contained within a state wetland database, using an accepted statewide wetland classification system developed by Corrick and Norman. Mapping was undertaken in 1981 that involved colour aerial photographs, field checking and developed into spatial geographic information systems (GIS) spatial layers. This database is commonly known as the 1994 wetland layer and contains the following information:

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

Victoria's wetland classification and inventory was updated in 2024 and replaces the system developed by Corrick and Norman. The updated classification is based on the Australian National Aquatic Ecosystem (ANAE) Classification Framework with data on wetlands and their classification attributes converted in GIS spatial layers.

Utilising the 1994 inventory, the Bottle Bend wetlands within the target area have been classified as Permanent Open Freshwater within the Corrick-Norman wetland classification system.

It has been possible to determine the depletion of wetland types across the state using the primary category only, based on a comparison of wetland extent between the 1788 and 1994 wetland layers (Table 8). Comparison between the wetland layers has demonstrated the impact of European settlement and development on Victorian Wetlands. This has been severe, with approximately one-third of the state's wetlands being lost since European settlement; many of those remaining are threatened by continuing degradation from salinity, drainage and agricultural practices (ANCA, 1996).

Across the state, the greatest decreases in original wetland area have been in the Freshwater Meadow (43 per cent decrease), Shallow Freshwater Marsh (60 per cent decrease) and Deep Freshwater Marsh (70 per cent decrease) categories (DNRE 1997).

Table 8. Regional change in area of wetland type

Corrick category	Wetland name	Total area (ha)	Change in Victoria	Change in Mallee CMA	Change in Robinvale Plains bioregion
Permanent Open Freshwater	Northern wetlands	7.9	-6	+5	-1
*Source: DEECA Biodiversity – NatureKit, 2024					

Fauna

Bottle Bend consists of a series of wetlands and creeks that provide habitat for a large range of fauna. Native species recorded in the area are listed in Appendix 4. This list includes a range of water dependent species which will benefit from the wetland in the target area receiving water on a more regular basis. Of special interest and responsibility are the water dependent species listed in legislation, agreements or conventions summarised in Table 9.

Table 9. Listed water dependent fauna species recorded at Bottle Bend

Common name	Scientific name	Type	International agreements	FFG Act status	EPBC Act status
Eastern Great Egret	*Ardea alba modesta*	B	CAMBA, JAMBA	V	
Nankeen Night Heron	*Nycticorax caledonicus hillii*	B			
Hardhead	*Aythya australis*	B			
Blue-billed Duck	*Oxyura australis*	B		V	
Regent Parrot*	*Polytelis anthopeplus monarchoides*	B		V	V
Broad-shelled Turtle	*Chelodina expansa*	R		E	
Growling Grass Frog	*Litoria raniformis*	A		V	V

Lifeform type: Amphibian (A), Bird (B), Fish (F), Reptile (R)
International Agreements: China-Australia Migratory Bird Agreement (CAMBA), Japan-Australia Migratory Bird Agreement (JAMBA)
EPBC status: Conservation Dependent, Vulnerable, Endangered, Critically Endangered, Extinct in the Wild, Extinct
FFG status: Threatened, Conservation Dependent, Vulnerable, Endangered, Critically Endangered, Extinct
*Indirectly water dependent

Table 9 includes water dependent species that forage or nest in or on water or require flooding to trigger breeding and fledging. In order to provide breeding opportunities, habitat elements such as temporary wetlands and Lignum communities must be maintained in good condition. The list also includes the Regent Parrot (*Polytelis anthopeplus monarchoides*) which is indirectly dependent on water. One such reason for this is they require riparian trees for breeding and feeding habitat.

Birds

The Regent parrot is listed as nationally vulnerable under the EPBC Act, with population estimates of no more than 1,500 adult breeding pairs. They breed almost exclusively in River Red Gum (*Eucalyptus camaldulensis*) forest and woodland, typically in large, old and healthy hollow-bearing trees close to water. They require trees that are a minimum of 160 years old (Baker-Gabb and Hurley, 2011). However, Regent parrots have also been known to breed in Black Box and (*Eucalyptus largiflorens*). They mostly feed in large blocks of intact Mallee woodlands usually within 5-10km (maximum 20km) of nest sites, but also consume flower buds of River Red Gum, Black Box and Buloke (*Allocasuarina leuhmanii)*

(Baker-Gabb and Hurley, 2011). Regent Parrots are reluctant to fly through open areas and require corridors of vegetation between nesting and foraging sites.

Nankeen Night Herons utilise shallow water for foraging and breed in colonies building stick nests over water (Pizzey and Knight, 2007). They are nomadic in response to rainfall and flooding of suitable habitat. Breeding usually occurs from September to February. Nankeen Night Herons have a minimum lag time to breeding of three months from flood, and breeding success is significantly enhanced by longer durations of inundation, up to 12 months (Rogers & Ralph, 2011).

Great Egrets breed on a stick platforms built over water, usually between November and February (Pizzey & Knight, 2007). They have a preference for permanent water sites, and forage in water up to 30 cm deep (Rogers & Ralph, 2011). Fish are a significant part of the diet (Rogers & Ralph, 2011). Nests are built in the forks of trees over water, in colonies (which can be of mixed species). Long lag times for breeding have been recorded, though this may be variable depending on whether flooding occurs during the optimal breeding season of November to May or whether it occurs outside of the main breeding season (in which case the lag period is longer) (Rogers & Ralph, 2011). Minimum flood duration needs to be six to seven months to support breeding (Rogers & Ralph, 2011).

The Hardhead (Aythya australis) favours inland wetlands, preferring deep waters, but also frequents shallow and ephemeral wetlands and inundated floodplains (Rogers and Ralph, 2011; Marchant and Higgins, 1990). The Hardhead dives deep to forage and nests in dense vegetation above the water level, whether permanent water or ephemeral deep water (Rogers and Ralph, 2011; Marchant and Higgins, 1990). The Hardhead lives for approximately three to four years in the wild, therefore conditions suitable for breeding should occur every second year to maintain numbers of breeding adults. Breeding is stimulated by flooding and season (Briggs, 1990). Although information on breeding is limited, it is estimated that fledging occurs at two to three months suggesting flooding should last for four to six months. Food resources are more abundant for Hardhead when a flood follows a period of wetland drying, suggesting that inter-flood drying for a few months may increase breeding success of the Hardhead (Rogers and Ralph, 2011).

The Blue-billed Duck (Oxyura australis) is secretive and prefers stable or permanent deep wetlands with dense and abundant vegetation such as rushes, sedges or lignum. The species is herbivorous (leaves and seeds) (Marchant and Higgins, 1990) but opportunistically consumes crustaceans and insects. Feeding occurs in open water adjacent to vegetation and the species can dive to three metres depth (Rogers and Ralph, 2011). The breeding season is mostly between September and February, though this varies with hydrological conditions and food availability. Breeding occurs in temporary or permanent waterbodies. For breeding to occur in temporary wetlands, an (estimated) minimum of five to six months flooding is required (Rogers and Ralph, 2011). The Blue-billed Duck nests in vegetation over water, preferring vegetation within one metre of the edge of vegetation in deep water (Marchant and Higgins, 1990).

As well as the listed species recorded in Table 7, Bottle Bend has historically supported a diverse range of waterbirds with 24 species recorded in the species list for this site (Appendix 1). Australia's waterbirds are often nomadic and take advantage of highly variable and often temporary aquatic resources. The distribution of temporary habitat patches throughout the landscape may facilitate movement and exploitation of available resources for waterbirds (Roshier et al., 2001). The provision of environmental water to wetlands is one method of creating such habitat patches for waterbirds, allowing them to move between suitable habitat to survive and reproduce (MDBA, 2009). Taft et al. (2002, cited in MDBA, 2009) states that wetland management which increases the diversity of available habitat types such as variable water depths, mud flats, inundated vegetation and deep-water areas have the greatest abundance and diversity of waterbirds. For this reason, drawdown patterns are important as they change habitat types and influence waterbird presence (MDBA, 2009). Exposed mud flats and fringing vegetation provide ideal feeding grounds for wading birds upon drawdown (DEWNR, 2012).

Frogs

The EPBC Act listed Growling Grass Frog (Litoria raniformis), is usually found in seasonally flooded wetlands with complex aquatic vegetation communities and relies on drought refuges to survive dry periods. The Growling Grass Frog is particularly sensitive to changes in wetland hydrology and prefers annual flooding and long periods of inundation (five to seven months) due to a long larval phase. This frog requires flooding in spring/summer for successful recruitment as this is when it is active, and breeding takes place. It can be excluded from wetlands under reduced flood frequency (Rogers & Ralph 2011).

Five additional species of native frog have been recorded at Bottle Bend (Table 8). The diversity of frog species and the presence of the Growling Grass Frog, which has suffered major declines throughout the Murray-Darling Basin (Rogers & Ralph 2011), is of significant ecological value. Like most flood dependent species frogs respond to the timing, duration and frequency of flooding, with the timing of inundation being the most significant factor. Close proximity to permanent waterbodies and drought refuges is also important for frogs. Aquatic vegetation complexity is important for many species, particularly at tadpole stage, and can drive occupancy patterns and recruitment success (Tarr & Babbitt, 2002, cited in Rogers & Ralph, 2011).

Frogs are considered as good indicators of environmental health and may act as ‘sentinel’ species for secondary salinisation (DSE, 2006). A study by the Arthur Rylah Institute (2006) found that salinity levels up to 3000 EC did not limit amphibian occupancy but amphibian diversity declined significantly between 3000 and 6000 EC.

Table 10. Breeding habitat requirements of frogs at Bottle Bend

Common Name	Preferred length of inundation			Timing of Breeding				Tadpole lifespan (months)
	<3 months	3-6 months	Permanent	Spring	Summer	Autumn	Winter	
Growling Grass Frog		*	*	C	CM	M		3-5
Barking Marsh Frog		*	*	C	CM	M		3-4
Spotted Marsh Frog	*	*	*	C	CM	M		3-4
Plains Froglet	*	*	*	C	CM	CM	M	2-4
Peron's Tree Frog	*	*	*	C	CM	M		3-4
Eastern Banjo Frog		*	*	CT	CM	CM	T	5-6

C = Calling
M= Mating
T = Tadpoles

Murray Hardyhead

Murray Hardyhead is considered critically endangered under the FFG Act and endangered under the EPBC Act. Although Murray Hardyhead have not been recorded in historical species lists at the Bottle Bend Wetland Complex, the salinity levels make Bottle Bend a potential translocation site with additional investigation required to determine this.

Murray Hardyhead generally persists in waters with elevated salinity (ranging from approximately 1,000 to 110,000 EC) and submerged vegetation. Backhouse et al. (2008) states that it is not clear if this indicates a preference for saline habitats or if it is due to the exclusion of less salt tolerant species which compete or prey on Murray Hardyhead. Salt tolerant Ruppia is often a key aquatic macrophyte in saline wetlands where Murray Hardyhead is found. Zooplankton is the main source of food for Murray Hardyhead and some of these micro-crustaceans also rely on Ruppia for habitat. The biggest threat to Murray Hardyhead is reduced inflows to wetlands as a result of river regulation. A reduction in inflows also has a detrimental effect on macrophyte communities reducing feeding and breeding habitat for Hardyhead. As an annual species, Murray Hardyhead relies heavily on successful recruitment each year. Ellis (2006, cited in Ellis 2010) states that this means even short-term changes which have a negative ecological impact on fish could have a significant effect on the long-term viability of Murray Hardyhead populations. Environmental watering on an annual basis is listed as a key management action for the long-term preservation of Murray Hardyhead populations (Backhouse et al. 2008).

Flora

A full list of flora recorded at Bottle Bend can be found in Appendix 4. Water dependent flora species listed in the various legislation and agreements which have been recorded at Bottle Bend are shown in Table 11.

Table 11. Listed water dependent flora species recorded at Bottle Bend

Common name	Scientific name	FFG Act status	EPBC Act status
Spiny-fruit Saltbush	*Atriplex spinibractea*	E	
Goat Head	*Malacocera tricornis*	V	
Waterbush	*Myoporum montanum*	E	
Lagoon Spurge	*Phyllanthus lacunarius*	E	
Hoary Scurf-pea	*Cullen cinereum*	E	
Low Hibiscus	*Hibiscus brachysiphonius*	CE	
Cane Grass	*Eragrostis australasica*	CE	
Spotted Emu-bush	*Eremophila maculata* subsp. *maculata*	CE	
Dwarf Flat-sedge	*Cyperus pygmaeus*	E	
Jerry-jerry	*Ammannia multiflora*	E	
Twin-leaf Bedstraw	*Asperula gemella*	E	
Small Water-fire	*Bergia trimera*	E	
Spreading Emu-bush	*Eremophila divaricata* subsp. *divaricata*	V	
Tall Nut-heads	*Ethuliopsis cunninghamii*	E	

Common name	Scientific name	FFG Act status	EPBC Act status
EPBC status: Conservation Dependent, Vulnerable, Endangered, Critically Endangered, Extinct in the Wild, Extinct FFG status: Threatened, Conservation Dependent, Vulnerable, Endangered, Critically Endangered, Extinct			

The Land Conservation Council survey (1989) stated that the understorey at Bottle Bend included the only known Victorian populations of Hibiscus brachysiphonius and Abutilon oxycarpum at that time. Abutilon oxycarpum is an annual herb that can grow to 8 cm, while Hibiscus brachysiphonius is a perennial subshrub to 15 cm high. The Victorian populations of these species are widely separated from other populations and represent their southern limit. Their Victorian range is an area less than 3 km of Murray River floodplain within 0.6 km of the River at Bottle Bend. Browne & Parsons (2000) suggest that the determinants of Abutilon oxycarpum occurrence are warm-season rainfall, which is required for recruitment, and flooding, which temporarily excludes Abutilon by increasing competitive species. While many transient species such as this regenerate profusely once favourable conditions return, if habitat is continuously unfit for occupation, then these species may be lost entirely (Browne & Parsons, 2000). Both species are found within Bottle Bend but outside the target area and will not be subject to inundation.

5.1.3 Current Condition

The use of wetlands within Bottle Bend as irrigation drainage basins has led to issues with salinity and resulted in degradation of the floodplain and its vegetation. Tree health has diminished and colonisation by reed bed vegetation such as Cumbungi and Spiny Rush (Juncus acutus) has occurred in wetlands that are permanently inundated by drainage water (Bluml 1992).

River Red Gum stands that line the Murray River and wetlands are in poor condition and many mature trees have died or are dying. A stand of Slender Cypress-pine (Callitris preisii) on the northern side of the Southeast Drainage Basins is in a state of decline due to grazing, rubbish dumping and vehicle access. Figure 12 and Figure 13 illustrate the current condition within the target area, including a decline in Black Box health between the Murray River and the wetland with a carpet of saltbush.

Figure 12. Northern wetlands looking southwest (Mallee CMA August 2024)

Figure 13. Northern wetlands looking west (Mallee CMA August 2024)

ARI (2025) conducted a field survey of the northern wetlands and found high levels of species diversity due to the presence of a broad range of species functional types including flood-responding species persisting following the recent flooding as well as recruitment and regeneration of terrestrial species (Figure 13).

Figure 14. A diversity of species present on the wetland margins (ARI, 2025)

5.2 SHARED BENEFITS

5.2.1 Traditional Owner Cultural Values

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.

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 2024) confirms that Bottle Bend and the River Murray are defined as areas of cultural heritage sensitivity.

The Bottle Bend area is of significant cultural value to First Nations people with the area popular for walking, birdwatching, fishing, boating and camping. In regard to cultural values, some cultural sites have been documented through various archaeological investigations, but the true extent of the number and types of sites present is still unknown.

Surveyed sites within the Mallee region include middens, earth features, scarred trees, oven mounds, surface scatters, stone quarries and places of burial. The recorded cultural heritage sites show the area was an important meeting place for Aboriginal people, with water and food sources making it possible to survive in this landscape.

The First Peoples of Milewa Mallee Aboriginal Corporation (FPMMAC) are the registered party for this region, which includes Bottle Bend. Mallee CMA work in partnership with FPMMAC through regular meetings and Talk water events with Traditional owners. FPMMAC value revegetation in wetlands with a focus on cultural significant plants as well as the importance of supporting bird breeding and wanting to see water on floodplains.

5.2.2 Recreational Values

Community engagement has highlighted that the region holds importance for a range of recreational activities. Such activities include walking, birdwatching, horse-riding, fishing, boating and camping along the river. The ability to provide many of these recreational values is highly dependent on the delivery of environmental water.

5.2.3 Economic Values

The Bottle Bend site has been used for grazing, irrigation, stock and domestic water in the past. The Southeast Drainage Basins actively provide the function of drainage water disposal for the adjacent Red Cliffs irrigation district.

5.2.4 Significance

The environmental, social and economic values outlined contribute to the significance of this site. The riparian and floodplain communities of the Murray River are important to the functioning of the river system and its sustainability. The area is rich in biodiversity, essential as habitat to native species and a refuge for listed flora and fauna species.

The site already supports many listed species, including the EBPC listed Growling Grass Frog and Regent Parrot. Regular inundation and drawdown of the wetland in the target area would provide shallow and mudflat habitat for wader birds that frequent the site.

The cultural importance of this site is significant as wetlands and floodplains of the Murray River are highly valued by Indigenous communities. There are also significant recreational values associated with Bottle Bend. These social and cultural values are important to local communities of the area. The values contained within Bottle Bend and specifically the target area for this plan makes this area a priority for protection and enhancement through environmental water management.

5.3 CONDITION TRAJECTORY

Without management intervention in the form of environmental watering, water dependent condition within the target area is expected to worsen. Dry conditions and salinity will continue to impact already severely stressed vegetation, including key species like River Red Gum and Black Box. This will result in loss of valuable habitat for listed fauna within the target area and these species may be lost from the area. Wetland productivity and biodiversity, which is directly dependent on water, will continue to decline.

6 Managing Water Related Threats

Changed water regime

As discussed in the hydrology section of this EWMP, the hydrology of the target area has been greatly impacted by the regulation of the River Murray. The proposed water regime (refer Section 4) takes into account the impacts of regulation of the primary water source of the wetland (River Murray), and other activities which may impact the wetland water regimes and proposes a watering regime that will support the achievement of the environmental objectives and goals of the site.

The Mallee Waterway Strategy 2014-2022 identifies Bottle Bend as a high priority wetland in the Karadoc WMU.

Loss or reduction of wetland connectivity

Loss of connectivity between wetlands and the Murray River disable the biotic and abiotic connections between complex habitats. Water depth, flow and intensity define the characteristic flora and fauna, including aquatic species such as fish, shrimp, and some insects.

Poor water quality

The use of Bottle Bend for irrigation drainage has led to an increase in salinity levels, leading to degradation of the surrounding land and its vegetation. Salt tolerant species such as salt bush are thriving at Bottle Bend, reducing habitat for native species.

Permanent inundation of wetlands can alter natural hydrological regimes and reduce water circulation. This can lead to changes in water temperatures, dissolved oxygen levels, salinity and pH which, in turn, can lead to acid sulphate soils over time. Nutrient outflow can be reduced resulting in a build-up of salt and/or agricultural chemicals. Sedimentation within the wetland can increase as soils are no longer exposed to periods of drying (Mitsch & Gosselink 1993).

Introduction/increase of exotic flora and fauna

Introduced fish species Common Carp (Cyprinus carpio), and Mosquito fish (Gambusia holbrooki) pose a serious threat the ecology of the Bottle Bend wetlands. Ho et al (2004) found both these species to be present during aquatic vertebrate surveys at one of the Bottle Bend wetlands. Carp have been found to contribute to the loss of aquatic vegetation and increased turbidity, resulting in loss of habitat for waterfowl (Purdey & Loyn 2008). This species also competes with the native fish for habitat and food as well as having a detrimental effect on water quality (Mallee CMA, 2003. Spencer and Wassen (2009, cited in Rogers & Ralph 2011) suggest that Common Carp also significantly reduce recruitment success of the Growling Grass Frog.

Agricultural and other weeds are an ongoing threat and management issue along the Murray River floodplain. Cumbungi and Spiny Rush in particular have become problematic at Bottle Bend as they have formed dense stands in areas inundated by irrigation drainage (Bluml 1992). These plants use large amounts of water and can alter wetland character, reduce plant diversity and obstruct water flow (Roberts & Marston 2011). The dense Cumbungi stands which have established in the wetlands also provide cover for feral pigs which, in turn, cause major damage to the ecosystem. Pigs can destroy native vegetation through wallowing and rooting out underground plants leading to erosion and reduced water quality. Pigs may also spread invasive plants and disease and are known to prey on native wildlife such as frogs, turtles, ground-nesting birds and freshwater crayfish (DEPI 2014).

Biodiversity can decline as breeding cues and recruitment of flora and fauna are lost. Invasive species which favour permanent inundation, such as Carp and Cumbungi, may thrive contributing further to the decline of native biodiversity (Mallee CMA, 2012). In summary, the overall productivity and ability of the wetland to perform essential ecosystem functions is reduced.

ASSESSING RISK

Risk assessments identify and prioritise system threats and support development of risk management strategies, that may be implemented over seasonal or decadal time frames. 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 creek 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. The Mallee CMA considers consequences at the scale of their region, for the VEWH it is Victoria-wide and the CEWH it is the scale of 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 5.

7 Management Goals, Objectives and Targets

7.1 MANAGEMENT GOAL

The management goal for Bottle Bend is:

The target area of Bottle Bend will be managed to maintain the condition of fringing Riverine Chenopod Woodland and provide seasonal habitat for waterfowl, wading birds and frogs.

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.

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) undertook a refinement process 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 Bottle Bend can be found in Section 5.3.1 of Butcher et al. (2020), and in Appendix 6.

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

Table 12. Environmental objectives and targets for Bottle Bend

EWMP Objective	Target
BB1a. By 2030, maintain representative populations of shallow-water and deep-water feeding guilds of waterbird (F2 and F3, respectively, after Jaensch 2002) at Bottle Bend asset, by	By 2030, 80% of representative F2 and F3 species recorded at Bottle Bend in 8 years out of any 10-year period in which conditions are suitable. • Representative F2 species include: Black Swan (*Cygnus atratus*), Australian Shelduck (*Tadorna tadornoides*), Pacific Black Duck (*Anas supercilicosa*), Grey Teal (*Anas gracilis*), White-faced Heron (*Egretta novaehollandiae*), White-necked

maintaining a mixture of shallow and deep-water habitats.	Heron (*Ardea pacifica*), Great Egret (*Ardea alba modesta*), Yellow-billed Spoonbill (*Platalea flavipes*), Purple Swamphen (*Porphyrio porphyrio*), Dusky Moorhen (*Gallunula tenebrosa*) • Representative F3 species include: Australian Pelican (*Pelecanus conspicillatus*), Blue-billed Duck (*Oxyura australis*), Hardhead (*Aythya australis*), Musk Duck (*Biziura lobata*), Australasian Darter *(Anhinga novaehollandiae*), Little Black Cormorant (*Phalacrocorax sulcirostris*), Little Pied Cormorant (*Microcarbo melanoleucos*) • 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.
BB1b. By 2030, maintain nesting and recruitment of non-colonial waterbirds (N1, N2, N3, and N4, after Jaensch 2002) at the Bottle Bend asset, 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 Bottle Bend will be confirmed over time. By 2030, at least two of the following species to be recorded as nesting and/or breeding at the Bottle Bend asset in 7 out of any 10 year period in which nesting/breeding condition are suitable: Representative N1 and N2 species include: Yellow-billed Spoonbill (*Platalea flavipes*), Purple Swamphen (*Porphyrio porphyyrio*) Representative N3 and N4 species include: Dusky Moorhen (*Gallinula tenebrosa*), Black-winged Stilt (*Himantopus himantopus*), Black-fronted Dotterel (*Elseyornis melanops*), Red-kneed Dotterel (*Erythrogonys cinctus*), Masked Lapwing (*Vanellus miles*) Pacific Black Duck (*Anas supercilliosa*)
BB2. By 2030, improve vital habitat at the Bottle Bend asset by increasing the diversity of aquatic macrophytes present across a range of Water Regime Indicators Groups.	By 2030, increase diversity of native macrophytes at the Bottle Bend asset 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) (Common Blown-grass *Lachnagrostis filiformis s.l.*,Narrow-leaf Nardoo *Marsilea costulifera* Common Nardoo, *Marsilea drummondii*) • Seasonally inundated – emergent non woody (Sen) (Spiny Flat-sedge *Cyperus gymnocaulos* ;Southern Cane-grass *Eragrostis infecunda*, Warrego Summer-grass *Paspalidium jubiflorum*) By 2030, increase diversity of native of macrophytes at the Bottle Bend asset with ≥9 species from Slg Water Regime Indicator Groups present in 80% of years - Seasonally immersed – low growing (Slg) (Lesser Joyweed *Alternanthera denticulata s.s.*, Twin-leaf Bedstraw *Asperula gemella* , Salt Club-sedge *Bolboschoenus caldwellii*, Marsh Club-sedge *Bolboschoenus medianus*, Yellow Twin-heads *Eclipta platyglossa subsp. Platyglossa*, Common Spike-sedge *Eleocharis acuta*, Spreading Goodenia *Goodenia heteromera*, Rough Raspwort *Haloragis aspera*, Creeping Knotweed *Persicaria prostrata* Tall Fireweed *Senecio runcinifolius*, Rat-tail Couch *Sporobolus mitchellii*, River Bluebell *Wahlenbergia fluminalis*)

BB3. By 2030, protect and restore biodiversity by maintaining representative populations of frogs at the Bottle Bend asset.	By 2030, maintain self-sustaining populations of frogs at Bottle Bend with the following species present: • Barking marsh frog (*Limnodynastes fletcheri*), Perons tree frog (*Litoria peronii*), Plains froglet (*Crinia parainsignifera*), Eastern Banjo Frog (*Limnodynastes dumerili*) and Spotted marsh frog (*Limnodynastes tasmaniensis*) in 80% of years. • Growling Grass Frog (*Litoria raniformis*) in 70% of years
BB4. 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 the Bottle Bend asset.	A positive trend in the condition score of Black Box dominated EVC benchmarks at Bottle Bend at 50% of sites over the 10 year period. OR By 2030, at stressed sites (see Wallace et al. 2020) at the Bottle Bend asset: 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.

7.3 REGIONAL SIGNIFICANCE

As shown above in Section 5.1, Bottle Bend supports a range of environmental values with local, regional and Murray-Darling Basin significance. These values inform the above environmental objectives. Details of links between the environmental objectives and environmental outcomes at a regional and basin scale are provide in Appendix 6.

The management goals and environmental objectives and targets are aligned with the regional goals of the Mallee Waterway Strategy 2014-2022 as described in Section 7.1. The Mallee Water Strategy 2014-2022 identifies Bottle Bend as a high priority wetland in the Karadoc WMU.

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 Plan's (LTWP), the Basin-wide Environmental Watering Strategy (BWS) and annual Basin environmental watering priorities.

Details on the alignment of the updated Bottle Bend 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 6.

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
BB1a. By 2030, maintain representative populations of shallow-water and deep-water feeding guilds of waterbird (F2 and F3, respectively, after Jaensch 2002) at the Bottle Bend asset, by maintaining a mixture of shallow and deep-water habitats.	8.05, 3(b)	8.06, 6(b)	n/a
BB1b. By 2030, maintain nesting and recruitment of non-colonial waterbirds (N1, N2, N3, and N4, after Jaensch 2002) at the Bottle Bend asset, by maintaining a mixture of tree, low vegetation/shrubs, and ground/islet nesting habitat.	n/a	8.06, 6(b)	n/a
BB2. By 2030, improve vital habitat at the Bottle Bend asset 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
BB3. By 2030, protect and restore biodiversity by maintaining representative populations of frogs at the Bottle Bend asset.	8.05, 3(a) 8.05, 3(b)	8.06, 6(a)	n/a
BB4. 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 the Bottle Bend asset.	8.05, 3(b)	8.06, 6(b)	n/a

8 Environmental Water Requirements and Intended Water Regime

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

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

8.1 WATERING REQUIREMENTS AND INTENDED WATERING REGIMES

Hydrological objectives describe the components of the water regime required to achieve the ecological objectives at this site. The hydrological requirements to achieve each of these 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 woodland will become dysfunctional (Roberts and Marston, 2000).

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 from 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, Lawler and Thornton, 1997). Receding waters levels over summer provide shallow open water and mudflats which are important foraging habitat for wading birds (Ecological Associates, 2013).

Growling Grass Frogs prefer large continuous areas containing a range of regularly flooded permanent and ephemeral waterbodies with nearby refugia (Clemann and Gillespie, 2012). During the winter months individuals may shelter under cover close to the water such as rocks, logs and vegetation (Pyke, 2002). Breeding is triggered by flooding of wetlands and floodplains during spring and summer (Clemann and Gillespie, 2012).

The ecological character of the northern wetlands supports suitable habitat for Murray Hardyhead and could be used as a translocation site. This would increase the conservation significance of the target area and salinity levels would need to be managed for persistence of Murray Hardyhead at this site. If any of these wetlands are to support Murray Hardyhead populations, water will need to remain in the chosen wetland on a permanent basis. This will require annual environmental water inflows to the wetland to maintain adequate levels to allow Murray Hardyhead to complete their life cycle and increase in abundance. Environmental watering should commence from August to October to coincide with Hardyhead breeding season (October – November). Water levels should be high enough to inundate exposed sediments to promote a rise in zooplankton as a food source for breeding Murray Hardyhead. Water levels should be allowed to decrease through summer to expose wetland sediments and fringing vegetation whilst also maintaining aquatic macrophyte beds within the wetland. Allowing the wetlands to drawdown during December and January will ensure depleted habitat for Eastern Gambusia's breeding season, therefore reducing competition for the Murray Hardyhead.

Table 14. Hydrological objectives for Bottle Bend

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)	Total volume per event (ML)
	Min.	Opt.	Max.	Min.	Max.	Min.	Opt.	Max			
BB1a. By 2030, maintain representative populations of shallow-water and deep-water feeding guilds of waterbird (F2 and F3, respectively, after Jaensch 2002) at the Bottle Bend asset, by maintaining a mixture of shallow and deep-water habitats.	Provided by other objectives.									35.9	Provided by natural drawdown/evaporative losses following watering to meet Black box objective
BB1b. By 2030, maintain nesting and recruitment of non-colonial waterbirds (N1, N2, N3, and N4, after Jaensch 2002) at the Bottle Bend asset, by maintaining a mixture of tree, low vegetation/shrubs, and ground/islet nesting habitat.	Provided by other objectives.										
BB2. By 2030, improve vital habitat at the Bottle Bend asset 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	35.9	Provided by natural drawdown/evaporative losses following watering to meet Black box objective
BB3. By 2030, protect and restore biodiversity by maintaining representative populations of frogs at the Bottle Bend asset.	Provided by other objectives.					3			Spring/ Summer	35.9	
BB4. 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 the Bottle Bend asset.	1	2	3	3	10	2	4	6	Winter/ Spring	36.3	350

Minimum watering regime

Prefill the northern wetlands to 36.3 mAHD every three years in late spring to inundate surrounding Riverine Chenopod Woodland vegetation, allow water to recede naturally, gradually exposing the littoral zone and mudflats.

Optimum watering regime

Fill wetlands #11380 to 35.9 mAHD every year in late spring to inundate littoral zone, allow water to recede naturally, gradually exposing the littoral zone and mudflats.

In every third year, fill the northern wetlands to 36.3 mAHD late winter/spring to inundate surrounding Riverine Chenopod Woodland vegetation, allow water to recede naturally, gradually exposing the littoral zone and mudflats.

8.2 EXPECTED WATERING EFFECTS

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

Table 15. Expected watering effects and potential watering action required to achieve environmental objectives

Objective code	Environmental Objective	Potential Watering Action	Expected Watering Effect
BB1a	**BB1a**. By 2030, maintain representative populations of shallow-water and deep-water feeding guilds of waterbird (F2 and F3, respectively, after Jaensch 2002) at the Bottle Bend asset, by maintaining a mixture of shallow and deep-water habitats.	Achieved through watering actions for other objectives.	Suitable habitat (food, refuge) is provided in flooded wetland vegetation in spring and summer.
BB1b	**BB1b.** By 2030, maintain nesting and recruitment of non-colonial waterbirds (N1, N2, N3, and N4, after Jaensch 2002) at the Bottle Bend asset, by maintaining a mixture of tree, low vegetation/shrubs, and ground/islet nesting habitat.	Achieved through watering actions for other objectives.	Suitable habitat (food, refuge) is provided in flooded wetland vegetation in spring and summer.
BB2	**BB2.** By 2030, improve vital habitat at the Bottle Bend asset by increasing the diversity of aquatic macrophytes present across a range of Water Regime Indicators Groups.	Facilitate flooding to 35.9 m AHD every two years during spring/summer, with ponding for six months.	Suitable conditions for germination, growth and reproduction are provided for a variety of aquatic macrophytes through variation in water levels.

BB3	**BB3.** By 2030, protect and restore biodiversity by maintaining representative populations of frogs at the Bottle Bend asset.	Achieved through watering actions for other objectives.	Appropriate seasonal variation in water levels provides suitable habitat and food resources for frogs.
BB4	**BB4.** 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 the Bottle Bend asset.	Facilitate flooding every five years to 36.3 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.

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 Bottle Bend are described in Figure 15. The example watering actions presented in Figure 15 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.

Planning scenario	Drought	Dry	Average	Very wet
Expected Conditions	Limited water, drying likely over summer	Limited water available to manage risks	Unregulated flows and storage releases enable facilitated watering	Large unregulated flows, releases from storage and piggy-back events
	Protect	Maintain	Recover	Enhance
Management Objectives	•Avoid critical loss •Maintain refuges •Avoid catastrophic events	•Maintain wetland function •Manage within species tolerance	•Improve ecological health and resilience •Improve recruitment opportunitie s	•Facilitate dispersal •Support recruitment
Example watering actions	•Provide low volumes to protect priority environment -al assets •Maintain refuges (permanent habitat pool in deepest part of freshwater marsh)	•Provide environment al water in spring to maintain aquatic vegetation and littoral zone, and support sedentary waterbird species •Manage risks such as invasive species	•Inundate exposed sediments in spring to increase aquatic macrophyte extent •Inundate Black Box communities •Maintain suitable water levels to support shallow feeding waterbirds •Provide nesting habitat for N3 and N4 waterbirds	•Top up natural flows as needed to meet target water levels •Manage inundation to avoid exceeding maximum ponding durations •Inundate trees, low vegetation/ shrubs and ground/islet habitat to support and recruit N1, N2, N3 and N4 waterbirds •Provide deep water habits for deep-feeding waterbirds

Figure 15. Indicative seasonally adaptive approach

9 Environmental Water Delivery Infrastructure

9.1 WATER DELIVERY INFRASTRUCTURE

No current infrastructure. Temporary works are required to facilitate environmental water delivery.

9.2 CONSTRAINTS

Salinity impacts and inflows of drainage water are the main constraints limiting the extent of environmental water delivery at Bottle Bend. The watering regime has been developed to mitigate any risks associated with these threats.

10 Demonstrating Outcomes

10.1 ENVIRONMENTAL MONITORING

The following monitoring activities have been proposed for the Bottle Bend target area (Table 16). 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 16.

Table 16. Environmental monitoring at the Bottle Bend area

Objective	Monitoring Focus	Monitoring Question	Method	When
Overarching management goal	Wetland condition	Has there been an overall improvement in the condition of the target area by 2030?	Undertake IWC method	Every five years
Water regime	Volume	How much water has been delivered and retained in Bottle Bend	Lower Murray Water	Annually
	Inundation extent	Which components of Bottle Bend were inundated	Sentinel 2	Annually
	Maximum Depth (AHD & depth classes)	When filled, to what height (AHD) and what 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
BB1a	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 Bottle Bend in 8 of any 10-year period where conditions are suitable?	Undertake waterbird surveys.	Intervention monitoring at an appropriate time after watering.

BB1b	Nesting and recruitment of non-colonial waterbirds	Are at least two of the representative waterbird species recorded as nesting and/or breeding at Bottle Bend in 7 of any 10-year period in which conditions are suitable?	Undertake waterbird surveys.	Intervention monitoring at an appropriate time after watering.
BB2	Diversity of aquatic macrophytes	By 2030, has there been an increase in the diversity of aquatic macrophytes? What species are present 80% of years?	Undertake surveys of aquatic macrophytes (including species ID and extent). Compare results against benchmark of initial survey.	Every three years
BB3	Abundance and diversity of populations of frogs	Are there self-sustaining populations of frogs present at Bottle Bend	Undertake frog surveys (audio recordings and/or presence of tadpoles).	Annually
BB4	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

10.2 MONITORING PRIORITIES AT THE ASSET

Ecological monitoring is required to demonstrate the effectiveness of environmental watering in achieving environmental objectives, to help manage environmental risks and to identify opportunities to improve the efficiency and effectiveness of the program.

The highest priorities for monitoring at Bottle Bend are the monitoring questions that most strongly influence watering decisions and the evaluation of watering effectiveness. The monitoring priorities at Bottle Bend are shown in Table 17.

Table 17. Monitoring priorities at Bottle Bend

Monitoring Priority	Reason for Priority
Water delivery	Adaptive management: water is managed to meet EWMP objectives.
Inundation extent	To ensure inundation does not extend onto private land.
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.
Groundwater monitoring	A small groundwater-monitoring program could also be implemented focusing on bores located around the perimeter of Bottle Bend target area. The collection of groundwater level and salinity data will help assess the groundwater response to watering and the level of connection between Bottle Bend and the floodplain aquifer.
Soil sampling	Soil sampling is recommended at the conclusion of an environmental watering event, to help to evaluate the success of watering relative to leaching salts from the upper soil profile.
Black box, river red gum and lignum 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.
Diversity of aquatic macrophytes	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 16 shows an illustration of the adaptive management cycle for environmental water delivery.

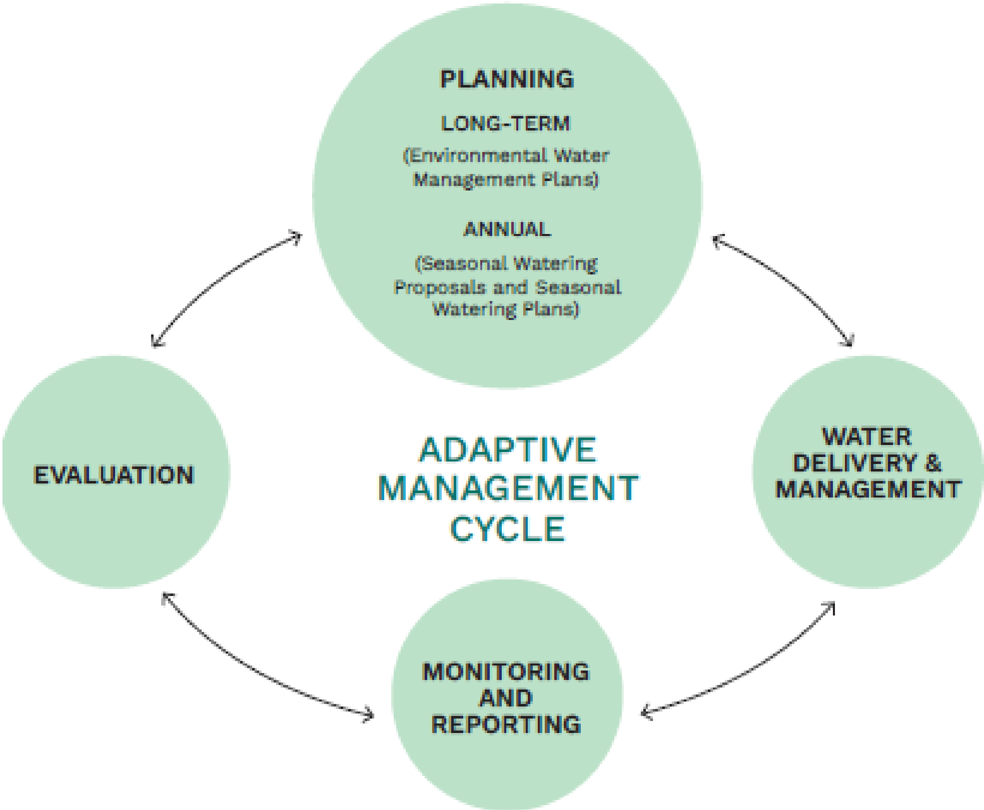


Figure 16. The adaptive management cycle for environmental water delivery and management

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.

In 2022, Mallee CMA further refined its adaptive management approach, implementing the Environmental Watering Adaptive Management Framework (Mallee CMA 2022)

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.

Mallee CMA's 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. In this way, we iteratively improve 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.

11.1 ADAPTIVE MANAGEMENT COMPONENTS

Environmental Watering Database

Mallee CMA uses an Environmental Watering Database for storage of watering information. It stores hydrological, environmental, and ecological watering event details, including data for informing adaptive management decisions.

Annual adaptive management checkpoint

An annual adaptive management checkpoint (AM Checkpoint) for each of Mallee CMA's Seasonal Watering Proposals provides a structured and formalised forum for evaluation and review.

The outcomes from each AM Checkpoint:

- informs the annual reporting to relevant stakeholders, including VEWH and DEECA
- identifies the key lessons from environmental water delivery events throughout the year, to be documented into the Watering Event Lessons (WEL) Record (below)
- informs Mallee CMA environment water annual planning for subsequent years.

Watering Event Lessons (WEL) record

Key decisions and justifications, new knowledge and lessons learned are documented in a 'live', site-specific, centralised, document called a Watering Event Lessons (WEL) Record. The WEL Record provides an opportunity for planning and delivery information to be systematically recorded and retained for subsequent evaluation at the AM Checkpoint (see above).

The WEL Record is also used to capture outcomes and knowledge generated from lesson review at the AM Checkpoint.

WEL Records are updated at the end of each watering event providing an accessible library of lessons ready to be uploaded into the CMA's organisational knowledge base via the EWMP update process.

Seasonal watering proposal presentation adaptive management section

The annual seasonal watering proposals presentation to Mallee CMA Chief Executive Officer and Executive Management includes a section on adaptive management.

This section explicitly focuses on outcomes and observations from previous events and any subsequent changes being made as a response within that years' Seasonal Watering Proposal. This promotes for the broader dissemination of findings and outcomes within Mallee CMA.

Monitoring consultants' findings summary

Monitoring consultants are required to synthesise their results and describe the implications of results for ongoing environmental watering programs. This promotes the transfer and uptake of knowledge from monitoring and other investigations into Mallee CMA water planning and management.

Figure 16 shows how adaptive management processes are integrated with Mallee CMA's environmental watering program.

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 Bottle Bend 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 Bottle Bend

Knowledge and data gap	Action recommended	Responsibility
Wetland condition	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.
Impacts of nearby irrigation on wetland health	Investigation of surface water, groundwater and irrigation water interaction	
Salt loads within the wetland	Data collection and monitoring	
Role of wetland on waterbird breeding and populations	Data collection and monitoring	
Accurate depth and volumes of wetland	Install depth gauges and undertake bathymetric survey	
Extent of Cumbungi infestation within the wetlands	Data collection and monitoring	
Current fauna and flora populations using the site	Surveys, data collection and monitoring	
Cultural Heritage and Values Assessments	Traditional Owners to carry out cultural heritage and values assessment at site to understand cultural constraints to watering.	

13 References

ANCA. (1996) A Directory of Important Wetlands in Australia Second Edition. Australian Nature Conservation Agency, Canberra, ACT

ARI. (2025). Mallee Wetland Understorey Vegetation Surveys 2024-2025.

Australian Water Environments. (2014) Salinity impact assessments for Karadoc Swamp, Lake Hawthorn and Bottle Bend, prepared for Mallee CMA, Mildura.

Baker-Gabb, D. and Hurley, V., (2011). National Recovery Plan for the Regent Parrot (eastern subspecies). East Melbourne, Victoria: Department of Sustainability and Environment.

Bluml, M. (1992). Sunraysia Salinity Management Plan - Environmental Report. Report prepared by Mildura Region, Department of Conservation and Environment, Victoria.

Browne, J. H. & Parsons, R. F. (2000). Causes of rarity in Abutilon oxycarpum and Hibiscus Brachysiphonius (Malvaceae) on the River Murray floodplain, south-eastern Australia. Transactions of the Royal Society of South Australia, 124 (1), 41-44.

Browne, P., Ellis, I., Henderson, M. & Lampard, B. (2014). Monitoring response of fish communities to the operation of The Living Murray environmental regulators at Hattah Lakes. Interim report prepared for the Mallee Catchment Management Authority by The Murray-Darling Freshwater Research Centre, MDFRC, Mildura.

Butcher, R., Cottingham, P. and Fenton, A. (2020) Briefing paper: Update of Mallee EWMP objectives, Report prepared by Water's Edge Consulting for Mallee Catchment management Authority, Mooroolbark, Victoria.

DCCEEW 2024. Protected Matters Search Tool (online). Available at: https://www.dcceew.gov.au/environment/epbc/protected-matters-search-tool

DEECA 2005. NatureKi*t*. Accessed at: https://maps2.biodiversity.vic.gov.au/Html5viewer/index.html?viewer=NatureKit

DEECA. (2024). Bioregions and EVC benchmarks. State Victoria. Department of Environment, Energy and Climate Action. Accessed at https://www.environment.vic.gov.au/biodiversity/bioregions-and-evc-benchmarks

Department of Environment and Primary Industries, Bioregions: http://www.DEPI.vic.gov.au/conservation-and-environment/victorias-bioregions#bioregion (Nov 2011)

Department of Environment and Primary Industries, Pig (feral or wild): http://www.depi.vic.gov.au/agriculture-and-food/pests-diseases-and-weeds/pest-animals/a-z-of-pest-animals/pig-feral-or-wild

Department of Environment, Land, Water and Planning Interactive Map: http://www.depi.vic.gov.au/environment-and-wildlife/biodiversity/biodiversity-interactive-map

Department of Planning and Community Development: http://www.dpcd.vic.gov.au/indigenous/heritage-tools/areas-of-cultural-sensitivity/roster-mallee-region-maps

DEWNR. (2012). Riverine Recovery Monitoring and Evaluation Program – Conceptual understanding of the ecological response to water level manipulation. Department of Environment, Water and Natural Resources (DEWNR), Adelaide, South Australia.

DNRE. (1997). Victoria's Biodiversity – Our Living Wealth – Sustaining Our Living Wealth and Directions in Management. Department of Natural Resources and Environment, East Melbourne, Victoria

DSE. (2005) Index of Wetland Condition. Conceptual framework and selection of measures. Department of Environment and Primary Industries, East Melbourne, Victoria

DSE. (2006). Wetlands, Biodiversity and Salt; Frogs. Department of Sustainability and Environment, East Melbourne, Victoria.

Ecological Associates. (2007a). Feasibility Investigation of Options for Hattah Lakes, Final Report. Ecological Associates for Mallee Catchment Management Authority Mildura, Victoria.

Ecological Associates. (2007b). Investigation of Water Management Options for the River Murray – Robinvale to Wallpolla Island: Final Report, Ecological Associates for Mallee Catchment Management Authority Mildura, Victoria

Ecological Associates (2013). Locks 8 and 9 Weir Pool Manipulation Optimisation Plan- Analysis Report. Buronga, NSW: NSW Office of Water.

Ecological Associates and Tonkins Consulting. (2016). Options for the Control and Management of Cumbungi at Woorlong and Bottle Bend Wetlands. Mallee Catchment Management Authority, Irymple, Victoria.

Green, D and Alexander, P. (2006). River Murray Wetland Database: NSW, Victoria. Wetland Commence to flow levels, June 2006 NSW Wetland Working Group Albury, NSW.

Ho, S., Ellis, I., Suitor, L., McCarthy, B. & Meredith, S. (2004). Distributions of aquatic vertebrates within the Mallee region; A baseline survey of fish, turtles and frogs February to May 2004. Murray-Darling Freshwater Research Centre, Mildura, Victoria.

Kingsford, R.T. and Norman, F.I. (2002). Australian waterbirds - products of the continent's ecology. Emu, (102), pp.47–69.

Land Conservation Council. (1989). Mallee Area Review Final Recommendations Land Conservation Council, Melbourne Victoria

Mallee CMA. (2003). Murray River Frontage Action Plan – Nyah to Robinvale Mallee Catchment Management Authority Mildura, Victoria

Mallee CMA. (2006). Mallee River Health Strategy Mallee Catchment Management Authority Mildura, Victoria

Mallee CMA. (2006A). Mallee Wetland Strategy Mallee Catchment Management Authority Mildura, Victoria

Mallee CMA. (2012). Kings Billabong Operating Plan Mallee Catchment Management Authority Mildura, Victoria.

Mallee CMA. (2014). Mallee Waterway Strategy 2014-22 Mallee Catchment Management Authority Mildura, Victoria.

MDBC. (2001). Rivers as Ecological Systems: The Murray-Darling Basin. Murray Darling Basin Commission, Canberra, ACT.

Mitsch, W. J. and Gosselink, J. (1993). Wetlands, Second Edition. New York: Van Nostrand Reinhold.

Murray-Darling Basin Authority. (2009). Environmental Watering for Waterbirds in The Living Murray Icon Sites. A literature review and identification of research priorities relevant to the environmental watering actions of flow enhancement and retaining floodwater on floodplains. Murray-Darling Basin Authority, Canberra, ACT.

Murray-Darling Basin Authority. (2019). Basin-wide environmental watering strategy, Murray–Darling Basin Authority Canberra, ACT.

Parks Victoria, Mildura's Murray River Parklands: http://parkweb.vic.gov.au/explore/parks/river-murray-reserve

Purdey, D. & Loyn, R. (2008). Wetland use by Blue-billed Ducks Oxyura australis during Summer Waterfowl Counts in North-West Victoria, 1984-2008. Arthur Rylah Institute for Environmental Research, Heidleberg, Victoria.

Richardson, S. and Currie, D. (2015). Preliminary Salinity Impact Assessment for Mallee Environmental Watering Sites. Melbourne, Victoria: CDM Smith.

Roberts, J. & Marston, F. (2011). Water Regime for Wetland and Floodplain Plants; a source book for the Murray-Darling Basin. National Water Commission, Canberra, ACT.

Rogers, K. & Ralph, T. J. (2011). Floodplain wetland biota in the Murray Darling Basin. Edited by Rogers K and Ralph TJ. Pages 17-82. CSIRO Publishing. Collingwood.

Roshier, D.A., Robertston, A.I. and Kingsford, R.T. (2002). Responses of waterbirds to flooding in an arid region of Australia and implications for conservation. Biological Conservation, (106), pp.399–411.

Sinclair S.J. (2004). River Red Gum decline in the Nyah-Piangil Area: Is the semi-parasitic Pale-fruit Ballart involved? Report to Mallee CMA. Arthur Rylah Institute for Environmental Research. Heidelberg, Victoria

SKM. (2002). Karadoc Swamp Wetland Management Plan. Final Report, Sinclair Knight Merz for Mallee Catchment Management Authority, Mildura, Victoria.

Sunraysia Environmental. (2014). Regional Context Document for Environmental Water Management Plans: Mallee CMA Region, Sunraysia Environmental for Mallee Catchment Management Authority Mildura, Victoria.

VEAC. (2008). River Red Gum Investigation Victorian Environmental Assessment Council East Melbourne, Victoria

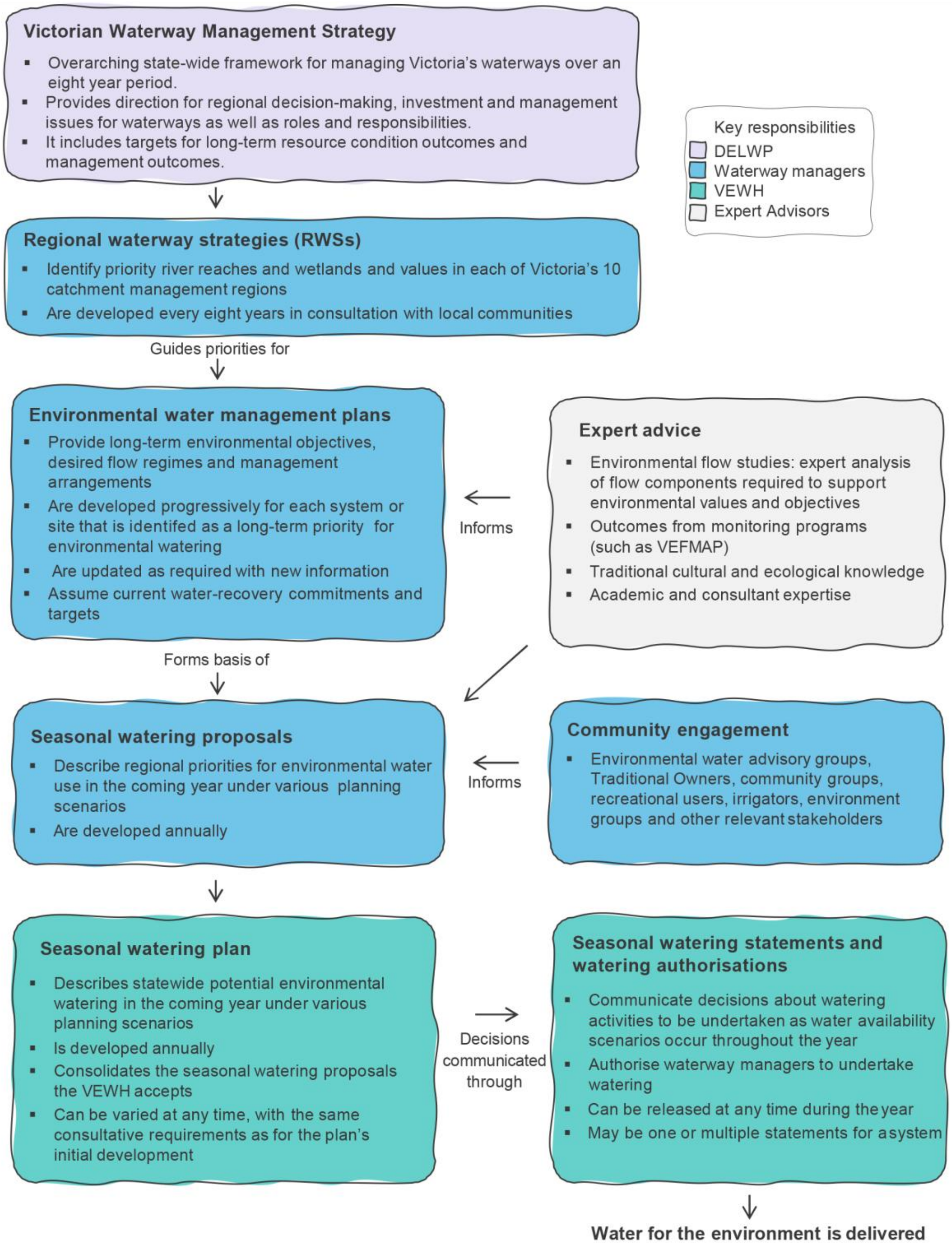
Young, W.J. (2001). Rivers as ecological systems: the Murray-Darling Basin. Canberra, ACT: Murray-Darling Basin Commission.

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 Bottle Bend 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 Bottle Bend 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 Bottle Bend.

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 2025

Community stakeholders were engaged on the update of this and other EWMPs in-person at local events, including local markets (Red Cliffs Market), local environmental group outings to the site (Mildura Birdlife) and onsite community group events (general community). 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 the sites within the Bottle Bend and other WMU subunits. Community consultation occurs at the IAP2 level of CONSULT.

In-person community engagement:

Community stakeholders provided information about Bottle Bend at in-person meetings with Mildura Birdlife, and in general community events and markets. These stakeholders had specific interests in birds, recreational activities and water values at the site.

Traditional Owner engagement on Country:

Traditional Owner representatives were engaged on the Bottle Bend EWMP at an in-person meeting at Mallee CMA offices in October 2024. Representatives from FPMMAC attended the meeting. A 'pins in maps' exercise was also completed at this meeting. Traditional Owners identified water-dependent values, flora and fauna values (birdlife and native vegetation), recreational values (camping), and other cultural values across Bottle Bend. The true extent of cultural heritage at Bottle Bend is unknown.

Agency Engagement:

Mallee CMA engaged with representatives from agency stakeholders Parks Victoria, Lower Murray Water, Mildura Rural City Council and Goulburn Murray Water in June 2025 via email and presentation seeking site specific input regarding changes to site condition, site and surrounding land use, known flora and fauna and infrastructure (drainage, bores etc) at the site.

APPENDIX 3.

ECOLOGICAL VEGETATION CLASSES

EVC no.	EVC name	Bioregional Conservation Status	Description
810	Floodway Pond Herbland	Depleted	Low herbland to < 0.3 m tall with occasional emergent life forms, usually with a high content of ephemeral species. Floors of ponds associated with floodway systems. Typically, heavy deeply cracking clay soils. Characteristically smaller wetlands with a more regular flooding and drying cycle in comparison to sites supporting Lakebed Herbland.
103	Riverine Chenopod Woodland	Depleted	Eucalypt woodland to 15 m tall with a diverse shrubby and grassy understorey occurring on most elevated riverine terraces. Confined to heavy clay soils on higher level terraces within or on the margins of riverine floodplains (or former floodplains), naturally subject to only extremely infrequent incidental shallow flooding from major events if at all flooded.
806	Alluvial Plains Semi-arid Grassland	Vulnerable	Grassland (turf) to herbland to <0.2 m tall with only incidental shrubs. Flood-promoted flora, potentially including a wide range of opportunistic ephemeral / annual species occupying low-lying areas within at least previously flood-prone (mostly) higher-level terraces, which may be effectively shallow lakes when flooded. Also, sometimes on flats along creeks of the further north-west, in habitat akin to that of Floodway Pond Herbland.
813	Intermittent Swampy Woodland	Depleted	Eucalypt woodland to 15 m tall with a variously shrubby and rhizomatous sedgy - turf grass understorey, at best development dominated by flood stimulated species in association with flora tolerant of inundation. Flooding is unreliable but extensive when it happens. Occupies low elevation areas on river terraces (mostly at the rear of point-bar deposits or adjacent to major floodways) and lacustrine verges (where sometimes localised to narrow transitional bands). Soils often have a shallow sand layer over heavy and frequently slightly brackish soils.
808	Lignum Shrubland	Least concerned	Relatively open shrubland of species of divaricate growth form. The ground-layer is typically herbaceous or a turf grassland, rich in annual/ephemeral herbs and small chenopods. Characterised the open and even distribution of relatively small Lignum shrubs. Occupies heavy soil plains along Murray River, low-lying areas on higher-level (but still potentially flood-prone) terraces.
DEECA 2024			

APPENDIX 4.

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

Scientific Name	Common Name	FFG Act Status	EPBC Act Status
Acanthiza chrysorrhoa	Yellow-rumped Thornbill		
Acanthiza nana	Yellow Thornbill		
Acanthiza uropygialis	Chestnut-rumped Thornbill		
Acanthorhynchus tenuirostris	Eastern Spinebill		
Accipiter fasciatus	Brown Goshawk		
Anas gracilis	Grey Teal		
Anas superciliosa	Pacific Black Duck		
Anhinga novaehollandiae	Darter		
Anthochaera carunculata	Red Wattlebird		
Ardea alba modesta	Eastern Great Egret	Vulnerable	
Ardea pacifica	White-necked Heron		
Artamus leucorynchus	White-breasted Woodswallow		
Aythya australis	Hardhead		
Barnardius zonarius barnardi	Mallee Ringneck		
Cacatua galerita	Sulphur-crested Cockatoo		
Cacatua sanguinea	Little Corella		
Cacomantis flabelliformis	Fan-tailed Cuckoo		
*Carassisus auratus**	Goldfish		
Certhionyx variegatus	Pied Honeyeater		
Chelodina expansa	Broad-shelled Turtle	Endangered	
Chelodina longicollis	Eastern Long-necked Turtle		
Chenonetta jubata	Australian Wood Duck		
Chrysococcyx basalis	Horsfield's Bronze-Cuckoo		
Chrysococcyx osculans	Black-eared Cuckoo		
Circus approximans	Swamp Harrier		
Climacteris picumnus victoriae	Brown Treecreeper (south-eastern ssp.)		Vulnerable
Colluricincla harmonica	Grey Shrike-thrush		
Coracina novaehollandiae	Black-faced Cuckoo-shrike		
Corcorax melanorhamphos	White-winged Chough		
Corvus coronoides	Australian Raven		
Cracticus nigrogularis	Pied Butcherbird		
Cracticus torquatus	Grey Butcherbird		
Craterocephalus stercusmuscarum	Fly-specked Hardyhead		
Crinia parinsignifera	Plains Froglet		
Cryptoblepharus pannosus	Carnaby's Wall Skink		
Ctenophorus pictus	Painted Dragon		
Ctenotus orientalis	Eastern Striped Skink		
Ctenotus regius	Regal Striped Skink		
Cuculus pallidus	Pallid Cuckoo		
Cygnus atratus	Black Swan		
*Cyprinus carpio**	Common Carp		
Dacelo novaeguineae	Laughing Kookaburra		
Daphoenositta chrysoptera	Varied Sittella		

Dicaeum hirundinaceum	Mistletoebird		
Diplodactylus damaeus	Beaded Gecko		
Egernia striolata	Tree Skink		
Egretta novaehollandiae	White-faced Heron		
Elseyornis melanops	Black-fronted Dotterel		
Entomyzon cyanotis	Blue-faced Honeyeater		
Eolophus roseicapilla	Galah		
Epthianura albifrons	White-fronted Chat		
Erythrogonys cinctus	Red-kneed Dotterel		
Falcunculus frontatus	Crested Shrike-tit		
Gallinula tenebrosa	Dusky Moorhen		
*Gambusia holbrooki**	Gambusia		
Gehyra variegata	Tree Dtella		
Geopelia striata	Peaceful Dove		
Gerygone fusca	Western Gerygone		
Grallina cyanoleuca	Magpie-lark		
Gymnorhina tibicen	Australian Magpie		
Haliastur sphenurus	Whistling Kite		
Heteronotia binoei	Bynoe's Gecko		
Hieraaetus morphnoides	Little Eagle	Vulnerable	
Himantopus himantopus	Black-winged Stilt		
Hydromys chrysogaster	Water Rat		
Hypseleotris spp	Carp Gudgeon spp		
Lerista punctatovittata	Spotted Burrowing Skink		
Lerista timida	Dwarf Burrowing Skink	Endangered	
Lialis burtonis	Burton's Snake-Lizard		
Lichenostomus penicillatus	White-plumed Honeyeater		
Limnodynastes dumerilii	Southern Bullfrog (ssp. unknown)		
Limnodynastes dumerilii dumerilii	Pobblebonk Frog		
Limnodynastes fletcheri	Barking Marsh Frog		
Limnodynastes tasmaniensis	Spotted Marsh Frog (race unknown)		
Litoria peronii	Peron's Tree Frog		
Litoria raniformis	Growling Grass Frog	Vulnerable	Vulnerable
Macropus fuliginosus	Western Grey Kangaroo		
Malurus lamberti	Variegated Fairy-wren		
Manorina melanocephala	Noisy Miner		
Megalurus gramineus	Little Grassbird		
Melithreptus brevirostris	Brown-headed Honeyeater		
Melopsittacus undulatus	Budgerigar		
Menetia greyii	Grey's Skink		
Merops ornatus	Rainbow Bee-eater		
Microcarbo melanoleucos	Little Pied Cormorant		
Microeca fascinans	Jacky Winter		
Milvus migrans	Black Kite		
Myiagra inquieta	Restless Flycatcher		
Nycticorax caledonicus hillii	Nankeen Night Heron		
Nymphicus hollandicus	Cockatiel		

Ocyphaps lophotes	Crested Pigeon		
Oxyura australis	Blue-billed Duck	Vulnerable	
Pachycephala pectoralis	Golden Whistler		
Pachycephala rufiventris	Rufous Whistler		
Pardalotus striatus	Striated Pardalote		
Pelecanus conspicillatus	Australian Pelican		
Petrochelidon neoxena	Welcome Swallow		
Petrochelidon nigricans	Tree Martin		
Petroica goodenovii	Red-capped Robin		
Phalacrocorax sulcirostris	Little Black Cormorant		
Phaps chalcoptera	Common Bronzewing		
Philemon citreogularis	Little Friarbird		
Philypnodon grandiceps	Flathead Gudgeon		
Phylidonyris albifrons	White-fronted Honeyeater		
Phylidonyris novaehollandiae	New Holland Honeyeater		
Platalea flavipes	Yellow-billed Spoonbill		
Platycercus elegans flaveolus	Yellow Rosella		
Plectorhyncha lanceolata	Striped Honeyeater		
Podargus strigoides	Tawny Frogmouth		
Poliocephalus poliocephalus	Hoary-headed Grebe		
Polytelis anthopeplus monarchoides	Regent Parrot	Vulnerable	Vulnerable
Pomatostomus ruficeps	Chestnut-crowned Babbler		
Pomatostomus superciliosus	White-browed Babbler		
Porphyrio porphyrio	Purple Swamphen		
Porzana fluminea	Australian Spotted Crake		
Porzana tabuensis	Spotless Crake		
Psephotus haematonotus	Red-rumped Parrot		
Pseudonaja textilis	Eastern Brown Snake		
Ramphotyphlops bituberculatus	Peters's Blind Snake		
Rhipidura albiscarpa	Grey Fantail		
Rhipidura leucophrys	Willie Wagtail		
Rhynchoedura ornata	Beaked Gecko	Endangered	
Smicrornis brevirostris	Weebill		
Strepera versicolor	Grey Currawong		
Strophurus intermedius	Southern Spiny-tailed Gecko		
*Sturnus vulgaris**	Common Starling		
Sugamel niger	Black Honeyeater		
Tadorna tadornoides	Australian Shelduck		
Tiliqua occipitalis	Western Blue-tongued Lizard		
Todiramphus sanctus	Sacred Kingfisher		
Trichosurus vulpecula	Common Brushtail Possum		
*Turdus merula**	Common Blackbird		
Vanellus miles	Masked Lapwing		
Vermicella annulata	Bandy Bandy	Endangered	
*Vulpes vulpes**	Red Fox		
*Indicates introduced species			

DEECA 2025, DCCEEW 2024

FLORA SPECIES LIST - COMBINED NATUREKIT, VICTORIAN BIODIVERSITY ALTAS WITH RESULTS OF A WETMAP FLORA SURVEY (WETMAP 2024)

Scientific Name	Common Name	FFG Act Status	EPBC Act Status
Abutilon fraseri	Dwarf Lantern-flower	Endangered	
Abutilon malvifolium	Mallow-leaf Lantern-flower	Critically Endangered	
Acacia colletioides	Wait-a-while	Endangered	
Acacia ligulata	Small Cooba		
Acacia salicina	Willow Wattle		
Acacia stenophylla	Eumong		
Acacia wilhelmiana	Dwarf Nealie		
Alternanthera denticulata s.s.	Lesser Joyweed		
Ammannia multiflora	Jerry-jerry	Endangered	
Amphipogon caricinus var. caricinus	Long Grey-beard Grass		
Arabidella trisecta	Shrubby Cress		
Arctotheca calendula*	Cape weed		
Asperula gemella	Twin-leaf Bedstraw	Endangered	
Asperula wimmerana	Wimmera Woodruff	Endangered	
Asphodelus fistulosus*	Onion Weed		
Aster subulatus*	Aster-weed		
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 prostrata*	Hastate Orache		
Atriplex pseudocampanulata	Mealy Saltbush		
Atriplex pumilio	Mat Saltbush		
Atriplex semibaccata	Berry Saltbush		
Atriplex spinibractea	Spiny-fruit Saltbush	Endangered	

Atriplex spp.	Saltbush		
Atriplex suberecta	Sprawling Saltbush		
Austrostipa acrociliata	Graceful Spear-grass		
Austrostipa elegantissima	Feather Spear-grass		
Austrostipa scabra subsp. falcata	Rough Spear-grass		
Austrostipa spp.	Spear Grass		
Avena fatua*	Wild Oat		
Bergia trimera	Small Water-fire	Endangered	
Bolboschoenus caldwellii	Salt Club-sedge		
Brachyscome basaltica var. gracilis	Woodland Swamp-daisy		
Brachyscome ciliaris	Variable Daisy		
Brachyscome lineariloba	Hard-head Daisy		
Bromus diandrus*	Great Brome		
Bromus rubens*	Red Brome		
Bulbine semibarbata	Leek Lily		
Callitris gracilis	Slender Cypress-pine		
Calocephalus citreus	Lemon Beauty-heads		
Calocephalus sonderi	Pale Beauty-heads		
Calostemma purpureum s.l.	Garland Lily		
Calotis cuneifolia	Blue Burr-daisy	Endangered	
Calotis erinacea	Tangled Burr-daisy		
Calotis hispidula	Hairy Burr-daisy		
Calotis scapigera	Tufted Burr-daisy		
Casuarina pauper	Belah		
Centaurea melitensis*	Malta Thistle		
Centipeda cunninghamii	Common Sneezeweed		
Chenopodium spp.	Goosefoot		
Chloris truncata	Windmill Grass		
Cirsium vulgare*	Spear Thistle		
Codonocarpus cotinifolius	Bell-fruit Tree		
Cotula bipinnata*	Ferny Cotula		

Craspedia haplorrhiza	Plains Billy-buttons	Endangered	
Crassula colorata	Dense Crassula		
Crassula sieberiana s.l.	Sieber Crassula		
Cucumis myriocarpus subsp. Leptodermis*	Paddy Melon		
Cullen cinereum	Hoary Scurf-pea	Endangered	
Cullen tenax	Tough Scurf-pea	Endangered	
Cuscuta campestris*	Field Dodder		
Cynodon dactylon	Couch		
Cyperus exaltatus	Tall Flat-sedge		
Cyperus gunnii subsp. gunnii	Flecked Flat-sedge		
Cyperus gymnocaulos	Spiny Flat-sedge		
Cyperus hamulosus*	Curry Flat-sedge		
Cyperus pygmaeus	Dwarf Flat-sedge	Endangered	
Daucus glochidiatus	Australian Carrot		
Digitaria ammophila	Silky Umbrella-grass	Endangered	
Disphyma crassifolium subsp. clavellatum	Rounded Noon-flower		
Dissocarpus paradoxus	Hard-head Saltbush		
Dittrichia graveolens*	Stinkwort		
Dodonaea viscosa subsp. angustissima	Slender Hop-bush		
Duma florulenta	Tangled Lignum		
Dysphania cristata	Crested Goosefoot		
Eclipta platyglossa subsp. platyglossa	Yellow Twin-heads		
Einadia nutans	Nodding Saltbush		
Elachanthus glaber	Smooth Elachanth	Endangered	
Eleocharis acuta	Common Spike-sedge		
Emex australis*	Spiny Emex		
Enchylaena tomentosa var. tomentosa	Ruby Saltbush		
Enneapogon avenaceus	Common Bottle-washers		
Eragrostis australasica	Cane Grass	Critically Endangered	
Eragrostis dielsii	Mallee Love-grass		
Eragrostis exigua	Slender Love-grass	Endangered	
Eragrostis infecunda	Southern Cane-grass		

Eragrostis parviflora	Weeping Love-grass		
Eremophila deserti	Turkey Bush		
Eremophila divaricata subsp. divaricata	Spreading Emu-bush	Vulnerable	
Eremophila longifolia	Berrigan		
Eremophila maculata subsp. maculata	Spotted Emu-bush	Critically Endangered	
Ethuliopsis cunninghamii	Tall nut-heads	Endangered	
Eucalyptus camaldulensis	River Red-gum		
Eucalyptus largiflorens	Black Box		
Euchiton sphaericus	Annual Cudweed		
Euphorbia drummondii	Flat Spurge		
Euphorbia terracina*	Terracina Spurge		
Exocarpos sparteus	Broom Ballart		
Goodenia fascicularis	Silky Goodenia		
Goodenia glauca	Pale Goodenia		
Goodenia heteromera	Spreading Goodenia		
Goodenia pinnatifida	Cut-leaf Goodenia		
Grevillea huegelii	Comb Grevillea		
Hakea leucoptera subsp. leucoptera	Silver Needlewood		
Hakea tephrosperma	Hooked Needlewood		
Haloragis aspera	Rough Raspwort		
Helichrysum luteoalbum	Jersey Cudweed		
Heliotropium curassavicum	Salt heliotrope		
Hibiscus brachysiphonius	Low Hibiscus	Critically Endangered	
Hordeum leporinum*	Barley-grass		
Hordeum murinum s.l.*	Barley-grass		
Hypochaeris glabra*	Smooth Cat's-ear		
Hypochaeris radicata*	Flatweed		
Juncus acutus subsp. Acutus*	Spiny Rush		
Lachnagrostis filiformis s.l.	Common Blown-grass		
Lactuca saligna*	Willow-leaf Lettuce		

Lactuca serriola*	Prickly Lettuce		
Leiocarpa websteri	Stalked Plover-daisy		
Lepidium africanum*	Common Peppercress		
Lepidium papillosum	Warty Peppercress		
Lomandra collina	Pale Mat-rush		
Lycium australe	Australian Box-thorn		
Lycium ferocissimum*	African Box-thorn		
Maireana aphylla	Leafless Bluebush		
Maireana brevifolia	Short-leaf Bluebush		
Maireana decalvans s.l.	Black Cotton-bush		
Maireana pentagona	Hairy Bluebush		
Maireana pentatropis	Erect Bluebush		
Maireana pyramidata	Sago Bush		
Malacocera tricornis	Goat Head	Vulnerable	
Marsilea costulifera	Narrow-leaf Nardoo		
Marsilea drummondii	Common Nardoo		
Medicago minima*	Little Medic		
Medicago sativa subsp. Sativa*	Lucerne		
Melilotus indicus*	Sweet Melilot		
Mesembryanthemum crystallinum*	Common Ice-plant		
Mesembryanthemum nodiflorum*	Small Ice-plant		
Minuria leptophylla	Minnie Daisy		
Minuria integerrima	Smooth Minuria	Vulnerable	
Monoculus monstrosus*	Tripteris		
Myoporum montanum	Waterbush	Endangered	
Myoporum platycarpum	Sugarwood		
Neobassia proceriflora	Soda bush	Critically endangered	
Olearia lepidophylla	Club-moss Daisy-bush		
Olearia pimeleoides	Pimelea Daisy-bush		
Osteocarpum acropterum var. deminutum	Babbagia		
Parapholis incurva*	Coast Barb-grass		
Paspalidium constrictum	Knottybutt Grass		

Paspalidium jubiflorum	Warrego Summer-grass		
Paspalum dilatatum*	Paspalum		
Paspalum distichum*	Water Couch		
Pentameris airoides subsp. Airoides*	False Hair-grass		
Persicaria prostrata	Creeping Knotweed		
Phragmites australis	Common Reed		
Phyla canescens*	Fog-fruit		
Phyllanthus lacunarius	Lagoon Spurge	Endangered	
Picris angustifolia	Native Picris		
Picris squarrosa	Squat Picris	Endangered	
Pittosporum angustifolium	Weeping Pittosporum		
Plantago drummondii	Dark Plantain		
Plantago lanceolata*	Ribwort		
Polycalymma stuartii	Poached-eggs Daisy		
Polygonum aviculare s.l.*	Prostrate Knotweed		
Prostanthera serpyllifolia subsp. microphylla	Small-leaf Mint-bush		
Psilocaulon granulicaule*	Wiry Noon-flower		
Ptilotus nobilis	Mulla Mulla		
Ptilotus nobilis subsp. nobilis	Pink Mulla-mulla		
Ptilotus nobilis var. nobilis	Yellow Tails	Endangered	
Ptilotus sessilifolius	Crimson Tails		
Ranunculus pumilio var. politus	Ferny Small-flower Buttercup		
Ranunculus pumilio var. pumilio	Ferny Small-flower Buttercup		
Ranunculus spp.	Buttercup		
Reichardia tingitana*	False Sow-thistle		
Rhagodia spinescens	Hedge Saltbush		
Rorippa spp.	Bitter Cress		
Rytidosperma caespitosum	Common Wallaby-grass		
Salsola tragus subsp. tragus	Prickly Saltwort		

Salvia verbenaca*	Wild Sage		
Scaevola spinescens	Prickly Fan-flower		
Schenkia australis	Spiked Centaury		
Schismus barbatus*	Arabian Grass		
Schoenus subaphyllus	Desert Bog-sedge		
Sclerochlamys brachyptera	Short-wing Saltbush		
Sclerolaena diacantha	Grey Copperburr		
Sclerolaena muricata	Black Roly-poly		
Sclerolaena muricata var. villosa	Grey Roly-poly		
Sclerolaena obliquicuspis	Limestone Copperburr		
Sclerolaena tricuspis	Streaked Copperburr		
Senecio glossanthus s.l.	Slender Groundsel		
Senecio runcinifolius	Tall Fireweed		
Senna artemisioides spp. agg.	Desert Cassia		
Senna form taxon 'coriacea'	Broad-leaf Desert Cassia		
Sesbania cannabina var. cannabina	Yellow Pea-bush	Critically Endangered	
Sida ammophila	Sand Sida	Endangered	
Sida trichopoda	Narrow-leaf Sida		
Sisymbrium erysimoides*	Smooth Mustard		
Sisymbrium irio*	London Rocket		
Sisymbrium orientale*	Indian Hedge-mustard		
Sonchus asper s.l.*	Rough Sow-thistle		
Sonchus hydrophilus	Native Sow-thistle		
Sonchus oleraceus*	Common Sow-thistle		
Spergularia brevifolia	Salt Sea-spurrey		
Spergularia diandra*	Lesser Sand-spurrey		
Spergularia media s.l.	Coast Sand-spurrey		
Spergularia rubra s.l.*	Red Sand-spurrey		
Spergularia rubra s.s.*	Red Sand-spurrey		
Sporobolus mitchellii	Rat-tail Couch		
Stelligera endecaspinis	Star Bluebush		

Stemodia florulenta	Blue rod		
Suaeda spp.	Seablite		
Tecticornia pergranulata	Blackseed Glasswort		
Tetragonia eremaea s.l.	Desert Spinach		
Tetragonia moorei	Annual Spinach		
Thysanotus baueri	Mallee Fringe-lily		
Vittadinia cervicularis	Annual New Holland Daisy		
Vittadinia cervicularis var. subcervicularis	Annual New Holland Daisy		
Vittadinia dissecta var. hirta	Dissected New Holland Daisy		
Vittadinia gracilis	Woolly New Holland Daisy		
Vulpia myuros*	Rat's-tail Fescue		
Wahlenbergia fluminalis	River Bluebell		
Xanthium spinosum*	Bathurst Burr		
Xanthium strumarium spp. agg.*	Noogoora Burr spp. agg.		
Zygophyllum apiculatum	Pointed Twin-leaf		
Zygophyllum crenatum	Notched Twin-leaf		
Zygophyllum eremaeum	Climbing Twin-leaf		
*Indicates introduced species			

APPENDIX 5.

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	

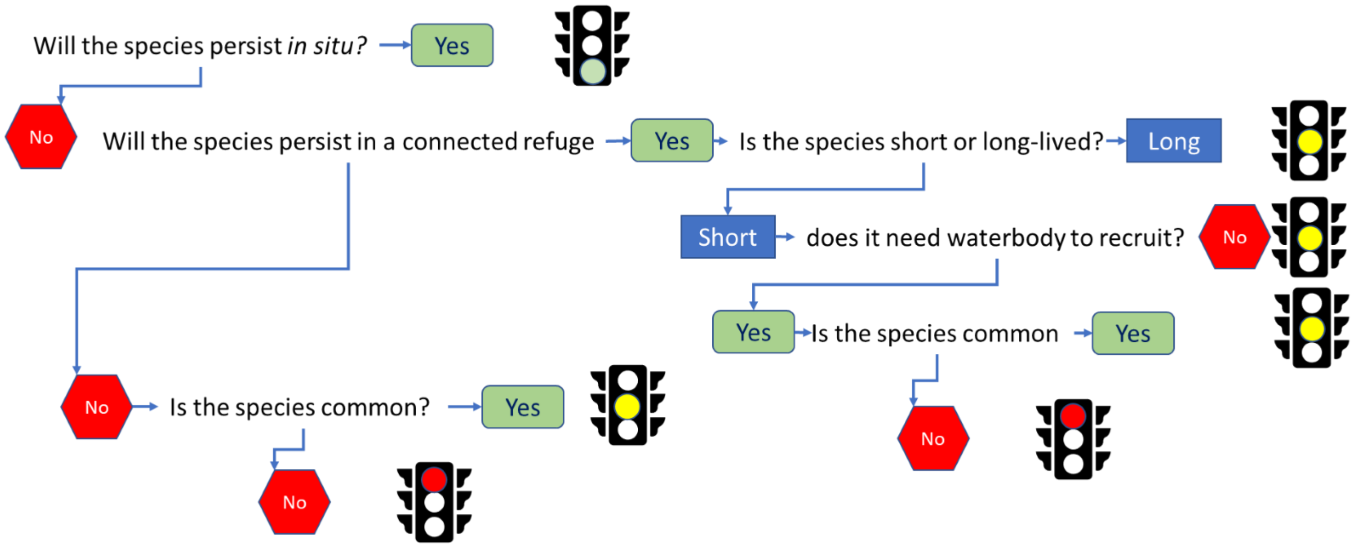


Figure A1 – Decision tree for assessing risk

APPENDIX 6.

EWMP UPDATED ENVIRONMENTAL OBJECTIVES, FURTHER INFORMATION 9FROM BUTCHER ET AL. 2020)

5.3 Bottle Bend

5.3.1 SMARTness and rationalisation

Site-specific environmental objectives for the Bottle Bend EWMP (Mallee CMA 2016a).

EWMP objectives
BB1: Provide shallow water habitat that supports waterfowl and waders through improved conditions for foraging, nesting and recruitment
BB2: Promote a diverse aquatic macrophyte zone
BB3: Provide seasonal aquatic habitat that supports a diverse frog population
BB4: Support the health of the fringing Riverine Chenopod Woodland

Assessment of SMARTness of current Bottle Bend 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
BB1	0	0	1	1	1	0.5	1	1	1	0	0
BB2	0	0	1	1	1	0.5	1	1	1	0	0
BB3	0	0	0.5	1	1	0.5	1	1	0.5	0	0
BB4	0	0	1	1	1	0.5	1	1	0.5	0	0

Rationalised environmental objectives for the Bottle Bend EWMP (Mallee CMA 2016).

Objective	Issue	Outcome
BB1	Nothing wrong with objective other than not fully SMART – focus is on waterbird habitat supporting feeding, nesting and breeding. However, the specific species that breed at the site are not recorded so focus will be on shallow and deep habitat with the view that it will capture most species	Split into two objectives – one about feeding and one about nesting/breeding. Need to know what species do actually breed at the site before being able to set a target.
BB2	Nothing wrong with objective other than not fully SMART	No significant change – align with Basin Plan
BB3	Nothing wrong with objective other than not fully SMART	No significant change – align with Basin Plan
BB4	Black Box and RRG are noted as being in a stressed condition. Black box is the dominant tree species in the EVC (103)	Specified for tree condition for Black Box with the assumption that will cover the grassy understory.

5.3.2 Mapping to Basin Plan

Basin Plan Schedule 8 and 9 criteria.

Schedule 8 criteria met	Schedule 9 criteria met
From DELWP (2015a)	
1: JAMBA, CAMBA, ROKAMBA, BONN **2:** 292 Red Gum Swamp - Vulnerable^ **4:** FFG Act, EPBC act, DSE Listed	**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 **4(a)** Supports EPBC listed species	**1(c):** Vital habitat - feeding, breeding, nursery sites **1(e)**: Vital habitat - preventing decline of native biota

^ Mapping PEA criteria 2 to EVC is not appropriate

Mapping Bottle Bend 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
BB1: Provide shallow water habitat that supports waterfowl and waders through improved conditions for foraging, nesting and recruitment	8.05,3(b) 8.06,6(b)	Condition of priority asset - prevention of decline in native biota Recruitment and populations of native water-dependent birds	B3.2	LTWPVM13 LTWPVM11 LTWPVM12
BB2: Promote a diverse aquatic macrophyte zone	8.05,3(b) 8.06,6(b)	Condition of priority asset - prevention of decline in native biota Condition of priority ecosystem functions - creation of vital habitat - habitat for prevention of decline in native species Diversity of native water dependent vegetation	B2.11	LTWPVM2

EWMP objectives	Relevant Basin Plan EWP objective	Relevant Schedule 7 target	Relevant BWS QEEO	LTWP objective
BB3: Provide seasonal aquatic habitat that supports a diverse frog population	8.06,6(a) 8.05,3(a) 8.05,3(b)	Condition of priority asset - prevention of decline in native biota Condition of priority asset - Vital habitat - feeding, breeding, nursery Condition of priority asset - supports listed species and communities Recruitment and populations of other native water-dependent biota	None specified	LTWPVM19 LTWPVM20
BB4: Support the health of the fringing Riverine Chenopod Woodland	8.05,3(b) 8.06,6(b)	Condition of priority asset - prevention of decline in native biota Condition of priority ecosystem functions - creation of vital habitat - habitat for prevention of decline in native species Condition of native water dependent vegetation	None specified	None specified, but possible covered by Lignum objectives?

5.3.3 *Updated objectives for Bottle Bend*

Current objective	BB1: Provide shallow water habitat that supports waterfowl and waders through improved conditions for foraging, nesting and recruitment.
Comments	Split into two objectives – one about feeding and one about nesting/breeding
EWP objective(s)	8.06,6(b) 8.05,3(b)
Schedule 7 targets	Condition of priority asset - prevention of decline in native biota Recruitment and populations of native water-dependent birds
PEA/PEF criteria met	PEA 3(a) iii Vital habitat - feeding, breeding, nursery sites PEA 3(b) Prevents declines in native biota PEF 1 (c) Vital habitat - feeding, breeding, nursery sites PEF 1(e) Vital habitat - preventing decline of native biota
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	LTWPVM11: Improve breeding opportunities for waterbirds 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 BB1a:	By 2030, maintain representative populations of shallow-water and deep-water feeding guilds of waterbird (F2 and F3, respectively, after Jaensch 2002) at the Bottle Bend asset, by maintaining a mixture of shallow and deep-water habitats.
2020 Targets BB1a:	By 2030, 80% of representative F2 and F3 species recorded at Bottle Bend in 8 years out of any 10-year period in which conditions are suitable. • Representative F2 species include: Black Swan (*Cygnus atratus*), Australian Shelduck (*Todorna tadornoides*), Pacific Black Duck (*Anas superciliosa*), Grey Teal (*Anas gracilis*), White-faced Heron (*Egretta novaehollandiae*), White-necked Heron (*Ardea pacifica*), Great Egret (*Ardea modesta*), Yellow-billed Spoonbill (*Platalea flavipes*), Purple Swamphen (*Porphyrio porphyrio*), Dusky Moorhen (*Gallinula tenebrosa*) • Representative F3 species include: Australian Pelican (*Pelecanus conspicillatus*), Blue-billed Duck (*Oxyura australis*), Hardhead (*Aythya australis*), Musk Duck (*Biziura lobata*), Australasian Darter (*Anhinga novaehollandiae*), Little Black Cormorant (*Phalacrocorax sulcirostris*), Little Pied Cormorant (*Microcarbo melanoleucos*) • 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.
Comments	Need to identify which species if any breed at the site.
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 PEA 3(b) Prevents declines in native biota PEF 1 (c) Vital habitat - feeding, breeding, nursery sites PEF 1(e) Vital habitat - preventing decline of native biota
BWS 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	LTWPVM11: Improve breeding opportunities for waterbirds LTWPVM12: Improve habitat for waterbirds LTWPVM13: Improve feeding areas for waterbirds
LTWP target	No target for non-colonial breeding
2020 Objective BB1b:	By 2030, maintain nesting and recruitment of non-colonial waterbirds (N1, N2, N3 and N4, after Jaensch 2002) at the Bottle Bend asset, by maintaining a mixture of tree, low vegetation/shrubs, and ground/islet nesting habitat.

2020 Targets BB1b:	There is a lack of data on species that breed at the site. The expectation is that the list of species commonly nesting at Bottle Bend will be confirmed over time By 2030, at least two of the following species to be recorded as nesting and/or breeding at the Bottle Bend asset in 7 out of any 10-year period in which nesting/breeding conditions are suitable: Representative N1 and N2 species include: Yellow-billed Spoonbill (*Platalea flavipes*), Purple Swamphen (*Porphyrio porphyrio*) Representative N3 and N4 species include: Dusky Moorhen (*Gallinula tenebrosa*), Black-winged Stilt (*Himantopus himantopus*), Black-fronted Dotterel (*Elseyornis melanops*), Red-kneed Dotterel (*Erythrogonys cinctus*), Masked Lapwing (*Vanellus miles*) Pacific Black Duck (*Anas supercilliosa*)

Current objective	BB2: Promote a diverse aquatic macrophyte zone
Comments	Adopted WRIGs for aquatic macrophytes.
EWP objective(s)	8.05,3(b) 8.06,6(b)
Schedule 7 targets	Condition of priority asset - prevention of decline in native biota Condition of priority ecosystem functions - creation of vital habitat - habitat for prevention of decline in native species Diversity of native water dependent vegetation
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 the Bottle Bend asset 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 macrophytes at the Bottle Bend asset 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) (Common Blown-grass *Lachnagrostis filiformis* s.l., Narrow-leaf Nardoo *Marsilea costulifera* Common Nardoo, *Marsilea drummondii)*

	• Seasonally inundated – emergent non woody (Sen) (Spiny Flat-sedge *Cyperus gymnocaulos; Southern* Cane-grass *Eragrostis infecunda,* Warrego Summer-grass *Paspalidium jubiflorum*) By 2030, increase diversity of native of macrophytes at the Bottle Bend asset with ≥9 species from Slg Water Regime Indicator Groups present in 80% of years - Seasonally immersed – low growing (Slg) (Lesser Joyweed *Alternanthera denticulata* s.s., Twin-leaf Bedstraw *Asperula gemella*, Salt Club-sedge *Bolboschoenus caldwellii,* Marsh Club-sedge *Bolboschoenus medianus,* Yellow Twin-heads *Eclipta platyglossa* subsp. *Platyglossa*, Common Spike-sedge *Eleocharis acuta*, Spreading Goodenia *Goodenia heteromera,* Rough Raspwort *Halorogis aspera,* Creeping Knotweed *Persicaria prostrata* Tall Fireweed *Senecio runcinifolius,* Rat-tail Couch *Sporobolus mitchellii,* River Bluebell Wahlenbergia fluminalis)

Current objective	**BB3: Provide seasonal aquatic habitat that supports a diverse frog population**
Comments	Update and relate to vital habitat to support biodiversity. Objective doesn't mention Growling Grass Frog but it is listed as recorded at the site.
EWP objective(s)	8.06,6(a) 8.05,3(a) 8.05,3(b)
Schedule 7 targets	Condition of priority asset - prevention of decline in native biota Condition of priority asset - Vital habitat - feeding, breeding, nursery Condition of priority asset - supports listed species and communities Recruitment and populations of other native water-dependent biota
PEA/PEF criteria met	PEF 1(e) Vital habitat - preventing decline of native biota PEA 3(b) Prevents declines in native biota PEA 3(a)iii Vital habitat - feeding, breeding, nursery sites PEA 4(a) Supports listed species
BEWS QEEO	None specified
LTWP objective	LTWPVM19 Improve habitat for frog communities LTWPVM20 Maintain species richness of frog communities
LTWP target	Maintain the number of native frog species recorded in 80% of years to 2025
2020 Objective:	By 2030, protect and restore biodiversity by maintaining representative populations of frogs at the Bottle Bend asset.
2020 Targets:	By 2030, maintain self-sustaining populations of frogs at Bottle Bend with the following species present: • Barking marsh frog (*Limnodynastes fletcheri*), Perons tree frog (*Litoria peronii*), Plains froglet (*Crinia parainsignifera*), Eastern Banjo Frog (*Limnodynastes dumerili*) and Spotted marsh frog (*Limnodynastes tasmaniensis*) in 80% of years. • Growling Grass Frog (*Litoria raniformis*) in 70% of years

Current objective	BB4: Support the health of the fringing Riverine Chenopod Woodland
Comments	Objective updated to align with Basin Plan language – this is EVC 103 which has Black Box as the dominant with grassy and Acacia understory
EWP objective(s)	8.05,3(b) 8.06,6(b)
Schedule 7 targets	Condition of priority asset - prevention of decline in native biota Condition of priority ecosystem functions - creation of vital habitat - habitat for prevention of decline in native species Condition of native water dependent vegetation
PEA/PEF criteria met	PEA 3(b) Prevents declines in native biota PEF 1(e) Vital habitat - preventing decline of native biota
BWS QEEO	B2.8 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 the Bottle Bend asset.
2020 Targets:	A positive trend in the condition score of Black Box dominated EVC benchmarks at Bottle Bend at 50% of sites over the 10-year period. OR By 2030, at stressed sites (see Wallace et al. 2020) at the Bottle Bend asset: 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.

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