Environmental Water Management Plan

Spences Bend

mallee
catchment management authority

Version Number	Description	Issued To	Issue Date
1	Draft V1	M. Stacey	2010
2	Draft submitted to scientific panel for review	J. Roberts	02/06/2014
3	Incorporate Comments	S. Wilkie (Riverness Pty Ltd)	14/11/2014
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7	Updated ecological objectives - Water's Edge Consulting	D. Wood (Mallee CMA)	16/12/2020
8	Reviewed and updated to align with DEECA guidelines – Alluvium Consulting Australia	E. Johnston (Mallee CMA)	17/05/2024

Acknowledgement of Country

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

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

Abbreviations and acronyms

ACHRIS	Aboriginal Cultural Heritage Register and Information System
AHD	Australian Height Datum
AM	Adaptive Management
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
MDBA	Murray-Darling Basin Authority
LTWP	Long Term Watering Plan
RAP	Registered Aboriginal Party
ROKAMBA	Republic of Korea – Australia Migratory Bird Agreement
SMART	Specific, Measurable, Achievable, Relevant, Time-bound
SWP	Seasonal Watering Proposal
VBA	Victorian Biodiversity Atlas
VEWH	Victorian Environmental Water Holder
VWMS	Victorian Waterway Management Strategy
WMU	Waterway Management Unit

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). The hydrological interconnectedness and commonality of threats impacting on the waterways values were used to group them into planning units. This EWMP has been developed for the Spences Bend WMU Sub-Unit. Hereafter referred to as Spences Bend in this document. The EWMP will help to guide future environmental watering activities for this area.

Spences Bend is located in the Robinvale Plains bioregion within the Mallee Catchment Management Authority (Mallee CMA) region 40 km south-east of Mildura and covers 1,210 ha. The main features of Spences Bend are Bullock Swamp, Lake Iraak, Carwarp Creek and a series of smaller wetlands including Spences Bend Billabong and Callanders Swamp. This plan focuses on a target area within Spences Bend, covering 341 ha, able to be inundated through environmental watering.

Spences Bend consists of a forested floodplain area with several wetlands, ranging from deep freshwater marsh to permanent open water and semi-permanent saline systems. These provide habitat for a large range of flora and fauna, including 25 listed flora species and 8 listed fauna species, such as the regent parrot (*Polytelis anthopeplus monarchoides*).

The long-term management goal of the Spences Bend EWMP is to provide a water regime that reflects natural inundation seasonality and duration that will maintain and promote the mosaic of available habitats through the Spences Bend target area.

To achieve this, ecological and hydrological objectives were designed with the consideration of three inundation stages. These have been developed to sustain the various ecological components of six targeted wetlands. The ecological objectives for Spences Bend target area are outlined below:

SB1: By 2030, improve condition and maintain extent from baseline levels of lignum (*Duma florulenta*) to sustain communities and processes reliant on lignum communities at Stage 1 – Bullock Swamp North, Spence Bend.

SB2: By 2030, improve condition and maintain extent from baseline levels of river red gum (*Eucalyptus camaldulensis*), and black box (*E. largiflorens*) and to sustain communities and processes reliant on such communities at Stage 2 – Spences Bend Billabong, Callanders Swamp and wetland #7329 246886, Spences Bend

SB3: By 2030, improve condition and maintain extent from baseline levels of river red gum (Eucalyptus camaldulensis), and black box (E. largiflorens) and to sustain communities and processes reliant on such communities at the Spences Bend asset.

SB5: By 2030, protect and restore connectivity within and between water-dependent ecosystem at the Spences Bend asset, including by ensuring that: ecological processes dependent on hydrologic connectivity laterally between watercourses and their floodplains (and associated wetlands) are maintained.

SB6: By 2030, improve vital habitat at the Spences Bend asset by increasing the diversity of aquatic macrophytes present across a range of Water Regime Indicators Groups.

The intended watering regime to meet the environmental objectives for each of the wetlands is provided below.

Stage 1

Inundation of approximately 140 ha of Bullock Swamp north of Rudds Road, requiring approximately 312 ML of environmental water.

Stage 2

Inundation of Spences Bend Billabong, Callanders Swamp and Unnamed wetland (11418), requiring approximately 650 ML of environmental water.

Stage 3

Inundation of Spences Bend Billabong and Bullock Swamp south and north, using approximately 2486mL of environmental water.

Table of Contents

1 Introduction

1.1 PURPOSE AND SCOPE OF AN EWMP

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

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

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

1.2 POLICY CONTEXT

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

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

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

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

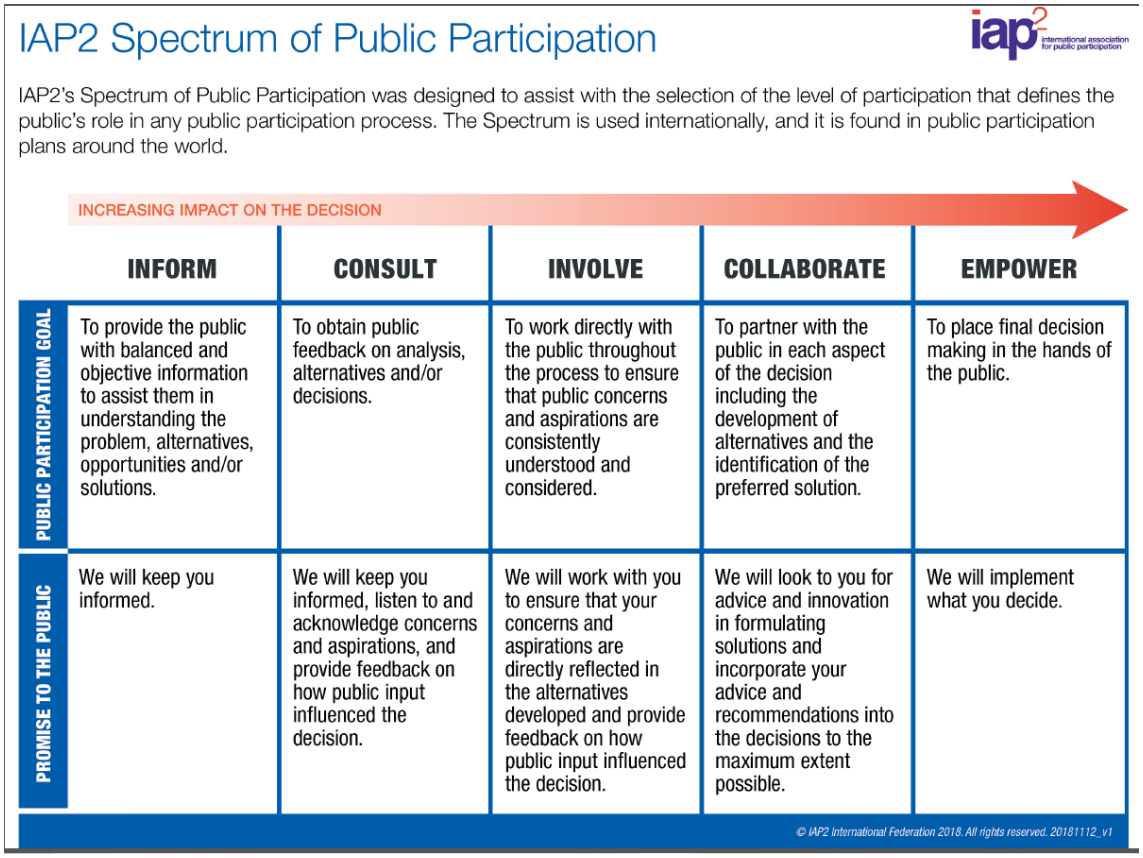
Legislation, Agreement or Convention	Jurisdiction
Environment Protection and Biodiversity Conservation Act 1999	National
Flora and Fauna Guarantee Act 1988	State
Japan-Australia Migratory Bird Agreement (JAMBA)	International
China-Australia Migratory Bird Agreement (CAMBA)	International
Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA)	International

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 (**Error! Reference source not found.**). The spectrum allows for a tailored approach based on stakeholder groups and their needs.



IAP2 Spectrum of Public Participation

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

INCREASING IMPACT ON THE DECISION

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

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

Error! Reference source not found. lists the main stakeholder groups with an i nterest in environmental water based on their needs and interests and level of engagement required. To read more about the role of specific stakeholders in overseeing environmental water at Spences Bend, refer to Section 4.2.2.

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

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

Stakeholder groups	Stakeholders	Needs and interests	IAP2 level	Consultation modes
Public Land Managers	DEECA, Parks Victoria	Managing impacts from watering such as access, State-level environmental management	Collaborate	Via monthly meetings
River Operators	Goulburn Murray Water	Manage water storage	Collaborate	Via formal meetings.
Local Government	Mildura Rural City Council	Access during watering events.	Involve.	Meetings, phone calls, correspondence.

Stakeholder groups	Stakeholders	Needs and interests	IAP2 level	Consultation modes
Aboriginal Stakeholders	See 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. Provides assistance in planning and implementation of programs.	Involve	Via Mallee CMA's Aboriginal engagement team. Consultation is largely undertaken in-person and, where possible, on Country.
Private landowners and managers	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 (interest groups)	Trust for Nature Community members	Watering benefits and impacts on local communities such as access to parks and river during watering events. Oversight of the site in accordance with the conditions of the management covenant for Bullock Swamp north.	Consult	Via existing groups such as the Mallee CMA Land and Water Committee. Via Mallee CMA social media and news
Environmental Water holders	Victorian Environmental Water Holder	Decision-making around annual environmental water usage.	Collaborate	Via formal meetings.

2.2 DEVELOPING/UPDATING THE EWMP

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

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

2.2.1 Verifying asset values

Asset values at Spences 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 long worked with those who have an extensive knowledge of Spences Bend and floodplain ecosystems. This work has been central to providing a basis for local knowledge and expertise.

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

2.2.3 Promoting adaptive management

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

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

2.3 COMMUNITY ENGAGEMENT

Community stakeholders were engaged during local events such as the local markets, local environmental group meetings, and a drop in event at Nangiloc reserve. This engagement included a 'Pins in Maps' activity, where the community provided information on uses and values at specific locations at the site.

Community stakeholders were also engaged via an online survey, which was hosted on the Mallee CMA website in December 2023 – January 2024. The survey was designed to enable community, landholders, recreational users, environmental groups and other interested parties to provide input to the plans. The survey supplements earlier community engagement about the Spences Bend EWMPs, and annual community engagement that informs the Seasonal Watering Proposal (SWP). Community consultation occurs at the IAP2 level of CONSULT.

2.4 TRADITIONAL OWNERS

Engagement with Traditional Owners is conducted in an intimate 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 Latji Latji Mumthelang Aboriginal Corporation on Country at the river inlet to Callenders Swamp, Callender Swamp and Spences Bend Billabong in February 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 use and values incorporated into this EWMP. In-line with EWMP guidelines, consultation with Traditional Owners is ongoing.

3 Asset Overview

The Mallee CMA region is situated in the north-west of Victoria. The area of responsibility is close to 39,000 km2 (3.9 million ha) and has a regional population estimated to be 65,000. 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 Spences Bend Water Management Unit (WMU) sub-unit of the Karadoc WMU (referred to as Spences Bend in this document). The Karadoc WMU encompasses the Spences Bend wetlands, as well as Lake Iraak, Karadoc Swamp, and the Psyche-Woorlong wetlands.

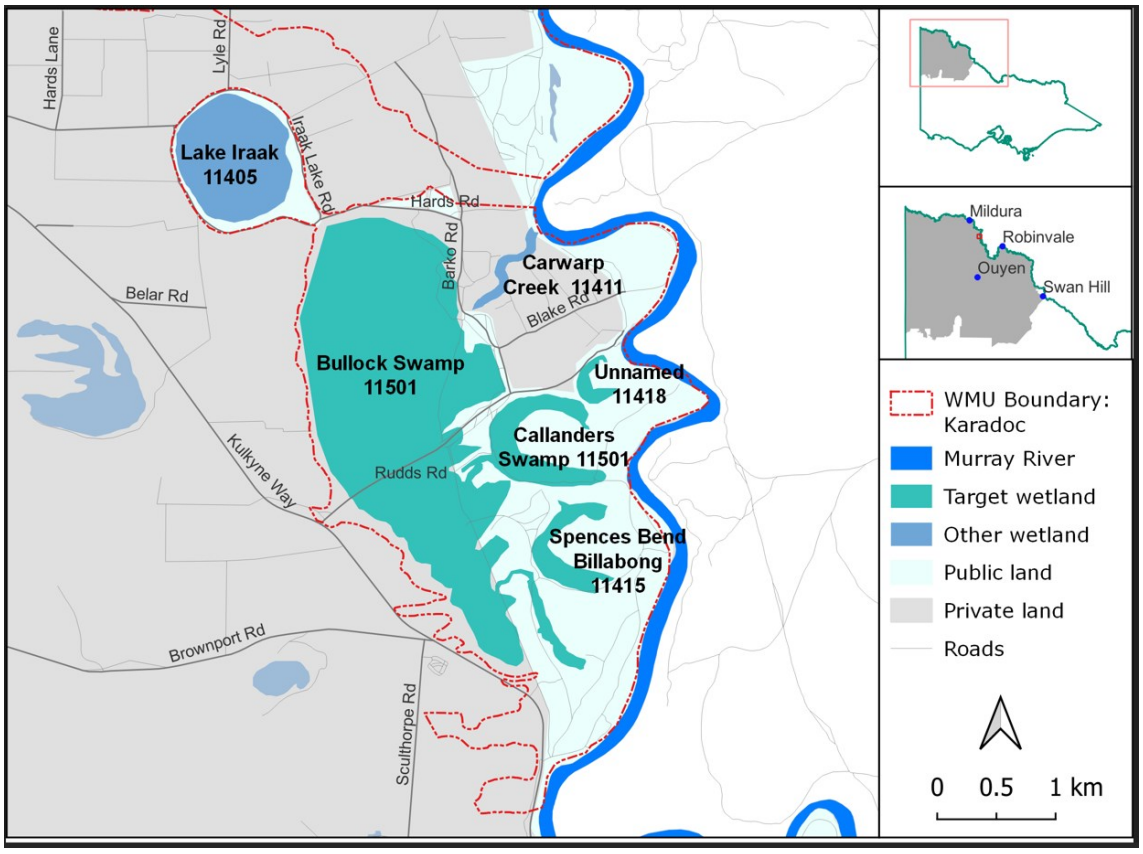


Figure 2. Spences Bend wetlands

3.1 CATCHMENT SETTING

Spences Bend is located in the Robinvale Plains bioregion within the Mallee CMA region 40 km south-east of Mildura. The Robinvale Plains bioregion is characterised by a narrow gorge confined by the cliffs along the River Murray, which is entrenched within older sedimentary rocks. Alluvium deposits from the Cainozoic period gave rise to the red brown earths, cracking clays and texture contrast soils

(Dermosols, Vertosols, Chromosols and Sodosols) which support Riverine Grassy Forests and Riverine Grassy Chenopod Woodlands.

The mean annual rainfall at Spences Bend is between 275 and 300 mm. The area consists of naturally draining riverine soils, in the Murray Trench aquifer. The underlying geology is made up of windblown sands overlaying alluvial sediments, then Channel Sands, followed by Blanchetown Clays and Parilla Sands. The alluvial sediments contain a perched groundwater table, which causes natural groundwater discharge features such as Bullock Swamp. The groundwater beneath Bullock Swamp is now generally within 1.57 – 2.55 m of the surface (SKM, 2002).

The private land surrounding Spences Bend is irrigated horticulture, with crops being predominantly grapevines for wine production, followed by citrus and other fruit trees. The horticultural area has been classified as Low Impact Zone 4, which correlates to tonnes of salt displaced to the River Murray from irrigation. The classification is used to levy new development and report river salinity impacts to the Murray Darling Basin Authority's salinity register. Irrigation drainage water coming from the north of the area discharges to floodplain basins, whilst that from the west discharges to inland basins (Sunrise 21, 2010).

In 2009, land use comprised 621 ha of irrigated horticulture, 140 ha of crops not irrigated and some private land for rural production. Irrigation methods underwent significant changes from 1997 to 2009, with a 63% decline in overhead sprays and 43% increase in drip irrigation. The irrigation drainage water within the WMU currently outfalls into Lake Iraak. The Lake Iraak drainage system comprises a catchment area of 960 ha, with eight outfall points discharging into the lake (Sunrise 21, 2010).

3.2 LAND STATUS AND MANAGEMENT

Several agencies and individuals are involved in managing the land and water at Spences Bend (Table 3). Spences Bend is subject to four land classifications, including the proposed Murray River Park Land management boundaries, as shown in Figure 3.

Table 3. Land and water managers for the Spences Bend EWMP

Organisation	Management Role
Minister for Water (Vic)	• 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.
Lower Murray Water	• River Murray operations and Irrigation drainage
Mildura Rural City Council	• Local Government
Victorian Environmental Water Holder	• Manager of Victoria's environmental water entitlements

Organisation	Management Role
Trust for Nature	• Oversight of the site in accordance with the conditions of the management covenant for Bullock Swamp north
Private Landholders	• Land managers for the majority of the site (see Figure 3**Error! Reference s ource not found.**).

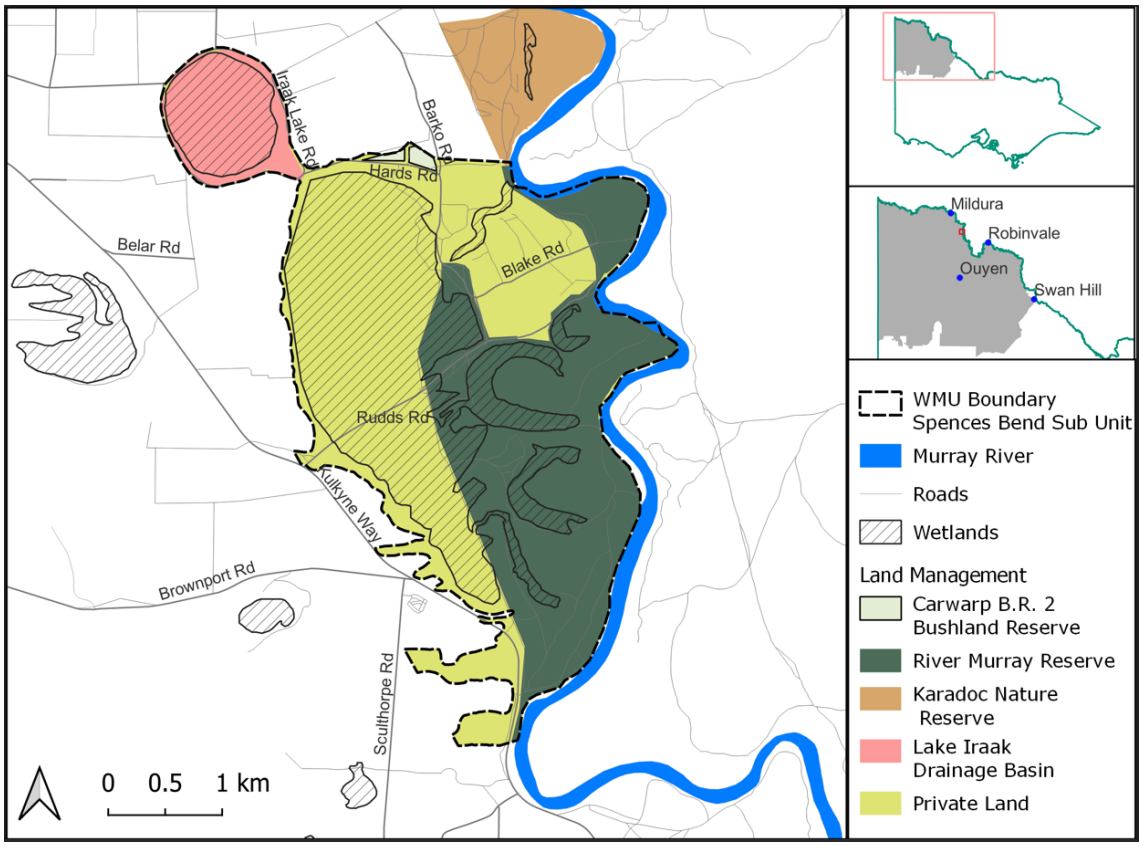


Figure 3. Spences Bend land management boundaries

3.3 ASSET CHARACTERISTICS

The whole of Spences Bend has a water requirement as a floodplain complex but the focus for this plan is restricted to a target area within Spences Bend of 341 ha, as shown in Figure 2.

This target area is the area of Spences Bend that is able to be managed with environmental water. It includes to six of the seven wetlands in Spences Bend WMU Sub-Unit.

Lake Iraak has been excluded from the target area as this wetland is an active irrigation drainage disposal basin. Rehabilitation of this wetland is not possible as long as active drainage to the lake is occurring. Expansion of the target area is possible only with significant alterations to the operations of the River Murray, such as large releases from storage which is beyond the scope of this plan.

Table 4. Wetland Characteristics at Spences Bend

Characteristics	Description
Name	Spences Bend
Mapping ID (Wetland Current layer)	Lake Iraak: 11405 Bullock Swamp & Callanders Swamp: 11501 Carwarp Creek: 11411 Spences Bend Billabong: 11415 Unnamed: 11418
Area of wetlands (in target area)	548.18ha (453.61ha)*
Bioregion	Robinvale Plains
Conservation status	Bioregional conservation status: area of EVCs listed as Vulnerable, Depleted and Least Concern
Land status	Regional Park and Private
Land manager	Parks Victoria and Private landholders
Surrounding land use	Farming Zone
Water supply	Bullock Swamp North receives inflows from the River Murray during very high flow events, seepage from an adjacent irrigation channel, groundwater and rainfall. Bullock Swamp South receives River Murray inflows when the river reaches 86,000 ML/day. Unnamed wetland (11418), Spences Bend Billabong and Callanders Swamp receive flows from the River Murray via a regulated channel. Lake Iraak currently receives irrigation drainage water.
Wetland category (Corrick classification)	Lake Iraak: 6 – Semi-permanent Saline Bullock Swamp & Callanders Swamp: 99 – no category Carwarp Creek: 5 – Permanent Open Freshwater Spences Bend Billabong: 4 – Deep Freshwater Marsh Unnamed: 5 – Permanent Open Freshwater
Wetland type (current wetland layer)	Lake Iraak: Temporary saline lakes Bullock Swamp & Callanders Swamp: Unknown Carwarp Creek: Unknown Spences Bend Billabong: Temporary freshwater swamps Unnamed: Temporary freshwater lakes
Wetland depth at capacity	1-4m approximately.

*Lake Iraak and Carwarp Creek are excluded from the Spences Bend EWMP target area, see Figure 2
**ctf – CTF is the term 'commence to flow' and refers to the flow in ML/day in the River Murray when the wetland will begin to fill. The ctf's have been estimated through modelling.

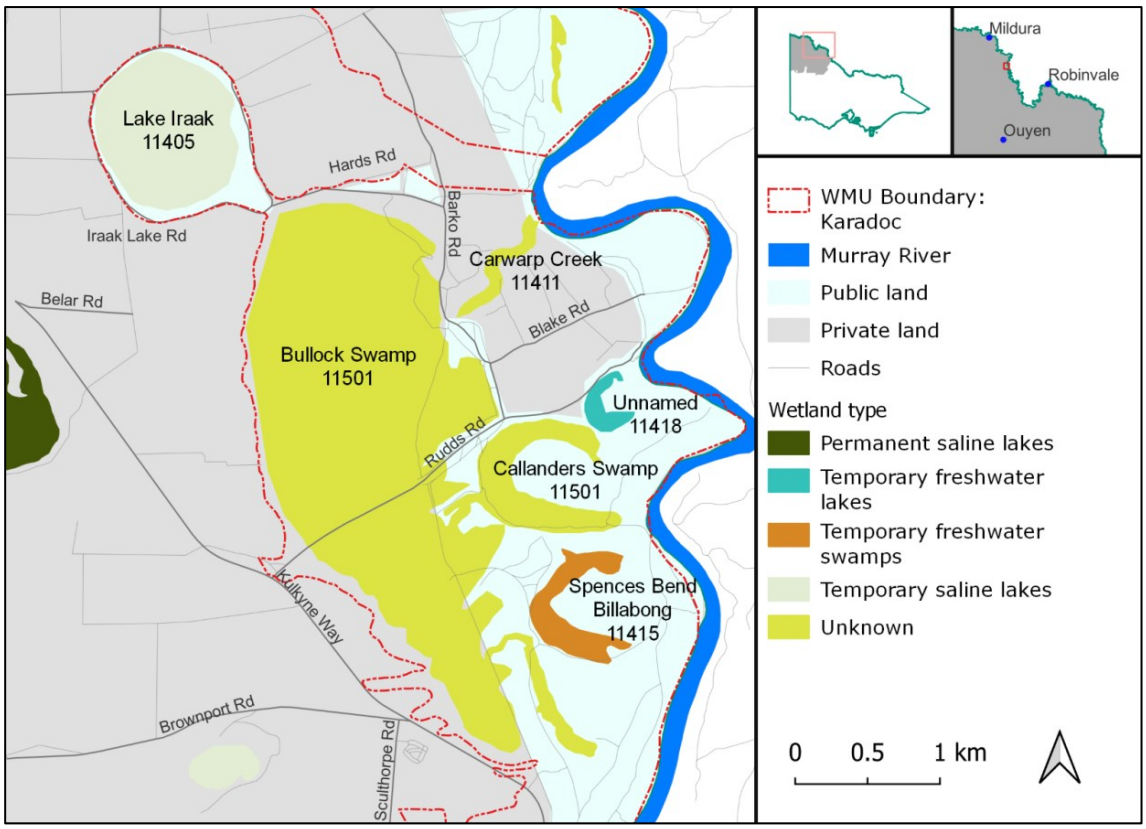


Figure 4. Spences Bend wetland type

3.3.1 Conceptualisation of the Site

Spences Bend has been represented in two conceptual models. These models provide a visual representation of the sites processes and components that are discussed throughout the document. They represent the two key types of wetland systems being targeted. The first model is the semi-permanent saline wetland, which is Bullock Swamp (Figure 5), and the second model is the freshwater wetlands, of various types, which represent Callanders Swamp, Spences Bend Billabong and two unnamed wetland 11418 (Figure 6).

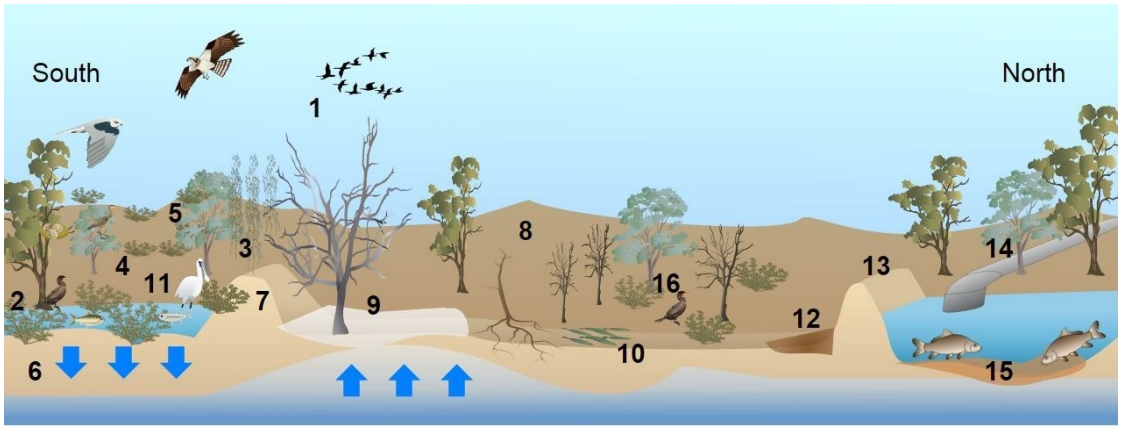


Figure 5. Conceptualisation of semi-permanent saline wetland (Bullock Swamp)

1. Bullock Swamp is a semi-permanent saline marsh. Saline marshes provide habitat for crustaceans, attracting dabbling ducks, such as the Hardhead, and significant migratory wading bird species
2. The Lignum Swamp vegetation community covers the majority of Bullock Swamp. When inundated it becomes an aquatic habitat for reptiles and macroinvertebrates and salt-tolerant fish native fish; and provides a feeding area for waterbirds, raptors, owls and reptiles.
3. Lignum Swampy Woodland is found at higher elevations around the eastern edge of Bullock Swamp north and around the southern section of the Swamp. It is dominated by Lignum but also contains River Red Gums and Black Box and small areas of the threatened tree species Buloke and Swamp Sheoak.
4. When inundated, Lignum Swampy Woodland provides feeding, nesting and roosting habitat for waterbirds such as dabbling ducks and Ibis, Spoonbill, Egrets and other wading birds.
5. Lignum shrubland on the higher terraces can be used by Ibis and Spoonbill as nesting sites
6. During flood events water seeps through the substrate and recharges groundwater.
7. A road levee (2m high x 3m wide x 200m long) divides the Swamp into north and south sections, impacting hydraulic connectivity and the movement of flora propagules and fauna.
8. Past irrigation water disposal, a high groundwater table and decreased magnitude and frequency of flood events has led to higher than normal salt loads and water stress for vegetation. This has resulted in degradation of vegetation in the northern section of Bullock Swamp and Black Box tree mortality.
9. In the northern area of the Swamp there is evidence of saline scalds (bare salt-encrusted ground) due to surface seepage
10. Dry conditions diminish the productivity of floodplain plants leading to reduced organic matter inputs into the riverine food chain
11. More frequent flooding has left the vegetation, particularly the understorey, in better condition in Bullock Swamp South.
12. An irrigation channel along the northern and western border of Bullock Swamp leaks water into the Swamp.
13. A regulating structure installed on Carwarp Creek (at the River Murray end) and a levee (at the Bullock Swamp end) reduce connectivity between the Swamp and the river. This restricts the flushing of groundwater and drainage water when floods subside and the movement of aquatic species between the two. It also reduces the frequency and magnitude of flooding events.
14. Regulation of the River Murray, water extraction for irrigation use and in-stream structures such as weirs and dams also reduce the frequency and duration of flooding events.
15. Common Carp present in Carwarp Creek (and potentially in other wetlands at the site) increasing turbidity and reducing aquatic vegetation.
16. Habitat for breeding opportunities for colonial waterbirds such as Ibis and Egrets is greatly reduced by diminished flooding frequency, extent and duration.

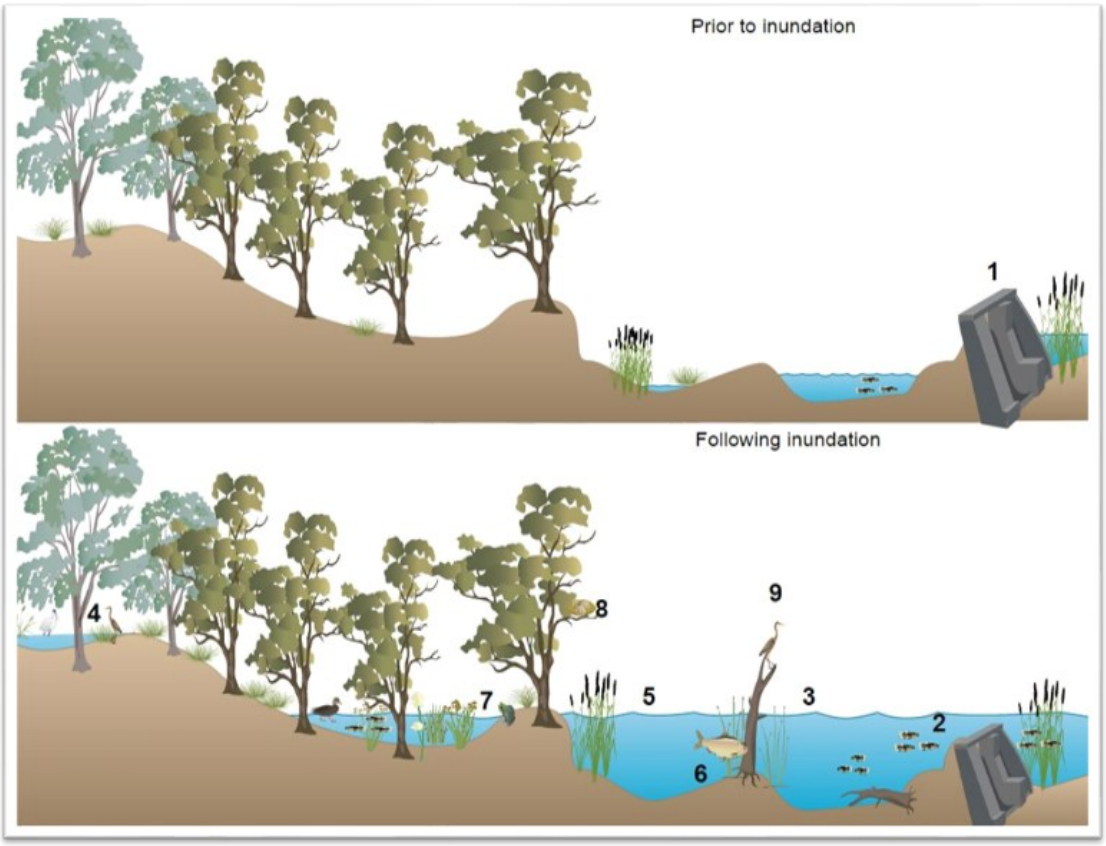


Figure 6. Conceptualisation for freshwater wetlands (Callanders Swamp, Spences Bend Billabong and two unnamed wetland 11418)

1. Regulation of the River Murray, water extraction for irrigation use and in-stream structures such as regulators and levees reduce the magnitude, frequency and duration of flooding events.
2. In-stream structures prevent the movement of flora and fauna between waterbodies and the River Murray during low flows. This has negative impacts on recolonization, dispersal, genetic diversity within species, breeding and the completion of life cycles
3. A range of wetland types are present, ranging from shallow to deep freshwater and a forested floodplain.
4. During higher River Murray flows, water moves into the billabongs from upstream and floodplains are inundated.
5. These freshwater wetlands will host deep freshwater marsh, permanent open freshwater and shallow freshwater marsh; providing habitat for turtles, frogs, waterbirds and a range of small-bodied fish.
6. Slow-flowing areas of warm, turbid water provide habitat for Golden Perch
7. In areas of intermediate water depth, dense semi-emergent macrophytes covered with biofilms will provide shelter and food for macroinvertebrates, tadpoles and small-bodied fish. Dabbling Ducks will graze on the soft-bodied vegetation and prey on macroinvertebrates.
8. River Red Gum dominated Riverine Forest and Woodland communities fringe the temporary wetlands and creeks at points of intermittent flooding, with Blackbox vegetation communities present further up the terraces that receive less frequent flooding. During flooding of adequate duration and extent these wetland and woodland mosaics provide shelter, food and nesting habitat for Darters, Cormorants, Egrets, Herons and Spoonbills.
9. River Red Gums drop woody debris into wetlands, providing structural habitat such as perching sites for waterbirds and snags for fish.

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 Victorian Minister for Environment, Climate Change and Water appointed Commissioners to Victoria's first independent body for holding and managing environmental water on 1 July 2011. The Victorian Environmental Water Holder (VEWH) is responsible for holding and managing Victoria's environmental water entitlements sourcing water from the Victorian Murray system for delivery to Spences Bend. This could include water held by the VEWH or CEWH. Details of the VEWH's environmental water entitlements are available at: https://www.vewh.vic.gov.au/watering-program/how-much-water-is-available.

4 Current/Historical Hydrological Regime and System Operations

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

The target area within Spences Bend is located on the Victorian floodplain of the River Murray (954.5 km to 962 km) between river gauges Euston (#414203C) and downstream Mildura Weir (#414216A).

Prior to regulation of the River Murray flowing past Spences Bend, the floodplain experienced late winter to spring flood events, which were major drivers of floodplain character and condition (SKM, 2002). Under natural conditions Bullock Swamp filled from the River Murray first through Carwarp Creek (at 62,000 ML/day at Mildura), then Callanders Swamp to the east (at 86,000 ML/day at Mildura) and finally low-lying areas to the south (at flows of 125,000 ML/day) (SKM, 2002).

With the effects of major storages and river regulation on the River Murray, the frequency, duration and magnitude of most flood events have decreased compared to natural conditions. Since 1922, 13 weirs and locks across the River Murray have been constructed and the hydrology of the region has been altered significantly. River regulation and increased consumptive water use have reduced overbank flows that are important for water dependent flora and fauna species. Floods of 15,000 ML/day are most affected and occur less often than pre regulation. Floods generated by flows less than 90,000 ML/day are of shorter duration than under pre-regulation conditions. The reduction in duration and frequency of events has helped increased the interval between events with flows above 10,000 ML/day. The flooding regime has also been affected by local works such as the construction of levees, regulators and other earthworks, which prevent or reduce inflows to flood-dependent ecosystems (Ecological Associates, 2007b).

Table 5. Commence to flow rates measured in ML/day downstream of Euston Weir or upstream of Mildura Weir for the wetlands within Spences Bend

Wetland	Commence to flow (ctf) with River Murray flows
Unnamed wetland and Callanders Swamp	8,000 - 19,300 ML/day
Callanders Swamp and Spences Bend Billabong	19,300 - 37,900 ML/day
Bullock Swamp south	86,000ML/day
Bullock Swamp north	140,000ML/day

Bullock Swamp

In addition to the effects of river regulation, the water regime of Bullock Swamp has been affected by several structures (SKM, 2002). The impact of these structures on hydrology are summarised in Table 7.

Table 6. Bullock Swamp hydrological impacts

Structure	Impact
2m high levee dividing the Swamp in two (Rudds Rd)	Reduced flooding frequency & duration
Regulating structures on Carwarp Creek	Reduced flooding frequency & duration
Internal levees on the bed of the wetland	Increased ponding time Water logging

Bullock Swamp has been divided into a northern section and southern section by a 200m long, 2m high and 3m wide road levee (Rudds Road). Barling and Linke (1993, cited in SKM 2002) state that water can now only flow between the northern and southern sections of the Swamp when River Murray flows exceed 180,000 ML/d at Mildura (average recurrence interval (ARI) of 16.7 years) and water overtops Rudds Road. They also state that although a culvert was constructed under Rudds Road when it was first built it is thought that it has silted up over time and no longer allows through-flow of water. The exact location of this culvert remains unknown.

A regulating structure on Carwarp Creek near the River Murray is in place so that irrigators can pump from the River Murray to the creek to irrigate their properties (SKM, 2013). A levee was later constructed between Carwarp Creek and Bullock Swamp to protect the water quality of the Carwarp Creek from becoming salinized (SKM, 2002). Before this levee was put in place, when floodwaters receded from Bullock Swamp, groundwater and drainage water was carried back through the creek increasing the salinity of supply water (SKM, 2002). Bullock Swamp now only receives inflows through Carwarp Creek when the levee is over-topped by River Murray at flows above 140,000 ML/d (SKM, 2002).

There is also an internal levee within the northern section of Bullock Swamp that forms a pond which was used up until the mid-1990's for irrigation drainage evaporation. Although the wetland no longer receives irrigation drainage, it is suspected that there is some leakage to the Swamp from the irrigation channel that runs along its western and northern side. There are patches of lush vegetation at points adjacent to this channel that are not found anywhere else within the Swamp (SKM, 2002)

Bullock Swamp received inflows from the Channel Sands aquifer in the past (SKM, 2002), however this is no longer the case. There is also evidence of irrigation

leakage or spills from the irrigation channel on the western side of Bullock Swamp at five or more points.

Other Wetlands

Unnamed wetland (11418) receives water from the River Murray via a regulated channel. A further channel links this to Callanders Swamp and is regulated to provide and control flows at low river levels. If flows allow, water continues to spill to Spences Bend Billabong and Bullock Swamp.

At higher river flows, water enters the northern section of Bullock Swamp from upstream and general floodplain inundation occurs. The narrow, southern part of Bullock Swamp, south of Spences Bend Billabong is isolated from the other wetlands by a sandy ridge and is thought to fill by an independent effluent from the River Murray or by spill from the northern part of Bullock Swamp (Ecological Associates, 2007b).

4.1 GROUNDWATER AND SALINITY INTERACTIONS

Bullock Swamp is a naturally semi-permanent saline wetland, and the ecology of the system is somewhat adapted to this environment. The floodplain is characterised by a shallow, saline water table that is within 5 m of the ground surface and may be within a metre of the ground surface below the bed of the Swamp itself. Bullock Swamp behaves as a groundwater discharge feature when empty, with salt moving upwards into the unsaturated zone due to evaporation. This, coupled with the location of the Swamp on high terrace floodplain that is infrequently flooded, suggests the potential for high salt concentrations within the unsaturated zone. Historical use of the site as a disposal point for saline drainage water may have also contributed to this.

A study undertaken by Australian Water Ecosystems (2014) on groundwater monitoring indicated that since inception of the Nangiloc-Colignan Salinity Management Plan in 1991 the groundwater table within the Nangiloc-Colignan irrigation district has been variable with a decline in groundwater levels between 1992 and 2009, and an increase in the mound following a period of high river flow and rainfall between 2009 and 2013. Within the Nangiloc-Colignan district, irrigation occurs on the floodplain whereas districts of Merbein, Mildura, Red Cliffs and Robinvale occurs on the highland. This means that groundwater levels in the Nangiloc-Colignan district are more responsive to changes in river level and flood events.

Groundwater monitoring undertaken in 2012 indicated that groundwater levels in the Channel Sands aquifer were between 36.5 and 37.6m AHD at Bullock Swamp, compared with 38.3m AHD for the bed of Bullock Swamp (as determined by LiDAR). Linke (1990) in (Barling and Linke, 1993) suggest that the salinity of the regional groundwater mound in the Channel Sands is approximately 50,000 EC. These results show that groundwater was not connected to Bullock Swamp at that time. However, it is expected that once Bullock Swamp is refilled, it will recharge the shallow aquifer (SKM, 2013).

4.2 ENVIRONMENTAL WATERING

Environmental watering occurred at Spences Bend during the Millennium Drought (mid 1990's to early 2010/11), in 2005 and 2006. The purpose of the initial watering program was to address the prolonged dry conditions that had resulted in a drastic decline in River Red Gum health on the River Murray floodplain. The water for these events was from various sources as outlined in Table 8.

Table 7. A Summary of environmental watering at Spences Bend

Water year	Waterbody	Time of inflow	Environmental Water Source	Total volume delivered (ML)	Area (ha) inundated
2005	Callanders Swamp and Spences Bend Billabong	Spring	Environmental Water Allocation (EWA) / River Murray Unregulated Flow (RMUF)	640	65
2006	Callanders Swamp and Spences Bend Billabong	Autumn	Donations	955	65
2010-11	Bullock Swamp North, Callanders Swamp, Spences Bend Billabong		Natural inundation	Unknown	Unknown
2013-14	Bullock Swamp North	Autumn-Winter	Environmental water	531	Unknown
2014-15	Bullock Swamp North	Winter-Spring	CEWH/VEWH	480.8	150
2016-17	Bullock Swamp North, Callanders Swamp	Summer	Natural inundation	Unknown	Unknown
2022-23	Bullock Swamp North, Callanders Swamp, Spences Bend Billabong, Bullock Swamp South	Spring - Summer	Natural inundation	Unknown	Unknown
2023-24	Callanders Swamp, Spences Bend Billabong	Spring	Natural inundation	Unknown	Unknown

The purpose of the environmental watering has evolved from emergency response to long term sustainability of the system. Environmental watering took place in spring 2005 with a second event in autumn 2006. These events filled the unnamed wetland, Callanders Swamp and Spences Bend Billabong. This delivery of environmental water was effective in improving the health of River Red Gum trees fringing the wetlands. Benefits of these watering events would have extended to other flora and provided drought refuge for waterbirds, frogs, fish and turtles. The extent of emergency watering was limited by current infrastructure within the target area. The three horseshoe billabongs received further inundation during the floods of 2010/2011.

Bullock Swamp north was watered during 2014, with 523 ML delivered between May and August 2014 and an additional 156 ML delivered in the months after that (Australian Water Environments, 2014). Bullock Swamp south has not been inundated during the environmental watering undertaken to date, however has benefited from floods events in recent years.

5 Water Dependent Values

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

functions provided by floodplain complexes include water filtration, slowing surface water flow to reduce soil erosion, flood mitigation and reducing nutrient input into waterways. Protecting the ecological functioning of wetlands ensures these vital services are maintained.

Spences Bend provides a range of shelter and food resources for indigenous fauna, flora and vegetation communities. The types of habitat provided, and consequently the species that utilise the site, change as water fills the wetlands, creek and floodplain and recedes again. It is recommended that flora and fauna surveys are repeated at the site to improve knowledge of the site's ecological values.

5.1 ENVIRONMENTAL VALUES

5.1.1 Ecosystem type and function

The conservation significance of Victorian wetland types has been determined by comparing the estimated extent prior to European settlement (Victorian Wetland Inventory - Pre-European) with the current extent (Victorian Wetland Inventory - Current).

Spences Bend target area contains seven wetlands. They have been classified using the Corrick-Norman wetland classification system as semi-permanent saline, permanent open freshwater or deep freshwater marsh, or are not categorised (see Table 4.) It has been estimated that about 4000 wetlands have been lost since European settlement, with more than 90% of these lost on private land (Mallee CMA 2006). Spences Bend represents an excellent opportunity to help protect wetlands and a creek system on private land.

Based on a comparison of the geospatial wetland layers (1788 and 1994), Deep Freshwater Marshes are the most depleted (-70% change) type of wetland in Victoria, second most (-45% change) in the Mallee CMA region and second most (-37% change) in the Robinvale Plains Bioregion. This makes Spences Bend Billabong, which is a Deep Freshwater Marsh, significant in the region.

Permanent open freshwater wetlands have only experienced minimal changes and in the Mallee CMA region have actually increased in area (4%). Semi-permanent saline wetlands have decreased slightly across Victoria (-7%) but increased in the Mallee CMA and Robinvale Plains bioregion.

Table 8. Regional change in area of wetland type at Spences Bend

Corrick category (Current and Pre - European)	Wetland name	Area (ha)	Percentage change in wetland area from 1788 to 1994

			Change in Victoria	Change in Mallee CMA	Change in Robinvale Plains Bioregion
Permanent Open Freshwater	Carwarp Creek Unnamed wetland (11418)	7.19 5.98	-60%	-6%	-10%
Deep Freshwater Marsh	Spences Bend Billabong	19.84	-70%	-45%	-6%
Semi-Permanent Saline	Lake Iraak	81.38	-7%	9%	100%

Ecosystem functions

Healthy creek and wetland ecosystems have the potential to support distinctive communities of plants and animals and provide numerous ecosystem services. These ecosystems can perform important functions necessary to maintain the hydrological, physical and ecological health of the river systems and floodplain.

These ecosystem functions can include:

- providing extended foraging and breeding opportunities for native terrestrial fauna;
- providing extended foraging and breeding habitat for water birds during periods of inundation;
- absorbing and releasing floodwaters;
- in-stream primary production;
- providing organic material to rivers to maintain riverine food chains; and
- providing feeding, breeding and drought refuge sites for an array of flora and fauna.

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

5.1.2 Flora and Fauna Values

EVCs

Healthy ecosystems are composed of distinctive bacterial, fungal, plant and animal communities that rely on one another through various symbiotic relationships. This EWMP identifies the ecological vegetation classes (EVCs) found at the target site – EVCs are a standard unit for classifying vegetation types and are described through a combination of floristics, lifeforms and ecological characteristics, and through an inferred fidelity to particular environmental attributes (DEECA, 2023).

Twelve EVCs occur within the WMU Sub-Unit as shown in Figure 7. The bioregional conservation status of all water-dependent EVCs in the target area is shown inTable 10. For a full list of EVCs and details on each see Appendix 2.

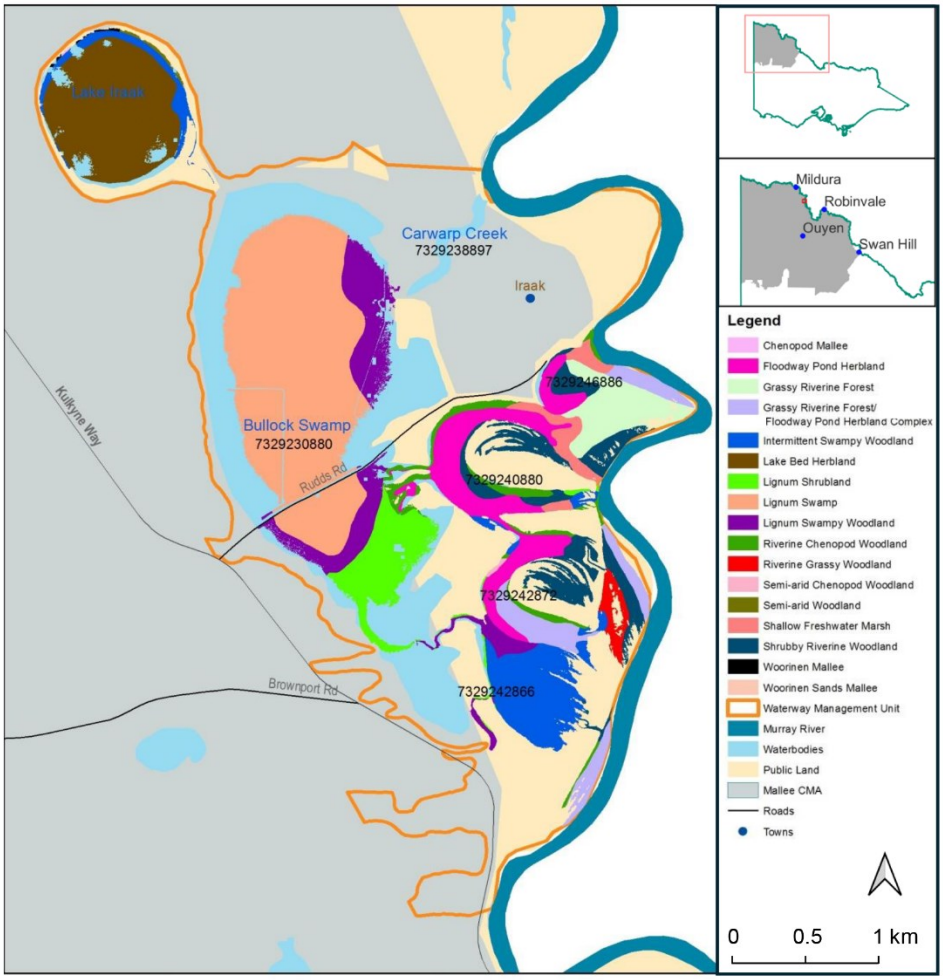


Figure 7. Ecological Vegetation Communities (EVCs) in the target area of Spences Bend (note: numbers shown in figure are superseded wetland IDs)

Table 9. Ecological Vegetation Classes listed as present within the Spences Bed target area

EVC Number	EVC Name	Bioregional Conservation Status
104	Lignum Swamp	Vulnerable
823	Lignum Swampy Woodland	Depleted
808	Lignum Shrubland	Least Concern
810	Floodway Pond Herbland	Depleted
818	Shrubby Riverine Woodland	Least Concern
813	Intermittent Swampy Woodland	Depleted
107	Lake Bed Herbland	Depleted
200	Shallow Freshwater Marsh	Vulnerable
103	Riverine Chenopod Woodland	Depleted
295	Riverine Grassy Woodland	Depleted
106	Grassy Riverine Forest	Depleted
811	Grassy Riverine Forest/Floodway Pond Herbland Complex	Depleted

Lignum Swamp covers the majority of Bullock Swamp. This typically treeless EVC is widespread in low rainfall areas and is subject to infrequent inundation (DSE, 2005). This EVC is dominated bylLignum, (*Muehlenbeckia florulenta)*, which becomes an extensive aquatic habitat for fish, reptiles and macroinvertebrates when inundated. It is also used as a nesting site by waterbirds, and as a feeding area by raptors, owls, and predatory reptiles (Ecological Associates, 2007a).

Lignum Swampy Woodland is found along the eastern edge of Bullock Swamp north and around the southern section of the Swamp. Lignum dominates this EVC but it also supports eucalypt or acacia woodland with river red gum and black box being the dominant trees species. At Bullock Swamp these woodlands also support small stands of the threatened species buloke (*Allocasuarina leuhmannii)* and swamp sheoak (*Casuarina obesa)*. Black box woodlands provide habitat links to the surrounding Mallee landscape in this region. They are rich in bird diversity, with both riverine and woodland species (Ecological Associates, 2007a). Both Lignum EVC's would have experienced a flooding event once in 2-8 years under natural conditions, with a critical interval of 15 years between events. The recommended duration of ponding for Lignum Swamp is 2-6 months and 2-4 months for Lignum Swampy Woodland (VEAC, 2008).

The majority of the wetland bed at Spences Bend Billabong, Callanders Swamp and surrounding wetlands is covered by Floodway Pond Herbland. This threatened wetland EVC is dependent on a regular wetting and drying cycle, characteristic of semi-permanent wetlands. Under the appropriate water regime, this EVC supports aquatic herbs and emergent sedges which form important habitat for fish, frogs and waterbirds. Under natural conditions this wetland EVC would have flooded 6-9 years in every ten, with duration of 4-10 months ponding and a critical interval of three years between events (VEAC, 2008).

The remaining section of Bullock Swamp south of Rudds Road and wetland #7329 242866 are dominated by various woodland EVC's (EVC's 808, 818, 813, 107, 200, 103, 295, 106 and 811 – see Table 10) with river red gum and black box as the dominant tree species.

Fauna

128 species are recorded at Spences Bend (Appendix 3), one of which is introduced. Of special interest are the 8 water dependant fauna species listed in legislation, agreements or conventions.

Spences Bend supports species listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), Victoria's *Flora and Fauna Guarantee Act 1988* (FFG Act) (Table 11). These records are drawn from incidental and targeted surveys; however, it is fair to assume that more listed species are likely to occur due to the availability of habitat and nearby sightings.

Table 10. Listed water dependant fauna at Spences Bend

Scientific Name	Common Name	FFG Act	EPBC Act Status
Climacteris picumnus	Brown treecreeper	N/A	Vulnerable
Hydroprogne caspia	Caspian tern	Vulnerable	N/A
Aythya australis	Hardhead	Vulnerable	N/A
Lophochroa leadbeateri	Major Mitchell's cockatoo	Critically Endangered	Endangered
Ardea intermedia plumifera	Plumed egret	Critically Endangered	N/A
Polytelis anthopeplus monarchoides	Regent parrot	Vulnerable	Vulnerable
Lophoictinia isura	Square-tailed kite	Vulnerable	N/A
Haliaeetus leucogaster	White-bellied sea-eagle	Endangered	N/A

The eight bird species are considered water-dependent because they forage or nest in or over water, or require flooding to trigger breeding and fledging. The list includes the regent parrot, (*Polytelis anthopeplus monarchoides)* which is indirectly dependent on water as they require riparian trees for nesting habitat.

The eastern regent parrot is listed as nationally vulnerable under the *EPBC Act*, with estimates of only 2,900 birds left in the wild. This species has quite specific habitat requirements. It breeds 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 (*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). eastern regent parrots are reluctant to fly through open areas and require corridors of vegetation between nesting and foraging sites. Regent parrot breeding has previously been recorded along the Spences Bend section of the River Murray and a nest site was identified within this WMU Sub-Unit in a study which ran from 2001 to 2005 (Webster and Belchar, 2005).

The hardhead (*Aythya australis)* uses dense shrubby vegetation such as lignum for nesting, and breeding is stimulated by flooding and season. Rogers & Ralph (2011) suggest that breeding primarily occurs between August and December. 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. 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).

Two egret species recorded in the target area are the plumed egret (*Ardea intermedia)* and the great egret (*Ardea modesta)*. Egrets mainly forage in shallow freshwater wetlands with emergent vegetation and use overhanging trees for nesting, with river red gum being their preferred tree. Egrets require shallow water with dense aquatic vegetation for foraging and feed mainly on fish but also consume shrimp, crayfish, frogs and insects (Rogers and Ralph, 2011). Draining of

wetlands for agriculture is the main cause of habitat loss for egrets in Victoria (DSE, 2001).

Bullock Swamp has been identified as a potential site for reintroduction of Murray hardyhead, if appropriate habitat conditions are provided. Adult Murray hardyhead spawn in stands of *Ruppia spp.* in saline lakes (Raadik and Fairbrother, 1999; Backhouse, Lyon and Cant, 2008). While adults may be relatively salt-tolerant, the early life stages, particular eggs and fry, may be more sensitive to high salinity levels. Salinity tolerance also varies between populations ((Bill Dixon DSE ARI unpub. data):(Backhouse, Lyon and Cant, 2008)).

Flora

Three-hundred and sixty flora species have been recorded at Spences Bend (Appendix 4). Of these, 25 are listed under the FFG Act, and 33 are introduced.

Table 11. Listed Flora at Spences Bend

Scientific Name	Common Name	FFG Act	EPBC Act Status
Dianella porracea	Riverine flax-lily	Critically Endangered	N/A
Dissocarpus biflorus var. biflorus	Twin-flower saltbush	Critically Endangered	N/A
Duma horrida subsp. horrida	Spiny lignum	Critically Endangered	N/A
Eragrostis australasica	Cane grass	Critically Endangered	N/A
Acacia oswaldii	Umbrella wattle	Critically Endangered	N/A
Eleocharis plana	Flat spike-sedge	Critically Endangered	N/A
Swainsona reticulata	Kneed swainson-pea	Endangered	N/A
Abutilon otocarpum	Desert lantern	Endangered	N/A
Roepera angustifolia	Scrambling twin-leaf	Endangered	N/A
Sarcozona praecox	Sarcozona	Endangered	N/A
Cullen pallidum	Woolly scurf-pea	Endangered	N/A
Acacia victoriae subsp. victoriae	Bramble wattle	Endangered	N/A
Swainsona microphylla	Small-leaf swainson-pea	Endangered	N/A
Sida ammophila	Sand sida	Endangered	N/A
Sida intricata	Twiggy sida	Endangered	N/A
Eragrostis lacunaria	Purple love-grass	Endangered	N/A
Phyllanthus lacunellus	Sandhill spurge	Endangered	N/A
Ammannia multiflora	Jerry-jerry	Endangered	N/A
Aristida holathera var. holathera	Tall Kerosene grass	Endangered	N/A
Picris squarrosa	Squat picris	Endangered	N/A
Eremophila divaricata subsp. divaricata	Spreading emu-bush	Vulnerable	N/A
Sclerolaena patenticuspis	Spear-fruit copperburr	Vulnerable	N/A
Minuria cunninghamii	Bush minuria	Vulnerable	N/A
Malacocera tricornis	Goat head	Vulnerable	N/A
Minuria integerrima	Smooth minuria	Vulnerable	N/A

Lignum EVC's dominate Bullock Swamp and tangled lignum has particular ecological value as waterbird breeding habitat (Rogers and Ralph, 2011) making it especially significant at this site. Wetland birds that breed over water, such as egrets, use flooded Lignum shrublands (Ecological Associates, 2007a) for resting and the hardhead duck uses lignum for nesting (Rogers and Ralph, 2011).

Bullock Swamp is fringed by black box communities of degraded health (Ecological Associates, 2007b). Black box occurs in the less frequently flooded, more elevated areas of the floodplain and is found in the Lignum Swampy Woodland EVC which fringes Bullock Swamp. Black box communities are extensive around the Spences Bend Billabong and Callanders Swamp. 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 woodlands are particularly important to the endangered regent parrot which has been recorded using black box hollows for breeding (Baker-Gabb and Hurley, 2011). These woodlands are also an important connection to surrounding Mallee landscape, allowing movement of fauna between these landscapes (Ecological Associates, 2007a). Black box can tolerate a range of conditions from wet to dry and saline to fresh (Roberts and Marston, 2011). However, under extended periods of dry conditions trees will suffer a decline in health and eventually death (Ecological Associates, 2007a).

River red gum woodlands are found around the Spences Bend Billabong and Callanders Swamp area. They provide extensive habitat for a range of fauna, and waterbirds such as the intermediate egret which use these trees for nesting. However, trees in poor condition contribute little to the function and productivity of the ecosystem and the quality of woodland habitat is greatly reduced (Roberts and Marston, 2011). River red gums also deposit organic woody debris to wetlands which provide structural habitat features for wetland fauna such as perching sites for waterbirds and snags for fish (Ecological Associates, 2007b).

5.1.3 Current Condition

Sunraysia Environmental on behalf of the Mallee CMA undertook a baseline 'Index of Wetland Condition assessment during April 2014. A total of five sites were assessed which was limited to the section of Bullock Swamp north of Rudds Road. This assessment indicated Bullock Swamp to be in moderate condition overall with a total score of 5 (Table 13). Factors including the wetland only receiving water intermittently, reduced wetland connectivity and wetland size and saline groundwater had impacted on flora composition and health. The majority of the lignum has disappeared, and the black box overstorey has poor canopy health. Photo point monitoring has been undertaken during this assessment to capture condition before and after watering (Figure 8).

Table 12. Index of Wetland Condition score for Bullock Swamp North, 2014

Sub Index	Score	Weighting	Weight Adjusted Score	Condition Category
Wetland Catchment	10.5	0.26	2.73	Moderate
Physical Form	11	0.08	0.88	Moderate
Hydrology	5	0.31	1.55	Poor
Water Properties	12	0.47	5.64	Moderate
Soils	20	0.07	1.40	Excellent
Biota	9.57	0.73	6.99	Moderate
Sub Total	68		19.19	
Total Score			5	Moderate

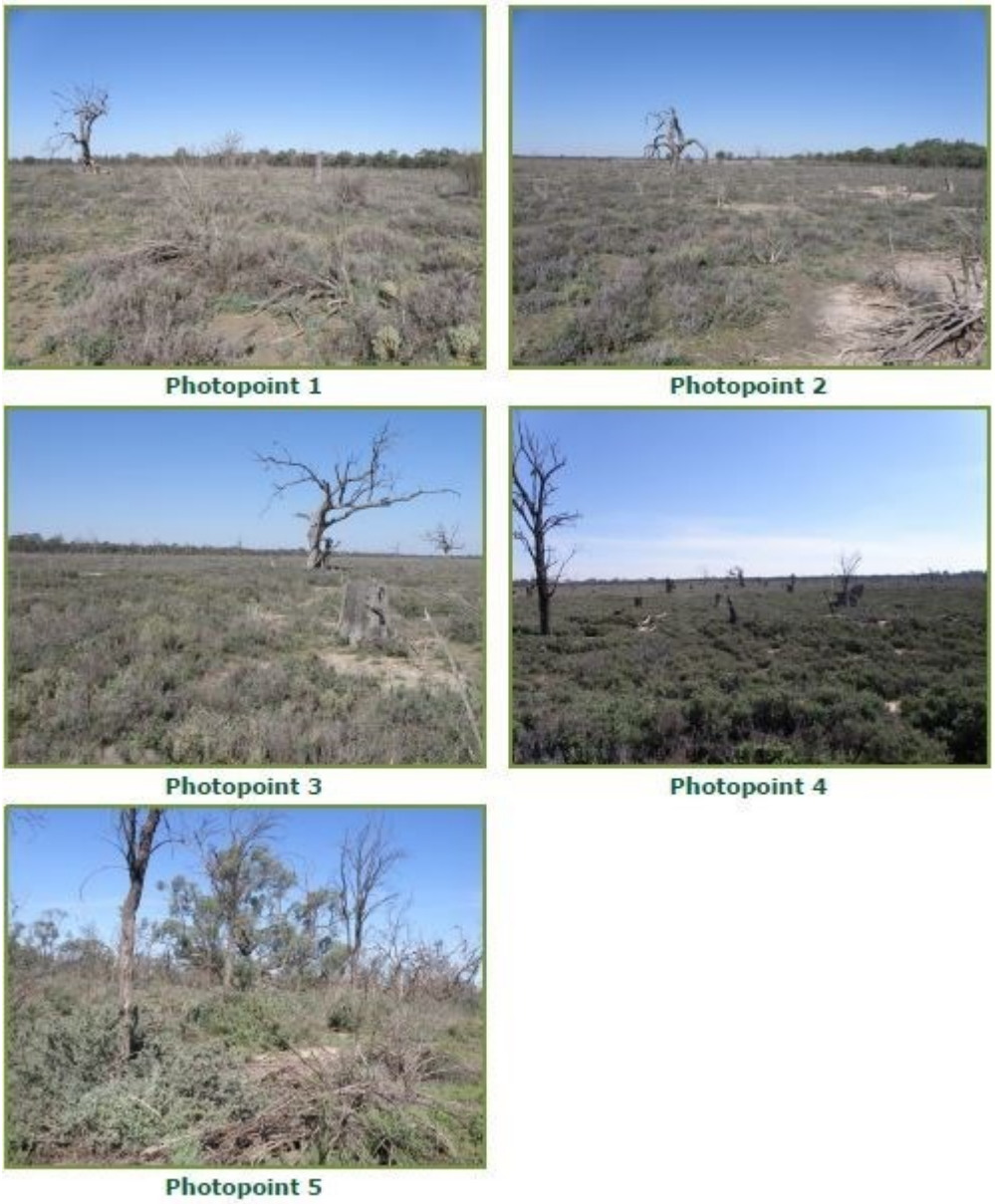


Figure 8. Photo points taken during IWC Assessment (Sunraysia Environmental, 2014)

The condition of the wetlands at Spences Bend is dependent on an appropriate environmental watering regime. Environmental watering at Spences Bend has met environmental watering targets for Callanders Swamp and Spences Bend Billabong. This would indicate that the condition of Callanders Swamp and Spences Bend Billabong are in a desirable state and is able to support the ecological values identified in this EWMP. Environmental watering targets have not been met for Bullock Swamp North and Bullock Swamp South, indicating that Bullock Swamp North and Bullock Swamp South values are at risk .

5.2 SHARED BENEFITS

5.2.1 Traditional Owner Cultural Values

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

In Indigenous culture, water is inseparable from the land, air, plants and animals. Caring for, and healing, Country is an inherited cultural obligation that is reliant upon having water in the landscape in the right place, at the right time of year. Water creates and sustains life, and is a living and cultural entity that connects Traditional Owners to Ancestors, Country, cultural practice and identity.
Within the Mallee CMA region, the River Murray and its associated waterways continue to be culturally significant habitation areas for many Aboriginal groups. The high number of Indigenous cultural heritage sites throughout the Murray floodplain is unique in Victoria because of their concentration and diversity. It is typical to find high densities of identified Indigenous cultural heritage sites located around, or close to, freshwater sources. The Aboriginal Heritage Regulations 2018 define "areas of cultural heritage sensitivity" which include land within 200 m of named waterways and land within 50 m of registered Aboriginal cultural heritage places. A review of the Aboriginal Cultural Heritage Register and Information System (ACHRIS) confirms that the wetlands at Spences Bend are defined as areas of cultural heritage sensitivity.

Within the Mallee CMA region, the River Murray and its associated waterways were important areas for multiple Aboriginal groups, containing many places of spiritual significance. The high number of Indigenous Cultural Heritage sites throughout the Murray floodplain is unique in Victoria, for both concentration and diversity. They include large numbers of burial, middens and hunting sites.

Several early European records exist of different language groups within the area (Clark, cited in Bell 2013) including Tati Tati (Tindale, cited in Bell 2012) and Wadi Wadi (Howitt, cited in Bell 2012). Aboriginal people had a strong connection to the area and made use of the natural resources within the forest for bush medicine, basket weaving and other cultural activities.

Engagement undertaken with Latji Latji Mumthelung Traditional Owners on Country in February 2024 found that there was an ongoing connection to the wetlands at Spences Bend, with Traditional Owner community members invested in the ecological health and sustainable management of water at the site. Participants in the on Country engagement identified that native flora and fauna, environmental water and the cultural heritage of the site was valued.

5.2.2 European Heritage Values

European heritage reflects the pioneering history of the area. The town of Iraak, along with nearby Colignan and Nangiloc, were set up as soldier settlement farming areas after the first World War (Noelker Consulting, 2008). Dry land farming was the most prominent form of farming undertaken by these settlers. By the 1920's the area relied on irrigation as river frontage land was leased and primarily used for vegetable farming (Nangiloc/Colignan and District Community, 2014).

5.2.3 Recreational Values

The region is popular for swimming, camping, fishing, boating, four-wheel driving, picnicking, barbequing, trail bike riding, horse riding, birdwatching, kayaking, cycling, nature appreciation, dog walking and walking/running.

At recent community engagement events, it was identified that the top priority use of the site was camping (30% of respondents ranked this use as #1), with socialising, fishing walking, nature appreciation – plants and four-wheel driving -- also receiving top priority rankings from respondents.

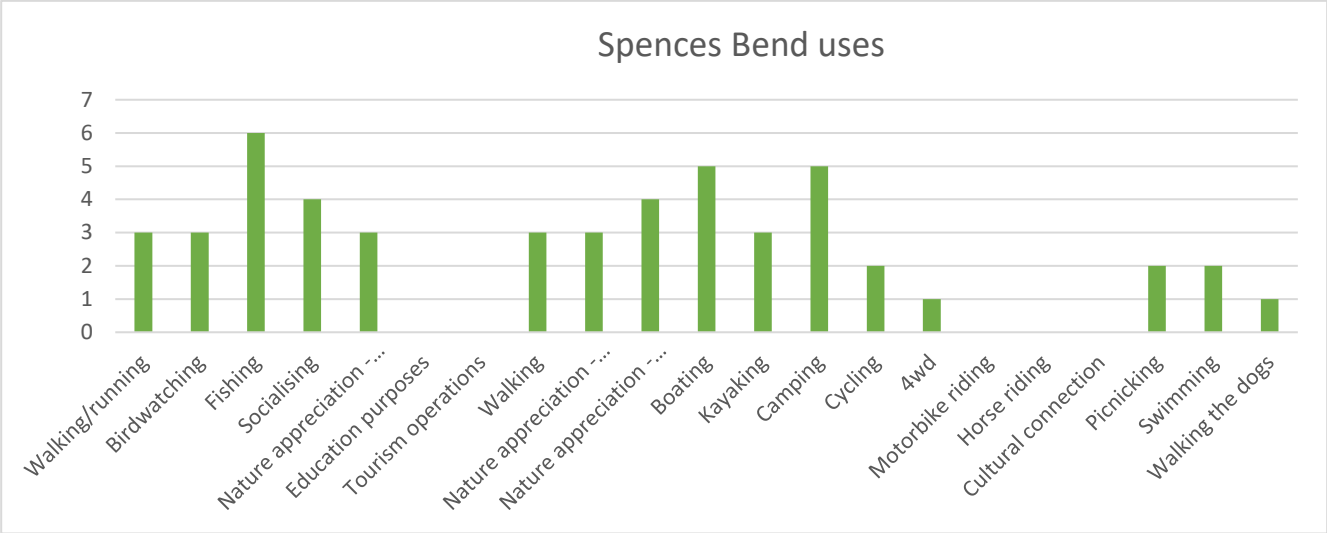


Figure 9. Identified uses at Spences Bend. Source: Mallee CMA online survey engagement 2024.

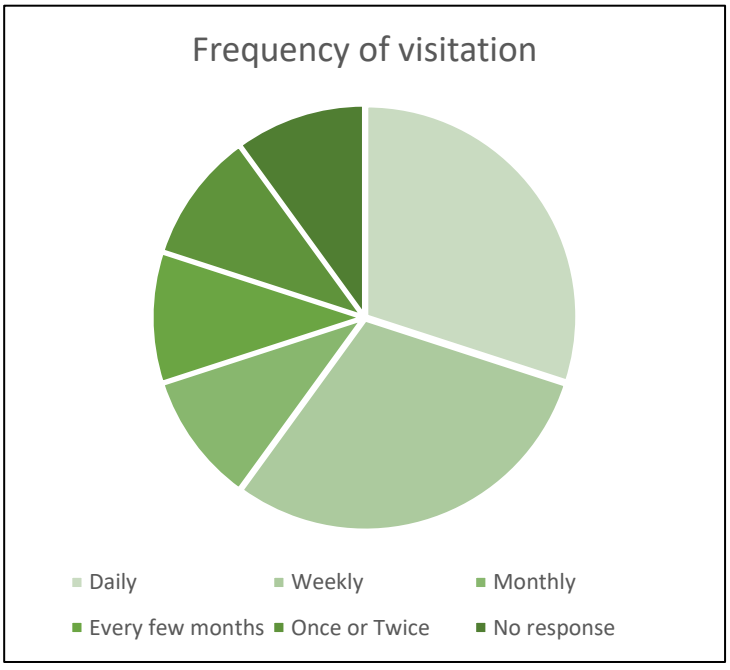


Figure 10. Frequency of visitation to Spnces Bend. Source: Mallee CMA online survey engagement 2024.

The respondents to this recent community engagement described their connections to the sites as Resident, Recreational User, Business Operator, Community Environmental Group or Researcher/Citizen Scientist.

Most respondents (60%) to the online survey indicated that they visited Spences Bend Daily or Weekly. The majority of respondents (60%) indicated that they visited Spences Bend sites in all seasons. More information about recent community engagement can be found in Appendix 5.

5.2.4 Economic Values

Spences Bend has been used for grazing, irrigation and irrigation drainage water disposal (still occurring in Lake Iraak). There is evidence that timber harvesting has occurred at some stage in the past (SKM, 2002).

Figure 11. The tree stumps on the lakebed provide evidence of timber harvesting in Bullock Swamp North

5.2.5 Educational values

Spences Bend is not known to be currently used for educational purposes.

5.3 TRAJECTORY OF CHANGE

Condition of wetlands within the target area will continue to decline without regular and well-planned environmental watering targeting appropriate objectives. Bullock Swamp north is the most impacted under post-regulation conditions, although all wetlands in the target area are impacted by reduced flooding frequency and duration.

The reduced flooding duration and frequency will continue to impact the ecology of the wetlands through:

- reduced connectivity for movement of organic matter, fish and transport of salt;
- reduced suitable nesting and roosting sites for waterbird species who rely on flooded shrub land and forest; and
- limited food sources for all waterbirds, reptiles and amphibians through reduced invertebrates and reduced extent of emergent and submergent macrophytes.

Figure 12. Photopoints taken at Bullock Swamp, Spences Bend. Left: 2015, Right: 16/05/2023.

Photopoint monitoring is undertaken at Spences Bend to monitor wetland conition over time (Figure 12). Photopoints were taken in 2015 and 2023 – during that time, Bullock Swamp North (2016/17, 2022/23, 2023/24), Callanders Swamp (2016/17, 2022/23, 2023/24), Spences Bend Billabong (2022/23, 2023/24), and Bullock Swamp South (2023/24) received flows from Natural inundation (see Table 8).

6 Managing Water Related Threats

Changed water regime

The regulation of the River Murray has seen the water regime altered through the Spences Bend section. Flow events of the magnitude required allowing flows into the creeks and wetlands of the floodplain are less frequent and of shorter duration. Combined with dry conditions over the last decade, this has affected the vigour of vegetation and placed trees under stress, affecting the productivity and functioning of the floodplain ecosystem.

The lack of floodwater to the northern section of Bullock Swamp is believed to be partially responsible for the degradation of vegetation (Predebon, 1990). Carwarp Creek is now permanently inundated to maintain amenity and supply of irrigation water. The structures in place to achieve this create a barrier to fish passage and prevent more frequent inundation of Bullock Swamp north. Invasive species which favour permanent inundation, such as carp, may thrive, contributing further to the decline of native biodiversity (Mallee CMA, 2012).

Loss or reduction of wetland connectivity

Bullock Swamp continues to be subject to seepage from an irrigation channel on its western edge (SKM, 1998). Carwarp Creek, the effluent between the River Murray and Bullock Swamp is now blocked at both ends to contain water pumped from the river for relifting by pumps along the creek. The use of wetlands for irrigation drainage can lead to a rise in groundwater tables and salinity, waterlogging and increased nutrient loads. Poor water quality can lead to algal blooms, a decline or death of native vegetation and impact the amenity of the site (Mallee CMA 2018).

Bullock Swamp behaves as a groundwater discharge feature when empty, with salt moving upwards into the unsaturated zone due to evaporation (see section 4.1). Inundation of the Swamp may mobilise salts stored in the unsaturated zone through salt wash-off from the surface. Bullock Swamp is also likely to behave as a recharge feature when filled, mobilising salts in the unsaturated zone via infiltration through the Swamp bed and subsequent groundwater mounding. This process may flush salts from the top of the soils profile initially but may require multiple watering events to be maintained. The current management of Carwarp Creek is resulting in relatively fresh groundwater to the River Red Gums lining this section of the creek. Salinity of Bullock Swamp should be carefully monitored to ensure that objectives are not compromised by watering effects on the salinity levels.

Invasive fauna aquatic

Common carp (Cyprinus carpio) are prevalent in Carwarp Creek and may be present in other wetlands at Spences Bend. Carp have been found to contribute to the loss of aquatic vegetation and increased turbidity, resulting in loss of habitat for waterfowl (Purdey and Loyn, 2008) and native fish species. This species also competes with native fish for habitat and food (Mallee CMA, 2003).

Invasive fauna terrestrial

The red fox (Vulpes vulpes), is a significant threat to freshwater turtle breeding along Carwarp Creek. Turtle nest predation by foxes is very high. Although the fox is not a water related threat, it is having a substantial impact on a water dependent ecological value at the site.

Invasive flora wetland

Agricultural and other weeds are an ongoing threat and management issue along the River Murray floodplain. These may pose a threat when water is applied as increased water availability can cause weeds to thrive and displace native vegetation. A list of exotic flora species identified at Spences Bend is given in Appendix 4.

Management of water-related threats

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

ASSESSING RISK

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 6.

7 Management Goals, Objectives and Targets

7.1 MANAGEMENT GOAL

The overall goal for the Spences Bend target area has been developed through consultation with various experts and stakeholders including DEWLP, Parks Victoria, and local residents. The goal considers the values the wetland supports and the potential threats that need to be managed. This includes consideration of the values the wetland has historically supported and the likely values it could support into the future.

The management goal for Spences Bend is:

"To provide a water regime that reflects natural inundation seasonality and duration, that will maintain and promote the mosaic of available habitats through the Spences Bend target area."

This is strongly linked to the goals of the Mallee Waterway Strategy 2014-22 (Mallee CMA 2014):

- To maintain or improve habitat within waterways and on surrounding riparian land;
- To manage all land tenures for water quality benefits and respond appropriately to threatening events (both natural and pollution based);
- To restore appropriate water regimes and improve connectivity;
- To protect the extent and condition of Cultural Heritage (Indigenous and non-Indigenous) sites associated with waterways; and
- To 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 Spences Bend can be found in Section 5.25.1 of Butcher et al. (2020).

The outcome of the refinement process in 2020 resulted in the consolidation of the original eight objectives into five concise objectives. Updated objective numbering is consistent with Butcher et al (2020).

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

Table 13. Updated Environmental Objectives and Targets for Spences Bend

EWMP Objective	Target
SB1: By 2030, improve condition and maintain extent from baseline levels of Lignum (Duma florulenta) to sustain communities and processes reliant on Lignum communities at Stage 1 – Bullock Swamp North, Spences Bend.	By 2030, condition in standardised transects that span the floodplain elevation gradient and existing spatial distribution at Stage 1 – Bullock Swamp North, Spences Bend ≥70% of Lignum plants in good condition with a Lignum Condition Score (LCI) ≥4.
SB2: By 2030, improve condition and maintain extent from baseline levels of River Red Gum (Eucalyptus camaldulensis), and Black Box (E. largiflorens) and to sustain communities and processes reliant on such communities at Stage 2 – Spences Bend Billabong, Callanders Swamp and wetland #7329 246886, Spences Bend	By 2030, a positive trend in the condition score of River Red Gum dominated EVC benchmarks at Stage 2 – Spences Bend Billabong, Callanders Swamp and wetland #7329 246886, Spences Bend at 80% of sites over the 10 year period. OR By 2030, at stressed sites (see Wallace et al. 2020) at Stage 2 – Spences Bend Billabong, Callanders Swamp and wetland #7329 246886: 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 River Red Gum trees needs to be established. **AND** By 2030 a positive trend in the condition score of Black Box dominated EVC benchmarks at Stage 2 – Spences Bend Billabong, Callanders Swamp and wetland #7329 246886, Spences Bend at 80% of sites over the 10 year period OR By 2030, at stressed sites (see Wallace et al. 2020) at Stage 2 – Spences Bend Billabong, Callanders Swamp and wetland #7329 246886, Spences Bend: 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 by 2030
SB3: By 2030, improve condition and maintain extent from baseline levels of River Red Gum (Eucalyptus camaldulensis), and Black Box (E. largiflorens) and to sustain communities and processes reliant on such communities at the Spences Bend asset.	By 2030, a positive trend in the condition score of River Red Gum dominated EVC benchmarks at the Spences Bend asset at 80% of sites over the 10 year period. OR By 2030, at stressed sites (see Wallace et al. 2020) at the Spences 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 River Red Gum trees needs to be established. AND By 2030 a positive trend in the condition score of Black Box dominated EVC benchmarks at the Spences Bend at 80% of sites over the 10 year period OR By 2030, at stressed sites (see Wallace et al. 2020) at the Spences 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.
SB5: By 2030, protect and restore connectivity within and between water-dependent ecosystem at the Spences Bend asset, including by ensuring that: ecological processes dependent on hydrologic connectivity laterally between watercourses and their floodplains (and associated wetlands) are maintained.	By 2030, lateral connectivity between floodplain and wetland areas at Spences Bend occurs on a seasonal basis (i.e., spring filling/connectivity) in 7 out of any 10 year period. Maximum dry interval between connected wet periods is 5 years.

EWMP Objective	Target
SB6: By 2030, improve vital habitat at the Spences Bend asset by increasing the diversity of aquatic macrophytes present across a range of Water Regime Indicators Groups.	By 2030, increase diversity of native of macrophytes at the Spences Bend asset with ≥2 species from each of the following Water Regime Indicator Groups present in 80% of years: • Aquatic (obligate submerged) (Aos) (no species recorded) • Aquatic (submerged to partially emergent) (Ase) (Slender Water-ribbons *Cycnogeton dubium*) • Aquatic graminoids (persistent) (Agp) (no species recorded) • Aquatic to semi-aquatic (persistent) (Asp) (Common Blown-grass *Lachnagrostis filiformis s.l.,* Common Nardoo *Marsilea drummondii*, Creeping Monkey-flower *Thyridia repens*) By 2030, increase diversity of native of macrophytes at the Spences Bend asset with ≥4 species from each of the following Water Regime Indicator Groups present in 80% of years: • Seasonally immersed – low growing (Slg) (Lesser Joyweed *Alternanthera denticulata* s.s., Twin-leaf Bedstraw *Asperula gemelli*, Salt Club sedge *Bolboschoenus caldwellii*, Rosinweed *Cressa australis*, Rough Raspwort *Haloragis aspera*, Tall Fireweed *Senecio runcinifolius*, Rat-tail Couch *Sporobolus mitchellii*, Blue Rod *Stemodia florulenta*, River Bluebell *Wahlenbergia fluminalis*) • Seasonally inundated – emergent non woody (Sen) (Common Swamp Wallaby-grass Amphibromus nervosus, Southern Cane-grass Eragrostis infecunda, Tussock Rush Juncus aridicola, Warrego Summer-grass Paspalidium jubiflorum)

7.3 REGIONAL SIGNIFICANCE

Spences Bend supports a range of environmental values of local, regional and Basin significance as described in Section 5. These values are linked to the management goals and environmental objectives and targets described in Section 7. Details of the links between the environmental objectives and environmental outcomes at a regional/Basin scale are provided in Appendix 7.

The management goals and environmental objectives and targets are aligned with the goals of the Mallee Waterway Strategy as described in Section 7.1. The Mallee Waterway Strategy identifies Lake Iraak as a medium priority wetland, and Bullock Swamp as a low priority wetland within 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 Basin Plan 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 Spences Bend EWMP environmental objectives to the Basin Plan are provided in

Table 14 and Appendix 7.

Table 14. Mapping updated Spences Bend EWMP objectives to Basin Plan

EWMP Objective	Alignment with Basin Plan		
	8.05 Ecosystem and biodiversity	8.06 Ecosystem function	8.07 Ecosystem resilience
SB1: By 2030, improve condition and maintain extent from baseline levels of Lignum (Duma florulenta) to sustain communities and processes reliant on Lignum communities at Stage 1 – Bullock Swamp North, Spences Bend.	8.05,3(b)	8.06,6(b)	N/A
SB2: By 2030, improve condition and maintain extent from baseline levels of River Red Gum (Eucalyptus camaldulensis), and Black Box (E. largiflorens) and to sustain communities and processes reliant on such communities at Stage 2 – Spences Bend Billabong, Callanders Swamp and wetland #7329 246886, Spences Bend	8.05,3(b)	8.06,6(b)	N/A
SB3: By 2030, improve condition and maintain extent from baseline levels of River Red Gum (Eucalyptus camaldulensis), and Black Box (E. largiflorens) and to sustain communities and processes reliant on such communities at the Spences Bend asset.	8.05,3(b)	8.06,6(b)	N/A
SB5: By 2030, protect and restore connectivity within and between water-dependent ecosystem at the Spences Bend asset, including by ensuring that: ecological processes dependent on hydrologic connectivity laterally between watercourses and their floodplains (and associated wetlands) are maintained.	N/A	8.06,3b(ii)	N/A
SB6: By 2030, improve vital habitat at the Spences 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

8 Environmental Water Requirements and Intended Water Regime

8.1 WATERING REQUIREMENTS AND INTENDED WATERING REGIME

The management objectives at Spences Bend focus on providing a water regime that reflects natural inundation seasonality and duration, to maintain and promote the mosaic of available habitats in the target area.

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

Black Box stands occur in all the woodland EVC's within the target area. They require flooding to occur every three to seven years with durations of two to six months. This species can tolerate shorter flood durations but plant vigour will suffer. Although timing of flood events is not crucial for Black Box it will 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 woodlands will become dysfunctional (Roberts and Marston, 2011).

Lignum can tolerate a wide range of wet and dry conditions as well as moderate salinity levels. Flood requirements vary with frequencies of one to three years needed to maintain large shrubs with vigorous canopy and flooding every three to five years for maintenance of healthy shrubs. Intervals of seven to ten years can be tolerated by small shrubs but growth will decline and plants in this state do not accommodate nesting by birds. Durations of three to seven months sustain vigorous canopy, but continuous flooding is detrimental. Although timing of flooding is not crucial for Lignum, following natural seasonality is encouraged to provide for understorey and wetland plants (Roberts and Marston, 2011). Longer durations of flooding would be required for specific species of colonial waterbirds, who will abandon nests as flooding recedes. Specific objectives have not been set at this site for these species.

Semi-permanent saline marshes in the target area require inundation one to six months with a minimum frequency of one in ten years and a maximum frequency of every year (Ecological Associates, 2007b). Promotion of semi-emergent macrophytes can be managed with inundation at a depth up to a metre, with duration of one to twelve months. Events should occur with a minimum frequency of every two years and a maximum frequency of every year (Ecological Associates, 2007b).

Overview of inundation stages

The Spences Bend EWMP proposes a staged implementation of environmental watering. The area inundated following implementation of the three stages of the EWMP is the target area for the EWMP.

Stage 1 and 2 (Figure 13) can be achieved using existing infrastructure, whereas Stage 3 (Figure 14) requires extensive works.

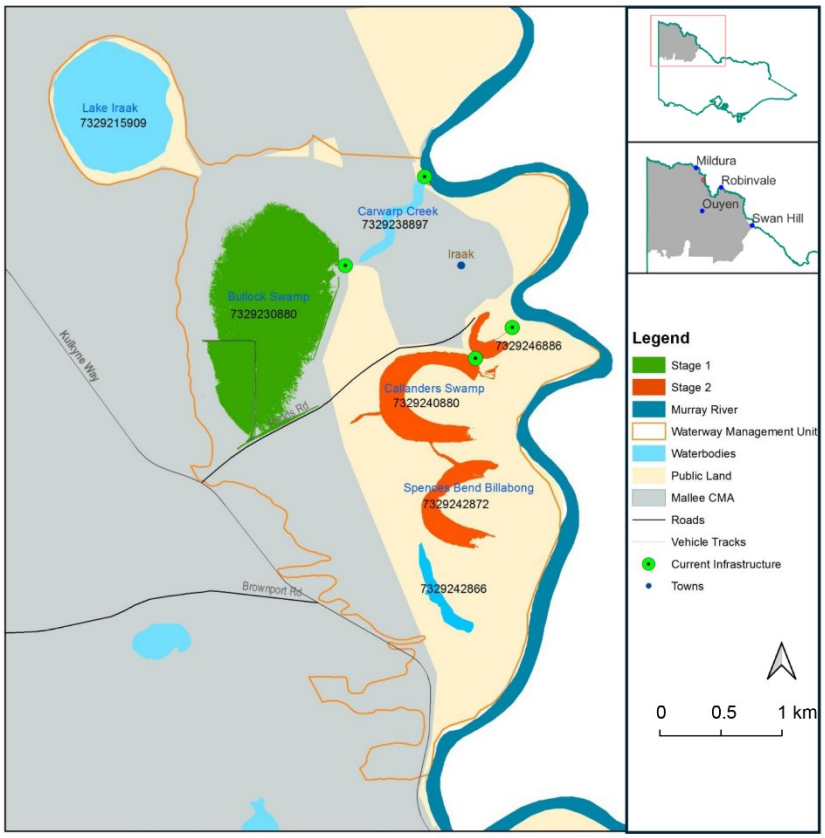


Figure 13. Inundation Extent for Stages 1 and 2 of Spences Bend (note: Numbers in image represent superseded wetland IDs)

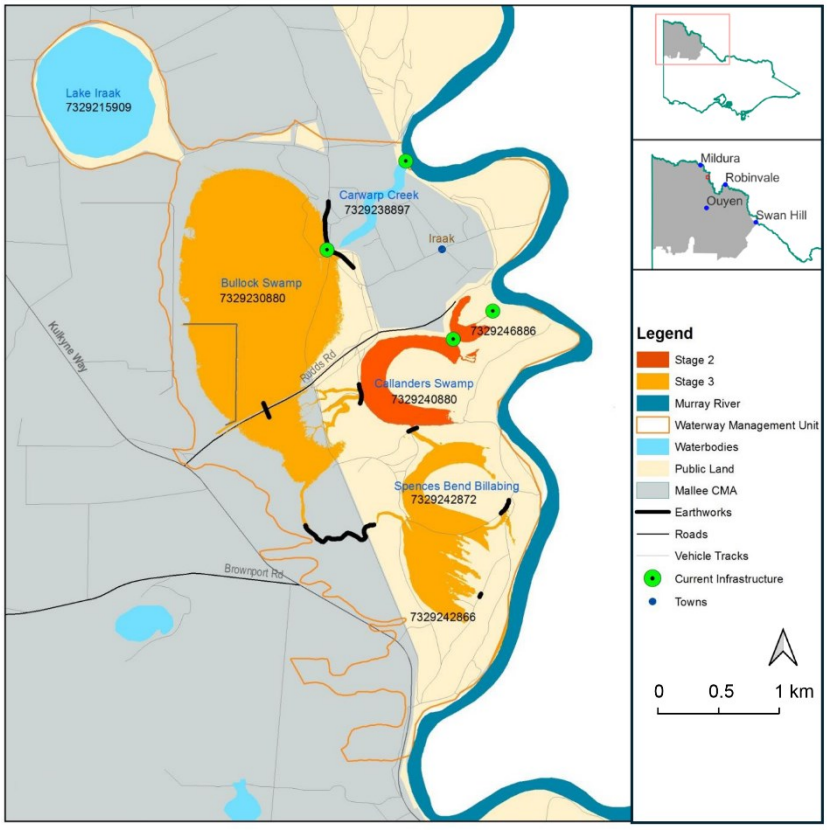


Figure 14. Inundation extent for Stages 2 & 3 of Spences Bend (note: Numbers in image represent superseded wetland IDs)

Stage 1
Stage 1 (Figure 13) involves the inundation of approximately 140 ha of Bullock Swamp north of Rudds Road, requiring approximately 312 ML of environmental water. This will be the option adopted in the early phases of environmental water delivery to Spences Bend.

Stage 2
The wetlands involved in Stage 2 (Figure 14) include Spences Bend Billabong, Callanders Swamp and Unnamed wetland (11418). This stage will inundate an area of approximately 53 ha and require approximately 650 ML of environmental water. These wetlands are the first to receive inflows under high River Murray levels, although their connection to the river is regulated. These wetlands have received environmental water in the past and in mid-2014 were in a drying phase. Environmental water may be delivered to these sites again in the future under Stage 2.

Stage 3
The inundation extent for Stage 3 (Figure 14) includes Spences Bend Billabong and Bullock Swamp south and north. This stage aims to restore connectivity between all the wetlands and provide major inundation of the target area. This stage would inundate approximately 306 ha and require approximately 2486 ML of environmental water.
Combining Stage 2 and 3 to inundate all wetlands in the target area at once would inundate an area of approximately 341 ha and require approximately 2949 ML of environmental water.

Table 15. Intended watering regime for Spences Bend target area

Objective	Mean frequency of events (number per 10 yrs)			Tolerable interval between events (years)		Duration of ponding (months)			Timing of inflows
	Min	Opt	Max	Min	Max	Min	Opt	Max	
SB1: Improve condition and maintain extent of Lignum (Duma florulenta) to sustain communities and processes reliant on Lignum communities.	3	5	10	1	7	3	5	7	Winter / Spring
SB2 & SB3: Improve condition and maintain extent from baseline levels of River Red Gum (Eucalyptus camaldulensis) to sustain communities and processes reliant on such communities.	3	4	7	1	7	2	3	8	Spring / Summer
SB2 & SB3: Improve condition and maintain extent from baseline levels of Black Box (E. largiflorens) to sustain communities and processes reliant on such communities.	2	3	3	3	10	2	4	6	Winter / spring

Objective	Mean frequency of events (number per 10 yrs)			Tolerable interval between events (years)		Duration of ponding (months)			Timing of inflows
	Min	Opt	Max	Min	Max	Min	Opt	Max	
SB5: Protect and restore connectivity within and between water-dependent ecosystem by ensuring that ecological processes dependent on hydrologic connectivity laterally between watercourses and their floodplains (and associated wetlands) are maintained.*	Ecological objective met by other watering for other objectives								
SB6: Improve vital habitat by increasing the diversity of aquatic macrophytes present across a range of Water Regime Indicators Groups.	2	5	10	0		1	6	12	Winter/Spring

8.2 EXPECTED WATERING EFFECTS

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

Table 16. Expected watering effects and potential watering action required to achieve environmental objectives

Objective code	Environmental Objective	Potential Watering Action	Expected Watering Effect
SB1	By 2030, improve condition and maintain extent from baseline levels of Lignum (Duma florulenta) to sustain communities and processes reliant on Lignum communities at Stage 1 – Bullock Swamp North, Spences Bend.	• Maintain regular flooding every second year (5 out of 10 years), with ponding of 3-7 months duration. • Allow water levels to recede over Summer / Autumn	Maintain appropriate seasonal variation in water levels to improve condition and extent of Lignum.
SB2	By 2030, improve condition and maintain extent from baseline levels of River Red Gum (Eucalyptus camaldulensis), and Black Box (E. largiflorens) and to sustain communities and processes reliant on such communities at Stage 2 – Spences Bend Billabong, Callanders Swamp and wetland #7329 246886, Spences Bend.	• Maintain regular flooding every 2-3 years, with ponding of 2-6 months duration. • Allow water levels to recede over Autumn	Maintain appropriate seasonal variation in water levels to improve condition and extent of River Red Gum and Black Box and related communities and processes.

Objective code	Environmental Objective	Potential Watering Action	Expected Watering Effect
SB3	By 2030, improve condition and maintain extent from baseline levels of River Red Gum (Eucalyptus camaldulensis), and Black Box (E. largiflorens) and to sustain communities and processes reliant on such communities at the Spences Bend asset.	• Maintain regular flooding every 2-3 years, with ponding of 2-6 months duration. • Allow water levels to recede over Autumn	Maintain appropriate seasonal variation in water levels to improve condition and extent of River Red Gum and Black Box and related communities and processes.
SB5	By 2030, protect and restore connectivity within and between water-dependent ecosystem at the Spences Bend asset, including by ensuring that: ecological processes dependent on hydrologic connectivity laterally between watercourses and their floodplains (and associated wetlands) are maintained.	• Ecological objective met by other objectives (no specific watering actions).	Maintain appropriate seasonal variation in water levels to improve connectivity between water-dependent ecosystems.
SB6	By 2030, improve vital habitat at the Spences Bend asset by increasing the diversity of aquatic macrophytes present across a range of Water Regime Indicators Groups.	• Maintain regular flooding every second year (5 out of 10 years), with ponding of 1-12 months duration. • Allow water levels to recede over Summer / Autumn	Maintain appropriate seasonal variation in water levels to improve the diversity of aquatic macrophytes present.

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. The planning scenarios under different seasonal conditions for Spences Bend are described in **Error! Reference source not found.**. 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.

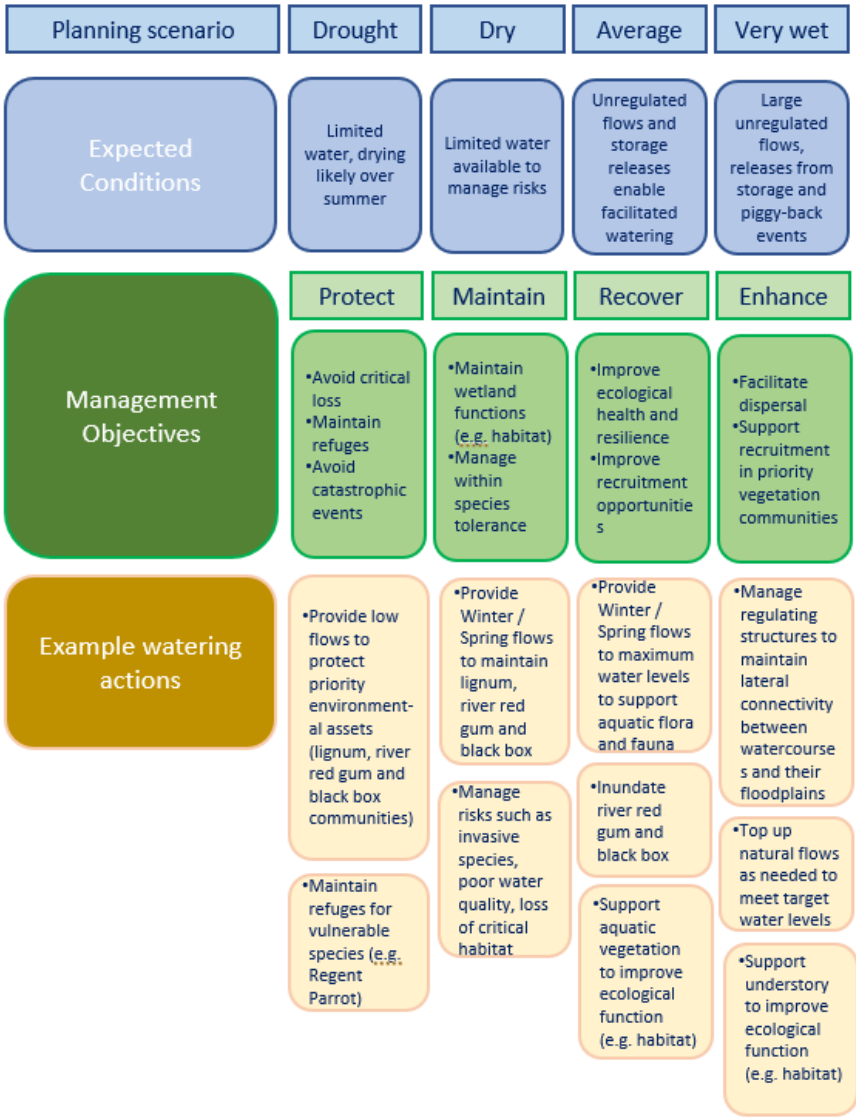


Figure 15. Indicative seasonally adaptive approach

9 Environmental Water Delivery Infrastructure

9.1 WATER DELIVERY INFRASTRUCTURE

The existing arrangements limit the frequency and duration of inundation by flows at Spences Bend. Current infrastructure at Spences Bend was described in further detail in section 4, and broadly consists of:

- A regulator on unnamed wetland #11418 is constructed out of bricks, framed by an iron structure and operated by drop boards. There are difficulties operating this structure in its current condition.
- A regulator on Callanders Swamp made of concrete with a 300 mm pipe and one way valve (therefore requiring no active operation). This structure is in fair to good condition.
- A road levee (Rudds Rd) across Bullock Swamp which prevents water from flowing from south into the northern section. There is a small culvert through Rudds Rd, which is believed to be silted up and does not let water past. The location of this culvert is unknown.
- Regulating structures on both ends of Carwarp Creek.

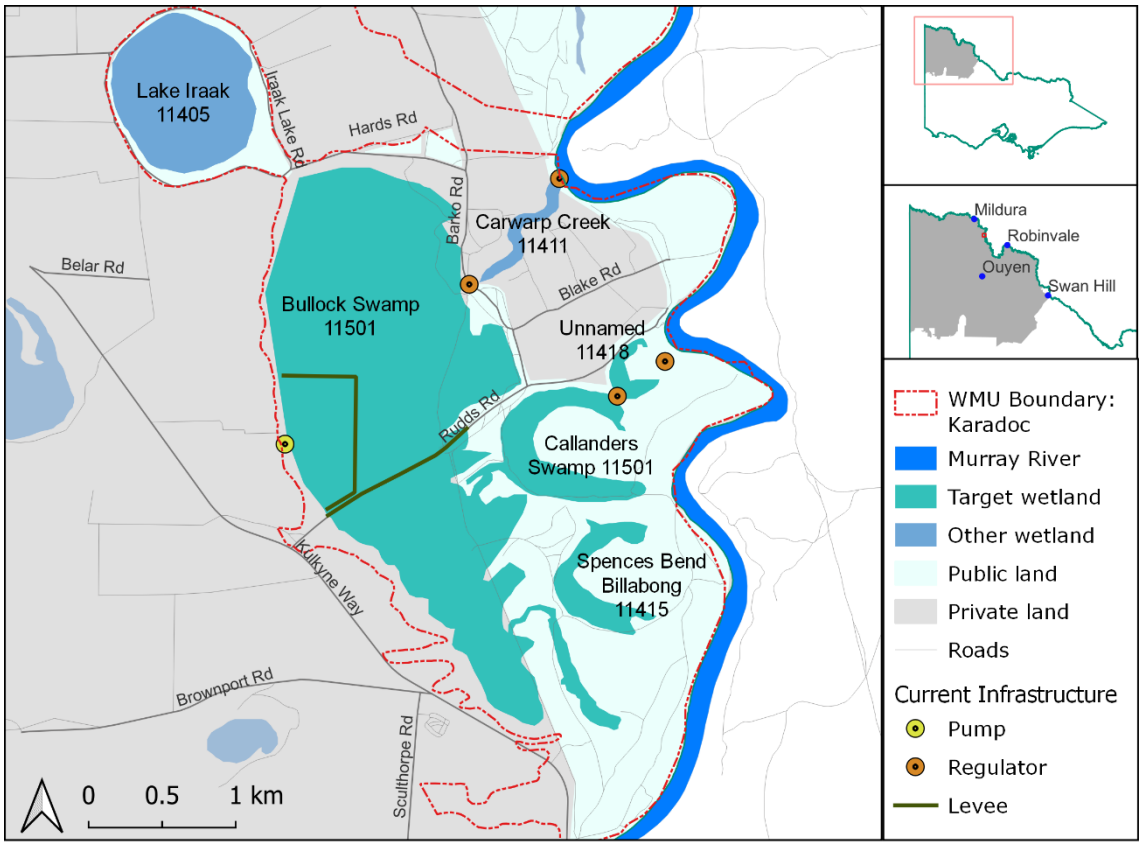


Figure 16. Location of current infrastructure at Spences Bend.

9.2 CONSTRAINTS

The most significant constraints to returning the Bullock Swamp system to a more natural water regime are the risks associated with salinity. These include:

- If Carwarp Creek was to be decommissioned, receding water from the northern section of the wetland to the River Murray may release high salt loads back to the River Murray (SKM 1998).
- If the levee between the wetland and the creek was modified to allow floodwaters to pass, receding floodwaters high in salt would enter the creek.
- There is limited mixing within the northern section of the wetland, meaning accumulated salt may be difficult to flush from the system.
- The desolation of the Rudds Rd culvert may allow saline water from the northern section to mix with the southern section. The southern section currently receives water from river flows and has more intact vegetation as a result.

10 Demonstrating Outcomes

10.1 ENVIRONMENTAL MONITORING

The following priorities for monitoring have been identified for the Spences Bend target area (Table 19). These monitoring priorities 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 20.

Table 17. Environmental monitoring proposed for Spences Bend

Objective	Monitoring Focus	Monitoring Question	Method	When
Overarching management objective	Wetland Condition	Has there been an overall rehabilitation in the condition of the target area by 2030?	Undertake IWC method assessment	Every five years
SB1	Condition and extent of lignum	By 2030, are ≥70% of Lignum plants in good condition with a Lignum Condition Score (LCI) ≥4?	Undertake Lignum population monitoring using standardised transects that span the floodplain elevation gradient and existing spatial distribution	Every three years
SB2 & SB3	Condition and extent of River Red Gum and Black Box	Is the condition of Black Box / River Red Gum improving? What is the extent of Black Box / River Red Gum 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	Annually
SB5	Connectivity within and between water-dependent ecosystems	Does lateral connectivity between floodplain and wetland areas at Spences Bend occurs on a seasonal basis in 7 out of any 10 year period? Is the maximum dry interval between connected wet periods 5 years?	Field assessments, remote sensing.	Every three years
SB6	Diversity of aquatic macrophytes	By 2030 has there been an increase in 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

10.2 MONITORING PRIORITIES AT THE ASSET

Ecological monitoring is required to demonstrate the effectiveness of environmental watering in achieving ecological 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 Spences Bend are the monitoring questions that most strongly influence watering decisions and the evaluation of watering

effectiveness. Ongoing water quality monitoring should occur in each of the target area wetlands. This should include both baseline and event based monitoring, particularly focusing on salinity.

All these priorities align with the following long-term outcomes of the Mallee Regional Catchment Strategy Waterway theme:

- The condition of high value aquatic and riparian habitat is improved
- Appropriate water regimes are restored to priority waterways and connectivity is improved.

Table 18. Monitoring priorities at Spences Bend

Monitoring Priority	Reason for Priority
Water delivery	Adaptive management: water is managed to meet EWMP objectives.
Index of wetland condition assessments	These provide information on changes in hydrology and water quality that impact on flora and fauna
Groundwater monitoring	A small groundwater-monitoring program could also be implemented focusing on bores located around the perimeter of Bullock Swamp and adjacent Carwarp Creek. The collection of groundwater level and salinity data will help assess the groundwater response to watering and the level of connection between the Swamp and the floodplain aquifer. This will in turn improve assessments of leakage rates and mounding beneath the Swamp bed (Australian Water Environments, 2014).
Soil sampling	Soil sampling is recommended at the conclusion of an environmental wearing event, to help to evaluate the success of watering relative to leaching salts from the upper soil profile.
Black Box stand condition and extent	To develop baselines to assist condition assessments. Key for assessing progress against objectives of the Basin Plan Environmental Watering Plan (EWP), Basin Plan Schedule 7 targets, Basin wide Environmental Watering strategy (BWS) and Victorian Murray Long Term Watering Plan. Black Box stands are an important long-term indicator of the effectiveness of environmental water.
River Red Gum stand condition and extent	To develop baselines to assist condition assessments. Key for assessing progress against objectives of the Basin Plan Environmental Watering Plan (EWP), Basin Plan Schedule 7 targets, Basin wide Environmental Watering strategy (BWS) and Victorian Murray Long Term Watering Plan.
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 17 shows an illustration of the adaptive management cycle for environmental water delivery.

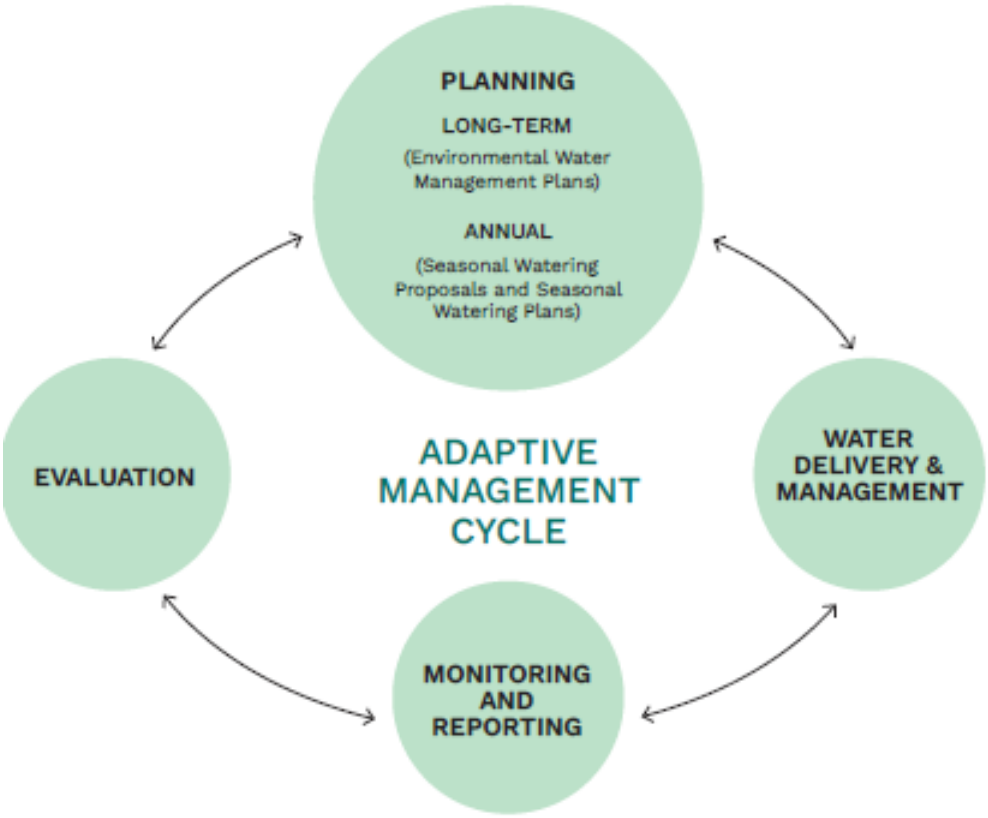


Figure 17. The adaptive management cycle for environmental water delivery and management

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.

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. Some areas where further knowledge would be beneficial are outlined in Table 21. Any future monitoring plan could include a number of these recommendations.

Table 19. Knowledge gaps and recommendations for the target area

Knowledge and data gaps	Action recommended	Responsibility
Index of Wetland Condition/ Index of Stream Condition Assessments	IWC/ISC assessments undertaken to establish baseline condition and as the basis for ongoing monitoring of improvement over time	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
Full extent of cultural Heritage values	Cultural heritage assessment and mapping of values within target area	
Impact of watering program on native vegetation	Continue to investigate and understand the range of species at the site, including surveys of vegetation, including aquatic macrophytes.	
Condition and extent of Black Box stands, River Red Gum stands, and Lignum and aquatic macrophytes. The range of species at the site, including surveys of vegetation, including aquatic macrophytes.	Undertake methods identified in Table 17.	
Optimal salinity conditions for Bullock Swamp, including the long-term interactions with groundwater, irrigation and drainage.	Undertake methods identified in Table 17.	
Best environmental option between returning environmental water to the river and retaining water in the wetlands following environmental watering of the target area.	Options analysis	

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APPENDIX 1. ENVIRONMENTAL WATER MANAGEMENT PLAN CONTEXT

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

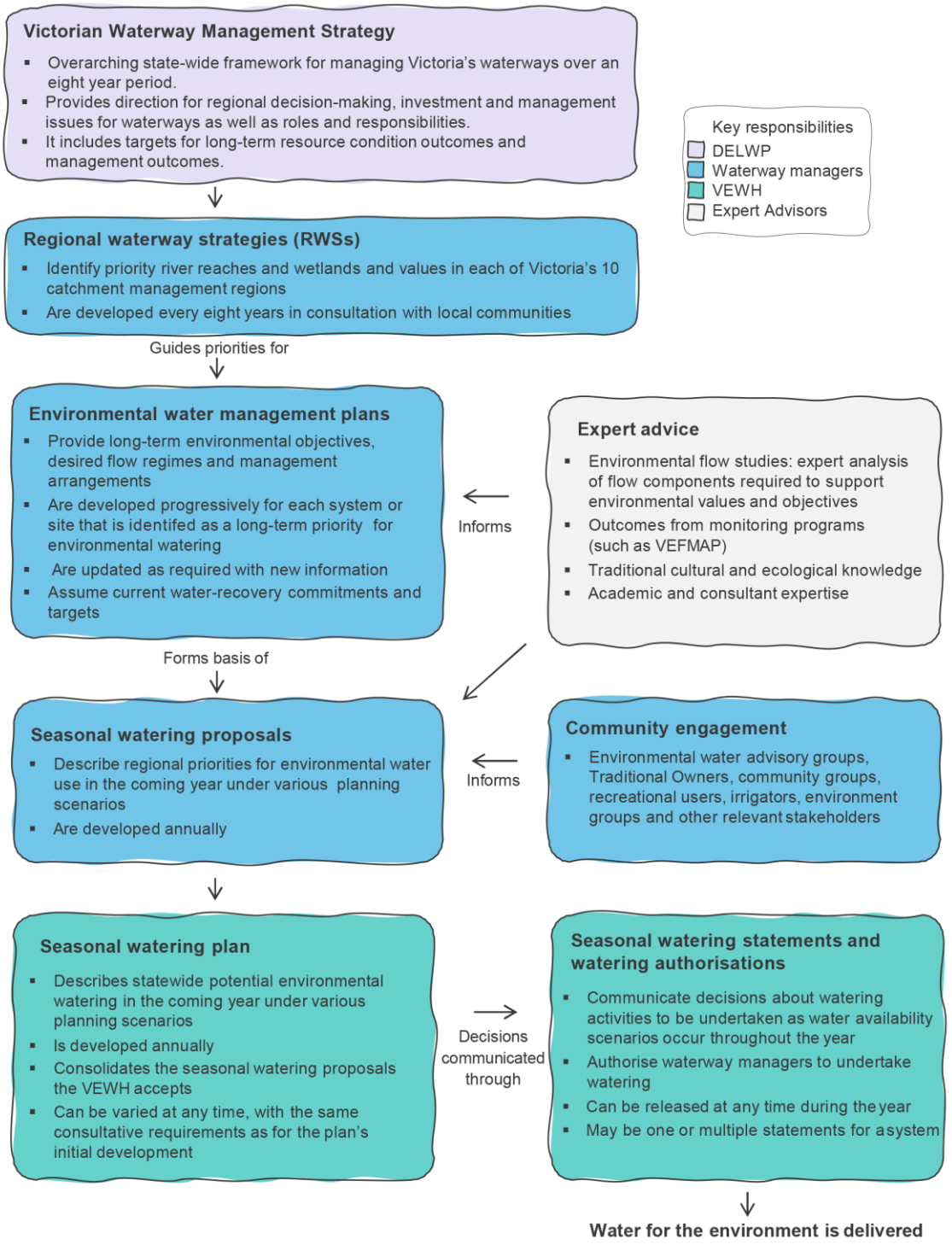

Figure 18. EWMP Policy Context

APPENDIX 2. ECOLOGICAL VEGETATION CLASSES

EVC no.	EVC name	Bioregional conservation status	Description
810	Floodway Pond Herbland	Depleted	Low herbland to <0.3m 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 Lake Bed Herbland.
295	Riverine Grassy Woodland	Depleted	Occurs on the floodplain of major rivers, in a slightly elevated position where floods are rare, on deposited silts and sands, forming fertile alluvial soils. River Red Gum woodland to 20m tall with a groundlayer dominated by graminoids and sometimes lightly shrubby or with chenopod shrubs.
106	Grassy Riverine Forest	Depleted	Occurs on the floodplain of major rivers, in a slightly elevated position where floods are infrequent, on deposited silts and sands, forming fertile alluvial soils. River Red Gum Forest to 25m tall with a groundlayer dominated by tussock-forming graminoids. Occasional tall shrubs present.
811	Grassy Riverine Forest / Floodway Pond Herbland Complex	Depleted	Eucalypt forest or woodland of flood-prone areas, where herbaceous species characteristic of drying mud within wetlands (Floodway Pond Herbland or in part Lake Bed Herbland) are conspicuous in association or fine-scale mosaic with *Paspalidium jubiflorum* and other species characteristic of Grassy Riverine Forest. Restricted extent, River Murray system mainly in far north-west, but upstream at least as far as Barmah Forest.
104	Lignum Swamp	Vulnerable	Typically treeless shrubland to 4m tall, with robust (but sometimes patchy) growth of lignum. Widespread wetland vegetation type in low rainfall area on heavy soils, subject to infrequent inundation resulting from overbank flows from rivers or local runoff.
823	Lignum Swampy Woodland	Depleted	Understorey dominated by Lignum, typically of robust character and relatively dense (at least in patches), in association with a low Eucalypt and/or Acacia woodland to 15 m tall. The ground layer includes a component of obligate wetland flora that is able to persist even if dormant over dry periods.
808	Lignum Shrubland	Least Concern	Relatively open shrubland of species of divaricate growth form. The ground-layer is typically herbaceous or a turf grassland, rich in annual/ephemeral herbs and small chenopods. Characterised the open and even distribution of relatively small Lignum shrubs. Occupies heavy soil plains along River Murray, low-lying areas on higher-level (but still potentially flood-prone) terraces.
818	Shrubby Riverine Woodland	Least Concern	Eucalypt woodland to open forest to 15 m tall of less flood-prone (riverine) watercourse fringes, principally on levees and higher sections of point-bar deposits. The understorey includes a range of species shared with drier floodplain habitats with a sparse shrub component, ground-layer patchily dominated by various life-forms. A range of large dicot herbs (mostly herbaceous perennial, several with a growth-form approaching that of small shrub) are often conspicuous.
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 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.
107	Lake Bed Herbland	Depleted	Herbland or shrubland to 0.5m tall dominated by species adapted to drying mud within lake beds. Some evade periods of prolonged inundation as seed, others as dormant tuber-like rootstock. Occupies drying deep-cracking mud of lakes on floodplains, Floods are intermittent but water may be retained for several seasons leading to active growth at the 'drying mud stage'.
200	Shallow Freshwater Marsh	Vulnerable	Generally, shallow freshwater marshes are no more than half a metre deep and usually dry out in summer. They are usually formed in volcanic flow beds. Large stands of River Red Gum or Lignum are often found around shallow freshwater marshes, with reeds, rushes and Cane Grass, or low-growing herbs and sedges, dominating the vegetation.
103	Riverine Chenopod Woodland	Depleted	Eucalypt woodland to 15m 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.

APPENDIX 3. FAUNA SPECIES LIST

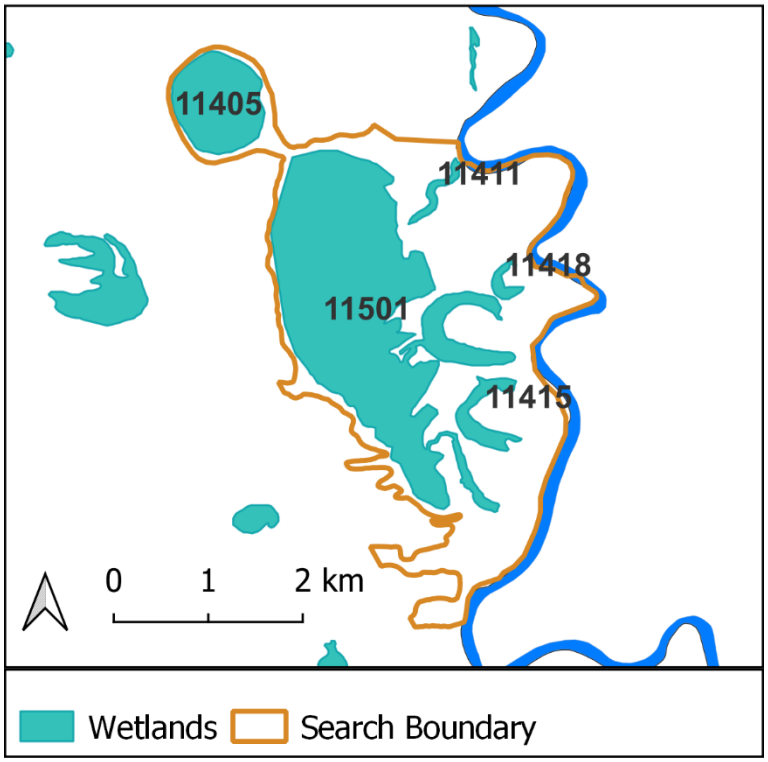

Table 20. Spences Bend fauna species list

Scientific Name	Common Name	FFG Act Status	EPBC Act Status
Anhinga novaehollandiae	Australasian darter	-	-
Tachybaptus novaehollandiae	Australasian grebe	-	-
Gymnorhina tibicen	Australian magpie	-	-
Pelecanus conspicillatus	Australian pelican	-	-
Corvus coronoides	Australian raven	-	-
Barnardius zonarius	Australian ringneck	-	-
Tadorna tadornoides	Australian shelduck	-	-
Threskiornis molucca	Australian white ibis	-	-
Chenonetta jubata	Australian wood duck	-	-
Limnodynastes fletcheri	Barking marsh frog	-	-
Milvus migrans	Black kite	-	-
Cygnus atratus	Black swan	-	-
Coracina novaehollandiae	Black-faced cuckoo-shrike	-	-
Elseyornis melanops	Black-fronted dotterel	-	-
Northiella haematogaster	Blue bonnet	-	-
Entomyzon cyanotis	Blue-faced honeyeater	-	-
Climacteris picumnus	Brown treecreeper	-	Vulnerable
Hydroprogne caspia	Caspian tern	Vulnerable	-
Anas castanea	Chestnut teal	-	-

Scientific Name	Common Name	FFG Act Status	EPBC Act Status
Pomatostomus ruficeps	Chestnut-crowned babbler	-	-
Acanthiza uropygialis	Chestnut-rumped thornbill	-	-
Nymphicus hollandicus	Cockatiel	-	-
Accipiter cirrocephalus	Collared sparrowhawk	-	-
Turdus merula	Common blackbird*	-	-
Phaps chalcoptera	Common bronzewing	-	-
Paratya australiensis	Common freshwater shrimp	-	-
Sturnus vulgaris	Common starling*	-	-
Ocyphaps lophotes	Crested pigeon	-	-
Platycercus elegans	Crimson rosella	-	-
Gallinula tenebrosa	Dusky moorhen	-	-
Artamus cyanopterus	Dusky woodswallow	-	-
Gambusia holbrooki	Eastern gambusia*	-	-
Pandion cristatus	Eastern osprey	-	-
Crinia parinsignifera	Eastern sign-bearing froglet	-	-
Dromaius novaehollandiae	Emu	-	-
Fulica atra	Eurasian coot	-	-
Carduelis carduelis	European goldfinch*	-	-
Petrochelidon ariel	Fairy martin	-	-
Malurus spp.	Fairywrens	-	-
Eolophus roseicapilla	Galah	-	-
Ardea alba	Great egret	-	-
Cracticus torquatus	Grey butcherbird	-	-
Rhipidura albiscapa	Grey fantail	-	-
Colluricincla harmonica	Grey shrike-thrush	-	-
Anas gracilis	Grey teal	-	-
Aythya australis	Hardhead	Vulnerable	-
Poliocephalus poliocephalus	Hoary-headed grebe	-	-
Chrysococcyx basalis	Horsfield's bronze-cuckoo	-	-
Acanthiza apicalis	Inland thornbill	-	-
Dacelo novaeguineae	Laughing kookaburra	-	-
Phalacrocorax sulcirostris	Little black cormorant	-	-
Cacatua sanguinea	Little corella	-	-
Corvus bennetti	Little crow	-	-
Philemon citreogularis	Little friarbird	-	-
Microcarbo melanoleucos	Little pied cormorant	-	-
Corvus mellori	Little raven	-	-
Grallina cyanoleuca	Magpie-lark	-	-
Lophochroa leadbeateri	Major Mitchell's cockatoo	Critically Endangered	Endangered
Vanellus miles	Masked lapwing	-	-
Dicaeum hirundinaceum	Mistletoebird	-	-
Psephotellus varius	Mulga parrot	-	-

Scientific Name	Common Name	FFG Act Status	EPBC Act Status
Falco cenchroides	Nankeen kestrel	-	-
Nycticorax caledonicus	Nankeen night-heron	-	-
Manorina melanocephala	Noisy miner	-	-
Anas superciliosa	Pacific black duck	-	-
Cacomantis pallidus	Pallid cuckoo	-	-
Geopelia placida	Peaceful dove	-	-
Falco peregrinus	Peregrine falcon	-	-
Litoria peronii	Peron's tree frog	-	-
Cracticus nigrogularis	Pied butcherbird	-	-
Charadriidae spp.	Plovers, dotterels and lapwings	-	-
Ardea intermedia plumifera	Plumed egret	Critically Endangered	-
Merops ornatus	Rainbow bee-eater	-	-
Corvus spp.	Ravens and crows	-	-
Anthochaera carunculata	Red wattlebird	-	-
Charadrius ruficapillus	Red-capped plover	-	-
Petroica goodenovii	Red-capped robin	-	-
Psephotus haematonotus	Red-rumped parrot	-	-
Acrocephalus australis	Reed-warbler	-	-
Polytelis anthopeplus monarchoides	Regent parrot	Vulnerable	Vulnerable
Myiagra inquieta	Restless flycatcher	-	-
Pachycephala rufiventris	Rufous whistler	-	-
Todiramphus sanctus	Sacred kingfisher	-	-
Chroicocephalus novaehollandiae	Silver gull	-	-
Gavicalis virescens	Singing honeyeater	-	-
Limnodynastes dumerilii	Southern bullfrog (ssp. unknown)	-	-
Acanthagenys rufogularis	Spiny-cheeked honeyeater	-	-
Malurus splendens	Splendid fairy-wren	-	-
Limnodynastes tasmaniensis	Spotted marsh frog (race unknown)	-	-
Lophoictinia isura	Square-tailed kite	Vulnerable	-
Threskiornis spinicollis	Straw-necked ibis	-	-
Pardalotus striatus	Striated pardalote	-	-
Plectorhyncha lanceolata	Striped honeyeater	-	-
Cacatua galerita	Sulphur-crested cockatoo	-	-
Malurus cyaneus	Superb fairy-wren	-	-
Petrochelidon nigricans	Tree martin	-	-
Egernia striolata	Tree skink	-	-
Malurus lamberti	Variegated fairy-wren	-	-
Aquila audax	Wedge-tailed eagle	-	-
Smicrornis brevirostris	Weebill	-	-
Hirundo neoxena	Welcome swallow	-	-

Scientific Name	Common Name	FFG Act Status	EPBC Act Status
Haliastur sphenurus	Whistling kite	-	-
Cheramoeca leucosterna	White-backed swallow	-	-
Haliaeetus leucogaster	White-bellied sea-eagle	Endangered	-
Artamus leucorynchus	White-breasted woodswallow	-	-
Pomatostomus superciliosus	White-browed babbler	-	-
Egretta novaehollandiae	White-faced heron	-	-
Purnella albifrons	White-fronted honeyeater	-	-
Ardea pacifica	White-necked heron	-	-
Ptilotula penicillata	White-plumed honeyeater	-	-
Corcorax melanorhamphos	White-winged chough	-	-
Rhipidura leucophrys	Willie wagtail	-	-
Acanthiza nana	Yellow thornbill	-	-
Acanthiza chrysorrhoa	Yellow-rumped thornbill	-	-
Manorina flavigula	Yellow-throated miner	-	-
Taeniopygia guttata	Zebra finch	-	-

* indicates introduced.

Source: Naturekit search 2023, and personal observations by Mallee CMA field staff.

APPENDIX 4. FLORA SPECIES LIST

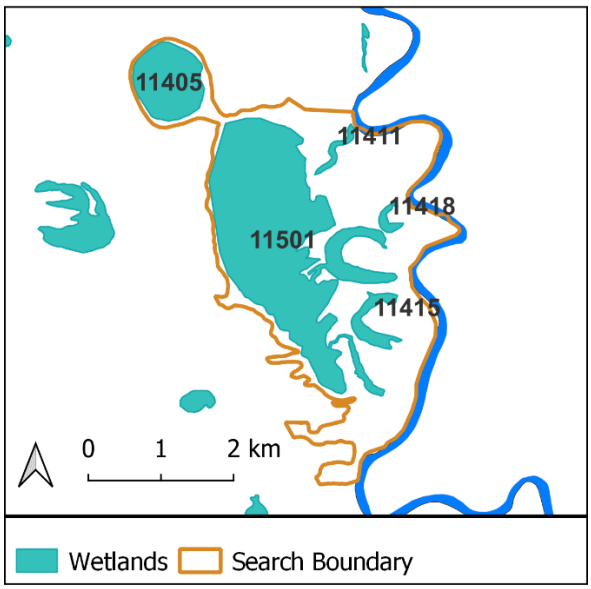

Table 21. Spences Bend flora species list

Scientific Name	Common Name	FFG Act Status	EPBC Act Status
Euchiton sphaericus	Annual cudweed		
Vittadinia cervicularis	Annual New Holland daisy		
Tetragonia moorei	Annual spinach		
Schismus barbatus	Arabian grass*		
Asparagus officinalis	Asparagus*		
Symphyotrichum subulatum	Aster-weed*		
Ophioglossum lusitanicum	Austral adder's-tongue		
Cynoglossum australe	Australian hound's-tongue		
Osteocarpum acropterum var. deminutum	Babbagia		
Austrostipa nitida	Balcarra spear-grass		
Hordeum leporinum	Barley grass*		
Hordeum murinum s.l.	Barley-grass*		
Agrostis s.l. spp.	Bent/blown grass		
Atriplex semibaccata	Berry saltbush		
Suaeda baccifera	Berry seablite*		
Eucalyptus largiflorens	Black box		
Maireana decalvans s.l.	Black cotton-bush		
Solanum nigrum s.l.	Black nightshade*		
Sclerolaena muricata var. muricata	Black roly-poly		
Tecticornia pergranulata	Blackseed glasswort		
Tecticornia pergranulata subsp. pergranulata	Blackseed glasswort		
Atriplex vesicaria	Bladder saltbush		

Scientific Name	Common Name	FFG Act Status	EPBC Act Status
Stemodia florulenta	Blue rod		
Wahlenbergia spp.	Bluebell		
Amyema miquelii	Box mistletoe		
Acacia victoriae subsp. victoriae	Bramble wattle	Endangered	
Rytidosperma setaceum	Bristly wallaby-grass		
Senna artemisioides subsp. coriacea	Broad-leaf desert cassia		
Typha spp.	Bulrush		
Medicago polymorpha	Burr medic*		
Minuria cunninghamii	Bush minuria	Vulnerable	
Eragrostis australasica	Cane grass	Critically Endangered	
Arctotheca calendula	Cape weed*		
Senna spp.	Cassia		
Alectryon oleifolius subsp. canescens	Cattle bush		
Roepera eremaea	Climbing twin-leaf		
Parapholis incurva	Coast barb-grass*		
Grevillea huegelii	Comb grevillea		
Lachnagrostis filiformis s.l.	Common blown-grass		
Wurmbea dioica	Common early nancy		
Erodium cicutarium	Common heron's-bill*		
Mesembryanthemum crystallinum s.l.	Common ice-plant*		
Marsilea drummondii	Common nardoo		
Lepidium africanum	Common peppercress*		
Centipeda cunninghamii	Common sneezeweed		
Sonchus oleraceus	Common sow-thistle*		
Rytidosperma caespitosum	Common wallaby-grass		
Atriplex lindleyi subsp. inflata	Corky saltbush		
Senecio quadridentatus	Cotton fireweed		
Cynodon dactylon	Couch^		
Heliotropium supinum	Creeping heliotrope*		
Myoporum parvifolium	Creeping myoporum		
Plantago turrifera	Crowned plantain		
Goodenia pinnatifida	Cut-leaf goodenia		
Plantago drummondii	Dark plantain		
Crassula colorata	Dense crassula		
Abutilon otocarpum	Desert lantern	Endangered	
Vittadinia dissecta s.l.	Dissected New Holland daisy		
Maireana pentatropis	Erect bluebush		
Acacia stenophylla	Eumong^		
Pentameris airoides subsp. airoides	False hair-grass*		
Reichardia tingitana	False sow-thistle*		

Scientific Name	Common Name	FFG Act Status	EPBC Act Status
Cotula bipinnata	Ferny cotula*		
Rumex pulcher subsp. pulcher	Fiddle dock*		
Actinobole uliginosum	Flannel cudweed		
Eleocharis plana	Flat spike-sedge	Critically Endangered	
Euphorbia drummondii s.l.	Flat spurge*		
Atriplex lindleyi	Flat-top saltbush		
Alyssum linifolium	Flax-leaf alyssum*		
Erigeron bonariensis	Flaxleaf fleabane*		
Amyema miraculosa subsp. boormanii	Fleshy mistletoe		
Phyla nodiflora var. minor	Fog-fruit*		
Fumaria spp.	Fumitory*		
Calostemma purpureum s.l.	Garland lily		
Gazania linearis	Gazania*		
Malacocera tricornis	Goat head	Vulnerable	
Isoetopsis graminifolia	Grass cushion		
Oxalis perennans	Grassland wood-sorrel		
Convolvulus remotus s.l.	Grassy bindweed		
Bromus diandrus	Great brome*		
Maireana appressa	Grey bluebush		
Sclerolaena diacantha	Grey copperburr		
Sclerolaena muricata var. villosa	Grey roly-poly		
Wahlenbergia gracilenta s.s.	Hairy annual-bluebell		
Maireana pentagona	Hairy bluebush		
Calotis hispidula	Hairy burr-daisy		
Amsinckia calycina	Hairy fiddle-neck*		
Brachyscome lineariloba	Hard-head daisy		
Dissocarpus paradoxus	Hard-head saltbush		
Lysiana exocarpi	Harlequin mistletoe		
Rhagodia spinescens	Hedge saltbush^		
Marrubium vulgare	Horehound*		
Ranunculus pentandrus var. platycarpus	Inland buttercup		
Ammannia multiflora	Jerry-jerry	Endangered	
Laphangium luteoalbum	Jersey cudweed		
Atriplex stipitata subsp. stipitata	Kidney saltbush		
Swainsona reticulata	Kneed swainson-pea	Endangered	
Bulbine semibarbata	Leek lily		
Orobanche minor	Lesser broomrape*		
Alternanthera denticulata s.s.	Lesser joyweed		
Alternanthera denticulata s.l.	Lesser Joyweed		
Spergularia diandra	Lesser sand-spurrey*		
Sclerolaena obliquicuspis	Limestone copperburr		

Scientific Name	Common Name	FFG Act Status	EPBC Act Status
Medicago minima	Little medic*		
Sisymbrium irio	London rocket*		
Silene apetala var. apetala	Mallee catchfly*		
Thysanotus baueri	Mallee fringe-lily		
Senecio spanomerus	Mallee groundsel		
Eragrostis dielsii	Mallee love-grass		
Centaurea melitensis	Malta thistle*		
Atriplex pumilio	Mat saltbush		
Atriplex pseudocampanulata	Mealy saltbush^		
Silene nocturna	Mediterranean catchfly*		
Brassica tournefortii	Mediterranean turnip*		
Olearia muelleri	Mueller daisy-bush		
Marsilea spp.	Nardoo		
Cynodon dactylon var. pulchellus	Native couch		
Sonchus hydrophilus	Native sow-thistle		
Vittadinia spp.	New holland daisy		
Chenopodium nitrariaceum	Nitre goosefoot		
Nitraria billardierei	Nitre-bush		
Einadia nutans	Nodding saltbush		
Xanthium strumarium s.l.	Noogoora burr species aggregate*		
Xanthium occidentale	Noogoora burr*		
Avena spp.	Oat*		
Asphodelus fistulosus	Onion weed*		
Calocephalus sonderi	Pale beauty-heads		
Goodenia glauca	Pale goodenia		
Roepera glauca	Pale twin-leaf		
Paspalidium spp.	Panic grass		
Olearia pimeleoides	Pimelea daisy-bush		
Polycalymma stuartii	Poached-eggs daisy		
Roepera apiculata	Pointed twin-leaf		
Lactuca serriola	Prickly lettuce*		
Salsola tragus subsp. tragus	Prickly saltwort		
Salsola tragus	Prickly saltwort		
Eragrostis lacunaria	Purple love-grass	Endangered	
Solanum esuriale	Quena		
Vulpia myuros	Rat's-tail fescue*		
Sporobolus mitchellii	Rat-tail couch		
Lotus cruentus	Red bird's-foot trefoil		
Bromus rubens	Red brome*		
Spergularia rubra s.s.	Red sand-spurrey*		
Spergularia rubra s.l.	Red sand-spurrey*		

Scientific Name	Common Name	FFG Act Status	EPBC Act Status
Chloris gayana	Rhodes grass*		
Wahlenbergia fluminalis	River bluebell		
Eucalyptus camaldulensis	River red-gum		
Dianella porracea	Riverine flax-lily	Critically Endangered	
Cressa australis	Rosinweed		
Austrostipa scabra subsp. falcata	Rough spear-grass		
Disphyma crassifolium subsp. clavellatum	Rounded noon-flower		
Enchylaena tomentosa var. tomentosa	Ruby saltbush		
Maireana pyramidata	Sago bush		
Atriplex spp.	Saltbush		
Pachymitus cardaminoides	Sand cress		
Sida ammophila	Sand sida	Endangered	
Phyllanthus lacunellus	Sandhill spurge	Endangered	
Sarcozona praecox	Sarcozona	Endangered	
Maireana turbinata	Satiny bluebush		
Roepera angustifolia	Scrambling twin-leaf	Endangered	
Suaeda spp.	Seablite		
Maireana brevifolia	Short-leaf bluebush		
Sclerochlamys brachyptera	Short-wing saltbush		
Crassula sieberiana s.l.	Sieber crassula		
Crassula sieberiana s.s.	Sieber crassula		
Chondrilla juncea	Skeleton weed*		
Glinus oppositifolius	Slender carpet-weed		
Callitris gracilis	Slender cypress-pine		
Senecio glossanthus s.l.	Slender groundsel		
Senecio glossanthus s.s.	Slender groundsel		
Dodonaea viscosa subsp. angustissima	Slender hop-bush		
Atriplex leptocarpa	Slender-fruit saltbush		
Acacia ligulata	Small cooba		
Mesembryanthemum nodiflorum	Small ice-plant*		
Calandrinia eremaea	Small purslane		
Swainsona microphylla	Small-leaf swainson-pea	Endangered	
Hypochaeris glabra	Smooth cat's-ear*		
Heliotropium curassavicum	Smooth heliotrope^		
Minuria integerrima	Smooth minuria	Vulnerable	
Sisymbrium erysimoides	Smooth mustard*		
Eragrostis infecunda	Southern cane-grass		
Sonchus spp.	Sow thistle		
Cirsium vulgare	Spear thistle*		
Sclerolaena patenticuspis	Spear-fruit copperburr	Vulnerable	

Scientific Name	Common Name	FFG Act Status	EPBC Act Status
Enteropogon acicularis	Spider grass		
Duma horrida subsp. horrida	Spiny lignum	Critically Endangered	
Eremophila divaricata subsp. divaricata	Spreading emu-bush	Vulnerable	
Picris squarrosa	Squat picris	Endangered	
Leiocarpa websteri	Stalked plover-daisy		
Sclerolaena stelligera	Star bluebush		
Scleroblitum atriplicinum	Starry goosefoot		
Pogonolepis muelleriana	Stiff cup-flower		
Dittrichia graveolens	Stinkwort*		
Sclerolaena tricuspis	Streaked copperburr		
Fimbristylis aestivalis	Summer fringe-sedge		
Melilotus indicus	Sweet melilot*		
Senecio runcinifolius	Tall fireweed		
Erigeron sumatrensis	Tall fleabane*		
Aristida holathera var. holathera	Tall kerosene Grass	Endangered	
Calotis erinacea	Tangled burr-daisy		
Duma florulenta	Tangled lignum		
Euphorbia terracina	Terracina spurge*		
Maireana triptera	Three-wing bluebush		
Rostraria pumila	Tiny bristle-grass*		
Monoculus monstrosus	Tripteris*		
Sida intricata	Twiggy sida	Endangered	
Dissocarpus biflorus var. biflorus	Twin-flower saltbush	Critically Endangered	
Acacia oswaldii	Umbrella wattle	Critically Endangered	
Brachyscome ciliaris	Variable daisy		
Paspalidium jubiflorum	Warrego summer-grass^		
Pittosporum angustifolium	Weeping pittosporum		
Plagiobothrys plurisepalus	White rochelia		
Roepera similis	White twin-leaf		
Avena fatua	Wild oat*		
Salvia verbenaca	Wild sage*		
Limonium lobatum	Winged sea-lavender*		
Amyema preissii	Wire-leaf mistletoe		
Podolepis capillaris	Wiry podolepis		
Senna artemisioides subsp. petiolaris	Woody cassia		
Vittadinia gracilis	Woolly New Holland daisy		
Cullen pallidum	Woolly scurf-pea	Endangered	
Eclipta platyglossa subsp. platyglossa	Yellow twin-heads^		

* indicates introduced
^ indicates native, but some stands may be alien
Source: Naturekit search 2023, and personal observations by Mallee CMA field staff.

APPENDIX 5. COMMUNITY AND AGENCY ENGAGEMENT 2024 SUMMARY

Community Engagement

At in-person engagement at local events, 24 community stakeholders identified Spences Bend sites as valued sites between September-December 2023. 33% of participants at the in-person engagement identified recreation values at the site (e.g. bushwalking, camping, birdwatching and fishing), 29% of participants identified flora and fauna values at the site (e.g. frogs, pelicans, waterbirds, turtle), and 21% of stakeholders identified water values at the site.

Community stakeholders were engaged via an online survey, which was hosted on the Mallee CMA website in December 2023 – January 2024. The survey was designed to enable community, landholders, recreational users, environmental groups and other interested parties to provide input to the plans. Community stakeholders were also engaged during local events such as the Mildura markets, Red Cliff markets, Mildura Birdlife meeting, Greening Mildura, environmental volunteer event and Cabarita Inc Day, and a drop in event at Nangiloc reserve. The survey supplements earlier community engagement about the Spences Bend EWMPs, and annual community engagement that informs the Seasonal Watering Proposal (SWP). Community consultation occurs at the IAP2 level of CONSULT.

Ten participants to the online survey identified Spences Bend as a site that they visit and provided information on site use and values, and twenty-three respondents engaged with Mallee CMA about Spences Bend at in-person events.

From the online survey, 70% of respondents visited Spences Bend, 60% of respondents visited Bullocks Swamp, and 50% of respondents visited Callanders Swamp, Lake Iraak and Carwarp Creek (note that respondents could select multiple sites).

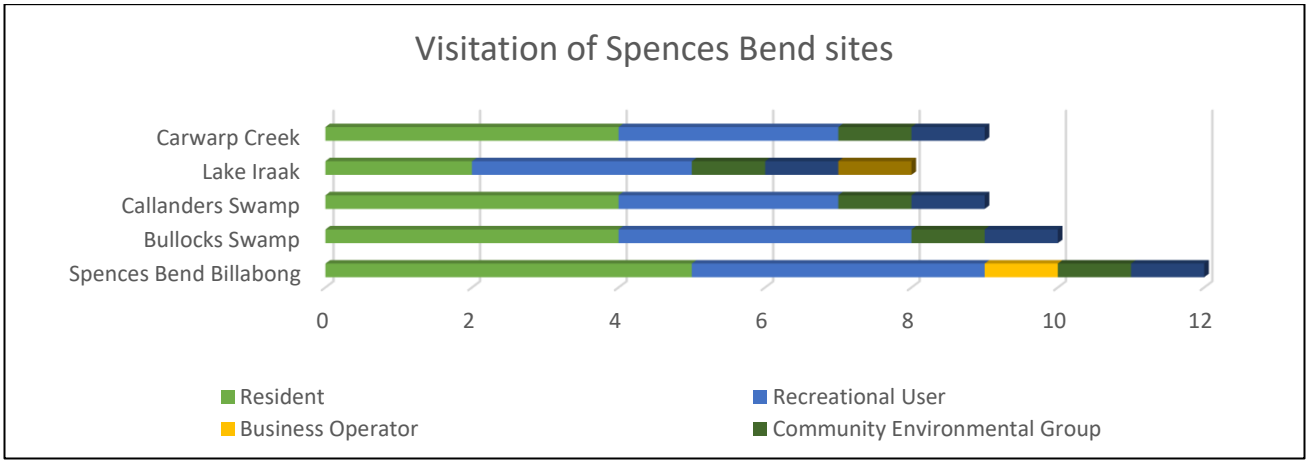

Figure 19. Visitation of Spences Bend sites. Source: Mallee CMA online survey engagement 2024.

Agency Engagement

Mallee CMA consulted with Mildura Rural City Council, Parks Victoria and Lower Murray Water about the Spences Bend EWMP in February 2024. During this session, Mildura Rural City Council and Lower Murray Water discussed Spences Bend infrastructure assets.

APPENDIX 6. ASSESSING RISKS

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 2
			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	

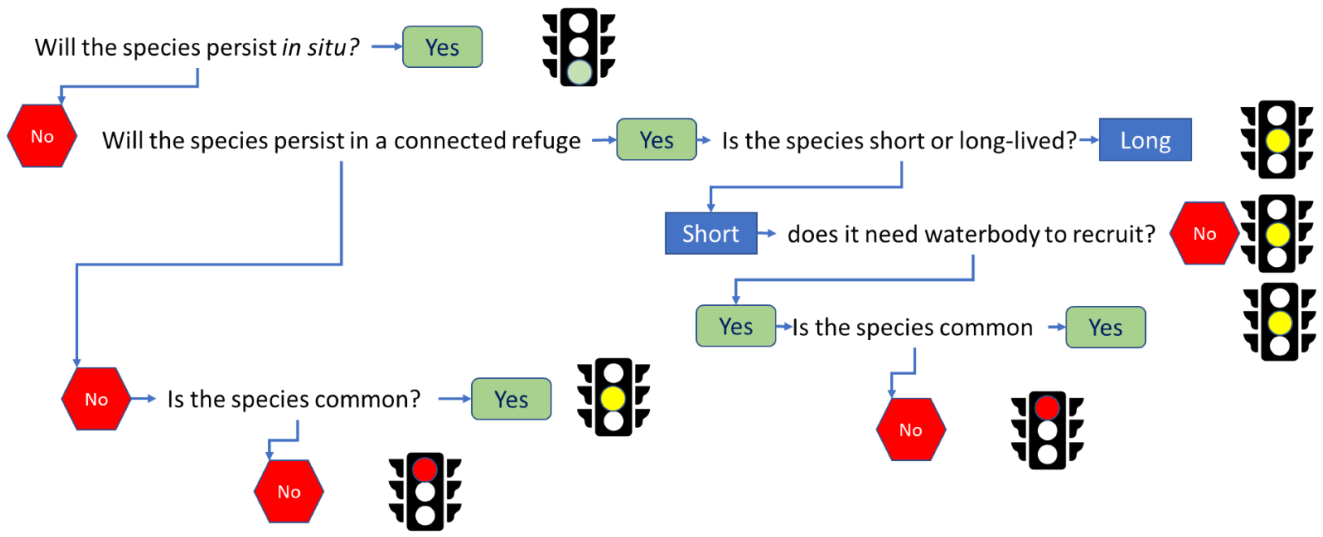

Figure A1 – Decision tree for assessing risk

APPENDIX 7. SPENCES BEND EWMP UPDATED ENVIRONMENTAL OBJECTIVES, FURTHER INFORMATION (FROM BUTCHER ET AL. 2020)

Information describing rationale behind updated environmental objectives and targets for Spences Bend EMWP (from Butcher at al. 2020).

SMARTness and rationalisation

Site-specific environmental objectives for the Spences Bend EWMP (Mallee CMA 2015f).

EWMP objectives
SB1: Improve Swamp and woodland diversity and productivity to meet EVC benchmarks for Lignum Swamp (104) and Lignum Swampy Woodland (823) Communities in Bullock Swamp north – (Wetland area: Stage 1 – Bullock Swamp North)
SB2: Increase woodland and shrubland diversity and productivity (including tree health) to meet EVC benchmarks for EVCs 103, 810, 818, 811, 813 – (Wetland area: Stage 2 – Spence's Bend Billabong, Callanders Swamp and wetland #7329 246886)
SB3: Maintain and Improve woodland, shrubland and Swamp diversity and productivity (including tree health) to meet EVC benchmarks for EVCs 103, 104, 808, 810, 811, 813, 818, 823 0 (Wetland area: Stage 3 – Spence's Bend Billabong, wetland # 7329242866 and Bullock Swamp south)
SB4: Improve semi-permanent saline marsh habitat for Murray Hardyhead reintroduction – (Wetland area: Stage 3 – Bullock Swamp)
SB5: Reinstate seasonal connectivity between all wetlands in the target area
SB6: Increase aquatic macrophyte (submerged and emergent) diversity and area
SB7: Increase dissolved organic matter, particulate matter and macroinvertebrate productivity
SB8: Improve or maintain water quality (particularly salinity) to meet standards for each wetland type and key species.

Assessment of SMARTness of current Spences 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
SB1	0	0.5	1	1	1	0.5	1	1	1	0	0
SB2	0	0.5	1	1	1	0.5	1	1	1	0	0
SB3	0	0.5	1	1	1	0.5	1	1	1	0	0
SB4	0	0.5	1	1	1	0.5	0.5	1	1	0	0
SB5	0	0	1	1	1	0.5	1	1	1	0	0
SB6	0	0	1	1	1	0.5	1	1	1	0	0
SB7	0	0	0.5	0.5	0.5	0.5	0	0.5	0.5	0	0
SB8	0	0	1	1	1	0.5	1	1	1	0	0

Rationalised environmental objectives for the Spences Bend EWMP (Mallee CMA 2015f)

Objective	Issue	Outcome
SB1	Incudes multiple aspects of biodiversity (diversity) and function (recruitment). Options are to split or consolidate to a measure of condition.	Rationalised to align with LTWP objectives – change to be about condition with the assumption that if condition is improved this incorporates diversity and productivity
SB2	No issue with objective other than its not fully SMART and no baseline data.	Objective updated to align with Basin Plan language
SB3	No issue with objective other than its not fully SMART and no baseline data.	Objective updated to align with Basin Plan language
SB4	Not considered viable by MCMA, not viable for MHH	Deleted
SB5	Lateral connectivity is achieved by water delivery for the other objectives, as such this is a cascading objective	Cascading objective
SB6	No issue with objective other than its not fully SMART and no baseline data.	Objective updated to align with Basin Plan language
SB7	No baseline to establish magnitude of change in dissolved organic carbon and particulate matter. Macroinvertebrates are notoriously variable and difficult to measure as an outcome of watering. Not considered a priority value for the asset by the MCMA. Likelihood that invertebrate communities will be adequately supported from the other watering actions at the asset.	Deleted
SB8	Not considered viable by MCMA	Deleted

Basin Plan Schedule 8 criteria for which the site is identified as a PEA in the Victorian Murray LTWP (DELWP 2015).

Schedule 8 criteria met	Schedule 9 criteria met
From DELWP (2015a)	
1: CAMBA **3:** Dominated by Lignum, (*Muehlenbeckia florulenta*), which becomes an extensive aquatic habitat for fish, reptiles and macroinvertebrates when inundated. **4:** EPBC Act, FFG Act, DSE Listed **5:** Six bird species are considered water-dependent because they forage or nest in or over water, or require flooding to trigger breeding and fledging (Eastern Regent Parrot). Twelve ecological vegetation classes (EVCs) occur.^	**1:** Supports the creation and maintenance of vital habitats and populations **2:** water quality - ecosystem processes supports 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)ii: Vital habitat - pathways for migration, dispersal, movement	**1(e):** Vital habitat - preventing decline of native biota **3(a):** Longitudinal connectivity - dispersal and recolonisation **4(a):** Lateral connectivity - foraging, migration, recolonisation

^ Mapping PEA criteria 5 to EVC is not appropriate

Mapping Spences 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
SB1: Improve Swamp and woodland diversity and productivity to meet EVC benchmarks for Lignum Swamp (104) and Lignum Swampy Woodland (823) Communities in Bullock Swamp north – (Wetland area: Stage 1 – Bullock Swamp North)	8.05,3(b) 8.06,6(b)	Condition of priority asset - prevention of decline in native biota Condition of water-dependent vegetation Diversity of native water dependent vegetation	B2.10	LTWPVM8
SB2: Increase woodland and shrubland diversity and productivity (including tree health) to meet EVC benchmarks for EVCs 103, 810, 818, 811, 813 – (Wetland area: Stage 2 – Spence's Bend Billabong, Callanders Swamp and wetland #7329 246886)	8.05,3(b) 8.06,6(b)	Condition of priority asset - prevention of decline in native biota Condition of water-dependent vegetation Diversity of native water dependent vegetation	B2.2 B2.8	LTWPVM5 LTWPVM6
SB3: Maintain and Improve woodland, shrubland and Swamp diversity and productivity (including tree health) to meet EVC benchmarks for EVCs 103, 104, 808, 810, 811, 813, 818, 823 0 (Wetland area: Stage 3 – Spence's Bend Billabong, wetland # 7329242866 and Bullock Swamp south)	8.05,3(b) 8.06,6(b)	Condition of priority asset - prevention of decline in native biota Condition of water-dependent vegetation Diversity of native water dependent vegetation	B2.2 B2.8	LTWPVM5 LTWPVM6
SB4: Improve semi-permanent saline marsh habitat for Murray Hardyhead reintroduction – (Wetland area: Stage 3 – Bullock Swamp)	8.05,3(a)	Condition of priority asset - supports listed species and communities Condition of priority asset - prevention of decline in native biota	B4.1	LTWPVM16
SB5: Reinstate seasonal connectivity between all wetlands in the target area	8.06,3b(ii)	Condition of priority ecosystem functions - connectivity - lateral - foraging, dispersal, recolonisation	None specified	LTWPVM1
SB6: Increase aquatic macrophyte (submerged and emergent) diversity and area	8.05,3(b) 8.06,6(b)	Condition of priority asset - prevention of decline in native biota Diversity of native water dependent Vegetation Condition of priority ecosystem functions - creation of vital habitat - habitat for prevention of decline in native species	B2.11	LTWPVM2
SB7: Increase dissolved organic matter, particulate matter and macroinvertebrate productivity	8.05,3(b) 8.06,7	Condition of priority asset - prevention of decline in native biota Condition of priority ecosystem functions - connectivity - lateral - off-stream primary productivity	None specified	None specified
SB8: Improve or maintain water quality (particularly salinity) to meet standards for each wetland type and key species.	8.06,2	Condition of priority asset - prevention of decline in native biota	None specified	None specified

Updated objectives for Spences Bend

Current objective	**SB1: Improve Swamp and woodland diversity and productivity to meet EVC benchmarks for Lignum Swamp (104) and Lignum Swampy Woodland (823) Communities in Bullock Swamp north** – (Wetland area: Stage 1 – Bullock Swamp North)
Comments	Rationalised to align with LTWP objectives – change to be about condition with the assumption that if condition is improved this incorporates diversity and productivity
EWP objective(s)	8.05,3(b) 8.06,6(b)
Schedule 7 targets	Condition of priority asset - prevention of decline in native biota Condition of water-dependent vegetation 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
BEWS QEEO	B2.10 Maintain extent of Lignum along the Murray River from the junction with the Wakool River to downstream of Lock 3, including Chowilla and Hattah Lakes
LTWP objective	LTWPVM8: Improve the condition of shrub and lignum dominated EVCs
LTWP target	A positive trend in the condition score of Shrub and Lignum 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 levels of Lignum (*Duma florulenta*) to sustain communities and processes reliant on Lignum communities at Stage 1 – Bullock Swamp North, Spence's Bend.
2020 Targets:	By 2030, condition in standardised transects that span the floodplain elevation gradient and existing spatial distribution at Stage 1 – Bullock Swamp North, Spence's Bend ≥70% of Lignum plants in good condition with a Lignum Condition Score (LCI) ≥4.

Current objective	**SB2: Increase woodland and shrubland diversity and productivity (including tree health) to meet EVC benchmarks for EVCs 103, 810, 818, 811, 813 – (Wetland area: Stage 2** – Spence's Bend Billabong, Callanders Swamp and wetland #7329 246886)
Comments	May need to simplify or split this objective. Assumes EVC 810 is accounted for by watering the other EVCs which are higher on the floodplain/terrace. 810 may pond and retain water.
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 water-dependent vegetation 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	B2.2 No decline in the condition of river red gum and black box across the Basin B2.8 By 2024 improve condition of Black Box and River Red Gum
LTWP objective	LTWPVM5 Improve the condition of River Red Gum dominated EVCs LTWPVM6 Improve the condition of Black Box dominated EVCs
LTWP target	A positive trend in the condition score of River Red Gums dominated Ecological Vegetation Class (EVC) benchmarks at 80% of sites over the 10 year period to 2025 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 levels of River Red Gum (*Eucalyptus camaldulensis*), and Black Box (*E. largiflorens*) and to sustain communities and processes reliant on such communities at Stage 2 – Spence's Bend Billabong, Callanders Swamp and wetland #7329 246886, Spence's Bend
2020 Targets:	By 2030, a positive trend in the condition score of River Red Gum dominated EVC benchmarks at Stage 2 – Spence's Bend Billabong, Callanders Swamp and wetland #7329 246886, Spence's Bend at 80% of sites over the 10 year period. OR By 2030, at stressed sites (see Wallace et al. 2020) at Stage 2 – Spence's Bend Billabong, Callanders Swamp and wetland #7329 246886: 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 River Red Gum trees needs to be established. **AND** By 2030 a positive trend in the condition score of Black Box dominated EVC benchmarks at Stage 2 – Spence's Bend Billabong, Callanders Swamp and wetland #7329 246886, Spence's Bend at 80% of sites over the 10 year period OR By 2030, at stressed sites (see Wallace et al. 2020) at Stage 2 – Spence's Bend Billabong, Callanders Swamp and wetland #7329 246886, Spence's Bend: 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 by 2030

Current objective	**SB3: Maintain and Improve woodland, shrubland and Swamp diversity and productivity (including tree health) to meet EVC benchmarks for EVCs 103, 104, 808, 810, 811, 813, 818, 823** - (Wetland area: Stage 3 – Spence's Bend Billabong, wetland # 7329242866 and Bullock Swamp south)
Comments	May need to simplify or split this objective. Assumes EVC 810 is accounted for by watering the other EVCs which are higher on the floodplain/terrace. 810 may pond and retain water.
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 water-dependent vegetation 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
BEWS QEEO	B2.2 No decline in the condition of river red gum and black box across the Basin B2.8 By 2024 improve condition of Black Box and River Red Gum
LTWP objective	LTWPVM5 Improve the condition of River Red Gum dominated EVCs LTWPVM6 Improve the condition of Black Box dominated EVCs
LTWP target	A positive trend in the condition score of River Red Gums dominated Ecological Vegetation Class (EVC) benchmarks at 80% of sites over the 10 year period to 2025 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 levels of River Red Gum (*Eucalyptus camaldulensis*), and Black Box (*E. largiflorens*) and to sustain communities and processes reliant on such communities at the Spence's Bend asset.
2020 Targets:	By 2030, a positive trend in the condition score of River Red Gum dominated EVC benchmarks at the Spence's Bend asset at 80% of sites over the 10 year period. OR By 2030, at stressed sites (see Wallace et al. 2020) at the Spence's 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 River Red Gum trees needs to be established. **AND** By 2030 a positive trend in the condition score of Black Box dominated EVC benchmarks at the Spence's Bend at 80% of sites over the 10 year period OR By 2030, at stressed sites (see Wallace et al. 2020) at the Spence's 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.

Current objective	SB4: Improve semi-permanent saline marsh habitat for Murray Hardyhead reintroduction – (Wetland area: Stage 3 – Bullock Swamp)
Comments	Deleted

Current objective	SB5: Reinstate seasonal connectivity between all wetlands in the target area
Comments	Need to confirm is seasonal does equate to annual inundation.
EWP objective(s)	8.06,3b(ii)
Schedule 7 targets	Condition of priority ecosystem functions - connectivity - lateral - foraging, dispersal, recolonisation
PEA/PEF criteria met	PEA 3(a) ii Vital habitat - pathways for migration, dispersal, movement PEF 4(a) - lateral connectivity - foraging, migration, recolonisation
BEWS QEEO	None specified
LTWP objective	LTWPVM1 Improve connectivity between floodplains, anabranches and wetlands
LTWP target	Meet required watering regime at 80% of wetland sites that have water delivered through anabranch connections
2020 Objective:	By 2030, protect and restore connectivity within and between water-dependent ecosystem at the Spencers Bend asset, including by ensuring that: ecological processes dependent on hydrologic connectivity laterally between watercourses and their floodplains (and associated wetlands) are maintained.
2020 Targets:	By 2030, lateral connectivity between floodplain and wetland areas at Spencers Bend occurs on a seasonal basis (i.e., spring filling/connectivity) in 7 out of any 10 year period. Maximum dry interval between connected wet periods is 5 years.

Current objective	SB6: Increase aquatic macrophyte (submerged and emergent) diversity and area
Comments	Adopted WRIGs developed by DELWP. Some species need to be identified as currently not all aquatic WRIGs represented in the flora lists in the EWMP.
EWP objective(s)	8.05,3(b) 8.06,6(b)
Schedule 7 targets	Condition of priority asset - prevention of decline in native biota Diversity of native water dependent vegetation Condition of priority ecosystem functions - creation of vital habitat - habitat for prevention of decline in native species
PEA/PEF criteria met	PEA 3(b) Prevents declines in native biota PEF 1(e) Vital habitat - preventing decline of native biota
BWS QEEO	None specified
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 Spence's 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 Spence's Bend asset with ≥2 species from each of the following Water Regime Indicator Groups present in 80% of years: • Aquatic (obligate submerged) (Aos) (no species recorded) • Aquatic (submerged to partially emergent) (Ase) (Slender Water-ribbons *Cycnogeton dubium*) • Aquatic graminoids (persistent) (Agp) (no species recorded) • Aquatic to semi-aquatic (persistent) (Asp) (Common Blown-grass *Lachnagrostis filiformis s.l.*, Common Nardoo *Marsilea drummondii*, Creeping Monkey-flower *Thyridia repens*) By 2030, increase diversity of native of macrophytes at the Spence's Bend asset with ≥4 species from each of the following Water Regime Indicator Groups present in 80% of years: • Seasonally immersed – low growing (Slg) (Lesser Joyweed *Alternanthera denticulata s.s.*, Twin-leaf Bedstraw *Asperula gemelli*, Salt Club-sedge *Bolboschoenus caldwellii*, Rosinweed *Cressa australis*, Rough Raspwort *Haloragis aspera*, Tall Fireweed *Senecio runcinifolius*, Rat-tail Couch *Sporobolus mitchellii*, Blue Rod *Stemodia florulenta*, River Bluebell *Wahlenbergia fluminalis*) • Seasonally inundated – emergent non woody (Sen) (Common Swamp Wallaby-grass *Amphibromus nervosus*, Southern Cane-grass *Eragrostis infecunda*, Tussock Rush *Juncus aridicola*, Warrego Summer-grass *Paspalidium jubiflorum*)

Current objective	SB7: Increase dissolved organic matter, particulate matter and macroinvertebrate productivity
Comments	Deleted

Current objective	SB8: Improve or maintain water quality (particularly salinity) to meet standards for each wetland type and key species.
Comments	Deleted

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