



Victorian Murray Floodplain Restoration Project

Flora and Fauna Assessment - Gunbower National Park Floodplain Restoration Project

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Contents

Executive Summary	1
Abbreviations	5
1. Introduction.....	8
1.1 Project overview	8
1.2 Project location.....	8
1.3 Proposed works	9
1.3.1 Fish passage.....	11
1.3.2 Ancillary components of the project.....	11
1.3.3 Key construction activities.....	12
1.3.4 Key operational activities.....	13
1.3.4.1 Permanent wetland watering (Upper Gunbower Forest)	14
1.3.4.2 Semi-permanent wetland inundation.....	14
1.3.4.3 Forest floodplain and semi-permanent wetland watering (Upper and Middle Gunbower).....	14
1.3.4.4 Hybrid events.....	15
1.4 Previous studies.....	16
1.5 Purpose of this report	17
2. Biodiversity responses to environmental watering	21
3. Methods	24
3.1 Assessment areas.....	24
3.2 Limitations associated with current design	24
3.3 Desktop assessment.....	25
3.3.1 Determination of likelihood of occurrence.....	26
3.3.2 Inundation Area mapping and impact assessment.....	27
3.4 Field assessment.....	27
3.4.1 Vegetation condition assessment	27
3.4.2 Targeted threatened flora surveys.....	28
3.4.3 Fauna surveys.....	28
3.4.4 Targeted threatened fauna surveys.....	28
3.4.5 Flora and fauna species inventory	32
3.5 Permits	32
3.6 Nomenclature.....	32
3.6.1 Flora species	32
3.6.2 Native vegetation.....	32
3.6.3 Vegetation communities.....	33
3.6.4 Tree Protection Zones.....	33
3.6.5 Fauna species and communities.....	33
3.6.6 Weeds	33
4. Native Vegetation	34

4.1	Introduction	34
4.2	Ecological Vegetation Classes (EVCs).....	40
4.2.1	EVC 56: Floodplain Riparian Woodland.....	40
4.2.2	EVC 103: Riverine Chenopod Woodland	41
4.2.3	EVC 295: Riverine Grassy Woodland	42
4.2.4	EVC 803: Plains Woodland.....	42
4.2.5	EVC 814: Riverine Swamp Forest.....	43
4.2.6	EVC 816: Sedgy Riverine Forest.....	44
4.2.7	EVC 821: Tall Marsh.....	46
4.2.8	Mapped EVCs.....	46
4.3	Large Trees.....	47
4.4	Threatened Communities	47
4.4.1	EPBC-listed threatened ecological communities.....	47
4.4.2	FFG-listed threatened communities	49
4.4.3	NSW BC-listed endangered ecological communities	49
4.5	Wetlands.....	50
4.5.1	Wetlands of international significance	50
4.5.2	DELWP mapped wetlands.....	50
5.	Targeted Threatened Species Surveys.....	53
5.1	Threatened Flora Assessment	53
5.1.1	Desktop Assessment and Likelihood of Occurrence.....	53
5.1.2	Field survey results.....	54
5.1.3	Presence of EPBC Act listed flora	54
5.1.3.1	River Swamp Wallaby-grass (<i>Amphibromus fluitans</i>).....	55
5.1.3.2	Winged Peppercress (<i>Lepidium monoplacoides</i>).....	55
5.1.3.3	Ridged Water-milfoil (<i>Myriophyllum porcatum</i>).....	56
5.1.3.4	Floodplain Rustyhood (<i>Pterostylis cheraphila</i>)	56
5.1.3.5	Stiff Groundsel (<i>Senecio behrianus</i>).....	56
5.1.3.6	Slender Darling-pea (<i>Swainsona murrayana</i>)	57
5.1.4	Presence of FFG Act-listed and DELWP Advisory-listed threatened flora	57
5.1.5	Presence of FFG Act-protected flora.....	58
5.2	Threatened Fauna Assessment	59
5.2.1	Desktop assessment and Likelihood of Occurrence	59
5.2.2	Field survey results.....	59
5.2.3	Squirrel Glider arboreal remote-sensor camera survey results.....	62
5.2.4	Grey-crowned Babbler targeted survey results	62
5.2.5	Likely presence of EPBC Act listed fauna species within the proposed construction footprint.....	62
5.2.6	Likely presence of EPBC Act Migratory Species.....	67
6.	Overview of potential impacts.....	77

6.1	Construction.....	77
6.2	Operation	77
7.	Impacts to threatened species and communities	78
7.1	Potential impacts to threatened vegetation communities.....	78
7.1.1	EPBC Act listed Threatened Ecological Communities.....	78
7.2	Potential impacts to threatened flora	79
7.2.1	Impacts to EPBC Act listed flora.....	86
7.2.2	Impacts to FFG Act listed and DELWP Advisory listed threatened flora	92
7.2.3	Impacts to FFG Act-protected flora.....	92
7.3	Potential impacts to threatened fauna	93
7.3.1	Impacts to EPBC Act listed fauna species.....	106
7.3.1.1	Impacts to EPBC Act listed fish species during construction phase.....	115
7.3.1.2	Impacts to EPBC Act listed fish species during operational phase.....	115
7.3.2	Impacts to EPBC Act Migratory Species	116
7.3.3	Impacts to FFG Act, NSW BC Act and DELWP Advisory listed fauna and communities	116
7.4	Potential impacts to Wetlands of International Importance	120
7.5	FFG Act threatening processes.....	121
8.	Impacts to native vegetation	123
8.1	Objective of the Guidelines	123
8.2	Proposed construction impacts to native vegetation.....	123
8.2.1	Ecological Vegetation Classes	123
8.2.2	Canopy Trees	125
8.2.3	Proposed operational impacts to native vegetation.....	125
8.3	Assessment Pathway	127
8.4	Summary of Vegetation Impacts.....	128
8.4.1	Offset requirements.....	128
9.	Avoidance, minimisation and mitigation measures	130
10.	Legislative and policy requirements	134
11.	Recommendations.....	141
11.1	Next steps	141
12.	References	142

Appendix A. Ecological Vegetation Classes (EVCs) and Large Old Tree mapping in the construction footprint (GHD 2017 and R8 2019 field assessment)

Appendix B. Ecological Vegetation Classes (EVCs) mapping in the construction footprint (based on Bennetts 2014)

Appendix C. Summary of previous ecological studies

Appendix D. Likelihood of occurrence - threatened flora - construction footprint

Appendix E. Likelihood of occurrence - threatened flora - inundation area

Appendix F. Likelihood of occurrence - threatened fauna - construction footprint

Appendix G. Likelihood of occurrence - threatened fauna – inundation area

Appendix H. Habitat Hectare (VQA) Assessment Results – Proposed native vegetation impacts – construction footprint

Appendix I. Flora species recorded during surveys (2019)

Appendix J. Fauna species recorded during R8 surveys (2019)

Appendix K. Weed species recorded in the project area

Appendix L. Large Old Tree (LOTs) / large trees recorded within the construction footprint (combined list from GHD 2017 and R8 2019)

Appendix M. EPBC Act threatened community mapping within the project area

Appendix N. Example photos from Squirrel Glider arboreal camera surveys

Appendix O. Significance assessment for critically endangered and endangered ecological communities

Appendix P. Significance assessment for EPBC Act listed flora

Appendix Q. Significance assessment for EPBC Act listed fauna

Appendix R. Significance assessment for migratory species

Appendix S. Significance assessment for Wetland of International Importance (Ramsar Wetlands)

Appendix T. Native Vegetation Removal Report (NVR)

Executive Summary

Project understanding and project area

The Gunbower National Park Floodplain Restoration Project (the project) is one of nine discrete environmental works projects being undertaken as part of the Victorian Murray Floodplain Restoration Project (VMFRP), which is being implemented as part of Victoria's obligations under the Murray Darling Basin Plan. The VMFRP aims to return a more natural wetting and drying regime across more than 14,000 ha of Murray River floodplain and wetlands of high ecological value in Victoria through the construction of new infrastructure and modification of existing infrastructure.

The VMFRP is being implemented in partnership between Lower Murray Urban and Rural Water Corporation (LMW), Goulburn-Murray Rural Water Corporation (GMW), Mallee Catchment Management Authority (Mallee CMA), North Central Catchment Management Authority (North Central CMA), Parks Victoria and the Department of Environment, Land, Water and Planning (DELWP), and is funded by the Commonwealth Department of Agriculture, Water and Environment (DAWE). LMW has been nominated by the partnership as the project proponent for the purpose of submitting referrals and approval applications.

The project aims to reinstate a more natural inundation regime across approximately 704 ha of high-ecological-value Murray River floodplain within the Gunbower National Park, through the construction of new infrastructure and the modification of existing infrastructure within the River Murray Reserve. This will promote the growth of flood dependent understory associated with the River Red Gum riparian forests and wetland systems, providing critical habitat and food resources for native flora and fauna within the Gunbower National Park which forms a significant part of the Gunbower Forest Ramsar site. Tree canopy health will improve and the encroachment of terrestrial species and weed invasion will be minimised (North Central CMA 2014). The works associated with the project are located across Gunbower National Park. Ecological survey is required for the proposed construction footprint and the inundation area, to assist with the planning approvals process for the project. The proposed works occur across three works areas:

- Upper Gunbower Forest
- Middle Gunbower Forest (upstream of Deep Creek)
- Middle Gunbower Forest (downstream of Deep Creek)

The concept design of environmental infrastructure proposed in Middle Gunbower Forest (downstream of Deep Creek) and Camerons Creek pump station and pipeline in Upper Gunbower is currently being developed and were included after the field assessments were undertaken in 2019. Therefore, no field assessment has been undertaken in this area of the project and the approach for assessing potential impacts in this area adopts a conservative approach, based on desktop assessment only.

VMFRP engaged R8 (GHD Pty Ltd and Jacobs Group Australia Pty Ltd partnering as the R8 Joint Venture) to survey the construction footprint, to identify any listed flora or fauna and communities, and to provide desktop information on the flora and fauna that may potentially occur in the inundation area.

The purpose of this report is to provide a consolidated ecological assessment report of the project area (construction footprint and inundation area). This involves summarising previous ecological assessment reports prepared for the project area (Biosis 2014a, North Central CMA 2014, GHD 2017) as well as outlining the results of the assessments undertaken by R8 in October to December 2019 (native vegetation assessment and targeted surveys for rare and threatened species within the construction footprint for Upper Gunbower Forest and Middle Gunbower Forest (upstream of Deep Creek)).

Methods and Results

Desktop assessment of potential listed flora, fauna and ecological communities that may occur within a broader investigation area was undertaken (e.g. the study area which is defined as a 10 km buffer on the project area). Field assessments were conducted in October to December 2019. Following field assessments, likelihood of occurrence assessments were undertaken to determine which species may occur in the project area (construction footprint and inundation area). For listed threatened species and communities with potential to occur, impact assessments were also undertaken and mitigation measures proposed.

Assessments also included review of vegetation mapping for the project area and groundtruthing of data during field assessments of the number and type of Ecological Vegetation Classes (EVCs) present. Native vegetation within the construction footprint would be impacted by the proposed works. In total, 19.57 hectares of native vegetation comprising eight different EVCs was identified within the construction footprint, including 58 large trees. Large tree data is not available for the Middle Gunbower Forest (downstream of Deep Creek) and Camerons Creek pump station and pipeline in Upper Gunbower, and thus this number is expected to increase following field assessment in Spring 2020 of these works areas. Extensive areas of native vegetation have been mapped along access tracks that will be required to access the construction area and may require upgrades and/or trimming of adjacent vegetation. The final amount of vegetation loss in these areas is to be confirmed, conservative estimates of areas / number of large trees that will be impacted by the proposed works are provided.

Desktop assessment highlighted six Threatened Ecological Communities (TEC) listed under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) with potential to occur in the wider project area. However, field assessment (and review of DELWP and existing EVC mapping (Bennetts 2014a)) confirmed only one listed TEC was present within the project area; Grey Box (*Eucalyptus microcarpa*) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia. A total of 2.50 ha of this TEC was identified in the construction footprint in Upper and Middle Gunbower Forest (upstream) and 1.68 ha has been predicted to occur in Middle Gunbower Forest (downstream of Deep Creek) based on EVC Plains Woodland mapping (Bennetts 2014a). Middle Gunbower Forest (downstream of Deep Creek) and Camerons Creek pump station and pipeline in Upper Gunbower will be assessed during field survey in spring 2020 and the presence or absence of this TEC confirmed.

Desktop assessment highlighted a total of 26 flora and 66 fauna state and federally listed as species as having the potential to occur in the project area based on modelled EPBC Protected Matters Search Tool (PMST) results, previous records within the broader study area, i.e. 10km buffer on the project area, and habitat based on EVC mapping. Fifty-six of the fauna species are listed as threatened, fourteen are EPBC listed as migratory, of which four are also listed as threatened; Glossy Ibis, Curlew Sandpiper, Eastern Curlew, White-throated Needletail.

No EPBC Act listed flora species were identified within the construction footprint associated with Upper Gunbower (excluding Camerons Creek pump station and pipeline) and Middle Gunbower (upstream of Deep Creek) during field surveys in 2019, although one species, River Swamp Wallaby-grass (*Amphibromus fluitans*, Vulnerable) was identified in the broader area of investigation. Another five species, Winged Peppergrass (*Lepidium monophloides*, Endangered), Stiff Groundsel (*Senecio behrianus*, Endangered), Ridged Water-milfoil (*Myriophyllum porcatum*, Vulnerable), Floodplain Rustyhood (*Pterostylis cheraphila*, Vulnerable) and Slender Darling-pea (*Swainsona murrayana*, Vulnerable), although not recorded in current or previous surveys, are considered to have the potential to occur in floodplains within the inundation area. All of these species are flood responders and will benefit from the project.

Other rare or threatened flora were recorded in, or close to, the construction footprints including one species listed as threatened under the FFG Act, Umbrella Wattle (*Acacia oswaldii*) and Long Eryngium (*Eryngium ovinum*) listed as vulnerable in Victoria (DELWP Advisory List).

In addition, five (5) flora species listed under the FFG Act and eleven (11) considered rare or threatened in Victoria (DELWP Advisory) may also occur within the Middle Gunbower Forest (downstream of Deep Creek) based on previous assessments and modelling of habitat. Their presence/likelihood of occurrence will be confirmed after surveys are undertaken in Spring 2020.

No EPBC Act listed fauna species were identified within the project area during field surveys in 2019 or in previous assessments in the project area. Of the 66 federally and state listed threatened and migratory fauna species considered, an assessment of the likelihood of occurrence identified the following number of listed fauna species/communities considered as possible to occur:

- Eleven (11) EPBC Act listed fauna species
- Fourteen (14) EPBC Act Migratory species
- Twenty-nine (29) FFG Act listed fauna species

- Two FFG Act listed fauna communities (Victorian Temperate Woodland Bird Community and Lowland Riverine Fish Community of the Southern Murray-Darling Basin) and one NSW Biodiversity Conservation (BC Act) listed endangered ecological community (Lower Murray River Aquatic Ecological Community)

Impacts to EPBC Act and FFG Act listed fauna species/communities that are considered to have the potential to occur within the construction footprint are likely to be low where mitigation measures outlined in Section 8 are implemented in full. Impacts during operation (i.e. inundation phase) are considered to be largely beneficial to listed species with improved habitat availability due to a returned flooding regime. Construction and operational impacts to threatened fish species are considered low following the implementation of mitigation measures.

A self-assessment against the Significant Impact guidelines concludes the project was unlikely to represent a significant impact on the Gunbower Forest Ramsar site with the implementation of mitigations for construction and operational phases of the project (R8, 2020). The assessment recognises that further work is required to develop a construction specific aquatic fauna management plan and an EWP including monitoring and adaptive management to address the threat of invasive species.

Legislation, permits and approvals

There are a number of ecological values present within the proposed construction footprint with the potential to trigger the requirement to obtain permits under various items of legislation if impacted. The following permits/approvals will be required for this project:

- A referral to the Victorian Minister for Planning is being prepared to determine whether an Environmental Effects Statement is required under the *Environment Effects Act 1978* (EE Act). This Flora and Fauna Assessment has determined that the project is likely to require the removal of more than 10 hectares of native vegetation, which is a criterion for referral under the EE Act.
- A referral to the Commonwealth Environment Minister is being prepared to determine whether the project is a controlled action requiring approval under the EPBC Act due to the potential for a significant impact on Matters of National Environmental Significance (MNES).
- Planning approval to remove native vegetation under the Campaspe Shire Council and Gannawarra Shire Council Planning Scheme in accordance with the Guidelines for the removal, destruction or lopping of native vegetation (DELWP 2017).
- Offsets would be sought in accordance with the requirements of the *Guidelines for removal, destruction or lopping of native vegetation* (DELWP 2017)
- A permit under the FFG Act is required where works may impact threatened and/or protected flora and native vegetation that threatened fauna are likely to use. Once the construction footprint at each of the sites is finalised a permit will need to be obtained for impacts to both listed and protected flora species.
- A permit (Management Authorisation) under the *Wildlife Act 1975* is likely to be required for salvage, handling and disturbance of native fauna that may be at risk of harm during construction. This could be achieved by engaging a qualified ecologist in possession of this permit to undertake this task.
- If the capture, handling or translocation of fish is required during construction (e.g. dewatering work sites) or operation of the project, persons undertaking these activities will need to hold the appropriate permit or licence under the *Fisheries Act 1995*.

Recommendations and Next Steps

Additional steps to avoid and minimise impacts to ecological values during the design, construction and implementation of the project have been outlined in Section 10.1, including but not limited to the following steps:

- Complete field assessment for Middle Gunbower (downstream of Deep Creek) and Camerons Creek pump station and pipeline in Upper Gunbower including vegetation mapping and threatened species surveys.

- Targeted surveys recommended for EPBC Act listed Sloane's Froglet (*Crinia sloanei*) during late winter 2020 and Growling Grass Frog (*Litoria raniformis*) during late spring early summer 2020 in areas where the construction footprint intersects major waterways (Cameron's Creek, Deep Creek).
- Additional targeted surveys for EPBC Act and FFG Act species may be required to support Federal and State approval processes.
- Refine the construction footprint utilising the existing ecological values mapping (Appendix A and B) to avoid and minimise impacts to native vegetation and threatened flora/fauna and communities within the construction footprint.
- Engage with DELWP, discussing the proposed construction footprint and the efforts that have been made to avoid and minimise impacts to native vegetation during the preliminary and refinement phases of the project.
- Depending on the extent of impacts to areas of treed vegetation a qualified arborist may need to be engaged to determine the full extent of impacts to native trees (both within and immediately adjacent to the proposed construction footprint). This assessment would take into account direct impacts to trees (tree removal) and indirect impacts to trees (through encroachment of their Tree Protection Zones (TPZs)). An arborist assessment would also consider the individual tree location and habit, as well as specific characteristics of certain tree species where it's possible that individual trees will survive greater than 10% encroachment of their TPZs or the pruning of over 30% of the existing crown (the standard measures for determining indirect tree losses under the guidelines).
- Engage with DELWP, discussing the proposed approach for planning approval and obtaining offsets for the project under the *Planning and Environment Act 1987* and whether a conservation exemption may apply to the works at Gunbower National Park. This conservation exemption would be an alternative arrangement agreed with the Secretary to DELWP under clause 52.17 of the Campaspe Shire Council and Gannawarra Shire Council Planning Schemes. The loss of native vegetation due to construction activities is proposed to be offset, at least in part, by the expected improvement in native vegetation quality in the inundation areas resulting from environmental watering. The method for confirming this offset would be developed in consultation with DELWP. Any offset requirements that cannot be met through environmental watering would be purchased by the project. This approach may include the establishment of a vegetation condition monitoring regime within the proposed inundation area that would identify changes in condition to the vegetation within these areas that results from the environmental watering regime. Prepare an Offset Plan for the project to support any application for planning approval to remove native vegetation under the *Planning and Environment Act 1987*.
- A Construction Environmental Management Plan (CEMP) should be developed for the project and implemented in full to further avoid and minimise impacts to areas of ecological value. A specific Flora and Fauna Management Plan should be developed as part of the CEMP which includes the avoidance, minimisation and mitigation measures as specified in section 9. The CEMP should be prepared once the footprint and construction methods for the proposed works have been finalised and should include provisions relevant to protecting the ecological values identified within the construction footprint (Appendix A and B).

This report is subject to, and must be read in conjunction with, the limitations set out below and the assumption and qualifications contained throughout the report.

Abbreviations

Abbreviation	Description
CaLP Act	Victorian <i>Catchment and Land Protection Act 1994</i>
CMA	Catchment Management Authority
CEMP	Construction Environmental Management Plan
DAWE	Commonwealth Department of Agriculture, Water and Environment (formerly DOEE)
DBH	Diameter at breast height
DELWP	Victorian Department of Environment, Land, Water and Planning (formerly DEPI)
DEPI	Victorian Department of Environment and Primary Industries (now DELWP)
DOEE	Commonwealth Department of the Environment and Energy (formerly DOTE now DAWE)
DOTE	Commonwealth Department of the Environment (now DAWE)
EE Act	Victorian <i>Environment Effects Act 1978</i>
EPBC Act	Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i>
EVC	Ecological Vegetation Class
FFG Act	Victorian <i>Flora and Fauna Guarantee Act 1988</i>
GHD	GHD Pty Ltd
GIS	Geographic Information System
LGA	Local Government Authority
MDBA	Murray-Darling Basin Authority
MNES	Matters of National Environmental Significance
PMST	Protected Matters Search Tool
R8	R8 Joint Venture by GHD and Jacobs
SDL	Sustainable Diversion Limits
sp.	Species
spp.	More than one species
SRZ	Structural Root Zone
subsp.	Subspecies
TPZ	Tree Protection Zone
var.	Variety
VBA	Victorian Biodiversity Atlas
VMFRP	Victorian Murray Floodplain Restoration Project
VTWBC	Victorian Temperate Woodland Bird Community
VROTS	Species listed on the <i>Advisory List of Rare or Threatened Plants in Victoria</i> (DEPI, 2014), the <i>Advisory List of Threatened Vertebrate Fauna in Victoria</i> (DSE, 2013) or the <i>Advisory List of Threatened Invertebrate Fauna in Victoria</i> (DSE, 2009).
WoNS	Weed of National Significance

Important note about your report

The purpose of R8's engagement under the Victorian Murray Floodplain Restoration Project (VMFRP) is to design infrastructure for the VMFRP including regulators, containment banks, roads, access tracks and culverts. The purpose of this infrastructure is to allow floodplains to be watered at the hydraulic design levels nominated by VMFRP. R8 are also engaged to provide Regulatory Approvals and Cultural Heritage Services. The purpose of these services is to support VMFRP to lodge the necessary approvals documents for the project with the relevant approval authorities.

The sole purpose of this report and the associated services performed by R8 is to complete a Flora and Fauna Assessment Report for VMFRP, as set out in Section 1.5 of this report and in accordance with the scope of services set out in the contract between R8 and VMFRP. That scope of services, as described in this report, was developed with VMFRP.

R8 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. 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.

In preparing this report, R8 has relied on the information provided by VMFRP in the data handover pack at the commencement of the project and others (government agencies). In particular R8 is reliant on VMFRP's prior flood modelling work to define inundation levels and extents.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by R8 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 VMFRP, and is subject to, and issued in accordance with, the provisions of the contract between R8 and VMFRP. R8 accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.

The services undertaken by R8 in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

- Field assessment was completed based on the Interim Concept Design for Gunbower and included the proposed construction footprint at Upper Gunbower Forest (excluding Camerons Creek pump station and pipeline) and Middle Gunbower Forest (upstream Deep Creek) only. No field assessment has been completed by R8 of Middle Gunbower Forest (downstream of Deep Creek) and Camerons Creek pump station and pipeline in Upper Gunbower. Results for this works area are reliant on desktop information compiled from past ecological reports completed for the area and review of databases.
- Field assessments were limited to an ecological assessment of vascular plant species (ferns, conifers and flowering plants). Non-vascular flora (e.g. mosses, liverworts, lichens) and fungi have not been considered in detail as part of this assessment, except where listed threatened species are known or suspected to occur, or where bryophytes comprise part of the EVC benchmark used for the habitat hectare assessment (e.g. cover of Bryophytes);
- Maps in this report displaying site information should not be relied on for the detailed design during the construction process. Please refer to engineering drawings/specifications and survey for detailed site information.
- Involved the use of Collector for ArcGIS version 10.3.3 mapping application to record site information. This mapping tool is accurate to within ten metres on site.
- Assumed there will be no impacts to native vegetation outside the proposed construction footprint provided by VMFRP.
- Did not include a detailed assessment of planning implications with relation to legislation outside of those considered from an ecological perspective.

- Some specific EVC determinations were difficult where there is a complete absence of entire lifeform classes which is the case for some of the survey areas (e.g. obligate wetland species lacking recent flooding). All effort has been made to consider previous mapping, however there are some minor and understandable discrepancies between the various vegetation mapping exercises undertaken.
- Included flora investigations as part of the ecological assessment were undertaken during late spring and summer 2019, which, while generally a good time to capture the majority of flora species in a terrestrial system, it does not account for the flooding cycle and the cryptic flood responder species that reappear after flooding. It is important to note that the Ecological Vegetation Classes and individual flora species (including threatened species) that have a flood dependency were compromised given the time since the last inundation event, understood to have occurred in 2016, with portions of the study area underwater for various durations (positive and negative) since that flooding event. Many of the flora species associated with the inundated areas complete their life cycles in response to flooding and are only observable for short periods during and/or after the specific flooding event. Some native flora are difficult or impossible to locate or identify outside of their response period due to a lack of vegetative or reproductive material and/or the seasonal nature of some species (in particular, annuals and geophytes).
- Did not consider targeted surveys for rare or threatened fauna species that involved extensive trapping (e.g. pitfall, Elliot, funnel trapping). This was beyond the scope of this assessment. Fauna surveys were limited to timed bird survey, remote-sensing camera surveys, active searching and incidental observations.
- Using the VBA database, a defined geographical area can be searched to produce lists and details of flora and fauna species that have been documented within the defined search area. These database results are only as accurate as the quality and quantity of data that have been recorded and documented from the area. The use of the database for this assessment has the following limitations:
 - Observations are regularly updated but there is a delay. Consequently, all known records, particularly recent records, may not be available at the time of use. The VBA was most recently accessed in February 2020.
 - This dataset is not exhaustive. Many locations locally and across Victoria have a low level of documented survey effort for one or more groups of flora and fauna. During field surveys, it is not uncommon to find species at locations for which there are few or no previous nearby database records.
 - The inundation extent at this stage has been assessed at a desktop level only.
 - The EPBC Act is undergoing a review that commenced in October 2019. Any changes to the applicable legislation and agreements may affect the outcomes of this report.
 - The FFG Act Amendment Bill 2019 has passed through Victorian Parliament with amendments taking effect on 1 June 2020. This report has been prepared based on the current requirements of the Act and these may change prior to the construction of the project.

Acknowledgments

R8 acknowledges the assistance, advice and/or information provided by.

- The Victorian Department of Environment, Land, Water and Planning (DELWP) for access to the VBA database and NatureKit.
- The Commonwealth Department of Agriculture, Water and Environment (DAWE) for access to its Protected Matters Search Tool (PMST).

1. Introduction

1.1 Project overview

The Gunbower Forest Floodplain Restoration project (the project) is one of nine discrete environmental works projects being undertaken as part of the Victorian Murray Floodplain Restoration Project (VMFRP), which is being implemented as part of Victoria's obligations under the Murray Darling Basin Plan. The VMFRP aims to return a more natural inundation regime across more than 14,000 ha of high ecological value Murray River floodplain in Victoria through the construction of new infrastructure and modification of existing infrastructure to target flooding to high priority areas for biodiversity.

The VMFRP is being implemented in partnership between Lower Murray Urban and Rural Water Corporation (LMW), Goulburn Murray Rural Water Corporation (GMW), Mallee Catchment Management Authority (Mallee CMA), North Central Catchment Management Authority (North Central CMA), Parks Victoria and the Department of Environment, Land, Water and Planning (DELWP), and is funded by the Commonwealth Department of Agriculture, Water and Environment (DAWE). LMW has been nominated by the partnership as the project proponent for the purpose of submitting referrals and approval applications.

The project aims to reinstate a more natural inundation regime across approximately 704 ha of high-ecological-value Murray River floodplain within the Gunbower National Park, through the construction of new environmental water infrastructure and the modification of existing infrastructure within the River Murray Reserve (Figure 1-1 and Figure 1-2). This will promote the growth of River Red Gum flood dependent understory and wetland vegetation, providing critical habitat and food resources for native flora and fauna. Tree canopies will improve and the encroachment of terrestrial species and weed invasion will also be minimised (North Central CMA 2014).

The proposed works will occur across three environmental works areas:

- Upper Gunbower Forest
- Middle Gunbower Forest (upstream of Deep Creek)
- Middle Gunbower Forest (downstream of Deep Creek).

1.2 Project location

The project is located on the mid-Murray floodplain in Northern Victoria. Gunbower National Park covers approximately 9,330 ha and includes part of Gunbower Forest, an internationally important wetland listed under the Ramsar Convention. Gunbower Forest also forms part of the Gunbower-Koondrook-Perricoota Forest icon site under The Living Murray Initiative. The forest is bounded to the north by the River Murray and along its southern edge by private land and Gunbower Creek. The forest comprises a system of natural drainage paths, creeks, permanent and temporary wetlands, Black Box and Grey Box woodlands and River Red Gum forest.

The project is designed to facilitate managed inundation to address the hydrological deficit in the inundation regime caused by river regulation, particularly the reduced frequency and duration of flooding. Under natural conditions flooding would have occurred seven years in ten and at present flooding is only occurring four years in ten (North Central CMA 2014). The proposed managed inundation targets water dependent habitat that characterises the lower elevations of the upper forest by pumping water from the Murray River across approximately 704 ha of the Gunbower National Park. The planned inundation events will require a much lower volume of water than that involved in a natural inundation event as the proposed infrastructure will enable water to be pumped to target areas in the floodplain whilst still achieving a similar frequency and duration of inundation as a natural event. In addition, there are existing environmental water works in the Lower Gunbower Forest that were delivered under The Living Murray Project which, while complementary, are separate to this project.

The proposed works for the Gunbower National Park floodplain and wetlands are designed to provide a combination of pumped inflows from the Murray River and the National Channel via Camerons Creek into the Forest. The works will result in inundation of approximately 457 ha in Middle Gunbower Forest and 247 ha in Upper Gunbower Forest (Figure 1-2).

Environmental works areas

The Upper and Middle Gunbower Forest areas, while related, act separately and independently to each other in lower to medium level flooding events and therefore have been developed as separate environmental works areas. The Middle Gunbower Forest works have been split into two different areas to reflect a distinct change in elevation and therefore target water level. This split also reflects changes to the proposed inundation extent since the completion of the Business Case in 2014 (environmental works were not proposed downstream of Deep Creek in the Business Case)

The key environmental works areas that will be targeted for managed inundation as part of the project include:

- Upper Gunbower Forest (84.8 to 85.0 mAHD target water level) – inundation of approximately 247 ha of floodplain forest and wetlands containing:
 - Upper Camerons Creek
 - Camerons Creek Lagoon 1, 2, 3 and 4 (permanent wetlands)
 - Black Charlie Lagoon (permanent wetland)
 - Baggots Swamp (floodplain forest)
- Middle Gunbower Forest (upstream of Deep Creek, 83.7 to 84.4 mAHD target water level) – inundation of approximately 336 ha of floodplain forest and wetlands including:
 - Deep Creek
 - Middle forest floodplain area
 - Pig Swamp (semi-permanent wetland)
 - Emu Hole Lagoon (semi-permanent wetland)
- Middle Gunbower Forest (downstream of Deep Creek, up to 83.0 mAHD target water level) – inundation of approximately 121 ha of floodplain forest and wetlands containing:
 - Broken Axle Creek
 - Spur Creek
 - Red Rise Swamp – upper and lower (seasonal wetland)

1.3 Proposed works

The project involves the construction of infrastructure in Table 1-1 to divert, retain and release water in the Gunbower National Park.

The main components of the project are described below. The design and location of project structures and extent of levees and access track upgrades has not yet been confirmed and will be refined through the design process. Therefore, the information in this section is indicative, but provided as a basis of assessing the potential impacts of the project during construction and operation for the purposes of preparing referrals. This is discussed further in Section 3.2.

Findings from on-site assessments particularly ecology fieldwork and cultural heritage complex assessment (undertaken for the Cultural Heritage Management Plan, CHMP) have and will continue to be progressively fed into the design, with modifications made to avoid and minimise environmental impacts where feasible and practicable. Design and construction of the project would also need to comply with the mitigation measures outlined in the project's environmental management documentation (e.g. Environmental Management Framework) including those mitigation measures outlined in Section 9.

The proposed works for each inundation area are summarised in the table below.

Table 1-1 Summary of proposed works at Gunbower National Park.

Area	Main components
Upper Gunbower	<ul style="list-style-type: none"> ▪ Three small regulators <ul style="list-style-type: none"> – Camerons Creek River Track – Camerons Mid Creek – Dry Tree Creek Outlet ▪ Dry Tree Creek Culvert ▪ Containment banks / levees – adjacent to and supporting the Camerons Mid Creek Regulator ▪ One cone fishway – Camerons Mid Creek fishway. ▪ One spillway located within Baggots Creek Track ▪ One Pump Station located on GMW's National Channel ▪ One Pipeline to deliver environmental water into Gunbower National Park. The pipeline will also include several irrigation and stock and domestic supply offtakes to replace existing customer points. ▪ Power supply to new pump station.
Middle Gunbower (upstream Deep Creek)	<ul style="list-style-type: none"> • One Pump station located on the bank of the Murray River and associated discharge pipeline. • Power supply to new pump station. • Five regulators <ul style="list-style-type: none"> – Pig Swamp Offtake – Emu Hole Lagoon Offtake – Middle Forest Offtake – Deep Creek River Return – Dalley Bend Inlet • Emu Hole Lagoon offtake pipeline • Middle Forest offtake pipeline (main discharge to OSCC) • Old Straight Cut Channel minor upgrade works • Road and car park works <ul style="list-style-type: none"> – Brereton Road works – Riverside car parking area ▪ Containment banks / levees as required
Middle Gunbower (downstream of Deep Creek)	<ul style="list-style-type: none"> • Three spillways <ul style="list-style-type: none"> – Broken Axle Creek Regulator Spillway – Munroe Track Spillways 1 and 2 • Four regulators <ul style="list-style-type: none"> – Broken Axle Creek Regulator – Tickells Track Regulator – Spur Creek River Return Regulator – Spur Creek Forest Regulator • One drop structure: Spur Creek drop structure • Three culverts: <ul style="list-style-type: none"> – Broken Axle Creek Culvert – Munroe Track Culvert 1

	<ul style="list-style-type: none"> - Munroe Track Culvert 2 • Drainage Outlets within the containment banks (2 No.) ▪ A series of containment banks on Munroe Track, Tickells Track and River Track as required.
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1.3.1 Fish passage

The project includes:

- Provision of safe downstream fish passage for small bodied fish through all new regulating structures. This includes safe fish passage from the floodplain and into the Murray River during forest draining events and low Murray River flow water levels;
- Provision of screens for fish protection on each intake structure associated with the pump station.

Fish passage is planned to be provided at the proposed Camerons Mid Creek Regulator to maintain connectivity for small bodied fish between the wetland areas separated by this structure (Stuart 2020). The fish passage at Camerons Mid Creek Regulator will be a cone type fishway consisting a simple channel and precast cones. Dedicated fishways are not required at any other structure. Further information on the type of fish passage can be found in the Upper Gunbower Fish Management Plan (Stuart 2020).

The design of all other regulators and drop structures will allow for passive fish passage. Small regulator structures will be operated either in fully open or fully closed position. When water is released with the regulator gate in fully open position, fish have passage through the regulator both in managed release and natural flood scenarios. Structures have been designed to have flow velocities appropriate for fish passage (based on O'Connor et. al, 2015).

1.3.2 Ancillary components of the project

Containment banks / levees / access tracks

- **Containment banks** = raised embankment, predominantly earthfill, whose primary objective is to provide water containment for the purpose of keeping environmental water within a designated area, or stopping the escape of water from a designated area. Typically, the break of a containment bank will not cause unintended flooding of private land as spilt water returns to a downstream waterway via public land.
- **Levees** = raised embankment, predominantly earthfill, whose primary objective is to provide flood protection along a river or artificial waterway. Levees may also be used to serve a secondary purpose of environmental water containment.

The containment banks will be located along existing access tracks or at new sites. Once the containment bank has been constructed, the tracks would either be reinstated, or new tracks developed, on top of the bank with a gravel surface. The containment banks would provide operator access to the regulators. A few short lengths of containment bank would be required at tie-in locations where the bank needs to match the natural river bank. Proposed locations of containment banks are included in the construction footprint.

VMFRP is in the process of undertaking a levee risk assessment process relating to the flood mitigation levee banks which are located along the outer perimeter of the Upper and Middle Gunbower Forests. Therefore, the works associated with the levee banks have not been confirmed and are not included in the construction footprint. Potential locations of the levees have been included in the area of investigations for completeness in desktop assessments.

The intended locations of the proposed containment banks and existing access tracks have been included in the construction footprint with the exception of access track associated with levees (see above) which are only included in the area of investigation given the requirement for their use is not yet confirmed. Some of these tracks would need to be upgraded as part of the project, the extent of which would be confirmed based on the outcomes of geotechnical investigations, complex cultural heritage assessment (as part of the Cultural Heritage Management Plan) and ground truthing.

Access Track Maintenance

Maintenance will need to be undertaken to existing access tracks to ensure they are suitable for use during construction and operation. This would involve grading and applying additional road base to the surface and in some cases minor trimming of branches. The construction footprint provides for a 5 m wide corridor along existing access tracks to carry out maintenance works.

Borrow pits/ quarry activities

Construction of the project would require the import of material (clay/rock). VMFRP is in the process of identifying possible borrow pits to acquire this material. The objective is to select locations as close as possible to the project, on private land outside of the Gunbower National Park, while also avoiding and minimising impacts. Once the locations are confirmed, the permits and approvals required for establishing new quarry/borrow sites or expanding existing sites will be identified and sought.

Power supply

New power supply connections will be required to facilitate operation of the pump stations in Gunbower National Park and on the National Channel. The key design components include new poles, stays and cables. The cable line will be directly buried (or bored depending on requirements) within the National Park boundary, following the alignment of containment banks to minimise the area of impact. The cable line within private land will be overhead and consultation with relevant landholders is currently being undertaken.

VMFRP and GMW are currently working with Powercor to confirm the preferred alignment and develop preliminary footprints and designs for the power supply and therefore power supply is currently not included in the construction footprint or area of investigation.

Concrete batching

Commercially sourced concrete for construction of the proposed works would be transported to the project area. There is no requirement for on-site concrete batching facilities.

1.3.3 Key construction activities

Construction activities would occur within the area identified in the construction footprint. Construction activities would include:

- Establishment of construction sites, set down areas and access routes
- Removal of existing structures / block banks where required
- Construction / installation of new structures (including steel sheet pile wall on regulator structures and containment banks)

Construction would use vehicles and machinery such as trucks, excavators, and access equipment.

Importation of construction materials, including regulator components and soils, would comply with Parks Victoria consent under Section 27 of the *National Parks Act 1975* and the future *Environment Protection Act 2017*.

An Environmental Management Plan (EMP) would be prepared for the works and would detail the measures to avoid and minimise impacts during construction. Once construction is complete, all waste and spoil will be removed from the sites and disposed of as required by the EMP.

Construction in the Murray River

The Brereton Pump Station will require construction works within the Murray River. This would include excavation and construction of intake pipes which will draw water down to the minimum river water level. The portion of the intake pipes near the edge of the bank profile will be concrete encased to serve as an anchor for the floating pumps and provide protection to minimise the risk of bank scouring / erosion.

Construction laydown areas

The construction footprint includes a working area (approximately 10 m wide) around the development footprint for proposed structures (e.g. regulators, drop structures pump stations) to accommodate movement of

vehicles and machinery and some limited storage of equipment and materials. A working area (approximately 3 m wide) is also included around proposed laydown areas and minor works sites (e.g. blockage bank removals/modifications). The specific laydown area details for each construction site will be confirmed as the detailed design process evolves, however sites will be selected to avoid and minimise impacts to ecological and cultural values.

Project area rehabilitation

Following completion of works, rehabilitation of construction areas would be undertaken in accordance with Parks Victoria consent under Section 27 of the *National Parks Act 1975*. General principles for site rehabilitation include:

- Use of local indigenous plant species
- Placement of habitat logs
- Retention and reuse of topsoil
- Rock beaching using materials consistent with the local geological settings, where practicable.

1.3.4 Key operational activities

The proposed works are intended to enable areas of the Gunbower National Park floodplain to be inundated with pumped inflows from the Murray River through Brereton Road Pump Station on the Murray River, a pump station and pipeline on the National Channel (upstream of Gunbower Creek) and gravity fed flows through Camerons Creek.

Three operating scenarios have been identified for water delivery to the Gunbower National Park. These have been proposed to meet the ecological objectives of the project and include:

- Permanent wetland watering (Camerons Creek and Black Charlie Lagoon).
- Forest floodplain watering, including:
 - River Red Gum forest with flood dependent understorey (Baggots Swamp and mid-forest floodplain) and temporary wetlands (Emu Hole and Red Rise Swamp).
 - Semi-permanent wetlands (Pig Swamp).
- Hybrid events, topping up natural flood events for the forest floodplain, temporary wetlands and semi-permanent wetlands to extend natural flood durations.

A summary of the proposed operating scenarios for Gunbower National Park is provided in Table 1-2 and discussed further below.

Table 1-2 Modelled frequency of operational scenarios for the Gunbower National Park Floodplain Restoration Project.

Scenario	Site	Optimal watering frequency	Modelled inundation frequency*	Expected frequency of operation	Peak filling inflow rate (ML/d)	Required timing of operation	Duration of inundation
Permanent wetland watering	Black Charlie Lagoon (BCL) & Camerons Creek (CC)	10 years in 10	NA	10 years in 10	15	Winter/Spring (BCL) Throughout year (CC)	1-12 months
Forest floodplain	Baggots Swamp	6 years in 10	3 years in 10	3 years in 10	20	Winter / Spring	2-3 months

watering/ semi- permanent wetland inundation	Pig Swamp	7 years in 10	3 years in 10	4 years in 10**	20	Winter / Spring	6 months
	Emu Hole Lagoon	6 years in 10	3 years in 10	3 years in 10	10	Winter / Spring	4 months
	Middle Forest floodplain	6 years in 10	3 years in 10	3 years in 10	125	Winter / Spring	3-5 months

* Based on Basin Plan 2750 flows (Gippel 2014)

** Pig Swamp requires 1 year in 10 in addition to filling during the middle forest floodplain watering to achieve the 7 year in 10 optimal inundation frequency.

1.3.4.1 Permanent wetland watering (Upper Gunbower Forest)

Water will be delivered to Black Charlie Lagoon and Camerons Creek in Upper Gunbower via the Camerons Mid Creek Regulator, with the option to deliver top-up flows via Cameron Creek and/or a new pump station on the National Channel and associated pipeline, if required. The proposed watering will include two phases:

- Filling phase: A gradual ramp up will be delivered in winter/spring, with peak inflow rate of up to a maximum of 15 ML/d through Camerons Creek (although lower flows will likely be delivered), filling Black Charlie Lagoon to full supply level (FSL) of 85.05 m AHD and achieve the maximum inundation extent in Camerons Creek Lagoons 1, 2, 3 and 4.
- Maintenance phase: Wetlands will be allowed to draw down naturally to minimum levels throughout summer and autumn. Constant flows through Camerons Creek will likely be required throughout the year to maintain minimum levels in the lagoons, however some fluctuation in water levels will be targeted. Top-ups to Black Charlie Lagoon may also be required to maintain minimum levels. The pipeline will enable delivery directly to Lagoon 4 and Black Charlie Lagoon, allowing these wetlands to be topped-up independently of Lagoons 1, 2 and 3 if water levels in these wetlands require drawing down. However, the preference is to deliver water via the natural waterway of Camerons Creek where possible.

1.3.4.2 Semi-permanent wetland inundation

Watering events for Pig Swamp will commence with opening the Pig Swamp Offtake Regulator gate and filling the wetland to a target water level of 84.12 mAHD, at which stage the regulator gate will be shut. If required, the regulator would be operated for short periods of time following the initial filling to achieve the target watering duration.

Watering events for Emu Hole Lagoon will commence with opening the Emu Hole Lagoon Pipeline Offtake and filling the wetland to a target water level of 84.2 mAHD, at which stage the pipeline outlet will be shut. If required, the regulator would be operated for short periods of time following the initial filling to achieve the target watering duration.

With no provision for drainage from the semi-permanent wetlands (via gravity outfalls or pumping), water will draw down naturally through evapotranspiration and seepage.

1.3.4.3 Forest floodplain and semi-permanent wetland watering (Upper and Middle Gunbower)

The forest floodplain and associated wetland watering includes inundating the RRG forests with flood dependent understorey and the lower lying temporary wetlands in the Upper and Middle Gunbower Forest. The one semi-permanent wetland in the Middle Forest (Pig Swamp), is included in this operating scenario as it will be watered via the same infrastructure and in the same years as the Middle Forest floodplain, with one additional watering every 10 years to achieve the optimal watering frequency for the wetland. The proposed watering scenarios and operation of infrastructure for each of these areas is outlined below.

Upper Gunbower

The Upper Gunbower WMA contains an area of RRG forest with flood dependent understorey immediately downstream of Black Charlie Lagoon. Watering events for Baggots Swamp will commence with the filling of the

permanent wetlands to the FSL of Black Charlie Lagoon (as described above), followed by overtopping the wetland into the surrounding floodplain of Baggots Swamp to the west. Once Black Charlie Lagoon is full, both the Camerons Mid Creek Regulator and pipeline outlet will be opened to provide a combined peak inflow rate of about 20 ML/day over a period of about 15 days to achieve the target water level of 84.8 m AHD in Baggots Swamp. RRG with flood dependent understorey vegetation fringing Camerons Creek will also be inundated at these higher target water levels. Inflows will then cease and the area will be allowed to drawdown naturally through evaporation and seepage, with a target inundation duration of 60 days.

Middle Gunbower

The Middle Gunbower floodplain proposed watering includes the inundation of RRG forest with flood dependent understorey, temporary wetlands and one semi-permanent wetland within the Middle Forest (upstream and downstream of Deep Creek WMA). Water will be delivered to meet the shortfall in frequency and duration of natural flooding (assuming Basin Plan 2750 flows) in the Middle Forest.

Watering events for Pig Swamp (semi-permanent wetland), will be delivered via the Pig Swamp Offtake Regulator in the Old Straight Cut Channel. Pig Swamp will be filled at a peak flow rate of 20 ML/d for approximately 10 days to achieve the target water level of 84.12 m AHD, at which stage the regulator gate will be shut and the wetland will be allowed to drawdown naturally through evaporation and seepage. If required, the regulator will be operated to deliver water for short periods of time following the initial filling to achieve the target watering duration of six months.

Watering events for Emu Hole Lagoon (temporary wetland) will be delivered via the Emu Hole Lagoon Offtake Regulator in the Old Straight Cut Channel. Emu Hole Lagoon will be filled at a peak flow rate of 10 ML/d for approximately 13 days to achieve the target water level of 84.2 m AHD, at which stage the regulator gate will be shut and the wetland will be allowed to drawdown naturally through evaporation and seepage. If required, the regulator will be operated for short periods of time to deliver water following the initial filling to achieve the target inundation duration of four months.

Watering events for the Middle Forest (excluding Pig Swamp and Emu Hole Lagoon) will be delivered via the Middle Forest Offtake Regulator in the Old Straight Cut Channel. Flows are conveyed beneath Brereton Road through pipes and through the forest along flood runners and low ground in a north-westerly direction, before passing through the broken banks of the Old Cohuna Main Channel (Tier 1) and forming a pool from the natural surface levels of the breaks in the downstream banks of Deep Creek (Tier 2). During the initial filling and subsequent top-up to achieve the target watering duration, the Deep Creek River Return Regulator would be closed to prevent any return flows to the Murray River. From Deep Creek, flows continue in a northerly direction to the Middle Forest (Tier 3), where water is contained by a number of containment banks and regulators, firstly at Munroe Track (Tier 3a) then at the Broken Axle Creek Regulator and Spur Creek River Return Regulator (Tier 3b). The Munroe Track Regulators would be closed prior to the commencement of the watering event and likely remain closed throughout to achieve the target water level of 83.4 m AHD upstream of Munroe Track (Tier 3a). Once Tier 3a is inundated, Munroe Track Regulators would be fully opened and the Spur Creek River Return Regulator, Broken Axle Creek Regulator and Tickells Track Regulator would each be closed prior to commencement of the watering event to achieve the target water level of 83.0 m AHD in Red Rise Swamp (83.4 m AHD in Red Rise Swamp Upper).

Once the target inundation extent has been achieved, the Spur Creek River Return Regulator and Deep Creek River Return Regulator will be opened to allow floodplain return flows into the Murray River and maintenance flows will be provided via the Brereton Road Pump Station to achieve the target inundation duration of three to five months for the RRG forest with flood dependent understorey and temporary wetlands (note: inundation duration includes combined filling, maintenance flow and ponding times).

1.3.4.4 Hybrid events

During natural (unregulated) inflows into the Middle Forest, environmental water may be used to extend the extent and/or duration of inundation via the Brereton Road Pump Station. In the event of natural flooding, the Dalley Bend Inlet Regulator and Deep Creek River Return Regulator would be full opened to maximise natural inflows and all internal forest regulators fully opened to allow floodwater to follow the natural flow path through the forest. If the duration of natural inflows is expected to be short, then the Tier 3a and 3b Regulators would likely be closed prior to the flood recession to capture floodwater on the floodplain and extend the duration of

inundation, with the addition of pumped inflows through the Brereton Road Pump Station to achieve the optimal duration. The Spur Creek Forest Regulator would remain open throughout the event to allow inflows through the Spur Creek flood runner into the lower Gunbower Forest (i.e. TLM area). Water could also be released in a controlled fashion from the Broken Axle Creek Regulator down Broken Axle Creek.

Fish passage has been considered in preliminary designs and will be further refined during subsequent stages of design and development of the operating plan. Carp screens will be required on the Murray River regulators to exclude large numbers of adult carp entering the floodplain, causing ecological damage to wetlands and spawning on the floodplain. Fish passage will also be required to allow native fish to enter and exit the floodplain during natural and hybrid events. Active upstream fish passage targeting small-bodied native fish will be provided through a cone fishway at Camerons Mid Creek Regulator.

1.4 Previous studies

Biodiversity information has been collected for the project over a number of years. During this time, the location and extent of construction areas has been revised numerous times with the overall aim of minimising impacts to areas of ecological value.

This flora and fauna assessment has been informed by the following previous studies undertaken for the project:

- Bennetts and Cook (2020) *Threatened Flora Monitoring Gunbower Forest Ramsar Site Spring 2019*. Report prepared for the North Central Catchment Management Authority. Kate Bennetts, Fire, Flood & Flora and Damien Cook, Rakali Consulting were engaged by the North Central CMA to survey for EPBC listed threatened flora at previously recorded locations and suitable habitat within the Gunbower Forest Ramsar site
- Stuart (2020) *Upper Gunbower Creek Fish Management Plan*. Ivor Stuart from the Arthur Rylah Institute for Environmental Research, DELWP was engaged by the North Central CMA to provide a fish management plan as part of the Victorian Floodplain Restoration Project (VMFRP) including Camerons Creek, Black Charlie Lagoon and Hall Road Lagoon.
- Bennetts and Jolly (2019). *Wetland and Understorey Vegetation Condition Monitoring Gunbower Forest Autumn 2019*. Technical Report for the North Central CMA. Fire, Flood and Flora have been engaged by the North Central CMA to repeat wetland and understorey vegetation condition monitoring in Gunbower Forest as part of The Living Murray (TLM).
- Seran BL&A (2018) *Screening of the potential impacts on threatened species and communities associated with the construction and operation of Victoria's nine Basin Plan environmental works projects*. Seran and BL&A were engaged to analyse impact pathways and identify potential mitigation measures in order to consider the potential impacts and recommendations for EPBC Act and EE Act referrals of nine proposed Basin Plan environmental works packages being overseen by the Department of Environment, Land, Water and Planning (DELWP).
- GHD (2017). *Gunbower National Park Flora and Fauna Assessment*. Report prepared for the North Central CMA. In 2017, GHD were engaged by the North Central Catchment CMA to undertake a flora and fauna assessment, to investigate ecological values which may be impacted during the construction required to deliver the Sustainable Diversions Limits (SDL) project at Gunbower National Park. Surveys included mapping of EVC, large old trees (LOTs), Habitat Hectare assessments and threatened flora surveys. Fauna surveys of the proposed structure footprints included bird surveys, bat harp trapping and Anabat recording, active searching, spotlight surveys and remote sensing fauna cameras.
- North Central CMA (2015) *Camerons Creek vegetation survey, mapping and analysis*. North Central CMA undertook a baseline condition assessment of the wetland vegetation along the Camerons Creek system prior to future potential changes to the hydrological regime.
- Sharpe (2015). *Autumn 2015 Fish surveys of Camerons Creek, Victoria, May 2015*. Final Report for North Central CMA by CPS Environmental Research. CPS Environmental Research were engaged by the North Central CMA to complete a follow up survey of the Camerons Creek fish community, with replicated survey

effort and site selection as in the first survey (below), but with the addition of boat electrofishing at several sites and a survey of Black Charlie Lagoon, using netting and boat electrofishing.

- Sharpe (2014). *Fish surveys of Camerons Creek, Victoria, September 2014*. A summary of Findings Report for North Central CMA by CPS Environmental Research. CPS Environmental Research were engaged to complete a study aimed to describe the fish species present and in particular to determine the occurrence of Southern pygmy perch in Camerons Creek, and to undertake an assessment of remnant fish habitats.
- Biosis (2014). *Flora and fauna assessment of the Gunbower National Park and Guttrum and Benwell State Forests*. Report prepared for the North Central CMA. In 2014, Biosis were engaged to undertake a flora and fauna assessment of construction footprint at Gunbower National Park and Guttrum and Benwell State Forests. The assessment included mapping of EVCs, LOTs and habitat values to make recommendations for further targeted threatened species surveys.
- Bennetts (2014). *Vegetation mapping in Upper Gunbower Forest*. Kate Bennetts of Fire Flood and Flora was engaged to delineate terrestrial woodland from woodland which tolerates periodic inundation in both Black Box and Grey Box vegetation in the Upper Gunbower Forest. The resulting GIS data provides a revised vegetation map for the North Central CMA in order to facilitate the evaluation of proposed water related works.
- North Central CMA (2014). *Gunbower National Park: Ecological Objectives and Hydrological Requirements*
- Ecological Associates (2014). *Ecological Objectives and Hydrological Targets in Upper Gunbower Forest*. Report prepared for North Central CMA.
- Howard, Stricker, Spencer and Beesley (2013). *Population demographics, abundance and movement of turtles within the Gunbower Lagoon system*. Arthur Rylah Institute for Environmental Research Unpublished Client Report for the North Central CMA.
- North Central CMA (2012). *Mapping Grey Box (Eucalyptus microcarpa) Grassy Woodland within Gunbower Forest*. Unpublished report prepared for GMW. The North Central CMA was requested by GMW to undertake surveys of Grey Box (*Eucalyptus microcarpa*) Grassy Woodland within Gunbower Forest.
- Bennetts, Jolly and Osler (2012). *Targeted rare and threatened flora survey of Gunbower Forest summer 2011*. Report for the Department of Sustainability and Environment (Swan Hill Regional Office), Fire, Flood and Flora, Cape Woolamai, Victoria.

A summary of previous ecological assessments, including methods, key findings and recommendations is presented in Appendix C, with conclusions and recommendations incorporated throughout this report.

1.5 Purpose of this report

The purpose of this report is to:

- Summarise the findings of an updated desktop assessment to review flora, fauna (native species and habitat) and vegetation communities within the study area.
- Summarise the previous ecological assessments (Bennetts et al. 2012, Howard et al. 2013, Bennetts 2014a, Biosis 2014a, North Central CMA 2014, Sharpe 2014a, Sharpe 2015b, GHD 2017, Seran BL&A 2018, Bennetts and Cook 2020, Bennetts and Jolly 2020, Stuart 2020) undertaken for the project.
- Describe targeted surveys for flora and fauna species and communities, listed under the Commonwealth EPBC Act and the Victorian FFG Act undertaken by R8 in late 2019.
- Provide an inventory of all incidental observations of flora and fauna recorded during 2019 surveys undertaken by R8.
- Determine the extent of impacts to native vegetation, as defined as Ecological Vegetation Classes (EVCs), (including large trees) within the proposed construction areas in accordance with the *Guidelines for the removal, destruction or lopping or native vegetation* (DELWP 2017a) as a base case to guide further design.
- Describe specific threatening processes associated with the project as listed under the FFG Act and EPBC Act.

- Determine the likelihood of occurrence of listed threatened flora and fauna species, listed threatened ecological communities and listed migratory species within the proposed construction and inundation area. Where listed species or communities are identified as occurring or having the potential to occur, determine the likely impact on these listed species and communities by the project (during both the construction and operation phases).
- Undertake high level assessment of potential impacts on significant wetlands (e.g. EPBC self-assessment for Ramsar sites, consideration of nationally important wetlands) and other aquatic ecosystems and species.
- Identify potential impacts to ecological values during the construction and operation of the project and recommend mitigation measures to minimise these impacts.
- Discuss potential legislative requirements of the proposed works during the construction and operation phase (with respect to potential flora and fauna impacts).

Figure 1-1: Construction footprint at Gunbower National Park

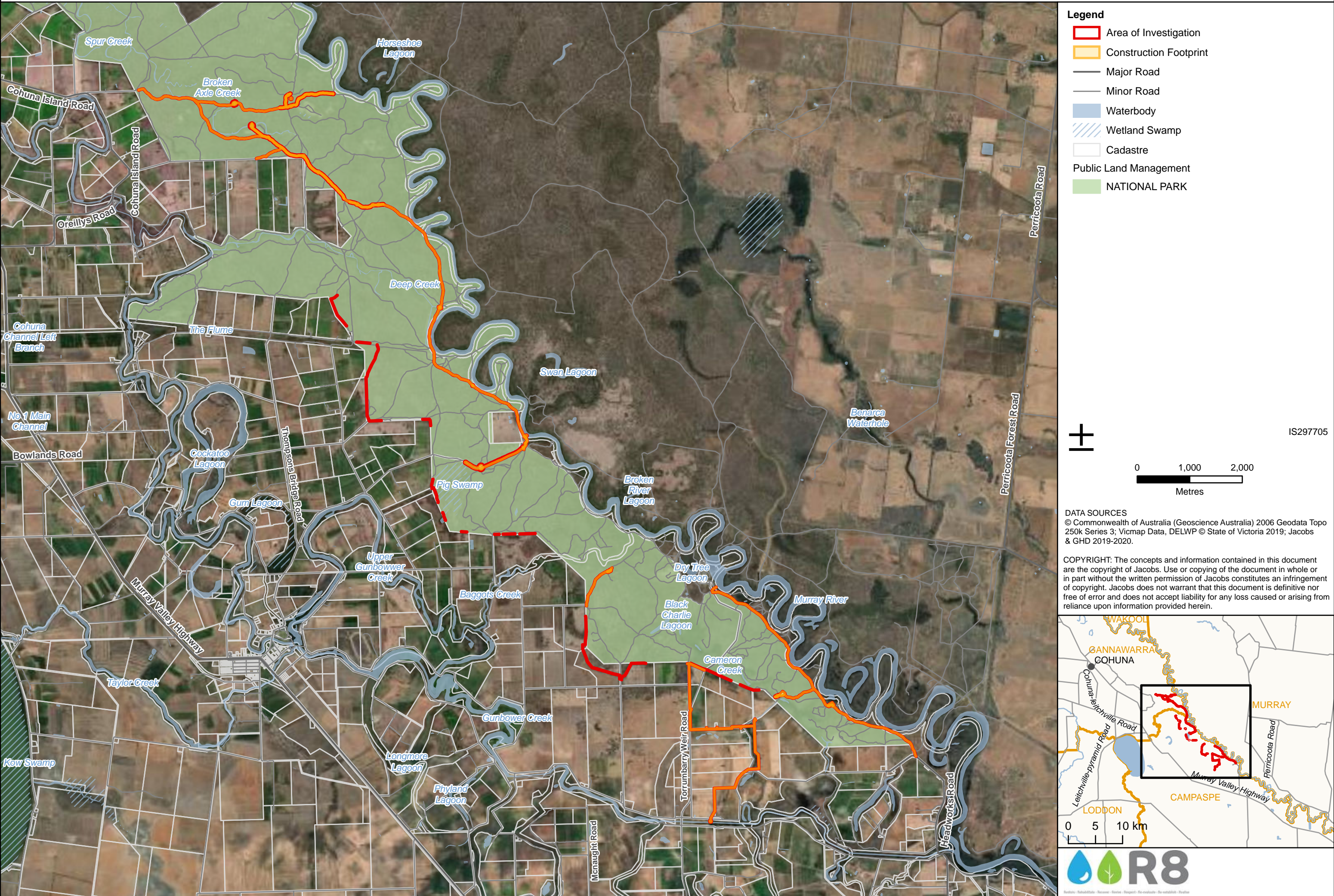
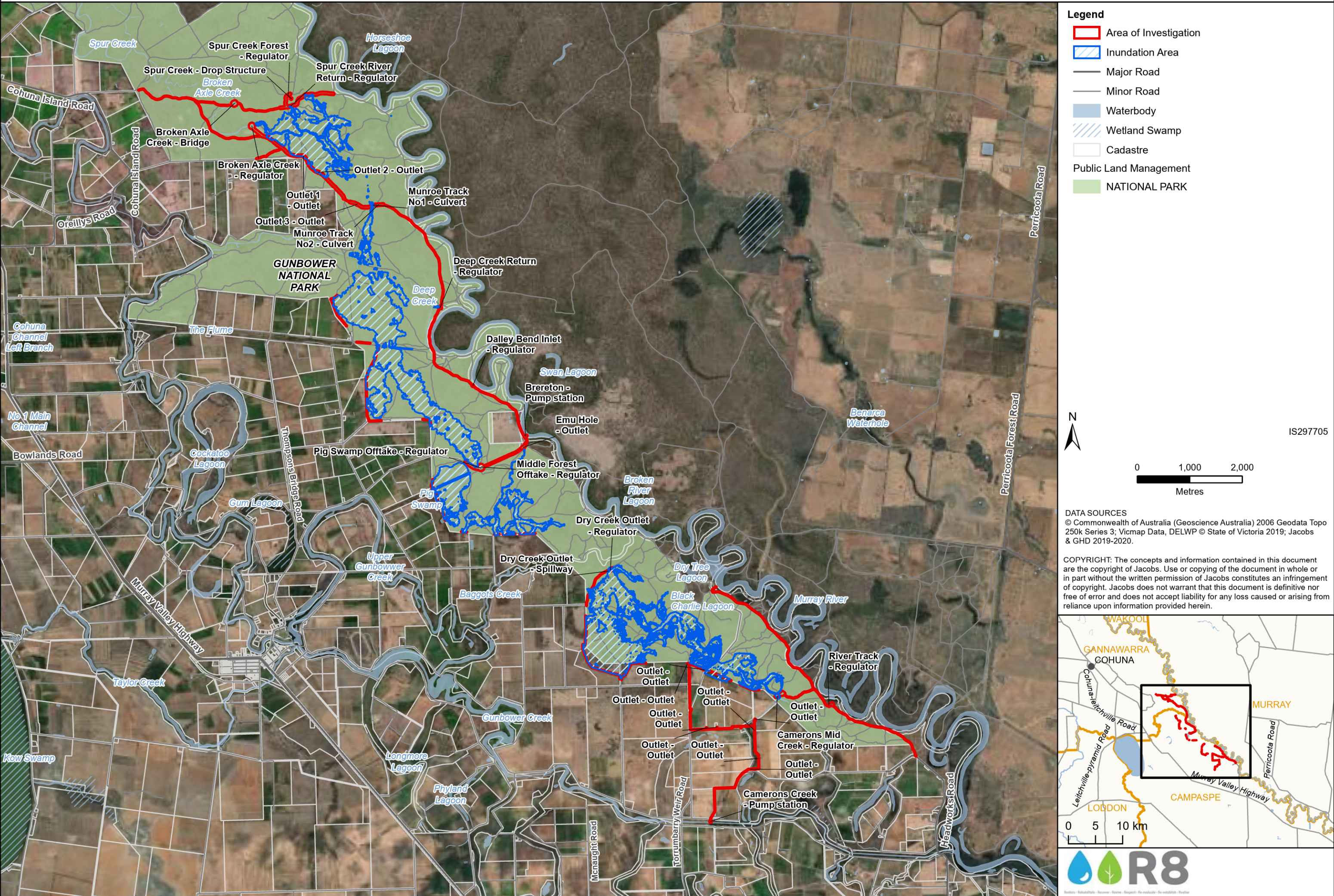


Figure 1-2: Inundation area at Gunbower National Park



2. Biodiversity responses to environmental watering

The lowland-dryland rivers of the Murray-Darling Basin (MDB) have either perennial, seasonal, intermittent or ephemeral hydrological regimes and their flows are variable over annual, decadal and centennial time-scales. Weather and climate variability drive the flow regimes of inland Australian rivers, while inland floodplain wetlands experience changes in the frequency, magnitude and duration of flooding in response to climatic cycles and extreme events of rainfall and runoff in their catchments (Ralph and Rogers 2011).

Over the past century, the natural pattern (frequency, intensity, duration and seasonality) of wetting and drying on floodplains of the MDB has been altered by flow regulation due to dam and weir construction, extraction of water for irrigation, stock and domestic uses, and construction of levees (Boulton & Brock 1999, Brock et al. 1999; Kingsford 2000; Kingsford et al. 2006; Walker 2006). In many cases, the effect has been to remove water from the environment, with the result that inundation of floodplain wetlands occurs less frequently and/or for shorter periods than in pre-European times, leading to chronic desiccation. Occasionally, and generally on a small scale, artificial structures can alter systems through the provision of excess water (as in the case of leaking irrigation channels) or extend inundation durations by blocking overflow channels.

Flooding is essential for the effective functioning of floodplain ecosystems; however, flow-ecology relationships and processes in rivers and floodplain wetlands are complex. Many biota in the MDB are adapted to variable flow and respond to flooding, but the optimal frequency, timing, duration and magnitude of floods vary between biota. Despite the variability in response, some common themes emerge when the benefits of flooding are examined for different ecological elements:

- **Vegetation:** Hydrological regimes are the major factor responsible for determining the composition, structure, diversity and function of floodplain forest and wetland communities. EVC distribution strongly correlates to micro-elevation throughout these systems, with communities with obligate wetland understorey components inhabiting the lower and more frequently inundated areas, transitioning to more flood 'tolerant' terrestrial species that have limited inundation at higher elevations in the landscape;
- **Trees:** Successful regeneration of floodplain trees usually occurs after major floods, while floods also provide an essential source of water to maintain tree canopy health and thin dense regeneration of recruiting trees. Trees are important for colonial waterbird breeding and enable terrestrial fauna to move into the inundated areas;
- **Understorey:** The obligate wetland understorey associated with several of the vegetation communities within Gunbower National Park do not persist given the current frequency of flooding. The understorey in the more terrestrial (flood tolerant) areas are also compromised due to a lack of recruitment opportunity. The understorey and ground cover is a crucial habitat resource for a variety of threatened plant and animal species, including critical waterbird foraging area when inundated to support breeding;
- **Waterbirds:** Flooding acts as the primary stimulus for breeding waterbirds, increasing reproductive performance as the flood pulse stimulates productivity in the wetlands and across the floodplain;
- **Fish:** Flooding may trigger spawning or migration to suitable breeding habitat in fish;
- **Frogs:** Flooding promotes a rapid response in frog activity, including calling, spawning, and tadpole development and metamorphosis providing a food source to other species;
- **Carbon processes:** Flooding is critical for releasing carbon from litter load by stimulating bacteria, which is a key component of the trophic cycle, increasing productivity by providing food for micro and macroinvertebrates and so on up the food chain, and
- **Soil processes:** In the biotic context, flooding revitalises the soil microbiome in a similar fashion to the above ground ecology, with the added consideration of the value of soil bacteria and fungus on all higher life. In the abiotic context detrimental hydrological functions such as the accumulation of irrigation salinity in the floodplain is at the detriment of floodplain biodiversity. Effectively washing the salinity out of the floodplain is beneficial in this regard (although it may move the salinity issue to another place).

The most extensive and severe drought in Victoria of the past century, known as the Millennium drought (1997-2010), brought the issue of floodplain ecosystem health into the mainstream, with widespread tree dieback

across the MDB symptomatic of an ecosystem in decline. During this time, the Murray Darling Basin Committee (MDBC) acknowledged that for the condition of floodplain ecosystems to be improved and to function effectively, adequate amounts of water needed to be provided to key iconic sites to ensure their continued survival. Consequently, since this time the focus of floodplain restoration/rehabilitation has centred on the return of water to help facilitate a more natural (i.e. pre-European settlement) hydrological regime (Boon 2011).

While drought-breaking rain (and subsequent flooding) in 2010-11 and natural floods again in 2016 have provided a much needed boost to MDB floodplain ecosystem condition, these natural floods have been supplemented by a range of environmental watering measures over the past decade, which have been considerably aided by the construction of water infrastructure (e.g. regulators, levees, channels) in strategic locations at a number of Murray River icon sites. This infrastructure has allowed floodplain managers to control the timing, volume, rate, depth and duration of environmental water into designated sites, so that maximum benefit of the water to the environment is able to be generated.

During this time, numerous long-term monitoring programs have been established, including The Living Murray icon site condition monitoring program, to monitor and track the response of floodplain forests and wetlands over time, and in particular, determine how the ecosystem responds to watering. Results to date indicate that the floodplain systems of the mid-lower Murray generally respond positively to flooding, whether it be landscape-scale overbank flooding or smaller scale events, e.g. watering of creeks, floodrunners and low-lying wetlands. Although vegetation condition monitoring has shown varying response to natural and environmental flooding, partially due to other factors such as carp, logging and the effects of climate change.

2.1 Ecological benefits – Gunbower National Park

The Gunbower National Park sits within the Gunbower Forest Ramsar site, which is part of the second largest River Red Gum forest within the Murray-Darling Basin and provides important breeding habitat for wetland and migratory birds (Hale and Butcher 2011). It is also part of the Gunbower-Koondrook-Perricoota Forest Icon Site, one of six icon sites under The Living Murray program established in 2002. Extensive environmental monitoring and assessments have documented the ecological importance of the Gunbower National Park and more recently, the impacts of major droughts on the forest system.

It is reported (North Central CMA 2014) that the ten years prior to the 2010-11 flooding (the millennial drought) resulted in below average inflows and general flooding availability within the Gunbower National Park. With a lack of required infrastructure to manage flooding delivery or management within the forest, environmental watering programs were not considered viable during previous high flow events. General observations of the forest in response to lack of flooding found:

- River Red Gum forests experienced a decline in tree health and exhibited a significant loss of plant diversity and increased weed invasion;
- Encroachment of terrestrial vegetation into areas previously occupied by flood dependant wetland species;
- The long period of dry conditions reduced floodplain productivity and access to food and habitat for native fauna. This was most obvious for colonial water bird populations, due to the limited large-scale breeding opportunities at the time;
- Breeding opportunities for native fish are considered to have been hindered due to the lack of connectivity and availability of breeding habitat;

Some small volumes of environmental water (19GL in 2004-5 and 7.5GL in 2009-10) were delivered to permanent and semi-permanent wetlands to maintain wetland vegetation communities and create critical refuge areas in the landscape for waterbirds. The delivery of environmental water saw the Little Gunbower Wetland Complex support a significant colony of waterbirds (egrets, ibis, darters, cormorants) for the first time in a number of years.

In 2010-11 Gunbower Forest received extensive natural flooding, with a 1 in 20 year major flood event with three major flooding 'peaks' of above 45,000 ML/day passing through the forest (North Central CMA 2014). Over bank flooding was again observed in 2012 and a small natural flood event was recorded in low-lying wetlands in 2013. Vegetation assessment undertaken in 2013 and 2014 (Bennetts and Jolly 2013, Bennetts 2014b, Bennetts 2014a) describe the vegetation response following the floods, with the floodplain forest re-

establishing an intact understorey, maintaining remaining rare and endangered species and improving the health of the canopy. However, it was identified that this flood response was short-lived, with understorey vegetation returning to pre-flood condition (Bennetts 2014b).

Annual vegetation condition monitoring has described the vegetation response to environmental water delivered in 2014, 2015 and 2018 through the Hipwell regulator (Bennetts and Jolly 2020). Vegetation responses in wetlands have been site-specific but have generally shown low flora cover with successive dry years and after natural flooding in 2010. Although, high flora cover observed following inundation after a dry phase (in most instances). Responses to environmental watering in River Red Gum forests shown an improvement in canopy health and varying responses to watering events in 2014 and 2018 likely due to climatic conditions influencing the flora's response to managed events.

Gunbower Forest is located in an area of low rainfall and high evapotranspiration, which creates a significant water deficit and places stress on the forest when no natural inflows are received to maintain the health of vegetation communities (North Central CMA 2014). Major hydrology changes have occurred due to the regulation and diversion of flows from the Murray River, resulting in a reduction in the frequency and duration of flooding. Modelling predicts that under current river operations, intervention is needed to maintain functioning floodplain ecosystems within Gunbower Forest (North Central CMA 2014).

The key environmental objectives of the Gunbower National Park Floodplain Restoration Project are to reinstate a more natural water regime that protects and enhances the ecological values within the Gunbower National Park and, where possible, supports values in downstream areas of Gunbower Island (North Central CMA 2014). The specific ecological objectives of the project are to:

River Red Gum forest

The overarching objective is for 'Healthy River Red Gum forests with flood dependent understorey and temporary wetlands'. Specific ecological objectives are to:

- Achieve an appropriate cover and diversity of species characteristic of the plant functional groups found in the River Red Gum forest flood dependent understorey.
- Maximise the proportion of trees with healthy canopy condition in the River Red Gum forests with flood dependent understorey.
- Maintain and where possible increase the current diversity of threatened flora species.
- Reduce the area of high threat weed species.

Native fish

The overarching objective is for 'Drought refuge habitat provided for fauna (particularly small-bodied native fish) in Black Charlie Lagoon'. Specific ecological objectives (NCCMA 2014) are to:

- Maintain and where possible improve the current diversity of the small-bodied native fish community in Black Charlie Lagoon.
- Promote recruitment of small-bodied native fish in Black Charlie Lagoon

The Upper Gunbower Creek Fish Management Plan (2020) also includes native fish objectives for Camerons Creek in addition to Black Charlie Lagoon.

Native fauna in wetlands

The overarching objective is for 'Healthy wetland bird community through improved access to food and habitat that promotes breeding and recruitment'. Specific ecological objectives are to:

- Support waterfowl breeding events in most years
- Contribute to the success of breeding events of colonial nesting waterbirds in the lower Gunbower Forest by providing foraging areas in Gunbower National Park.
- Maintain and where possible increase the current diversity of threatened wetland bird species.

3. Methods

3.1 Assessment areas

The following assessment areas are referred to throughout this report:

- **Development footprint** = The development footprint is the indicative area that the project infrastructure will occupy, based on the current design, and includes laydown areas to be used during construction. This does not include power supply and associated poles, stays, or cables, containment banks or tracks used for access during construction and operation. It forms the basis for the buffered area of investigation and construction footprint.
- **Construction footprint** = encompasses the current design footprint of proposed structures (included in the development footprint) as well as the indicative area of land required to construct the infrastructure based on the current design. The construction footprint includes a 10 m construction buffer around the development footprint of proposed structures (regulators, drop structure, pump hardstands) and a 3 m construction buffer around the development footprint of proposed containment banks, laydown areas and minor work sites. The construction footprint includes a typical access track width of approximately 5 m, which is relatively typical width for existing access tracks managed by Parks Victoria. The construction footprint is the area to be directly impacted by the proposed works (i.e. limits of disturbance) and is the area that will be used for calculating impacts to native vegetation and listed threatened species and communities.
- **Area of investigation** = provide the basis for desktop and field investigations to identify environmental values relevant to construction of the project. The area of investigation is not the proposed area of impact (see construction footprint) but includes a conservative buffer around the construction footprint to allow for possible design changes to avoid significant values where required without having to undertake further environmental investigations. It includes a 20 m buffer around the development footprint of proposed infrastructures (e.g. regulators, drop structures, pump stations, containment banks) and access tracks (10m either side of centreline for existing tracks), 15 m buffer around the development footprint of minor work sites (e.g. blockage bank removals/modifications) and 10 m buffer around the development footprint of laydown areas.
- **Inundation area** = The proposed managed inundation area of approximately 704 ha in Gunbower National Park (Upper Gunbower = 247 ha, Middle Gunbower = 457 ha). The inundation area was subject to desktop assessment only.
- **Project area** = The combined area of the proposed construction footprint and inundation area.
- **Study area** = All land within 10 km of the proposed construction footprint and inundation area.

The location of these areas is shown in Figure 1-1 and Figure 1-2.

3.2 Limitations associated with current design

Design and in some cases the type and location of infrastructure is currently being refined as part of the design process. The area of investigation provides a buffer around the current design of the development footprint and access tracks to allow for future changes. To the extent practicable, changes to the design and construction footprints of the main components of the project would be within the area of investigation. Any changes occurring outside of this area of investigation would require assessment to identify their potential to impact on ecological values.

Key design elements that are subject to change include the design and location of levees/ containment banks and power supply as these have not yet been confirmed. The containment banks are subject to further risk assessment to confirm if works are required and VMFRP is currently working with Powercor to confirm the preferred alignment for the power supply. The potential location of containment banks have been included in the area of investigation for completeness. The location of new poles, stays and cables associated with the pump

station power supply are yet to be confirmed and are not included in the project footprints assessed in this report.

The concept design of environmental infrastructure proposed in Middle Gunbower Forest (downstream of Deep Creek) and Camerons Creek pump station and pipeline in Upper Gunbower is currently being developed and was included after the field assessments were undertaken in 2019. Therefore, no field assessment has been undertaken in this area of the project and a conservative approach has been adopted to assessing potential impacts in this area based on desktop assessment only.

Given the design of the proposed environmental water delivery infrastructure is evolving as part of the design and approvals process, the potential flora and fauna impacts from the project assessed in this report will need to be reviewed and updated in response to design changes and additional field work undertaken. Findings from field assessments particularly ecology fieldwork and cultural heritage complex assessment (undertaken for the Cultural Heritage Management Plan) have and will continue to be progressively fed into the design, with modifications made to avoid and minimise environmental impacts.

3.3 Desktop assessment

A review of available biodiversity databases was undertaken to identify listed flora and fauna with the potential to occur within the area of investigation and inundation area. The review considered previous records, predicted occurrences of flora, fauna and vegetation communities, and an assessment of potential habitats from aerial imagery and native vegetation mapping.

The following databases and reports were used:

- The Protected Matters databases maintained by DAWE¹, accessed via the Protected Matters Search Tool (PMST) for matters protected by the EPBC Act
- Weeds of National Significance database²
- Victorian Biodiversity Atlas (VBA), maintained by DELWP³
- NatureKit, spatial database for native vegetation (Ecological Vegetation Class) mapping throughout Victoria, maintained by DELWP⁴
- Native Vegetation Information Management tool (NVIM), maintained by DELWP⁵
- Bennetts and Cook (2020) *Threatened Flora Monitoring Gunbower Forest Ramsar Site Spring 2019*. Report prepared for the North Central Catchment Management Authority
- Stuart (2020). *Upper Gunbower Creek Fish Management Plan*. Unpublished Client Report to North Central CMA. Arthur Rylah Institute for Environmental Research, DELWP.
- Bennetts and Jolly (2005-2020). *Wetland and Understorey Vegetation Condition Monitoring Gunbower Forest Autumn 2005-2019*. Technical Reports for the North Central CMA.
- Seran BL&A (2018). *Basin Environmental Works Screening of the potential impacts on threatened species and communities associated with the construction and operation of Victoria's nine Basin Plan environmental works projects*.
- GHD (2017). *Gunbower National Park Flora and Fauna Assessment*. Report prepared for the North Central CMA.
- North Central CMA (2015) *Camerons Creek vegetation survey, mapping and analysis*.

¹ <http://www.environment.gov.au/epbc/protected-matters-search-tool> (accessed on 18/02/2020)

² <http://www.environment.gov.au/biodiversity/invasive/weeds/weeds/lists/wons.html> (accessed 18/02/2020)

³ <https://www.environment.vic.gov.au/biodiversity/victorian-biodiversity-atlas> (accessed on 18/02/2020)

⁴ <http://maps.biodiversity.vic.gov.au/viewer/?viewer=NatureKit> (accessed on 18/02/2020)

⁵ <https://nvim.delwp.vic.gov.au/> (accessed on 18/02/2020)

- Sharpe (2015). *Autumn 2015 Fish surveys of Camerons Creek, Victoria, May 2015*. Final Report for North Central CMA by CPS Environmental Research.
- Sharpe (2014). *Fish surveys of Camerons Creek, Victoria, September 2014*. A summary of Findings Report for North Central CMA by CPS Environmental Research.
- Biosis (2014). *Flora and fauna assessment of the Gunbower National Park and Guttrum and Benwell State Forests*. Report prepared for the North Central CMA.
- North Central CMA (2014). *Gunbower National Park: Ecological Objectives and Hydrological Requirements*
- Ecological Associates (2014). *Ecological Objectives and Hydrological Targets in Upper Gunbower Forest*. Report prepared for North Central CMA.
- Bennetts (2014). *Vegetation mapping in Upper Gunbower Forest*. Fire Flood and Flora. Report prepared for the North Central CMA.
- Howard, Stricker, Spencer and Beesley (2013). *Population demographics, abundance and movement of turtles within the Gunbower Lagoon system*. Arthur Rylah Institute for Environmental Research Unpublished Client Report for the North Central CMA.
- North Central CMA (2012). *Mapping Grey Box (Eucalyptus microcarpa) Grassy Woodland within Gunbower Forest*. Unpublished report prepared for GMW.
- Bennetts, Jolly and Osler (2012). *Targeted rare and threatened flora survey of Gunbower Forest summer 2011*. Report for the Department of Sustainability and Environment (Swan Hill Regional Office).

A VBA search and PMST search of the Protected Matters databases was undertaken for the study area.

The results of the desktop assessment are presented in the likelihood of occurrence / impact tables contained in Appendix D (Flora – construction footprint), Appendix E (Flora - Inundation area), Appendix F (Fauna - Construction footprint) and Appendix G (Fauna - Inundation area).

3.3.1 Determination of likelihood of occurrence

For the desktop assessment, the likelihood of each threatened species or community occurring within the project area was assessed on the basis of the species' or community's history of occurrence and its habitat requirements. For each species or community, the presence of suitable habitat within the construction footprints was determined, along with the condition and approximate extent of suitable habitat within the project area and the broader context of the surrounding landscape. This was coupled with how often and how recently each species or community had been recorded (if at all) within the construction footprints or within the study area. Resources utilised to assist in determining likelihood of occurrences included VBA and PMST searches undertaken for the the study area, as well as the previous reports for the project and the most recent surveys. The basis of the likelihood of occurrence of each threatened species of community within one or more of the construction footprints was specifically:

PRESENT – Species known to occur within one or more construction footprints, or detected during the site visit.

POSSIBLE – Potentially suitable habitat occurs within one or more construction footprints and species' known range encompasses the construction footprints. Species recorded historically in the study area within the last 30 years.

UNLIKELY – Species' known range encompasses the construction footprints, but suitable habitat does not occur within construction footprints, or occurs within construction footprints but with generally low quality and quantity. Species recorded historically in the study area and highlighted in the PMST output, but not within the last 30 years.

HIGHLY UNLIKELY – No historical records of the species within the last 30 years and/or no suitable habitat in the study area, but highlighted in the PMST output.

3.3.2 Inundation Area mapping and impact assessment

The extent of inundation that will result following the proposed works has been modelled and considered in this report. An assessment of potential impacts within the inundation area is required for approvals under the Environment Effects Act 1978 and EPBC Act by providing information as to the potential predicted impacts (both direct and indirect) on biodiversity values including threatened flora, fauna and ecological communities as a result of planned inundation events.

The potential impact on native vegetation within the inundation area has been considered using:

- Previous assessments completed within the Gunbower National Park, as described in section 1.4
- Ecological Vegetation Class (EVC) and Water Regime Class (WRC) mapping completed of Upper Gunbower Forest (Bennetts 2014a)
- Rare and threatened species based on VBA records and previous assessments within the inundation area, as described in section 1.4
- Outputs from the Protected Matters Search Tool for any matters protected under the EPBC Act

An assessment was then undertaken to determine whether threatened species or ecological communities are considered likely to occur within mapped vegetation communities within the inundation area. Detailed flora surveys previously completed during condition monitoring between 2005–2019 (Bennetts and Jolly 2020), and targeted threatened flora surveys (Bennetts et al. 2012, Bennetts and Cook 2020) provide greater certainty for assessments of occurrence for threatened flora. For threatened fauna species, assessments of occurrence have been based on habitat values predicted from vegetation mapping and previous assessments.

3.4 Field assessment

Field assessment was completed based on the interim area of investigation provided in September 2019 for Gunbower and included the proposed construction footprint at Upper Gunbower Forest (excluding Camerons Creek pump station and pipeline in Upper Gunbower) and Middle Gunbower Forest (upstream of Deep Creek). As discussed in Section 3.2, no field assessment of the construction footprint has been completed by R8 of Middle Gunbower Forest (downstream of Deep Creek) and Camerons Creek pump station and pipeline.

3.4.1 Vegetation condition assessment

A field assessment was undertaken in the area of investigation (as defined in September 2019) by R8 Senior Ecologists (Alicia Michael and Mike Timms) and Ecologist (Leo McComb) between 22–25 October and 2–5 December 2019 and included mapping the extent and condition of native vegetation present including:

- Defining and mapping the relevant EVCs within the proposed construction footprint.
- Estimating the cover and health of plants.
- Undertaking Habitat hectare (HabHa) Assessments for each Habitat Zone (HZ) (as described below).
- Mapping and measuring all Canopy Trees that meet the benchmark for Large Trees
- Recording the location of any rare or threatened flora or fauna and protected flora where encountered.
 - Collecting an inventory of incidental observations of both native and non-native flora and fauna encountered during the field assessment, together with their conservation status and origin.
 - Identifying the presence of significant weed species including those declared under relevant state and national legislation, policy or strategy, e.g. *Catchment and Land Protection Act 1994 (CALP Act)* and National Weeds Strategy.

EVC and Large Tree mapping is provided in Appendix A and Appendix B and the full list of Habitat hectare assessment is provided in Appendix H.

3.4.2 Targeted threatened flora surveys

Field surveys were undertaken between 22-25 October and 2-5 December 2019 R8 Senior Ecologists (Alicia Michael and Mike Timms) and Ecologist (Leo McComb). Fieldwork was undertaken in the area of investigation, and targeted surveys for rare or threatened flora were conducted (with particular emphasis on EPBC and FFG listed threatened flora) to update the results of previous assessments undertaken in the original construction footprint (GHD 2017, Seran BL&A 2018).

The surveys involved two field staff walking parallel linear transects 10 m apart over the extent of the construction footprint, with each ecologist having a 5 m field of view each side of the transect. Rare and threatened flora encountered were GPS marked and details recorded.

3.4.3 Fauna surveys

A number of previous fauna assessments in Gunbower Forest have been undertaken (Biosis 2014a, Sharpe 2014b, Sharpe 2015a, GHD 2017) using a variety of survey methods including fish surveys (fyke nets, traps and electrofishing) active searching, bird surveys, bat surveys (Bat harp trapping and Anabat recording), spotlight surveys including the use of call-playback and remote sensing fauna cameras. A summary of previous assessments is provided in Appendix C and further detail on survey methods is provided in those reports.

R8 surveys focussed on previously identified threatened fauna species reported in Biosis (2014a) and those recommended for targeted surveys (GHD 2017, Seran BL&A 2018). The surveys included:

- Surveys for the State listed Squirrel Glider (*Petaurus norfolcensis*) and Grey-crowned Babbler (*Pomatostomus temporalis*) and potential important breeding habitat.
- Recording all identified fauna, and their observed behaviour (e.g. feeding, roosting, breeding), abundance and conservation status.
- Pest fauna posing a threat to native vegetation and/or fauna.
- Active searching of appropriate fauna habitats (logs, tree hollows, tussocks, deep litter etc.) and food plants (i.e. fruit and/or nectar bearing) for mammals, birds, reptiles and frogs.
- Assessments of potentially suitable habitat for threatened fauna.

EPBC Act listed Migratory species were considered as part of this assessment.

3.4.4 Targeted threatened fauna surveys

Previous assessments had identified potential habitat and the requirement of targeted survey for Grey-crowned Babbler and Squirrel Glider (GHD 2017). Both species are listed as threatened species under the FFG Act and endangered under the Advisory list of Rare and Threatened Fauna in Victoria (DEPI 2013).

Targeted surveys for both species were undertaken between 22-25 October and 31 October-1 November 2019 by R8 Senior Ecologists (Briony Mitchell, Rebecca Sutherland and Mike Timms) and Ecologist (Leo McComb). The surveys were conducted in the area of investigation, as shown in Figure 5-4.

Squirrel Glider arboreal remote-sensor camera targeted surveys

The Squirrel Glider is an arboreal, nocturnal gliding possum in the Family Petauridae, occurring in northern and central Victoria, and through eastern New South Wales and eastern Queensland. In Victoria, Squirrel Gliders occur in River Red Gum (*Eucalyptus camaldulensis*) forests, and mixed-species dry forests, typically box-ironbark forests and woodlands. Within Gunbower Forest, Black Box (*Eucalyptus largiflorens*) and River Red Gum are the overstorey component of the following EVCs in the project area where targeted surveys were focused: Floodplain Riparian Woodland (EVC 56), Riverine Chenopod Woodland (EVC 103) and Plains Woodland (EVC 803).

Trees hollows are essential resources for den and breeding sites, with colonies utilising multiple den sites (average = 7) across a territory (Crane et al. 2010). Squirrel Gliders primarily move through their home range by

gliding from tree to tree (Figure 3-1). The average glide length is 30–40 m, with a maximum glide length of approximately 70 m (van der Ree et al. 2003). Sparse vegetation cover can force Squirrel Gliders to the ground, leaving them open to predation from owls, foxes or cats. The home range of Squirrel Gliders in high quality habitat is between 1.5 and 3.5 ha, but is larger (up to 10–12 ha) in low quality habitat (Quin, 1995; van der Ree & Bennett, 2003). Surveys were conducted during the breeding period for the species in Spring - Summer

Two records of this species occur along the Murray River within close proximity (< 1km) of the area of investigation and suitable habitat has been identified in previous assessments (Biosis 2014a, GHD 2017). It appears unlikely a significant number of targeted nocturnal surveys have been undertaken in this location. Therefore, records of the species are not considered indicative of the species' entire distribution in this region, and the species is likely to be more widespread than these known records.

Survey Method

The aim of the targeted survey was to determine the presence/ absence of the threatened Squirrel Glider within the area of investigation.

Surveys were undertaken by conducting initial habitat assessments across the entire area of investigation, specifically targeting areas with high densities of hollow-bearing trees, *Acacia spp.* or other shrub species for foraging and being located close to waterways. Remote sensing, infra-red camera surveys are considered to have the highest detection probability than other survey methods for arboreal marsupials e.g. spotlighting and live-trapping and offer reduced disturbance (DSEWPac 2004, Nelson et al. 2017).

Thirty remote-sensing Reconyx HF2X HyperFire2 cameras were installed across the area of investigation, 3–4 m above the ground. Cameras were placed approximately 100 m (+/- 20 m) apart to account for home-range ecology and gliding distance in transects of five (van der Ree et al. 2003). Cameras attached to pre-made steel brackets, 1.2 m from the tree were attached to large, hollow-bearing trees (DBH >60cm), with clear 'landing pads' to maximise detection rates, see Figure 3-1 below.

Cameras remained in place for seven days, resulting in a total survey effort of 210 trap nights. Cameras were set to take 5 images per trigger with a quiet period of 3 minutes between triggers. Each transect was considered a survey site. Site selection was dependent on suitability of habitat and type of proposed impacts. For instance, levee construction areas where wide, linear fragments of woodland may be created, including, removal of large hollow-bearing trees, were focused upon, as the creation of movement barriers within forested areas would potentially have the greatest impact to the species if present. Camera traps were set as linear transects or in a grid, depending on the shape and extent of woodland habitat at each. The GPS location of each camera tree (Datum: GDA), its species and diameter at breast height (DBH) were recorded. A bait consisting of a tea strainer filled with small mammal specific bait: a mixture of oats, honey and peanut butter, was attached to the tree. Diluted honey was sprayed from the canopy down the tree trunk to the bait to encourage movement from the canopy. The tea strainer was 10 cm in length, helping to determine Glider size at the image identification phase.

An experienced ecologist deployed each camera and examined each image taken by each camera. Camera configuration aimed to improve data collection, particularly the likelihood of Squirrel Glider detection and to increase data analysis efficiency. All images were analysed and all animals were identified to species level, with each set of three images recorded as a single observation event.

Timing of surveys

Surveys were undertaken in October and November during the optimal part of breeding season for Squirrel Glider (typically between July to January), which is dependent on seasonal conditions such as winter/spring rainfall.



Figure 3-1 Squirrel Glider remote sensing arboreal camera and bracket set 1.2 m away from bait holder attached to tree

Grey-crowned Babbler targeted surveys

The aim of the targeted survey was to determine the presence/ absence of the threatened Grey-crowned Babbler from the area of investigation.

The Grey-crowned Babbler is a medium-sized woodland bird that occurs across eastern Australia and includes northern Victoria. The species inhabits open Box-Gum Woodlands on fertile soils, however has experienced significant population declines of >90% across its southern distribution as a result of loss and fragmentation of habitat (Stevens et al. 2016). Grey-crowned Babblers live in large family groups of up to 15 individuals, that consist of a breeding pair and young from previous breeding seasons. They build and maintain several conspicuous, dome-shaped nests in shrubs or sapling eucalypts (DSE 2003). Colony groups possess large home range sizes up to 53 hectares (Blakers et al. 1984) and breed during spring and summer.

The species is known from many records along the Murray River although only two records (VBA) occur within 5 km of the project area. Suitable Grey-crowned Babbler habitat comprising dry, open River Red Gum forest and Black Box woodland has been identified in previous assessments (Biosis 2014a, GHD 2017) occurs across the entire inundation area, targeted surveys were conducted using the methods detailed below.

Survey Method

Surveys were undertaken by conducting initial habitat assessments across the area of investigation, specifically targeting areas with high densities of *Acacia* spp. or other shrub species for foraging and nesting and areas close to waterways with more fertile soils. An example of suitable habitat identified for targeted surveys is shown in Figure 3-2 and survey locations are provided in Figure 5-4.

Survey methods were selected based on the recommended survey techniques for threatened passerines (DEWHA 2010) and used in recent surveys for the Grey-crowned Babbler (Stevens et al. 2016). A combination of

Transect-point call-playback surveys were undertaken for Grey-crowned Babbler during the early morning when diurnal birds are most active. Broadcasts occurred every 200 m for 15 minutes at each point location. Pre-recorded vocalisations of the Grey-crowned Babbler were played for a period of one minute followed by a four-minute listening period repeated three times for a total of 15 minutes. Surveys were conducted between 6:45 am and 10:00 am where temperatures during these surveys were mild to warm.

Two Ecologists undertook each survey and recorded the following:

- Start and finish time;
- Location (confirmed using GPS);
- Weather conditions;
- Habitat values present along transect;
- Details of Grey-crowned Babbler activity;
- Any nests identified; and
- Other bird species present

Timing of surveys

Surveys were undertaken in October and November during the optimal part of breeding season for Grey-crowned Babbler (September to January, inclusive), which is dependent on seasonal conditions such as winter/spring rainfall. Grey-crowned Babbler activity is reduced during the middle (warmer) part of the day, therefore it is preferable to conduct surveys from the early morning (sunrise) until no later than midday.



Figure 3-2 Suitable woodland habitat where surveys were undertaken for Grey-crowned Babbler

3.4.5 Flora and fauna species inventory

A record of flora species, together with conservation status, origin and weed status recorded in the construction footprint during detailed vegetation assessment is provided in Appendix I. A record of fauna species, together with conservation status and origin recorded incidentally and during targeted surveys within the area of investigation is provided in Appendix J.

3.5 Permits

Surveys were completed in accordance with the R8 flora and fauna survey permit conditions issued under the *Wildlife Act 1975* and *National Parks Act 1975*; Research Permit 10009193 and 10008653 administered by DELWP.

One of the permit conditions requires that all flora and fauna data collected during the surveys are submitted to the VBA and the Atlas of Victorian Wildlife database (which is also a condition of the data-sharing agreement between R8 and DELWP).

In addition, R8 has an operating Animal Ethics Committee (AEC). Approval to undertake the proposed survey methods was obtained from the R8 AEC prior to the commencement of field studies.

3.6 Nomenclature

3.6.1 Flora species

Unless otherwise noted, common and scientific names for flora follow the VBA database (Version 3.2.5).

Flora conservation status was determined in accordance with the Commonwealth EPBC Act, the Victorian FFG Act, and the *Advisory List of Rare or Threatened Plants in Victoria* – 2014 (DEPI, 2014).

3.6.2 Native vegetation

Native vegetation is defined in the Victoria Planning Provisions as 'plants that are indigenous to Victoria, including trees, shrubs, herbs and grasses'. For the purpose of the *Guidelines for the removal, destruction or lopping of native vegetation* (DELWP 2017a), native vegetation is classified into two categories: a **Patch** of vegetation or a **Scattered Tree**:

A **patch** of native vegetation is either:

- An area of native vegetation where at least 25% of the total perennial understorey plant cover⁶ is native.
- Any area with three or more native canopy trees⁷ where the drip line⁸ of each tree touches the drip line of at least one other tree, forming a continuous canopy.
- Any mapped wetland included in the Current wetlands map.

A **scattered tree** is a native canopy tree that does not form part of a patch.

Other forms of vegetation include:

Planted native vegetation, i.e. includes non-indigenous native species and areas of revegetation.

⁶ Plant cover is the proportion of the ground cover that is shaded by vegetation foliage when lit directly from above. Areas that include non-vascular vegetation (such as mosses and lichens) but otherwise support no native vegetation are not considered to be patch for the purpose of the Guidelines. However, when non-vascular vegetation is present with vascular vegetation, it does contribute to the cover when determining the percentage of perennial understorey plant cover.

⁷ A native canopy tree is a mature tree (i.e. it is able to flower) that is greater than 3 metres in height and is normally found in the upper layer of the relevant vegetation type.

⁸ The drip line is the outer most boundary of a tree canopy (leaves and/or branches) where the water drips on to the ground.

Scattered native plants, i.e. patches of vegetation dominated by introduced species where less than 25% of the total perennial understorey plant cover is native.

Non-native vegetation, i.e. vegetation that comprises entirely introduced flora species.

3.6.3 Vegetation communities

Native vegetation in Victoria is mapped in units known as Ecological Vegetation Classes (EVCs). EVCs are described according to a combination of floristic, life form and ecological characteristics, and through an inferred fidelity to particular environmental attributes. Each EVC occurs under a common regime of ecological processes within a given biogeographic range and may contain multiple floristic communities.

Other vegetation types that may occur in Victoria include flora communities listed as threatened under the EPBC Act and/or the FFG Act. These have separate vegetation classification systems, each of which is also separate to the EVC classification system. As such, any single patch of native vegetation occurring in the project area (or anywhere in Victoria) will be classifiable as a particular EVC, and may also be separately classified as a different ecological community under the EPBC Act and/or as another vegetation community under the FFG Act.

3.6.4 Tree Protection Zones

In addition to the native vegetation patches, there may be trees present that whilst being situated outside of the construction areas, could be impacted indirectly through encroachment of their Tree Protection Zones (TPZs). When determining whether construction and earthworks near scattered trees, and patches of vegetation containing trees, would result in the loss of the tree, the *Australian Standard AS 4970-2009 – Protection of trees on development sites* is considered (Standards Australia, 2009). This standard specifies Tree Protection Zones⁹ (TPZs) and Structural Root Zones (SRZs) that should be protected. Where encroachment into the TPZ (above or below ground) is greater than 10 percent, or is inside the SRZ, then the tree is assumed lost (DELWP, 2017b).

Note: The TPZs of a tree were calculated by recording the diameter at breast height (DBH) of a tree at 1.3 m above ground level (under the Guidelines).

3.6.5 Fauna species and communities

Unless otherwise noted, common and scientific names for fauna follow the VBA database (Version 3.2.5).

Fauna conservation status was determined in accordance with the Commonwealth EPBC Act, the Victorian FFG Act, the *Advisory List of Threatened Vertebrate Fauna in Victoria* (DSE, 2013) and the *Advisory List of Threatened Invertebrate Fauna in Victoria* (DSE 2009).

The FFG Act lists a number of threatened fauna communities, at a national or state scale, respectively. Fauna communities known or potentially occurring within the project area are only considered if they are listed under this Acts

3.6.6 Weeds

The *Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants*, is a listed key threatening process under the EPBC Act. In addition, *Invasion of native vegetation by 'environmental weeds'*, is a listed potentially threatening process under the FFG Act.

During the field surveys, a list of all flora observed within the area of investigation was created. This includes environmental weeds, noxious weeds listed under the CaLP and Weeds of National Significance (WoNS). All such weed species are listed in Appendix K.

⁹ A Tree Protection Zone is an area around the trunk of the tree which has a radius of 12 x the diameter at breast height to a maximum of 15 metres but no less than 2 metres (DSE 2010).

4. Native Vegetation

4.1 Introduction

A summary of the Ecological Vegetation Classes (EVCs) present within the construction footprint and the inundation area in Gunbower National Park is shown below in Table 4-1. Water Regime Classes as defined in previous hydrological studies (Ecological Associates 2014) and their associated EVCs are shown below and in Figure 4-1.

Table 4-1 Ecological Vegetation Classes (EVCs) within the construction footprint and inundation area in the project area

Water Regime Class	Ecological Vegetation Class	Construction footprint (ha)	Inundation Area (ha)
Scroll Bar and Riparian Billabong	Floodplain Riparian Woodland (EVC 56)	0.22	
	Billabong Wetland Aggregate (EVC 334)		12.84
Seasonal Wetlands	Drainage Line Aggregate (EVC 168)		9.17
	Grassy Riverine Forest - Riverine Swamp Forest (EVC 812)		85.95
	Riverine Swampy Woodland (EVC 815)		10.77
	Tall Marsh (EVC 821)	0.06	12.58
	Riverine Swamp Forest - Floodway Pond Herbland (EVC 954)		1.26
	Sedgy Riverine Forest - Tall Marsh Complex (EVC 1071)		78.10
Red Gum Forest and Woodlands	Grassy Riverine Forest (EVC 106)	0.19	56.75
	Riverine Grassy Woodland (EVC 295)	0.17	
	Riverine Swamp Forest (EVC 814)	0.73	5.95
	Riverine Swampy Woodland (EVC 815)	7.62	316.37
	Sedgy Riverine Forest (EVC 816)	2.37	3.94
Flood-dependent Woodlands	Riverine Chenopod Woodland (EVC 103) *	4.04	92.69
	Lignum Swampy Woodland (EVC 823) ^		8.92
Terrestrial Box Woodlands	Plains Woodland (EVC 803)	4.19	0.98
NA	No EVC Mapping		7.84
Total		19.57	704.11

* Categorised as 'Box Woodland' in Bennetts 2014 mapping, this EVC has been assigned to flood-dependent woodlands to fit with the Water Regime Classes provided in Ecological Associates (2014). Though categorised as flood-dependent by Ecological Associates (2014) this EVC is considered 'flood tolerant'

^ Categorised as 'Red Gum Forest and Woodlands' in Bennetts 2014 mapping, this EVC has been assigned to Flood-dependent Woodlands to fit with the Water Regime Classes provided in Ecological Associates (2014).

The native vegetation communities associated with the wetland forest systems of the Murray River are both cryptic and dynamic, having evolved to persist along the riparian corridor, increasingly oscillating between flood and drought conditions in a general landscape recognised for its low rainfall and high evapotranspiration. While River Red Gum (and in some areas Black Box) provides a relatively consistent canopy over the treed vegetation communities (EVCs) throughout the forests, there is an enormous change in the species make up and quality of sub-canopy elements in response to the availability of flood input and exposure to drought conditions.

The frequency and volume of flood penetration into the forest system is the basic ecological driver of the wetland forest ecology, with river volumes of 25,000ML/d at Torrumbarry Weir required to over top the banks as a minimum input (Ecological Associates 2014) for the communities most reliant on flooding. The forests of the riparian zone are on a series of benches, terraces, paleo-channels and paleo-banks associated with river evolution over the millennia, with each landscape unit being of a unique elevation range providing specific exposure to flood events and housing a responding vegetation community. There is a continuum of flood requirement, from the 'true' wetland EVCs (obligate) which generally require flooding on a near annual basis at the lower elevations, through to the flood 'tolerant' terrestrial EVC on the upper/outer terraces of the alluvial system which require large flooding events that submerge the entire system at around the 50,000 ML/d flow rate at Torrumbarry Weir (Ecological Associates 2014), that drive canopy tree recruitment. Disconnected wetlands within the forest require these large flood events to fill and if flows exceed 50,000 ML/d for more than one month then higher-level terrestrial woodlands experience inundation.

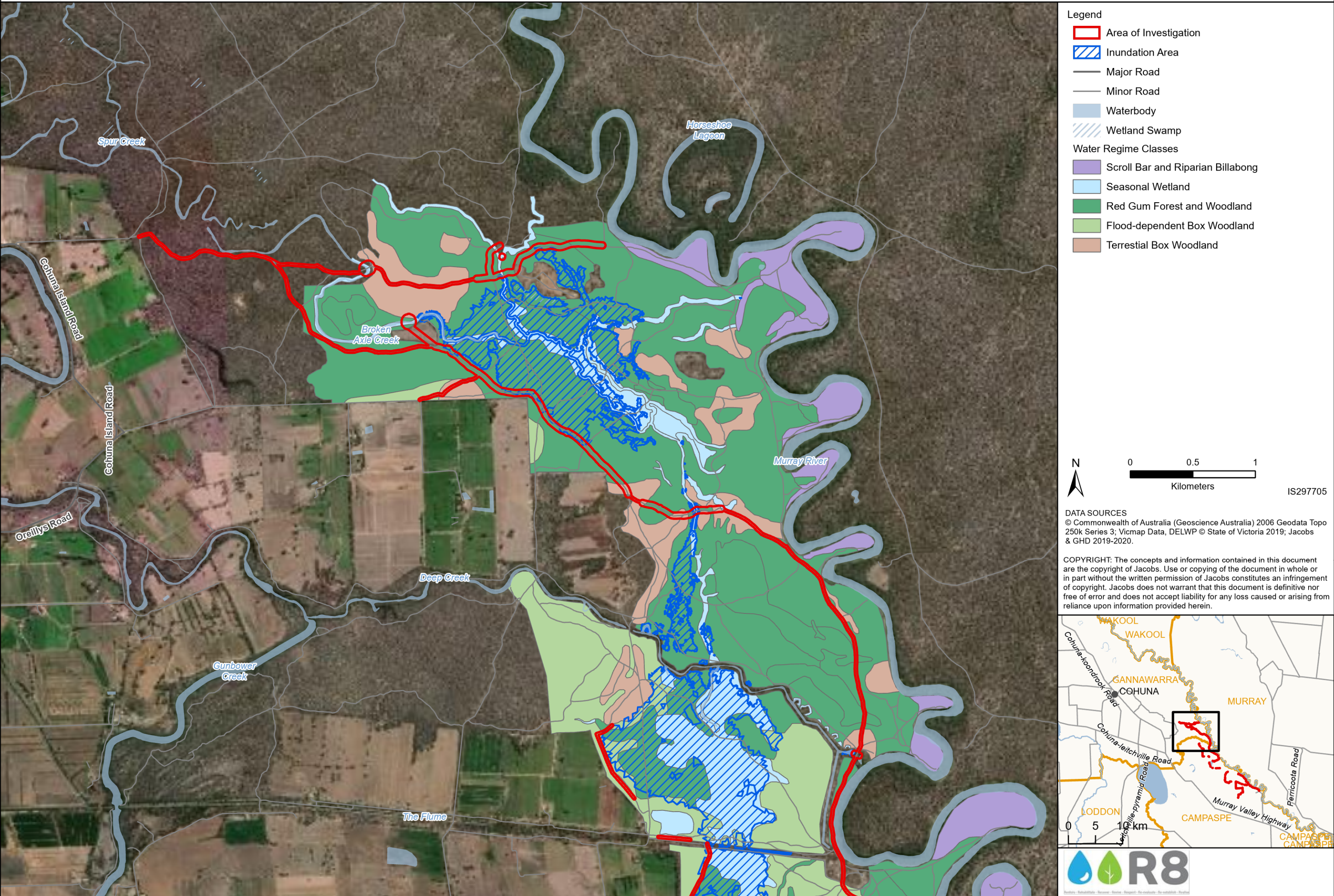
The frequency of inundation events of the various geomorphic elements of the riparian forest system is directly related to the flood volume available for over bank flows. Historical hydrological data (Gippel 2014), lidar and satellite imagery data have been combined with EVCs present in Gunbower National Park to determine respective flooding frequencies. Ecological Associates (2014) has compared the suggested inundation requirement of the EVCs present in the Gunbower National Park (Table 4-2).

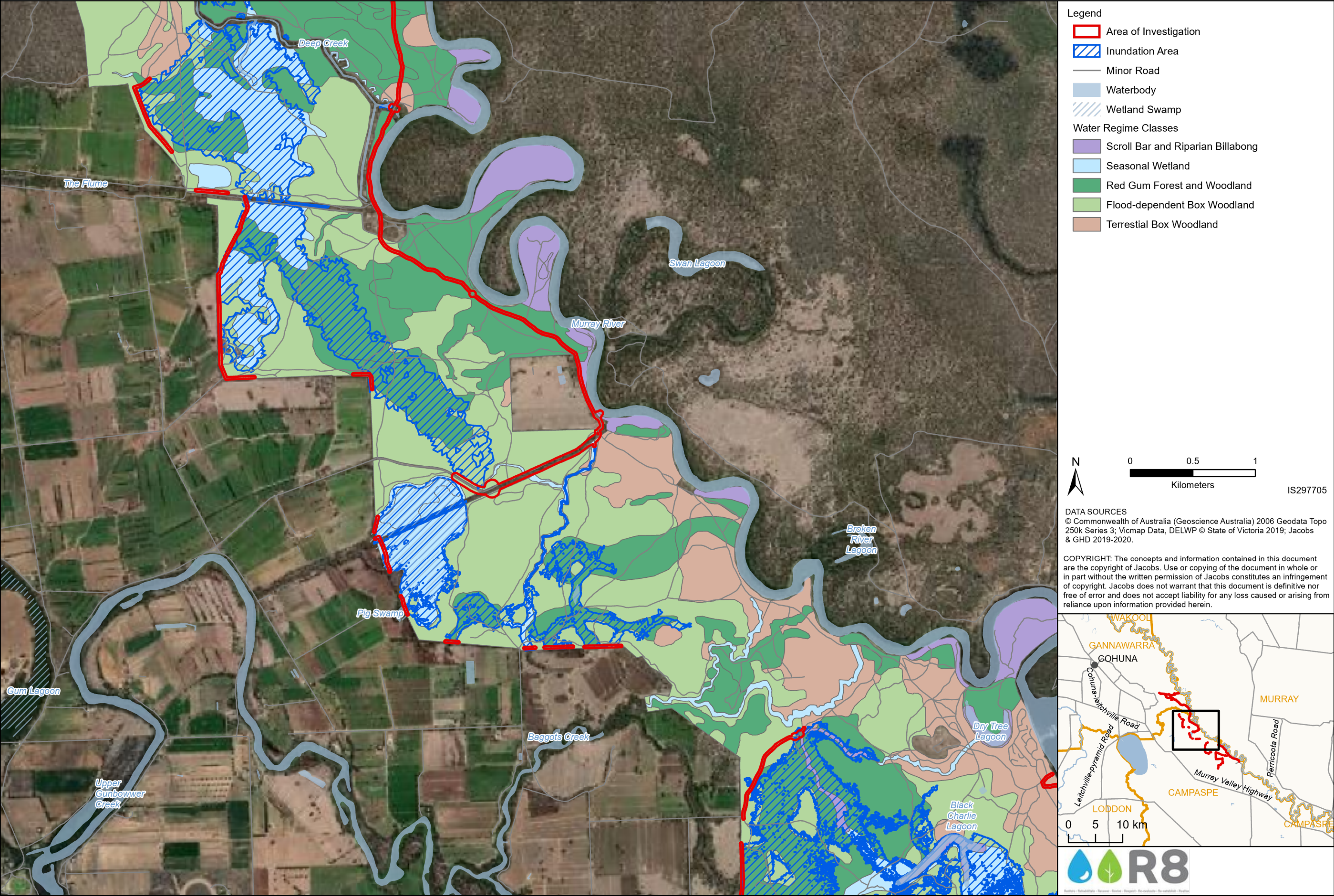
Table 4-2 Suggested flood frequencies for the relevant EVCs of the Gunbower National Park (Ecological Associates 2014).

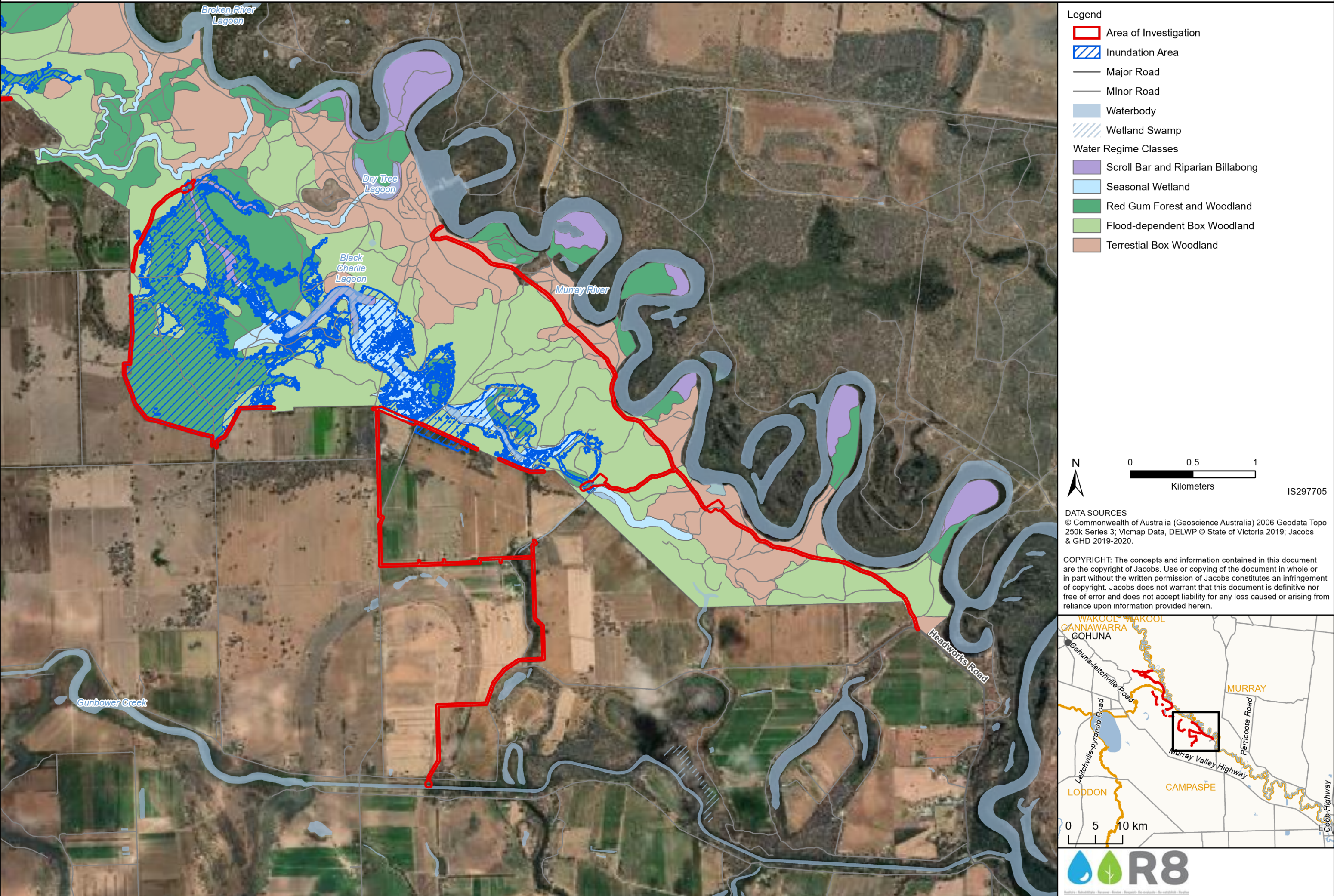
Water Regime Class	Ecological Vegetation Class	Suggested flood frequencies (Ecological Associates 2014)
Scroll Bars and Riparian Billabongs	Floodplain Riparian Woodland (EVC 56) Billabong Wetland Aggregate (EVC 334)	Inundating scroll bars for 3 to 4 months in spring and early summer in 9 out of 10 years
Seasonal Swamps	Drainage Line Aggregate (EVC 168)	Inundating seasonal wetlands for 1 to 4 months for 5 to 7.5 out of 10 years
	Grassy Riverine Forest – Riverine Swamp Forest (EVC 812)	
	Riverine Swampy Woodland (EVC 815)	
	Tall Marsh (EVC 821)	
	Riverine Swamp Forest – Floodway Pond Herbland (EVC 954)	
	Sedgy Riverine Forest / Tall Marsh complex (EVC 1071)	
Red Gum Forest and Woodland	Grassy Riverine Forest (EVC 106)	Flooding for 1 to 3 months in 5 out of 10 years with a maximum interval of 4 years
	Riverine Swamp Forest (EVC 814)	
	Riverine Swampy Woodland (EVC 815)	
	Sedgy Riverine Forest (EVC 816)	
	Riverine Chenopod Woodland (EVC 103)*	

Flood-dependent Box Woodlands	Lignum Swampy Woodland (EVC 823)	Inundation for 2 months in 2.5 out of 10 years with a maximum interval between events of 5 years
Terrestrial Box Woodlands	Plains Woodland (EVC 803)	Flooding represents an intermittent disturbance and is not an ecological requirement

* Categorised as 'Box Woodland' in Bennetts 2014 mapping, this EVC has been assigned to flood-dependent woodlands to fit with the Water Regime Classes provided in Ecological Associates (2014). Though categorised as flood-dependent by Ecological Associates (2014) this EVC is considered 'flood tolerant'.







4.2 Ecological Vegetation Classes (EVCs)

A total of seven EVCs were identified during the field assessment (2019), with a further two previously mapped as occurring within the construction footprint. Given the cryptic and dynamic nature of these communities, there is a large degree of structural diversity evident over relatively short time periods, resulting in some conjecture over the specific EVCs present. Depending on the flood – drought cycle, an assessor may experience an open semi-arid forest system or a swamp. The vegetation of the Gunbower Forests have been mapped several times in the past 10 years with minor, yet understandable discrepancies in relation to the vegetation recorded. Discrepancies also relate to the purpose and intent of mapping, with some programs focussing on the entire forest system and others on specific impact areas.

Recent vegetation (EVC) mapping (Bennetts 2014a) set out to delineate terrestrial woodland from flood-tolerant woodland in both Black Box and Grey Box vegetation. This mapping has been used in this report for assessment of EVCs present at Middle Gunbower (downstream of Deep Creek) where field assessment has yet to be completed. Where field assessment has not been completed for Camerons Creek pump station and pipeline in Upper Gunbower, a combination of aerial imagery and DELWP 2005 EVC mapping was used to calculate native vegetation extents. This will be refined during field survey in spring 2020.

4.2.1 EVC 56: Floodplain Riparian Woodland

Floodplain Riparian Woodland consists of an open eucalypt woodland or open forest to 20 m tall over a medium to tall shrub layer with a ground layer consisting of amphibious and aquatic herbs and sedges. It occurs along the banks and floodplains of the larger meandering rivers and major creeks, often in conjunction with one or more floodplain wetland communities. Within the Gunbower Forest, Floodplain Riparian Woodland (EVC 56) occurs along the banks and associated immediate floodplain of the Murray River (see Figure 4-2).

Floodplain Riparian Woodland in the project area consisted of a River Red Gum (*Eucalyptus camaldulensis*) canopy with a shrub layer consisting of Pale-fruit Ballart (*Exocarpus strictus*) and Weeping Pittosporum (*Pittosporum angustifolium*). A sparse ground layer that is disturbed from activities adjacent to the river supported limited herbs and graminoids, namely Cotton Fireweed (*Senecio quadridentatus*), Tussock Rush (*Juncus aridicola*) and Broad-leaf Cumbungi (*Typha orientalis*) along the river's edge.

This vegetation type is present along the Murray River at Camerons Creek bridge in Upper Gunbower Forest and at the Brereton Pump Station in Middle Gunbower Forest (downstream Deep Creek). At these locations, deep-pooled water providing habitat for fish species occurs within the construction footprint.



Figure 4-2 EVC 56 Floodplain Riparian Woodland occurring along the edge of the Murray River adjacent to Cameron's Creek bridge.

4.2.2 EVC 103: Riverine Chenopod Woodland

Riverine Chenopod Woodland consists of a eucalypt woodland to 15 m tall with a diverse shrubby and grassy understorey occurring on most elevated riverine terraces. It is confined to heavy clay soils on higher level terraces within or on the margins of riverine floodplains (or former floodplains), naturally subject to only extremely infrequent incidental shallow flooding from major events if at all flooded. It is widespread across the Gunbower Forest, particularly occurring along the outer margins of the National Park (Figure 4-3).

This vegetation type contained a Black Box (*Eucalyptus largiflorens*) canopy over a shrub layer consisting of Gold-dust Wattle (*Acacia acinacea*), Black Cotton-bush (*Maireana decalvans*) and Weeping Pittosporum. In wetter areas a shrub layer was dominated by Tangled Lignum (*Duma florulenta*). A diverse understorey of prostate shrubs and chenopods were present including Grey Copperburr (*Sclerolaena diacantha*), Ruby Saltbush (*Enchylaena tomentosa* var. *tomentosa*) and Nodding Saltbush (*Einadia nutans*). Annual herbs, Paper Sunray (*Rhodanthe corymbiflora*) and Pale Beauty-heads (*Calocephalus sonderi*) were common during surveys in spring and in some instances the threatened Long Eryngium (*Eryngium Paludosum*, DELWP Advisory listed vulnerable) was present.



Figure 4-3 Riverine Chenopod Woodland in the vicinity of the Cameron's Mid Creek Regulator, a diverse understorey with a Black Box dominant canopy.

4.2.3 EVC 295: Riverine Grassy Woodland

Riverine Grassy Woodland occurs as a River Red Gum woodland to 20 m tall with a groundlayer dominated by graminoids and sometimes lightly shrubby or with chenopod shrubs. It occurs on the floodplain of major rivers, in a slightly elevated position where floods are rare, on deposited silts and sands, forming fertile alluvial soils.

This vegetation type was only recorded once within the area of investigation, however is expected to occur more extensively within the inundation area where the lowest swamp forest depressions transition to more terrestrial flood-tolerant environments. The canopy of this vegetation type consisted of a canopy of River Red Gum with some adjacent Black Box and Grey Box (*Eucalyptus microcarpa*) over a sparse shrub layer of Wingless Bluebush (*Maireana enchylaenoides*) and Nodding Saltbush (*Einadia nutans*). A higher cover of grasses including Rough Spear-grass (*Austrostipa scabra*) and Common Wallaby-grass (*Rytidosperma caespitosum*) and herbs Golden Everlasting (*Xerochrysum bracteatum*) and River Bluebell (*Wahlenbergia fluminalis*) than surrounding vegetation types was present.

4.2.4 EVC 803: Plains Woodland

This vegetation class is defined as a grassy or sedgy woodland to 15 m tall with a sparse understorey supporting a range of annual or geophytic herbs adapted to low summer rainfall. It occurs on terrain of low relief with fertile, alluvial soils. Within Gunbower National Park, Plains Woodland (EVC 803) is characteristic of the higher elevation sites along the floodplain, supporting a primarily terrestrial plant community (Figure 4-4).

Plains Woodland contained a canopy dominated by Grey Box (*Eucalyptus microcarpa*) with some Black Box also present. A shrub layer was made up of Weeping Pittosporum and Gold-dust Wattle over a chenopod layer of Short-leaf Bluebush (*Maireana brevifolia*), Nodding Saltbush (*Einadia nutans*) and Grey Copperburr. The understorey consisted of a sparse cover of tussock grass including Common Wallaby-grass and Feather Spear-grass (*Austrostipa elegantissima*) and supported a diverse herb layer of spring flowering Golden Everlasting and River Bluebell and Fuzzy New Holland Daisy (*Vittadinia cuneata* subsp. *cuneata*).

In areas with less disturbance, Plains Woodland (EVC 803) was a general indicator for the presence of the EPBC Act listed Grey Box (*Eucalyptus microcarpa*) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia threatened community, see section 4.4.1 for more details.



Figure 4-4 Plains Woodland (EVC 803) present around Cameron's Creek bridge with a Grey Box dominant canopy

4.2.5 EVC 814: Riverine Swamp Forest

Riverine Swamp Forest is an open Eucalypt forest with an understorey composed of obligate wetland species (or opportunistic annuals in prolonged dry periods) ranging from closed sedgeland or herbland to grassy-herbaceous or extremely sparse with a cover of primarily leaf-litter (Figure 4-5). Riverine Swamp Forest occupies low lying areas exposed to regular flooding on the lower terraces and adjacent to floodways and ponds within riverine forests.

Within Gunbower National Park most areas of Riverine Swamp Forest were in a dry phase, with little or no understorey apparent. The canopy consisted entirely of River Red Gum over an almost absent shrub layer typical of this EVC. Ground layer species included Variable Sida (*Sida corrugata*), Common Cotula (*Cotula australis*) and rushes (*Juncus* sp.). Very little of the Riverine Swamp Forest EVC was intact at the time of assessment, with large areas of forest appearing to have been inundated likely corresponding to the 2016 flood

event, however, without subsequent flooding the associate obligate wetland species are currently rare in the patches identified.

In some instances, there was invasion of terrestrial prostrate shrubs and weeds indicating an absence of natural flooding in the system.



Figure 4-5 Area of Riverine Swamp Forest, lacking the obligate wetland groundcover, but showing the heavy leaf litter cover that characterises this EVC during dry periods.

4.2.6 EVC 816: Sedgy Riverine Forest

Sedgy Riverine Forest is an open Eucalypt forest to 25 m tall with a sedge dominated understorey dependant on occasional shallow flooding on heavy soils usually saturated in winter. It is considered to occupy areas infrequently flooded and in which flood duration may be short, for example, higher ground surrounding the box ridges or occurring along the levee in a position remote from the channels from which the forest first floods. These areas are therefore the last to flood and the first from which floods quickly recede. Soils are typically heavy clays. The major understorey species Poong'ort (*Carex tereticaulis*) is intolerant of total immersion.

This vegetation type consisted of a canopy of River Red Gum with some adjacent Black Box over a tree and shrub layer of Pale-fruit Ballart (*Exocarpos strictus*). Away from the main channel of Cameron's Creek, this vegetation type was in a poor, dry condition with little understorey species persisting except for *Carex tereticaulis* (Figure 4-6). In areas engaged by suitable inundation a high ground layer diversity was observed (Figure 4-7), including Common Swamp Wallaby-grass (*Amphibromus nervosus*), Common Spike-sedge (*Eleocharis acuta*), and a range of herbs including Common Nardoo (*Marsilea drummondii*), Slender Goodenia (*Goodenia gracilis*), Poison Pratia (*Lobelia concolor*) and River Bluebell.



Figure 4-6 Sedgy Riverine Forest under dry conditions with a high leaf litter cover and only the *Carex* sedge element of the understorey persisting



Figure 4-7 Sedgy Riverine Forest experiencing a suitable inundation regime along Cameron's Creek with a high cover of *Carex* sedge amongst a high diversity of other graminoids and herbs.

4.2.7 EVC 821: Tall Marsh

Wetland dominated by tall emergent graminoids (rushes, sedges, reeds), typically in thick species-poor swards. Occupies wetlands usually associated with anabranch creeks. Soils are almost permanently moist. Dominant species are tolerant of relatively deep and sustained inundation, but not total immersion for any sustained period. Tall rushes and reeds, Broadleaf Cumbungi (*Typha orientalis*) and Native reed (*Juncus amabilis*) were dominant over Ferny Azolla (*Azolla pinnata*).

Tall Marsh was identified occurring primarily along artificial channels bordering the forest on private property providing water to farmland (see Figure 4-8). It was also mapped as occurring along Cameron's Creek near the Mid Creek regulator.



Figure 4-8 EVC 821 Tall Marsh within the area of investigation occurring along the levee bank on the outer edge of the Middle Gunbower Forest

4.2.8 Mapped EVCs

The following EVCs were not identified in the construction footprint however have been mapped as occurring in the inundation area (Bennetts 2014a):

- Drainage Line Aggregate (EVC 168)
- Billabong Wetland Aggregate (EVC 334)
- Grassy Riverine Forest - Riverine Swamp Forest (EVC 812)
- Riverine Swampy Woodland (EVC 815)
- Lignum Swampy Woodland (EVC 823)
- Riverine Swamp Forest - Floodway Pond Herbland (EVC 954)
- Sedgy Riverine Forest - Tall Marsh Complex (EVC 1071)

4.3 Large Trees

Large trees, previously referred to as Large Old Trees (LOTs) are prescribed in the Benchmark relevant to each treed EVC assessed (e.g. DSE, 2007) and are protected under legislation (DEWLP, 2018). Large trees are 40 (Black Box) – 90 cm DBH (River Red Gum) for the treed EVCs assessed throughout the forest. Within the Gunbower National Park there are a disproportionate number of large trees mapped specifically in the area of investigation, most aligned in a linear fashion and directly associated with the existing constructed levee network, particularly that associated with the initial water storage facility developed in the late 19th century. It is likely that a mass recruitment event occurred following the development of the levee and an early fill of this system and this has resulted in the high density of large trees recorded on the levees. It is possible that growing on the raised material sitting above the natural soil environment may have resulted in a faster growth rate than nearby individuals on the natural soil horizon.

A total of 58 large trees were identified and mapped within the construction footprint. However, no large tree mapping was completed for Middle Gunbower (downstream of Deep Creek) or in areas associated with the Camerons Creek pump station and pipeline because these were not included in the area of investigation that was surveyed in October 2019 (refer to section 3.2).

Each large tree identified during the field assessment was given a unique Tree Number ID and the location, tree species and Diameter at Breast Height (DBH) were all recorded (see Appendix L).

4.4 Threatened Communities

4.4.1 EPBC-listed threatened ecological communities

The PMST identified six threatened ecological communities (TECs) with potential to occur within the study area (Table 4-3).

One of these TECs, Grey Box (*Eucalyptus microcarpa*) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia is consistent with vegetation mapped or modelled within either the construction footprint or inundation area. This community has been identified in previous assessments (North Central CMA 2012b, Bennetts 2014a, Biosis 2014a, GHD 2017) and confirmed to be present during the R8 field assessment within the Upper Gunbower Forest and Middle Gunbower Forest (upstream of Deep Creek) work areas. Field assessment is required of the Middle Gunbower Forest (downstream of Deep Creek) and Camerons Creek pump station and pipeline in Upper Gunbower to confirm the presence and extent of the community within that work area.

The Grey Box (*Eucalyptus microcarpa*) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia TEC is primarily present across Gunbower National Park in Terrestrial Box Woodland Water Regime Class (Figure 4-1). It occurs in continuous areas of woodland primarily on the upper terraces adjacent to the Murray River. The TEC present within the project area often occurs alongside existing tracks and areas of disturbance from visitation within the National Park. Understanding the extent of the threatened community within the Gunbower National Park has been a focus of previous assessments undertaken for the project (North Central CMA 2012b, Bennetts 2014a, Seran BL&A 2018). Further discussion on the landscape context and impacts on this threatened community are below and in section 7.1.

Table 4-3 Threatened ecological communities with potential to occur within the project area.

Threatened Ecological Community	Conservation Status	Likelihood of Occurrence
Buloke Woodlands of the Riverina and Murray-Darling Depression Bioregions	Endangered	Not Present. Not detected in 2019 and no matching vegetation communities identified in previous assessments. Not associated with the alluvial environment (Cheal et al. 2011).
Grey Box (<i>Eucalyptus microcarpa</i>) Grassy	Endangered	Present. Identified during 2019 field assessment in Upper Gunbower at Cameron's Creek Bridge and along River Track,

Woodlands and Derived Native Grasslands of South-eastern Australia		and Middle Gunbower (upstream of Deep Creek) adjacent to the Brereton Pump Station. It is also expected to occur in areas mapped as Plains Woodland (EVC 803) in Middle Gunbower (downstream of Deep Creek, Bennetts 2014). A total of 4.18 ha of this community was identified in the construction footprint (2.50 ha confirmed during field assessment and 1.68 ha predicted to occur based on EVC mapping).
Natural Grasslands of the Murray Valley Plains	Critically Endangered	Not Present. Not detected in 2019 and no matching vegetation communities identified in previous assessments. This community is more closely associated with the plain's environment to the south of the riparian corridor where it has been depleted by agriculture (TSSC 2012).
Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains	Critically Endangered	Not Present. Not detected in 2019 as all wetland vegetation communities present within the area of investigation contain a dominant tree canopy, such as Riverine Swamp Forest (EVC 814) or Sedgy Riverine Forest (EVC 816) or are semi-permanent wetlands consisting of Tall Marsh (EVC 821).
Weeping Myall Woodlands	Endangered	Not Present. Not detected in 2019 and no matching vegetation communities identified in previous assessments. These are not part of the riparian environment and listing advise states they are 'rarely, if ever flooded' (DEWHA 2009).
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Critically Endangered	Not Present. Not detected in 2019 and no matching vegetation communities identified in previous assessments. Occurs on lower slopes above 170 m (TSSC 2006).

Grey Box (*Eucalyptus microcarpa*) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia

The EPBC Act listed Grey Box (*Eucalyptus microcarpa*) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia TEC (Grey Box Grassy Woodland community) was once widespread across the drier edge of the temperate grassy eucalypt woodland belt across south-eastern Australia, but now only 10-15% of its original extent remains. The ecological community has suffered extensive clearing in the past for agriculture and pastoral purposes.

Grey Box Grassy Woodland community was confirmed to be present in Upper Gunbower and Middle Gunbower (upstream of Deep Creek). This threatened community was identified as being relatively synonymous with Plains Woodland (EVC 803) occurring on the drier, freely drained areas of the floodplain in these works areas. Modelled mapping of EVC distribution within the Middle Gunbower Forest (downstream of Deep Creek), indicates that the Plains Woodland EVC is likely to be present. However, Grey Box woodlands occurring on the lower floodplain have been previously assessed as supporting a different understorey of water-dependent species and more closely resemble Riverine Swampy Woodland (EVC 815) (Bennetts 2014a). A field assessment ideally during Spring is required to confirm the presence and extent of the threatened ecological community within that works area.

A total of 4.18 ha of this community is present or predicted to occur based on EVC mapping (Bennetts 2014a) within the construction footprint. 2.50 ha has been confirmed to be present in Upper and Middle Gunbower (upstream of Deep Creek) and based on EVC mapping a further 1.68 ha is considered likely to be present in areas that have not yet been surveyed. The locations are shown in Appendix M and impacts to this threatened community is discussed in Section 7.1



Figure 4-9 EPBC Act listed Grey Box Grassy Woodland threatened ecological community

4.4.2 FFG-listed threatened communities

No FFG-listed vegetation communities were identified during the field assessment or have been considered to be present in previous assessments within the Gunbower Forest project area.

One FFG-listed vegetation community, Grey Box – Buloke Grassy Woodland Community has the potential to occur within the Grey Box woodland present in the Gunbower National Park project area. This community was not determined to be present, as there was an insufficient number and density of Buloke occurring within Grey Box Woodlands and the ground layer was dominated by plants from the *Maireana* and *Chenopodium* genus instead of native grasses.

Two FFG-listed fauna communities are considered as being present within the project area:

- Lowland Riverine Fish Community of the Southern Murray-Darling Basin (LRFC)
- Victorian Temperate Woodland Bird Community (VTWBC)

These fauna communities are assessed in Section 7.3.3.

4.4.3 NSW BC-listed endangered ecological communities

One NSW BC-listed endangered ecological community is considered as being present within the project area:

- Lower Murray River Aquatic Ecological Community

This fauna community is assessed in Section 7.3.3.

4.5 Wetlands

4.5.1 Wetlands of international significance

The EPBC PMST output highlighted two Ramsar Wetlands of international significance within the study area: Gunbower Forest and NSW Central Murray State Forests. An additional four Ramsar Wetlands were identified 200-500 km downstream of the Gunbower National Park project area (Hattah-Kulkyne Lakes, Riverland, Banrock Station Wetland Complex and the Coorong, and Lakes Alexandrina and Albert).

Of the highlighted Ramsar wetlands, the most relevant is the Gunbower Forest, which the project area occurs within, see Figure 4-10 below. The NSW Central Murray Forests Ramsar Wetland which occurs across the Murray River from the Gunbower National Park is considered discrete from the Gunbower project area and more specifically the construction footprint. Impacts to Ramsar Wetlands from construction and operation of the project are discussed in section 7.4.

4.5.2 DELWP mapped wetlands

Four DELWP mapped wetlands occur within the Gunbower National Park project area (Table 4-4). Impacts to DELWP mapped wetlands require assessment in relation to EES triggers. Also, if in poor condition, DELWP condition scores can be used for vegetation assessment. Given that one of the aims of the project is to restore wetland health, impacts need to be carefully considered in relation to referral triggers. Impacts are generally considered to be vegetation removal to allow works to restore wetland hydrology. In addition, Gunbower Island (20,218 ha DEPI 2013) is considered a nationally important wetland listed on the Directory of Important Wetlands in Australia and is shown in Figure 4-10 below.

Figure 4-10 Gunbower Forest Ramsar Site and Gunbower Island Location

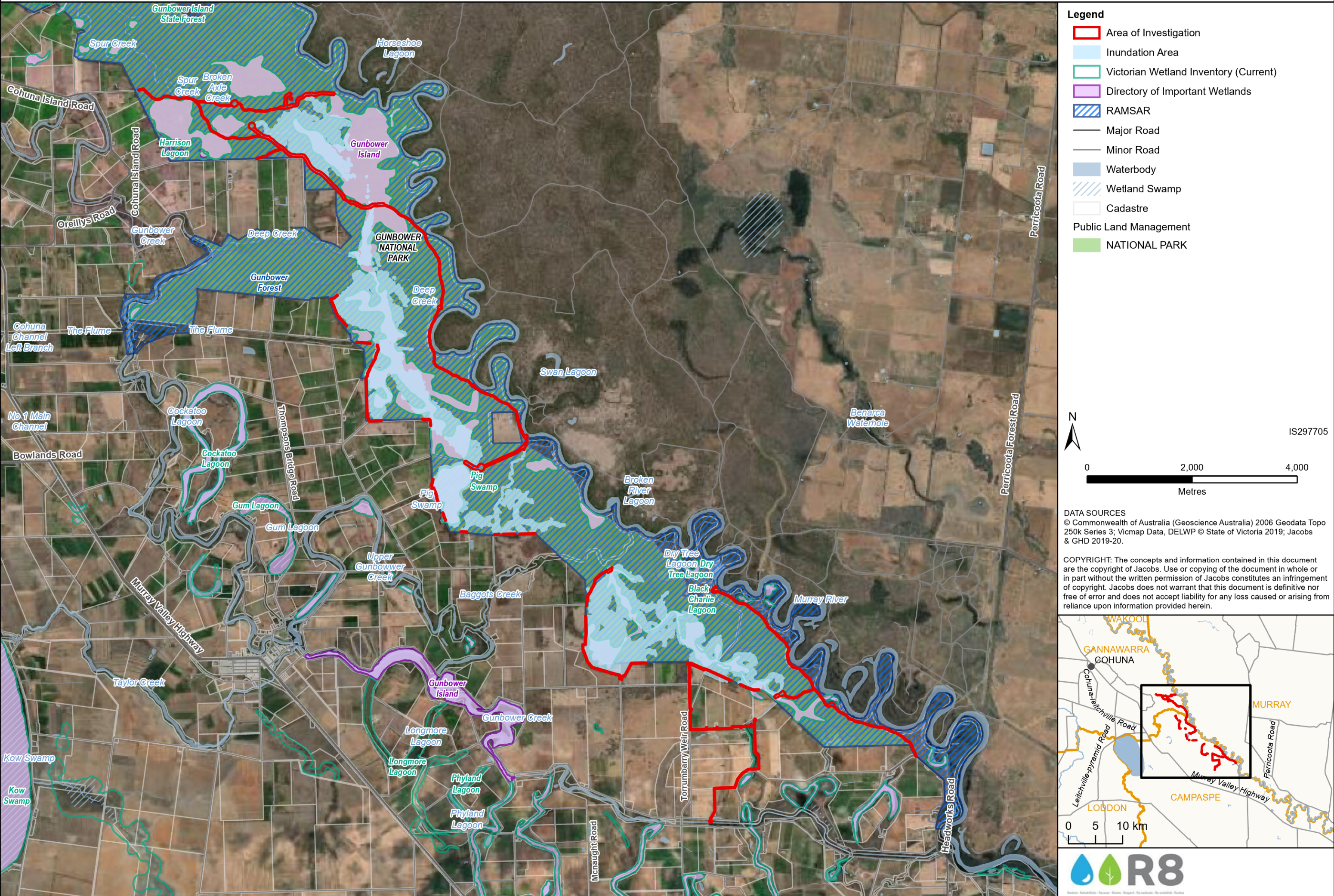


Table 4-4 DELWP Mapped Wetlands (DELWP, 2020a)

Wetland ID	Name	Type and Comment	Area (Ha)
45364	Gunbower Island	Temporary freshwater swamps and associated marshes and meadows periodically inundated directly from the Murray River and broadly follows Camerons Creek and associated floodplain.	33.09
45376	Gunbower Island	Temporary freshwater swamps periodically inundated directly from Camerons Creek and associated floodplain flows to Black Charlie Lagoon	50.01
45353	Gunbower Island	Temporary freshwater swamps periodically inundated episodically from Baggot's Creek and overflow floodplain in Upper Gunbower	52.21
45339	Gunbower Island	Temporary freshwater swamps periodically inundated episodically in Middle Gunbower (upstream and downstream of Deep Creek)	460.93