Third Reedy Lake

Goulburn-Murray Water Connections Project

Operational Environmental Management Plan

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Third Reedy Lake Operational Environmental Management Plan

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Contents

Executive Summary

Project overview

The Goulburn-Murray Water (GMW) Connections Project delivers large scale irrigation infrastructure modernisation across the Goulburn-Murray Irrigation District (GMID). The objectives of the project are to reduce delivery losses from the GMID, to recover water for the environment, improve the reliability of water supply to irrigators and provide a sustainable irrigation system into the future. In addition to modernisation works, several 'special environmental projects' were identified that represented opportunities for environmental enhancement.

The Third Reedy Bypass Project ('the Project') was identified as one of several 'special environmental projects' under the GMW Connections Project Stage 2 Business Case. It proposes to restore Third Reedy Lake by reinstating a more natural watering regime by disconnecting the lake from the Torrumbarry Irrigation System. When implemented, the water regime at the lake will change from permanently full to one that includes wetting and drying, generating environmental benefits for the lake.

Works and measured associated with the Project include the construction of a bypass channel (1.4 km) and associated infrastructure to disconnect the lake from the irrigation system, while maintaining a supply point for the delivery of environmental water. GMW customers who currently extract water directly from the lake will be reconnected to the adjacent irrigation system.

In addition to the environmental benefits, the Project will also generate water savings through reduced evaporation losses and more efficient water delivery to customers. The water savings will contribute to the overall GMW Connections Project Stage 2 water savings target, which will be owned by the Commonwealth Environmental Water Holder and used to improve the health of priority wetlands and waterways.

Approval to proceed with the Project was provided by State and Commonwealth Governments subject to conditions in accordance with a Bilateral Agreement. Referrals were made under both the *Victorian Environmental Effects Act 1978* and the *Environmental Protection and Biodiversity Conservation Act (EPBC) 1999* following completion of an Environmental Report for the Project in early 2018.

The Project Environmental Report concluded that if the proposed water regime was implemented there was a high likelihood of achieving the project goal. However, there are risks to some current values present at the lake, namely fish, but that other values (e.g. waterbirds) would be enhanced by the proposed regime and that the change in water regime did not represent a risk to the Kerang Wetlands Ramsar Site. Some potential risks from increased salinity, acid sulphate soils and low dissolved oxygen were identified, but mitigation measures are available should these risks manifest. Overall the Environment Report concluded that risks to issues identified in the Bilateral Agreement were low and manageable.

As part of the approvals, a requirement of the *EPBC Act 1999* conditions is the preparation of an Operational Environmental Management Plan (this report).

Operational Environmental Management Plan

In accordance with the conditions of approval, the Operational Environmental Management Plan (OEMP) provides the operational arrangements required to minimise impacts to the Kerang Wetlands Ramsar Site and to the three fish species listed in the conditions of approval. Furthermore, the OEMP also provides the operational arrangements required to maximise the likelihood of achieving the overall project goal of restoring Third Reedy Lake.

The OEMP has been developed in collaboration with key stakeholders including Goulburn Murray Water (GMW) Connections Project, North Central Catchment Management Authority (CMA), Department of Environment Land, Water and Planning (DELWP) and Parks Victoria; and builds on collaboration activities from previous project stages. The Project has conducted significant public and stakeholder engagement to date. This has included direct engagement with potentially affected landholders, liaison with a range of working groups involving government and non-government entities and dissemination of information on the progress of the project. The main groups involved, and the key engagement activities delivered, are documented in Section 6.4 of the Project Environmental Report (Jacobs, 2017a).

The GMW Connections Project Environmental Technical Advisory Committee (ETAC) met to provide advice on the development of the OEMP to ensure quality, completeness and practicality. The committee includes representation from CMAs, GMW, DELWP, GMW Connections Project and the Department of Economic Development, Jobs, Transport and Resources (DEDJTR).

In addition, the GMW Connections Project Expert Review Panel (ERP) was engaged by GMW to provide technical review of the OEMP. The ERP is a panel of independent consultants experienced in the relationship between hydrology and ecology and in evaluating ecological consequences of changing hydrology. The panel has commented on the draft OEMP and were also key reviewers of the Project Environmental Report (Jacobs 2017a) and the Kerang Lakes Bypass Investigation Project Technical Report – Third Reedy Lake (North Central, 2014).

Third Reedy Lake

The Third Reedy Lake reserve includes the 234 ha lake and 16 ha of surrounding land currently managed by GMW. It is the most northerly (downstream) lake in the Reedy Lakes Complex, comprising First Reedy, Middle Reedy and Third Reedy Lakes. Third Reedy Lake is located within the component of the Kerang Lakes systems that is recognised as being of international and national importance. The lake also supports cultural, social recreational and economic values, as well as providing flood mitigation functions.

Prior to irrigation development, the Reedy Lakes Complex would have filled intermittently with floodwaters from the Loddon River (via Washpen Creek and Wandella Creek). As the most downstream lake in the complex, Third Reedy Lake would have flooded less frequently and experienced more prolonged drying phasing compared to other lakes. Since becoming included in the Torrumbarry Irrigation System in 1925, the lakes became permanent freshwater lakes. Third Reedy Lake has suffered ecological decline because of these changes and reinstating a wetting-drying regime more closely aligned with natural conditions is expected to improve the conservation value of the lake.

Third Reedy Lake has a high density of dead River Red Gums (*Eucalyptus camaldulensis*) across the entire shallow open water zone which provide evidence of its pre-regulated condition as a River Red Gum dominated intermittent wetland. The lake is devoid of submerged aquatic vegetation. Emergent vegetation fringes the open water area with *Typha* spp. and *Juncus* spp. extending for approximately 50 metres from the edge of the wetland. Small patches of rushes and aquatic herbs occur in isolated areas. The boundary of Third Reedy Lake is characterised by River Red Gum and, to a lesser extent, Black Box (*Eucalyptus largiflorens*) overstorey, with a shrubby understorey predominantly Tangled Lignum (*Duma florulenta*).

Third Reedy Lake currently supports three different vegetation communities, two of which are considered depleted in Victoria. Six species of plants with conservation significance have been recorded at Third Reedy Lake of which only the Winged Water-starwort (*Callitriche umbonate*) is a listed (*FFG Act 1988*) species.

Third Reedy Lake provides habitat for a range of animals. Thirty-two waterbird species have been recorded as using the site for foraging or fly-over purposes. Ten native and six exotic fish species have been recorded in Third Reedy Lake however, many of the native species previously recorded have not been detected for some time. Two turtle species, the *FFG Act 1988* listed Murray River Turtle (*Emydura macquarii*) and Common Long-necked Turtle (*Chelodina longicollis*), have also been recorded at Third Reedy Lake.

Restoration of the lake

The long term management goal for Third Reedy Lake is to

"Achieve projected water savings whilst providing a watering regime that restores Third Reedy Lake to a deep freshwater marsh wetland type (dominated by Intermittent Swampy Woodland (EVC 813)) able to support recruitment of River Red Gums and promoting a diverse and extensive range of habitat suitable for a variety of waterbirds"

Achievement of the goal is supported by ecological objectives, being to:

- Maintain the health of remnant Black Box and River Red Gum trees surrounding Third Reedy Lake
- Facilitate the establishment of River Red Gum trees across the bed of the lake
- Restore a diverse ground layer of vegetation in the inundated zones of the wetland, characteristic of a deep freshwater marsh.

The water regime proposed for the lake is divided into two phases. An establishment phase to provide opportunities for River Red Gums to establish within the bed of the lake and a long term operational phase that maintains Third Reedy Lake as a deep freshwater marsh.

It is difficult to determine with certainty how long the establishment phase will take to complete – it may take several 4-year cycles, and it is anticipated that some active revegetation may be required. To facilitate the change in water regime and transition to a new vegetation community a management framework has been adopted that includes adaptive management of the ecological outcomes and risks.

Adaptive management of ecological outcomes

There are uncertainties in the likely response of flora present in the system to the proposed change in water regime, including the recovery of target vegetation. To appropriately respond to these uncertainties and to manage the risk of failing to meet the Project objectives, an EVC establishment guideline was developed. The guideline includes an adaptive approach to the management of flora at Third Reedy Lake. Assessment of progress, thought targeted monitoring (summary of monitoring provided in Appendix E), toward the achievement of the managements targets defined by the guidelines will help to determine when management interventions or variations to the proposed watering regime may be required.

Adaptive management of risks

Two types of risks to the Project have been identified, being risks to achieving the ecological outcomes and risks to values as a result of changing the water regime. This OEMP presents strategies that will be used to manage these risks through a combination of monitoring (summary of monitoring provided in Appendix E) and contingency measures if monitoring indicates a risk has or is likely to occur.

Response to Approval Conditions

Commonwealth Approval conditions related to 1) adverse impacts during construction, 2) adverse impacts during operation and 3) specific impacts on three listed fish species (Silver Perch, Flathead Galaxias, Murray Hardyhead). The construction activities will be managed, in accordance with the environmental approval conditions, under the existing GMW Connections Project Construction Environmental Management Plan, which has been amended to address the Third Reedy Lake Bypass Project. This OEMP describes the specific monitoring, triggers and reporting protocols for Commonwealth Approval Conditions 2 and 3 in relations to operational impacts on the Kerang Wetlands Ramsar Site and impacts on nominated *EPBC Act 1999* listed fish species.

Important note about your report

The sole purpose of this report and the associated services performed by Jacobs is to develop an Operational Environmental Management Plan for Third Reedy Lake in accordance with the scope of services set out in the contract between Jacobs and the Goulburn Murray Water (GMW) Connections Project. That scope of services, as described in this report, was developed with the GMW Connections Project.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the GMW Connections Project and/or from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report. Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Jacobs for use of any part of this report in any other context.

This report has been prepared on behalf of, and for the exclusive use of, the GMW Connections Project, and is subject to, and issued in accordance with, the provisions of the contract between Jacobs and the GMW Connections Project. Jacobs accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.

Glossary

4-year cycles	Multi-year water regime management cycles consisting of inundation followed by drying prior to the next inundation (as determine in North Central CMA, 2014). Key water regime management approach within the establishment phase and long term operational phase of the water regime.
Adaptive management	"Adaptive environmental management is a systematic process for improving management effectiveness by 'learning from doing'. The approach uses real-life actions (e.g. projects, activities or policy) to test and improve our understanding about how these actions relate to the outcomes we are trying to achieve. The knowledge gained then provides the basis for continuing with, or adapting, our actions in response to what has been learnt." [Draft Victorian Strategy for Healthy Rivers, Estuaries, and wetlands]
Change in ecological character	The human induced adverse alteration of any ecosystem component, process and or ecosystem benefit/service (Ramsar Convention Secretariat 2010)
Contingency measures	Mitigation actions to reduce the level of risk associated with a potential threat.
Deep Freshwater Marsh	Deep Freshwater Marsh is a wetland type defined in the Victorian Wetland Classification Framework as a wetland that is generally inundated to a depth of 1 – 2 m throughout the year (DELWP 2016a). The objective of this project is to restore Third Reedy lake to a Deep Freshwater Marsh that supports vegetation communities characteristics of Intermittent Swampy Woodland and Lake Bed Herbland Ecological Vegetation Classes (North Central CMA, 2014).
Ecological character	The combination of the ecosystem components, processes and benefits/services that characterise the wetland at a given point in time (Ramsar Convention Secretariat 2010)
Ecological Vegetation Class (EVC)	Ecological Vegetation Classes (EVC) are the standard unit for classifying vegetation types in Victoria. EVCs are described through a combination of floristics, lifeforms and ecological characteristics, and through an inferred fidelity to particular environmental attributes (https://www.environment.vic.gov.au/biodiversity/bioregions-and-evc-benchmarks).
Establishment phase	A water regime that provides opportunities for River Red Guns to establish across the Wetland Bed, as well as allow time for high value remnant vegetation in the Wetland Fringe to adapt to direr conditions (as determine in North Central CMA, 2014). Consists of several 4-year cycles, continued until revegetation targets are met.
Intermittent Swampy Woodland EVC	An Ecological Vegetation Class (EVC) characterised by eucalyptus dominated woodland with (variously shrubby) sedge-turf grass understory dominated by flood-stimulated species in association with flora tolerant of inundation (DELWP 2016b).
Invasive Species	Any species (native or exotic) in excessive numbers that could pose a threat to the ecological condition of Third Reedy Lake and the Kerang Wetlands Ramsar Site.
Impacts on listed fish species	Death or harm to the *EPBC Act 1999* listed Flathead Galaxias, Murray Hardyhead and Silver Perch

Kerang Bypass Lakes	First Reedy Lake, Middle Reedy Lake, Third Reedy Lake, Little Lake Charm (and Scott's Creek) and Racecourse Lake.
Kerang Lakes	A system of over 100 permanent and intermittent aquatic ecosystems comprising freshwater lakes, swamps and marshes, and saline and hypersaline lakes, located near Kerang in Northern Victoria.
Kerang Wetlands Ramsar Site	A cluster of 23 distinct wetlands in the Kerang Lakes system stretching from Lake Tutchewop, northwest of Kerang, to Hird Swamp in the southeast. Includes Kangaroo Lake, Racecourse Lake, Lake Charm, Little Lake Charm (and Scott's Creek), Reedy Lake, Middle Reedy Lake, Third Reedy Lake, Kerang Weir, Town Swamp, Johnson Swamp, Hird Swamp, Lake Cullen, Lake Tutchewop, Lake William, Lake Kelly, Little Lake Kelly, Stevenson Swamp, Lake Bael Bael, First Marsh, Second Marsh, Third Marsh, Foster Swamp and Cemetery Swamp.
Lake Bed Herbland EVC	An Ecological Vegetation Class (EVC) dominated by herbaceous species adapted to drying mud within lake beds (DELWP 2016b).
Long term operational phase	Long term water regime that aims to maintain Third Reedy Lake as a Deep Freshwater Marsh (as determine in North Central CMA, 2014). Consists of 4-year cycles.
Matters of National Environmental Significance	Matters of National Environmental Significance protected under Part 3 of the *Environment Protection and Biodiversity Conservation Act 1999*. For this project, it includes wetlands of international importance (sections 16 and 17B) and listed threatened species and communities.
Project area	The area impacted by the Third Reedy Lake Bypass Project which includes Third Reedy Lake and the proposed bypass channel and associated construction footprint.
Reedy Lakes complex	First Reedy, Middle Reedy and Third Reedy Lake and their associated fringing wetland vegetation.
Third Reedy Lake	Third Reedy Lake and its associated fringing wetland vegetation.
Wise Use	Wise use of wetlands is the maintenance of their ecological character, achieved through the implementation of ecosystem approaches, within the context of sustainable development (Ramsar Convention Secretariat 2010)

Abbreviations

ASS	Acid Sulfate Soils
BBNAC	Barapa Barapa Nations Aboriginal Corporation
BBNTG	Barapa Barapa Native Title Group
CEMF	Connections Project Construction Environmental Management Framework
EMP	GMW Connections Project Environmental Management Plan
CEWH	Commonwealth Environmental Water Holder
CHMP	Cultural Heritage Management Plan
CMA	Catchment Management Authority
CPS	Critical Components, Processes and Services
DEE	Department of Environment and Energy
DEDJTR	Department of Economic Development, Jobs, Transport and Resources
DELWP	Department of Environment, Land, Water and Planning
DEPI	Department of Primary Industries
EVC	Ecological Vegetation Community
EES	Environment Effects Statement
EE Act 1978	Environment Effects Act 1978
EPBC Act 1999	Environment Protection and Biodiversity Conservation Act 1999
ERP	Expert Review Panel
ETAC	Environmental Technical Advisory Committee
EWP	Environmental Watering Plan
FFG Act 1988	Flora and Fauna Guarantee Act 1988
FSL	Full supply level
GMID	Goulburn Murray Irrigation District
GMW	Goulburn Murray Water
IUCN	International Union for Conservation of Nature
KLAN	Kerang Local Aboriginal Network
KLBP	Kerang Lakes Bypass Project
LAC	Limits of Acceptable Change
ML	Megalitres
MNES	Matters of national environmental significance
OEMP	Operation Environmental Management Plan
VEWH	Victorian Environmental Water Holder
WCMF	Water Change Management Framework

1. Background

1.1 Goulburn-Murray Water Connections Project

The Goulburn-Murray Water (GMW) Connections Project delivers large scale irrigation infrastructure modernisation across the Goulburn-Murray Irrigation District (GMID). The objectives of the project are to reduce delivery losses from the GMID, to recover water for the environment, improve the reliability of water supply to irrigators and provide a sustainable irrigation system into the future. Activities to modernise the irrigation system include lining and automating channel operations, building pipelines and installing new, modern, metering technology.

In addition to modernisation works, several 'special environmental projects' were identified by Victorian environmental agencies (including the Catchment Management Authorities (CMA)) that represented opportunities for environmental enhancement.

1.2 Third Reedy Lake Bypass Project

The GMW Connections Project Stage 2 Business Case (prepared by the State Government and approved by the Commonwealth Government), identified the Kerang Lakes Bypass Project (KLBP) as one of the 'special environmental projects'. The project proposed removing several Kerang Lakes from the Torrumbarry Irrigation System to return the wetlands to a more natural wetting/drying regime, as well as constructing connecting channels to facilitate environmental watering of lakes. The key focus of this project was environmental enhancement.

A Business Case for the KLBP was developed in 2015 (RMCG, 2015) to assess the feasibility of constructing bypass channels around First Reedy, Middle Reedy and Third Reedy Lakes, Little Lake Charm (and Scott's Creek) and Racecourse Lake, all located within the Kerang Lakes wetland system. The business case recommended that Third Reedy Lake be bypassed; however, the remaining lakes in the investigation did not meet the Business Case criteria and therefore were not recommended to be further investigated.

The KLBP Business Case was submitted to the Commonwealth and State Governments. In May 2015, the GMW Connections Project was advised by the Department of Environment, Land, Water and Planning (DELWP), acting on advice from the Commonwealth Department of Environment and Energy (DEE), that the project, hereafter called the Third Reedy Lake Bypass Project (The Project), could proceed subject to a range of conditions and further investigations.

The Project proposes to restore Third Reedy Lake by reinstating a more natural watering regime through undertaking works and measures to disconnect the lake from the Torrumbarry Irrigation System. This will generate environmental benefits for the lake and reduce current water losses in the GMID. When implemented, the water regime at the lake will change from permanently full to one that includes wetting and drying. Native vegetation is expected to positively respond to an intermittent watering regime, similar to what would have occurred across the lake bed prior to regulation.

Works and measures associated with the project include the construction of a bypass channel (1.4 km) and associated infrastructure to disconnect the lake from the irrigation system, while maintaining a supply point for the delivery of environmental water. GMW customers who currently extract water directly from the lake will be reconnected to the adjacent irrigation system.

In addition to the environmental benefits, the Project will also generate water savings through reduced evaporation losses and more efficient water delivery to customers. The water savings will contribute to the overall GMW Connections Project Stage 2 water savings target, which will be owned by the Commonwealth Environmental Water Holder and used to improve the health of priority wetlands and waterways.

1.3 Approvals process

To manage the implementation of the GMW Connections Project, a Water Change Management Framework (WCMF) (GMW 2013) was developed that describes the process for assessing and if necessary mitigating the

impacts of any modernisations works on rivers and wetlands. The WCMF does not strictly apply to the Project due to it being a 'special environmental project' under the GMW Connections Project however the principles of the WCMF, including the approach for preparing an Environmental Water Plan (EWP) provide useful guidance for the development of this Operational Environmental Management Plan (OEMP).

The GMW Connections Project and the Project have been subject to a comprehensive approvals process including numerous investigations and reporting requirements.

The Project was referred under the *Victorian Environmental Effects* (*EE) Act 1978* with the Minister for Planning determining on 27 June 2016 that an environmental effects statement (EES) was not required, subject to meeting a number of conditions. These conditions pertained to the development of an 'Environmental Report' to document the environmental impacts and benefits of the Project.

The Project was also referred under the *Environmental Protection and Biodiversity Conservation (EPBC) Act 1999*. On 21 October 2016, the Department of Environment and Energy (DEE) advised that the project is a 'controlled action'. Assessment of the project under the *EPBC Act 1999* was carried out via the accredited Environmental Report process under the Bilateral (Assessment) Agreement between the Commonwealth and the State. The terms of reference for the Environmental Report required an assessment of impacts to:

1) Species identified in the bilateral agreement as being present or likely to be present at Third Reedy Lake.
2) Ecological character of the Kerang Wetlands Ramsar Site and the contribution Third Reedy Lake makes to that character.
3) Critical Components, Processes and Services that could benefit or be impacted upon by the proposed change in water regime.

The Environmental Report was prepared by Jacobs (2017a) and provides a comprehensive description of the Project (including the current values of the lake and their condition, the proposed changes to the water regime and objectives for the lake in terms of vegetation outcomes), identifies the potential impacts and benefits of the Project to values at the lake (including those items listed in the Bilateral Agreement) and provides recommendations for actions to mitigate potential impacts and enhance the likelihood of the project achieving its stated goal.

The Environmental Report concludes that if the proposed water regime was implemented there is a high likelihood of achieving project goal, there are risks to some current values present at the lake, namely fish, but that other values (e.g. waterbirds) would be enhanced by the proposed regime. Some potential risks from increased salinity, acid sulphate soils and low dissolved oxygen were identified, but mitigation measures are available should these risks manifest. Overall the Environment Report concluded that risks to issues identified in the Bilateral Agreement were low and manageable, and the change in water regime did not represent a risk to the Kerang Wetlands Ramsar Site.

Following submission of the Environmental Report, on 18 February 2018, the Minister for Planning concluded that, under the *EE Act 1978*, the environment impacts of the Project will be acceptable subject to conditions. On 4 July 2018, the DEE granted approval under the *EPBC Act 1999*, also subject to conditions. The conditions under both the *EE Act 1978* and *EPBC Act 1999* are provided in Appendix A.

A requirement of the *EPBC Act 1999* conditions is the preparation of an Operational Environmental Management Plan (OEMP) covering the elements described below.

To minimise adverse impacts to the Kerang Wetlands Ramsar Site, the approval holder must ensure that the Operational Environmental Management Plan for the proposed action:

i. Includes a commitment to monitoring of water quality, with trigger levels for the implementation of contingency measures in the event of increased salinity, reduced dissolved oxygen and increased acidity.

ii. Where contingency measures are implemented, the approval holder must evaluate and report their effectiveness to the Department, including commitments to adaptive management measures if the contingency measures are determined not to be effective, within three months of implementing the contingency measures.

iii. Includes a commitment to monitoring and adaptive management of invasive flora and fauna species to prevent any increase in their presence within the Project area.

iv. The approval holder must provide the Department an electronic copy of the draft Operational Environmental Management Plan for comment prior to seeking approval of the plan from the relevant state authority.

v. Is provided to the Department within 14 days following approval by the relevant state authority.

Further conditions were included with respect to three *EPBC Act 1999* listed fish species, as described below.

To minimise adverse impacts to the Flathead Galaxias (*Galaxias rostratus*), Murray Hardyhead (*Craterocephalus fluviatilis*) and Silver Perch (*Bidyanus bidyanus*) the approval holder must:

i. Monitor fish exit from Third Reedy Lake during exit flows before the regulator is closed or until the water level drops to a level such that the lake is not connected to the bypass.

ii. Within three months of the completion of monitoring, the approval holder must provide a written report to the Department of the fish exit monitoring results.

iii. The written report must list any presence of and death or harm to the Flathead Galaxias, Murray Hardyhead and Silver Perch. The report must list adaptive management measures that will be implemented to minimise further death or harm throughout future drying cycles.

iv. Following a report of death or harm to the Flathead Galaxias, Murray Hardyhead or Silver Perch, subsequent reports must evaluate the success of adaptive management measures and, where measures were unsuccessful', propose further measures to minimise death or harm throughout future drying cycles.

v. Continue the monitoring and reporting for the life of the approval unless permission to cease monitoring and reporting is provided in writing by the Minister.

The conditions of approval also require the preparation of a Construction Environmental Management Plan to manage and mitigate any risks during construction activities. The construction activities will be managed, in accordance with the environmental approval conditions, under the existing GMW Connections Project Construction Environmental Management Plan, which has been amended to address the Project.

1.4 Purpose of the OEMP

In accordance with the conditions of approval, the OEMP (this report) provides the operational arrangements required to minimise impacts to the Kerang Lakes Ramsar Site and three fish species listed in the conditions of approval. Furthermore, the OEMP also provides the operational framework required to maximise the likelihood of achieving the overall project goal of restoring Third Reedy Lake.

The OEMP contains the following sections:

Section 2 - Third Reedy Lake. This section provides a description of the lake's regional setting and local site characteristics, including current values, hydrology, current management, current conditions and likely trajectory.

Section 3 – Approach to Restoration. This section describes the Third Reedy Lake Bypass Project including the project goal, the water requirements and proposed water regime (including establishment and long term phases) and a management framework (supported by monitoring) that incorporates both adaptive management and risk management.

Section 4 – Adaptive management of ecological outcomes. This section describes the adaptive management approach to achieving the ecological outcomes of the Project, including a conceptual model for ecosystem response to the proposed water regime, management objectives required to meet the project goal and management hypotheses, actions, monitoring, evaluation and revision (if necessary) to maximise likelihood of achieving the project goal.

Section 5 – Adaptive management of risks. This section describes the adaptive management approach to mitigating risks and threats, objectives related to risk management, monitoring (to determine if risks or threats are occurring) and actions if risks and threats manifest.

Section 6 - Approval Conditions – This section describes the monitoring, triggers and reporting protocols for each of the Approval Conditions.

Section 7 - Reporting and review – This section discusses the process for reporting project outcomes and ongoing review of the OEMP

Sections 8, 9 and **10** cover opportunities for indigenous engagement, governance arrangements and references.

A range of reports and investigations from earlier stages of the Project have informed the development of this OEMP, as listed in Appendix B.

1.5 OEMP development process

The OEMP has been developed in collaboration with key stakeholders including GMW, GMW Connections Project, North Central CMA, DELWP and Parks Victoria. Figure 1-1 outlines the tasks completed as part of the development process noting that a number of tasks were completed as part of the previous investigations (e.g. the KLBP Business Case (RMCG, 2015) and the Project Environmental Report (Jacobs, 2017a)).

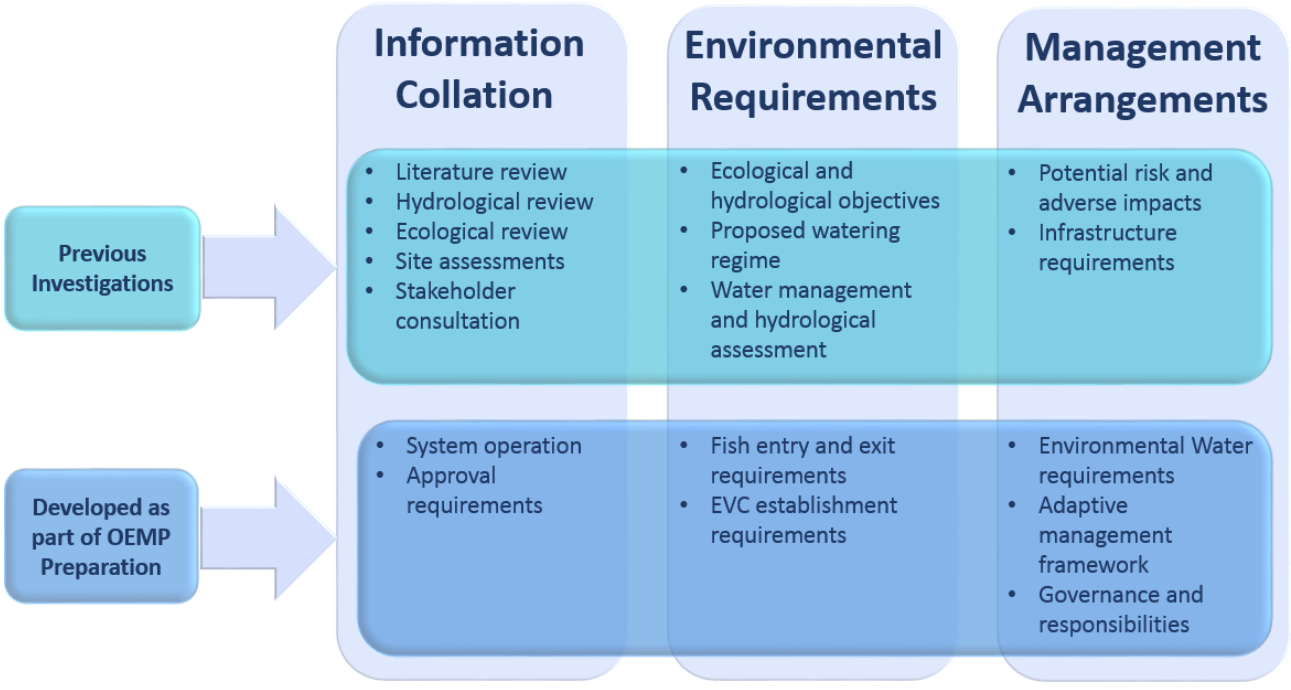

Figure 1-1: OEMP development process (Source: adapted from North Central CMA, 2014)

1.5.1 Consultation and engagement

The Project, including KLBP investigations, has conducted significant public and stakeholder engagement to date. This has included direct engagement with potentially affected landholders, liaison with a range of working groups involving government and non-government entities and dissemination of information on the progress of the project. The main groups involved, and the key engagement activities delivered, are documented in Section 6.4 of the Project Environmental Report (Jacobs, 2017a).

1.5.2 Review

The GMW Connections Project Environmental Technical Advisory Committee (ETAC), met to provide advice on the development of the OEMP to ensure quality, completeness and practicality. The committee includes representation from CMAs, GMW, DELWP, GMW Connections Project and the Department of Economic Development, Jobs, Transport and Resources (DEDJRT).

In addition, the GMW Connections Project Expert Review Panel (ERP) was engaged by GMW to provide technical review of the OEMP. The ERP is a panel of independent consultants experienced in the relationship between hydrology and ecology and in evaluating ecological consequences of changing hydrology. The membership includes Dr Jane Roberts and Dr Terry Hillman who have reviewed and commented on the draft OEMP and were also key reviewers of the Project Environmental Report (Jacobs 2017a) and the Kerang Lakes Bypass Investigation Project Technical Report – Third Reedy Lake (North Central, 2014).

To satisfy the project requirements under the *EPBC Act 1999,* the OEMP was submitted to the Commonwealth DEE for comment prior to submission to the State Secretary of DELWP for approval. The comments received from DEE have been taken into account during the preparation of this version of the OEMP.

2. Third Reedy Lake

This section provides a description of the lake's regional setting and local site characteristics, including current values, hydrology, current management, current conditions and likely trajectory.

2.1 Regional context

2.1.1 Regional setting

The Third Reedy Lake reserve includes the 234 ha lake and 16 ha of surrounding public land. The lake is part of the Kerang Lakes system that comprises over 100 permanent and intermittent wetlands located near Kerang in northern Victoria. It is the most northerly (downstream) lake in the Reedy Lakes Complex, comprising First Reedy, Middle Reedy and Third Reedy Lakes.

A cluster of 23 distinct wetlands within the Kerang Lakes system, including Third Reedy Lake, form the Kerang Wetlands Ramsar Site which was designated as a Wetland of International Importance (Ramsar wetland) in 1982 (North Central CMA, 2014) (Figure 2-1). The Kerang Wetlands Ramsar Site covers 9,419 ha and is also listed in the Directory of Important Wetlands in Australia.

The diversity of wetland types is one of the critical components of the ecological character for the Kerang Wetlands Ramsar Site, as shown in Figure 2-1 and Table 2-1. Third Reedy Lake currently represents one of the six permanent freshwater lakes.

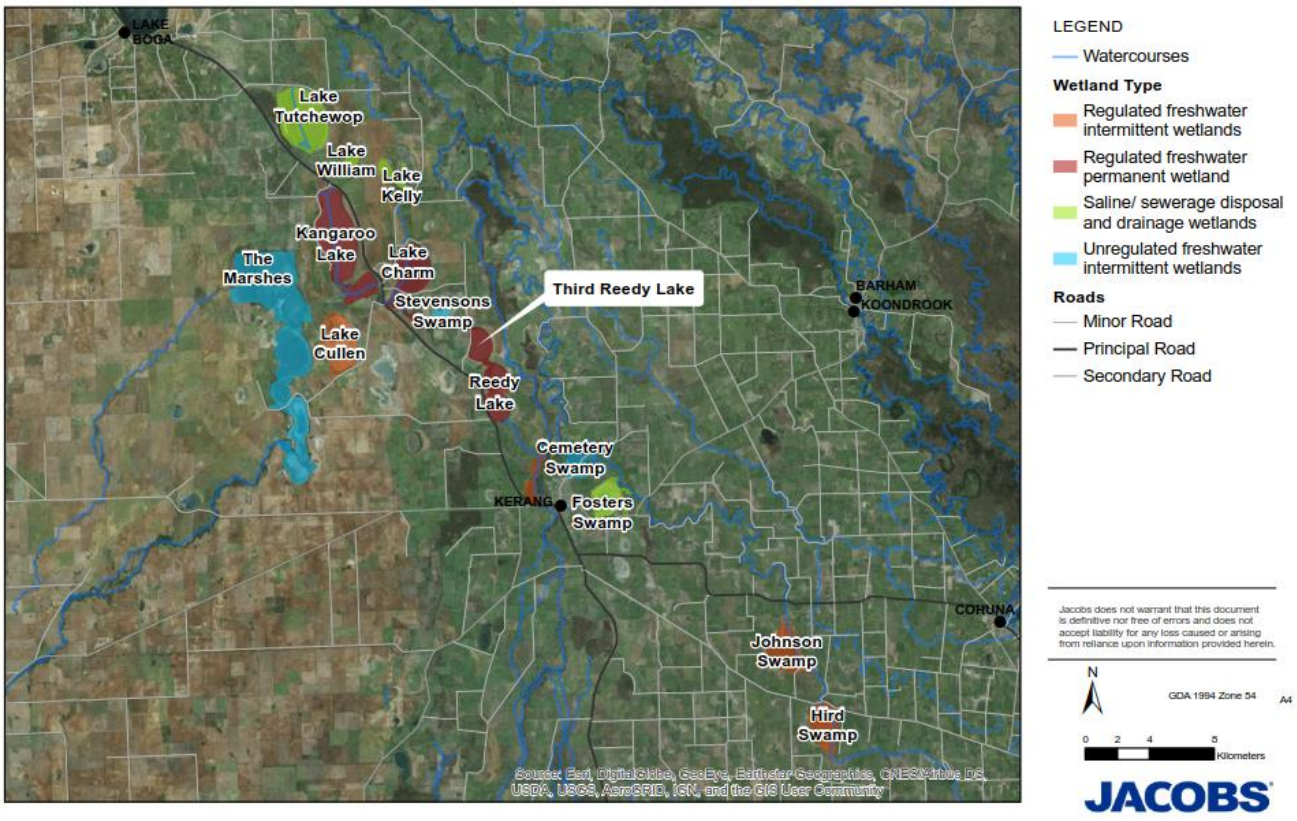

Figure 2-1 Third Reedy Lake location within the Kerang Wetlands Ramsar Site

Table 2-1: Ramsar wetland types and four hydrological categories as given in the Kerang Wetlands Ramsar Action Plan (Source: North Central CMA, 2016, Butcher and Hale 2016).

Hydrological category	Wetland	Wetland type[2]
Regulated freshwater permanent wetlands	Kangaroo Lake	O - Permanent freshwater lakes (over 8 hectares)
	Racecourse Lake	O - Permanent freshwater lakes (over 8 hectares)
	Lake Charm	O - Permanent freshwater lakes (over 8 hectares)
	Little Lake Charm/ Scott's Creek	O - Permanent freshwater lakes (over 8 hectares)
	Reedy Lake	O - Permanent freshwater lakes (over 8 hectares)
	Middle Reedy Lake	Tp - Permanent freshwater marshes/pools
	Third Reedy Lake	*O - Permanent freshwater lakes (over 8 hectares)*
Regulated freshwater intermittent wetlands	Kerang Weir	W - Shrub-dominated wetlands
	Town Swamp	W - Shrub-dominated wetlands
	Johnson Swamp	Ts -Seasonal/intermittent freshwater marshes W - Shrub-dominated wetlands
	Hird Swamp	Ts - Seasonal/intermittent freshwater marshes W - Shrub-dominated wetlands
	Lake Cullen	R - Seasonal/ intermittent saline/ brackish/ alkaline marshes/ pools
Saline/ sewerage disposal and drainage wetlands	Lake Tutchewop	Q - Permanent saline/brackish/alkaline lakes
	Lake William	Q - Permanent saline/brackish/alkaline lakes
	Lake Kelly	Q - Permanent saline/brackish/alkaline lakes
	Little Lake Kelly	Q - Permanent saline/brackish/alkaline lakes
	Fosters Swamp	R - Seasonal/ intermittent saline/ brackish/ alkaline marshes/ pools Q - Permanent saline/brackish/alkaline lakes Wastewater treatment area
Unregulated freshwater intermittent wetlands	Stevenson Swamp[1]	R - Seasonal/ intermittent saline/ brackish/ alkaline marshes/ pools
	Lake Bael Bael	P - Seasonal/intermittent freshwater lakes (over 8 hectares)
	First Marsh	P - Seasonal/intermittent freshwater lakes (over 8 hectares)
	Second Marsh	W - Shrub-dominated wetlands
	Third Marsh	W - Shrub-dominated wetlands
	Cemetery Swamp	W - Shrub-dominated wetlands

[1] Stevensons Swamp was noted as freshwater in DSE 2004 and saline in DSE 2010.

[2] O = permanent freshwater lakes (over 8 hectares); Tp = Permanent freshwater marshes/ pools; W = shrub-dominated wetlands; Ts = Seasonal/ intermittent freshwater marshes; R = Seasonal/ intermittent saline/ brackish/ alkaline marshes/ pools; Q = Permanent saline/ brackish/ alkaline lakes; P = Seasonal/ intermittent/ freshwater lakes (over 8 hectares)

2.1.2 Land status and management

There are multiple stakeholders involved in the management of Third Reedy Lake and the broader Kerang Wetlands Ramsar Site. Initial discussions around future management of the lake have been undertaken as part of the development of the Project (GMW, 2016 a, b).

Third Reedy Lake is currently on public land managed by GMW. Discussions with DELWP and Parks Victoria indicate that Third Reedy Lake public land could be classified Nature Conservation Reserve post project implementation with management coordinated by both stakeholders in conjunction with similar nearby public land areas. A process to finalise the future land manager will be undertaken by GMW, outside of this OEMP.

2.1.3 Cultural Heritage

The Kerang Lakes region was a favourable location for Aboriginal occupation and resource procurement as evidenced by the archaeological record as well as the availability of food, fresh water and raw material resources associated with these water sources. Although there are no previously registered Aboriginal Places within Third Reedy Lake itself, the Victorian Aboriginal Heritage Register (VAHR) search showed that 58 Aboriginal Places are located within the geographic region and a review of regional and local archaeological assessments showed that mounds, artefact scatters and shell deposits in areas with a similar environmental

context (Jacobs, 2018). Most of these Aboriginal Places are located on the lunette (eastern) side of the three Reedy Lakes, with only one Aboriginal Place recorded on the western side of Third Reedy Lake.

The Barapa Barapa Nations Aboriginal Corporation (BBNAC) and Barapa Barapa Native Title Group (BBNTG) are important stakeholders and have indicated a willingness to participate in the ongoing management of Third Reedy Lake.

2.1.4 Recreation

Third Reedy Lake is used by the local community and a wider tourist population for a range of recreational activities. The main fishing area is the outlet from Third Reedy Lake and RMCG (2013) estimated that there are over 500 visits to the lake per year for fishing and, to a lesser extent, boating purposes.

2.1.5 Operational uses

Third Reedy Lake forms part of the Torrumbarry Irrigation System (as discussed in Section 2.1.6). No diverters are located on Third Reedy Lake itself, but irrigators are supplied by the Torrumbarry No 7 and No 1/7 channels. As part of the Third Reedy Lake Bypass Project, irrigators off the Torrumbarry No 1/7 channel will be reconnected to the proposed pipeline. There will be no impact on irrigators off the Torrumbarry No 7 channel.

Third Reedy Lake currently provides a flood conveyance and storage function. Operation of the Middle Reedy to Third Reedy regulator gates can be used to help retain flood flows (Figure 2-5) and help mitigate downstream flooding or pass flood flows through the Torrumbarry Irrigation System. In very large events the gates may be overtopped.

Third Reedy Lake is not currently used to store or carry irrigation drainage water (RMCG, 2013).

2.1.6 Regional hydrology

The wetlands are situated at the junction of three large river systems, receiving water from the Murray River (via the Torrumbarry Irrigation System), and the Avoca and Loddon Rivers (North Central CMA, 2016). Under natural conditions most of the wetlands in the Kerang Lakes system would have filled intermittently with floodwaters from the Loddon River (via Washpen Creek and Wandella Creek). Once First Reedy Lake was full, water would travel to Middle Reedy Lake then onto Third Reedy Lake. This means that Third Reedy Lake would have flooded less frequently and experienced a more prolonged drying phase compared to Middle and First Reedy Lake (SKM 2008). During high flow events, Third Reedy Lake could also receive water via Sheepwash Creek to the east and would convey water to Little Lake Charm via Scotts Creek at the western boundary (SKM 2010).

In 1925 a number of lakes, including Third Reedy Lake, were included in the Torrumbarry Irrigation System and became permanent freshwater lakes – now receiving the majority of their water from the Murray River via diversion at Torrumbarry Weir. From Torrumbarry Weir, water is diverted into the National Channel, Kow Swamp, Pyramid Creek and the Kerang Weir. Regulated flows also pass along Washpen Creek and outfall into Reedy Lake and ultimately Third Reedy Lake (North Central CMA, 2016). Water from Third Reedy Lake is then supplied to irrigation channels to the west (Torrumbarry No 7 Channel) and north (Torrumbarry No 1/7 Channel).

Unregulated flood flows originating from the Loddon River (via Washpen Creek), and flood water from Wandella Creek can still enter the system, initially into First Reedy Lake and then once full, onto Middle Reedy Lake and then Third Reedy Lake.

2.1.7 Regional groundwater

Third Reedy Lake is part of the Riverine Plains region, comprising the fluvial plains of the Murray, Murrumbidgee, Goulburn and Lachlan Rivers and their tributaries. A major feature of these plains is the lunette, a crescent-shaped ridge of up to 4 or 5 m on the eastern side of the lakes comprised of sand, silt, clay. These are aeolian in nature and often contain pellets of salts including gypsum (Rosengren, 1992).

The stratigraphy underlying Third Reedy Lake and its surrounds includes a thin (≤5 m) upper layer of Quaternary clays that are aeolian, lacustrine and fluvial in nature, as well as fluvial sands and gravels. The Quaternary deposits are underlain by 20-30 m of relatively impermeable grey clays of the Shepparton Formation, which are subsequently underlain by >30 m of Loxton Parilla Sands. Groundwater in the Shepparton Formation aquifer (and Parilla Sand aquifer) is generally brackish close to the Reedy Lakes (Reedy, Middle and Third) (GMW, 2015).

A conceptual model of the regional groundwater systems was developed by URS (2013) for the KLBP bypass lakes (including Third Reedy Lake) (Figure 2-2). The Parilla Sand aquifer situated below the Shepparton Formation aquifer is important at a regional scale but in the context of Third Reedy Lake it plays little part in the salinity or acid sulphate risk assessment due to the lower (by several orders on magnitude) hydraulic conductivity of the overlying Shepparton Formation sediments, and the relatively small vertical hydraulic gradient between the two formations (in the study area).

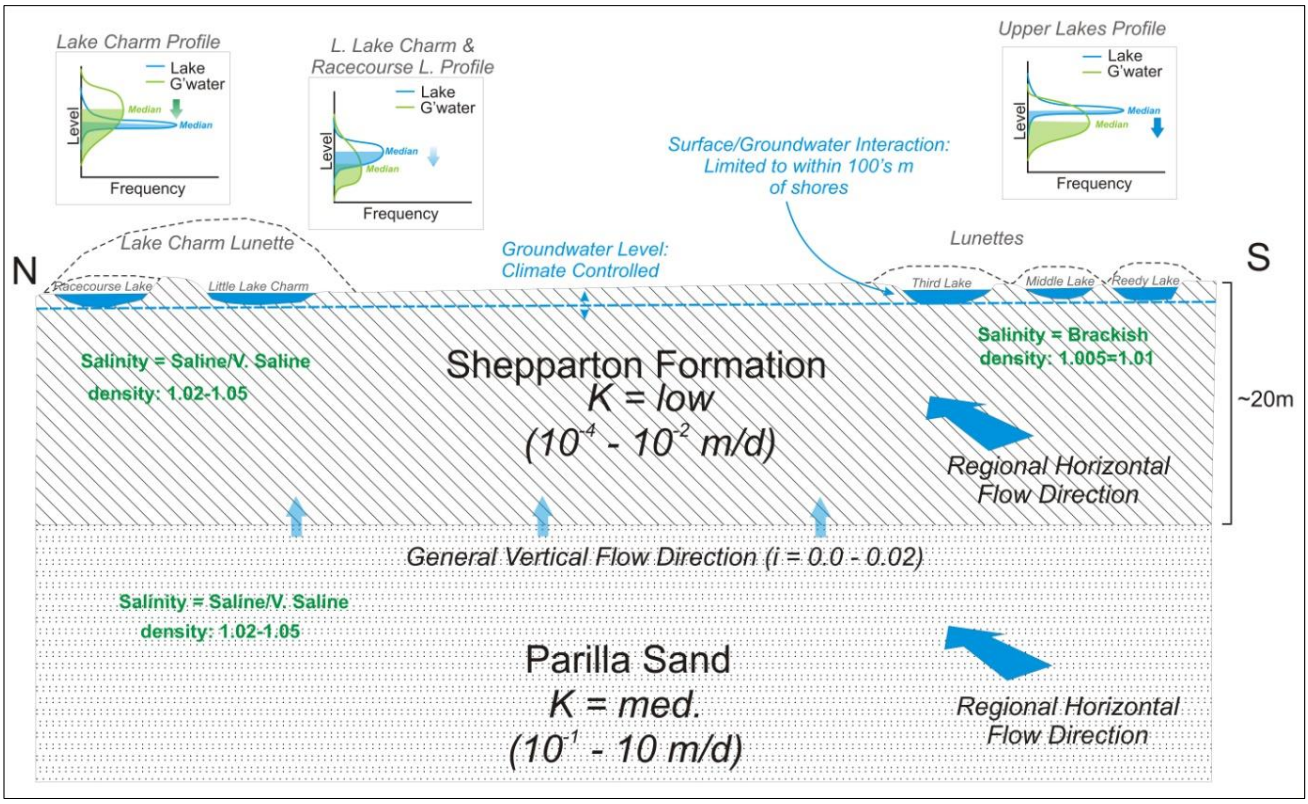

Figure 2-2: Kerang Lakes Bypass Conceptual Model (Source: URS, 2013)

2.2 Local characteristics

Third Reedy Lake supports a range of environmental values, some of which have established because of its current, permanent, water regime. These are described in detail in the Project Environmental Report (Jacobs, 2017a) and briefly summarised below.

2.2.1 Flora values

The current vegetation communities and records of individual species has been described by Rakali Consulting (2013) and Cook and Bayes (2014). Mapping of Ecological Vegetation Communities (EVCs) (Rakali Consulting, 2013 and Cook and Bayes, 2014) has identified three EVCs associated with the current water regime of the lake (Tall Marsh – EVC821, Intermittent Swampy Woodland – EVC813 and Aquatic Herbland – EVC 653) (Table 2-2 and Figure 2-3).

Table 2-2: Ecological vegetation communities recorded at Third Reedy Lake (from Rakali Consulting, 2013)

EVC No.: EVC Name	Bioregional Conservation Status (Victorian Riverina)	General vegetation description (Rakali, 2013)
EVC653: Aquatic Herbland	Not listed for Victorian Riverina (Vulnerable in Murray Fans bioregion)	Small, localised areas of Aquatic Herbland occur in association with Tall Marsh. Species included: *Ludwigia peploides* subsp. *montevidensis* (Clove-strip), *Myriophyllum papillosum* (Robust Water-milfoil) *Persicaria decipiens* (Slender Knotweed)
EVC813: Intermittent Swampy Woodland	Depleted	Overstorey of *Eucalyptus camaldulensis* (River Red Gum), with an understorey including *Duma florulenta* (Tangled Lignum), *Rhagodia spinescens* (Hedge Saltbush), *Cressa australis* (Rosinweed), *Cyperus gymnocaulos* (Spring Flat-sedge) and *Sporobolus mitchellii* (Rat-tail Couch). Littoral species *Eleocharis acuta* (Common Spike-rush), *Amphibromus nervosus* (Veined Swamp Wallaby-grass), *Eragrostis infecunda* (Barren Cane-grass) and *Carex tereticaulis* (Poong'ort) are locally dominant. Includes a range of herbs characteristic of seasonal inundation including *Marsilea drummondii* (Common Nardoo), *Senecio runcinifolius* (Tall Fireweed) and the rare *Asperula gemella* (Twin-leaf Bedstraw).
EVC821: Tall Marsh	Depleted	Occurs around the wetland perimeter; dominated by reeds, rushes and sedges. *Typha orientalis* (Broad-leaf Cumbungi) and *Typha domingensis* (Narrow-leaf Cumbungi) often formed mixed stands with *Schoenoplectus tabernaemontani* (River Club-rush); with small patches of *Juncus ingens* (Giant Rush) and occasionally *Phragmites australis* (Common Reed).

Third Reedy Lake has a high density of dead River Red Gums (*Eucalyptus camaldulensis*) across the entire shallow open water zone which provide evidence of its pre-regulated condition as a River Red Gum dominated intermittent wetland. The lake is devoid of aquatic vegetation; although, it is noted that in the 1990s, the open water zone had abundant of Robust Water-milfoil (*Myriophyllum papillosum*) and Clove-strip (*Ludwigia peplodies subsp. montevidensis*) (North Central CMA, 2014). Emergent vegetation (Tall Marsh EVC821) fringes the open water area with *Typha* spp. and *Juncus* spp. extending for approximately 50 metres from the edge of the wetland to depths of about 0.3-0.7 metres. Small (<10 m^2) patches of rushes and aquatic herbs are present in some isolated areas. The boundary of Third Reedy Lake is characterised by River Red Gum and, to a lesser extent Black Box (*Eucalyptus largiflorens*) overstorey, with a shrubby understorey predominantly Tangled Lignum (*Duma florulenta*) representative of Intermittent Swampy Woodland EVC813.

Six species of plants with conservation significance have been recorded at Third Reedy Lake, which also occur around Middle and First Reedy Lakes (Cook and Bayes 2014). Of these, only the Winged Water-starwort (*Callitriche umbonate*) is a listed (*FFG Act 1988*) species (Table 2-3). Three other threatened species are potentially present but have not been recorded in the area of potential impact (the *EPBC Act 1999* and *FFG Act 1988* listed Chariot Wheels, Winged Peppercress and Slender Darling-pea). An assessment of the habitat preferences for each species was undertaken to determine their likelihood of occurrence at Third Reedy Lake (Jacobs 2017 and summarised in Table 2-3), this included an assessment of any critical habitat identified in a species recovery plan or habitat listed on the Register of Critical Habitat under the *EPBC Act 1999*.

The freshwater EVCs identified at Third Reedy Lake have a combined cover of 3,278 hectares within the Kerang Wetlands Ramsar Site, occurring at Little Lake Charm, Lake Charm, Kangaroo Lake, Racecourse Lake, the Reedy Lake Complex, Lake Bael Bael and the Avoca Marshes, Hird Swamp and Johnson Swamp. The extent of freshwater EVCs at Third Reedy Lake is less than 10% of that found across the 23 Ramsar wetlands (Rakali Consulting, 2013). Furthermore, the Project Environmental Report (Jacobs 2017b) concluded that Third Reedy Lake does not provide critical habitat for any plant species of conservation significance.

Table 2-3 Plants of conservation significance recorded at Third Reedy Lake or potentially present at the lake. Shaded rows represent species for which detailed impact assessment has been undertaken (see Jacobs, 2017a).

Common Name	Scientific Name	Vic advisory / FFG #	EPBC @	Likelihood of presence at Third Reedy Lake
Twin-leaf Bedstraw	*Asperula gemella*	r		High - Recorded associated with existing Intermittent Swampy Woodland (EVC) (Rakali Consulting 2013)
Flat-top Saltbush	*Atriplex lindleyi* subsp. *lidleyi*	k		High - Recorded associated with existing Intermittent Swampy Woodland (EVC) (Rakali Consulting 2013)
Winged Water-starwort	*Callitriche umbonata*	r, L		High - Recorded associated with existing Intermittent Swampy Woodland (EVC) (Rakali Consulting 2013)
Spiny Lignum	*Duma horrida subsp. Horrida*	r		High - Recorded associated with existing Intermittent Swampy Woodland (EVC) (Rakali Consulting 2013)
Winged Peppercress*	*Lepidium monoplocoides*	En.L	En	Low - Not recorded in direct association with Third Reedy Lake or bypass area.
Chariot wheels*	Maireana cheelii	V,L	V	Medium - Not recorded in direct association with Third Reedy Lake or bypass area but has been recorded south west of First Reedy Lake (Rakali Consulting 2013).
Dark Roly-poly	*Sclerolaena muricata var. muricata*	k		High - Recorded associated with existing Intermittent Swampy Woodland (EVC) (Rakali Consulting 2013)
Branching Groundsel	*Senecio cunninghamii var. cunninghamii*	r		High - Recorded associated with existing Tall Marsh (EVC) (Rakali Consulting 2013)
Slender Darling-pea*	*Swainsona murrayana*	En,L	V	Low - Not recorded in direct association with Third Reedy Lake or bypass area.

* Species specifically included in the Bilateral Agreement
Vic Advisory / FFG: Ce – critically endangered, En – endangered, V – vulnerable, r – rare, NT – near threatened, k - insufficient known / L – listed, I - rejected for listing as threatened; taxon invalid
EPBC: Ce – critically endangered, En – endangered, V – vulnerable

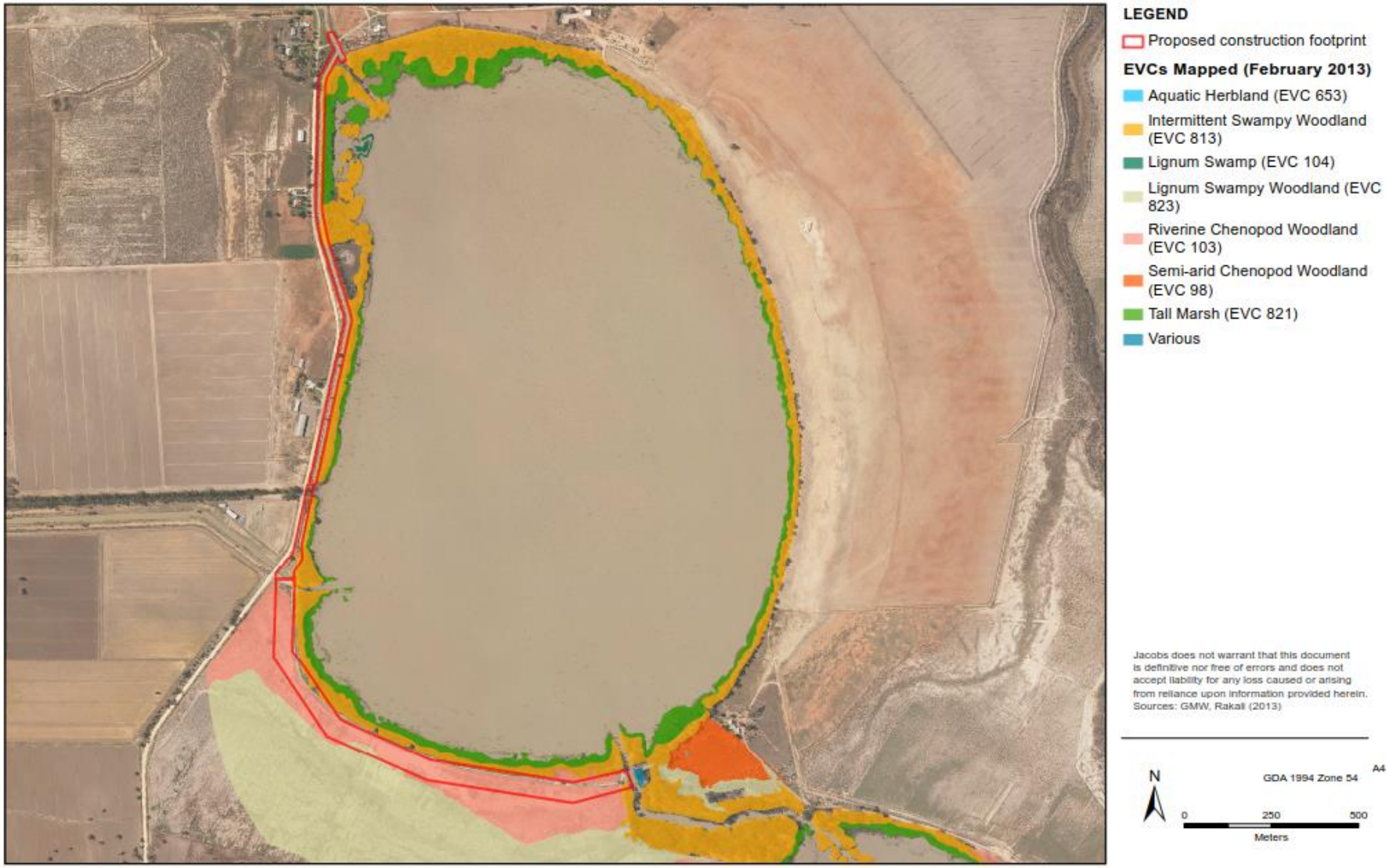

Figure 2-3: Mapped EVCs associated with the current water regime of the lake (Rakali, 2013)

2.2.2 Fauna values

Third Reedy Lake provide habitats for a range of animals due to its extensive fringing aquatic vegetation, abundant snags (that provide good perching, basking and roosting locations) and permanent open water for fish. A number of fauna surveys have been undertaken at Third Reedy Lake and the broader Kerang Lakes system. These include Ho et al. 2006; SKM 2010; Rakali Consulting, 2013; Biosis, 2013; DEPI, 2013 and BirdLife Australia records (http://birdlife.org.au).

Thirty-two waterbird species have been recorded at Third Reedy Lake. Species include fish-eaters, shoreline foragers, deep-water foragers and waders. Species of conservation value (i.e. listed threatened species and/or species listed on International migratory bird agreements) recorded at the lake include Eastern Great Egret (*Ardea modesta*), Little Egret (*Egretta garzetta*), White-bellied Sea Eagle (*Haliaeetus leucogaster*), Caspian Tern (*Anas caspia*) and Musk Duck (*Biziura lobata*). There are no records of Third Reedy Lake supporting significant waterbird breeding events; most records appear to relate to foraging or fly-over observations.

Ten native and six exotic fish species have been recorded in Third Reedy Lake. The most abundant fish species recorded in the most recent survey by Biosis (2013) was the exotic Common Carp (*Cyprinus carpio*) (37% of catch abundance and 99% of the biomass), followed by the common and widespread native Carp Gudgeon (*Hypseleotris compressa*) (30% of catch abundance but just 0.02% of biomass). Other abundant species include Australian Smelt (*Retropinna semoni*) and Flathead Gudgeon (*Philypnodon grandiceps*).

Five of the native fish species previously recorded are of conservation significance (Murray Cod, Silver Perch, Freshwater Catfish, Golden Perch, Flathead Galaxias). All are listed under the *Flora and Fauna Guarantee (FFG) Act 1988* and Murray Cod, Silver Perch and Flathead Galaxias are also listed under the *EPBC Act 1999*. Murray Cod (and Golden Perch) are likely to be the result of stocking (Hunt et al. 2010) but have not been recorded since 2006. Silver Perch have not been recorded since 2006, although they were recorded in the connecting channel between Third Reedy and Middle Reedy Lakes in 2013 (Biosis 2013) and are assumed to be occasionally present in the lake. Flathead Galaxias have not been recorded since 1963 and are believed to be locally extinct (North Central CMA, 2014). Freshwater Catfish were last recorded in 1981. Catfish prefer dense aquatic vegetation, and the lake has not supported extensive submerged vegetation since the 1990s (North Central CMA, 2014). A single Murray Hardyhead (*FFG Act 1988* and *EPBC Act 1999* listed) was recorded in Middle Reedy Lake in 2013 (Biosis, 2013), but follow up targeted surveys failed to find any Murray Hardyhead in either Middle Reedy Lake or Third Reedy Lake (Sharpe, C. 2014).

Two turtle species, the *FFG Act 1988* listed Murray River Turtle (*Emydura macquarii*) and Common Long-necked Turtle (*Chelodina longicollis*), have also been recorded at Third Reedy Lake. Although the Murray River Turtle was recorded in high numbers in 2006 (total of 19 individuals), no individuals were caught during the survey by Biosis (2013) and only one Common Long-necked Turtle was recorded compared to three by Ho et al. (2006).

Three common frog species have been recorded, however, the Bilateral Agreement has identified the site may support suitable habitat for the *FFG Act 1988* listed Brown Toadlet (*Pseudophryne bibronii*).

A total of 14 macroinvertebrates families were recorded at Third Reedy Lake in a recent survey (Biosis, 2013) compared to 15 by Ho et al. in 2006. Compared to the 2006 survey, the macroinvertebrate taxa recorded in 2013 are substantially different, with a lack of aquatic molluscs (*Planorbidae* and *Physidae*) and some dipteran larvae (*Ceratopogonidae* and *Sciomyzidae*). The change in assemblage may be attributed to non-ideal weather conditions for macroinvertebrates during the survey conducted in February-March 2013 compared to the earlier surveys which were undertaken over a five month period from November to March (GMW, 2016a).

An assessment of the habitat preferences for each species was undertaken to determine their likelihood of occurrence at Third Reedy Lake (Jacobs 2017 and summarised in Table 2-4), this included an assessment of any critical habitat identified in a species recovery plan or habitat listed on the Register of Critical Habitat under the *EPBC Act 1999*.

Table 2-4 Aquatic fauna of conservation significance recorded at Third Reedy Lake or potentially present at the lake. Shaded rows represent species for which detailed impact assessment has been undertaken (see Jacobs, 2017a).

Common Name	Scientific Name	Vic advisory / FFG #	EPBC @	Likelihood of presence at Third Reedy Lake
Fish				
Silver Perch*	*Bidyanus bidyanus*	V,L	CE	Medium - Previously recorded from Third Reedy Lake (last record from 2006 despite several recent surveys).
Murray Hardyhead*	*Craterocephalus fluviatilis*	Ce,L	En	Low - Has not been recorded in Third Reedy Lake despite numerous surveys, but was recorded in Middle Reedy Lake (1 individual in 2013 – Biosis 2013) so potential to be present in Third Reedy Lake,
Unspecked Hardyhead+	*Craterocephalus stercusmuscarum fulvus*	L		High - Recorded from Third Reedy Lake in recent surveys (Biosis 2013).
Flathead Galaxias*	*Galaxias rostratus*	V,I	Ce	Low - Not recorded in the Kerang Lakes since 1963 (First Reedy Lake) (North Central CMA, 2014). While they may be present in the broader landscape (Biosis 2013), they have not been detected in numerous recent surveys at Third Reedy Lake and are considered locally extinct.
Murray Cod*	*Maccullochella peelii*	V,L	V	Medium - Previously recorded from Third Reedy Lake (last record from 2006 despite several recent surveys).
Golden Perch	*Macquaria ambigua*	NT,I		High - Recorded from Third Reedy Lake in recent surveys (Biosis 2013).
Macquarie Perch*	*Macquaria australasica*	En,L	En	Low - Not been recorded in the Kerang Lakes and the last recorded Macquarie Perch west of Torrumbarry Weir was in 1949 (Cadwallader 1977) and is considered extinct from the area.
Freshwater Catfish*	*Tandanus tandanus*	En,L		Low - Previously recorded from Third Reedy Lake (last record 1981). Lack of submerged vegetation means the lake in its current form no longer provides suitable habitat for this species.
Frogs				
Growling Grass Frog	*Litoria raniformis*	En, L	V	Low - Not recorded from Third Reedy Lake but suitable habitat may be present
Brown Toadlet*	*Pseudophryne bibronii*	En,L		Low - Not recorded from Third Reedy Lake. Prefers grasslands and forests where eggs are laid under leaf litter and tadpoles develop in wet depressions and is not reliant on permanent wetlands.
Turtles				
Murray River Turtle*	*Emydura macquarii*	V		High - Recorded in low numbers in Third Reedy Lake in recent surveys (Biosis 2013).

* Species specifically included in the Bilateral Agreement
+ Unspecked Hardyhead was not included in the April 2013 release of the Advisory List of Threatened Vertebrate Fauna in Victoria (DSE, 2013). The species has been reassessed as abundant across many locations within Victoria, however it is currently gazetted under FFG (March 2017).
Vic Advisory / FFG: Ce – critically endangered, En – endangered, V – vulnerable, r – rare, NT – near threatened, k - insufficient known / L – listed, I - rejected for listing as threatened; taxon invalid
EPBC: Ce – critically endangered, En – endangered, V – vulnerable

2.2.3 Ecological condition and trajectory

Although a number of vegetation communities and individual plant and animal species of conservation significance have been recorded at Third Reedy Lake, none of these communities or species are considered to be reliant on Third Reedy Lake for critical habitat (Jacobs 2017a). Furthermore, none of the values recorded at Third Reedy Lake are critical for maintaining the characteristics of the broader Kerang Lakes Ramsar Site – the lake does not contribute to any of the individual criteria for which the Kerang Lakes Ramsar Site is listed (Jaocbs 2017a).

Based on the condition assessment provided in Rakali Consulting (2013) and a review of the project by the GMW Expert Review Panel, it was considered that Third Reedy Lake has suffered ecological decline as a result

of the artificial flow regime from irrigation. However, the lake is considered to now be in a reasonably stable state (equilibrium) and reinstating a wetting-drying regime more closely aligned with natural conditions is likely to improve the conservation value of the lake (Figure 2-4).

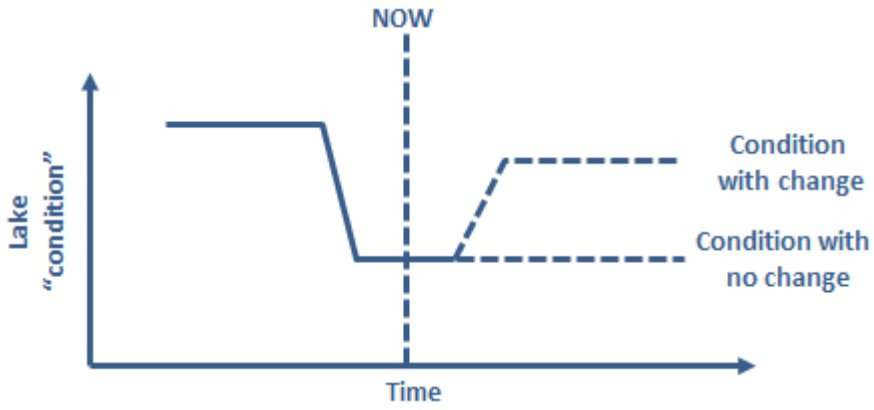

Figure 2-4: Possible future trajectories following a step change deterioration in lake condition (RMCG, 2015).

2.2.4 Local hydrology and bathymetry

As discussed in Section 2.1.6, the lake currently forms part of the Torrumbury Irrigation System. Water enters the lake via the Middle Reedy Lake to Third Reedy Lake inlet channel. Water leaves the lake via the Torrumbarry No. 7 channel and Torrumbarry No 1/7 channel during regulated flow conditions, or Scott's Creek during unregulated flood events. Figure 2-5 shows the location of these key inlet and outlets.

Under regulated conditions water levels are maintained at a maximum of 74.56 m AHD (full supply level) and a minimum of 74.2 m AHD, with the lake operating above 74.47 m AHD for 95% of the time and a level of 74.56 m AHD for 50% of the time. The wetland is constantly kept at full supply level between 1 August and 31 January. After 31 January, the lake can be drawn down for irrigation purposes by up to 30 cm and in some cases, generally at the end of the irrigation season, the wetland can be further drawn down by evaporation (North Central CMA, 2014).

The bathymetry of Third Reedy Lake (Figure 2-6) shows a maximum depth of 1.66 metres (bed elevation 72.9m AHD[1]) with a slight gradient of 0.4 metres to the littoral zone (at 73.6 m AHD). The bed of the lake is relatively flat, with only minor variations in depth (North Central CMA, 2014) and it has relatively steep sides; 50% of the area of the lake bed has a level of 73.3 -73.4 mAHD.

The capacity of the lake at full supply level (FSL) is 2459 megalitres (ML).

[1] There are inconsistencies in various reports about the elevation of the floor of Third Reedy Lake (e.g. 72.8m AHD, 73.2m AHD, 72.77m AHD, 72.77m AHD, 73.17m AHD, 72.9m AHD) however the differences are not material in terms of lake area or volume.

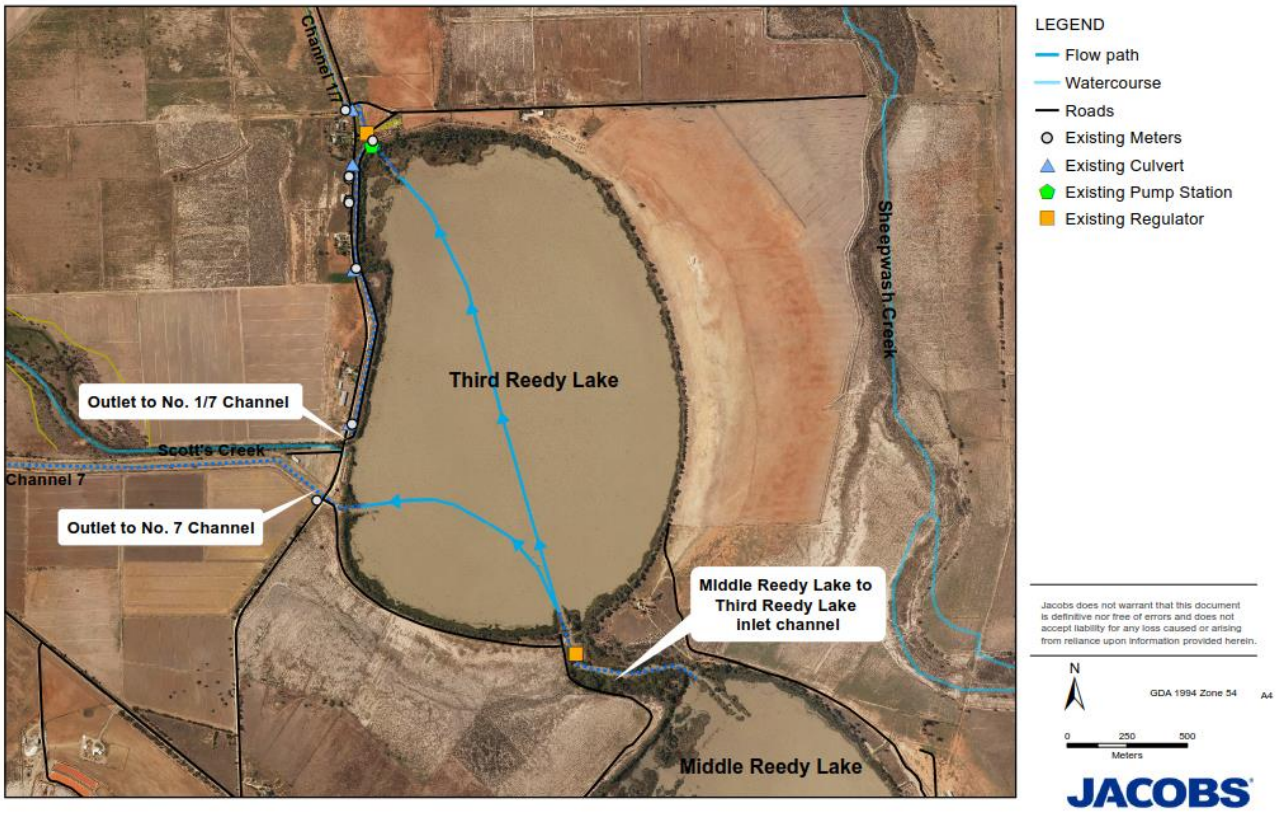

Figure 2-5 Third Reedy Lake inlet and outlet pathways.

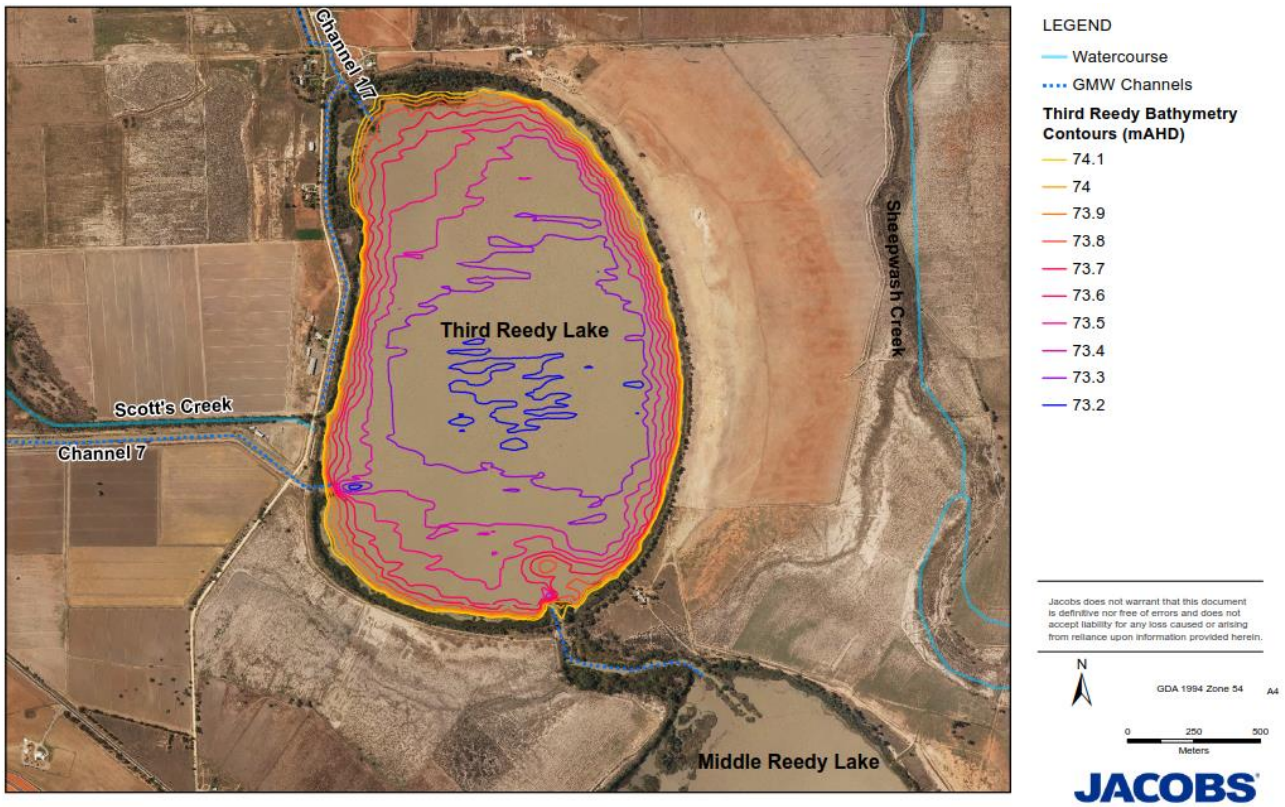

Figure 2-6: Third Reedy Lake Bathymetry

2.2.5 Local groundwater

Monitoring of groundwater-surface gradients, major ion chemistry and stable water isotopes ($\delta^{18}O$/ $\delta^{2}H$) (Jacobs, 2017b) indicate that the surface water in Third Reedy Lake infiltrates into the underlying groundwater system (i.e. it is a losing system). However, there is a small chance that if regional groundwater levels are high during lake drying, the groundwater surface-water gradient could reverse for a period of time, resulting in groundwater seepage to the lake (i.e. change to a gaining system). The groundwater underlying Third Reedy Lake is brackish, so any seepage towards the lake could increase lake salinity compared to the current concentration.

3. Approach to restoration

The Project proposes to restore Third Reedy Lake by reinstating a more natural watering regime by disconnecting the lake from the Torrumbarry Irrigation System. When implemented, the water regime will change from permanently full to one that includes wetting and drying. In response to this changed regime, the lake is expected to progressively transition from being largely devoid of live vegetation to a River Red Gum dominated wetland, with a diversity of understorey plants.

The following sections describe the approach to achieving the management goal, including definition of management units, expected vegetation response, ecological objectives and hydrological requirements.

3.1 Management goal

The overall management goal for Third Reedy Lake was developed as part of the *Kerang Lakes Bypass Investigation Project Technical Report – Third Reedy Lake* (North Central CMA, 2014).

Third Reedy Lake long term management goal

"Achieve projected water savings whilst providing a watering regime that restores Third Reedy Lake to a deep freshwater marsh wetland type (dominated by Intermittent Swampy Woodland (EVC 813)) able to support recruitment of River Red Gums and promoting a diverse and extensive range of habitat suitable for a variety of waterbirds"

The essential elements of the management goal are therefore to provide a water regime that supports the reestablishment of vegetation typical of a deep freshwater marsh.

3.2 Management units

Third Reedy Lake has been divided into two broad management units (Wetland Fringe and Wetland Bed) and further divided into zones based on the wetland topography (see Figure 2-6) which influences the depth and duration of flooding (Table 3-1 and Figure 3-1).

Table 3-1: Management units and predicted vegetation response under an intermittent watering regime

Management Unit	Wetland fringe		Wetland bed		
Zone	Dry zone	Wet zone	Shallow zone	Transition zone	Deep zone
Indicative elevation (mAHD)	>74.56	74.2 to 74.56	73.4 to 74.2	73.25 to 73.4	72.9-73.25
Receives environmental water	No	Yes	Yes	Yes	Yes
Area inundated at upper limit of zone elevation (Ha)	-	230	218	125	49
Volume at upper limit of zone elevation (ML)	-	2459	1652	135	12

The spatial distribution of the management units and zones at Third Reedy Lake is shown in Figure 3-1.

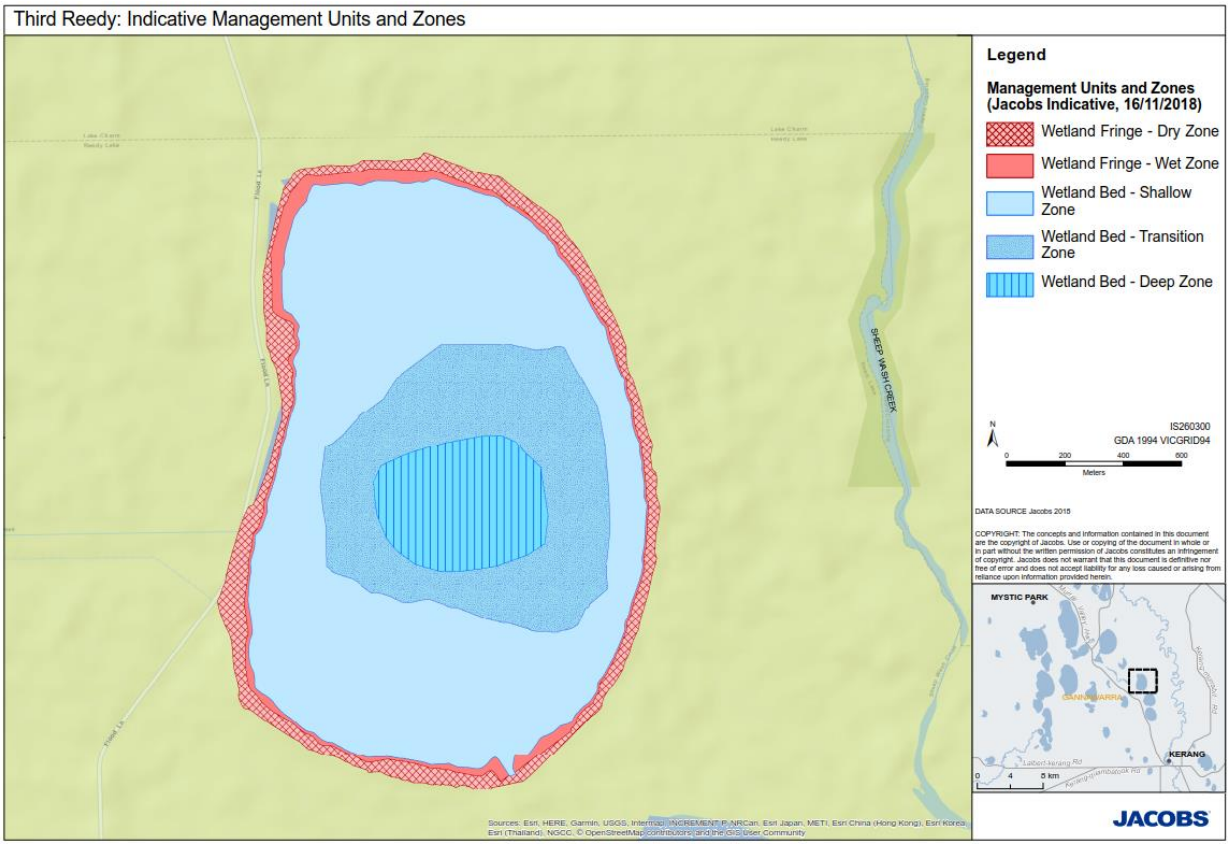

Figure 3-1: Spatial representation of management units at Third Reedy Lake

3.3 Expected vegetation response

The depth and duration of inundation associated with each of the management units and zones influences the type of vegetation communities that may occur at Third Reedy Lake, which ultimately provide the criteria against which success of the Project will be assessed. Broadly:

- Most of the wetland is expected to be covered by Intermittent Swampy Woodland (EVC 813) and Intermittent Swampy Woodland/ Lake Bed Herbland Complex (EVC A119), with Aquatic Herbland (EVC 653)/Lake Bed Herbland (EVC 107) occurring in the deeper parts of the lake bed, and
- the presence of Tall Marsh (EVC 821) is expected to contract and possibly disappear under the drier regime. Stands of *Phragmites australis* and *Juncus ingens* may persist, becoming integrated into the Intermittent Swampy Woodland.

Table 3-2: Management units and predicted vegetation response under an intermittent watering regime

Management Unit	Zone	EVC	Bioregional conservation status
Wetland fringe	Dry zone	EVC 813	Depleted
	Wet zone		
Wetland bed	Shallow zone	EVC A119	Not classified
	Transition zone		
	Deep zone	EVC 653/107	653: Not listed for Victorian Riverina (depleted for Murray Fans); 107: Depleted

A brief description of the vegetation communities expected to occur within each management unit is provided below.

3.3.1 Wetland fringe management unit

The wetland fringe management unit is expected to support plant species characteristic of the Intermittent Swampy Woodland vegetation community (EVC 813). The floristic composition is expected to vary within the unit driven by topography and is described as two zones. The primary difference between each of these zones is:

- the presence of Black Box trees at higher elevations of the management unit that will not be inundated by environmental water (dry zone)
- a transition in the understorey plants from flood tolerant species at higher elevations to the occurrence of flood dependent species at lower lying areas of the management unit that will be inundated through environmental watering.

Dry zone

The dry zone represents the higher elevation areas (e.g. above 74.56 mAHD) fringing the wetland that will not be inundated by the delivery of environmental water (but may be flooded occasionally by extremely large natural flood events).

This zone currently supports a canopy of River Red Gum with some areas of Black Box. The tree canopy may become more open under an intermittent water regime as the trees adjust to reduced water availability. It is possible that, over time, Black Box may become more dominant and some loss of River Red Gums may occur. This zone should support an open shrub-layer of Tangled Lignum and Willow Wattle (*Acacia salicina*). The ground layer of this zone will be composed of sedges, grasses and other herbs tolerant of flooding but not reliant on regular inundation such as Spiny Flat-sedge (*Cyperus gymnocaulis*), Australian Salt-grass (*Distichlis distichophylla*) and Grassy Bindweed (*Convolvulus remotus*).

Wet zone

The wet zone represents the lower elevation areas (e.g. between 74.2 and 74.56 mAHD) fringing the wetland that will be subject to periodic inundation from environmental watering.

Much of this zone currently supports a canopy of River Red Gum and areas that do not currently support trees are likely to be rapidly colonised by River Red Gums under the proposed water regime. This zone should support an open to relatively dense shrub-layer of Tangled Lignum and Eumong (*Acacia stenophylla*). The ground layer of this zone will be composed of sedges, grasses and other herbs that are responsive to regular inundation such as Common Spike-sedge (*Eleocharis acuta*), Common Swamp Wallaby-grass (*Amphibromus nervosus*), Upright Milfoil (*Myriophyllum crispatum*) and Red Pondweed (*Potamogeton cheesemanii*).

3.3.2 Wetland bed management unit

The wetland bed management unit is expected to be characterised by:

- Intermittent Swampy Woodland/Lake Bed Herbland Complex (EVC A119) across most of the wetland bed, transitioning to
- Aquatic Herbland (EVC 653)/Lake Bed Herbland (EVC 107) in the lower lying areas where inundation is deeper and more prolonged.

When inundated, water in this management unit will be up to 1.66 m deep and persist for approximately 12 to 18 months in deeper areas, depending on climatic conditions. It is more likely that duration will be at the lower end of this range, as lack of shading may result in warmer water temperatures and higher evaporation rates. The floristic composition is expected to vary across the bed with duration of inundation, as described below.

Shallow zone

The area between 73.4 and 74.2 m AHD is expected to be characterised by Intermittent Swampy Woodland/Lake Bed Herbland Complex (EVC A119) and covers a significant area of the lake. Flooding within this zone will be shallower (up to 1.16 m in depth at FSL) and will evaporate more quickly that other areas of the wetland (around 6 to 9 months depending on the timing of filling).

This zone is currently devoid of living River Red Gum and initial water management will be geared towards restoring the reestablishment of this species, ideally via seed drop from the wetland fringe management unit, which currently supports mature River Red Gum and supported by targeted revegetation. The tree density in this zone should be about 10 to 15 mature trees per hectare. This zone may support an open shrub-layer of Tangled Lignum and Eumong, particularly in the transitional area between the wetland fringe and wetland bed management units.

The ground layer of this zone will vary depending on whether the wetland is in a wet phase or a dry phase. When wet this zone should support a range of floating and submerged aquatic plant species including Robust Milfoil, Billabong Pondweed (*Potamogeton sulcatus*), Curly Pondweed (*Potamogeton crispus*) and Eel Grass (*Vallisneria australis*) with at least 30% cover. When dry the bed of the wetland should support at least 50% cover of species that germinate in drying mud including Common Blown-grass (*Lachnagrostis filifolia*), Pale Knotweed (*Persicaria lapathifola*), Clammy Goosefoot (*Dysphania pumilio*), Australian Hollyhock (*Malva weinmanniana)* and Southern Liquorice (*Glycyrrhiza acanthocarpa*).

Transition zone

The transition zone is the area between 73.25 to 73.4 mAHD. Inundation in this area will be up to 1.56 m deep (at FSL) for 9-11 months but more often around 1 m in depth or less as drawdown proceeds, approaching the limits of River Red Gum tolerance to inundation if flooding persists for more than 6 months. Species found within this area are likely to represent a shift toward the Aquatic Herbland EVC with species characteristic of the Intermittent Swampy Woodland EVC (such as lignum and sedges) disappearing from the floristic structure. The presence of River Red Gum within this zone is likely to be at a lower density than the adjacent shallow zone, possibly disappearing altogether as it approaches the deep zone because of deeper and longer duration inundation.

Deep zone

The deep zone represents the area below 73.25 m AHD (1.66 m at FSL inundation) and is expected to be inundated for 12-18 months, depending on climatic conditions. The longer period of inundation is expected to favour Aquatic Herbland (EVC 653) during the wetted phase, transitioning to Lake Bed Herbland (EVC 107) after being dry for 6 months. When inundated the zone may be open water, particularly after the wetland has just filled.

Vegetation found within the Aquatic Herbland EVC is typical of that found in semi-permanent and seasonal wetlands but will depend on factors such as hydroperiod and turbidity. It typically lacks woody species (or nearly so) therefore the reestablishment of River Red Gums within this area of the lake is not anticipated, or may be at very low densities. This represents a major different between the transition and deep zones of this management unit. Vegetation found within the Lake Bed Herbland is dominated by species adapted to drying mud within lake beds, that persist during periods of inundation as seed or dormant tuberous rootstocks. Indicator species include Common Nardoo (*Marsilea drummondii*), Milfoil (*Myriophyllum spp*) and Pondweed (*Potamogeton spp.*).

The plant species expected to occur in association with each of the Management Units is provided in Appendix C.

3.4 Ecological objectives

As the management goal focuses on vegetation (including plant habitat used by waterbirds), the key drivers of future water management at Third Reedy Lake are those objectives related to vegetation. The objectives

developed by the North Central CMA (2014) have been adapted for use in this Operational Environmental Management Plan and are:

Third Reedy Lake ecological objectives relevant to the long term management goal

- Maintain the health of remnant Black Box and River Red Gum trees surrounding Third Reedy Lake
- Facilitate the establishment of River Red Gum trees across the bed of the lake
- Restore a diverse ground layer of vegetation in the inundated zones of the wetland, characteristic of a deep freshwater marsh.

For the purposes of these objectives:

- 'Surrounding Third Reedy Lake' is defined as the Wetland Fringe Management Unit
- 'Across the bed of the lake' is defined as the Wetland Bed Management Unit. Noting that variations in the density of River Red Gums are likely to occur across the shallow, transitional and deep zones of the Wetland Bed Management Unit.
- 'Inundated zones of the wetland' are defined as those areas below full supply level (74.56 mAHD) and correspond to the Wetland Bed Management Unit
- 'Vegetation characteristic of a deep freshwater marsh' means:
    - Intermittent Swampy Woodland (EVC 813) at elevations between 73.4 and 74.56 mAHD (Wetland Bed Management Unit – Shallow Zone).
    - Intermittent Swampy Woodland/Lake Bed Herbland Complex (EVC A119) at elevations between 73.25 and 73.4 mAHD (Wetland Bed Management Unit – Transitional Zone)
    - Aquatic Herbland (EVC 653) alternating with Lake Bed Herbland (EVC 107) during wet and dry phases respectively at elevations below 73.25 mAHD in areas of deeper and more prolonged inundation (Wetland Bed Management Unit – Deep Zone).

3.5 Hydrological considerations

The management goal for Third Reedy Lake aims to return it to a deep freshwater marsh wetland type with an intermittent water regime. As the most downstream lake in the Reedy Lakes complex (i.e. the last to receive water), this reflects the natural wetting and drying regime Third Reedy Lake is likely to have experienced before inclusion in the irrigation supply system.

The water requirements of the vegetation communities expected to occur at Third Reedy Lake is presented in Table 3-3 and are based on the *Guide to Water Regimes of Victorian wetland Ecological Vegetation Classes* (Frood and Papas, 2016). The water requirements reflect variability in both the frequency, duration and depth of inundation, as uniformity in the water regime in undesirable.

Table 3-3: Water requirements for EVCs predicted to occur at Third Reedy Lake (adapted from Frood and Papas, 2016)

EVC	Frequency in 10 years	Duration (months)		Depth (m)	Comments
		Range	Maximum		
Intermittent Swampy Woodland 813	3 to 7	1 to 6	9	0.3 to 1m	Can tolerate depths of up to 2 m occasionally. Frequency is based on water requirements for an intermittent wetland.
Intermittent Swampy Woodland/Lake Bed Herbland Complex A119	3 to 7	1 to 6	9	0.3 to 2m	Can tolerate depths of greater than 2 m occasionally. Frequency is based on water requirements for an intermittent wetland.
Lake Bed Herbland 107	3 to 7	>6	Not permanent	0.3 to 2m	Frequency is based on water requirements for an intermittent wetland. This EVC is typically expressed in the dry phase.
Aquatic Herbland 653	8 to 10	>6	Not permanent	0.3 to 2m	Can tolerate occasional periods at greater depths than the preferred range. This EVC is typically expressed in the wet phase.

Frequency of inundation: refers to the usual frequency of inundation that the wetland EVC experiences.

Duration of inundation: represents the typical range and maximum duration of inundation events that the wetland EVC can tolerate.

Depth: represents the maximum depth of sustained or regular inundation experienced (and often tolerated) by the range of species represented in the wetland EVC. Depth will not be uniform across the EVC as the outer edges may be shallower. Depth should be interpreted as an upper limit for deepest part of the range of the EVC.

3.6 Proposed water regime

The proposed watering regime has been developed with regard to the hydrological considerations outlined above (i.e. Table 3-3). It is anticipated that the water requirements may differ while River Red Gums (*Eucalyptus camaldulensis*) become established within Third Reedy Lake, hence the water regime has been divided into two phases, being the:

- **Establishment phase (Table 3-4)**: aims to provide opportunities for River Red Gums (*Eucalyptus camaldulensis*) to establish across the Wetland Bed, as well as allow time for high value remnant vegetation (important habitat and cultural heritage trees) in the Wetland Fringe to adapt to drier conditions.
- **Long term operational phase (Table 3-5):** aims to provide a watering regime that maintains Third Reedy Lake as a deep freshwater marsh.

Both the establishment phase and long term operational phases regimes are based on a multi-year cycles of inundation followed by drying prior to the next inundation event (Figure 3-2). The establishment phase commences following the initial lake drawdown and ends once the River Red Gum establishment targets have been achieved. It is difficult to determine with certainty how long the establishment phase will take – it may take several 4-year cycles. Monitoring to track the establishment phase and inform adaptive management (e.g. variations to the water regime, whether active revegetation is required, weed control etc) will be undertaken and

the establishment phase watering regime will continue until revegetation targets are met. This is discussed in more detail in Section 4.

The key differences between each of the phases is the provision of more frequent filling during the establishment phase to facilitate River Red Gum growth and establishment, as illustrated conceptually in Figure 3-2. Once establishment is deemed successful (Section 4.2), the frequency of inundation can decrease.

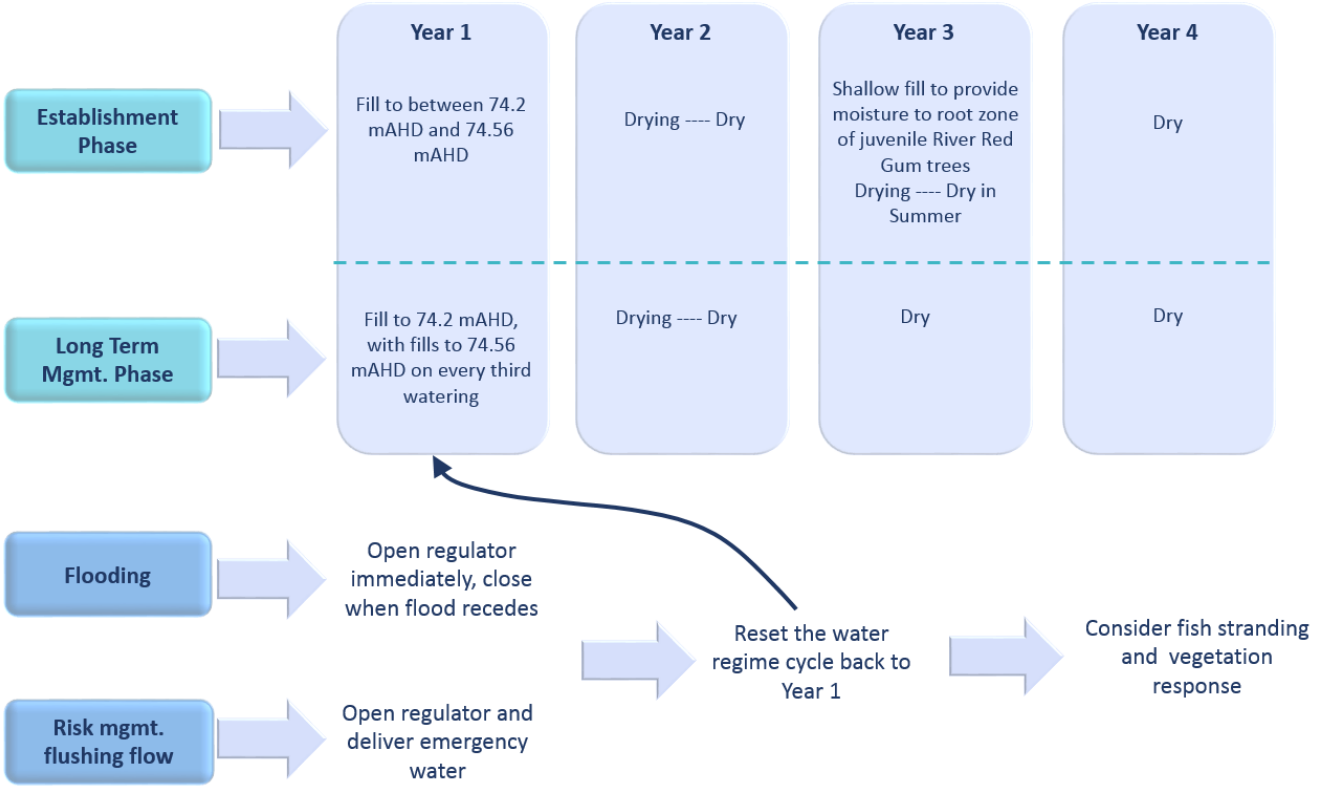

Figure 3-2 Conceptual flow chart of establishment and long term management water regime phases

Figure 3-2 also shows that the water regime at Third Reedy Lake will consider all potential sources of water including environmental water, natural flooding or emergency water provided to manage risks (Section 5). Environmental water will be used to meet the shortfall in the proposed water regime.

During wetter periods Third Reedy Lake receives flood flows arising from the Loddon River (via Washpen Creek) and from Wandella Creek. As such, some of the water requirements for Third Reedy Lake may be met by natural flooding. The proposed water regime should therefore be implemented having regard to the frequency of both naturally occurring and managed events. In the case of a flood event the cycle would reset to Year 1 (i.e. the year of inundation). Moreover, there may be the opportunity to use the spare capacity in the lake to attenuate flooding events throughout the complex. Therefore, the existing flooding operation plan for the Reedy Lakes complex should be updated to reflect the change in operation at Third Reedy Lake.

Management intervention may also be required to ensure the salinity tolerances of vegetation communities are not exceeded; and that the system can respond to variable climate and associated hydrological conditions (e.g. storms and floods). Further details on risk management actions are provided in Section 5.

The proposed water regimes for the establishment and long term phases is provided in Table 3-4 and Table 3-5 respectively, which embed the variability in timing, duration and frequency of flooding that occurs in natural systems. For example, in wetter and cooler climatic conditions the lake bed is likely to be waterlogged for longer durations, providing the soil moisture needed for tree survival. Under these conditions the tolerable intervals between flood events will be longer compared to dry years where there is greater demand and less water.

Table 3-4: Proposed watering regime – establishment phase (GMW, 2016a,b, North Central CMA 2014, Frood and Papas, 2016)

Management Unit	Frequency (years in 10)			Fill level (mAHD)	Duration of ponding (months)	Timing	Comments
	Minimum	Optimum	Maximum				
Wetland Fringe Management Unit – wet zone	1	2	3	74.56	1 – 2 months (est)	Winter – early spring	It is important that water levels are not artificially held at this level and that natural drawdown is allowed (maximum fill rate 50 mm/day).
Wetland Bed Management Unit – shallow and transitional zones	3	4-6	7	Variable up to 74.2	2 to 11 months (est)	Winter – early spring	It is important that water levels are not artificially held at this level and that natural drawdown is allowed. The duration of ponding recognises that the outer edges of this zone (Shallow zone) will dry more quickly than the inner (Transition) zone (maximum fill rate 50 mm/day). Optimum frequency of watering aims to provide suitable soil moisture for River Red Gum establishment. Monitoring should be undertaken to prevent the drowning of juvenile trees on rewatering. Deliveries should cease by early spring to allow a summer-autumn drying regimes
Wetland Bed Management Unit – deep zone	4	6-8	12	73.25	6 months	Autumn to spring	Expected to be variably wet and dry due to local rainfall (based on hydrological by Gippel (2012 updated 2014). Additional benefit includes permanent habitat required for frogs and turtles, sought by North Central CMA (2014).

Table 3-5: Proposed watering regime – long term management phase (GMW, 2016a,b, North Central CMA 2014)

Management Unit	Frequency (years in 10)			Fill level (mAHD)	Duration of ponding (months)	Timing	Comments
	Minimum	Optimum	Maximum				
Wetland Fringe Management Unit – wet zone; Wetland Bed Management Unit – shallow and transitional zone	2	3-4	5	Variable up to 74.56	Up to 12 months (est)	Winter to spring	It is important that water levels are not artificially held at this level and that natural drawdown is allowed (maximum fill rate 50 mm/day).. North Central CMA (2014) recommends filling to higher water levels (above 74.56 mAHD) once in every 12 years and appears to be focussed on the water requirements of Black Box vegetation. This may be insufficient to meet the requirements of remnant River Red Gum or understorey species found within EVC 813. Deliveries should cease by early spring to allow a summer-autumn drying regimes
Wetland Bed Management Unit – deep zone	4	6-8	9	Variable up to 73.2	6 months	Autumn to spring	Expected to be variably wet and dry due to local rainfall (based on hydrological by Gippel (2012 updated 2014). Additional benefit includes permanent habitat required for frogs and turtles, sought by North Central CMA (2014).

3.7 Operationalising the proposed water regime

The actual water regime delivered in any given year will be determined through a Seasonal Watering Proposal and will be informed by this OEMP. The North Central CMA (as the waterway manager for the Kerang Lakes system) will be responsible for annual water planning at Third Reedy Lake through the development of the Loddon Murray Wetlands Seasonal Watering Proposal.

Future decisions to deliver water to Third Reedy Lake will be made in the context of other regional watering actions, considering the need to (i) provide a diverse range of habitats across the landscape and (ii) prioritise where environmental water will be used (particularly in those years when less water is available).

Amongst other things, the annual Seasonal Watering Proposal identifies:

- priority sites for environmental water delivery based on past watering history e.g. sites that have not had their water requirements met may be given higher priority for that year
- the volumes of environmental water sought based on a range of potential seasonal conditions (from drought through to very wet)
- delivery point for the supply of water and the planned timing for that to occur
- the water regime to be delivered in accordance with the recommended regime for either the establishment phase or long term operational phase (see Figure 3-2)
- any contingency (or emergency) water that may be required as part of the adaptive management of ecological outcomes and risks (e.g. dilution flows to manage excessive salinity, variations in depth and duration of inundation to suppress weed growth etc. (see Section 4 and 5 for adaptive management of ecological outcomes and adaptive management of risks)).
- risks that may need to be managed and mitigation strategies should those risks occur (see Section 5 for adaptive management of risks).
- any monitoring that is planned for that season, which may include monitoring of flora and fauna (e.g. waterbirds)
- roles and responsibilities of different stakeholders involved, including communication and reporting requirements.

The Seasonal Watering Proposal is submitted to the Victorian Environmental Water Holder (VEWH), who may provide authorisation for the North Central CMA to proceed with the planned watering action. The North Central CMA then operationalises the planned watering action into a site-based Delivery Plan which forms the basis of agreement between stakeholders, documenting the operational processes for the coming year (what is to occur and who is responsible for overseeing that activity). The Delivery Plan comes into effect once formal instruction is provided to GMW by the North Central CMA to commence water deliveries.

3.8 Delivery infrastructure and flow measurement

Environmental water will be delivered to Third Reedy Lake through the Third Reedy Isolation Regulator, located at the existing Middle Reedy Lake Regulator in the channel that connects Middle and Third Reedy Lakes (Figure 3-3).

Figure 3-3: Existing regulator between Middle Reedy Lake and Third Reedy Lake

As part of the Project, the existing regulator will:

- be retrofitted with new gates in the existing drop bar bays to facilitate a watertight seal
- be fitted with instream flow measurement to measure water delivered to the lake
- have provision for the installation of fish exclusion screens to prevent large carp (and large native fish) from entering the lake (Section 5.2.2).

Construction is anticipated to begin in early 2019.

3.9 Adaptive management framework for ecological outcomes and risks

An adaptive approach to achieving the planned restoration outcomes (as defined by the management goal and ecological objectives) for Third Reedy Lake will be guided by the framework illustrated in Figure 3-4. The adaptive management framework will also specifically address the adaptive management and implementation of contingency measures requirements under Approval Conditions 2 and 3 in relation to operational impacts on the Kerang Wetlands Ramsar Site and impacts on nominated *EPCA Act 1999* listed fish species (detailed in Section 1.3).

Adaptive environmental management is a systematic process for improving management effectiveness by 'learning from doing'. The approach uses real-life actions (e.g. implementation of the proposed water regime) to test and improve our understanding about how these actions relate to the outcomes we are trying to achieve. The knowledge gained then provides the basis for continuing with, or adapting, our actions in response to what has been learnt." [*Draft Victorian Strategy for Healthy Rivers, Estuaries, and wetlands*].

The adaptive management framework deals exclusively with factors that relate to a conceptual model (in this case, the ecological response and outcomes to a change in the water regime of the lake). The incorporation of the adaptive management of risk into the framework, considers threats (not covered in the conceptual model) that have the potential to limit the achievement of desired ecological outcomes, as well as emergent threats that may adversely affect other components of the ecosystem (e.g. as identified in the Approval Conditions 2 and 3) - ultimately reducing, or even negating, the value of the ecological gains from the environmental water.

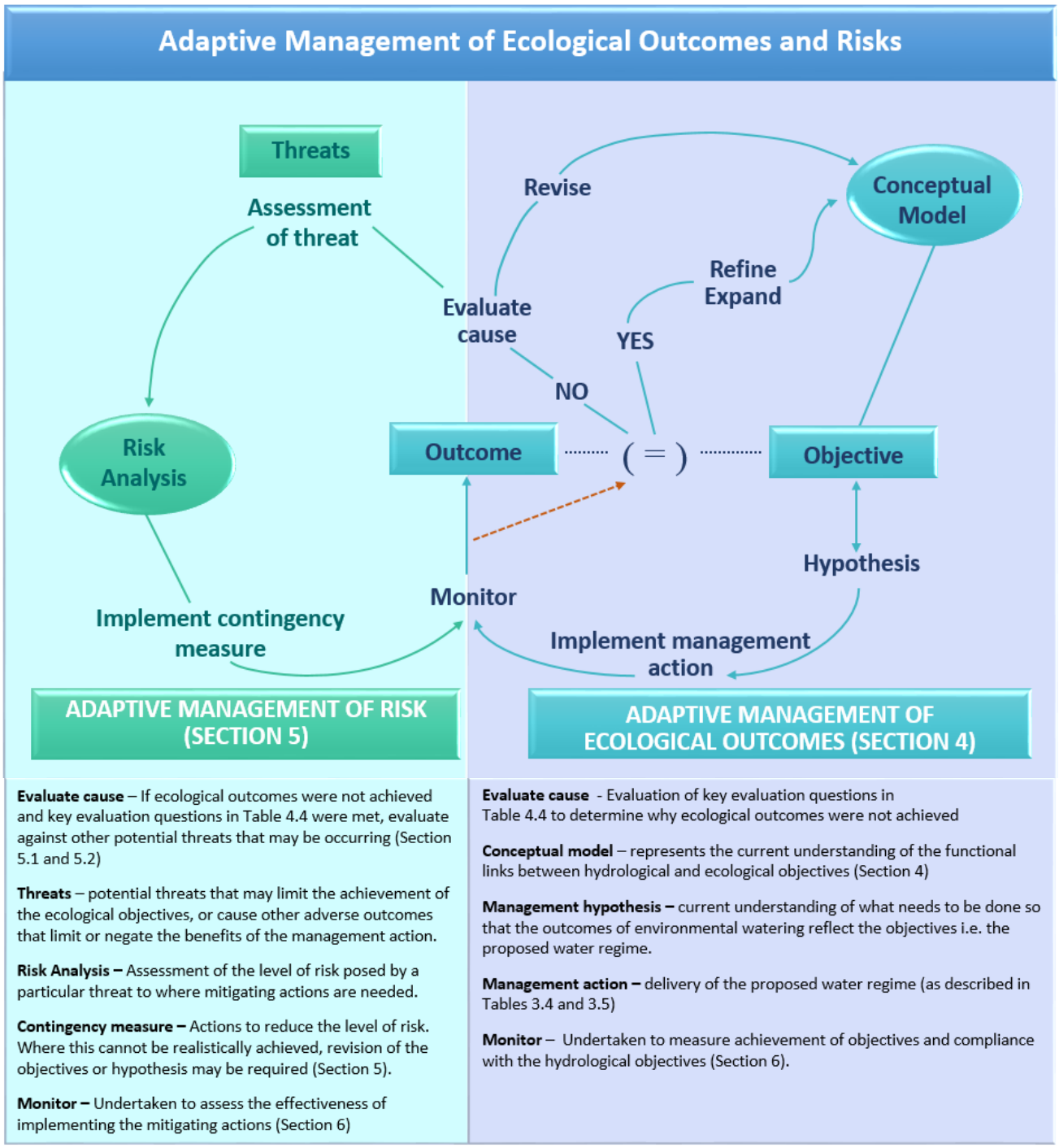

Figure 3-4: Adaptive management framework incorporating adaptive management of ecological outcomes and risk to meet Approval Conditions 2 and 3 in relation to operational impacts on the Kerang Wetlands Ramsar Site and impacts on *EPCA Act 1999* listed fish species (Source: Adapted from Terry Hillman)

This framework guides the subsequent sections of this plan, primarily:

- Section 4 outlines the adaptive management of ecological outcomes at Third Reedy Lake, including the conceptual models and targets by which progress toward the objectives can be measured and the monitoring activities that underpin the adaptive management approach.
- Section 5 outlines the adaptive management of risk and monitoring activities required to track risk and inform contingency measures, notably those required to address Approval Conditions 2 and 3.

4. Adaptive management of ecological outcomes

This section describes the adaptive management of ecological outcomes associated with the implementation of the establishment phase and long term operational phase of the proposed watering regime for the purposes of meeting the project goal. It includes a conceptual model for ecological response to the proposed water regime, management objectives required to meet the project goal and management hypotheses, actions, monitoring, evaluation and revision (if necessary) to maximise likelihood of achieving the project goal.

Intermittent Swampy Woodland EVC and associated species are currently restricted to the fringes of Third Reedy Lake. The proposed water regime aims to extend this community across the majority of the lake (underpinned by conceptual models and management hypotheses). However, there are uncertainties in the likely response of flora present in the system to the proposed change in water regime, including the recovery of target vegetation. For example, poor recruitment and regeneration of indicator species due to lack of seedbank because of the history of extended inundation of the lake is a possible outcome.

An EVC establishment guideline has been developed for Third Reedy Lake (Jacobs and Rakali 2018) to respond to these uncertainties and manage the risk associated with failure to establish the target EVC at Third Reedy Lake.,. This guideline is used as the basis for adaptive management at Third Reedy Lake and includes appropriate intervention actions and triggers for response (if monitoring indicates an unwanted outcome).

4.1 Conceptual model, ecological objectives and management hypotheses

As part of the North Central CMA (2014) investigation, conceptual cross sections were developed to illustrate the various components of the lake under the current water regime and the proposed water regime, including hydrological and ecological outcomes (Appendix D). These models were used to define the overall goal for the project and identify specific ecological objectives.

As discussed in section 3, the proposed water regime at Third Reedy Lake includes an establishment phase (length of phase dependent on timing to achieve acceptable establishment of targeted EVCs) and long term operational phase. During the establishment phase, the watering regime will need to be tailored so that each four-year management (wetting and drying) cycle provides condition that are both:

i. conducive to germination, and

ii. beneficial to seedling growth (to avoid drowning seedlings on subsequent inundations) through a series of low level (30-40cm) fills.

The establishment phase will conclude once River Red Gum establishment within the Wetland Bed Management Unit reflects the management targets (Section 4.2).

The aim of the long term operational phase is to provide a watering regime that maintains Third Reedy Lake as a deep freshwater marsh dominated by River Red Gums (with a sedge and lignum understorey, fringed by a healthy Black Box community).

Management hypotheses which aim to achieve the ecological objectives have been developed based on the conceptual models for ecosystem response and water regime requirements for the target vegetation communities (Table 4-1).

Table 4-1: Third Reedy Lake Adaptive Management – Management Hypothesis

Ecological objective	Management Hypothesis
Maintain the health of remnant Black Box and River Red Gum trees surrounding Third Reedy Lake*	Filling the lake to full supply level (74.56) in late winter or early spring (two years in ten) will provide sufficient water to maintain the health of the existing Black Box community at Third Reedy Lake.
Facilitate the establishment of River Red Gum trees across the bed of the lake	Introduction of a wetting and drying regime at Third Reedy Lake will promote River Red Gum establishment across the shallow and transition zones of the lake bed (noting that the deep zone is likely to resemble a lake bed herbland with very low density or absent River Red Gum (see Table 4-2 for more detailed description of predicted distribution of vegetation types across the lake bed).
Restore a diverse ground layer of vegetation in the inundated zones of the wetland, characteristic of a deep freshwater marsh	Introduction of a wetting and drying regime at Third Reedy Lake will promote vegetation germination and create a diverse layer of vegetation across the inundated area of the lake.

* Note, for the purposes of management, maintaining health of remnant vegetation on the lake margin is addressed in Risk Management (Section 5) via monitoring and actions if there is an observed decline in vegetation health.

4.2 Management targets and actions

4.2.1 Management targets

The establishment of management targets, allow managers to evaluate progress toward the management objectives and determine whether active management interventions are required. The management targets for Third Reedy Lake are shown in Table 4-2 and have been set with regards to the EVC benchmarks (recognising the benchmark is a guide for the average density of trees that could be expected to establish over time).

There is some uncertainty in the length of time (or number of management cycles) it will take for the target EVCs to establish.

Table 4-2: Representative Vegetation management targets for Third Reedy Lake

Management unit	Zone & target EVC	Vegetation target
Wetland Fringe	Dry zone / EVC 813	• Trees (River Red Gum and/or Black Box) average 15 per hectare • At least one species of shrub listed in the EVC Benchmark (Appendix C). At least 3 small (to medium) herbs listed in the EVC Benchmark at 5% cover • At least 2 small (to medium) non-tufted graminoids (grasses and sedges) listed in the EVC Benchmark (Appendix C) at 20% cover
	Wet zone / EVC 813	• As above but River Red Gum is expected to be the only overstorey species present
Wetland Bed	Shallow zone / EVC A119	• Trees (River Red Gum) average 10 per hectare • When dry 7 species of native semi-shrubs, grasses and other herbs listed in the EVC Benchmark (Appendix C) with 50% cover 6 months after drying • When inundated at least 2 species of aquatic or amphibious herbs listed in the EVC Benchmark (Appendix C) with 30% cover 6 months after filling
	Transition zone / EVC A119	• As above, but with a lower density of River Red Gums

Management unit	Zone & target EVC	Vegetation target
	Deep zone / EVC 653/707	• When wetland level has dropped to 73.4 at least 2 species of aquatic herbs listed in the EVC Benchmark (Appendix C). • After being dry for 6 months should support Lake Bed Herbland consisting of at least 3 indigenous species listed in the EVC Benchmark (Appendix C) with more than 50% cover.

Transition toward the achievements of the vegetation targets will occur over time. Table 4-3 outlines the interim targets for each (four-year) cycle of the conceptual watering regime during the establishment phase, as illustrated in Figure 3-2.

Table 4-3: Indicative progress for each management cycle for measuring progress toward the vegetation management targets

Cycle	Desired response
1	• Before refilling above 73.4 m AHD, consider the height of juvenile River Red Gums present in the Wetland Bed Management Unit to ensure inundation does not adversely impact (e.g. drown) greater than 80% of trees. • 60 to 80% proportional cover (native or exotic) across all management units to stabilise soils in the bed of the wetland within 6 months of the wetland drying. Noting that during this cycle exotic vegetation would not meet the definition of invasive species and any exotic species would be expected to be replaced with native species over subsequent cycles.
2	• Recovery of understorey species in the Wetland Bed Management Unit (all zones), with increasing nativeness observed in the proportional cover over time (30% in cycle 2, 50% in cycle 3) within 6 months of the wetland drying. • Reestablishment of River Red Gums within the Wetland Bed Management Unit shallow zone of average 5 trees per hectare in cycle 2, and average 10 trees per ha in cycle 3
3	• Reestablishment of River Red Gums within the Wetland Bed Management Unit transition zone of average 2 trees per hectare in cycle 2, and avg 4 trees per ha in cycle 3 • Presence of 3 species expected for that management unit in any 1 ha plot.
4	• Mosaic of vegetation communities restored, showing a diversity of species expected for that EVC class.

It is difficult to determine with certainty how Third Reedy Lake will respond to a changed water regime. Should the target density of River Red Gums be achieved in a shorter timeframe than indicated above (i.e. prior to cycle 4), then the shift to the long term operational phase will commence earlier than anticipated. However, it is likely that the targets for River Red Gum will not be achieved through passive regeneration alone and that some active revegetation will be required (See Section 5.1).

4.2.2 Management triggers and actions

Determining when a management intervention may be required (i.e. testing the management hypotheses) will be guided using the process outlined in Table 4-4.

If progress toward the ecological outcomes is not being realised, and this cannot be attributed to factors associated with the management triggers in Table 4-4, the process outlined in Figure 3-4 should be followed. That is, evaluation of the outcomes against the key threats to the ecological goal (Section 5.1) and existing values (Section 5.2) to assess potential risks that may require adaptive management and mitigation.

Table 4-4: Key evaluation questions for assessing progress toward the achievement of vegetation objectives and targets

Objective	Management Unit	Management Question		Management response	Evaluation method
Facilitate the establishment of **River Red Gum** trees across the bed of the lake	Wetland Bed – shallow and transition zones	Are juvenile trees of appropriate height not to be impacted by inundation (e.g. drown)?	Yes	Continue with watering regime as planned provided that there are at 10 - 15 trees per ha at height that will not be impacted by inundation proposed as part of the water regime (or no more than 20% of juveniles).	Assess height juvenile River Red Gums against proposed filling level. Compare against tree density assessment (as below)
			No	If target density has not been achieved, then delay commencement of next management cycle and consider further shallow fills.	
	Wetland Bed – shallow and transition zones	Is the density of River Red Gum establishing within the wetland bed progressing toward the EVC benchmark?	Yes	It is assumed that reestablishment will occur over several management cycles, assisted by active revegetation. Monitor trees density against targets outlined in Table 4-3. If target is not met, consider active revegetation.	Monitor tree density
			No	Once the desired density of River Red Gums has been met (as outlined in Table 4-2) move to the water regime for the long term operational phase. If density of regenerated River Red Gums is too high (refer to Table 4-2) consider commencing a watering action to drown out some juvenile trees.	
	Wetland Bed – shallow and transition zones	Is the frequency of water deliveries sufficient to support the establishment of River Red Gum trees?	Yes	It is assumed that inundation every four years during the establishment phase may be insufficient for the establishment of juvenile trees.	Monitor tree density
			No	Monitoring young trees for evidence of water stress such as leaf drop, cracking bark and sapling mortality. If evident consider reducing the interval between watering events to replenish soil moisture.	

Objective	Management Unit	Management Question		Management response	Evaluation method
Restore a diverse ground layer of vegetation in the inundated zones of the wetland, characteristic of a deep freshwater marsh.	Wetland Bed	Is the proportion of cover in the ground layer what is expected for that stage of the management cycle?	Yes	It is assumed that carp populations will limit the reestablishment of the ground layer in the initial management cycle. Cycle 1: No action required. Wait until cycle 2 to determine impact of carp on recovery.	Wetland plant surveys Monitor carp presence /absence
			No	Cycle 2 onwards: Measure progress against indicative targets outlined in Table 4-3 above. If desired response is not observed, determine cause and consider active replanting.	
		Does the species composition reflect what is expected for that management unit, based on the number of management cycles delivered?	Yes	It is assumed that carp populations will limit the reestablishment of the ground layer in the initial management cycle. Cycle 1: No action required. Wait until cycle 2 to determine impact of carp on recovery.	Wetland plant surveys
			No	Cycle 2 onwards: Measure progress against indicative targets outlined in Table 4-3. If desired response is not observed, determine cause and consider active replanting.	

4.3 Monitoring activities

Monitoring activities required to evaluate progress toward the achievement of the ecological outcomes and objectives at Third Reedy Lake are outlined in Table 4-5. This monitoring will evaluate the effectiveness of River Red Gum establishment and inform the point at which the transition from the establishment phase to the long term operational phase will occur. Management of risks and implementation of contingency measures (such as decline in fringing vegetation condition, impacts of pest plants and animals etc.) are discussed in Section 5.

Table 4-5: Monitoring against management objectives at Third Reedy Lake

Relevant objective	Monitoring Activity	Approach
Facilitate the establishment of River Red Gum trees across the bed of the lake	Monitor the progress of River Red Gum establishment within the Wetland Bed Management Unit against the targets outlined in Table 4-2. Evaluate the density of remnant vegetation against the EVC benchmarks.	TLM tree condition assessment prior to the initial drawdown stage to establish baseline. Ongoing assessment to occur each management cycle once drawdown has occurred (anticipated to be in the spring following a wetland fill) until the target of 15 trees per ha has been achieved.
Restore a diverse ground layer of vegetation in the inundated zones of the wetland, characteristic of a deep freshwater marsh	Monitor the recovery of species within the bed of the lake. Evaluate the success of revegetation activities (where relevant). Monitor the density of invasive species.	Using the WetMAP sampling protocol survey three transects in the Wetland Fringe Management Unit. Note: the transects selected will be used for ongoing vegetation understorey and pest plant monitoring activities.
Hydrological monitoring	Monitor the water regime at the lake Monitor the delivery of environmental water through Third Reedy Lake Isolation regulator	Installation of a staff gauge in a lower elevated area of the lake to determine the rate of drying during the draw down period. Installation of instream flow measurement at Third Reedy Lake Isolation regulator

5. Adaptive management of risks

If the ecological outcomes for Third Reedy Lake are not being achieved and cannot be attributed to factors associated with the management triggers in Table 4-4, assessment of other potential threats should be undertaken to identify adaptive management and mitigating actions (as illustrated in Figure 3-4). Two categories of threats to the Project have been identified, 1) risks to achieving the ecological goal and 2) risks to values because of changing the water regime. The following sections describes the potential threats in each of these categories, monitoring, risk analysis and adaptive management, including contingency measures if monitoring indicates a risk has or is likely to occur.

5.1 Risk to the ecological outcomes

The risk to the ecological outcomes of the Project is the failure to establish the target EVC (i.e. Intermittent Swampy Woodland across the majority of the Wetland Bed Management Unit). There are a number of threats that may influence the success of EVC establishment at Third Reedy Lake (described in detail in the EVC establishment guideline (Jacobs and Rakali 2018)). These are summarised below and in Table 5-1, along with suggested monitoring activities to track the manifestation of threats

Lack of seed bank

There is some uncertainty about whether passive regeneration will be successful as this is reliant upon a soil stored seed bank or species dispersing into the wetland from adjacent areas. As the wetland has been permanently inundated for over 90 years the seed of any species that was dispersed into the wetlands soil the last time it dried may not be viable. Even if it were, it would be likely to be buried under a layer of sediment that would prevent it from germinating. Sampling the seed bank in the wetland sediments may provide some insight into what may germinate when the wetland dries. Similarly, the wetlands directly upstream of Third Reedy Lake have also been permanently inundated and are unlikely to be a source of the required propagules. In fact, most of the wetlands in the entire landscape surrounding Third Reedy Lake have been severely impacted by changed hydrology and salinity regimes. It is considered very unlikely that the diversity and quantity of the propagules of appropriate native species required to restore the wetland will arrive passively by natural means.

Dispersal from existing trees

Even in the case of River Red Gums, where a seed source is readily available from fringing trees, total reliance of passive regeneration may not be the best option for restoring the tree canopy. This is because the seed of River Red Gums often only disperses as far from its parent tree the distance that the tree is tall. At this rate of dispersal trees would take more than the establishment phase to recolonise the entire wetland. During floods River Red Gum seed may disperse greater distances as the seed can float, however under these conditions seed will float to the edge of the wetland, resulting in dense regeneration on a flood strand line but with no regeneration in the middle of the wetland.

For these reasons, GMW has committed to target River Red Gum revegetation following the first drawdown. Long stemmed River Red Gum saplings will be planted at a density of around 10 trees per hectare (depending on access). Trees will be guarded with tall (at least 900 mm high) tree guards to prevent browsing animals from eating them down to a height that would be over-topped the next time the wetland fills. Planting long-stemmed saplings as a wetland dries gives them the best chance to reach a height at which they will survive the next inundation event.

Biotic constraints

Biotic constraints are the result from the action of other plants or animals (biota) on limiting the desired outcome and include:

- High threat environmental weeds have the potential to have significant adverse impacts on efforts to restore indigenous vegetation at Third Reedy Lake, including aquatic weeds when the lake is inundated and terrestrial weeds that may invade the wetland during dry phases.

- High threat aquatic weeds that occur in the Kerang region include Parrot's Feather (**Myriophyllum aquaticum*), Mexican Waterlily (**Nymphea mexicana*), Sagittaria (**Sagittaria platyphylla*), Water Plantain (**Alisma lanceolatum*) and Water Couch (**Paspalum distichum*). Maintaining regular drying cycles will assist with preventing the establishment or controlling these species. The most effective time to monitor the invasion of these weeds is late summer, when they will be obvious and there is time to instigate control measures before they become dormant in autumn.

- High threat weeds that may invade the bed of the lake as it dries include False Daisy (**Eclipta prostrata*) which is present at Second Reedy Lake, Cockleburrs (**Xanthium species*), Dock species (including **Rumex crispus* and **R. conglomeratus*), Drain Flat-sedge (**Cyperus eragrostis*) and Hastate Orache (**Atriplex hastata*). Early detection and control of these species may be necessary to prevent their spread across the lake as it dries.

- Excessive regeneration of native species, namely River Red Gum (in the shallow and transitional zones and *Typha sp.*(Cumbungi) (in the deep zone) which restrict spaces available for germination and growth of desirable species.

- Presence of carp during inundation, which disturb lake bed sediments (bioturbation), dislodging macrophytes and creating turbid conditions that can limit light penetration and reduce photosynthetic potential of submerged macrophytes.

- Grazing (herbivory) by native and introduced species that results in poor growth form, exposed soils and poor recruitment success.

Table 5-1: Key threats and potential monitoring and management responses/ contingency measures to the establishment of target EVCs (Jacobs and Rakali 2018)

Threat	Potential impact	Monitoring and Management Response/ Contingency Measures
Lack of Seed bank	Loss of viable seed from the wetland bed limits the recovery of understorey species. Reseeding from fringing River Red Gums results in reestablishment on the outer zones of the wetland only, or regeneration occurring in growth rings on receding water levels.	• Active planting of long stem River Red Gums will take place during the first draw down cycle to accelerate the establishment of River Red Gum trees.
Drowning trees	Poorly timed watering of wetland drowns juvenile River Red Gums.	• Monitor height of juvenile trees and manage depth of inundation accordingly (i.e. to not drown juvenile plants)
Weed invasion	Displacement of native understorey species by aquatic and terrestrial weeds.	• Monitor and distribution of invasive aquatic and terrestrial weeds as part of the WetMAP sampling. • Provide a watering regime that favours native species consistent with EVC benchmark. • Spraying of regionally controlled or highly invasive species if detected.
Excessive regeneration of River Red Gum	Excessive regeneration of River Red Gums (e.g. over 100 stems per hectare) may impact on the recovery of understorey vegetation. As a general guide some dispersed thickets are acceptable, but thickets growing in concentric rings may be undesirable.	• Monitor River Red Gum establishment to determine whether thinning is required in order to retain the target number of trees per hectare. • Consider delivering water to the wetland to drown out some juvenile trees.

Threat	Potential impact	Monitoring and Management Response/ Contingency Measures
Excessive regeneration of *Typha sp.*	While the native *Typha sp.* (Cumbungi) provide excellent habitat for a range of wetland fauna they can become over-dominant under certain conditions (particularly where prolonged shallow inundation occurs over the warmer parts of the year). If allowed to form dense extensive stands these species can invade open water and other habitat types and reduce overall habitat diversity.	• Monitor *Typha sp.* distribution and density, maintain maximum cover of 20% within the deep zone with a trigger level of 5% to initiate active management. • Management actions include increased depth and duration of inundation to suppress excessive growth.
Grazing	Grazing by kangaroos, wallabies and rabbits results in poor growth form of River Red Gums (multiple stems) delaying the amount of time until they reach sufficient height to resist drowning on rewetting. Grazing of understory species prior to flowering and seed set reduces seed stock.	• Establish exclusion plots to evaluate whether grazing is excessive and to inform the need for intervention programs. • Spotlight counts and rabbit control programs to limit the size of populations if needed.
Carp	Increased turbidity of water leading to low light penetration and poor growth conditions for aquatic plants. Destruction of aquatic vegetation from uprooting.	• Fish exclusion screens are being included on the inlet regulator (Third Reedy Isolation Regulator) to prevent large carp entering the wetland during regulated filling. This will limit carp numbers and biomass during inundation phases

5.2 Risks to existing values

The Environmental Report (Jacobs 2017a) completed a comprehensive assessment of risk to existing values. These risks and potential intervention actions are summarised Table 5-2 and discussed in more detail in subsequent sections.

Table 5-2: Key risks at Third Reedy Lake as a result of a change in water regime and contingency measures to minimise risk.

Key Risk	Risk description	Contingency measures
Decline in health of Black Box and River Red Gums in Wetland Fringe Management Unit	Trees in the fringing zone are adapted to the current water regime and the introduction of a drying results in water stress and unacceptable decline in tree health or tree death.	Monitor tree health and implement actions identified in the EVC Management Guidelines (Jacobs and Rakali 2018) (Summarised in Section 5.2.1)
Stranding of fish in lake during drying phase	There is a risk to fish present in the lake during drying phase as those that do not exit the wetland during the drawdown phase may die as the wetland dries.	Implement actions to encourage fish currently present in the lake to move out of the lake at the commencement of the initial drawdown. Actions informed by a fish exit strategy developed by Stuart and Sharpe (2018 and summarised in Section 5.2.2)
Mass mortality of fish create odour and public complaints	Mass mortality, particularly of large bodied fish (e.g. Carp) are stranded in large numbers could cause odour and public complaints.	
Impacts on Murray River Turtles	Whilst recorded in low numbers in Third Reedy Lake (Biosis, 2013), there is potential for Murray River Turtles present in the lake to become trapped in the lake during the drying phase.	Contingency measures include providing pathways to assist turtle movement, translocation of stranded individuals (where feasible), water regime management, timing of drying and management of external threats (e.g. fox predation).
Exposure of acid sulfate soils	Sampling has indicated the presence of acid sulfate soil, however at a whole of lake scale the generation of acid sufficient to cause	Undertake monitoring and implement contingency measures (if necessary) recommended in the Acid

Key Risk	Risk description	Contingency measures
	wide scale impact was considered a low risk. There is potential that isolated pockets may have a higher potential for acid generation and therefore there is a higher localised risk.	Sulfate Soil Management Guideline (Jacobs 2018 and summarised in Section 5.2.3).
Increased surface water salinity during wetland filling	During the filling phase there is a risk that salts that have accumulated in the lake sediments will be dissolved and contribute to excessive salinity increase. If excessive, this could impact on the establishment and persistence of target EVCs and on downstream values (environmental and irrigation supplies).	Monitor salinity and manage the risk associated with increased salinity which may occur as a result of the change in water regime. Triggers and contingency measures are detailed in Section 5.2.4.
Depleted dissolved oxygen	Inundation after the drying of the lake could result in an initial decline in dissolved oxygen which can reduce water quality and impact on aquatic species sensitive to low dissolved oxygen (e.g. fish that re-enter the lake during the inundation phase).	Monitor salinity and manage the risk associated with decreased dissolved oxygen which may occur as a result of the change in water regime. Triggers and contingency measures are detailed in Section 5.2.4.

The following Sections provide more detailed description around the risk and the proposed management actions.

5.2.1 Decline in fringing Black Box and River Red Gums

The current permanent water regime at Third Reedy Lake may have resulted in River Red Gums growing in the Wetland Fringe Management Unit at a higher density than would have occurred naturally. Additionally, the root zones of these trees may have adapted to ready access to water and are less suited to dry conditions. It is anticipated that some tree death may occur in the Wetland Fringe Management Unit during the initial management cycles. These trees will be monitored during the establishment phase using the TLM tree condition assessment method to identify any change in condition and the need for any management intervention (Table 5-3)

Table 5-3: Key evaluation questions for assessing risks to Fringing vegetation.

Risk	Management Unit	Management Question		Management response	Monitoring method
Decline in health of **remnant Black Box and River Red Gum** trees surrounding Third Reedy Lake	Wetland fringe - dry zone only	Has there been a significant decline in the canopy health of critical habitat or cultural trees fringing the lake?	No	The proposed water regime is assumed to be sufficient to allow root zones to adapt to a drier regime.	Map critical habitat and cultural trees. Benchmark current canopy condition and monitor for change, comparing against a control (no intervention) and reference site (regional conditions) using TLM tree condition assessment (focussing on canopy) every 2 years during cycles 1 and 2. Every four years for cycles 3 and 4.
			Yes	If decline in health is observed, consider reducing the intervals between watering to full supply level.	
	Wetland fringe – both zones	Is the density of River Red Gum and Black Box trees at or above	Yes	Some tree loss is anticipated with the transition to a drier regime and is appropriate provided tree density does not	Stand density and canopy condition assessment

Risk	Management Unit	Management Question		Management response	Monitoring method
		the EVC benchmark?		fall below the EVC benchmark of average 15 trees per ha.	
			No	If evidence indicates tree density if likely to fall below the benchmark, consider reducing the intervals between watering to full supply level.	

5.2.2 Fish exit strategy

A fish exit strategy has been developed that suggests approaches to maximise the likelihood of fish currently present in the lake moving out of the lake at the commencement of the initial drawdown (Stuart and Sharpe, 2018). The fish exit strategy focusses on reducing the risk of fish stranding and potential mortality during the initial drawdown following the disconnection of the lake from the irrigation system. The strategy considers:

1. The recession hydrograph
2. Facilitation of fish exit
3. Fish entry and management during refilling events, and
4. Monitoring to inform management intervention.

These are summarised below.

Recession hydrograph

As water levels recede at Third Reedy Lake, there are two pathways for fish movement out of the lake (Figure 5-1):

Pathway 1: leave the lake by swimming downstream into the Torrumbarry No 7 Channel regulator and then into other permanent lakes (e.g. Little Charm, Charm, Racecourse or Kangaroo), or

Pathway 2: leave the lake by swimming upstream and attempting to negotiate the Middle Reedy Lake and swim into Middle Reedy Lake and beyond or Lake Charm and other downstream lakes, via the new Third Reedy Lake bypass channel and regulator.

A third outcome is that fish remain within the lake, probably in the deep central refuge pool where they will likely die as the water recession progresses.

Figure 5-1: Location of pathways for fish movement at Third Reedy Lake

A recession hydrograph has been developed that aims to encourage small and large bodied fish (including exotic species) to actively leave the lake (either via the inlet or outlet channels) (Table 5-4). The first phase of the exit strategy is to provide a sharp drop (i.e. ~0.2 m over 24-48 hours) in lake water level followed by a period of stable water levels. The first drop would be achieved by substantially reducing inflows at the Third Reedy Lake Isolation Regulator and opening the Torrumbarry No. 7 regulator (750-1000 ML/d). This is the first and primary cue for native fish to recognise that floodplain recession is underway.

The aim is to provide the cue that the floodplain water is receding but to attenuate the fall in water levels, while still providing a flow for fish to find the exits from Third Reedy Lake. Ideally, a large proportion of the fish biomass will leave the lake via either of the exit pathways, with relatively few fish remaining in the lake.

Fish catches and accumulations on the Third Reedy Lake side of the Torrumbarry No 7 regulator (pathway 1) and Third Reedy Lake Isolation Regulator (pathway 2) should be monitored and then either: (i) holding Third Reedy Lake steady and continuing to remove fish or (ii) implementing a second rapid drop of ~0.2 m and then repeating the steady water level and fish collection effort. Following the second holding phase there should be either a long, attenuated recession as identified in drawdown and recession modelling completed by Gippel (2015) or a third rapid drop-hold steady cycle, before the recession. The total recession time is at least 30 days but this could be significantly extended by increasing the duration of the hold steady components (e.g. from 3-4 days to 7-21 days, or longer).

Table 5-4: Summary of major components of the fish exit strategy, operations, monitoring and management decision for drawdown of Third Reedy Lake.

Recession Phase	Third Reedy Lake level (AHD)	Operation	Monitoring component	Management decision
1st drop over 48 hours	74.56 m AHD to 74.36m AHD	Open Torrumbarry No 7 channel, reduce Middle Lake regulator flow	Monitor fish numbers/accumulations at No 7 (upstream side) and Third Reedy Lake Isolation (downstream side) regulators	
Hold steady for 3-4 days, can be extended to 7-14 days	74.36 m AHD	Reduce outflows and/or match inflows to outflows	Monitor fish numbers/accumulations at No 7 and Third Reedy Lake Isolation regulators	When fish numbers reduce then go to 2nd drop
2nd drop over 48 hours	74.36m AHD to 74.16 m AHD	Open Torrumbarry No 7 channel, reduce Middle Lake regulator flow	Monitor fish numbers/accumulations at No 7 and Third Reedy Lake Isolation regulators	
Hold steady for 3-4 days, can be extended to 21 days	74.16 m AHD	Reduce outflows and/or match inflows to outflows	Monitor fish numbers/accumulations at No 7 and Third Reedy Lake Isolation regulators	When fish numbers reduce then go to 3nd drop
3nd drop over 48 hours	74.16 m AHD to 73.96 m AHD	Open Torrumbarry No 7 channel, reduce Middle Lake regulator flow	Monitor fish numbers/ accumulations at Torrumbarry No 7 and Third Reedy Lake Isolation regulators Continue to monitor fish numbers/accumulations	Decide on further drops or go to attenuated recession Where accumulations are observed take appropriate action, such as briefly opening Torrumbarry No 7 regulator to pass fish downstream
Attenuated recession – natural rate of fall	<73.96 m	Slow lake recession	Continue to monitor fish numbers/ accumulations Use drone where required	Manual native fish rescue or carp harvest by commercial fisher if considered at the time to be too high.

Facilitating fish exit

Fish exiting the lake are required to negotiate the outlet regulator to the Torumbarry No 7 channel (if travelling downstream) or pass through the inlet (upstream) regulator leading to Middle Reedy Lake.

For fish exiting via the Torrumbarry No. 7 channel headloss across the outlet regulator should be minimised and the gates opened as wide as possible (while still maintaining appropriate drawdown rates).

For fish exiting upstream, movement through the Third Reedy Lake Isolation regulator is more difficult due to the ability to manipulate water levels in the upstream lakes and a fish exclusion screen being included in the regulator design. Therefore, active trapping and translocation across the regulator may be required. Alternatively, a temporary fish way could be installed in one of the regulator bays each time the lake is lowered. This arrangement is described in more detail in Stuart and Sharpe (2018).

Fish that do not leave Third Reedy Lake via either regulator during the exit drawdown will be trapped in the drying lake. Over time these fish will be concentrated into a decreasing refuge pool. It can be expected that piscivorous birds will consume smaller fish and that larger fish will be exposed to mortality as the lake dries. Depending on the density and biomass of trapped fish, active removal may be required to reduce potential odour issues and public complaints as fish decompose. The criteria for excessive fish stranding and the trigger for active removal will be developed at the time in consultation with fish ecologists as part of the fish exit monitoring.

Fish entry and management

During re-filling events there will be opportunities for fish to re-enter Third Reedy Lake. To minimise carp impacts the fish management strategy suggests filling in winter (May to early August) when carp larvae are *not* present. Furthermore, GMW has committed to installation of a fish exclusion screen on 2 of the Third Reedy Lake Isolation regulator bays. Managed inundation events (e.g. delivery of environmental water) will pass through the two bays containing fish screens, hence reducing the likelihood of large carp (and large native fish) entering the lake during filling. However, unregulated inflows (i.e. during flood events) will likely pass through all 6 bays and therefore large bodied fish are likely to enter the lake during these events.

The strategy also suggests some actions for maximising the potential for Third Reedy Lake to act as a recruitment area for small bodied native fish, but this is not a specific objective of the future wetland management. However, opportunistic fish breeding should be allowed to occur and opportunities for fish exit be provided on each subsequent drawdown phase provided objectives relating to vegetation establishment are not compromised.

Monitoring to enable adaptive management of risk

Monitoring of fish exit from Third Reedy Lake is required during exit flows (e.g. during the stepped recession). The fish exist strategy proposes a number of monitoring options (Stuart and Sharpe 2018). Of these options the following are deemed necessary to 1) inform the implementation of the exit strategy and 2) enable reporting of the effectiveness of the strategy as required under Approval Condition 3 (Table 5-5).

Table 5-5 Monitoring objectives, methods and outcomes for Third Reedy Lake drawdown.

Monitoring objective	Method	Outcome
Baseline survey of fish communities in Third Reedy Lake before recession to provide estimate of individual species population size	Standard suite of nets and electrofishing within the lake	Inform management (e.g. biomass estimate and potential for odour problems if large biomass is present during decomposition) Enable fish translocation of threatened species Identify size classes/species including threatened species Provide baseline for project evaluation
Document fish exit from lake during drawdown (species and abundance)	Trapping on the Third Reedy Lake (upstream) side of the No 7 regulator and downstream side of the Third Reedy Isolation regulator. Weekly until the regulators are closed or the lake level falls below the sill level and becomes disconnected from the inlet channel.	Demonstrate fish exit rates/behaviour and pathways Identify the influential hydrological cues Report against conditions of *EPBC Act 1999* approval – monitor fish exit during exit flows and report results to the Department. List any presence of and death or harm to Flathead Galaxias, Murray Hardyhead and Silver Perch (see Section 6.2).

5.2.3 Acid sulfate soil management

An Acid Sulfate Soil (ASS) Management guideline was developed to monitor and manage the risk posed by ASS during the drying of Third Reedy Lake and are provided in Jacobs (2018). The environmental risks associated with the drying of Third Reedy Lake were assessed as part of previous investigations (Jacobs, 2017b) and were used as the basis for the development of the plan.

The inherent and residual risks (assuming effective monitoring and management) associated with the drying Third Reedy Lake are low for all risks identified, except for:

a. The occurrence of isolated sections of lake bed sediment with higher concentrations of sulfides than identified during sampling, and

b. The pooling of acidic (low pH) water in the centre of the lake during the later stages of lake drying.

A monitoring program was developed to allow for the identification of the above risks if they manifest and to inform adaptive management.

Monitoring

Three monitoring activities are suggested to provide unique information regarding ASS oxidation and impact:

1. Soil monitoring (installation of piezometers) to tell if the soils are responding to drying as indicated by lab tests (this will provide warning if they are becoming more acidic then expected)

2. Visual survey is to tell if there are patches of more "severe" ASS that have been missed and need to be treated directly

3. Assessment of surface water quality (impacts on surface water quality were identified as the highest ASS related risk) will inform if/when flushing needs to occur.

Each of these is described below.

Soil monitoring will be undertaken (initially monthly) at approximately 18 sites at Third Reedy Lake. The number of monitoring locations has been determined based on field observations, previous investigations (Jacobs 2017b) and the *Guidelines for Acid Sulfate Soil Assessment in the Murray Darling Basin* (MDBA 2010) as being sufficient to provide sampling across the range of soil types present at the lake (MDBA, 2010 recommends 12-20 sampling locations for an area of 100-500 ha with low risk of ASS). To allow monitoring of soil water quality and provide consistency of locations during monitoring events, a shallow (~2 m) piezometer will be installed at each location. To allow for spatially diverse monitoring, the installation of piezometers will occur sequentially as the lake dries (e.g. the sequential installation of 6 piezometers when the lake level reaches 73.8 mAHD, another 6 when the level reaches 73.5 mAHD and a final 6 when the level reaches 73.3 mAHD). These represent fixed locations to be monitored monthly. Each site will be monitored for a number of ASS properties, specific details on the soil monitoring requirements are provided in Table 5-6. At this stage, piezometers will be installed in a uniform distribution, but as the lake water level recedes it may be necessary to adjust the distribution and number of piezometers depending on specific conditions (e.g. soil type, access, if locations of higher pyrite concentration become evident etc).

Visual survey of the dried/exposed sediment in the lake bed will be conducted while conducting the fixed soil monitoring to inspect for field indicators of acid sulfate soils in areas not captured by the fixed monitoring locations. Such indicators include, but are not limited to, soil pH (pH_F), sulfurous odours, jaroisitic (pale yellow) mottling, iron oxide (orange-red) staining of sediments and waters, clear or milky blue-green water and monosulfidic black oozes.

Lake water chemistry will be monitored as it will change during the drying response to the oxidation of acid sulfate soils. The lake water monitoring will be undertaken in conjunction with the soil monitoring. As indicated by the laboratory results presented in Jacobs (2017b), the oxidation of sulfides subsequent reduction in soil pH is unlikely to manifest within a 2-3 weeks of drying. As such, soil pH will be monitored via piezometers at monthly intervals. If trends in soil pH are consistent with those exhibited in Jacobs (2017b) (i.e. soil pH doesn't fall below 5.0 within the first month) then no increased pH monitoring will be undertaken. However, if pH reductions to <5.0 are observed, monitoring will be increased to fortnightly intervals to allow early identification and management of ASS risks.

As indicated by the predictive modelling results presented in Jacobs (2017b), acidification of lake surface water is a low risk during the first 3 months of drying as a result of latent alkalinity in the surface water and the small amount of acidity available during initial drying. As such, monthly monitoring of surface water quality will be undertaken during the initial 3 months of drying. This frequency will be increased to fortnightly after the initial 3 months when the risk of acidification is higher. Additionally, if the alkalinity of lake water is observed to be declining more rapidly than predicted (based on predictive modelling results) in the first 3 months, the frequency of monitoring will also be increased to fortnightly intervals, to allow early identification and proactive management of water quality if necessary.

Specific details on the soil and lake water chemistry monitoring requirements are provided in Table 5-6.Table 5-6 also provides the triggers for the monitoring program, for both moving to the next phase of monitoring (e.g. laboratory testing) or for reducing and or ceasing monitoring of acid sulfate soils at Third Reedy Lake. Reducing or ceasing monitoring is recommended if no triggers have been met, or the acid sulfate soil risk has not manifested during the first drying period.

Table 5-6: Summary of soil and water monitoring at each fixed site

Item		Monitoring	Frequency	Trigger for monitoring
Soil and soil water	Site description	Site number, GPS co-ordinates, vegetation, morphology, photo	Installation of piezometer	Baseline – no trigger required
	Soil description	Lithology, texture, colour, odour	Installation of piezometer	Baseline – no trigger required
	Soil pH	pH of soil measured with a calibrated pH probe	Installation of piezometer	Baseline – no trigger required
	Field soil water quality in piezometer	pH (plus EC, T, DO, ORP, which are all included in the same water quality meter)	Monthly	Monthly until 6 months after complete drying of a particular section of the lake. Review monitoring program after 1st cycle, if pH in field is >5.0 then cease monitoring. If pH <5.0 the continue monitoring during next drying phase.
	Lab soil water quality from Piezometer	Alkalinity, Dissolved cations (Na, K, Ca, Mg, Si) Dissolved anions (Cl, Br, F, SO4) dissolved nutrients (NO3, NH4, PO4) Trace dissolved metals/metalloids (Ag, Al, As, Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb, Se, Zn), DOC	If pH in field is <5.0	Baseline Subsequently if pH <5.0, undertake further lab assessment
Surface Water	Site description	Site number, GPS co-ordinates, vegetation, morphology, photo	Installation	Baseline – no trigger required
	Water description	Colour, odour, depth	Installation	Baseline – no trigger required
	Field water quality	T, pH, EC, DO, ORP, Turbidity	Monthly first 3 months of drying phase Fortnightly during high risk period (lake bed exposing)	Monthly to fortnightly until dry. Review monitoring program after 1st cycle, if pH in field is >5.0 then cease monitoring. If pH <5.0 the continue monitoring during next drying phase.
	Lab water quality	Alkalinity, Dissolved cations (Na, K, Ca, Mg, Si) Dissolved anions (Cl, Br, F, SO_4) dissolved nutrients (NO_3, NH_4, PO_4) Trace dissolved metals/metalloids (Ag, Al, As, Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb, Se, Zn), DOC	If pH in field is <5.0	Baseline Subsequently if pH <5.0, undertake further lab assessment

Triggers and contingency measures

In order to manage the risks associated with ASS, trigger levels have been set for the soil and water monitoring undertaken and contingency measures necessary to manage these risks developed if the triggers levels are reached. Trigger levels are based on ecological tolerances and guidelines for irrigation use as described in Section 5.2.4. Strategies suitable for managing these risks if they are realised include:

- The application of neutralising agents directly to isolated areas of ASS during drying. This is appropriate for the treatment of more “severe” and localised ASS if they exist.
- Flushing of acidic soils by lake through-flow (flushing flow). Flushing of Third Reedy Lake is described further in Section 5.2.4 as part of salinity management. This is suitable if concentrations of soil and soil water acidity increase in a more pervasive nature throughout the lake.

- Neutralisation of acidic lake water via lake through-flow (flushing) with irrigation water (potentially supplemented by addition of neutralising agents). This is suitable if concentrations of acidity in surface water accumulate during drying and need to be neutralised and flushed.

- Dilution and removal of toxicants (potentially supplemented by precipitation via addition of neutralising agents). This is suitable if concentrations of toxicants increase in surface water and need to be diluted, removed or flushed.

The triggers levels and associated contingency measures are summarised in Table 5-7.

Table 5-7: Summary of triggers and contingency measures for ASS risk

Item	Triggers	Monitoring response	Contingency measures
Soil pH (pH_F)	<5.0	• Assess spatial extant via field analysis described above. • Conduct laboratory acid sulfate soil analysis characterise acidity (see MDBA, 2010)	• Neutralise soils to pH ≥5.0: – Addition of neutralising agents if isolated – Flushing with irrigation water if pervasive
Soil water pH	<5.0	• Collect water sample for analysis of lab water quality parameters listed in Table 5-6	• Flushing with irrigation water
Surface water pH	<6.5	• Monitoring water quality during management response • Ensure trigger level exceeded before releasing to linked waterways	• Flushing with irrigation water • May require lime addition to achieve pH objective
Surface water quality	Various (based ecological tolerances and guidelines for irrigation use as described in Section 5.2.4))	• Monitoring water quality during management response • Ensure trigger levels exceeded before releasing to linked waterways	• Flushing with irrigation water • May require lime addition to achieve trigger

5.2.4 Water quality management

Salinity

The proposed wetting and drying regime has the potential to influence groundwater, and by association, salt inflows to Third Reedy Lake. The risk of groundwater/salt influx to the lakes increases with a combination of decreasing lake levels (from current operational levels) and during periods when the lake is dry or almost dry. The risk is greatest if surrounding groundwater levels are elevated (i.e. following a wet climate period) during a dry phase. Increased salinity has the potential to impact on vegetation recovery if tolerances are exceeded at critical life history stages.

Modelling of the desired water regime (URS, 2014) suggests that the 50th%ile water column salinity increase is likely to be around 500 µS/cm and the 80th%ile salinity increase is likely to be ~3,300 µS/cm. The greatest risk to the ecological values and objectives is through salt accumulation in soil and the impact on the EVC establishment during filling when salts in the soil could be dissolved in to the water column. Intermittent Swampy Woodland EVC (EVC 813) and Intermittent Swampy Woodland/ Lake Bed Herbland Complex (EVC A119) prefers salinity <3,000 mg/L (equivalent to electrical conductivity ~4,500 µS/cm) but can tolerate occasional increases in salinity above 3,000 mg/L (3,000-10,000 mg/L), for example during the drying phase (Frood and Papas 2016). The outcome therefore is that the salinity range in Third Reedy Lake is likely to be suitable for most of time. If there is elevated salinity towards the end of the drawdown phase this is unlikely to represent a risk. However, if salinity was elevated at the conclusion of the filling phase (above a trigger level >3,000 mg/L as determined by the tolerance of target vegetation) for a prolonged period (2 weeks) implementation of contingency measures through a monitoring and adaptive management approach may be required as described below.

Contingency measures include provisioning for a flushing flow to lower elevated salinity in Third Reedy Lake and timing drawdown periods to coincide with lower groundwater levels (i.e. during dry periods across the landscape) to minimise the potential for groundwater ingress to the lake (URS, 2014). Monitoring of water quality conditions in the lake will be required monthly during the drawdown period to confirm salinity levels and monitoring groundwater levels around the lake (or alternatively use result of existing groundwater monitoring programs) to identify level of risk and implement appropriate mitigation if salinity is greater than the salinity tolerances of the EVCs (e.g. above 3000 mg/L or 4,500 µS/cm). A contingency has also been included in the desired water regime to partially fill the wetland to around 73.2 m and hold it there for 31 days to flush the lake (if required).

Salt flushing means the dilution and downstream transport of lake water to acceptable limits. The aim is to ensure the salinity of lake water and salt accumulation in the soil remains within acceptable limits for EVC establishment and persistence. Dilution and flushing by natural floods or by managed flushing are the two most likely mechanisms salt concentrations and loads in the lake can be kept within desirable limits.

GMW Operators suggest that flushing from Third Reedy Lake is possible down to about 73.0 mAHD and very achievable at 74.0 (Lake is full at 74.56 mAHD, empty at 72.9 mAHD). This provides plenty of scope to flush salt from Third Reedy with minimal downstream salinity impact. Water and salt flushed from Third Reedy can be shandied using the bypass channel (Figure 5-2). Varying the ratio of lake water to bypass channel water provides the means of keeping the salinity levels in the Torrumbarry No 7 channel within acceptable limits The maximum acceptable level of salinity for protecting irrigation supply is 700 µS/cm, hence a trigger level of 450 µS/cm in Torrumbaryy no. 7 channel is suggested in order to avoid approaching the critical 700 µS/cm level. Simple modelling suggests impacts in Kangaroo Lake, downstream, can be limited to less than 100 µS/cm. Impacts in Little Lake Charm and the Torrumbarry No 1/7 channel system will be greater but need to be maintained below irrigation guideline values (700 µS/cm) (GMW, 2016a).

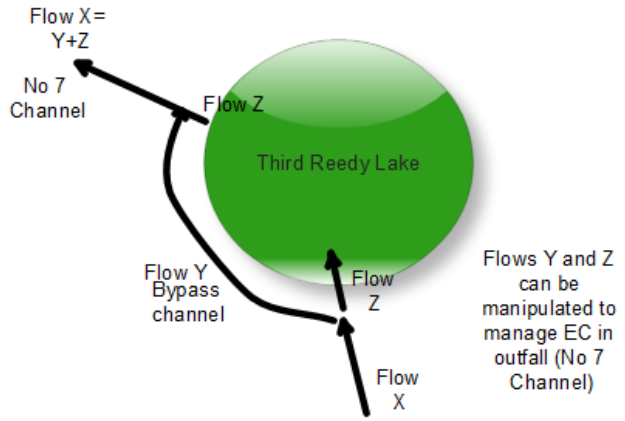

Figure 5-2: Schematic – flow manipulation to manage salinity (electrical conductivity - EC) downstream of Third Reedy Lake (Source: GMW, 2016a)

Flushing is not expected to impact on any native fish remaining in the lake, in fact, it may provide an additional exit option because both upstream and downstream regulators will be open at the same time providing opportunities for fish to leave the lake.

The management of salinity in Third Reedy Lake therefore highlights the need for monitoring a number of environmental variables to determine the salinity risk and to inform implementation of contingency measures (e.g. salt flushing, if required) (Table 5-8).

Table 5-8: Summary of triggers and contingency measures for risks to EVC establishment persistence associated with increased salinity.

Item	Trigger	Monitoring response	Contingency measures
Lake salinity once full	Electrical conductivity >4,500 µS/cm (TDS >3000 mg/L) (Based on vegetation tolerance)	Monitor lake water column salinity and rate of change weekly at several locations around the lake during filling stage.	If salinity is elevated above trigger level once the lake is full (i.e.in flows were insufficient to provide dilution of mobilised salts, provide a flushing flow within 2 week or exceeding trigger level (if salinity has not declined in the interim period) to dilute and remove accumulated salt from the lake. Note that increases in salinity towards the end of the drying phase are unlikely to represent a risk to EVC establishment or persistence.
Salinity in lake outflows (during flushing or regulated drawdown)	Electrical conductivity >450 µS/cm (based on a maximum acceptable level for irrigation use 700 µS/cm)	Targeted monitoring of outflows during flushing events or regulated drawdown.	Shandy using the bypass channel to maintain downstream salinity within acceptable limits for irrigation. Use trigger level of 450 µS/cm as a guide to prevent exceedence the maximum acceptable level for irrigation use of 700 µS/cm.
Groundwater levels	Within 0.5 m of the bed elevation 72.9 m AHD	Monitor groundwater levels adjacent to the lake	If groundwater levels are within 0.5 m of lake bed elevation consider avoiding drawdown and drying.

Dissolved oxygen

Inundation of Third Reedy Lake after a drying event may result in an initial decline in dissolved oxygen as organic matter that has accumulated on the wetland floor is inundated and decomposition commences. An assessment of the risks of blackwater conditions developing in the filling phase (SKM, 2013a) indicates that an initial reduction in dissolved oxygen is likely but the magnitude and duration of low dissolved oxygen depends on the starting load of organic matter, temperature and the lake level at the commencement of inundation: the more organic matter present, the higher the temperature and the lower the lake level, the greater the decline in dissolved oxygen at the commencement of filling and the longer the duration of low dissolved oxygen conditions.

The actual risk to values from low dissolved oxygen during filling depends on whether native fish and other biota enter the lake during the filling phase and are consequently exposed to low dissolved oxygen conditions (SKM 2013a). It is likely that inflows of high quality water during filling will be sufficient to maintain well oxygenated water in Third Reedy Lake. In the initial filling stages (from dry) there will be few aquatic organisms present due to the majority leaving as a result of the fish exit strategy or having died as a result of being stranded. Those species that do enter upon initial filling should be able to remain within the inflow zone where good water quality will be present and therefore their exposure to low dissolved oxygen will be low.

There is a low likelihood of aquatic species being exposed to low dissolved oxygen and decomposition of organic material and the development of low dissolved oxygen condition is a natural occurrence that would probably also occur during a natural filling event. However, to minimise any impacts on fish entering the lake during the filling it is recommended to monitor dissolved oxygen in the inflow area during filling. If dissolved oxygen falls rapidly and remains low <4 mg/L (considered to present a moderate to high risk of hypoxia to native fish of the Murray Darling Basin - Small *et al* 2014) within the inflow area consider a flushing flow to create a zone of oxygenated water (Table 5-9). It is not necessary to maintain dissolved oxygen above the trigger level across the entire lake

Table 5-9: Summary of triggers and contingency measures for risks to associated with decreased dissolved oxygen.

Item	Trigger	Monitoring response	Contingency measures
Inflow zone dissolved oxygen	<4 mg/L	Monitor dissolved oxygen in inflow zone during the filling phase	If dissolved oxygen in inflow zone falls below trigger level consider flushing flow to create a zone of oxygenated water as refuge for fish that may have entered during the filling phase.

6. Approval Conditions

The following sections describes the specific monitoring, triggers and reporting protocols for Approval Conditions 2 and 3 in relations to operational impacts on the Kerang Wetlands Ramsar Site and impacts on nominated fish.

Commonwealth approval for the Third Reedy Lake Bypass Project to proceed, subject to a number of conditions, was granted on 4 July 2018 (see Appendix A for the full set of Approval Conditions). Underpinning the approvals are conditions related to minimising impacts to the Kerang Wetlands Ramsar Site (through the preparation of this OEMP) and through monitoring, adaptive management, risk management and reporting.

Approval conditions related to 1) adverse impacts during construction, 2) adverse impacts during operation and 3) specific impacts on three listed fish species. The construction activities will be managed, in accordance with the environmental approval conditions, under the existing GMW Connections Project Construction Environmental Management Plan (GMW 2015a), which has been amended to address the Third Reedy Lake Bypass Project.

6.1 Approval Condition 2 - minimise impacts to the Kerang Wetlands Ramsar Site

Approval Condition 2 requires that an OEMP (this report) is developed that outlines the protocols for managing impacts to the Kerang Wetlands Ramsar Site and lists the specific impacts that need to be considered in the OEMP. Responses to each of the conditions are provided below.

6.1.1 Approval condition 2i

Approval Condition 2i requires a commitment to monitor water quality with trigger levels for salinity, dissolved oxygen and increased acidity. Section 3.9 and Section 5 provided details of the adaptive management approach to managing a range threats and associated risks, including salinity and outlined the monitoring and contingency measures (i.e. management response risk). The trigger levels, monitoring and contingency measures to specific items identified in the Approvals Conditions 2i are summarised in Table 6-1.

Table 6-1: Response to Approval Condition 2i - minimise water quality related impacts to the Kerang Wetlands Ramsar Site

Water quality risk	Issue	Trigger	Monitoring response	Contingency measures
Increased salinity	Elevated lake salinity when the lake is full may impact on establishment and persistence of target EVC – although EVCs are tolerant of increased salinity during wetland drying phases	>3,000 mg/L (equivalent to 4,500 µS/cm)	• Monitor lake water column salinity and rate of change weekly at several locations around the lake.	If salinity is elevated at the completion of filling provide a flushing flow to dilute and remove accumulated salt from the lake. Note that increases in salinity towards the end of the drying phase are unlikely to represent a risk to EVC establishment or persistence.
Decreased dissolved oxygen	Decreased dissolved oxygen in the inflow zone may impact on fish entering the lake during filling periods.	<4 mg/L	• Monitor dissolved oxygen in inflow zone during the filling phase	If dissolved oxygen in inflow zone falls below trigger level consider flushing flow to create a zone of oxygenated water as refuge for fish that may have entered during the filling phase.
Increased acidity	Decreased soil pH (pH_F)	<5.0	• Assess spatial extent via field analysis described above in Section 5.2.3. • If pH<5 conduct laboratory acid sulfate soil analysis characterise acidity (see MDBA, 2010).	Neutralise soils to pH ≥5.0: • Addition of neutralising agents if isolated • Flushing with irrigation water if pervasive

Water quality risk	Issue	Trigger	Monitoring response	Contingency measures
	Decreased soil water pH	<5.0	• Collect water sample for analysis of lab water quality parameters listed in Table 5-6.	Flushing with irrigation water
	Decreased surface water pH	<6.5	• Monitoring water quality during management response • Ensure trigger level exceeded before releasing to linked waterways.	Flushing with irrigation water: • May require lime addition to achieve pH objective

6.1.2 Approval condition 2ii

Where contingency measures are implemented in response to an exceedance of trigger levels specified in Condition 2i, Approval Condition 2ii requires the approval holder to evaluate and report their effectiveness to the Department, including commitments to adaptive management measures if the contingency measures are determined not to be effective, within three months of implementing the contingency measures.

GMW will evaluate and report on the effectiveness of contingency measures if triggers levels are exceeded within three months of implementing the contingency measures. The report will include commitments to adaptive management measures (e.g. through investigations and review of contingency measures) if the currently identified contingency measures were determined not to be effective.

6.1.3 Approval condition 2iii

Approval Conditions 2iii requires a commitment to monitoring and adaptive management of invasive flora and fauna species to prevent any increase in their presence within the Project area. Invasive species have the potential to impact on EVC establishment and persistence through competition (i.e. weeds), herbivory (i.e. grazing of regenerating vegetation) and bioturbation (i.e. disturbance of lake sediments and macrophytes by carp). Invasive species may also pose predation risks (i.e. predation of turtles and turtle nests by foxes).

Section 5 provided details of the adaptive management approach to managing invasive species; monitoring and contingency measures (management response) are summarised in Table 6-2. For all potential invasive flora and fauna species, the approval holder will review effectiveness of contingency measures if implemented and through adaptive management refine contingency measures if they are determined not to be effective.

Table 6-2: Response to Approval Condition 2iii – prevent an increase in invasive flora and fauna in the project area

Invasive species	Issue	Monitoring activity	Adaptive management and contingency measures
High threat weed invasion	Displacement of native understorey species by aquatic and terrestrial weeds (see Section 5.1 for specific high threat weed species)	• Monitor distribution and cover of invasive aquatic and terrestrial weeds as part of the WetMAP sampling. • Undertake surveillance monitoring (presence/absence) at same time as WetMAP monitoring to increase area of observation.	• Provide a watering regime that favours native species consistent with EVC benchmark. • Spray regionally controlled or highly invasive species if detected in accordance with relevant weed control guidelines. • If high threat species are detected, investigate pathway for colonisation and implement control measures or modify surveillance and contingency measures to minimise further outbreaks or

Invasive species	Issue	Monitoring activity	Adaptive management and contingency measures
			expansion. (note, a trigger level for intervention cannot be determined at this stage – trigger levels for intervention would depend on the specific species present and the colonisation pathway and needs to be evaluated at the time of detection)
Excessive regeneration of River Red Gum	Excessive regeneration of River Red Gums (e.g. over 100 stems per hectare) may impact on the recovery of understorey vegetation. As a general guide some dispersed thickets are acceptable, but thickets growing in concentric rings may be undesirable.	• Monitor River Red Gum establishment to determine whether thinning is required in order to retain the target number of trees per hectare.	• Consider delivering water to the wetland to drown out some juvenile trees. • Consider active thinning • Review effectiveness of contingency measures if implemented and adapt if necessary.
Excessive regeneration of Typha sp.	While the native Typha species (Cumbungi) provide excellent habitat for a range of wetland fauna they can become over-dominant under certain conditions (particularly where prolonged shallow inundation occurs over the warmer parts of the year). If allowed to form dense extensive stands these species can invade open water and other habitat types and reduce overall habitat diversity.	• Monitor Typha distribution and density, maintain maximum cover of 20% within the deep zone with a trigger level of 5% to initiate active management.	• Consider contingency measure to increase depth and duration of inundation to suppress excessive growth. • Review effectiveness of contingency measures if implemented and adapt if necessary.
Carp	Increased turbidity of water leading to low light penetration and poor growth conditions for aquatic plants. Destruction of aquatic vegetation from uprooting.	• Monitor carp movement into the lake during filling and assess population following filling phase.	• Exclusion screens on inlet regulator will limit large carp entering the lake.
Rabbits	Grazing by rabbits results in poor growth form of River Red Gums (multiple stems) delaying the amount of time until they reach sufficient height to resist drowning on rewetting. Grazing of understory species prior to flowering and seed set reduces seed stock.	• Establish exclusion plots to evaluate whether grazing is excessive and to inform the need for contingency actions	• Spotlight counts and rabbit control programs to limit the size of populations if needed. • Review effectiveness of contingency measures if implemented and adapt if necessary.
Foxes	Foxes pose a predation risk to turtles and turtle eggs	• Monitor fox populations and predation activities, particularly as the wetland dries and adult turtles look to move to alternative habitat and when nesting.	• Implement fox control program if numbers increase and predation is deemed an issue. • Review effectiveness of contingency measures if implemented and adapt if necessary.
Other invasive species	Any species (native or exotic) in excessive numbers could pose threats to Ramsar condition	• During monitoring for named species above, be aware of the presence of any other species (eg. Mosquito fish)	• If detected, investigate colonisation pathways, evaluate potential impacts and determine trigger levels and contingency / control measures on a case by case basis. • Review effectiveness of contingency measures if implemented and adapt if necessary.

6.2 Approval Condition 3 – minimise adverse impacts to Flathead Galaxias, Murray Hardyhead and Silver Perch

Approval Condition 3 requires the minimisation of adverse impacts to the Flathead Galaxias, Murray Hardyhead and Silver Perch. The Condition requires monitoring of fish exit during the draw down phase, reporting of the results of the exit monitoring and of any harm to or death of Flathead Galaxias, Murray Hardyhead and Silver Perch, and if there is harm to or death of Flathead Galaxias, Murray Hardyhead and Silver Perch then adaptive management measures must be developed and implemented to minimise further deaths throughout future drying cycles. A Fish Exit Strategy was developed to identify management actions to encourage small and large bodied fish to exit Third Reedy Lake during the commencement of drawdown so as to minimise impacts on all fish, including to Flathead Galaxias, Murray Hardyhead and Silver Perch , to monitor fish response and inform contingency measures (see Section 5.2.2).

Elements of the Fish Exit Strategy relevant to Approval Condition 3 are summarised in Table 6-3. The approach to responding to additional Approval Conditions in relation to fish (Conditions 3iii, 3iv and 3v) follows.

Table 6-3: Response to Approval Condition 3 – minimise adverse impacts to Flathead Galaxias, Murray Hardyhead and Silver Perch

Approval Condition		Activity	Outcome
3i	Monitor fish exit from Third Reedy Lake during exit flows before the regulator is closed or until the water level drops to a level such that the lake is not connected to the bypass	Monitor fish exit in accordance with Table 5-5 – trapping downstream of the inlet regulator (Third Reedy Isolation regulator) and upstream of the outlet regulator (No.7 .regulator). Monitor fish left stranded in Third Reedy lake after the regulators are closed (where feasible and safe to do so according to conditions, drones may be used to provide a visual estimate of stranded fish)	Provide written report in accordance with Condition 3ii
3ii	Within three months of the completion of monitoring, the approval holder must provide a written report to the Department of the fish exit monitoring results.	Prepare fish exit monitoring report, (noting requirements of Approval Condition 3iii) and submit within 3 months of completion of fish exit monitoring. The report will list presence of and any harm to or death of Flathead Galaxias, Murray Hardyhead and Silver Perch, either during fish exit through regulators, or left stranded in the receding lake	Compliance with Approval Condition 3ii

In accordance with Approval Condition 3iii, within three months of the completion of monitoring the approval holder will prepare a report that will list presence of and any harm to or death of Flathead Galaxias, Murray Hardyhead and Silver Perch. If there are records of death or harm to Flathead Galaxias, Murray Hardyhead and Silver Perch, adaptive management measures will be identified for future drying cycles. The process for reviewing and developing adaptive management measures for future drying will involve input from fish ecologists and be based on an evaluation of monitoring outcomes and fish response to the first drying phase.

Subsequent reports will evaluate the success of contingency measures and, where measures were determined not to be successful, the approval holder will propose further contingency measures to minimise death or harm throughout future drying cycles (Approval Condition 3iv).

Monitoring and reporting will continue for the life of the approval unless permission to cease monitoring and reporting is provided in writing by the Minister (Approval Condition v).

7. Reporting and review

7.1 Reporting

As described in Section 3.7, there are reporting requirements for the planning and delivery of environmental water in Victoria. An annual Seasonal Watering Proposal will be required to be prepared by the waterway manager (currently North Central CMA) and submitted to VEWH which will include any environmental water delivery required to Third Reedy Lake and reporting and evaluation of the outcomes of previous environmental water delivery to the lake.

There are also specific reporting requirements for the OEMP detailed in the *EPBC Act 1999* conditions. These include:

- Where contingency measures are implemented in the event of increased salinity, dissolved oxygen and acidity, the approval holder will evaluate and report their effectiveness to the Department, including commitments to further adaptive management measures if the contingency measures are determined not to be effective, within three months of implementing the contingency measures.

- Following each drawdown a report will be prepared (within 3 months) that documents the drawdown procedure and the outcomes of monitoring activities. In accordance with conditions of approval, the report will list any presence of and death or harm to the Flathead Galaxias, Murray Hardyhead and Silver Perch. The report will list adaptive management measures that will be implemented to minimise further death or harm throughout future drying cycles.

- If there is a report of death or harm to Flathead Galaxias, Murray Hardyhead or Silver Perch, subsequent reports will evaluate the success of adaptive management measures and, where measures were unsuccessful', propose further measures to minimise death or harm throughout future drying cycles. Fish ecologists will be engaged in the review of monitoring and effectiveness of contingency measures as part of evaluation and reporting processes.

7.2 Review

Periodic reviews provide the opportunity to evaluate monitoring results in terms of compliance, ecological objectives and to learn from implementation. This provides an opportunity to revise the management approach if ecological responses are observed that were not anticipated at the project outset (e.g. waterbirds commence using the site for breeding in response to vegetative habitat present as a result of the changed water regime).

As per the requirements of the WCMF, this OEMP be reviewed in 2023, 2028 and every five years thereafter, or at any time, if requested by the Victorian Minister for Water or Commonwealth Minister for the Environment (Sections 15 and 19, GMW 2013). The GMW Connections Project is responsible for reviews until responsibility is transferred.

Where monitoring indicates the need to adapt contingency measures, addendums to the OEMP will be prepared to ensure that adaptive management and revision of contingency measures can occur whenever necessary and does not need to wait until a formal 5-year review.

7.3 Adjustment

Adjustments may be made to

- operational management

- management hypotheses and, perhaps, to ecological objectives

- cope with unexpected issues.

These adjustments will be incorporated into the OEMP during the review process outline in Section 7.2.

8. Opportunities for Aboriginal involvement

As part of the development of the Cultural Heritage Management Plan (CHMP) (Reference No. 12825) (Jacobs, 2018) for Third Reedy Lake, the cumulative impact of the Third Reedy Lake project on Aboriginal cultural heritage in the region was considered negligible and no obligatory monitoring was required. However, in recognition of the concerns and interests of the Aboriginal stakeholder groups consulted through the project, the construction process will include actions for compliance inspections of construction activities.

Once the project moves into an implementation phase, there may be other opportunities to involve Aboriginal people and organisations in the future management of Third Reedy Lake. Such activities could include:

- Involvement in monitoring activities e.g. mapping important cultural heritage trees in the remnant vegetation surrounding Third Reedy Lake
- Participation in land management activities e.g. revegetation or pest plant and animal management
- Identification of shared benefits e.g. to enhance the customary values associated with the lake or build traditional ecological knowledge
- lake bed surveys of potential cultural heritage sites during the first drying phase.

Exploring opportunities to work collaboratively with, and build the capacity of, Aboriginal peoples and groups is part of routine business activities for both waterway managers and land managers across Victoria.

9. Governance Framework

There are several stakeholders involved in the delivery of environmental water and application of the adaptive management framework at Third Reedy Lake. Table 9-1 describes the key stakeholders that are involved in the management of Third Reedy Lake.

Currently the water manager for Third Reedy Lake is North Central CMA, the storage and resource manager GMW and the land owner GMW. As discussed in section 2.1.2, future land manager arrangements are currently being explored outside the OEMP process.

Table 9-1: Roles, responsibilities and interest in the management of Third Reedy Lake

Agency/ group	Responsibilities/ involvement
Department of Environment, Land Water and Planning (DELWP Victoria)	• Manage the water allocation and entitlements framework. • Develop state policy on water resource management and waterway management approved by the Minister for Water and Minister for Environment and Climate Change. • Develop state policy for the management of environmental water in regulated and unregulated systems. • Act on behalf of the Minister for Environment and Climate Change to maintain oversight of the VEWH and waterway managers (in their role as environmental water managers). • Legislative responsibilities for the management of flora and fauna. • Approve EWMPs and endorse Seasonal Watering Plans.
Victorian Environmental Water Holder (VEWH)	• Make decisions about the most effective use of the water holdings, including use, trade and carryover. • Authorise waterway managers to implement watering decisions. • Liaise with other water holders to ensure coordinated use of all sources of environmental water. • Publicly communicate environmental watering decisions and outcomes. • Author of the Statewide Seasonal Watering Plan. • Provides final endorsement of SWPs. • Approves delivery of environmental water (Seasonal Watering Statement), funds water delivery and some environmental water related monitoring.
Commonwealth Environmental Water Office (CEWO)	• Support the Commonwealth Environmental Water Holder to make decisions about the use of Commonwealth water holdings, including providing water to the VEWH for use in Victoria. • Liaise with the VEWH to ensure coordinated use of environmental water in Victoria. • Report on management of Commonwealth water holdings.
Murray-Darling Basin Authority (MDBA)	• Implement the Murray-Darling Basin Plan - the Basin Plan sets legal limits on the amount of surface water and groundwater that can be taken from the Basin from 1 July 2019 onwards. • Integrate Basin wide water resource management. • Manage The Living Murray water entitlements.
Waterway Manager	• Identify regional priorities for environmental water management in regional Waterway Strategies • In consultation with the community assess water regime requirements of priority rivers and wetlands to identify environmental watering needs to meet agreed objectives • Identify opportunities for, and implement, environmental works to use environmental water more efficiently. • Propose annual environmental watering actions to the VEWH and implement the VEWH environmental watering decisions. • Provide critical input to management of other types of environmental water (passing flows management, above cap water). • Report on environmental water management activities undertaken.
Storage and resource manager	As Water Corporation – Storage Manager and Resource Manager: • Work with the VEWH and waterway managers in planning the delivery of environmental water to maximise environmental outcomes. • Operate water supply infrastructure such as dams and irrigation distribution systems to deliver environmental water.
Land Manager*	• Implement the relevant components of EWMPs, including (as agreed) operation and maintenance of infrastructure that is not part of the GMW irrigation delivery system. • Where agreed, participate in the periodic review of relevant EWMPs.

Agency/ group	Responsibilities/ involvement
	• Manage and report on other relevant catchment management and risk management actions required due to the implementation of environmental water. • Implement management actions and monitoring outlined in the OEMP due to the implementation of the Third Reedy Lake Bypass Project. • Compliance with the *EE Act 1978* and *EPBC Act 1999* conditions
Input, advice and interest in management at Third Reedy Lake	
Traditional Owners/ Community Groups	• The delivery of environmental water is likely to provide other benefits that depend on the condition of our waterways, such as supporting social and cultural values. • The recognised Native Title Group for Third Reedy Lake Lakes Complex is BBNAC (Barapa Barapa Nations Aboriginal Corporation) and BBNTG (Barapa Barapa Native Title Group).
Local Council	• Local council (Gannawarra Shire council) for area that includes Third Reedy Lake. • Responsible for regulation of local development through planning schemes and on-ground works.
Local community	• Recreational users of Third Reedy Lake • Community Advisory Group established and consulted in the development of the Third Reedy Lake Bypass Project.

* GMW is currently the land manager for Third Reedy Lake. It is the intention that land management and responsibilities will be transferred to a more suitable agency/ group. Until this occurs GMW will remain land manager.

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Appendix A. EE Act 1978 and EPBC Act 1999 Approval Conditions

Conditions attached to the approval:

1. To minimise adverse impacts to the Kerang Lakes Ramsar Site, the approval holder must ensure that the construction environmental management plan for the proposed action:

    i. Includes a commitment to implementation of measures to identify any matters of national environmental significance within the project area during construction. Any matters of national environmental significance that were not identified in the Environment Report must be reported to the Department within 14 days of their identification.

    ii. Includes contingency measures to minimise impacts to matters of national environmental significance identified within the project area during construction and, when the contingency measures are implemented, evaluate and report their effectiveness to the Department within three months of implementation.

    iii. Includes a commitment to implementation of weed management measures in accordance with best practice techniques.

    iv. The approval holder must provide the Department an electronic copy of the draft construction environmental management plan for comment prior to seeking approval of the plan from the relevant state authority.

    v. Is provided to the Department within 14 days following approval by the relevant state authority.

2. To minimise adverse impacts to the Kerang Lakes Ramsar Site, the approval holder must ensure that the operational environmental management plan for the proposed action:

    i. Includes a commitment to monitoring of water quality, with trigger levels for the implementation of contingency measures in the event of increased salinity, reduced dissolved oxygen and increased acidity.

    ii. Where contingency measures are implemented, the approval holder must evaluate and report their effectiveness to the Department, including commitments to adaptive management measures if the contingency measures are determined not to be effective, within three months of implementing the contingency measures.

    iii. Includes a commitment to monitoring and adaptive management of invasive flora and fauna species to prevent any increase in their presence within the Project area.

    iv. The approval holder must provide the Department an electronic copy of the draft operational environmental management plan for comment prior to seeking approval of the plan from the relevant state authority.

    v. Is provided to the Department within 14 days following approval by the relevant state authority.

3. To minimise adverse impacts to the Flathead Galaxias, Murray Hardyhead and Silver Perch the approval holder must:

    i. Monitor fish exit from Third Reedy Lake during exit flows before the regulator is closed or until the water level drops to a level such that the lake is not connected to the bypass.

    ii. Within three months of the completion of monitoring, the approval holder must provide a written report to the Department of the fish exit monitoring results.

iii. The written report must list any presence of and death or harm to the Flathead Galaxias, Murray Hardyhead and Silver Perch. The report must list adaptive management measures that will be implemented to minimise further death or harm throughout future drying cycles.

iv. Following a report of death or harm to the Flathead Galaxias, Murray Hardyhead or Silver Perch, subsequent reports must evaluate the success of adaptive management measures and, where measures were unsuccessful', propose further measures to minimise death or harm throughout future drying cycles.

v. Continue the monitoring and reporting for the life of the approval unless permission to cease monitoring and reporting is provided in writing by the Minister.

4. Within 14 days following commencement of the action, the approval holder must advise the Department in writing of the actual date of commencement.

5. The approval holder must maintain accurate records substantiating all activities associated with or relevant to the conditions of approval and make them available upon request to the Department. Such records may be subject to audit by the Department or an independent auditor in accordance with section 458 of the *EPBC Act* or used to verify compliance with the conditions of approval. Summaries of audits may be posted on the Department's website or publicised through general media.

6. If the approval holder revises a management plan approved by the relevant state authority, as referred in Conditions 1 and 2, the revised management plan must be provided to the Department within 14 days following approval. Information confirming compliance of the new management plan with the requirements of Conditions 1 and 2 relevant to minimising impacts to the Kerang Lakes Ramsar Site must be provided with the revised management plan.

7. Unless otherwise agreed to in writing by the Minister, the approval holder must publish all plans referred to in these conditions of approval on their website within one month of being approved by the relevant state authority.

8. Within three months of every 12 month anniversary of the commencement of the action, the approval holder must publish a report on their website addressing compliance with the conditions of this approval over the previous 12 months, including implementation of any management plans. Non-compliance with any of the conditions of this approval must be reported to the Department at the same time as the compliance report is published. Unless otherwise agreed to in writing by the Minister, this condition applies for the life of the approval.

9. Upon direction of the Minister, the approval holder must ensure' that an independent audit of compliance with the conditions of approval is conducted and a report submitted to the Minister. The independent auditor must be approved by the Minister prior to the commencement of the audit. Audit criteria must be agreed to by the Minister and the audit report must address the criteria to the satisfaction of the Minister.

10. If, at any time after three years from the date of this approval, the approval holder has not commenced the action, then the approval holder must not commence the action without the written agreement of the Minister.

Definitions

Department - The Australian Government Department or any other agency administering the Environment Protection and Biodiversity Conservation Act 1999 (Cth) from time to time.

Environment Report - the Third Reedy Lakes Bypass Project Environment Report, Goulburn Murray Water Connections Project, Draft 16a (14 November 2017), prepared by Jacobs Australia Pty Limited.

EPBC Act - Environment Protection and Biodiversity Conservation Act 1999 (Cth).

Flathead Galaxias - the EPBC Act listed fish species *Galaxias rostratus*.

Minister - The Minister administering the Environment Protection and Biodiversity Conservation Act 1999 (Cth) and includes a delegate of the Minister.

Murray Hardyhead - the EPBC Act listed fish species *Craterocephalus fluviatilis*.

Project area - area marked by red border in Annex A.

Silver Perch - the EPBC Act listed fish species *Bidyanus bidyanus*.

Annex A

Appendix B. Supporting reports and investigations

Source of information
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Source of information
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Appendix C. Species lists for the target EVCs

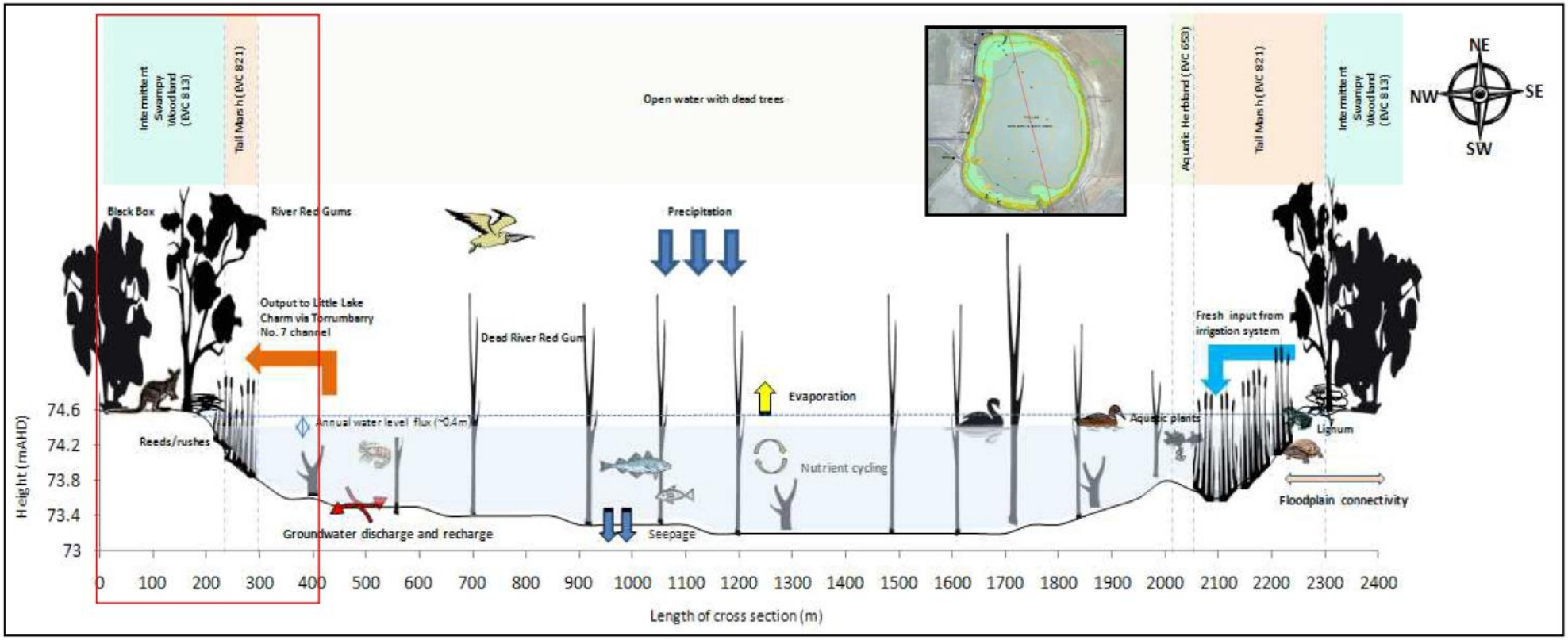
Management Unit			Wetland fringe		Wetland bed		
Zone			Dry zone	Wet zone	Shallow zone	Transition zone	Deep Zone
Flora species			EVC 813	EVC 813	EVC A119	EVC A119	EVC 653/107)
Scientific Name	Common Name	Form					
Acacia salicia	Willow Wattle	Shrub	x				
Acacia stenophylla	Eumong	Shrub	x	x	x	x	
Alternanthera denticulata s.s.	Lesser Joyweed	Ground		x	x	x	x
Amphibromus fluitans	Floating Swamp Wallaby-grass	Ground		x			
Amphibromus nervosus	Common Swamp Wallaby-grass	Ground		x			
Asperula conferta	Common Woodruff	Ground	x				
Asperula gemella	Twin-leaf Bedstraw	Ground		x			
Bolboschoenus caldwellii	Salt Club-sedge	Sedge/reed		x	x		
Carex bichenoviana	Plains Sedge	Sedge/reed	x	x			
Carex tereticaulis	Poong'ort	Sedge/reed		x			
Centipeda cunninghamii	Common Sneezeweed	Ground		x	x	x	x
Centipeda minima s.l.	Spreading Sneezeweed	Ground		x			
Centipeda pleiocephala	Tall Sneezeweed	Ground		x			
Ceratophyllum demersum	Hornwort	Ground			x	x	x
Chenopodium nitrariaceum	Nitre Goosefoot	Ground	x	x			
Convolvulus remotus	Grass Bindweed	Ground	x	x			
Cressa australis	Rosinweed	Ground	x	x			
Cullen cinereum	Hoary Scurf-pea	Ground		x	x		
Cycnogeton dubium	Slender Water Ribbons	Macrophyte		x			
Cycnogeton multifructum	Northern Water Ribbons	Macrophyte		x			
Cycnogeton procerum	Common Water Ribbons	Macrophyte		x			
Cynodon dactylon var. pulchellus	Native Couch	Ground	x	x			
Cyperus bifax	Downs Nutgrass	Ground	x	x			
Cyperus gymnocaulos	Spiny Flat-sedge	Sedge/reed	x	x			
Damasonium minus	Star Fruit	Ground		x			
Distichlis distichophylla	Australian Salt-grass	Ground	x				
Duma florulenta	Tangled Lignum	Shrub	x	x	x		
Duma horrida subsp. Horrida	Spiny Lignum	Shrub	x	x	x		
Dysphania pumilio	Clammy Goosefoot	Ground		x	x	x	x
Eleocharis acuta	Common Spike-sedge	Sedge/reed		x			
Eleocharis sp. aff. acuta (Wimmera)	Wimmera Spike-sedge	Sedge/reed		x	x		
Eleocharis pusilla	Small Spike-sedge	Sedge/reed		x			
Eleocharis pallens	Pale Spike-sedge	Sedge/reed		x			
Eragrostis australasica	Cane Grass	Ground	x	x			
Eragrostis infecunda	Southern Cane-grass	Ground	x	x			
Eucalyptus camaldulensis	River Red-gum	Tree	x	x	x	x	
Eucalyptus largiflorens	Black Box	Tree	x				

Management Unit			Wetland fringe		Wetland bed		
Zone			Dry zone	Wet zone	Shallow zone	Transition zone	Deep Zone
Flora species			EVC 813	EVC 813	EVC A119	EVC A119	EVC 653/107)
Eucalyptus x oxypoma	Natural hybrid between River Red Gum and Black Box	Tree	x				
Eutaxia microphylla var. diffusa	Spreading Eutaxia	Ground	x				
Glinus lotoides	Hairy Carpet-weed	Ground		x	x	x	x
Glinus oppositifolius	Slender Carpet-weed	Ground		x	x	x	x
Glossostigma elatinoides	Small Mud-mat	Ground		x	x		
Glycyrrhiza acanthocarpa	Southern Liquorice	Ground		x	x	x	
Goodenia glauca	Pale Goodenia	Ground	x				
Goodenia heteromera	Spreading Goodenia	Ground	x	x			
Haloragis aspera	Rough Raspwort	Ground	x				
Haloragis glauca f. glauca	Bluish Raspwort	Ground	x				
Heliotropium curassavicum	Smooth Heliotrope	Ground		x	x	x	x
Juncus aridicola	Tussock Rush	Sedge/reed		x			
Juncus flavidus	Gold Rush	Sedge/reed	x	x			
Lachnagrostis filiformis s.s.	Common Blown-grass	Ground			x	x	x
Laphangium luteoalbum	Jersey Cudweed	Ground		x	x	x	x
Lepilaena australis	Austral Water-mat	Ground		x	x		
Leptochloa fusca subsp. fusca	Brown Beetle-grass	Ground		x			
Lobelia concolor	Poison Pratia	Ground	x				
Lythrum hysoppifolium	Small Loosestrife	Ground		x	x	x	x
Malva weinmanniana	Australian Hollyhock	Ground		x	x		
Marsilea costulifera	Narrow-leaf Nardoo	Macrophyte		x			
Marsilea drummondii	Common Nardoo	Macrophyte	x	x	x		
Marsilea hirsute	Short-fruit Nardoo	Macrophyte		x			
Mentha australis	River Mint	Ground	x				
Mimulus prostrates	Small Monkey-flower	Ground		x	x		
Myriophyllum caput-medusae	Coarse Water-milfoil	Macrophyte		x	x	x	x
Myriophyllum crispatum	Upright Water-milfoil	Macrophyte		x			
Myriophyllum papillosum	Robust Milfoil	Macrophyte		x	x	x	x
Myriophyllum porcatum	Ridged Water-milfoil	Macrophyte		x			
Myriophyllum salsugineum	Lake Water-milfoil	Macrophyte			x	x	x
Myriophyllum verrucosum	Red Water-milfoil	Macrophyte		x	x	x	x
Najas tenuifolia	Water Nymph	Macrophyte		x	x		
Nymphoides crenata	Wavy Marshwort	Macrophyte		x	x		
Otellia ovalifolia	Swamp Lily	Macrophyte		x	x		
Persicaria lapathifolia	Pale Knotweed	Ground		x	x	x	x
Persicaria prostrata	Creeping Knotweed	Ground	x	x			
Phragmites australis	Common Reed	Sedge/reed		x			
Poa fordeana	Forde Poa	Ground		x			
Potamogeton cheesemanii	Red Ponweed	Macrophyte		x			
Potamogeton crispus	Curly Pondweed	Macrophyte			x	x	x
Potamogeton ochreatus	Blunt Pondweed	Macrophyte			x	x	x

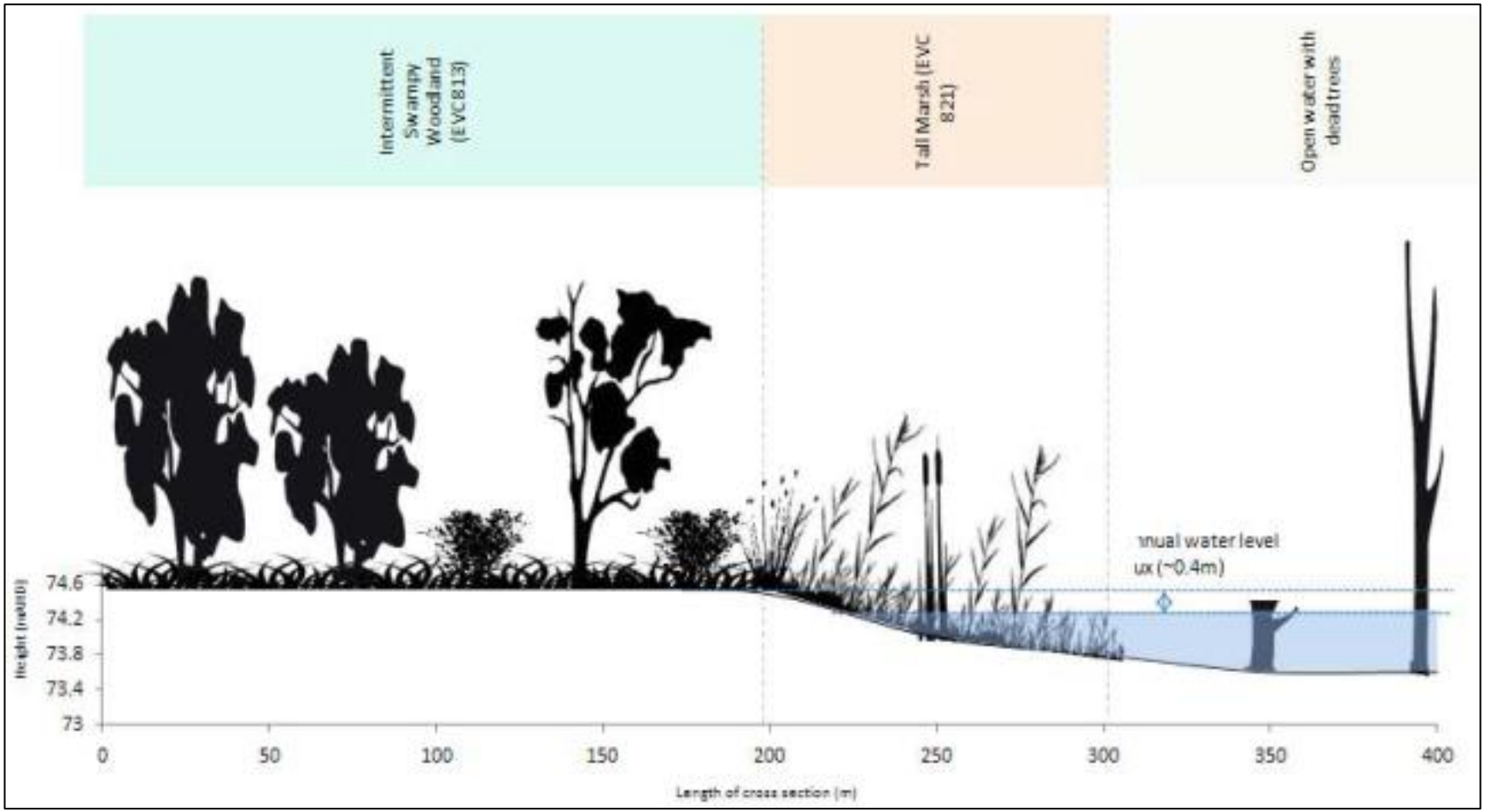
Management Unit			Wetland fringe		Wetland bed		
Zone			Dry zone	Wet zone	Shallow zone	Transition zone	Deep Zone
Flora species			EVC 813	EVC 813	EVC A119	EVC A119	EVC 653/107)
Ranunculus undosus	Swamp Buttercup	Ground		x			
Rumex bidens	Mud Dock	Ground		x			
Rumex tenax	Narrow-leaf Dock	Ground		x	x		
Rytidosperma caespitosum	Common Wallaby-grass	Ground					
Rytidosperma duttonianum	Brown-backed Wallaby-grass	Ground	x	x			
Rytidosperma setaceum	Bristly Wallaby-grass	Ground	x				
Scleroblitum atriplicinum	Starry Goosefoot	Ground		x	x	x	x
Senecio behrianus	Stiff Groundsel	Ground		x			
Senecio campylocarpus	Floodplain Fireweed	Ground		x	x	x	x
Senecio cunninghamii var. cunninghamii	Branching Groundsel	Ground	x	x			
Senecio glossanthus s.l.	Slender Groundsel	Ground		x	x	x	x
Senecio quadridentatus	Cotton Fireweed	Ground	x	x	x	x	x
Senecio runcinifolius	Tall Fireweed	Ground	x		x	x	x
Sphaeromorphaea australis	Spreading Nut-heads	Ground		x			
Sporobolus mitchellii	Rat-tail Couch	Ground		x	x		
Stemodia florulenta	Blue Rod	Ground	x	x			
Stuckenia pectinata	Fennel Pondweed	Ground			x	x	x
Swainsona swainsonioides	Downy Swainson-pea	Ground	x	x	x		
Teucrium racemosum s.s.	Grey Germander	Ground	x	x			
Trigonella suavissima	Sweet Fenugreek	Ground					
Vallisneria australis	Eel Grass	Macrophyte			x	x	x
Wahlenbergia fluminalis	River Bluebell	Ground	x	x			
Walwhalleya proluta	Rigid Panic	Ground	x	x			

Appendix D. Conceptual cross sections of Third Reedy Lake

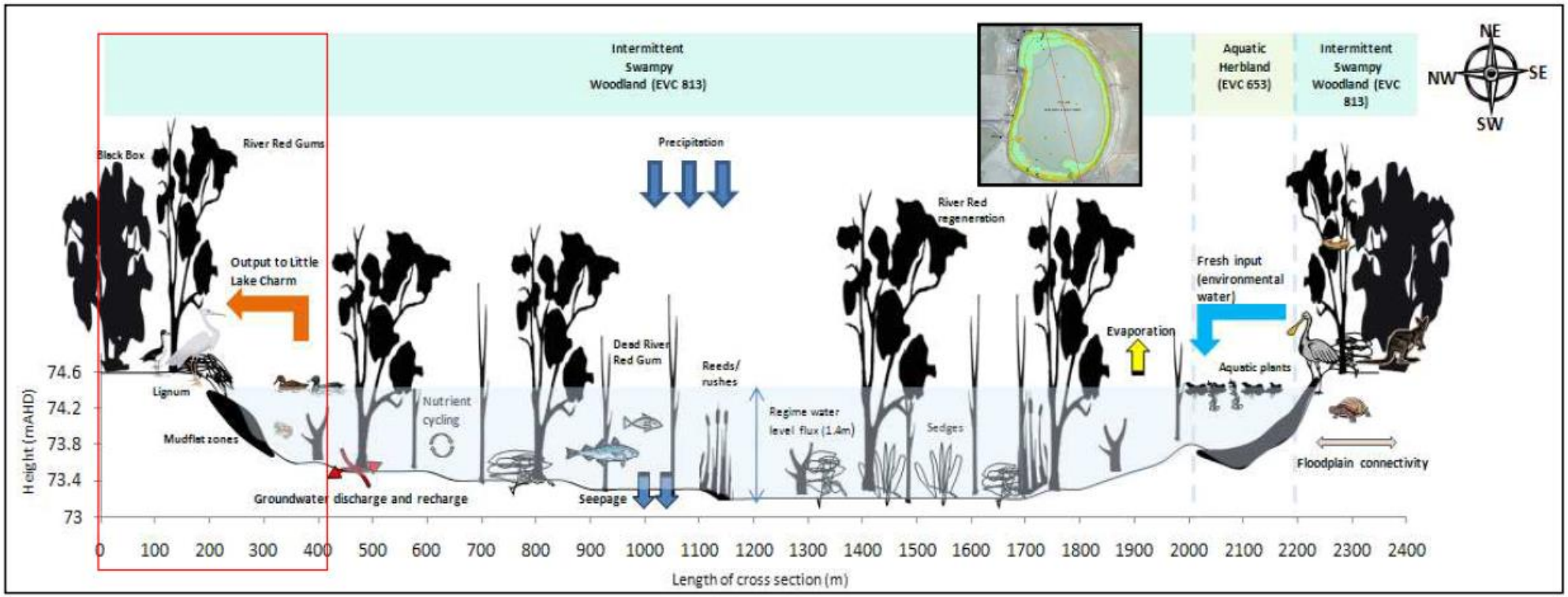
D.1 A conceptual cross section of Third Reedy Lake showing current conditions (Source: North Central CMA, 2014)



D.2 A conceptual model of the littoral zone of Third Reedy Lake under current regime (Source: North Central CMA, 2014)



D.3 A conceptual cross section of Third Reed Lake under proposed regime (Source: North Central CMA, 2014)



D.4 A conceptual model of the littoral zone of Third Reedy Lake under proposed regime (Source: North Central CMA, 2014)

Appendix E. Summary of monitoring

The following provides a summary of the proposed monitoring at Third Reedy Lake to support the adaptive management framework and Approval Conditions 2 and 3.

E.1 Adaptive management of ecological outcomes

Table E1-1: Monitoring against management objectives at Third Reedy Lake

Relevant objective	Monitoring Activity	Approach
Facilitate the establishment of River Red Gum trees across the bed of the lake	Monitor the progress of River Red Gum establishment within the Wetland Bed Management Unit against the targets outlined in Table 4-2 in Section 4.2.1. Evaluate the density of remnant vegetation against the EVC benchmarks.	TLM tree condition assessment prior to the initial drawdown stage to establish baseline. Ongoing assessment to occur each management cycle once drawdown has occurred (anticipated to be in the spring following a wetland fill) until the target of 15 trees per ha has been achieved.
Restore a diverse ground layer of vegetation in the inundated zones of the wetland, characteristic of a deep freshwater marsh	Monitor the recovery of species within the bed of the lake. Evaluate the success of revegetation activities (where relevant). Monitor the density of invasive species.	Using the WetMAP sampling protocol survey three transects in the Wetland Fringe Management Unit. Note: the transects selected will be used for ongoing vegetation understorey and pest plant monitoring activities.
Hydrological monitoring	Monitor the water regime at the lake Monitor the delivery of environmental water through Third Reedy Lake Isolation regulator	Installation of a staff gauge in a lower elevated area of the lake to determine the rate of drying during the draw down period. Installation of instream flow measurement at Third Reedy Lake Isolation regulator

Table E1-2: Monitoring for assessing progress toward the achievement of vegetation objectives and targets

Objective	Management Unit	Evaluation method
Facilitate the establishment of River Red Gum trees across the bed of the lake	Wetland Bed – shallow and transition zones	Assess height juvenile River Red Gums against proposed filling level. Compare against tree density assessment (as below)
	Wetland Bed – shallow and transition zones	Monitor tree density
	Wetland Bed – shallow and transition zones	Monitor tree density
Restore a diverse ground layer of vegetation in the inundated zones of the wetland, characteristic of a deep freshwater marsh.	Wetland Bed	Wetland plant surveys Monitor carp presence /absence
		Wetland plant surveys

E.2 Adaptive management of risks

E.2.1 EVC establishment and decline in health of existing EVCs/ vegetation

Table E2-1: Key threats and potential monitoring and management responses/ contingency measures to the establishment of target EVCs (Jacobs and Rakali 2018)

Threat	Monitoring and Management Response/ Contingency Measures
Lack of Seed bank	• Active planting of long stem River Red Gums will take place during the first draw down cycle to accelerate the establishment of River Red Gum trees.
Drowning trees	• Monitor height of juvenile trees and manage depth of inundation accordingly (i.e. to not drown juvenile plants)
Weed invasion	• Monitor and distribution of invasive aquatic and terrestrial weeds as part of the WetMAP sampling. • Provide a watering regime that favours native species consistent with EVC benchmark. • Spraying of regionally controlled or highly invasive species if detected.
Excessive regeneration of River Red Gum	• Monitor River Red Gum establishment to determine whether thinning is required in order to retain the target number of trees per hectare. • Consider delivering water to the wetland to drown out some juvenile trees.
Excessive regeneration of *Typha sp.*	• Monitor *Typha sp.* distribution and density, maintain maximum cover of 20% within the deep zone with a trigger level of 5% to initiate active management. • Management actions include increased depth and duration of inundation to suppress excessive growth.
Grazing	• Establish exclusion plots to evaluate whether grazing is excessive and to inform the need for intervention programs. • Spotlight counts and rabbit control programs to limit the size of populations if needed.
Carp	• Fish exclusion screens are being included on the inlet regulator (Third Reedy Isolation Regulator) to prevent large carp entering the wetland during regulated filling. This will limit carp numbers and biomass during inundation phases

Table E2-2: Monitoring risks to Fringing vegetation.

Risk	Management Unit	Monitoring method
Decline in health of **remnant Black Box and River Red Gum** trees surrounding Third Reedy Lake	Wetland fringe - dry zone only	Map critical habitat and cultural trees. Benchmark current canopy condition and monitor for change, comparing against a control (no intervention) and reference site (regional conditions) using TLM tree condition assessment (focussing on canopy) every 2 years during cycles 1 and 2. Every four years for cycles 3 and 4.
	Wetland fringe – both zones	Stand density and canopy condition assessment

E.2.2 Fish exit

Table E2-3: Monitoring to inform management decisions during the drawdown of Third Reedy Lake and implementation of the fish exit strategy.

Recession Phase	Third Reedy Lake level (AHD)	Monitoring component
1st drop over 48 hours	74.56 m AHD to 74.36m AHD	Monitor fish numbers/accumulations at No 7 (upstream side) and Third Reedy Lake Isolation (downstream side) regulators
Hold steady for 3-4 days, can be extended to 7-14 days	74.36 m AHD	Monitor fish numbers/accumulations at No 7 and Third Reedy Lake Isolation regulators
2nd drop over 48 hours	74.36m AHD to 74.16 m AHD	Monitor fish numbers/accumulations at No 7 and Third Reedy Lake Isolation regulators
Hold steady for 3-4 days, can be extended to 21 days	74.16 m AHD	Monitor fish numbers/accumulations at No 7 and Third Reedy Lake Isolation regulators
3nd drop over 48 hours	74.16 m AHD to 73.96 m AHD	Monitor fish numbers/ accumulations at Torrumbarry No 7 and Third Reedy Lake Isolation regulators Continue to monitor fish numbers/accumulations
Attenuated recession – natural rate of fall	<73.96 m	Continue to monitor fish numbers/ accumulations Use drone where required

Table E2-4: Monitoring objectives, methods and outcomes to enable adaptive management of risks to fish during Third Reedy Lake drawdown

Monitoring objective	Monitoring Method	Outcome
Baseline survey of fish communities in Third Reedy Lake before recession to provide estimate of individual species population size	Standard suite of nets and electrofishing within the lake	Inform management (e.g. biomass estimate and potential for odour problems if large biomass is present during decomposition) Enable fish translocation of threatened species Identify size classes/species including threatened species Provide baseline for project evaluation
Document fish exit from lake during drawdown (species and abundance)	Trapping on the Third Reedy Lake (upstream) side of the No 7 regulator and downstream side of the Third Reedy Isolation regulator. Weekly until the regulators are closed or the lake level falls below the sill level and becomes disconnected from the inlet channel.	Demonstrate fish exit rates/behaviour and pathways Identify the influential hydrological cues Report against conditions of *EPBC Act 1999* approval – monitor fish exit during exit flows and report results to the Department. List any presence of and death or harm to Flathead Galaxias, Murray Hardyhead and Silver Perch (see Section 6.2).

E.2.3 Acid Sulfate Soils

Table E2-5: Summary of soil and water monitoring at each fixed monitoring site

Item		Monitoring	Frequency	Trigger for monitoring
Soil and soil water	Site description	Site number, GPS co-ordinates, vegetation, morphology, photo	Installation of piezometer	Baseline – no trigger required
	Soil description	Lithology, texture, colour, odour	Installation of piezometer	Baseline – no trigger required
	Soil pH	pH of soil measured with a calibrated pH probe	Installation of piezometer	Baseline – no trigger required
	Field soil water quality in piezometer	pH (plus EC, T, DO, ORP, which are all included in the same water quality meter)	Monthly	Monthly until 6 months after complete drying of a particular section of the lake. Review monitoring program after 1st cycle, if pH in field is >5.0 then cease monitoring. If pH

Item		Monitoring	Frequency	Trigger for monitoring
				<5.0 the continue monitoring during next drying phase.
	Lab soil water quality from Piezometer	Alkalinity, Dissolved cations (Na, K, Ca, Mg, Si) Dissolved anions (Cl, Br, F, SO4) dissolved nutrients (NO3, NH4, PO4) Trace dissolved metals/metalloids (Ag, Al, As, Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb, Se, Zn), DOC	If pH in field is <5.0	Baseline Subsequently if pH <5.0, undertake further lab assessment
Surface Water	Site description	Site number, GPS co-ordinates, vegetation, morphology, photo	Installation	Baseline – no trigger required
	Water description	Colour, odour, depth	Installation	Baseline – no trigger required
	Field water quality	T, pH, EC, DO, ORP, Turbidity	Monthly first 3 months of drying phase Fortnightly during high risk period (lake bed exposing)	Monthly to fortnightly until dry. Review monitoring program after 1st cycle, if pH in field is >5.0 then cease monitoring. If pH <5.0 the continue monitoring during next drying phase.
	Lab water quality	Alkalinity, Dissolved cations (Na, K, Ca, Mg, Si) Dissolved anions (Cl, Br, F, SO_4) dissolved nutrients (NO_3, NH_4, PO_4) Trace dissolved metals/metalloids (Ag, Al, As, Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb, Se, Zn), DOC	If pH in field is <5.0	Baseline Subsequently if pH <5.0, undertake further lab assessment

Table E2-6: Monitoring to inform implementation of contingency measures for Acid Sulfate Soil risk

Item	Triggers	Monitoring response	Contingency measures
Soil pH (pH_F)	<5.0	• Assess spatial extant via field analysis described above. • Conduct laboratory acid sulfate soil analysis characterise acidity (see MDBA, 2010)	• Neutralise soils to pH ≥5.0: – Addition of neutralising agents if isolated – Flushing with irrigation water if pervasive
Soil water pH	<5.0	• Collect water sample for analysis of lab water quality parameters listed in Table 5-6	• Flushing with irrigation water
Surface water pH	<6.5	• Monitoring water quality during management response • Ensure trigger level exceeded before releasing to linked waterways	• Flushing with irrigation water • May require lime addition to achieve pH objective
Surface water quality	Various (based ecological tolerances and guidelines for irrigation use as described in Section 5.2.4))	• Monitoring water quality during management response • Ensure trigger levels exceeded before releasing to linked waterways	• Flushing with irrigation water • May require lime addition to achieve trigger

E.2.4 Salinity

Table 10-1: Summary of monitoring to inform implementation of contingency measures for associated with increased salinity.

Item	Trigger	Monitoring response	Contingency measures
Lake salinity once full	Electrical conductivity >4,500 µS/cm (TDS >3000 mg/L) (Based on vegetation tolerance)	Monitor lake water column salinity and rate of change weekly at several locations around the lake during filling stage.	If salinity is elevated above trigger level once the lake is full (i.e.in flows were insufficient to provide dilution of mobilised salts, provide a flushing flow within 2 week or exceeding trigger level (if salinity has not declined in the interim period) to dilute and remove accumulated salt from the lake.

Item	Trigger	Monitoring response	Contingency measures
			Note that increases in salinity towards the end of the drying phase are unlikely to represent a risk to EVC establishment or persistence.
Salinity in lake outflows (during flushing or regulated drawdown)	Electrical conductivity >450 µS/cm (based on a maximum acceptable level for irrigation use 700 µS/cm)	Targeted monitoring of outflows during flushing events or regulated drawdown.	Shandy using the bypass channel to maintain downstream salinity within acceptable limits for irrigation. Use trigger level of 450 µS/cm as a guide to prevent exceedence the maximum acceptable level for irrigation use of 700 µS/cm.
Groundwater levels	Within 0.5 m of the bed elevation 72.9 m AHD	Monitor groundwater levels adjacent to the lake	If groundwater levels are within 0.5 m of lake bed elevation consider avoiding drawdown and drying.

E.2.5 Dissolved Oxygen

Table 10-2: Summary of monitoring to inform implementation of contingency measures for risks to associated with decreased dissolved oxygen.

Item	Trigger	Monitoring response	Contingency measures
Inflow zone dissolved oxygen	<4 mg/L	Monitor dissolved oxygen in inflow zone during the filling phase	If dissolved oxygen in inflow zone falls below trigger level consider flushing flow to create a zone of oxygenated water as refuge for fish that may have entered during the filling phase.

E.3 Approval conditions

Table E3.1: Monitoring in response to Approval Condition 2i - minimise water quality related impacts to the Kerang Wetlands Ramsar Site

Water quality risk	Trigger	Monitoring activity	Contingency measures
Increased salinity	>3,000 mg/L (equivalent to 4,500 µS/cm)	• Monitor lake water column salinity and rate of change weekly at several locations around the lake.	If salinity is elevated at the completion of filling provide a flushing flow to dilute and remove accumulated salt from the lake. Note that increases in salinity towards the end of the drying phase are unlikely to represent a risk to EVC establishment or persistence.
Decreased dissolved oxygen	<4 mg/L	• Monitor dissolved oxygen in inflow zone during the filling phase	If dissolved oxygen in inflow zone falls below trigger level consider flushing flow to create a zone of oxygenated water as refuge for fish that may have entered during the filling phase.
Increased acidity	<5.0	• Assess spatial extent via field analysis described above in Section 5.2.3. • If pH<5 conduct laboratory acid sulfate soil analysis characterise acidity (see MDBA, 2010).	Neutralise soils to pH ≥5.0: • Addition of neutralising agents if isolated • Flushing with irrigation water if pervasive
	<5.0	• Collect water sample for analysis of lab water quality parameters listed in Table 5-6.	Flushing with irrigation water
	<6.5	• Monitoring water quality during management response • Ensure trigger level exceeded before releasing to linked waterways.	Flushing with irrigation water: • May require lime addition to achieve pH objective

Table E3-2: Monitoring in response to Approval Condition 2iii – prevent an increase in invasive flora and fauna

Invasive species	Monitoring activity	Adaptive management and contingency measures
High threat weed invasion	• Monitor distribution and cover of invasive aquatic and terrestrial weeds as part of the WetMAP sampling. • Undertake surveillance monitoring (presence/absence) at same time as WetMAP monitoring to increase area of observation.	• Provide a watering regime that favours native species consistent with EVC benchmark. • Spray regionally controlled or highly invasive species if detected in accordance with relevant weed control guidelines. • If high threat species are detected, investigate pathway for colonisation and implement control measures or modify surveillance and contingency measures to minimise further outbreaks or expansion. (note, a trigger level for intervention cannot be determined at this stage – trigger levels for intervention would depend on the specific species present and the colonisation pathway and needs to be evaluated at the time of detection)
Excessive regeneration of River Red Gum	• Monitor River Red Gum establishment to determine whether thinning is required in order to retain the target number of trees per hectare.	• Consider delivering water to the wetland to drown out some juvenile trees. • Consider active thinning • Review effectiveness of contingency measures if implemented and adapt if necessary.
Excessive regeneration of Typha sp.	• Monitor Typha distribution and density, maintain maximum cover of 20% within the deep zone with a trigger level of 5% to initiate active management.	• Consider contingency measure to increase depth and duration of inundation to suppress excessive growth. • Review effectiveness of contingency measures if implemented and adapt if necessary.
Carp	• Monitor carp movement into the lake during filling and assess population following filling phase.	• Exclusion screens on inlet regulator will limit large carp entering the lake.
Rabbits	• Establish exclusion plots to evaluate whether grazing is excessive and to inform the need for contingency actions	• Spotlight counts and rabbit control programs to limit the size of populations if needed. • Review effectiveness of contingency measures if implemented and adapt if necessary.
Foxes	• Monitor fox populations and predation activities, particularly as the wetland dries and adult turtles look to move to alternative habitat and when nesting.	• Implement fox control program if numbers increase and predation is deemed an issue. • Review effectiveness of contingency measures if implemented and adapt if necessary.
Other invasive species	• During monitoring for named species above, be aware of the presence of any other species (eg. Mosquito fish)	• If detected, investigate colonisation pathways, evaluate potential impacts and determine trigger levels and contingency / control measures on a case by case basis. • Review effectiveness of contingency measures if implemented and adapt if necessary.

Table E3-3: Monitoring in response to Approval Condition 3 – minimise adverse impacts to Flathead Galaxias, Murray Hardyhead and Silver Perch

Approval Condition		Monitoring Activity	Outcome
3i	Monitor fish exit from Third Reedy Lake during exit flows before the regulator is closed or until the water level drops to a level such that the lake is not connected to the bypass	Monitor fish exit in accordance with Table 5-5 – trapping downstream of the inlet regulator (Third Reedy Isolation regulator) and upstream of the outlet regulator (No.7 regulator). Monitor fish left stranded in Third Reedy lake after the regulators are closed (where feasible and safe to do so according to conditions, drones may be used to provide a visual estimate of stranded fish)	Provide written report in accordance with Condition 3ii
3ii	Within three months of the completion of monitoring, the approval holder must provide a written report to the Department of the fish exit monitoring results.	Prepare fish exit monitoring report, (noting requirements of Approval Condition 3iii) and submit within 3 months of completion of monitoring. The report will list presence of and any harm or death of Flathead Galaxias, Murray Hardyhead and Silver Perch, either during fish exit through regulators, or left stranded in the lake	Compliance with Approval Condition 3ii