GOULBURN BROKEN
CATCHMENT MANAGEMENT AUTHORITY

Resilient landscapes, thriving communities

Moodie Swamp
Environmental Water Management Plan

2023

Prepared by

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Summary

Moodie Swamp Environmental Water Management Plan 2012 (2012 Plan) has been updated to reflect the ecological changes to Moodie Swamp over the past 15 years since environmental water was first delivered in 2008. The Moodie Swamp Environmental Water Management Plan 2023 (the Plan) objectives and targets have been updated to better reflect alignment to the Basin Plan 2012 (Cth 2012) and Victorian Murray Long Term Water Plan (DELWP 2021). The response of the swamp from delivery of environmental water over the past 15 years is documented, indicating a positive increase in flora and fauna diversity at the site and an increase in the index of wetland condition scoring (DELWP 2020).

Moodie Swamp is a 180-hectare, intermittent[1] cane-grass swamp located on Broken Creek near Waggarandall. The swamp is the largest individual wetland on the Broken Creek floodplain and is classified as nationally significant in the Directory of Important Wetlands – VIC036 Broken Creek (EA 2001). Of the approximate 3,600 wetlands within the Goulburn and Broken River catchments, Moodie Swamp is one of only three wetlands in the Broken River catchment that can currently receive environmental water. Its availability to receive environmental water via a connection channel to the Broken Creek makes this site an important refuge for fauna.

Moodie Swamp has several values at the site that are water dependent. They include the threatened Ecological Vegetation Classes (EVCs) such as the endangered Shallow Sands Woodland and the vulnerable Cane-grass wetland (Section 3.1.2.3) and the *Environmental Protection Biodiversity Act 1999* (EPBC Act, [Cth 1999]) endangered species such as Sloane's Froglet *(Crinia sloanei)* and vulnerably listed Rigid Water-milfoil *(Myriophyllum porcatum)*. Moodie swamp is home to numerous waterbirds including Brolga *(Antigone rubiucunda)* that depends on the site for feeding and breeding. Brolga are listed as Endangered under the *Flora and Fauna Guarantee Act 1988* (FFG Act, [DELWP 2022]).

Moodie Swamp was an important gathering place for the Yorta Yorta People with evidence of oven mounds, scarred trees and artifact scatters recorded at the site. The swamp still provides resources for Yorta Yorta People who maintain a strong connection to their traditional country. The swamp also provides social and economic value to the local community who benefit from visitors to the site for recreational activities such as birdwatching and duck hunting.

Threats to the environmental values at the site include an altered water regime, flora and fauna pest species, fire and climate change.

THE LONG-TERM OBJECTIVE FOR MOODIE SWAMP EWMP IS:

Maintain and/ or improve the biological values, functioning and resilience of Moodie Swamp by providing a more natural wetting and drying regime.

1. Intermittent swamps usually fill naturally every 3-4 years (R.Butcher 2023).

It aligns with the following Goulburn Broken CMA Waterway Strategy (GBCMA 2014) goals:

- Maintaining or improving the resilience of the region's waterways.
- Wetlands with formally recognised significance are maintained or improved.
- Maintain or improve waterways of high community value.

To achieve the long-term and ecological objectives (Table 1), the following watering regime has been proposed for Moodie Swamp:

- Watering to occur three to seven years in ten.
- Watering to occur between late autumn to early spring.
- Drying out within a twelve-month period.

Delivery of environmental water to Moodie Swamp can be constrained by:

- **Timing of flows** – water may not be able to be delivered at the appropriate time for ecological benefit.
- **Irrigation demands** – Moodie Swamp does not have a delivery share; therefore, environmental water can only be delivered when there is spare capacity to carry the water in Broken Creek.

Risks can present in many forms including climate and environmental, community, management, cultural and legal risks. Risks associated with the delivery of environmental water are presented in this plan. Risk identification and assessments are undertaken annually at a formal workshop with the Victorian Environmental Water Holder (VEWH) during the development of the annual Seasonal Watering Proposals and include cultural risks related to Yorta Yorta cultural values.

Consultation was undertaken with the Yorta Yorta People to align the use of the site and their cultural values with environmental water values. A draft plan was also sent to the Goulburn Broken Environmental Water Wetland Advisory Group for comment which includes community members and land and water managers. Consultation to update objectives and targets with the Goulburn Broken Scientific Technical Reference Committee and Yorta Yorta Nation Aboriginal Corporation (YYNAC) also occurred.

The Plan details key environmental water management knowledge gaps including, the effect of groundwater on the swamp, the flood regime tolerances of water-dependent Ecological Vegetation Classes and their associated flora species such as the EPBC Act vulnerably listed Rigid Water-milfoil.

Table 1: Updated ecological objectives and targets for Moodie Swamp EWMP 2023

No.	Objective	Target
MS1	Maintain the presence of water-dependent threatened species recorded at Moodie Swamp by 2030.	Protect and restore biodiversity which is water-dependent, including supporting life cycles of threatened species at Moodie Swamp by 2030: 1. Maintain presence of Brolga *(Antigone rubicunda)* in 70% of targeted surveys undertaken. 2. Maintain presence of Sloane's froglet *(Crinia sloanei)* in 70% of targeted surveys undertaken. 3. Maintain presence of listed plant species including Rigid Water-milfoil *(Myriophyllum porcatum)* in 70% of surveys undertaken. Maintain the presence of four *Flora and Fauna Guarantee Act 1988* (Vic) listed waterbirds in three out of five targeted surveys including: 1. Australasian bittern *(Botaurus poiciloptilus)* 2. Eastern great egret *(Ardea alba modesta)* 3. Plumed egret *(Ardea intermedia plumifera)* 4. White bellied sea eagle *(Haliaeetus leucogaster).*

No.	Objective	Target
MS2	Improve diversity of native water-dependent flora species consistent with Aquatic herbland/ Cane-grass complex EVC 602 at Moodie Swamp by 2030.	Improve the condition of water-dependent native vegetation (EVC 602) at Moodie Swamp by 2030: 1. Cane grass one species of at least 5% cover (modified if less than benchmark cover towards outer margins). 2. Aquatic herbs three species of at least 15% cover. 3. Medium (to small) graminoids three species of at least 5% cover. 4. Small (to medium) herbs five species of at least 10% cover (often semi-aquatic, towards verge zone).
MS3	By 2030, support waterbird breeding at Moodie Swamp at least five times in every ten years.	Protect and restore ecosystem functions of water-dependent ecosystems that support successful non-colonial nesting of waterbird species at Moodie Swamp providing conditions for breeding and fledging at least five times every ten years: 1. As a minimum at least seven species recorded breeding at Moodie Swamp over any ten-year assessment period: 2. Australian wood duck *(Chenonetta jubata)* 3. Black swan *(Cygnus atratus)* 4. Grey teal *(Anas gracilis)* 5. Pacific black duck *(Anas superciliosa)* 6. Purple swamphen (*Porphyrio porphyrio)*. Protect and restore ecosystem functions at Moodie Swamp that support the creation of vital habitat for waterbird feeding habitat guilds on a regular basis. Target waterbird feeding habitat guilds are densely vegetated habitat and shallow water <0.5m habitat (Jaensch 2002).
MS4	Improve breeding of frogs to 80% of years in which water is present at Moodie Swamp by 2030.	Maintain breeding of frogs at Moodie Swamp in 80% of years in which water is present, including: 1. Sloane's froglet *(Crinia sloanei)* 2. Common spadefoot toad *(Neobatracus sudelli)* 3. Common froglet *(Crinia signifera)* 4. Peron's tree frog *(Litoria peronii)* 5. Plains froglet *(Crinia parinsignifera)* 6. Pobblebonk *(Limnodynastes dumerilii)* 7. Spotted marsh frog *(Limnodynastes tasmaniensis)*.
MS5	Maintain and provide opportunities for Brolga breeding.	Protect and restore ecosystem functions at Moodie Swamp that support successful breeding and fledging of Brolga (Antigone rubicunda) when conditions are suitable.
MS6	Reduce the cover of exotic water-dependent flora species at Moodie Swamp by 2030.	Reduced cover of target invasive aquatic plant species, especially aster-weed *(Symphyotrichum subulatus)* and water couch *(Paspalum distichum)*, by 30% at Moodie Swamp by 2030 compared to benchmark 2008- 2011.

Acknowledgements

The Goulburn Broken CMA respects the Yorta Yorta People and acknowledge the intrinsic connection they have to their country on which Moodie Swamp is located. We recognise the diversity of their culture and the deep connections they have with Victoria's lands and waters. We value our unique partnership with Yorta Yorta for the health of their people and their traditional country.

We respect Yorta Yorta Elders, their ancestors and acknowledge and recognise the Yorta Yorta People's embedded cultural connections, their bloodlines, their cultural obligations, rights and responsibilities to care for their traditional lands and waters and interact with their country for the purposes of life and resources.

As a valued partner Yorta Yorta Nation Aboriginal Corporation have been involved in the update of the Moodie Swamp Environmental Water Management Plan to ensure Yorta Yorta People's cultural connections, and their values of Moodie Swamp are recognised and aligned with their cultural protocols and environmental water objectives and targets.

Acknowledgement also goes to the team at Wetland Revival Trust and Water Technology for their consistent data collection within the Goulburn Broken Catchment wetlands and reports developed.

Thank you to members of the Goulburn Broken Scientific Technical Reference Committee especially Rhonda Butcher, Goulburn Broken Environmental Water Wetlands Advisory Group and numerous individuals for their input and development of the plan.

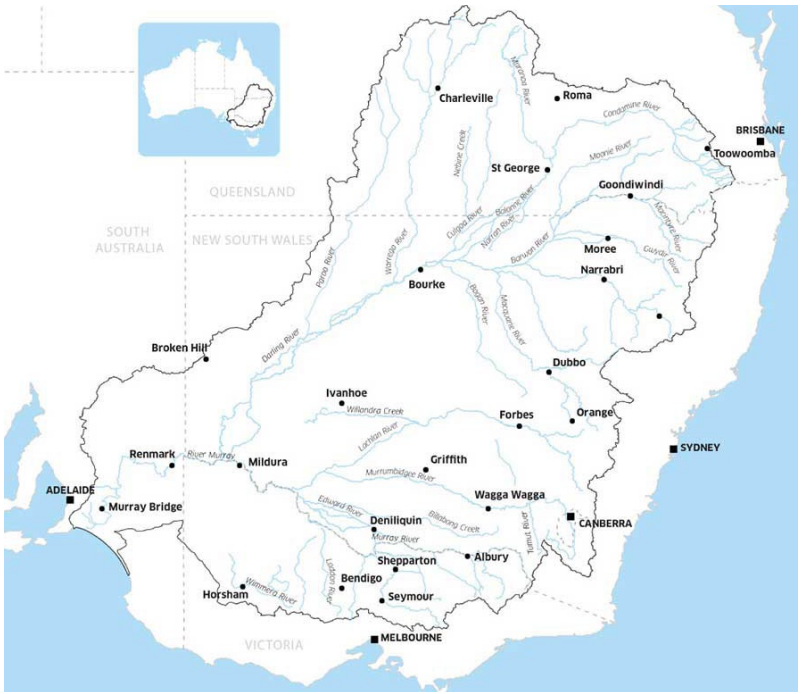
Abbreviations and acronyms

ACHLMA	Aboriginal Cultural Heritage Land Management Agreement
Basin Plan	Murray Darling Basin Plan 2012 (Cth)
BCS	Bioregional Conservation Status
CaLP Act	*Catchment and Land Protection Act 1994* (Vic)
CAMBA	China Australia Migratory Bird Agreemen
CEWH	Commonwealth Environmental Water Holder
CMA	Catchment Management Authority
DEECA	Department of Energy, Environment and Climate Action
DELWP	Department of Environment, Land and Water Planning
DSE	Department of Sustainability and Environment
EPBC Act	*Environment Protection Biodiversity Act 1999 (Cth)*
EVC	Ecological Vegetation Community
EWMP	Environmental Water Management Plan
EWR	Environmental Water Reserve
FFG Act	*Flora and Fauna Guarantee Act 1988* (Vic)
GB CMA	Goulburn Broken Catchment Management Authority
GB EWWAG	Goulburn Broken Environmental Water Wetland Advisory Group
GB STRC	Goulburn Broken Scientific Technical Reference Committee
GMID	Goulburn-Murray Irrigation District
GMW	Goulburn-Murray Water
IWC	Index of Wetland Condition
JAMBA	Japan Australia Migratory Birds Agreement
MDBA	Murray Darling Basin Authority
ML	Megalitre (one million litres)
MSC	Moira Shire Council
NVIRP	Northern Victoria Irrigation Renewal Project
PV	Parks Victoria
PEF	Priority Ecosystem Functions
PoE	Probability of Exceedance
RAP	Registered Aboriginal Party
ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement
RWS	Regional Waterway Strategy
TEK	Traditional Ecological Knowledge
VEWH	Victorian Environmental Water Holder
VWMS	Victorian Waterway Management Strategy
WetMAP	Wetland Monitoring and Assessment Program
WoNS	Weeds of National Significance
YYNAC	Yorta Yorta Nation Aboriginal Corporation

Relevant plans and legislation

International treaties, conventions, and initiatives	Japan Australia Migratory Birds Agreement (JAMBA) 1974
	Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) 1979
	China Australia Migratory Birds Agreement (CAMBA) 1986
	Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA) 2007.
Commonwealth legislation and policy	*Australian Heritage Commission Act 1975* (Register of the National Estate)
	Aboriginal and Torres Strait Islander Heritage Protection Act 1984 (Part IIA)
	Native Title Act 1993
	Wetlands Policy of the Commonwealth Government of Australia 1997
	Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)
	Water Act 2007 subparagraph 44(3)(b)(i) Basin Plan 2012
	A Framework for Determining Commonwealth Environmental Watering Actions 2009
Victorian legislation	*Aboriginal Heritage Act 2006*
	Catchment and Land Protection Act 1994 (CaLP Act)
	Water Act 1989 (Vic)
	Flora and Fauna Guarantee Act 1988 (FFG Act)
	State Environment Protection Policy (Waters of Victoria) 2003

Figure 1: Murray Darling Basin Boundary



1. Introduction

Environmental water management in Victoria is now firmly established with water recovery enabling significant volumes of water being returned to the environment. The increased environmental water availability has provided opportunities to protect, restore and reinstate high value ecosystems throughout Victoria.

Environmental watering in Victoria 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 in Victoria is managed as an integral part of the Victorian Waterway Management Program, with the state-level Victorian Waterway Management Strategy 2013 (VWMS; (DEPI 2013)) providing the overarching framework for environmental water management. Regional Waterway Strategies (RWSs) drive the implementation of the VWMS at the regional level. Information from the region's RWS is a key input to environmental water planning arrangements, including the selection of eligible assets to receive environmental water. Environmental water management plans (EWMPs) are site-specific plans developed for those assets deemed a priority to receive environmental water through the RWS development process.

In the Murray-Darling Basin, environmental water management is further underpinned by the Basin Plan 2012 (Cth 2012) and the associated Basin-wide environmental watering strategy (MDBA 2019). In accordance with Basin Plan requirements, Victoria has also developed relevant water resource plans and long-term watering plans (DELWP 2021).

Victoria's Catchment Management Authorities (CMAs), Melbourne Water, Department of Energy, Environment and Climate Action (DEECA – previously Department of Environment, Land, Water and Planning (DELWP)) the Victorian Environmental Water Holder (VEWH) and Traditional Owner groups have worked together to develop Environmental Water Management Plans (EWMPs) for most watered assets throughout Victoria. These plans are continually updated through an adaptive management process.

A primary purpose of the plans is to provide a consistent set of documents that support Seasonal Watering Proposals to be submitted by asset managers to the Victorian Environmental Water Holder annually. The supporting information includes:

- Lead management agencies and their management responsibilities.
- The water-dependent environmental, social, and economic values of the asset.
- The asset's environmental condition and threats.
- Environmental objectives and intended watering regime.
- Contributions from Traditional Owner groups (included in an EWMP with free, prior, and informed consent) that may include information about cultural values, management goals, environmental and cultural objectives and intended watering regime.
- Opportunities for improved water delivery, efficiency or capacity through structural works or other measures.
- Scientific knowledge gaps and recommendations for future work.

This Plan establishes priorities for the use of environmental water at Moodie Swamp within the Broken catchment described in section 2.1 Catchment setting. This revision builds on iterations of the 2012 Plan and has been revised to reflect upon learnings over the past 15 years of water delivery to the site and improve alignment of Moodie Swamp objectives to the Basin Plan's Environmental Watering Plan Framework and Victoria's Long Term Watering Plans.

The 2012 Plan has been used to guide water delivery to the site for the past 11 years. Monitoring of environmental water delivery to Moodie Swamp has improved Goulburn Broken CMAs understanding of ecological and hydrological needs and responses and operational conditions that are to be considered at the time of delivery.

The revision of the 2012 Plan has been coordinated by the Goulburn Broken CMA in consultation with DEECA guidelines to ensure a consistent approach to planning and management of wetlands across Victoria.

1.1 Consultation

The revision of the 2012 Plan was undertaken by Goulburn Broken CMA with input from Yorta Yorta Nation Aboriginal Corporation, the Goulburn Broken Scientific Technical Reference Committee (GB STRC), and the Goulburn Broken Environmental Water Wetland Advisory Group (GB EWWAG). Consultation with Yorta Yorta included phone calls and emails discussing the alignment of cultural and environmental water objectives. Consultation with the GB STRC Group and GB EWWAG largely involved online meetings and email communication.

The GB STRC assisted with the alignment of objectives to the Basin Plan and Victorian Long-term Watering Plans.

The GB EWWAG consists of Yorta Yorta Nation Aboriginal Corporation members, community members and land and water managers who were consulted on the draft plan. Consultation was held with DEECA regarding field survey data to feed into flora and fauna sections of this plan. VEWH were consulted on water allocation and available water sources. Table 2 indicates the level of engagement using the IAP2 Public Participation Spectrum (IAP2 2018) with each affiliated group.

Table 2: Engagement undertaken in development Moodie Swamp EWMP

Category	Who	IAP2 level of engagement	Engaged on Moodie Swamp EWMP	Engagement methods	Engagement Purpose
Government Agencies	Delivery Partners	Collaborate	Goulburn-Murray Water (River Operations Planning, Diversions) VEWH Parks Victoria DEECA VEWH	Formal advisory group (GB EWWAG) Direct engagement Review of draft proposal	Seek input into the development of the proposal. Ensure program partners understand the watering proposed and intended outcomes.
Traditional Owners	Yorta Yorta People	Collaborate	Yorta Yorta Nation Aboriginal Corporation	Formal advisory groups (GB EWWAG) Site visits Meetings	Seek input into the development of the EWMP by reviewing document, providing information, and aligning cultural outcomes and objectives.
Recreational Users	Field and Game Australia Local fishing clubs	Consult	Field and Game Trellys Fishing and Hunting	Formal advisory groups (GB EWWAG) Direct engagement	Ensure understanding of the EWMP and intended outcomes. Review EWMP and provide feedback/ input.
Community Groups	Environment Groups	Consult	Goulburn Murray Landcare Network Goulburn Valley Environment Group Turtles Australia	Formal advisory group (GB EWWAG) Direct	Ensure understanding of the EWMP and intended outcomes. Review EWMP and provide feedback/ input.
Local Landholders	Landholders	Consult	Landowners that adjoin wetlands that receive environmental water and/or use the delivery channel	Direct engagement (one-on-one) or email/mail drop.	Ensure understanding of the watering proposed and intended outcomes.
Technical experts	Scientists and Consultants	Collaborate	Research Scientists from Arthur Rylah Institute	Formal advisory group (GB STRC) Direct engagement	Seek input into the development of the EWMP and ecological and hydrological objectives. Review EWMP and provide feedback/input.

1.2
The Yorta Yorta People

Consultation and involvement of the Yorta Yorta People when developing this Plan was undertaken with Yorta Yorta Nation Aboriginal Corporation and is imperative to the conservation and protection of cultural sites, connection to country and establishing strong linkages.

Yorta Yorta Nation Aboriginal Corporation have worked closely with Goulburn Broken CMA in the development of this Plan via email communication. Alignment of cultural objectives with environmental watering objectives for Moodie Swamp will begin the first steps to healing country for Yorta Yorta People (Section 5.3).

Yorta Yorta Nation Aboriginal Corporation is the representative body that provides the interface between government and the Yorta Yorta People and is a Victorian Registered Aboriginal Party (RAP) under the *Aboriginal Heritage Act 2006* (Vic 2006) with decision making responsibilities for protecting Aboriginal cultural heritage, and other matters within the RAP area.

Yorta Yorta Nation Aboriginal Corporation and Goulburn Broken CMA have established an Aboriginal Cultural Heritage Land Management Agreement (ACHLMA). This agreement provides a framework for protecting and managing Aboriginal cultural heritage during ongoing, routine land management activities within a RAP area including works to assist with environmental water releases to Moodie Swamp.

Yorta Yorta lands lie on both sides of the Murray River from Cohuna in Victoria to Howlong in New South Wales. They include towns such as Echuca, Shepparton, Benalla, Corowa and Wangaratta and extend northwards to just south of Deniliquin (Figure 2). The people of the Yorta Yorta Nation are comprised of eight different clan groups, where the Yorta Yorta language is spoken commonly by all the Yorta Yorta clans which make up Yorta Yorta Nation. Yorta Yorta Nation Aboriginal Corporation list the following objectives and outcomes in Table 3 for their involvement in environmental water in Traditional Owner objectives and outcomes: Compilation of contributions to Victoria's water resource plans (DELWP 2019).

Figure 2: Yorta Yorta Country

Table 3: Yorta Yorta objectives and outcomes for water management (DELWP 2019)

Objective	Outcome
To look after country through land and water management to restore and maintain our wetlands, rivers, waterways, tributaries and lagoons which in turn look after our flora and fauna that make up cultural lore.	Increase awareness, understanding, respect and protection of Yorta Yorta interests and custodianship. Healthy country and economic outcomes for Yorta Yorta people.
To have decision making in the water planning process, water sharing and distribution.	Equal influence 'at the table' with other representatives from the water industry. Increased integration across the industry.
To develop a cultural flow that will complement the current water management process and have input to the current water flows that goes through country.	Watering country for healthy country and achieving economic outcomes for Yorta Yorta people.
To build TEK into strategies where appropriate e.g. red gum thinning, protection of wetlands, links with cultural lore, bring back native animals and plants etc. and involve Elders onsite to discuss TEK.*	"Bring people back, bring Country back". It will provide a better living culture, better caring for Country and better outcomes for Country.

** TEK is Traditional Ecological Knowledge is the knowledge base that has been handed down to the Yorta Yorta People and has direct contact with their cultural environment.*

Moodie Swamp has significant diversity within the landscape, multiple varieties of Nardoo (food source), native grasses, old man Weed (medicinal) and basket weaving sedges/rushes are in the area. The intermittent swamp supports a wide array of bird life and other fauna that provide a variety of cultural values i.e., food, clothing etc (Appendix 1). Evidence of artefacts, scarred trees and hearths have been found at Moodie Swamp, indicating the site was a source of food and provisions for Yorta Yorta people.

Yorta Yorta Whole-of-Country Plan 2021-2030 (Yorta Yorta Nation Aboriginal Corporation WOC Plan) states the following actions in Table 4. These are taken from section 4.2, pages 26 and 27 of the Yorta Yorta Nation Aboriginal Corporation WOC Plan to pursue an inherent right to water entitlements that are legally and beneficially owned by Yorta Yorta of a sufficient quantity and quality and which are relevant to this plan (YYNAC 2021).

Table 4: Yorta Yorta Whole-of-Country Plan for water management that may be relevant to this plan

WALLA – WATER **Pursue our inherent right to water entitlements that are legally and beneficially owned by Yorta Yorta of a sufficient quantity and quality to improve our spiritual, cultural, environmental, social and economic needs.**	
Actions	
WW12	Seek water policies and operational flows that: a. achieve healthier Country and better outcomes for ecosystems, and native plants and animals; and b. recognise and deliver legal water entitlements that meet broader Yorta Yorta cultural, social and economic needs.
WW13	Ensure water rights are negotiated in expanded management rights in co-management, joint management, treaty and other processes.
WW15	Watering country for healthy country and achieving economic outcomes for Yorta Yorta people.
WW18	Support government policies to allow waterways and floodplain wetlands to flood naturally, and the removal or managed weathering away of levees and constructed barriers.

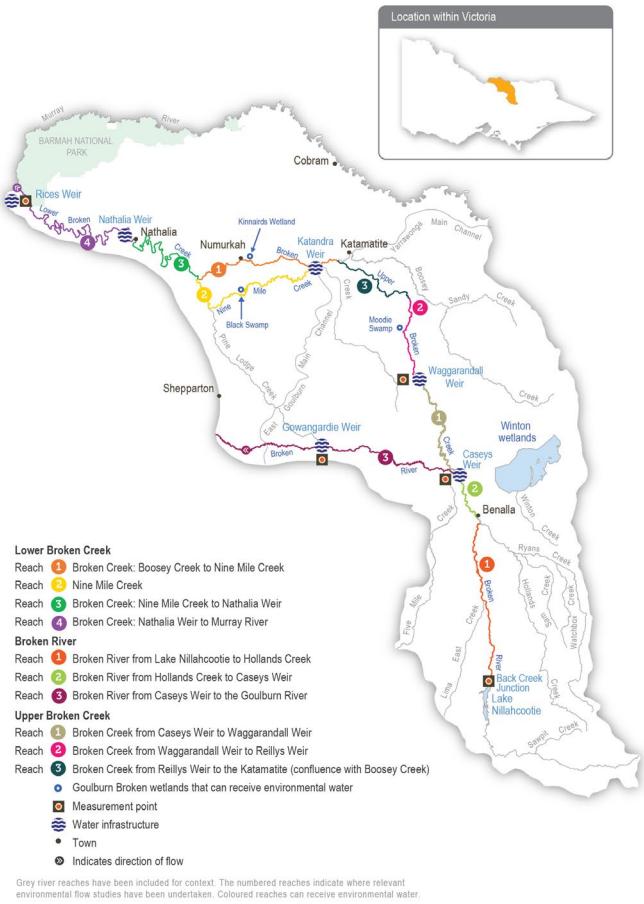
2. Asset overview

2.1 Catchment setting

Moodie Swamp is located on Broken Creek floodplain (Figure 3). Broken, Boosey and Nine Mile Creeks are the key waterways in the Broken catchment and have a combined total length of approximately 450km. Broken Creek and its associated floodplain is listed in the Directory of Important Wetlands in Australia (EA 2001) and stretches of Broken and Nine Mile Creeks have been reserved as State Park and Natural Features Reserve. The Broken catchment is 772,386 hectares or 3.4 per cent of Victoria's total area. The main waterway of the Broken catchment is the Broken River which flows into the Goulburn River at Shepparton. The Broken catchment also includes Broken Creek that diverges from the Broken River west of Benalla township and flows north-west into the Murray River. Broken Creek is an ancient course of the Broken River palaeovalley which began to form one hundred million years ago (Tickell 1989). Moodie Swamp can receive natural inflows and environmental water deliveries from the Broken Creek via Geary's channel and overland flows during flooding.

Most of the Broken catchment has been cleared for agriculture which supports grazing in the south, and mixed cereal and livestock farming in the central region. A large part of the northern section of the Broken catchment is within the Goulburn-Murray Irrigation District (GMID), with irrigation for fruit growing, dairying and livestock production. Drainage, land forming, and river regulation have significantly reduced the number and area of wetland habitats. Therefore, the remnant vegetation and wetlands fringing Broken, Boosey and Nine Mile creeks form an important corridor in the Broken catchment and are a stronghold for native flora and fauna.

Figure 3: Broken catchment indicating Moodie Swamp on Broken Creek



Within the Broken catchment only three wetlands currently receive environmental water. These are Black Swamp, Kinnairds Wetland and Moodie Swamp. These sites have been prioritised due to their ecological values, significance to the community and Yorta Yorta People. In addition, these sites have the infrastructure required to receive environmental water. As the wetland environmental program progresses, other wetlands of high ecological and cultural values will be considered for watering, provided they have the necessary infrastructure in place to deliver water and Yorta Yorta Nation Aboriginal Corporation and land manager approvals are met.

2.2
Land status and management

Moodie Swamp is located within the Moodie Swamp Wildlife Reserve managed by Parks Victoria (PV). A range of management agencies are responsible for ensuring that management of the site and environmental water deliveries comply with a broad range of legislative requirements. Lead management agencies and their key responsibilities are summarised in Table 5.

The broader community including adjacent landholders, Yorta Yorta Nation Aboriginal Corporation, Landcare, and recreational users such as Field and Game have an interest and role in Moodie Swamp. The successful management of the site therefore relies on effective cooperation and partnership between the government agencies and the broader community.

Table 5: Lead agencies and their key site responsibilities

Agency	Responsibility
Yorta Yorta Nation Aboriginal Corporation (YYNAC)	Yorta Yorta Nation Aboriginal Corporation is the representative body that provides the interface between government and the Yorta Yorta People. Foremost the Yorta Yorta People are the Traditional Owners of the area within the Plan, namely Moodie Swamp Yorta Yorta Nation Aboriginal Corporation is a Victorian Registered Aboriginal Party (RAP) under the *Aboriginal Heritage Act 2006 (Vic)*, which occurred in 2007. Yorta Yorta Nation Aboriginal Corporation have decision making responsibilities for protecting their traditional knowledge referred to in the AHA as Aboriginal cultural heritage, and other matters within the Rap area. Yorta Yorta Nation Aboriginal Corporation collaborate with the Goulburn Broken CMA regarding environmental water delivery to wetlands within Yorta Yorta Country that sits within the Goulburn Broken catchment.
Department of Energy, Environment and Climate Action (DECCA)	Provide financial, policy and strategic support for the management of public and private land. Management of flora and fauna, State Forest and public Land Water Frontage. Management of hunting and domestic stock licensing on public land.
Goulburn Broken Catchment Management Authority (Goulburn Broken CMA)	Implementation of the Goulburn Broken Regional Catchment Strategy 2021-27 (GBCMA 2021). Works on waterways, regional drainage and floodplain management, and co-ordinating Commonwealth and State natural resource management investment. Determining the environmental water requirements of wetlands and streams, developing and submitting Seasonal Watering Proposals to VEWH for consideration, and managing the delivery of environmental water in accordance with VEHW's watering plan.
Goulburn-Murray Water (GMW)	Manages water related services including storage, delivery and drainage systems across Northern Victoria.
Murray-Darling Basin Authority (MDBA)	The Murray–Darling Basin Authority's principal aim is to manage the Basin's water resources in the national interest.
Moira Shire Council (MSC)	Regulate local development through the planning scheme, on-ground works, and management of local roads and urban drainage.
Parks Victoria (PV)	Management of the site on behalf of DEECA.
Victorian Environmental Water Holder (VEWH)	Management of environmental water entitlements on behalf of the Minister for Environment as of July 2011. Development of annual Seasonal Watering Plans derived from CMA's Seasonal Watering Proposals.

2.3
Asset characteristics

Until 2014 wetlands in Victoria were classified using a system developed by Corrick and Norman which included information on water depth, permanency and salinity (Corrick and Norman 1980). Wetlands throughout Victoria were mapped and classified between 1975 and 1994 and developed into spatial GIS layers (DSE 2007). Moodie Swamp was classified as a shallow freshwater marsh in the Department of Sustainability and Environment wetlands 1994 layer. In 2014 a new classification framework for Victoria was developed and based on the Australian National Aquatic Ecosystem Classification Framework (AET 2012). Under this classification Moodie Swamp is classified as temporary freshwater meadow with an intermittent water regime category. Moodie Swamp has an approximate depth of 1.0m and has a calculated capacity of approximately 1,500ML.[2]

Moodie Swamp is situated in the Victorian Riverina bioregion and is adjoined by the northern inland slope's bioregion (Section 3.1.2.3) and is located within the Moodie Swamp Wildlife Reserve. The swamp is managed by Parks Victoria and is part of a larger 181.44-hectare swamp complex (Table 6). Moodie Swamp is surrounded by a small conservation area and dry land agricultural properties on the northern, eastern and southern edge, Benalla Tocumwal Road on the western edge and the Broken Creek to the east. Environmental water can currently be delivered to Moodie Swamp via Broken Creek and Geary's channel.

Table 6: Moodie Swamp site characteristics

Characteristics	Description
Name	Black Swamp
Traditional Owners	The Yorta Yorta People
Mapping Id	8025910900 (old); 67053 (new)
Area (hectares)	181.44
Bioregion	Victorian Riverina, Northern Inland Slopes
Conservation Status	Directory of Important Wetlands
Land Status	Natural Features Reserve – Wildlife Reserve
Land Manager	Parks Victoria
Surrounding Land Use	Dry land Agriculture/ Conservation area
Water Supply	Broken Creek
1788 Wetland Category	Shallow freshwater marsh
1994 Wetland Category	Shallow marsh
2014 Wetland Category	Temporary freshwater meadow
Wetland Capacity (ML)	1,500ML
Wetland depth at Capacity (mm)	Varies to 1,000mm

2. *An Environmental water allocation volume will vary corresponding with objectives and targets that need to be met at the time of delivery. 1,500ML will not be delivered to the swamp every time an environmental water allocation occurs at the site.*

2.4
Environmental water sources

The Environmental Water Reserve (EWR) is the legally recognised amount of water set aside to meet environmental needs. The reserve includes 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. Environmental entitlements are held by the Minister for Environment, who delegates management to the Victorian Environmental Water Holder.

Environmental Water for Moodie Swamp can be sourced from the water entitlements and their agencies listed in Table 7.

The amount of water available for use depends upon volumes acquired and seasonal water allocations.

As part of an agreed Watering Schedule between the Victorian Environmental Water Holder (VEWH) and the Commonwealth Environmental Water Holder (CEWH), the environmental water entitlement can be used in the upper Broken Creek, Moodie Swamp and Broken River. This allows the VEWH and or CEWH to transfer in volumes when required to meet environmental demand in these waterways. Environmental water can also be traded to meet environmental water needs in these systems including delivery to Moodie Swamp.

Table 7: Environmental Water Entitlements

Environmental water	Responsible agency	Description	Conditions
Bulk Entitlement (Broken System – Goulburn-Murray Water) Conversion Order 2004			
Environmental water entitlements			
Commonwealth Environmental Water Holdings	CEWH	534 ML Broken high reliability water and 4 ML Broken low reliability water shares.	Water use is subject to agreement with the CEWH.
Victorian Environmental Water Holdings	VEWH	90 ML Broken high reliability water share and 18.9 ML Broken low reliability water share.	

2.5
Hydrological 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 (DSE 2005). A wetlands hydrology is determined by surface and groundwater inflows and outflows in addition to precipitation and evapotranspiration (Mitsch & Gosselink 2000 cited in DSE 2005). Duration, frequency, seasonality (timing) and depth are the main components of a wetland's hydrological regime.

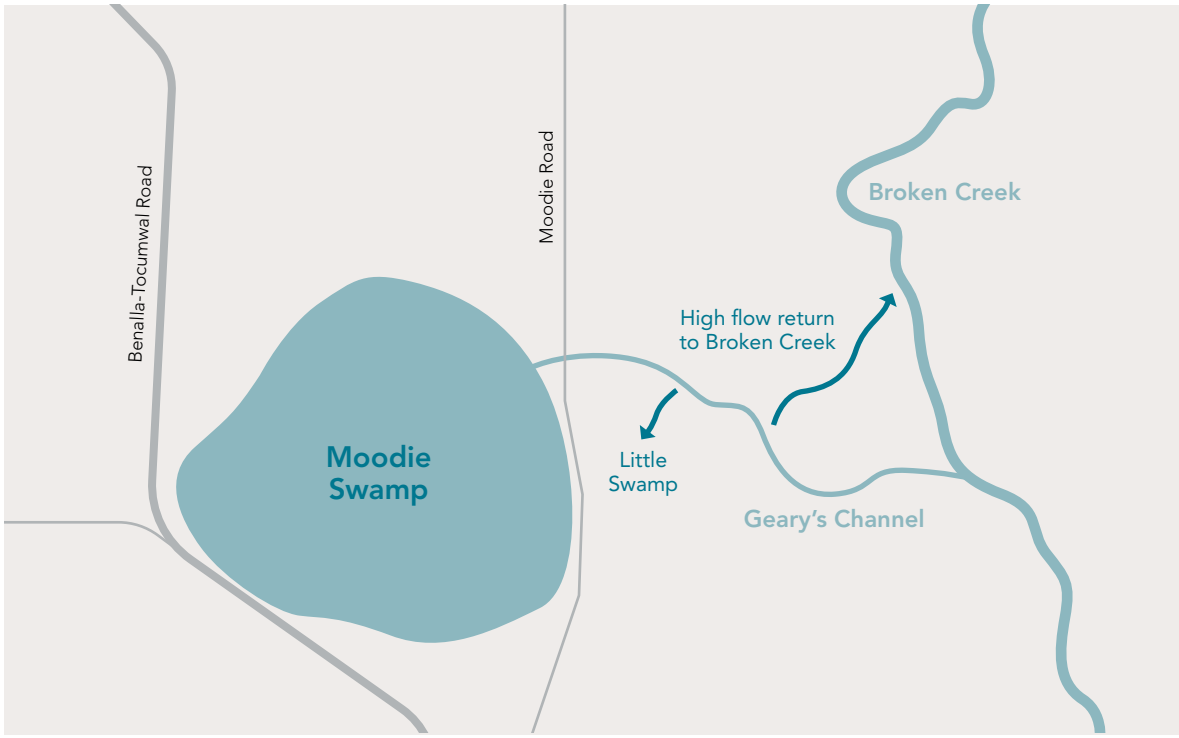
PRE-REGULATION

Under natural conditions, Moodie Swamp received flood water from Broken Creek to its east (Figure 5). The swamp would have been inundated most years during late winter and spring. Given the variable depth of the swamp it would have also dried out most years over the summer-autumn period. Groundwater is unlikely to have played a part in the swamp as ground bores levels within 3km of the area show the groundwater readings to be below 15 metres, however the Victorian Wetland Inventory determines that groundwater flows may moderately influence the swamp. This could be explored further with the addition of groundwater bores to the site.

RECOMMENDATION

Investigate groundwater impact, if any, upon Moodie Swamp – pre-European and current.

Figure 5: Arrows indicate flow path of water into and out of Moodie Swamp

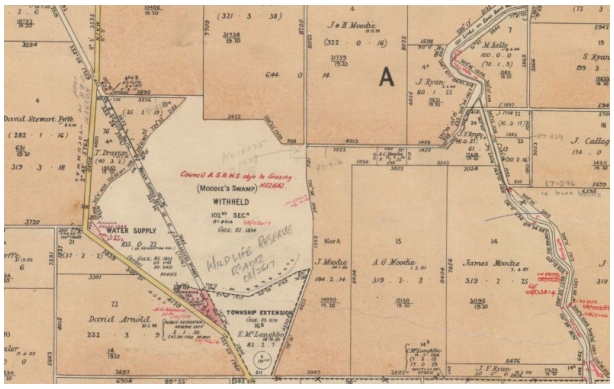


POST-REGULATION

1880s

A 42-hectare section on the eastern edge of Moodie Swamp was temporarily reserved for water supply in 1882. The remainder of the swamp was set aside for water supply later that year.

Figure 6: Moodie Swamp water reserve in 1880s



1890s

Moodie Swamp hydrology was significantly changed with the construction of Casey's Weir on the Broken River in the late 1890s which diverted water to Broken Creek to supply stock and domestic water to the district. Regulation of Broken Creek saw flows change from natural high autumn/winter flows to high flows in spring/summer when irrigation demand was the greatest. Prior to 1890 a section of the Broken Creek was straightened (which now forms part of Geary's channel) and River Red Gums removed from the swamp bed.

1910s

In 1910, Geary's channel was extended to Moodie Swamp. This was extended to facilitate dam fills in the area between Broken Creek and Moodie Swamp (SKM 2006).

1950s

In 1951, another channel (Moodie Channel) was connected to Moodie Swamp upstream of Geary's channel. This was an attempt to obtain flows into the swamp whatever the water level was in Broken Creek.

1980s

In 1985, the Land Conservation Council recommended that Moodie Swamp be classified as a Wildlife Reserve which was passed in 1989.

Works occurred on Geary's channel in 1986 to facilitate dam fills; however, these works possibly contributed to an increase in the frequency of unseasonal inflows into Moodie Swamp.

1990s

In 1991, the swamp was classified as a State Game Reserve and in 1995 it was listed on the Directory of Important Wetlands (EA 2001).

In 1993, a regulator was installed on Geary's Channel to prevent rain rejection flows[3] entering Moodie Swamp from Broken Creek. At this time, the Broken Creek was also dredged in an attempt to increase the channel capacity of the creek and to lower the running level of the creek (SKM 2006). This caused difficulties in filling the dams along Geary's channel and inadvertently reduced natural flood events entering Moodie Swamp.

In 1996, the swamp was recommended to be included in the Broken Boosey State Park. However, this recommendation was changed to Natural Features Reserve – Wildlife Area within the Box Iron Bark region so that hunting could be retained as a recreational value of the swamp (ECC 2001, SKM 2006).

2000s

In 2001, the swamp was relisted as a Natural Features Reserve – Wildlife Area. 2008 saw the upgrade of the regulator on the Broken Creek and the extension of Geary's channel to outfall directly into Moodie Swamp to allow more efficient water delivery to the swamp.

The first environmental water delivery to Moodie Swamp occurred in 2008. 50ML was delivered to the swamp between 29 April and ceased in the second week of June 2008. The delivery inundated approximately 60 per cent of the swamp area with a maximum depth of 200mm. The swamp dried in October 2008.

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3. Rain rejection flows occur when a combination of rainfall and reduced irrigation demands due to rain, leads to increased flows in the waterway.

The Tungamah pipeline was connected in 2009. This also affected flows in the Broken Creek with both base flows and peak flows being reduced.

2010s

In September 2010 the Millennial drought broke and Moodie Swamp filled to capacity. The swamp remained wet for 30 months due to a prolonged wet cycle. Cormorants (Figure 7) and Brolga nested at the site.

Figure 7: A pied cormorant chick on a nest at Moodie Swamp

The swamp dried in spring 2012. 2014 saw the second environmental water delivery to the swamp. 121 ML was delivered in May and then an extra 500ML in October 2014 to assist with Brolga breeding at the site. 500ML of environmental water was delivered to the swamp in April 2016. A large rainfall event occurred in September 2016 and the swamp held water until December 2017. Numerous waterbirds bred at the site during this time and a large number of Nankeen Night Heron were observed at the site. Another 500ML environmental water was delivered in April 2018, however delivery transition losses were extremely high and the swamp did not fill. The swamp held water until July 2018 with no environmental targets being met. The swamp remained dry until April 2020.

2020s

A large rainfall event in April 2020 filled Moodie Swamp. The Swamp held water until November 2020 before drawing down and drying. Due to COVID-19 restrictions, field work was limited in 2020. Rainfall in August 2021 saturated the soil profile in the swamp and a decision by the Goulburn Broken CMA was made to bring the proposed delivery of environmental water in Autumn 2022 forward to September 2021 to align with the natural wetting. 1000ML of environmental water was delivered to the site between September 4 and December 23 2021. A large rainfall event in January 2022 ensured the swamp remained wet over the warmer months. In October 2022 record flooding across the Goulburn and Broken catchments occurred and the swamp filled. The swamp held water for the next 12 months and was flooded naturally again in October 2023. Waterbird life thrived at the swamp. April 2024 saw the largest number of Brolga ever recorded at the swamp with 14 being observed displaying courtship behaviour. GB CMA applied for the swamp to be closed to duck hunting for the 2024 season and were successful. This record was broken in May 2024, when 20 Brolga were observed at the site. Aquatic herbs such as Upright water-milfoil *(Myriophyllum crispatum)* became the dominate species taking over from Cane grass *(Eragrostis infecunda)*.

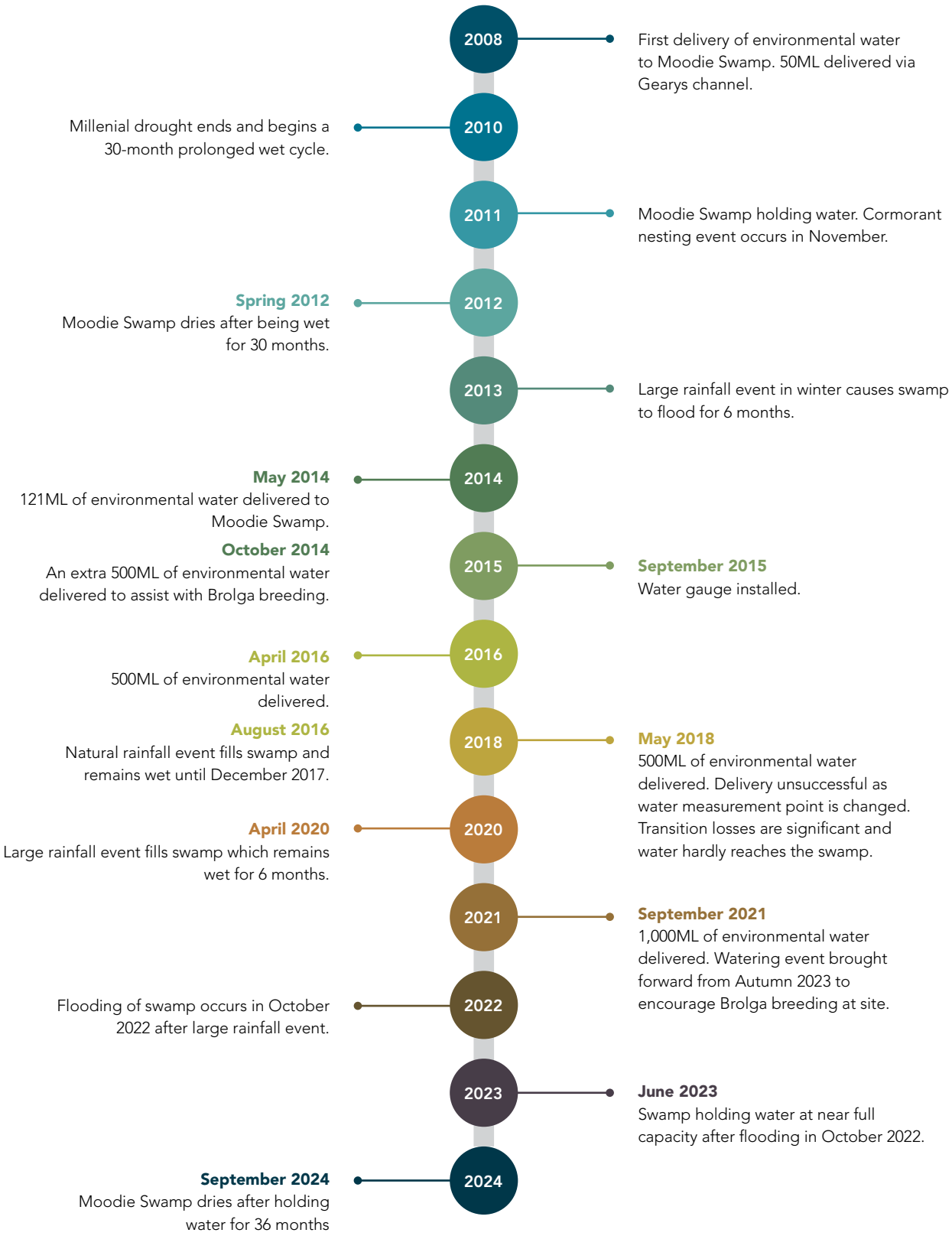
Figure 8: Upright water-milfoil *(Myriophyllum crispatum)* carpets sections of Moodie Swamp

Gearys channel was upgraded in 2024 to assist with more efficient environmental water deliveries into the swamp.

ENVIRONMENTAL WATER

Environmental water was first delivered to Moodie Swamp in 2008. Figure 9 presents a timeline of watering and events at Moodie Swamp since 2008.

Figure 9: Moodie Swamp timeline since environmental water delivery began in 2008



3. Water-dependent values

3.1 Environmental values

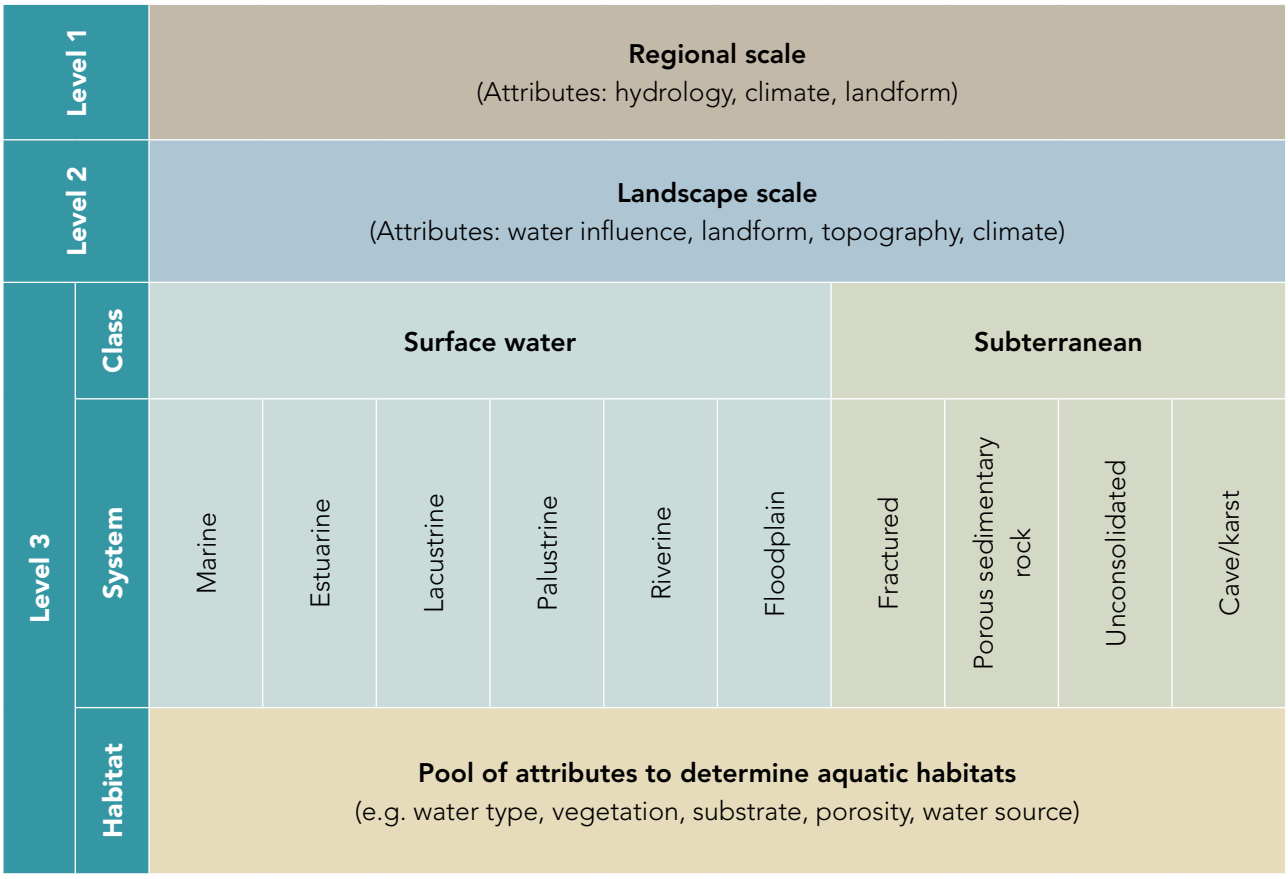
Moodie Swamp is classified under the Directory of Important Wetlands (EA 2001) as part of the Broken Creek listing (VIC036). It is a significant site in the Goulburn Broken catchment as it is one of only nine wetlands that can receive water from approximately 3,600 that have been mapped. The swamp has a population of the *EPBC Act* (1999) listed Rigid Water-milfoil *(Myriophyllum porcatum)* and provides refuge in dry years when other wetlands remain dry. Its ecological vegetation classes (EVCs) (Section 3.1.2.3, Table 11) are classified as endangered, vulnerable and depleted.

3.1.1 ECOSYSTEM TYPE

The need for a new wetland classification system in Victoria was identified in 2012. This resulted in the development of the Australian National Aquatic Ecosystem (ANAE) Classification Framework (AET 2012). This classification framework sets out a three-level hierarchical classification for aquatic ecosystems (Figure 10).

Level 1 of the hierarchy relates to regional attributes, Level 2 to landscape attributes and Level 3 to aquatic ecosystem class, system and habitat attributes. Wetlands are a subset of the aquatic ecosystems to which the framework applies.

Figure 10: ANAE structure for wetlands



Wetlands in the Victorian wetlands inventory edit tool all fall within the aquatic ecosystem surface water class.

The ANAE classification framework Level 3 attributes (with the exception of the class attribute) were reviewed to determine their relevance and applicability to the classification of Victoria's wetlands and to assist with the selection of the attributes, categories and structure used in the Victorian wetland classification framework (DELWP 2016). Under the ANAE framework, Moodie Swamp is classified as a Freshwater Meadow.

Moodie Swamp is classified as a temporary freshwater meadow within the 2014 Victorian wetland classification framework. Pre-European classification suggests the swamp would have been a shallow freshwater marsh.

The wetland regime categories adopted in the Victorian Wetland Classification Framework indicate that Moodie Swamp is classified as a palustrine ecosystem that is periodically inundated, infrequently holding water greater than one month on average three to less than eight years in every ten (Table 8).

Moodie Swamp is listed on the Groundwater Dependent Ecosystem Atlas within the Broken Groundwater Management Area. Its groundwater flow system is listed as "intermediate and local flow systems in Palaeozoic rocks or Mesozoic intrusives[4]" (BOM 2017). The Victorian wetland inventory edit tool indicates that the likelihood Moodie Swamp receives water from groundwater flows is moderate (DELWP 2022).

Table 8: Water regime categories adopted in the Victorian wetland classification framework

Wetland system	Water regime category	Category description	Water regime subcategory	Subcategory description	
				Frequency of inundation	Duration of inundation
Lacustrine and palustrine	Permanent	Inundated constantly, rarely drying completely.		Constant, annual, or less frequently but before usually wetland dries.	Never dries or dries rarely (i.e., holds water at least eight years in every ten), but levels may fluctuate within or between years.
	Periodically inundated	Inundated annually to infrequently, holding water for at least one month to more than one year before drying.	Seasonal	Annual or near annual inundation (i.e., holds water at least eight years in every ten).	Holds water one to eight months then dries.
			Intermittent	Infrequent, holds water, on average, three to less than eight years in every ten.	Holds water greater than one month to greater than one year then dries.
			Episodic	Infrequent, holds water, on average, less than three years in every ten.	Holds water greater than one month to greater than one year then dries.
	Unknown	Water regime category unable to be determined.			

4. *Intrusive rock is a rock formed under intense heat that has crystalised from molten magma.*

3.1.2
FLORA AND FAUNA VALUES

3.1.2.1
FAUNA

Moodie Swamp Wildlife Reserve provides habitat for a wide variety of water dependent and terrestrial fauna species. The fauna population at the site has increased since the first environmental water delivery in 2008. To date 173 species have been recorded at the swamp (Table 9, Appendix 2). This is an increase of 44 species since monitoring and environmental water delivery began in 2008. Noting that fauna numbers fluctuate depending on water availability within the broader landscape.

Numerous waterbirds that have been recorded breeding at Moodie Swamp including little pied cormorants *(Microcarbo melanoleuos)*, black swans *(Cygnus atratus)* and Australasian grebes *(Tachbaptus novaehollandiae)*. Brolga also breed at the swamp with sometimes more than one pair having been seen breeding. Of the waterbird species that have been recorded at the swamp, the most dominant functional feeding group is the large wading birds.

Blue-billed duck *(Oxyura australis)* and nankeen night heron *(Nyctocorax caledonicus)* were first recorded at the site in 2016 and Lewin's rail *(Lewinia pectoralis)* in 2021. Magpie geese (Anseranas semmipalmata) were also recorded at the swamp and its surroundings in 2021 by a local landholder.

Eight amphibian species have been recorded utilising Moodie Swamp, this includes the common spadefoot *(Neobatrachus sudelli)* and the EPBC Act listed Sloane's froglet (Section 3.1.2.2). Fish species and aquatic invertebrates have not been monitored at Moodie Swamp and records cited are only incidental. Future monitoring projects could include these components of the food chain to determine what is utilising the swamp and give a more complete picture of Moodie Swamp food web.

RECOMMENDATION

Undertake sampling of fauna such as reptiles, invertebrates and fish to better understand the food web at Moodie Swamp.

Table 9: Fauna count comparison at Moodie Swamp between 2008-2023

Species type	2008-2010 count	2011-2022 count	Difference
Terrestrial birds	57	79	22
Wetland birds	47	52	5
Amphibians	7	8	1
Reptiles	6	8	2
Aquatic insects	4	14	10
Mammals	8	9	1
Fish	0	3	3
Total	**129**	**173**	**44**

CASE STUDY

Brolga

Moodie Swamp is home to Brolga *(Antigone rubicunda)*.

Brolga is listed as endangered under the *Flora and Fauna Guarantee Act 1988*.

Brolga are a large, light grey coloured crane with a red-orange head. Standing at approximately 1.8 metres tall and having a wingspan of 2 metres.

Breeding usually occurs in freshwater meadows or shallow freshwater marshes between July and December. A display or dance along with a loud trumpeting call is usually observed when a male is attempting to attract a female.

Brolga pairs bond for life and have been known to utilise the same nesting area for up to 20 years.

Brolga are omnivorous and feed on a wide range of food sources from vegetables to freshwater molluscs and crustaceans.

MAJOR THREATS:

- Loss of habitat
- Predator species such as foxes
- Altered water regime to habitat.

3.1.2.2
FAUNA THREATENED STATUS

Species are classified by their threatened status. Most species found at Moodie Swamp do not have a threatened status, meaning their position in the landscape and their population numbers are not currently threatened nationally or in Victoria.

There are two pieces of legislation which list threatened species:

- Victorian *Flora and Fauna Guarantee Act 1988* (FFG Act)
- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The FFG Act (1988) is the Victorian legislation that provides for the conservation of biodiversity and the management of associated potentially threatening processes (DELWP 2022). Previously, Victoria had multiple lists of threatened species – those listed under the FFG Act, and non-statutory lists called the Victorian Threatened Species Advisory Lists. Recent amendments to the FFG Act have removed duplication by establishing a single comprehensive list of threatened flora and fauna species. This will continue to be known as the FFG Act Threatened List. With the new comprehensive list now in effect, the Advisory lists have been revoked. To date three species listed under the EPBC Act and 14 species that are listed under the FFG Act have been recorded at Moodie Swamp (Table 10).

Table 10: Conservation status of fauna species recorded at Moodie Swamp

Common Name	Scientific Name	Type	International Agreements	EPBC	FFG
Australasian Bittern	*Botaurus poiciloptilus*	B		EN	CE
Australasian Shoveler	*Anas rhynchotus*	B			VU
Blue-billed Duck	*Oxyura australis*	B			VU
Brolga	*Antigone rubicundas*	B			EN
Brown Treecreeper	*Climacteris picumnus victoriae*	B		VU	
Caspian Tern	*Hydroprogne caspia*	B	J		VU
Cattle Egret	*Ardea ibis*	B	C, J		
Eastern Great Egret	*Ardea modesta*	B	J, C, B		VU
Glossy Ibis	*Plegadis falcinellus*	B	C, B		
Lace monitor	*Varanus varius*	R			EN
Lewin's Rail	*Lewinia pectoralis*	B			VU
Magpie Goose	*Anseranas semipalmata*	B			VU
Marsh Sandpiper	*Tringa stagnatilis*	B	C, J, R, B		EN
Musk Duck	*Biziura lobata*	B			VU
Plumed Egret	*Ardea intermedia plumifera*	B			CE
Sloane's Froglet	*Crinia sloanei*	A		EN	EN
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	B	C		EN

Legend

Type: Bird (B), Reptile (R), Amphibian (A)
International Agreements: Bonn (B), CAMBA (C), JAMBA (J)
EPBC Act: Endangered EN Vulnerable VU
FFG Act: Critically Endangered CE Endangered EN Vulnerable VU

February 2024 saw a the largest number of the Critically Endangered Plumed Egrets observed outside of Barmah Forest (Figure 11). The Egrets stayed at the swamp for approximately three months.

Figure 11: WetMAP Waterbirds Survey results for Moodie Swanp

WetMAP – Victoria's Wetland Monitoring and Assessment Program for environmental water

Waterbirds – Survey Update

Wetlands	Moodie's Swamp, Black Swamp, Shepparton WTP, Reedy Swamp
Dates	19–21 February 2024
Data collected and methods	Full waterbird counts of wetland sites along with assessment of structural habitat cover at each wetland. Inundation extent estimated. Weather conditions noted.
Survey notes, dominant species and highlights	These wetlands were previously surveyed in December and remained mostly full following further floods in January. Numbers and species richness were fairly typical for Black and Reedy swamps, and high for Moodie's Swamp, where the numbers of egrets in particular were exceptional and two young Brolga were encouraging. ***Moodie's Swamp*** *(19 February)* • Estimated 80% full, with extensive milfoil in the centre of the wetland. • 5,972 waterbirds of 25 species, including 4,435 Straw-necked Ibis, 137 Eastern Great Egret, 101 Plumed Egret, 69 Royal Spoonbill, 6 Brolga (two pairs with one young each) and 3 Australasian Shoveler.

▼ Great Egret and Plumed Egret at Moodie Swamp – February 2024

Figure 12: A dead white faced Heron found at Moodie Swamp

Pest animals that pose major threat to Moodie Swamp include Carp *(Cyprinus carpio)* and Goldfish *(Carassius auratus)* as they compete for food, decrease water quality by foraging on the bottom of the swamp causing water to become turbid, can reproduce in large numbers and feed on native fish. Foxes *(Vulpes vulpes)* pose a threat to native bird species nesting at the site and have been observed wading through the water to raid nests. Cats *(Felius catus)* also pose a threat to birds nesting close to or on the shoreline or in the trees that overhang the edge of the swamp.

CASE STUDY

Sloane's Froglet

Moodie Swamp is home to Sloane's Froglet *(Crinia sloanei)*.

Sloane's Froglet is listed as endangered under the *Environment Protection Biodiversity Act* (1999) and the *Flora and Fauna Guarantee Act* (1988).

The Froglet is small, usually reaching up to 2cm in length. Sloane's Froglets have a brown or brown-grey back with darker brown or olive marks. Some males may also have orange-coloured spots and green marbling under the chin.

Sloane's Froglets are best identified by their "chick chick chick" call.

Breeding usually occurs in winter in both temporary and permanent waterbodies. They prefer wetlands that contain both terrestrial and aquatic vegetation of grasses and reeds.

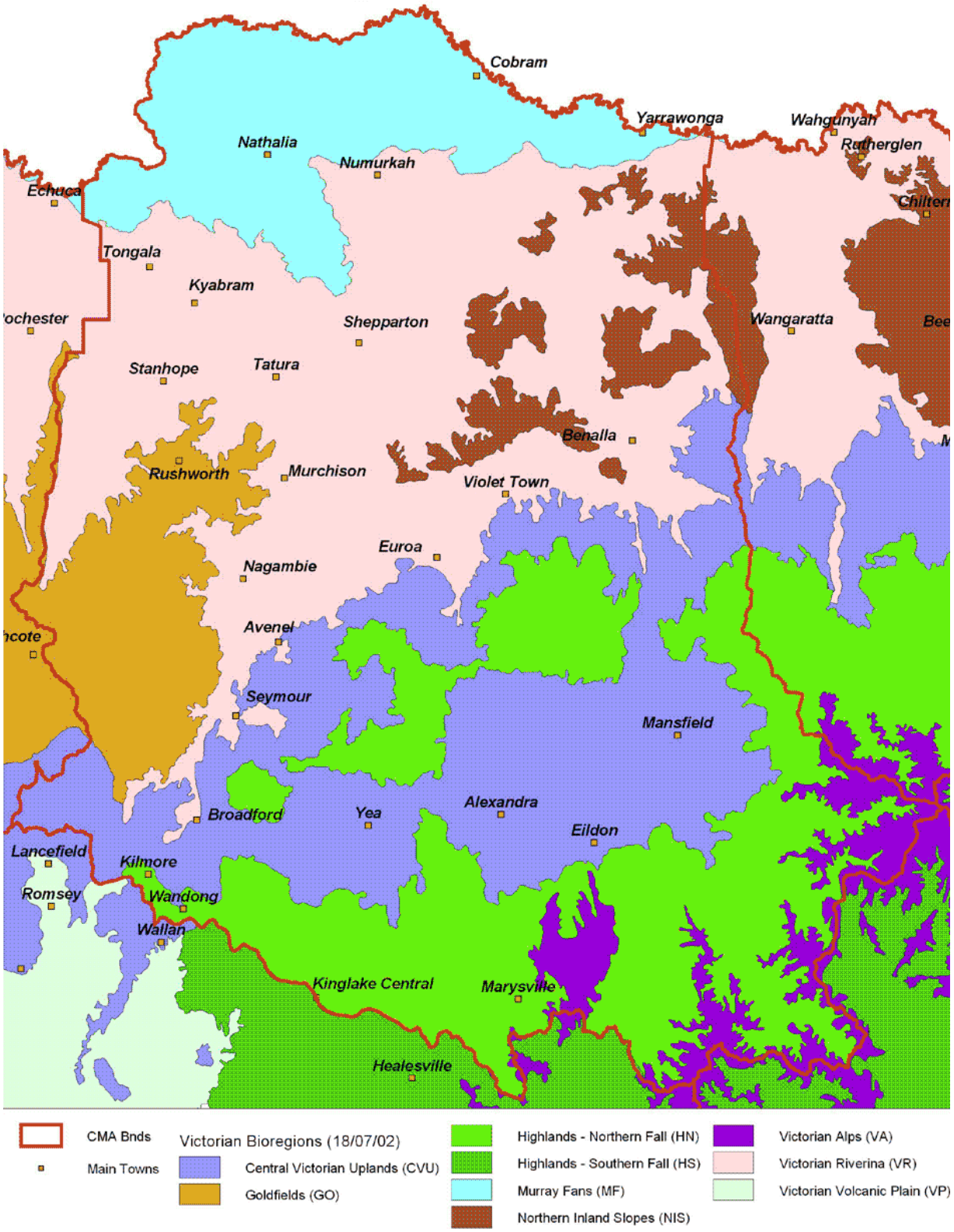
The froglets attach their eggs singly on vegetation under the water.

Sloane's froglets feed on insects.

MAJOR THREATS:

- Loss of habitat and habitat degradation
- Predator species such as Carp and Goldfish
- Altered water regime to habitat
- Chytrid fungus
- Climate change.

Figure 13: Bioregions of the Goulburn Broken CMA



3.1.2.3 FLORA – BIOREGIONS AND ECOLOGICAL VEGETATION CLASSES

Moodie Swamp is situated in the Victorian Riverina bioregion (Figure 13) and borders on the Northern Inland Slopes bioregion. Bioregions are a landscape-scale approach to classifying the environment using a range of attributes such as climate, geomorphology, geology, soils and vegetation (Figure 14). Victorian Riverina, located north of the Great Dividing Range in Victoria is characterised by flat to gently undulating landscape on recent unconsolidated sediments with evidence of former stream channels and wide floodplain areas associated with major river systems and prior streams. Alluvium deposits from the Cainozoic period (65 million years – present day) gave rise to the red brown earths and texture contrast soils (Chromosols and Sodosols) which dominate the Riverine Plain.

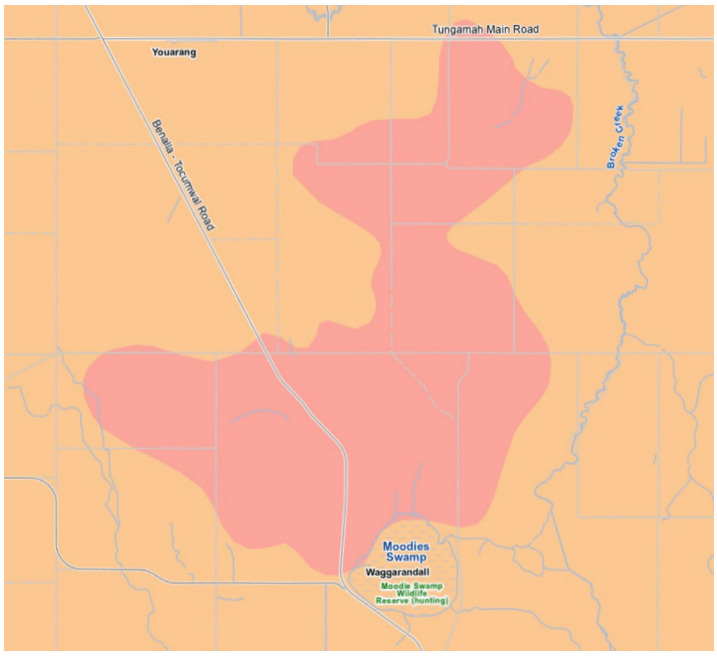
Annual average rainfall for the region ranges from 360-672mm per annum. The average annual minimum and maximum temperature range is from 3 to 9°C and 15 to 21°C respectively. The vegetation is dominated by Plains Grassy Woodland, Plains Grassland, Pine Box Woodland/Riverina Plains Grassy Woodland Mosaic, Riverine Grassy Woodland/Riverine Sedgy Forest/Wetland Mosaic, Plains Grassy Woodland/Gilgai Plains Woodland/ Wetland Mosaic, Grassy Woodland and Wetland Formation ecosystems.

The Victorian Riverina bioregion is associated with the eight river basin tributaries of the Murray River draining north, west, and southwest from the Great Dividing Range of eastern Australia (DELWP 2022).

A hierarchical system of classification of vegetation communities has been developed in Victoria over the past decade to classify vegetation into units that are both ecologically meaningful and useful for vegetation managers. The classification that has been adopted in Victoria is Ecological Vegetation Classes (EVCs), which are defined by a combination of floristics, lifeform, position in the landscape and an inferred fidelity to environments. Each EVC includes a collection of floristic communities, which occur across a biogeographic range, and although differing in species, have similar habitat and ecological processes operating. Approximately 300 EVCs have been described for Victoria. The combination of EVC and bioregion (BioEVC) is used to determine the bioregional conservation status (BCS) of an EVC.

This is a measure of the current extent and quality for each EVC, when compared to it's original (pre-1750) extent and condition. On this basis a BioEVC will have a BCS of endangered, vulnerable, depleted, least concern or rare (DELWP 2022).

Figure 14: Bioregions covering and adjoining Moodie Swamp



Victorian Riverina (VR)

Northern Inland Slopes (NIS)

Table 11: Conservation status of Ecological Vegetation classes recorded at Moodie Swamp

EVC number	EVC Name	Bioregional Conservation Status	Bioregion
291	Cane Grass Wetland	Vulnerable	Victorian Riverina
602	Cane Grass/ Aquatic Herbland Complex	Not Assessed	Victorian Riverina
813	Intermittent Swampy Woodland	Depleted	Victorian Riverina
104	Lignum Swamp	Vulnerable	Victorian Riverina
882	Shallow Sands Woodland	Endangered	Northern Slopes

Moodie Swamp has five major EVCs (Table 11). Dominant EVCs within the swamp body of Moodie Swamp include the vulnerable Cane Grass Wetland and Cane Grass Wetland/ Aquatic Herbland complex (which has not been assessed). EVCs surrounding the swamp include the depleted Intermittent Swampy Woodland, vulnerable Lignum Swamp and the endangered Shallow Sands Woodland. These EVCs provide important habitat for terrestrial fauna species. These species benefit when the swamp holds water as it provides both a water and a food source.

Before the introduction of environmental water in 2008, Moodie Swamp experienced regular, unseasonal and prolonged flooding due to the regulation of the Broken Creek to supply water for irrigation, stock and domestic use (Section 7.0). As a result, the mature river red gums *(Eucalyptus camaldulensis)* that once covered the swamp died. Many of these dead trees have since been removed by illegal wood cutters. Cane-grass EVC (#292) was the dominant EVC at the site in 2008 with limited aquatic herbs. Since the addition of environmental water to the swamp, Cane-grass and Aquatic herbs now dominate the swamp and the EVC has changed to Cane-grass/ Aquatic herbland complex (#602). There has been limited recruitment of river red gums at the swamp due to the prolonged flooding of the site. Recruitment of river red gums is slow but is beginning to occur on the western side of the of the swamp.

Moodie Swamp is surrounded by EVCs such as Intermittent Swampy Woodland, Lignum Swamp and Shallow Sands Woodland. The Shallow Sands Woodland is on the north/ northwestern edge of the swamp and is the only EVC at the site that sits in the Northern Slopes Bioregion.

Since 2008, the Goulburn Broken CMA with the cooperation of Parks Victoria, Goulburn-Murray Water and Yorta Yorta Nation Aboriginal Corporation have attempted to restore a more natural hydrological regime to Moodie Swamp by managing the delivery of environmental water to the site. This has increased the abundance of native wetland-dependent species. In March 2020, a drought employment crew undertook some cutting of non-local native wattles at the swamp, which will assist with reducing the competition to local native wattles and allow natural recruitment. The reintroduction and planting of native species within the swamp to assist with meeting EVC benchmarks and to increase diversity and improveaquatic vegetation may be required.

RECOMMENDATION

Replant to reintroduce wetland dependent species that may be required to assist with meeting EVC benchmarks.

3.1.2.4 FLORA – SPECIES LISTINGS AND SIGNIFICANCE

A total of 179 flora species have been recorded at Moodie Swamp since 2011. Flora surveys between 2008 and 2010 found a total of 163 species (Table 12). Of the 179 species observed between 2011 and 2023 at Moodie Swamp, 77 are native wetland dependant species, 53 are native terrestrial species and 49 introduced species. Of the introduced species aster weed *(Symphyotrichum subulatum)* and water couch *(Paspalum distichum)* pose the biggest threat to the site.

Table 12: Flora count comparison between 2008 and 2022

Species type	2008-2010 count	2011-2023 count	Change
Native Terrestrial plants	49	53	4
Native Wetland plants	72	77	5
Introduced Terrestrial plants	33	38	5
Introduced wetland plants	9	11	2
Total	**163**	**179**	**16**

▼ Water Pepper and Upright Water-milfoil at Moodie Swamp

3.1.2.5 FLORA THREATENED STATUS

Flora species are classified by their threatened status (Section 3.1.2.2). Most flora species found at Moodie Swamp do not have a threatened status, meaning their position in the landscape and their population numbers are not currently under threat either nationally or in Victoria.

Threatened flora species numbers have increased at Moodie Swamp with eleven species being present at the site in 2023 compared to nine in 2010 (Table 13). Changes to some of the threatened species at Moodie Swamp include the addition of the FFG Act endangered Blue-burr daisy *(Calotis cuneifolia)* and critically endangered Riverine flax lily *(Dianella longifolia var. grandis)*. In the 2012 Plan, In-land club sedge *(Isolepsis australiensis)* was identified as poorly known on the DSE 2005 Advisory list of rare or threatened plants (DSE 2005) but has since been removed from the 2022 FFG Act species list (DELWP 2022).

Rigid Water-milfoil is a small aquatic herb that is restricted to ephemeral wetlands, depressions and shallow swamps. Due to the loss of a majority of these sites the known population numbers in Victoria in 2007 was approximately 17 populations (DSE 2008). Little is known about the biology and growth requirements of Rigid Water-milfoil and Slender Water-milfoil.

Monitoring the effect of their responses to wetting and drying may assist with improved management of these species.

RECOMMENDATION

Monitoring the EPBC Act Rigid Water-milfoil and the FFG Act Slender Water-milfoil response to wetting and drying to assist with management of these species.

Table 13: Conservation Status of Flora species recorded at Moodie Swamp

Common Name	Scientific Name	EPBC Status	FFG Status
Blue-burr Daisy	*Calotis cuneifolia*		EN
Buloke	*Allocasuarina luehmannii*		CE
Dwarf Brooklime	*Gratiola pumilo*		EN
Groundsel	*Senecio campylocarpus*		EN
Rigid Water-milfoil	*Myirophyllum porcatum*	VU	CE
Riverine bitter-sedge	*Cardamine moirensis*		EN
Riverine Flax-lily	*Dianella longifolia var. grandis*		CE
Slender Water-milfoil	*Myriophyllum gracile var. lineare*		EN
Slender water-ribbons	*Cycnogeton dubium*		EN
Wavy marshwort	*Nymphoides crenata*		EN
Winged water-starwort	*Callitriche umbonate*		EN

Legend

EPBC Act: Endangered EN Vulnerable VU
FFG Act: Critically Endangered CE Endangered EN Vulnerable VU

CASE STUDY

Rigid Water-milfoil

Moodie Swamp is home to Rigid Water-milfoil *(Myriophyllum porcatum)*.

Rigid Water-milfoil is listed as vulnerable under the *Environment Protection Biodiversity Act* (1999) and critically endangered under the *Flora and Fauna Guarantee Act* (1988).

Rigid Water-milfoil is an annual aquatic herb growing to 40cm in length that grows in ephemeral wetlands.

Little is known about the ecology and biology of this species other than its seed will persist in sediment when the wetland dries out, germinating once the wetland refills. It flowers in September and fruits in October/ November.

Currently there are only a small number of wild populations of this species which is endemic to Victoria.

MAJOR THREATS:

- Wetland drainage and altered water regime to habitat
- Weed invasion and pest fish species such as European Carp
- Pollution, sedimentation and increasing salinity in wetlands
- Grazing
- Climate change.

3.2
Ecological condition

Rakali consulting has been monitoring the condition of Moodie Swamp since environmental watering began in 2008. A report written by the consulting company in 2018 describes progress against the ecological objectives established for the swamp in the 2012 Plan and recommendations to help achieve them (Cook and Just 2019). These are summarised in Table 14. Mitigation actions have been undertaken since the progress report was developed in 2018.

These include:

- Drying of the swamp to assist with Cane grass growth and ensure exotic weeds do not establish in the swamp body.
- Removal of woody weeds along the shoreline of the swamp to improve native plant recruitment and the prevention of these weeds moving into the body of the swamp.

Flora and fauna numbers at Moodie Swamp have increased since the first environmental water delivery in 2008, thus indicating a positive change in the ecological condition of the site. With continuous monitoring, delivery of environmental water and re-introduction of aquatic plant species to promote EVC health, Moodie Swamp's ecological condition should continue to improve.

Table 14: 2012 Ecological objectives and their review in 2018

2012 Ecological objectives	Discussion and recommendations from 2018	Actions since 2018
Maintain or improve Cane Grass Wetland/Aquatic Wetland Complex EVC 602 at Moodie Swamp by 2025: • 5% cover of cane grass • >15% cover of three species of aquatic herbs • >5% cover of three species of medium to small graminoids • >10% cover of five species of small to medium herbs towards the verges of the wetland.	All of the thresholds were met except for small to medium herbs towards the verges of the wetland. These species typically flourish during wet phases and were likely absent due to the dry conditions. Ensuring adequate dry phases for Cane Grass Wetland/Aquatic Wetland Complex EVC 602 is important, as too frequent inundation can significantly reduce the cover of Southern Cane-grass. Although the threshold for small to medium herbs towards the verge of the wetland was not met (including for the threatened *Myriophyllum porcatum*), these species are likely to re-establish during the next wet phase.	A prolonged drying phase between 2018 and 2020 occurred to assist with reestablishment of Southern Cane-grass. An environmental water delivery of 1000ML to the Swamp in September 2021 began to establish Southern Cane-grass population. The swamp is now in a prolonged wet phase due to flooding in October 2022. Southern Cane-grass has established well, as has the Aquatic Wetland Complex EVC.
Reduce the cover and diversity of exotic flora species.	There was generally a low cover and diversity of weeds across the site. Data collected from GBCMA wetlands that have been watered suggests that delivery of water in autumn results in less weed growth than if it is delivered in spring.	An environmental water delivery in 2021 and prolonged flooding from the October 2022 floods has seen a reduction in weeds in the swamp. A drought employment crew in 2020 also removed woody weeds along the edge of the swamp to assist with native plant regeneration and recruitment.
Maintain populations of Rigid Water-milfoil.	Ridged Water-milfoil *(Myriophyllum porcatum)* was not observed due to the dry conditions. This species usually only germinates if inundated in autumn or early winter.	Rigid Water-milfoil populations have begun to expand in the swamp. Environmental watering in spring 2021 saw the discovery of five new populations within the swamp and one in Geary's channel.
Maintain populations of Slender Water-milfoil.	Slender Water-milfoil was not observed due to the dry conditions.	N/A
Provide opportunities for waterbird breeding especially Brolga during flood events.	No waterbird breeding or Brolga recorded during assessment period.	Brolga are continually observed undertaking courtship displays at the site. No chicks were observed during the 2021 watering and have not been observed after the 2022 flooding event. Twenty Brolga have been observed at the swamp in 2024. Prolonged flooding has encouraged other waterbird species to breed at the site such as, Pied Cormorants, Black Swans, Grebes and Ducks. A large number of Herons and Egrets have been observed feeding at the swamp.
Maintain or increase the diversity and abundance of frog species supported by the wetland during flood events.	Over the monitoring period only very small numbers of Plains Froglet were heard calling at Moodie Swamp.	Prolonged flooding has seen a large increase in frog populations and frog calling at the site. Currently eight species have been observed at Moodie Swamp.

3.3
Shared benefits

Water for the environment is used to protect and restore the environmental condition of rivers and wetlands. In addition, there are recreational, social, economic and Aboriginal cultural benefits in delivering environmental water (Table 15). Environmental watering of wetlands increases opportunities and visitation of wetlands for community events, bird watching, picnicking, photography, walking and camping. Wetlands provide resources for Traditional Owners such as food, medicine and places for traditional activities.

Community understanding could be improved by signage and Yorta Yorta history of the swamp and the shared benefits that environmental water provides to the site.

RECOMMENDATION

Work with Parks Victoria to install/ improve signage for community understanding of environmental water and Yorta Yorta history at Moodie Swamp and their shared benefits to the swamp.

Table 15: Shared benefits for Moodie Swamp

Wetland	Beneficiary	Connection to wetland	Value	How have these benefits been considered for this EWMP?
Moodie Swamp	Yorta Yorta People Bird watchers Photographers	Cultural connection to country and wetland. Recreation and tourism play an important role in the Moira shire. Tourism is the seventh largest contributor to economic output with an estimated $90 million for the local community.	Environmental watering provides food, medicine and materials. Environmental watering provides an opportunity for all visitors and users to enjoy a valued site that is culturally diverse, ecologically protected, and who can in return value the site by ensuring native plant and animal species is protected. Opportunities for activities such as bird watching, and photography.	Environmental watering will provide a connection to country for Yorta Yorta People along with provisions and may assist with healing of country. Environmental watering will provide for passive recreational activities such as bird watching and photography through increased communications around planned delivery via social media, radio and local newspaper notifications. The Goulburn Broken CMA is constantly revising its communications strategy to expand networks to capture new audiences.

3.4
Yorta Yorta cultural values

Moodie Swamp was a highly valued site for the Yorta Yorta peoples. Evidence of scarred trees, isolated artefacts, artefact scatters, mounds and hearths adjoining the swamp edge have been mapped at the site. In its current condition, Moodie Swamp provides plant species for medicines, food and materials, fauna species for food and materials and a place of healing. These values have been written into objectives and aligned with environmental watering values (Section 5.3).

3.5
Recreational values

Activities enjoyed by visitors to the site include bird watching and photography, picnicking, bike riding and walking. Recreational hunting of ducks, quails and other game species in season is permitted at the site by licenced game shooters, however, environmental water is not delivered for the purpose of hunting.

4. Current condition

The condition of Moodie Swamp was assessed in March 2023 using the Index of Wetland Condition (IWC) by Water Technology (WT 2023). The IWC defines wetland condition as the state of the biological, physical, and chemical components of the wetland ecosystem and their interactions (DSE 2005, DELWP 2020).

The IWC has six subindices based on the catchment of the wetland and its fundamental characteristics: physical form, hydrology, water properties, soils and biota (Appendix 8). Each subindex is given a score between 0 and 20 based on the assessment of several measures. The overall IWC score is not a simple summation of the subindex scores. A formula is used that weights each subindex according to the contribution it makes to the overall condition of the wetland. The wetland hydrology subindex for example contributes more to the overall score than the soils subindex.

The 2006 IWC assessment is difficult to compare to 2010 and 2023 (Table 16) due to different scoring and surveying techniques. It has been added to this report due to observations of the site which can be compared to 2010 and 2023 surveys.

The overall IWC score for Moodie Swamp in December 2010 was eight out of ten, which is classified as "good" (Table 16). Water Technology undertook the 2023 IWC assessment at Moodie Swamp and made the following observations.

Wetland catchment

This sub-index identified the buffer to be mostly 20–50 m wide and the score is consistent with the previous 2010 assessment.

Physical Form

This sub-index has a very slightly reduced score due to the (historic) dams and earthworks on the northern and eastern edge of the swamp. The 2023 score shows no notable change since the previous assessments.

Hydrology

This sub-index was scored highly in 2023 as it is believed that the manipulated inflows are now more closely replicating the natural water regime (frequency, duration and timing). This score is unchanged from the 2010 assessment.

Water Properties

This score was downgraded slightly as it is assumed that the surrounding agricultural land causes low level enrichment to the swamp. This score is slightly higher than the previous 2010 assessment.

Soils

Carp were observed mumbling at the deepest eastern margins of the swamp. However, this disturbance was impacting a small area of the swamp and therefore the score reduction is minor. The true impact of the carp mumbling may be more evident as the swamp dries. The score is consistent with previous assessments.

Biota

The Biota score improved from the previous 2010 assessment, mainly due to a lower cover of weeds observed within the Cane Grass Swamp in 2023.

The Whole of Wetland score is higher than the previous 2010 score due to slight improvements in the Wetland Catchment, Water Properties and Biota sub-index scores.

RECOMMENDATION

Conduct an IWC assessment of Moodie Swamp every 3-5 years to monitor changes in condition and inform management decisions.

Table 16: Moodie Swamp IWC sub-index score, overall score and associated condition categories

IWC sub-index	Score 2006	Score 2010	2010 Condition category	Score 2023	2023 Condition category
Wetland catchment	8	10	Moderate	11.5/20	Good
Physical form	20	20	Excellent	19.9/20	Good
Hydrology	–	20	Excellent	20/20	Excellent
Water properties	20	15	Good	17/20	Excellent
Soils	20	19.75	Excellent	19.5/20	Excellent
Biota	19	17.62	Good	18.5/20	Moderate
Overall IWC Score	–	**8**	**Good**	**9/10**	**Excellent**

4.1 Trajectory of change

The addition of environmental water to Moodie Swamp since 2008, has seen progressive improvement of flora and fauna assets at the site (Section 3.1.2). Due to Moodie Swamp's moderate size, environmental water availability and the introduction of a more natural hydrological regime, the abundance, distribution and diversity of native wetland dependent species has increased at the site. The availability and use of environmental water is expected to support these values into the future despite the potential impacts of climate change on Moodie Swamp's water regime (Section 4.2).

If a "do nothing" approach was to occur at Moodie Swamp, it would be detrimental to the diversity and ecology of the site. Natural inflows into the swamp would only occur during extremely large rainfall or flooding events, with smaller events possibly only wetting the deeper section of the swamp. Invasive weed species could become prolific due to shallow flooding in summer and large stands of native Cumbungi may also form across the swamp bed, outcompeting other aquatic plant species.

4.2 Managing risks and threats

The key threats to the values of Moodie Swamp are outlined below. These threats result from activities in the swamp, on adjoining land and in the surrounding catchments. To address these threats and the impacts an integrated approach is therefore required.

Parks Victoria is responsible for land management at Moodie Swamp. Pest management of Foxes and Cats is a responsibility of Parks Victoria at this site.

Potentially threatening processes identified in the FFG Act (DELWP 2022) relevant to Moodie Swamp and its surrounding include:

- **Alteration to the natural flow regimes of rivers and streams.**

  The Broken Creek is the conduit of environmental water delivery to Moodie Swamp. It is a highly regulated system with increased flows in summer and lower flows in winter which can prevent natural inflows into Moodie Swamp. Climate change may also impact upon natural flow regimes if the projections for Australia as reported in the 2020 State of the Climate report (CSIRO 2020) occur. Predictions are for more heat extremes; more time in drought; more intense, short-duration storms; continued decrease in cool-season rainfall; and

a longer fire season for southern and eastern Australia. The likely effect of these impacts will be less water available for agriculture, urban water supplies and ecosystems in coming decades, especially in southern Australia. Reduced water availability will affect the quality of the limited water resources, leading to increased costs of water treatment, degradation of aquatic ecosystems, and loss of habitat for flora and fauna, followed by a decline in populations. The increased competition for water resources will make it essential to develop and implement water management plans that recognise and equitably share the available water between consumptive users, the environment and cultural practice (CSIRO 2020).

- **Alteration of the natural temperature regimes of rivers and streams.**

  Clearing of riparian vegetation along the Broken Creek and climate change may increase the natural temperature of the water. This may affect the quality of the water within the creek and water that enters the swamp. Illegal clearing of the riparian zone may increase nutrient runoff into the creek. Adversely, this may affect the aquatic ecosystem, impacting upon aquatic plant growth and encouraging weed species to thrive. This may also increase the loss of available native habitat within the swamp and cause a decline in the native flora and fauna populations.

- **High frequency fire resulting in disruption of life cycle processes in plants and animals and loss of vegetation structure and composition.**

  Wetland plants can only withstand limited burning regime. The increase of fires could have a devastating impact on established wetland plants within the swamp.

- **Infection of amphibians with Chytrid fungus, resulting in chytridiomycosis.**

  Chytrid fungus could have a devastating effect on the frog population at Moodie Swamp.

- **Input of toxic substances into Victorian rivers and streams.**

  Toxic substances may enter the swamp if they have been introduced to Broken Creek. Toxic substances could negatively affect flora and fauna at the swamp and have lasting effects.

- **Invasion of native vegetation by 'environmental weeds.'**

  Introduction of invasive aquatic weeds such as arrowhead to the swamp body via Broken creek and Geary's channel could impact upon native aquatic flora and delivery of water into the swamp. The growth of pest plants can be sufficiently vigorous to reduce or prevent the regeneration or establishment of native plant species, altering the composition and structure of native communities. Modifications to the composition and structure of native vegetation as a result of pest plant invasion can modify the abundance of native fauna, geomorphological process, the nutrient content of soil and disturbance regimes including fire, grazing and insect activity (PV 2003).

- **Introduction of live fish into waters outside their natural range within a Victorian river catchment after 1770.**

  Poor water quality may occur due to the introduction of European Carp and Goldfish into Moodie Swamp via Broken Creek.

- **Predation of native wildlife by the cat, Felis catus**.

  Cats have been observed at Moodie Swamp on numerous occasions. Nesting birds on the fringe of the swamp could be predated on by cats.

- **Predation of native wildlife by the introduced Red Fox, Vulpes vulpes.**

  Foxes have been observed at Moodie swamp preying on nesting birds. Foxes have been observed wading through water to raid nests such as Black Swans nests for eggs. Foxes are also known for digging up turtle nests to extract eggs. A recommendation to protect turtle nests at the site would be appropriate.

- **Wetland loss and degradation as a result of change in water regime, dredging, draining, filling and grazing.**

  This threat currently is classified as low due to the land status of Moodie Swamp. However, illegal draining, dredging, filling or grazing at the site may impact upon native flora and fauna.

RECOMMENDATIONS

Monitor and control of existing and new exotic flora species when conditions are deemed favourable for their prolific growth.

Monitor and eradicate pest animals where possible.

Protect turtle nests from predation by foxes where possible.

Since the delivery of environmental water to Moodie Swamp, Goulburn Broken CMA and Goulburn-Murray Water have worked together to mitigate some of these threats (Table 17).

Potential risks associated with impacts from the application of environmental water to Moodie Swamp during an actual watering event are listed in Table 17 and Appendix 4. These risks may or may not occur at any site obtaining an environmental water delivery. In addition, a detailed risk assessment process is developed prior to delivering environmental water in any given season and will be provided in the site watering proposal and delivery plan. Mitigation measures will also be implemented during environmental water delivery to address any potential risks.

As mentioned above climate change poses a threat for Moodie Swamp. 'Indicative assessment of climate change vulnerability for wetlands in Victoria' (DSE 2013) report, indicates that there is a predicted reduction of rainfall and increased temperatures across Victoria with wetlands in the north of the state to be most likely be affected. Moodie Swamp is classified as an intermittent swamp. The report identifies that intermittent wetlands may experience a longer dry phase, although they are already adapted to a mostly dry regime, so from a biological perspective are likely to remain relatively unchanged. Environmental water may be used to assist with the prevention of prolonged dry periods at the swamp.

In summary, there will likely be a decrease in the number and area of permanent and seasonal wetlands and an increase in the number and area of intermittent wetlands. Environmental water may assist with the prevention of prolonged dry phases which may occur at this site. Potential risks associated with impacts from the application of environmental water to Moodie Swamp during an actual watering event are listed in Appendix 4. These risks may or may not occur at any site obtaining an environmental water delivery. In addition, a detailed risk assessment process is developed prior to delivering environmental water in any given season and will be provided in the site Seasonal Watering Proposal and delivery plan. Mitigation measures are also implemented during environmental water delivery to address any potential risks.

Table 17: Identified threats and mitigation actions at Moddie Swamp

Cause	Identified threat 2011 EWMP	Likelihood	Consequence	Risk	Mitigation between 2008-2023	Residual Risk
Presence and operation of irrigation infrastructure	Altered water regime	High	Medium	Medium	Water delivered via Geary's channel with regulating structure on Broken creek	Low
Introduction of exotic plants and invasive natives	Exotic flora and fauna	High	High	High	Goulburn-Murray Water spray program of Broken creek and some mechanical removal of exotic and invasive native species.	Low

5. Management goals, objectives and targets

5.1 Management goal

THE LONG-TERM OBJECTIVE FOR MOODIE SWAMP EWMP IS:

Maintain and/ or improve the biological values, functioning and resilience of Moodie Swamp by providing a more natural wetting and drying regime.

It is linked to the Goulburn Broken CMA Waterway Strategy goals:

- Maintaining or improving the resilience of the region's waterways.
- Wetlands with formally recognised significance are maintained or improved.
- Maintain or improve waterways of high community value.

5.2 Environmental objectives and targets

Environmental objectives and targets have been updated since the 2012 Plan. Objectives now reflect improved alignment with the Basin Plan and Victorian Long-Term Watering Plans. Updated objectives can be found in section 5.2.2 and Table 19.

5.2.1
SUMMARY OF CHANGES

A summary of the changes suggested to the original EWMP objectives for Moodie Swamp are presented in Table 18. Note that post June 2019 the target for Basin Plan objectives is to improve outcomes, not just maintain.

In addition, objectives are required to address all the priority environmental asset criteria identified for the site that are not currently addressed by the existing objectives (Table19). This includes adding objectives specific to criteria:

- **3(b):** Essential for maintaining, and preventing declines of, native water-dependent biota (note this will be achieved by achieving provision of vital habitat as a lack of water in the landscape is the main reason for declines of native water dependent biota).
- **4(a):** Supports threatened species – EPBC Act listed.
- **4(c):** Supports threatened species – FFG Act listed.

Whilst some functions are listed as being met at the site in the update, most are not directly measured. Therefore, additional objectives are considered for the following ecosystem functions at the site. All the wetlands are managed to ensure water is in the landscape, particularly in dry periods so most act as refugium for native water dependent biota.

- **PEF 1(a):** a refugium for native water-dependent biota during dry periods and drought.
- **PEF 1(c):** a diversity of important feeding, breeding, and nursery sites for native water-dependent biota.

Table 18: Summary of recommended changes to objectives for Moodie Swamp

EWMP objectives (GBCMA 2011a)		Recommended change
BS1	Maintain the diversity of native wetland flora species to be consistent with Cane grass Wetland EVC benchmark.	Change language to Maintain or Improve as per Basin Plan Schedule 7 advice. Change date to 2030.
BS2	Reduce the cover and diversity of exotic and/ or highly invasive native flora species.	Change language to 'Reduced diversity and cover of target invasive aquatic plant species by 2030'.
BS3	Maintain populations of Rigid Water-milfoil and Slender Water-milfoil.	Change language to 'Maintain Rigid Water-milfoil *(Myriophyllum porcatum)* and Slender water milfoil (*Myriophyllum gracile var. lineare)* at Moodie Swamp at 2008 benchmark levels'.
BS4	Provide opportunities for Brolga breeding	Change language to 'Maintain and provide opportunities for Brolga breeding'.

5.2.2
UPDATED OBJECTIVES AND TARGETS

The update of this EWMP maintains the intent of the original Moodie Swamp (2012) objectives but improves the specificity and measurability of the objectives and targets and improves alignment to the Basin Plan Environmental Watering Plan.

Figure 15 shows the alignment of the updated Moodie Swamp EWMP objectives to the three overarching environmental objectives of the Basin Plan chapter 8 hierarchy and then to the relevant sections within this chapter (S8.05, 8.06 and 8.07). Table 19 presents the updated objectives and their targets.

Figure 15: Chapter 8 Basin Plan Objectives, sections, and their relationships to the updated objectives for Moodie Swamp

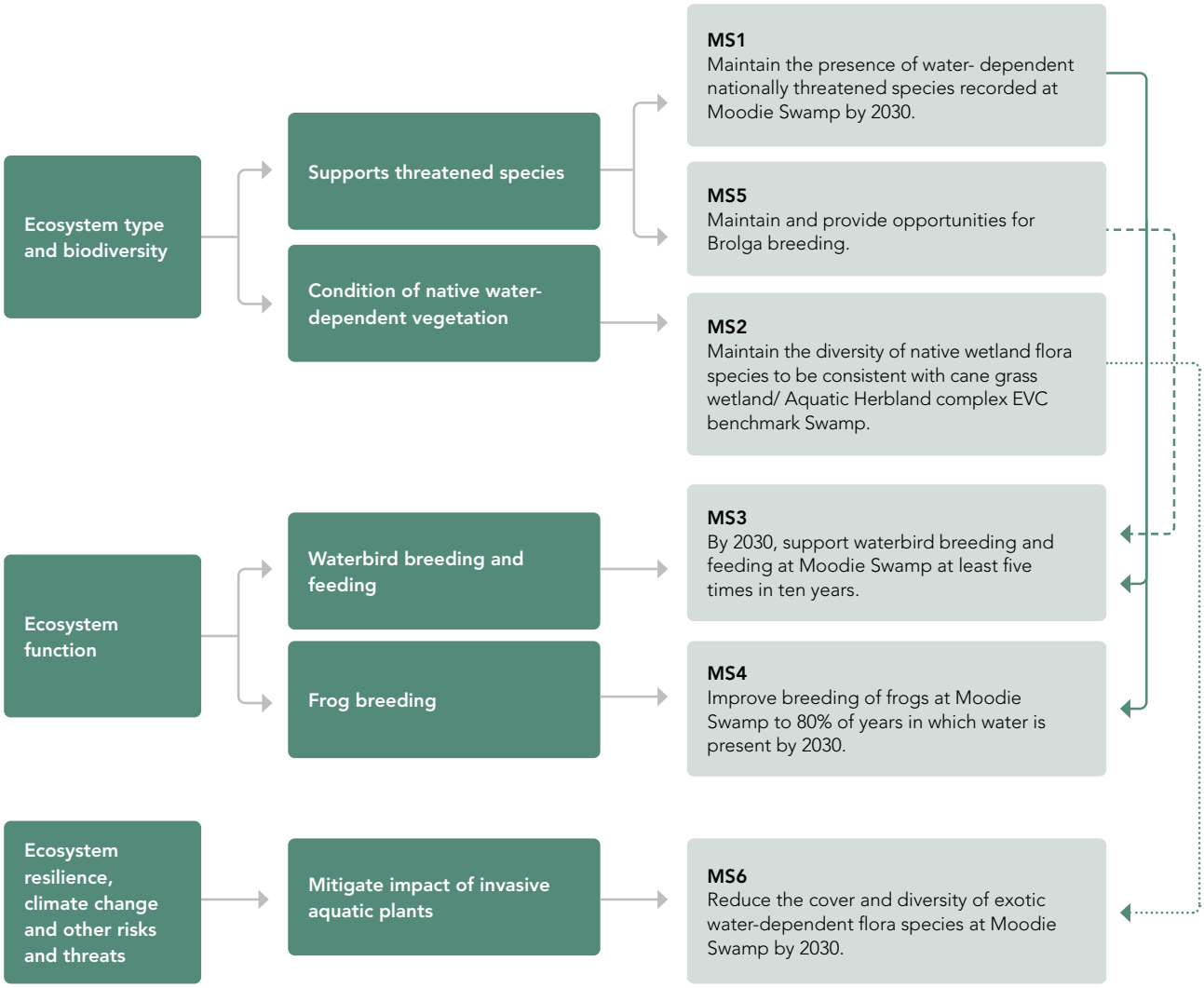
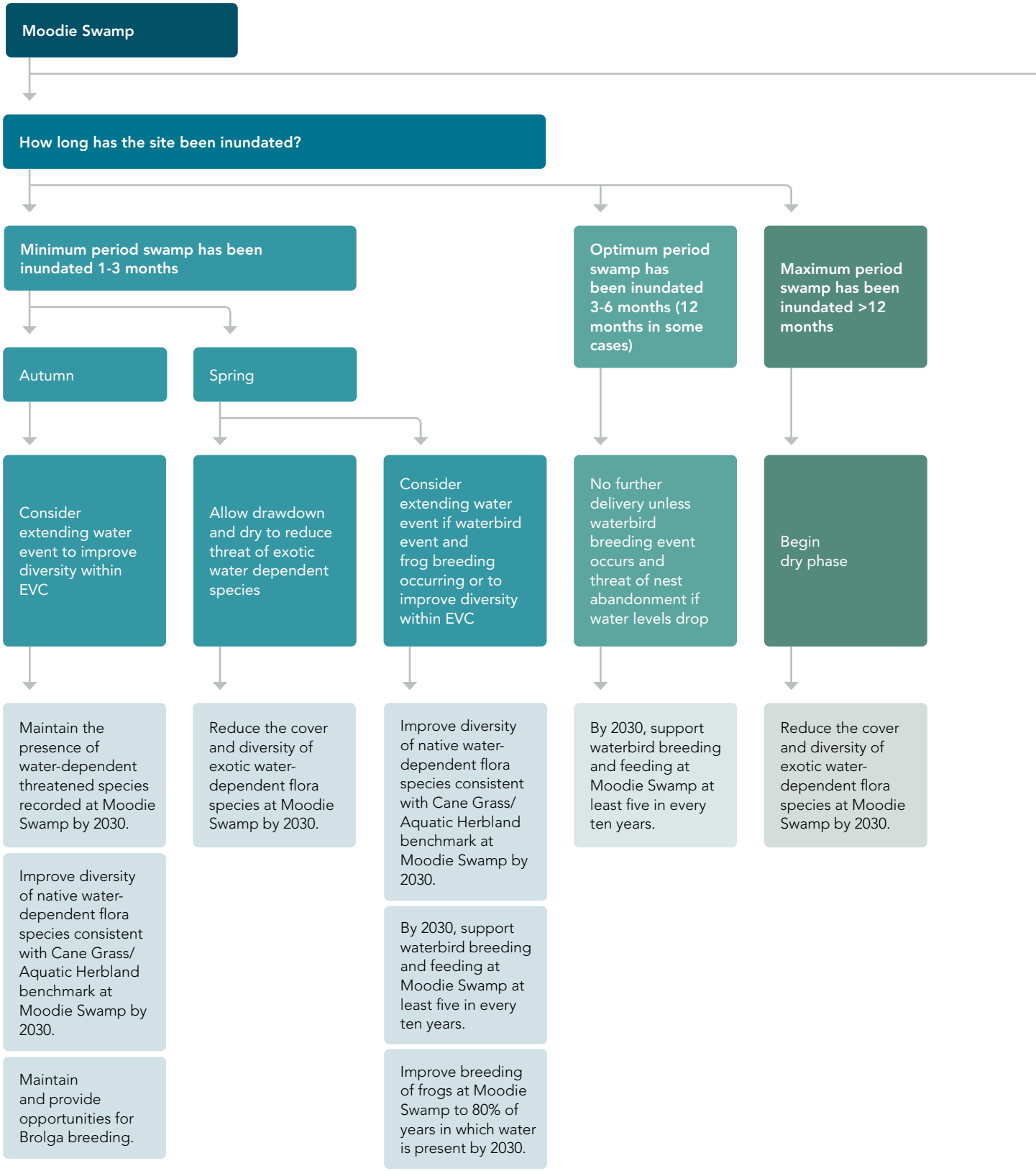


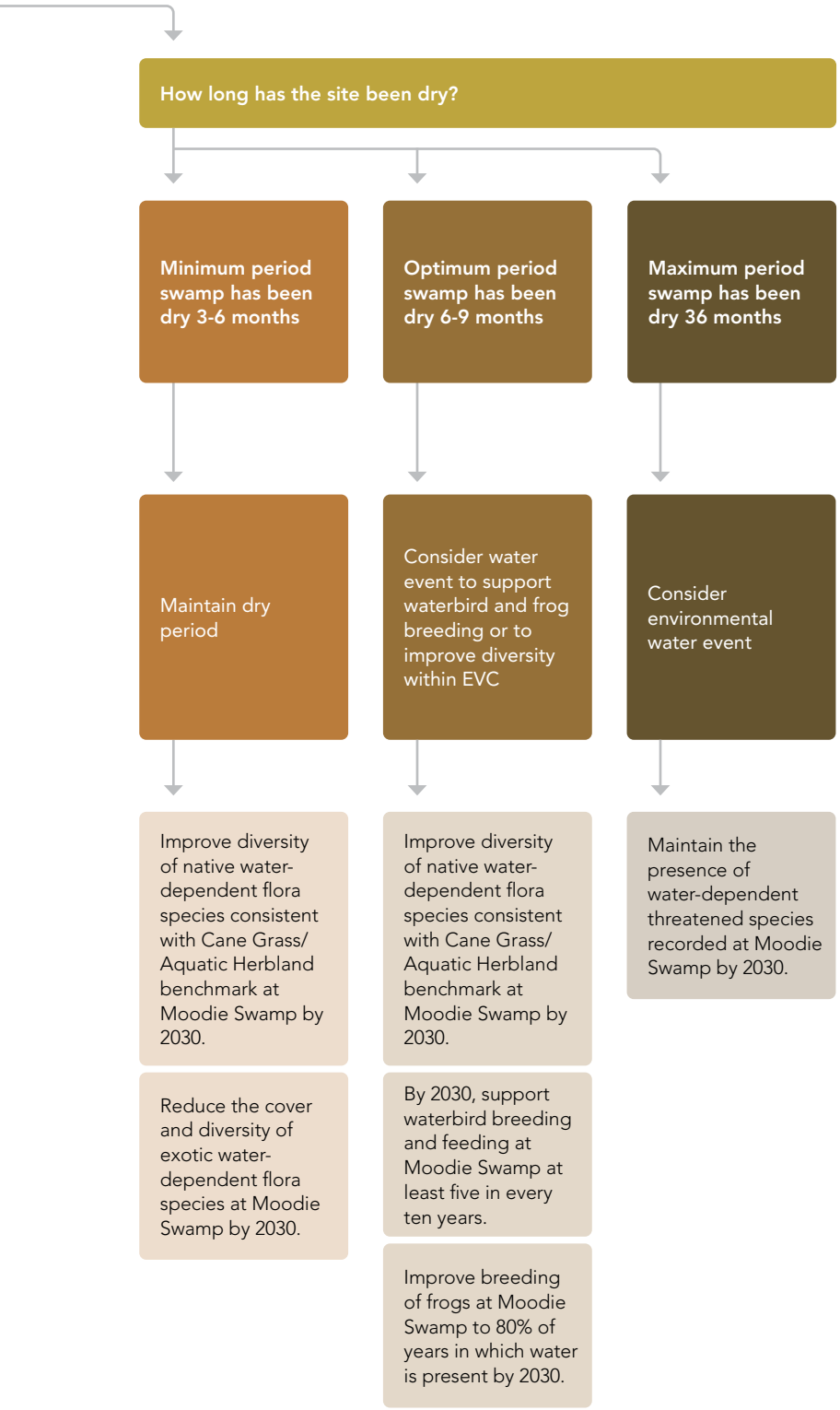
Table 19: Updated objectives and targets for Black Swamp EWMP

NO.	Objective	Target
MS1	Maintain the presence of water-dependent threatened species recorded at Moodie Swamp by 2030.	Protect and restore biodiversity which is water-dependent, including supporting life cycles of threatened species at Moodie Swamp by 2030: 1. Maintain presence of Brolga *(Antigone rubicunda)* in 70% of targeted surveys undertaken. 2. Maintain presence of Sloane's froglet *(Crinia sloanei)* in 70% of targeted surveys undertaken. 3. Maintain presence of listed plant species including Rigid Water-milfoil *(Myriophyllum porcatum)* in 70% of surveys undertaken. Maintain the presence of four Flora and Fauna Guarantee Act 1988 (Vic) listed waterbirds in three out of five targeted surveys including: 1. Australasian bittern *(Botaurus poiciloptilus)* 2. Eastern great egret *(Ardea alba modesta)* 3. Plumed egret *(Ardea intermedia plumifera)* 4. White bellied sea eagle *(Haliaeetus leucogaster)*.
MS2	Improve diversity of native water-dependent flora species consistent with Aquatic herbland/ Cane-grass complex EVC 602 at Moodie Swamp by 2030.	Improve the condition of water-dependent native vegetation (EVC 602) at Moodie Swamp by 2030: 1. Cane grass one species of at least 5% cover (modified if less than benchmark cover towards outer margins). 2. Aquatic herbs three species of at least 15% cover. 3. Medium (to small) graminoids three species of at least 5% cover. 4. Small (to medium) herbs five species of at least 10% cover (often semi-aquatic, towards verge zone).
MS3	By 2030, support waterbird breeding at Moodie Swamp at least five times in every ten years.	Protect and restore ecosystem functions of water-dependent ecosystems that support successful non-colonial nesting of waterbird species at Moodie Swamp providing conditions for breeding and fledging at least five times every ten years: 1. As a minimum at least seven species recorded breeding at Moodie Swamp over any ten-year assessment period: 2. Australian wood duck *(Chenonetta jubata)* 3. Black swan *(Cygnus atratus)* 4. Grey teal *(Anas gracilis)* 5. Pacific black duck *(Anas superciliosa)* 6. Purple swamphen *(Porphyrio porphyrio)*. Protect and restore ecosystem functions at Moodie Swamp that support the creation of vital habitat for waterbird feeding habitat guilds on a regular basis. Target waterbird feeding habitat guilds are densely vegetated habitat and shallow water <0.5m habitat (Jaensch 2002).
MS4	Improve breeding of frogs to 80% of years in which water is present at Moodie Swamp by 2030.	Maintain breeding of frogs at Moodie Swamp in 80% of years in which water is present, including: 1. Sloane's froglet *(Crinia sloanei)* 2. Common spadefoot toad *(Neobatracus sudelli)* 3. Common froglet *(Crinia signifera)* 4. Peron's tree frog *(Litoria peronii)* 5. Plains froglet *(Crinia parinsignifera)* 6. Pobblebonk *(Limnodynastes dumerilii)* 7. Spotted marsh frog *(Limnodynastes tasmaniensis)*.
MS5	Maintain and provide opportunities for Brolga breeding.	Protect and restore ecosystem functions at Moodie Swamp that support successful breeding and fledging of Brolga *(Antigone rubicunda)* when conditions are suitable.
MS6	Reduce the cover of exotic water-dependent flora species at Moodie Swamp by 2030.	Reduced cover of target invasive aquatic plant species, especially aster-weed *(Symphyotrichum subulatus)* and water couch *(Paspalum distichum)*, by 30% at Moodie Swamp by 2030 compared to benchmark 2008-2011.

Decision making on watering events at the site are shown below (Figure 16). Note this is only a guide as climate scenarios will also influence decision making at the site.

Figure 16: Moodie Swamp watering decision chart




How long has the site been dry?
Minimum period swamp has been dry 3-6 months
Optimum period swamp has been dry 6-9 months
Maximum period swamp has been dry 36 months
Maintain dry period
Consider water event to support waterbird and frog breeding or to improve diversity within EVC
Consider environmental water event
Improve diversity of native water-dependent flora species consistent with Cane Grass/ Aquatic Herbland benchmark at Moodie Swamp by 2030.
Reduce the cover and diversity of exotic water-dependent flora species at Moodie Swamp by 2030.
Improve diversity of native water-dependent flora species consistent with Cane Grass/ Aquatic Herbland benchmark at Moodie Swamp by 2030.
By 2030, support waterbird breeding and feeding at Moodie Swamp at least five in every ten years.
Improve breeding of frogs at Moodie Swamp to 80% of years in which water is present by 2030.
Maintain the presence of water-dependent threatened species recorded at Moodie Swamp by 2030.

5.3
Cultural objectives

Yorta Yorta cultural objectives were developed with Yorta Yorta Nation Aboriginal Corporation. These were aligned with watering objectives to ensure both Yorta Yorta cultural and environmental needs are met (Table 20).

Cultural assessments lead by Yorta Yorta could strengthen these objectives and possibly assist with healing country.

RECOMMENDATIONS

Observation of Yorta Yorta knowledge gaps at Moodie Swamp and working together for better preservation and protection of their knowledge.

Genuinely engage with Yorta Yorta Nation Aboriginal Corporation and undertake the appropriate cultural assessments led by Yorta Yorta Nation Aboriginal Corporation with respectful protocols.

Table 20: Alignment of environmental and cultural objectives at Moodie Swamp

2021 Objectives	Aligned Cultural Objective
Maintain the diversity of native wetland flora species to be consistent with cane grass wetland/ Aquatic Herbland complex EVC benchmark.	Improve diversity of native wetland dependent flora species consistent with cane grass wetland/ Aquatic Herbland complex EVC benchmark. Partially filling Moodie Swamp to maintain and promote growth of diverse plant communities which include traditional plant species important to the Yorta Yorta People.
By 2030, support waterbird breeding and feeding at Moodie Swamp at least five in every ten years.	Protect and restore ecosystem functions of water-dependent ecosystems that support successful non-colonial nesting of waterbird species at Moodie Swamp providing a variety of cultural values i.e., food and clothing.
Reduce the cover and diversity of exotic water-dependent flora species at Moodie Swamp by 2030.	Reduced diversity and cover of target invasive aquatic plant species, by undertaking cultural burning before and /or after environmental watering to assist with the reduction of weed cover within the swamp.

6. Environmental water requirements

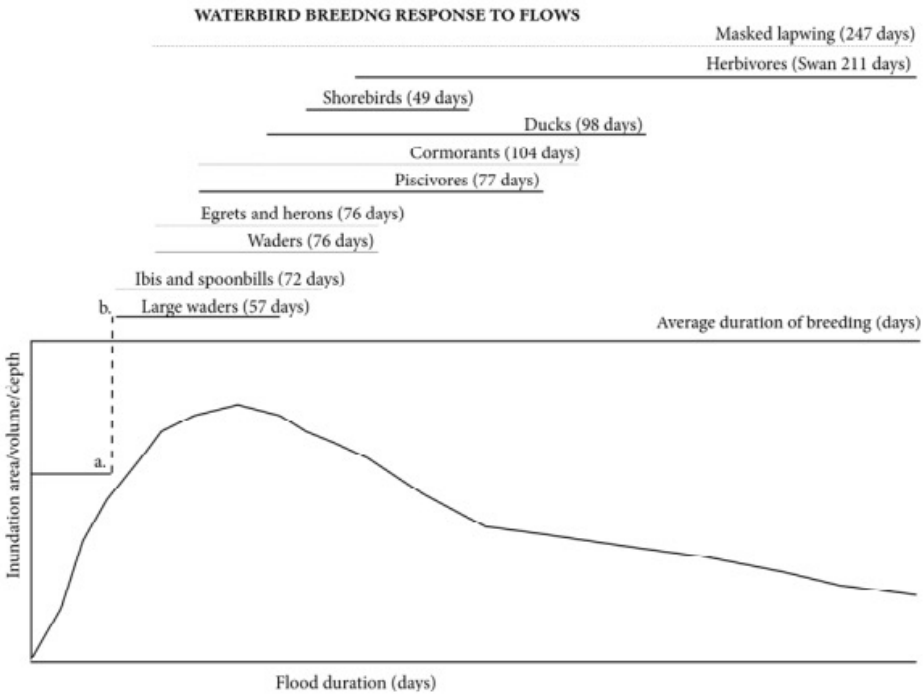
6.1 Watering requirements

The recommended frequency of watering events has changed from the 2012 Plan. The 2012 Plan recommended Moodie Swamp is watered five to seven years in ten. An updated recommendation of three to seven years in ten, aligns with the water regime adopted in the Victorian Wetland Classification Framework (Section 3.1.1, Table 21).

In the long term, reinstating a more natural hydrological regime will encourage and maintain EVCs and reduce the abundance and distribution of aquatic weeds and encourage the growth of aquatic native species.

Priming the swamp for bird breeding events in autumn with a possible top-up in spring may encourage birds to feed at the site during the autumn to assist with the "build-up of body condition" before breeding. Duration of the water in the swamp is critical for breeding success in waterbirds (Brandis and Bino 2016) (Figure 17). A spring top-up may be required if water volume in the swamp begins to decline. For many waterbirds, if their nests are not surrounded by water and the volume of water begins to decline, breeding may be initiated but reproductive success can be compromised.

Figure 177: Waterbird breeding response to flows



a. Colonial waterbird breeding threshold; point at which flow volumes are sufficient for colonail waterbirds to begin breeding.
b. Beginning of breeding by Large waders including colonially breeding species. Delayed breeding initiation and average duration of breeding for functional groups.

Extracted from Brandis, K and Bino, G, 2016.

Table 21: Hydrological requirements to meet environmental objectives for Moodie Swamp

Objectives	Water management area	Hydrological Objectives											
		Recommended number of events in 10 years			Tolerable interval between events once wetland is dry (months)			Duration of ponding (months)			Preferred timing of inflows	Volume to fill to target supply level (ML)	Depth (mm)
		Min	Opt	Max	Min	Opt	Max	Min	Opt	Max			
Maintain the presence of water-dependent threatened species recorded at Moodie Swamp by 2030.	Wetland body, floodway and fringe	2-3	3-7	10	12	12[1]-36	36-54	1-3	3-6 (up to 12)	>12	Late autumn to early spring	1,000	Variable to 1,000mm
Maintain the diversity of native wetland flora species to be consistent with cane grass wetland/ Aquatic Herbland complex EVC benchmark.	Wetland body and fringe	2	3-7	8-10	3	6	54	2	6-8	18	Late autumn to early spring	1,000	Variable to 1,000mm
By 2030, support waterbird breeding and feeding at Moodie Swamp at least five in every ten years.	Wetland body	5	7	10	6	9	12	6	8	>12	Prime swamp in autumn with possible top-up in early Spring[2]	1,000-1,500	Variable to 1,000mm[3]
Improve breeding of frogs at Moodie Swamp to 80% of years in which water is present by 2030.	Wetland body and fringe	3	5	10	6	9	12	3	6	12	Late autumn and/or early spring	1,000	Variable to 500-1,000mm
Maintain and provide opportunities for Brolga breeding.	Wetland body	3	7	10	6	9	12	1-3	3-6	>12	Prime swamp in autumn with possible top up in spring	1,000-1,500	Variable to 1,000mm
Reduce the cover and diversity of exotic water-dependent flora species at Moodie Swamp by 2030.	Wetland body and fringe	2	3-7	10	12	36	54	3	6	>12	Late autumn and/or early spring	1,000	Variable to 1,000mm

1. *Myriophyllum porcatum* may need dry period of at least 12 months (Committee 2012).
2. (Young 2003, Rogers and Ralph 2011).
3. Water depth should be kept constant if waterbirds are nesting/ breeding to avoid nests being abandoned (Young 2003).

6.2
Expected watering effects

The expected watering effects at a site relate to the physical, chemical, biological or behavioural responses to a watering regime and clarify the outcomes expected with environmental watering actions.

Table 22 provides detail on the expected watering effects that may take place at Moodie Swamp during an environmental water delivery.

Table 22: Expected watering effects at Moodie Swamp during an environmental water delivery

Environmental objectives	Potential watering action	Expected watering effect
Increase the extent and condition of EVCs	Fill Moodie Swamp in autumn or spring three to seven years in ten, to a maximum depth of 1m in the deepest parts, for six to eight months.	Aquatic plants inundated stimulating growth.
Increase opportunities for waterbird breeding	Fill Moodie Swamp in autumn or spring, five to seven years in ten, to a maximum depth of one metre in the deepest parts, for at least six to eight months.	Maintained water levels to trigger bird breeding event.
Increase opportunities for frog populations	Fill Moodie Swamp in autumn or spring, three to seven years in ten, to a maximum depth of 1m in the deepest parts, for three to six months.	Frog populations triggered to reproduce and spawn.

6.3
Seasonally adaptive approach

A seasonally adaptive approach identifies the priorities for environmental watering under different climatic conditions. This means that watering events can be tailored to current conditions and be easily adapted in response to short-term climatic variability, as conditions change throughout the year.

The demand and utilisation of environmental water will vary according to climatic conditions. In drier periods reduced natural inflows and restricted water resources may mean that less environmental water is available and hence strategic planning of sites that provide refuge or require protection to avoid critical loss.

However, in wetter periods the ecological and hydrological objectives of a wetland may be largely met by natural inflows and only small volumes of environmental water may be required.

Scenarios are based on receiving catchment inflows with a Probability of Exceedance (PoE) and the likely availability of environmental water, based on data from Goulburn-Murray Water. The scenarios are extreme dry/drought (99% PoE), dry (90% PoE), average (50% PoE) and wet (10% PoE). These scenarios were chosen as they may result in different natural inflows to the wetlands and the volume of environmental water required. Table 23 rationalises the volumes required for delivery at Moodie Swamp under these scenarios.

Table 23: Scenario planning for environmental water delivery to Moodie Swamp

Scenario 1 Extreme Dry	Scenario 2 Dry	Scenario 3 Average	Scenario 4 Wet
99% PoE **No natural inflow to wetlands**	**90% PoE** **Little to no natural inflow to wetlands, rainfall**	**50% PoE** **Average natural inflow to wetland**	**10% PoE** **Above average inflow to wetland**
500ML Provide drought refuge for fauna species and avoid critical loss of threatened species such as Rigid Water-milfoil.	**1,000ML** Provide refuge for fauna species and avoid critical loss of threatened species such as Rigid Water-milfoil.	**1,000ML** Maintain water levels or fill swamp if primed due to natural inflows. Provide conditions for bird breeding and improve or maintain EVCs.	**500-1,000ML** Maintain water levels if swamp holding water. Provide optimal conditions for bird breeding events and improve or maintain EVCs.

7. Environmental water delivery infrastructure

7.1 Water delivery infrastructure

Environmental water can be delivered to Moodie Swamp via Geary's channel that is connected to Broken Creek. A regulator on the channel is operated by Goulburn-Murray Water during times of environmental water delivery.

7.2 Complementary works

Broken Creek is the conduit to deliver environmental water to Moodie Swamp. Works over the past ten years on the creek to improve flows include spraying of aquatic vegetation and weeds by Goulburn-Murray Water 10-12km from the Upper Broken Creek offtake to Sharps Road as this was identified as the area where most irrigation water is used. Downstream of Sharps Road has not been identified as a threat to irrigation delivery.

An upgrade of Geary's channel will occur in early 2024. Due to flooding in 2022 the project to upgrade the channel was delayed. The upgrade of the channel will increase flows from 5-10ML/day to up to 20ML/d if flow capacity can be maintained at Waggarandall weir. This will allow environmental water to be delivered to the swamp more effectively and with minimal transition loss.

RECOMMENDATION

Model flows within the swamp upon completion of infrastructure upgrades.

7.3
Constraints

A notice period of one to two days minimum, preferably four days, is required for environmental water orders from Broken system storages. If constraints in making environmental water available are foreseen by Goulburn-Murray Water, the Environmental Water Manager will be advised accordingly. The physical delivery of environmental water to Moodie Swamp during the irrigation season depends on system demands. Currently environmental water can only be delivered to Moodie Swamp during August 15th and May 15th of each year, which may restrict environmental water deliveries that may be used to build upon a natural wetting event at the site.

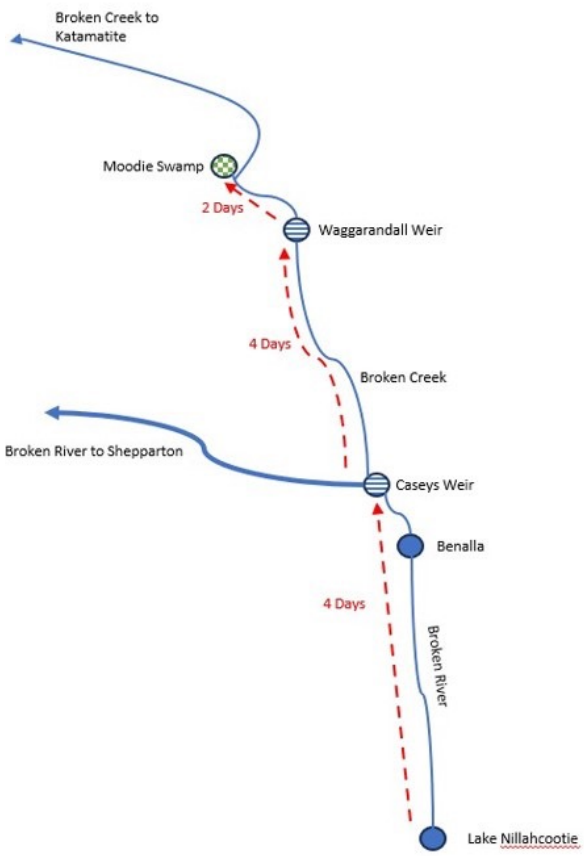
Figure 18 shows the usual delivery time to deliver environmental water to Moodie Swamp. This takes approximately ten days from the time the water is released from Lake Nillahcootie (four days from Nillahcootie to Caseys Weir, four days from Caseys Weir to Waggarandall Weir and two days from Waggarandall Weir to Moodie Swamp).

Delivery can be constrained by:

- **Water availability –** Environmental water allocations may not be available at the time of delivery.
- **Timing of flows –** water may not be able to be delivered at the appropriate time for ecological benefit.
- **Irrigation demands –** Moodie Swamp does not have a delivery share; therefore, environmental water can only be delivered when there is spare capacity to carry the water in the Broken Creek.

Mitigation actions for the constraints can be found in Table 24.

Figure 18: Delivery of environmental water from Lake Nillahcootie to Moodie Swamp



RECOMMENDATION

Continue to work with Goulburn-Murray Water to increase opportunities for delivery of environmental water outside the irrigation season.

Table 24: Mitigating actions to reduce the risk of constraints at Moodie Swamp

Delivery Constraint	Mitigation Action
Timing of flows.	Goulburn Broken CMA to discuss appropriate timing of watering with GMW to meet both irrigation demands and environmental water delivery requirements.
Moodie Swamp does not have a delivery share, thus environmental water con only be delivered when there is spare capacity to carry the water in Broken Creek.	Goulburn Broken CMA to discuss appropriate timing of watering with GMW to ensure channel capacity is available for the required amount of delivery time to the site.

8. Demonstrating outcomes

WetMAP - Victoria's Wetland Monitoring and Assessment Program for environmental water is a state-wide monitoring program designed to assess the ecological response of vegetation, waterbirds, and fish to the delivery of environmental water in Victorian wetlands (DELWP 2021). The WetMAP program objectives are:

- Build on current knowledge and conceptual models to improve the understanding of the relationships between environmental flows and ecological response/ outcomes.
- Determine whether the current ecological objectives for environmental watering are being met.
- Inform environmental flow management for CMAs – inform the development of objectives and planning for environmental water delivery.
- Communicate the ecological outcomes of environmental water delivery in Victorian wetlands to the Minister, water industry stakeholders and broader community.
- Contribute to Victoria's Murray Darling Basin Plan reporting requirements.

WetMAP monitoring began at Moodie Swamp in late 2017. This monitoring will complement the monitoring being undertaken by the Goulburn Broken CMA staff.

Compliance monitoring is also undertaken during the delivery of environmental water. This includes monitoring regulator operation and the volume of water delivered. This has been complimented by regular field observations by staff and acoustic monitoring to help determine the presence and number of waterbirds and frogs, and wetland condition.

The information collected has been highly valuable in informing the ongoing management of this wetland, and State Government and Victorian Environmental Water Holder reporting.

In the event Moodie Swamp naturally fills, waterbird monitoring, water depth and extent will be monitored on a regular basis to determine when and if environmental water is required. If environmental water is delivered to the site these attributes will continue to be monitored along with the volume of water delivered. Attention will be paid to water levels to ensure nests are not exposed by water losses and nests close to the water surface are not inundated by environmental water deliveries. Monitoring of ecological attributes such as vegetation will be dependent upon available funding and staff resources.

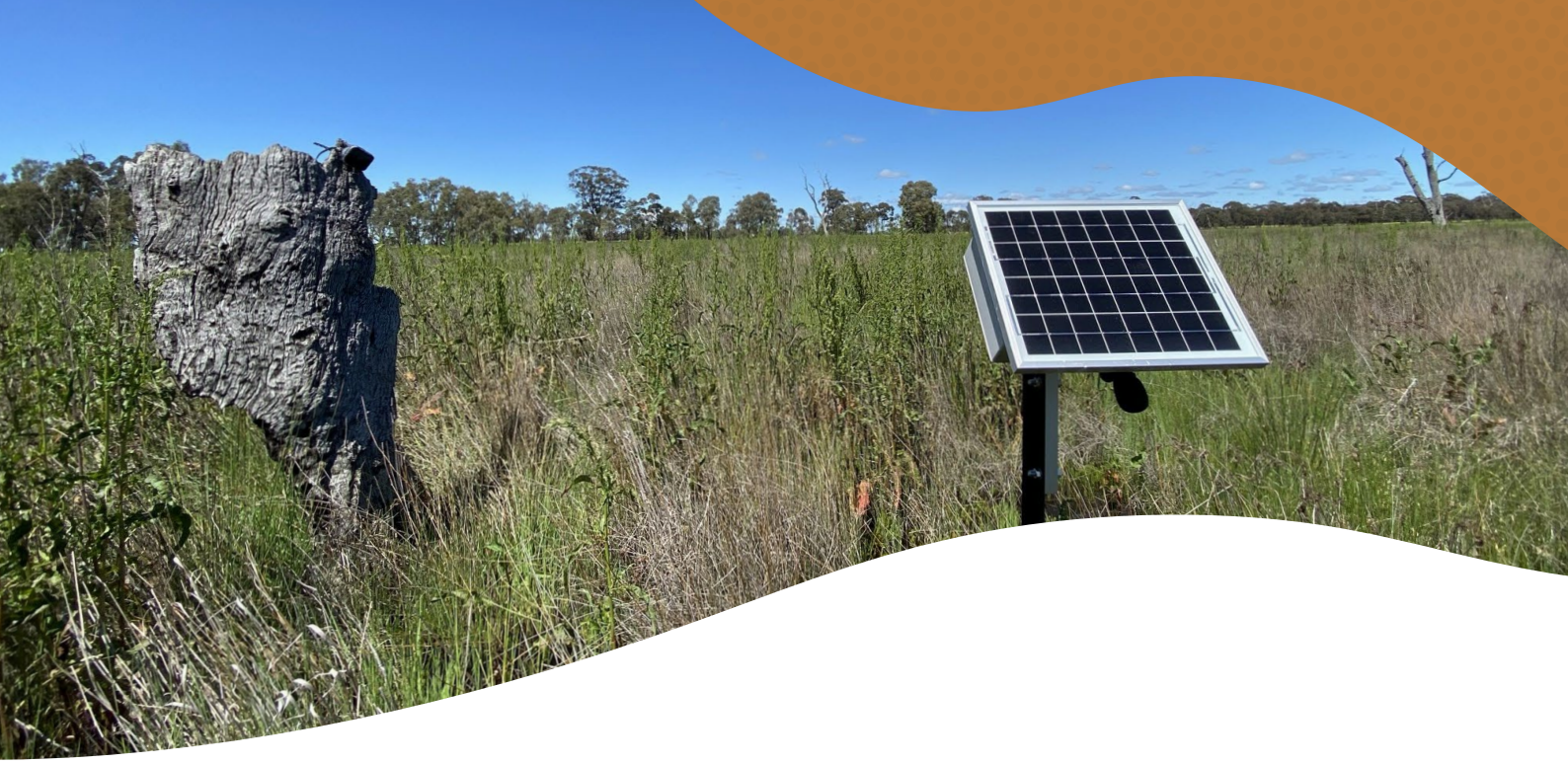
Monitoring by Yorta Yorta Nation Aboriginal Corporation should also be considered at this site. Monitoring the effect of environmental water on the aligned cultural objectives should be undertaken where possible.

9. Knowledge gaps and recommendations

There are currently several knowledge gaps in relation to environmental water management at Moodie Swamp. While most of these do not impact the ability to provide water to the swamp and generate ecological benefit, addressing these would significantly improve the accuracy of environmental water planning and management of the site (Table 25).

Table 25: Expected watering effects at Moodie Swamp during an environmental water delivery

Section	Recommendation	Who	Priority
2.5 Hydrological regime and system operations	Investigate groundwater impact, if any, upon Moodie Swamp – pre-European and current.	Goulburn Broken CMA with support from Goulburn-Murray Water	Medium
3.1.2.1 Fauna	Undertake sampling of fauna such as reptiles, invertebrates and fish to better understand the food web at Moodie Swamp.	Goulburn Broken CMA, WetMAP and consultants	Medium
3.1.2.3 Flora – Bioregions and Ecological vegetation classes	Replant to reintroduce wetland dependent species that may be required to assist with meeting EVC benchmarks.	Goulburn Broken CMA and consultants	Medium
3.1.2.5 Flora threatened status	Monitoring the EPBC Act Rigid Water-milfoil and the FFG Act Slender Water-milfoil response to wetting and drying to assist with management of these species.	Goulburn Broken CMA, WetMAP and consultants	High
3.3 Shared benefits	Work with Parks Victoria to install/ improve signage for community understanding of environmental water and Yorta Yorta history at Moodie Swamp and their shared benefits to the swamp.	Goulburn Broken CMA with support from Parks Victoria and Yorta Yorta	Medium
4.0 Current condition	Conduct an IWC assessment of Moodie Swamp every 3-5 years to monitor changes in condition and inform management decisions.	Goulburn Broken CMA	High



Section	Recommendation	Who	Priority
4.2 Managing risks and threats	Monitor and manage exotic flora species when conditions are deemed favourable for their prolific growth.	Goulburn Broken CMA and WetMAP	High
	Monitor and eradicate pest animals where possible.	Goulburn Broken CMA and consultants	Medium to high
	Protect turtle nests from predation by foxes where possible	Goulburn Broken CMA, Turtles Australia, local citizens	High
5.2.3 Cultural objectives	Observation of Yorta Yorta knowledge gaps at Moodie Swamp and working together for better preservation and protection of their knowledge.	Goulburn Broken CMA to support Yorta Yorta	High
	Genuinely engage with Yorta Yorta Nation Aboriginal Corporation and undertake the appropriate cultural assessments led by Yorta Yorta Nation Aboriginal Corporation with respectful protocols.	Goulburn Broken CMA to support Yorta Yorta	High
7.2 Complementary works	Model flows within the swamp upon completion of infrastructure upgrades.	Consultants	Medium
7.3 Constraints	Continue to work with Goulburn-Murray Water to increase opportunities for delivery of environmental water outside the irrigation season.	Goulburn Broken CMA and the Victorian Environmental Water Holder with support from Goulburn-Murray Water	Medium

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11. Appendices

Appendix 1: Flora of Moodie Swamp

Common Name	Scientific Name	EPBC	FFG	Indigenous use
Gold-dust Wattle	*Acacia acinacea s.l.*			Food source – mature seed ground for flour.
Rough Wattle	*Acacia aspera*			
Lightwood	*Acacia implexa*			Lotion made from bark was used to treat skin disorders, seeds were eaten and wood for craft.
Mallee Wattle	*Acacia montana*			Medicine and food source.
Golden Wattle	*Acacia pycnantha*			Roasted seeds and gum were eaten, bark used for medicine as a mild sedative for rheumatism. Wood used for tools.
Buloke	*Allocasurina luehmannii*		CE	Wood used for tools. Young shoots and female cones were eaten.
Lesser Joyweed	*Alternanthera denticulata s.s*			Seeds may have been ground into flour.
Common Swamp Wallaby-grass	*Amphibromus nervosus*			
Brush Wire-grass	*Aristida behriana*			
Nodding Chocolate-lily	*Arthropodium fimbriatum*			Edible tubers.
Small Vanilla-lily	*Arthropodium minus*			
Lily	*Arthropodium sp.2 (twin flowered)*			Edible tubers.
Chocolate Lily	*Arthropodium strictum s.l.*			
Spurred Spear-grass	*Austrostipa gibbosa*			Edible tubers.
Rough Spear-grass	*Austrostipa scabra*			
Pacific Azolla	*Azolla filiculoides*			
Tah-vine	*Boerhavia dominii*			Tap root cooked and eaten.
Red-leg Grass	*Bothriochloa macra*			
Water Starwort	*Callitriche hamulata*			
Matted Water-starwort	*Callitriche sonderi*			
Water Starwort	*Callitriche sp (germinant)*			
Winged Water-starwort	*Callitriche umbonata*		En	
White Cypress-pine	*Callitris columellaris*			Resin used as glue, leaves and twigs boiled and placed on chests for colds, salve for rashes and burnt as a smoking medicine for general illness.
Burr-daisy	*Calotis cuneifolia*		En	
Riverina Bitter-cress	*Cardamine moirensis*		En	Leaves are eaten and used for gut health.
Common Sedge/ Knob Sedge	*Carex inversa*			
Hollow Sedge	*Carex tereticaulis*			Perennial rush-like tussocky plants to 1 m tall. Stems of this sedge contain very strong longitudinal fibres and can be split lengthwise into fine strips and used for traditional weaving.
Drooping Cassinia	*Cassinia arcuata*			
Common Sneezeweed	*Centipeda cunninghamii*			Known as Old Man Weed. Medicinal powers highly regarded. Used to treat colds, infected eyes and throats, skin infections and as a contraceptive and is consumed for internal health. Prepared tonic used to cure colds, chest complaints, tuberculosis and as a general tonic. Also used externally for eye and skin complaints.

Common Name	Scientific Name	EPBC	FFG	Indigenous use
Chara	*Characeae spp.*			
Small-leaf Goosefoot	*Chenopodium desertorum ssp. microphylum*			Seeds ground as flour.
Clammy goosefoot	*Chenopodium pumilio*			Seeds ground as flour.
Windmill Grass	*Chloris truncata*			
Pink Bindweed	*Convolvulus erubescens*			A tough starchy root that is cooked and kneaded into a dough, leaves steamed as food. Also used medicinally
Swamp Billy buttons	*Craspedia paludicola*			Bulbous roots can be eaten.
Spreading Crassula	*Crassula decumbens var. decumbens*			
Australian Stonecrop	*Crassula sieberi ssp. tetramera*			
Sieber Crassula	*Crassula sieberiana s.s.*			
Slender Water-ribbons	*Cycnogeton dubia*		En	Small tuberous roots eaten.
Spiny Flat-sedge	*Cyperus gymnocaulos*			Strong stems used to make fine baskets, mats and string. Stems soaked in water for sore throats.
Star Fruit	*Damasonium minus*			
Moodie-anther Flax-lily	*Dianella revoluta s.l.*			Leaves split and twisted together to make a strong tie.
Riverine Flax-lily	*Dianella longifolia var. grandis*		CE	Berries edible when ripe.
Tangled Lignum	*Duma florulenta*			Seeds ground to flour and stems used to make light spears.
Clammy Goosefoot	*Dysphania pumilio*			
Nodding Saltbush	*Einadia nutans subsp. nutans*			Sweet edible fruit. Leaves edible after boiling
Waterwort	*Elatine gratioloides*			
Common Spike-sedge	*Eleocharis acuta*			Tubers can be eaten raw, baked or ground into flour.
Dark Nineawn-heads	*Enneapogon nigricans*			
Spider Grass	*Enteropogon acicularis*			
Grey Willow-herb	*Epilobium billardierianum var. cinereum*			
Hairy Willow-herb	*Epilobium hirigerum*			
Common Love-grass	*Eragrostis brownii*			
Close-headed Love-grass	*Eragrostis elongata*			
Southern Cane-grass	*Eragrostis infecunda*			
Weeping Love-grass	*Eragrostis parviflora*			
River Red-gum	*Eucalyptus camaldulensis*			Smaller scars indicate bark dishes (coolamons). Water containers made from large, gnarled burls.
Yellow Box	*Eucalyptus melliodora*			Bark used for canoes, shields, mia mia's and coolamons.
Grey Box	*Eucalyptus microcarpa*			Wood used for tool making. Food source and shelter
Annual Cudweed	*Euchiton sphaericus*			
Common Eutaxia	*Eutaxia microphylla var. diffusa*			
Variable Cranesbill	*Geranium sp2*			Roots used for food and medicine.
Hairy Carpet-weed	*Glinus lotoides*			
Slender Carpet-weed	*Glinus oppositifolius*			
Twining Glycine	*Glycine clandestine var. sericea*			Edible taproot.
Cut-leaf Goodenia	*Goodenia pinnatifida*			
Dwarf Brooklime	*Gratiola pumilo*		En	Used as medicine for liver complaints.

Common Name	Scientific Name	EPBC	FFG	Indigenous use
Rough Raspwort	*Haloragis aspera*			
Bluish Raspwort	*Haloragis glauca*			
Jersey Cudweed	*Helichrysum luteoalbum*			Drink made up for general sickness.
Quillwort	*Isoetes muelleri*			
Inland Club-sedge	*Isolepis australiensis*			May have been used for weaving and basketry.
Nodding Club-sedge	*Isolepis cernua var. platycarpa*			
Grassy Club-sedge	*Isolepis hookeriana*			
Toad Rush	*Juncus bufonius*			
Gold Rush	*Juncus flavidus*			
Joint-leaf Rush	*Juncus holoschoenus*			
Plains Rush	*Juncus semisolidus*			
Finger Rush	*Juncus subsecundus*			
Common Blown-grass	*Lachnagrostis filiformis var.1*			
Jersey Cudweed	*Laphangium luteoalbum*			
Common Duckweed	*Lemna disperma*			
Austral Water-mat	*Lepilaena australis*			
Austral Mudwort	*Limosella australis*			
Poison Lobelia	*Lobelia pratioides*			
Wattle Mat-rush	*Lomandra filiformis subs. coriacea*			Nectar collected from flowers. Fibre used to make baskets.
Many-flowered Mat-rush	*Lomandra mutliflora*			Leaves used for fibre, twine and net bags.
Small Loosestrife	*Lythrum hyssopifolia*			
Wingless Bluebush	*Maireana enchylaenoides*			
Common Nardoo	*Marsilea drummondii*			Spore cases eaten after being carefully prepared.
Minnie Daisy	*Miniura leptophylla*			
Upright Water-milfoil	*Myriophyllum crispatum*			
Clustered Water-milfoil	*Myriophyllum glomeratum*			
Slender Water-milfoil	*Myriophyllum gracile var. lineare*		En	
Rigid Water-milfoil	*Myriophyllum porcatum*	Vu	CE	
Amphibious Water-milfoil	*Myriophyllum simulans*			
Red Water Milfoil	*Myriophyllum verucosum*			
Stonewort	*Nitella spp.*			
Wavy Marshwort	*Nymphoides crenata*		En	Tubers and roots eaten.
Swamp Lily	*Ottelia ovalifolia subsp. ovalifolia*			Tubers and roots eaten.
Grassland Wood-sorrel	*Oxalis perennans*			Leaves and tap roots eaten.
Australian Millet	*Panicum decompositum var. decompositum*			Seeds eaten raw or ground into flour and cooked.
Creeping Knotweed	*Persicaria prostrata*			
Austral Pillwort	*Pilularia novaehollandiae*			
Curved Rice-flower	*Pimelea curviflora s.s.*			
Grey Tussock-grass	*Poa sieberiana var. sieberiana*			
Red Pondweed	*Potamogeton cheesemanii*			

Common Name	Scientific Name	EPBC	FFG	Indigenous use
Jersey Cudweed	*Pseudognaphalium luteoalbum*			
Pussy Tails	*Ptilotus spathulatus*			Tap root eaten.
Drumsticks	*Pycnosorus globosus*			
Ferny Small-flower Buttercup	*Ranunculus pumilio var. pumilio*			
Crystalwort	*Riccia duplex*			
Fringed Heartwort	*Ricciocarpos natans*			
Slender Dock	*Rumex brownii*			
Wiry Dock	*Rumex dumosus*			Rich in vitamin C, used as medicine.
Narrow-leaf Dock	*Rumex tenax*			
Common Wallaby-grass	*Rytidosperma caespitosa*			
Brown-back Wallaby-grass	*Rytidosperma duttoniana*			
Stiped Wallaby-grass	*Rytidosperma racemosa var. racemosa*			
Bristly Wallaby-grass	*Rytidosperma setacea*			
Grey Roly-poly	*Sclerolaena muricata var. villosa*			
Groundsel	*Senecio campylocarpus*		En	
Cotton Fireweed	*Senecio quadridentatus*			
Tall Fireweed	*Senecio runcinifolius*			
Variable Sida	*Sida corrugata*			Medicine and food source.
Sand-spurrey	*Spergularia brevifolia*			
Thin Duckweed	*Spirodela punctata*			
Broughton Pea	*Swainsona procumbens*			
Grey Germander	*Teucrium racemosum s.l.*			
Broad-leaf Cumbungi	*Typha orientalis*			Underground stems (rhizomes) a granular potato tasting starch cooked by steaming in an earth oven. This was then chewed until the starch was gone and the remaining fibre used to make string for waist belts, brow banks, bags and nets.
Annual New Holland Daisy	*Vittadinia cervicularis*			
Woolly New Holland Daisy	*Vittadinia gracilis*			
River Bluebell	*Wahlenbergia fluminalis*			Food source.
Granite Bluebell	*Wahlenbergia graniticola*			
Yellowish Bluebell	*Wahlenbergia luteola*			
Rigid Panic	*Walwhalleya proluta*			Grains ground into flour.

INTRODUCED SPECIES

Common Name	Scientific Name	EPBC	FFG	Indigenous use
Early Black Wattle	*Acacia decurrens*			
Delicate Hair-grass	*Aira elegans*			
Cape Weed	*Arctothecta calendula*			
Bearded Oat	*Avena barbata*			
Lesser Quaking-grass	*Briza minor*			
Great Brome	*Bromus diandrus*			
Soft Brome	*Bromus hordeaceus subsp. hordeaceus*			

Common Name	Scientific Name	EPBC	FFG	Indigenous use
Thread Water-starwort	*Callitriche brutia var. brutia*			
Kikuyu	*Cenchrus clandestinus*			
Slender Centaury	*Centaurium tenuiflorum*			
Common Mouse-ear Chickweed	*Cerastium glomeratum*			
Skeleton Weed	*Chondrilla juncea*			
Spear Thistle	*Cirsium vulgare*			
Flax Fleabane	*Conyza bonariensis*			
Couch	*Cynadon dactylon var. dactylon*			
Drain Flat-sedge	*Cyperus eragrostis*			
Paterson's Curse	*Echium plantagineum*			
Stink Grass	*Eragrositis cilianensis*			
Ox-tongue	*Helminthotheca echioides*			
Barley Grass	*Hordeum vulgare*			
Smooth Cat's-ear	*Hypochoeris glabra*			
Cat's Ear	*Hypochoeris radicata*			
Awned Club-sedge	*Isolepis hystrix*			
Tiny Flat-sedge	*Isolepis tenellus*			
Hairy Toadflax	*Kickxia elatine*			
Willow-leaf Lettuce	*Lactuca saligna*			
Prickly Lettuce	*Lactuca serriola*			
Hairy Hawkbit	*Leontodon taraxacoides subsp. taraxacoides*			
Wimmera Rye-grass	*Lolium rigidum*			
Small-flower Mallow	*Malva parviflora*			
Horehound	*Marribum vulgare*			
Burr Medic	*Medicago polymorpha*			
Water Couch	*Paspalum distichum*			
Paradoxical Canary-grass	*Phalaris paradoxa*			
Toowoomba Canary-grass	*Phalris aquatica*			
Sticky Ground-cherry	*Physalis viscosa*			
Prostate Knotweed	*Polygonum aviculare*			
Celery Buttercup	*Ranunculus sceleratus*			
Onion Grass	*Romulea rosea*			
Curled Dock	*Rumex crispus*			
Black Nightshade	*Solanum nigrum*			
Rough Sow-thistle	*Sonchus asper*			Used as medicine.
Common Sow-thistle	*Sonchus olercea*			Stem eaten like celery.
Aster-weed	*Symphyotrichum subulata*			
Caltrop	*Tribulus terrestris*			
Suckling Clover	*Trifolium dubium*			
Subterranean Clover	*Trifolium subterraneum*			
Squirrel-tail Fescue	*Vulpia bromoides*			
Bathurst Burr	*Xanthium spinosum*			

Appendix 2: Fauna of Moodie Swamp

AMPHIBIANS

Common Name	Scientific Name	IUCN Red List	EPBC	FFG 2022	Bonn	JAMBA	CAMBA	ROKAMBA
Common Froglet	*Crinia signifera*	Least concern						
Peron's Tree Frog	*Litoria peronii*	Least concern						
Plains Brown Tree Frog	*Litoria paraewingi*	Least concern						
Plains Froglet	*Crinia parinsignifera*	Least concern						
Pobblebonk/ Eastern Banjo Frog	*Limnodynastes dumerilii*	Least concern						
Sloane's Froglet	*Crinia sloanei*	Data deficient	En	En				
Spadefoot Toad	*Neobatrachus sudelli*	Least concern						
Spotted Marsh Frog	*Limnodynastes tasmaniensis*	Least concern						

BIRDS

Common Name	Scientific Name	IUCN Red List	EPBC	FFG 2022	Bonn	JAMBA	CAMBA	ROKAMBA
Australasian Bittern	*Botaurus poiciloptilus*	Endangered	En	CE				
Australasian Darter	*Anhinga novaehollandiae*	Least concern						
Australasian Grebe	*Tachybaptus novaehollandiae*	Not assessed						
Australian Pipit	*Anthus australis*	Not assessed						
Australasian Shoveler	*Spatula rhynchotis*	Least concern		Vu				
Australasian Swamphen	*Porphyrio melanotus*	Least concern						
Australian Hobby	*Falco longipennis*	Least concern						
Australian King-Parrot	*Alisterus scapularis*							
Australian Magpie	*Gymnorhina tibicen*	Least concern						
Australian Pelican	*Pelecanus conspicillatus*	Least concern						
Australian Raven	*Corvus coronoides*	Least concern						
Australian Reed Warbler	*Acrocephalus australis*	Least concern						
Australian Shelduck (Mountain Duck)	*Tadorna tadornoides*	Least concern						
Australian Crake	*Porzana fluminea*	Least concern						
Australian White Ibis	*Threskiornis molucca*	Least concern						
Australian Wood Duck (Maned Duck)	*Chenonetta jubata*	Least concern						
Baillons Crake	*Zapornia pusilla*	Least concern						
Black Swan	*Cygnus atratus*	Least concern						
Black-faced Cuckooshrike	*Coracina novaehollandiae*	Least concern						
Black-shouldered Kite	*Elanus axillaris*	Least concern						
Black-tailed Nativehen	*Tribonyx ventralis*	Least concern						
Black-winged Stilt	*Himantopus*	Least concern						
Blue-billed Duck	*himantopus*	Near threatened		Vu				

Common Name	Scientific Name	IUCN Red List	EPBC	FFG 2022	Bonn	JAMBA	CAMBA	ROKAMBA
Blue-faced Honeyeater	*Oxyura australis*	Least concern						
Brolga	*Entomyzon cyanotis*	Least concern		En				
Brown Falcon	*Antigone rubicunda*	Least concern						
Brown Goshawk	*Falco berigora*	Least concern						
Brown-headed Honeyeater	*Accipiter fasciatus*	Least concern						
Brown Quail	*Melithreptus brevirostris*	Least concern						
Brown Songlark	*Synoicus ypsilophorus*	Least concern						
Brown Treecreeper (south-eastern spp)	*Cincloramphus cruralis*	Not assessed	Vu					
Buff-banded Rail	*Climacteris picumnus victoriae*	Least concern						
Buff-rumped Thornbill	*Gallirallus philippensis*	Least concern						
Caspian Tern	*Acanthiza reguloides*	Not assessed		Vu		J	C	
Cattle Egret	*Hydroprogne caspia*	Not assessed				J	C	
Chestnut Teal	*Bulbuicus ibis*	Least concern						
Cockatiel	*Anas castanea*	Least concern						
Collard Sparrowhawk	*Nyphmicus hollandicus*	Least concern						
Crested Pigeon	*Accipiter cirrocephalus*	Least concern						
Crested Shrike-tit	*Ocyphaps lophotes*	Least concern						
Crimson Rosella	*Falcunculus frontatus*	Least concern						
Dollarbird	*Platycercus elegans*	Least concern						
Dusky Moorhen	*Eurystomus orentalis*	Least concern						
Dusky Woodswallow	*Gallinula tenebrosa*	Least concern						
Eastern Barn Owl	*Artamus cyanopterus*	Not assessed						
Eastern Great Egret	*Tyto javanica*	Least concern		Vu				
Eastern Rosella	*Ardea alba modesta*	Least concern						
Eurasian Coot	*Platycercus eximius*	Least concern						
Fairy Martin	*Fulica atra*	Least concern						
Flame Robin	*Petrochelidon ariel*	Least concern						
Galah	*Petroica phoenicea*	Least concern						
Glossy Ibis	*Eolophus roseicapilla*	Least concern			A2S			
Golden Whistler	*Plegadis falcinellus*	Least concern						
Golden-headed Cisticola	*Pachycephala pectoralis*	Least concern						
Great Cormorant	*Cisticola exilis*	Least concern						
Great Crested Grebe	*Phalacrocorax carbo*	Least concern						
Gray Fantail	*Podiceps cristatus*	Least concern						
Gray Shrike-thrush	*Rhipidura albiscarpa*	Least concern						
Gray Teal	*Colluricincla harmonica*	Least concern						
Hardhead	*Anas gracilis*	Least concern						
Hoary-headed Grebe	*Aythya australis*	Least concern						
Horsfield's Bronze-Cuckoo	*Poliocephalus poliocephalus*	Least concern						
Horsfield's Bushlark	*Chrysococcyx basalis*	Least concern						
Plumed Egret	*Mirafra javanica*	Least concern		CE				

Common Name	Scientific Name	IUCN Red List	EPBC	FFG 2022	Bonn	JAMBA	CAMBA	ROKAMBA
Laughing Kookaburra	*Ardea intermedia plumifera*	Least concern						
Lewins Rail	*Dacelo novaeguineae*			Vu				
Little Black Cormorant	*Phalacrocorax sulcirostris*	Least concern						
Little Corella	*Cacatua sanguinea*	Least concern						
Little Friarbird	*Philemon citerogularis*	Least concern						
Little Grassbird	*Poodytes gramineus*	Least concern						
Little Lorikeet	*Parvipsitta pusilla*	Least concern						
Little Pied Cormorant	*Microcarbo melanoleucos*	Least concern						
Little Raven	*Corvus mellori*	Least concern						
Long-billed Corella	*Cacatua tenuirostris*	Least concern						
Magpie Goose	*Anseranas semipalmata*	Least concern		Vu				
Magpie-lark	*Grallina cyanoleuca*	Least concern						
Marsh Sandpiper	*Tringa stagnatilis*	Least concern		En	A2H	J	C	R
Masked Lapwing	*Vanellus miles*	Least concern						
Musk Duck	*Biziura lobata*	Least concern		Vu				
Nankeen Kestrel (Australian)	*Falco cenchroides*	Least concern						
Nankeen Night Heron	*Nycticorax caledonicus*	Least concern						
Noisy Friarbird	*Philemon corniculatus*	Least concern						
Noisy Miner	*Manorina melanocephala*	Least concern						
Olive-backed Oriole	*Oriolus sagittatus*	Least concern						
Pacific Barn Owl	*Tyto javanica*	Not assessed						
Pacific Black Duck	*Anas superciliosa*	Least concern						
Peaceful Dove	*Geopelia striata*	Least concern						
Peregrine Falcon	*Falco peregrinus*	Least concern						
Pied Butcherbird	*Cracticus nigrogularis*	Least concern						
Pied Cormorant	*Phalacrocorax varius*	Least concern						
Pied Currawong	*Strepera graculina*	Least concern						
Pink-eared Duck	*Malacorhynchus membranaceus*	Least concern						
Plumed Whistling-Duck	*Dendrocygna eytoni*	Least concern						
Rainbow Bee-eater	*Merops ornatus*	Least concern				J		
Red Wattlebird	*Anthochaera carunculata*	Least concern						
Red-rumped Parrot	*Psephotus haematonotus*	Least concern						
Restless Flycatcher	*Myiagra inquieta*	Least concern						
Royal Spoonbill	*Platalea regia*	Least concern						
Rufous Songlark	*Cincloramphus mathewsi*	Least concern						
Rufous Whistler	*Pachycephala rufiventris*	Least concern						
Sacred Kingfisher	*Todiramphus sanctus*	Least concern						
Scarlet Robin	*Petroica boodang*	Least concern						
Shining Bronze-Cuckoo	*Chalcites lucidus*							

Common Name	Scientific Name	IUCN Red List	EPBC	FFG 2022	Bonn	JAMBA	CAMBA	ROKAMBA
Silver Gull	*Chriococephalus novaehollandiae*	Least concern						
Silvereye	*Zosterops laterlis*	Least concern						
Southern Boobook	*Ninox novaeseelandiae*	Least concern						
Spotless Crake	*Porzana tabuensis*	Least concern						
Spotted Harrier	*Circus assimilis*	Least concern						
Spotted Pardelote	*Pardalotus punctatus*	Least concern						
Straw-necked Ibis	*Threskiornis spinicollis*	Least concern						
Striated Pardelote	*Pardalotus striatus*	Least concern						
Striated Thornbill	*Acanthiza lineata*	Least concern						
Stubble Quail	*Coturnix pectoralis*	Least concern						
Sulphur-crested Cockatoo	*Cacatua galerita*	Least concern						
Superb Fairy-wren	*Malurus cyaneus*	Least concern						
Swamp Harrier	*Circus approximans*	Least concern						
Tawny Frogmouth	*Podargus strigoides*	Least concern						
Tree Martin	*Hirundo nigricans*	Least concern						
Wedge-tailed Eagle	*Aquila audax*	Least concern						
Weebill	*Smicrornis brevirostris*	Least concern						
Welcome Swallow	*Hirundo neoxena*	Least concern						
Western Gerygone	*Gerygone fusca*	Least concern						
Whiskered Tern	*Childonias hybridus javanicus*	Least concern						
Whistling Kite	*Haliastur sphenurus*	Least concern						
White-backed Swallow	*Cheromoeca leucosternus*	Least concern						
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	Least concern		En			C	
White-breasted Woodswallow	*Artamus leucorynchus*							
White-browed Woodswallow	*Artamus superciliosus*	Least concern						
White-faced Heron	*Egretta novaehollandiae*	Least concern						
White-fronted Chat	*Epthianura albifons*	Least concern						
White-necked Heron	*Ardea pacifica*	Least concern						
White-plumed Honeyeater	*Lichenostomus penicillatus*	Least concern						
White-winged Chough	*Corcorax melanorhamphos*	Least concern						
White-winged Triller	*Lalage sueurii*	Least concern						
Willie Wagtail	*Rhipidura leucophrys*	Least concern						
Yellow Thornbill	*Acanthiza nana*	Least concern						
Yellow-billed Spoonbill	*Platalea flavipes*	Least concern						
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	Least concern						
Zebra Finch	*Taeniopygia guttata*	Least concern						

INSECTS AND CRUSTACEANS

Common Name	Scientific Name	IUCN Red List	EPBC	FFG 2022	Bonn	JAMBA	CAMBA	ROKAMBA
Aurora Bluetail	*Ischura aurora*	Not assessed						
Backswimmer	*Family Notonectidae*	Not assessed						
Creeping Water bug	*Family Naucoridae*	Not assessed						
Damselfly Larvae	*Ischura sp*	Not assessed						
Dragonfly Larvae	*Hamianax sp*	Not assessed						
Dragonfly Larvae	*Hemicordula sp*	Not assessed						
Predaceous Diving Beetle	*Eretes australis*	Not assessed						
Shield Shrimp	*Triops australiensis*	Not assessed						
Seed Shrimp	*Notodromadidae sp*	Not assessed						
Slender Ringtail	*Austrolestes analis*	Not assessed						
Small water strider	*Family Veliidae*	Not assessed						
Wandering Percher	*Diplacodes bipunctata*	Least concern						
Water boatman	*Sigara sp*	Not assessed						
Water Scavenger Beetle	*Berosus sp*	Not assessed						

MAMMALS

Common Name	Scientific Name	IUCN Red List	EPBC	FFG 2022	Bonn	JAMBA	CAMBA	ROKAMBA
Common Brushtail Possum	*Trichosurus vulpecula*	Least concern						
Eastern Grey Kangaroo	*Macropus giganteus*	Least concern						
Little Red Flying Fox	*Pteropus scapulatus*	Least concern						
Swamp Wallaby	*Wallabia bicolor*	Least concern						
White-striped Freetail Bat	*Tadarida australis*	Least concern						

REPTILES

Common Name	Scientific Name	IUCN Red List	EPBC	FFG 2022	Bonn	JAMBA	CAMBA	ROKAMBA
Boulenger's Skink	*Morethia boulengeri*	Least concern						
Eastern Brown Snake	*Pseudonaja textillis*	Not assessed						
Eastern Snake-necked Turtle	*Chelodina longicollis*	Not assessed						
Eastern Striped Skink	*Ctenotus robustus*	Not assessed						
Lace Monitor	*Varanus varius*	Not assessed		En				
Olive-legless Lizard	*Delma inornate*	Least concern						
Robust Skink	*Ctenotus robustus*							
Tiger Snake	*Notechis scutatus*	Least concern						

INTRODUCED SPECIES

BIRDS

Common Name	Scientific Name	IUCN Red List	EPBC	FFG 2022	Bonn	JAMBA	CAMBA	ROKAMBA
Common Blackbird	*Turdus merula*	Least concern						
Common Myna	*Sturnus tristis*	Least concern						
Common Starling	*Sturnus vulgaris*	Least concern						
Eurasian Tree Sparrow	*Passer montanus*	Least concern						
House Sparrow	*Passer domesticus*	Least concern						
Spotted Dove	*Spilopelia chinesis*	Least concern						

FISH

Common Name	Scientific Name	IUCN Red List	EPBC	FFG 2022	Bonn	JAMBA	CAMBA	ROKAMBA
European Carp	*Cyprinus carpio*	Not assessed for Australia						
Eastern Gambusia	*Gambusia holbrooki*	Least concern						
Goldfish	*Carassius aurakus*	Not assessed						

MAMMALS

Common Name	Scientific Name	IUCN Red List	EPBC	FFG 2022	Bonn	JAMBA	CAMBA	ROKAMBA
Feral Cat	*Felis catus*	Not assessed						
Hare	*Lepus capensis*	Least concern						
Rabbit	*Oryctolagus cuniculus*	Near threatened						
Red Fox	*Vulpes vulpes*	Least concern						

Appendix 3: Index of wetland condition scoring

The total IWC score for a wetland is calculated by summing each sub-index score multiplied by its respective weight.

This can be represented by the following formula:

$$\mathrm{IWC}_{\mathrm{total}} = \sum_{i=1}^{6} (w_i \times s_i)$$

where IWC total is the total IWC score, si is the sub-index score and wi is the weight of the corresponding sub-index. The IWC data management system automatically calculates the sub-index scores and the IWC total score and assigns condition categories based on these scores.

Weights for each sub-index (DSE 2009)

IWC sub-index	Weight
Biota	0.190
Wetland catchment	0.068
Water properties	0.122
Hydrology	0.081
Physical form	0.021
Soils	0.018

Each sub-index has a maximum score of 20. After the weights are applied, the maximum possible total score is 10. This score should then be rounded to the nearest whole number to determine its wetland condition category. Where data is not available for one or more sub-indices (due to prolonged dry conditions, for example), no total score should be given and the wetland should be assigned the category 'insufficient data'.

Wetland condition categories and their respective score ranges

Sub-index score range (except hydrology and biota)	Hydrology score	Biota sub-index score range	IWC total score range	Wetland condition catagory
0–5	0	0–8	0–2	Very poor
>5–9	5	>8–13	3–4	Poor
>9–13	10	>13–16	5–6	Moderate
>13–17	15	>16–18	7–8	Good
>17–20	20	>18–20	9–10	Excellent

Appendix 4: Risk of environmental water delivery to Moodie Swamp

Risk description	Likelihood of risk occurring	Consequence	Risk Rating	Mitigation actions
Specified flow rates are insufficient to achieve the intended extent of wetland inundation or magnitude and duration of river flows, resulting in a failure to achieve planned environmental outcomes and loss of community support.	Possible	Major	Medium	• Communications on the environmental benefits of watering actions. • Monitor event (especially for deliveries to new sites or for previously untested events) and adjust flows as necessary or terminate event if it becomes clear that insufficient water is available. • Communicate the need for complimentary measures to optimise the benefits of environmental watering actions.
Overestimates of environmental water demand prevents planning for supplying demands at other locations *Note: Planning watering actions also includes decisions around the carryover and trade of water as alternatives to current year water use decisions.*	Possible	Minor	Low	• CMAs review demand estimates and targets met by unregulated flows throughout the delivery cycle and regularly advise VEWH of any changes so unused water can be reallocated. • CMAs review demand estimates at the conclusion of the watering year, prior to the development of the following Seasonal Watering Proposal, so estimates of future requirements are more accurate. • River operators provide regular updates on flows, including through OAG meetings. • Manage Water Holdings to maximise supply opportunities for all sites.
Volumes of environmental water delivered or released exceed volumes approved for use in the event, leading to potential overdrawing of accounts or preventing other planned actions being undertaken. *Note: Planning watering actions also includes decisions around the carryover and trade of water as alternatives to current year water use decisions.*	Unlikely	Major	Low	• Ensure that deliveries are reported progressively throughout the event and are monitored against ordered volume. • Ensure ordering and delivery procedures are kept up-to-date and adhered to. • Ensure metering and reporting processes for temporary pump operations are suitable and effective.
Environmental water account is overdrawn, leading to water not being available as per approved watering statement to complete planned actions and environmental benefits not being achieved. *Note: Planning watering actions also includes decisions around the carryover and trade of water as alternatives to current year water use decisions.*	Unlikely	Major	Low	• Monitor ABA balances and undertake regular communications with CMA and RWC as part of portfolio management activities. • Ensure that deliveries are reported progressively throughout the event and are monitored against ordered volume.

Risk description	Likelihood of risk occurring	Consequence	Risk Rating	Mitigation actions
Failure of poorly maintained environmental delivery infrastructure results in planned/ specified flows not being achieved, reducing the ability to achieve planned environmental outcomes.	Likely	Moderate	Medium	• Asset ownership is clarified, and the asset owners perform regular maintenance, and pre-event asset inspections, on delivery infrastructure. *Note: Insufficient resources are likely to limit the asset owner's ability to regularly inspect and maintain infrastructure. Increased resources for these activities may further reduce the likelihood and risk ratings.* • Report vandalism to police. • Review asset design to minimise opportunities for interference or damage. • For privately owned assets, arrange approvals to use/operate assets and undertake pre-delivery inspections. • Communicate failures to the CMA. • Initiate documentation of asset ownership and management arrangements in national parks.
High operational and consumptive water demands lead to reduced access for environmental deliveries, with the result that target flows/ volumes cannot be achieved, impacting on environmental outcomes.	Likely	Minor	Low	• Event planning will seek to avoid peak demand periods, and events will be monitored and adjusted as necessary. • System operators to provide longer term forecasts for future consumptive demands as an input to planning watering proposals. • Develop longer term agreements on river capacity access for environmental deliveries. • Investigate opportunities to undertake deliveries outside the irrigation season with consideration of appropriate delivery costs.
Environmental releases, either on their own or potentially in combination with unexpected tributary inflows, cause unauthorised inundation of private land, resulting in impacts on landowner activities and assets.	Possible	Major	Medium	• Ensure currency of any landholder agreements for inundation of private land. • Release plans designed to avoid overbank flows or unauthorised flooding. • Monitor events and adjust releases to avoid overbank flows. This may include limiting deliveries to daylight hours only, where feasible and consistent with watering requirements. • Monitor forecast rainfall and tributary inflows and adjust releases to avoid overbank flows. • Monitor deliveries to new locations to build an understanding of flow patterns and inundation thresholds and adjust releases accordingly.
Environmental water deliveries may generate or mobilise BGA blooms, with adverse water quality and/or health impacts (including to people, livestock and pets), resulting in cessation of releases and environmental impacts	Possible	Major	Medium	• Consider likelihood of initiating BGA blooms in event planning and amend as required to manage risk. • Land managers or water corporation implement a risk-based monitoring program during environmental watering events, and where issues are identified, activate BGA response processes. *Note: Parks Victoria are currently writing a BGA risk management plan for Northern Victoria Region that considers the potential risk of environmental water events. This plan will outline proactive and reactive monitoring and management responsibilities that Parks Victoria commits to as a Local Waterway Manager for BGA. Adequate BGA resourcing is being considering as part of this plan.* • Regional monitoring and advice on BGA status.

Risk description	Likelihood of risk occurring	Consequence	Risk Rating	Mitigation actions
Environmental water management activities may conflict with or not complement water based recreational objectives, leading to loss of community support for activities.	Almost certain	Moderate	High	• Communicate benefits of environmental water management to the broader community and engage with recreational user peak bodies. • Engage with local recreational user groups to inform them of environmental water management activities and the underlying rationale. • Adjust events or actions to reduce/avoid impact where practical without reducing environmental outcomes. • Communicate alternate recreational opportunities. • Enhance community understanding of water system operations and entitlement frameworks (water literacy).
Environmental watering causes harm to identified cultural heritage. *Note: difficult to assess consequence under cultural heritage category - needs further testing with TOs. Hard for non-TOs to try and assess, so doesn't really fit within a traditional risk assessment process*	Unlikely	Moderate	Low	• Work with Traditional Owners to ensure that the potential impact of environmental water deliveries on cultural heritage is understood and agreed, minimised or avoided.
Inability to demonstrate outcomes achieved through environmental watering activities may lead to a loss of public/ political support for activities	Possible	Major	Medium	• Rationalise and refocus current monitoring programs (e.g., Wetmap) to better identifying outcomes. • Seek additional funds to address gaps in monitoring programs and knowledge. • Communicate the benefits of environmental watering and monitoring results *Note: It may not be possible/affordable to address all monitoring gaps, so this risk may still be rated as medium after mitigation actions.*
Environmental deliveries improve conditions for non-native species (e.g. carp, invasive species, feral horses) leading to adverse environmental impacts. Or pest plants and animals prevent environmental water outcomes being achieved.	Likely	Moderate	Medium	• Study/understand life history of species and develop high level management strategies. • Develop and implement site specific management strategies aimed at eradication/control of existing populations (e.g. carp management strategy, willow removal program, water-lily spraying program, feral animal programs). *Note: This risk is still rated as medium after mitigation actions.*
Environmental watering actions trigger non-targeted environmental responses (e.g., bird breeding) causing unintended consequences (or lost opportunities) for other environmental values.	Likely	Moderate	Medium	• Undertake monitoring and communicate these issues as they arise and apply adaptive management and review of delivery plans. • Consider including contingency allowance in delivery plan water volumes to complete breeding events.

Appendix 5: Rationale for updated objectives

Site specific ecological objectives for Moodie Swamp from GB CMA (2012) and Butcher (2017 and 2020).

EWMP objectives (GBCMA 2012)	EWMP objectives (Butcher 2017)	EWMP objectives (Butcher 2020)	EWMP objectives (Geddes and Butcher 2023)	Targets for 2023 objectives
MS1. Maintain the diversity of native wetland flora species to be consistent with Cane Grass Wetland EVC benchmark.	Maintain or improve diversity (EVC benchmark), recruitment, and regeneration of Cane Grass Wetland EVC at Moodie Swamp from 2008-2011 benchmark by 2025.	Improve vital habitat at Moodie Swamp by 2030: Maintain or improve diversity (EVC benchmark), recruitment, and regeneration of Cane Grass Wetland EVC at Moodie Swamp from 2008-2011 benchmark by 2030.	MS1.Maintain the presence of water-dependent threatened species recorded at Moodie Swamp by 2030.	Protect and restore biodiversity which is water-dependent, including supporting life cycles of threatened species at Moodie Swamp by 2030: • Maintain presence of Brolga *(Antigone rubicunda)* in 70% of targeted surveys undertaken. • Maintain presence of Sloane's Froglet *(Crinia sloanei)* in 70% of targeted surveys undertaken. • Maintain presence of listed plant species including Rigid Water-milfoil *(Myriophyllum porcatum)* and Slender Water Milfoil (*Myriophyllum gracile var. lineare)* in 70% of surveys undertaken. Maintain the presence of four state listed threatened waterbird species at Moodie Swamp by 2030: continue to support the presence listed waterbirds including Australasian bitten *(Botaurus poiciloptilus)*, Eastern great egret *(Ardea alba modesta)*, Plumed egret *(Ardea intermedia plumifera)*, and White bellied sea eagle *(Haliaeetus leucogaster)* in 3 out of 5 targeted surveys.
	Maintain Rigid Water-milfoil (Myriophyllum porcatum) and Slender water milfoil (Myriophyllum gracile var. lineare) at Moodie Swamp at 2008 benchmark levels.		MS2. Maintain the diversity of native wetland flora species to be consistent with cane grass wetland/ Aquatic Herbland complex EVC benchmark.	Improve condition water-dependent native vegetation (EVC 602) at Moodie Swamp by 2030: • Cane grass 1 species or 5% cover (substantially modified if less than benchmark cover towards outer margins). • Aquatic herbs 3 species or 15% cover. • Medium (to small) graminoids 3 species or 5% cover. • Small (to medium) herbs 5 species or 10% cover (often semi-aquatic, towards verge zone).

EWMP objectives (GBCMA 2012)	EWMP objectives (Butcher 2017)	EWMP objectives (Butcher 2020)	EWMP objectives (Geddes and Butcher 2023)	Targets for 2023 objectives
MS2. Reduce the cover and diversity of exotic and/ or highly invasive native flora species.	Reduced diversity and cover of target invasive aquatic plant species by 2025.	Reduced diversity and cover of target invasive aquatic plant species, especially Aster-weed *(Symphyotrichum subulatus)*, and Water couch *(Pastpalum distichum)*, by 30% at Moodie Swamp by 2030 compared to benchmark 2008-2011.	MS6.Reduce the cover and diversity of exotic water-dependent flora species at Moodie Swamp by 2030.	Reduced diversity and cover of target invasive aquatic plant species, especially Aster-weed *(Symphyotrichum subulatus)* and Water couch *(Pastpalum distichum)*, by 30% at Moodie Swamp by 2030 compared to benchmark 2008-2011.
MS3. Provide opportunities for Brolga breeding.	Provide opportunities for waterbird breeding especially Brolga at Moodie Swamp	Protect and restore ecosystem functions at Moodie Swamp that support successful breeding and fledging of Brolga *(Antigone rubicunda)* when conditions are suitable.	MS5. Maintain and provide opportunities for Brolga breeding.	Protect and restore ecosystem functions at Moodie Swamp that support successful breeding and fledging of Brolga *(Antigone rubicunda)* in two out of five seasons in which conditions are suitable.
	Maintain or improve non-colonial waterbird breeding at Moodie Swamp by 2025 compared to benchmark (2008-2016).		MS3. By 2030, support waterbird breeding and feeding at Moodie Swamp at least five in every ten years.	Protect and restore ecosystem functions of water-dependent ecosystems that support successful non-colonial nesting of waterbird species at Moodie Swamp providing conditions for breeding and fledging at least five times every ten years: • As a minimum at least seven species recorded breeding at Moodie Swamp over any ten-year assessment period: Australian Wood Duck *(Chenonetta jubata)*, Black Swans *(Cygnus atratus)*, Grey Teal *(Anas gracilis)*, Pacific Black Duck *(Anas superciliosa)* and Purple Swamphen *(Porphyrio porphyrio)*. Protect and restore ecosystem functions at Moodie Swamp that support the creation of vital habitat for waterbird feeding habitat guilds on a regular basis, including during drought. Target waterbird feeding habitat guilds are densely vegetated habitat and shallow water <0.5m habitat as per Jaensch (2002).
			MS4. Improve breeding of frogs at Moodie Swamp to 80% of years in which water is present by 2030	Maintain breeding of frogs at Moodie Swamp in 80% of years in which water is present, including Sloane's Froglet *(Crinia sloanei)*, Common Spadefoot Toad *(Neobatracus sudelli)*, Common froglet *(Crinia signifera)*, Peron's tree frog *(Litoria peronii)*, Plains froglet *(Crinia parinsignifera)*, Pobblebonk *(Limnodynastes dumerili)*, and Spotted marsh frog *(Limnodynastes tasmaniensis)*.

Mapping objectives for Moodie Swamp to Basin Plan EWP objectives, Schedule 7 target groups, BWS QEEO and LTWP Vic Murray objectives.

Overarching EWMP objective (MDBA, 2012b)	Detailed EWMP objectives (MDBA 2012a)	Relevant Basin Plan EWP objective	Relevant Schedule 7 target groups	Relevant BWS QEEO	LTWP objective
To provide a watering regime that supports a Cane Grass Wetland EVC and its significant biota that occur there, particularly Brolga and milfoils.	**MS1.** Maintain the diversity of native wetland flora species to be consistent with Cane Grass Wetland EVC benchmark.	8.05,3(b) 8.06,6(a)	• Diversity of water-dependent native vegetation • Ecosystem type • Recruitment and populations of native water-dependent vegetation • Condition of priority assets – supports biodiversity	BWS11	LTWPNV8** LTWPNV7
	MS2. Reduce the cover and diversity of exotic and/or highly invasive native flora species.	8.07,5	• Condition of native water dependent vegetation	-	LTWPNV4 LTWPNV14
	MS3. Provide opportunities for Brolga breeding.	8.06,6(a) 8.06,6(b)	• Recruitment and populations of native water-dependent birds • Condition of priority ecosystem functions – creation of vital habitat for breeding	BWS19	LTWPNV15

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