

Victorian Murray Floodplain Restoration Project

Flora and Fauna Assessment - Guttrum and Benwell Forests Floodplain Restoration Project

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Lower Murray Water





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Executive Summary

Project understanding and project area

The Guttrum and Benwell Forests 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 facilitate environmental watering and inundate 1,149 ha of the Guttrum and Benwell Forests. This will increase the extent and condition of habitat for common indigenous and threatened aquatic and floodplain fauna, including waterbirds, fish, frogs, turtles and terrestrial species reliant on floodplain habitats, such as woodland birds, bats, small/medium mammals and reptiles. The project will enable environmental water to be delivered, which will be of particular benefit during long dry periods and under current climate change scenarios. Construction of infrastructure and modification of existing infrastructure is required for the project to divert, retain, release and control environmental water (Ecological Associates 2013). The works associated with the Project are located across the Guttrum and Benwell Forests. Ecological survey information is required for the proposed construction footprint at the locations and also for the inundation area, to assist with the planning approvals process for the project.

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 rare or threatened 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), which involves summarising previous ecological assessment reports prepared for the project area (Ecological Associates 2013, Biosis 2014a, Biosis 2014b, North Central CMA 2014a, North Central CMA 2014b, North Central CMA 2014c, GHD 2017) as well as outlining the results of the most recent assessments undertaken by R8 in October to December 2019 (native vegetation assessment and targeted surveys for rare and threatened species within the construction footprint).

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 undertaken and mitigation measures proposed.

Efforts have been made to avoid and minimise impacts to native vegetation wherever practicable throughout the project planning and design process. Despite the measures taken to avoid and minimise impacts to native vegetation it is not feasible to construct the required infrastructure without removing some native vegetation. Native vegetation was identified within the construction footprint that has the potential to be impacted by the proposed works. In total, 13.70 ha of native vegetation comprising five different Ecological Vegetation Classes (EVCs) was identified within the construction footprint, including 219 Large Trees. 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. Vegetation loss in these areas is to be confirmed, but has been included conservatively as impacted by the proposed works. The 13.70 ha of native vegetation also does not include native vegetation clearance associated with power supply and levee works which are subject to further risk assessment. If levee works are required, this would involve works along approximately 1.5 - 3 kilometres of existing, previously disturbed, levee banks.

No Threatened Ecological Communities (TEC) listed under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) modelled with the potential to occur were identified during the field assessment or are consistent with vegetation mapped within either the construction footprint or inundation area.

Desktop assessment highlighted a total of 20 flora and 60 fauna state and federal conservation listed species as having the potential to occur in the project area based on modelled EPBC Protected Matters Search Tool (PMST) results, Victorian Biodiversity Atlas (VBA) records within the broader study area, i.e. 10km buffer on the project area, and previous assessments completed.

No EPBC Act listed flora species were identified within the construction footprint dung the current survey, although one species (River Swamp Wallaby-grass, Vulnerable) has previously been recorded in swampy areas in the inundation area outside of the construction footprint. Another species (Winged Peppercress, Endangered), although not recorded in current or previous surveys, has the potential to occur in areas of the upper terrace of Guttrum and Benwell forests and may respond positively to flooding events. Both 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:

- Five flora species considered rare or threatened in Victoria (DELWP advisory)
- One flora species listed as protected under the FFG Act

No EPBC Act listed fauna species were identified within the project area, although an assessment of the likelihood of occurrence identified the following listed fauna species/communities as having the potential to occur:

- Eight (8) EPBC Act listed fauna species
- Eleven (11) EPBC Act Migratory species
- Forty-nine (49) 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)

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.

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 approvals 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 for a determination under the *Environment Effects Act 1978* (EE Act) as to whether an Environment Effects Statement, is being developed for the project. This 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.



- It is considered unlikely that the project will result in a significant impact to any Matter of National Environmental Significance (MNES) listed under the EPBC Act. However, a referral is to be submitted to the Department of Agriculture, Water and the Environment (DAWE) to provide VMFRP with certainty as to their obligations under the EPBC Act.
- Planning approval to remove native vegetation under the 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:

- Refine the construction footprint utilising the existing ecological values mapping (Appendix A) to avoid and minimise impacts to native vegetation and threatened flora/fauna and communities within the construction footprint.
- Complete additional field survey in spring 2020, including targeted threatened species surveys and Large Tree mapping for the construction footprint in Benwell Forest around the South-west regulator and Outlet 2 (approximately 700 m length) as design changes occurred following the completion of field survey in 2019.
- Targeted surveys recommended for FFG Act listed Brown Toadlet in seasonally inundated areas of riparian forest present in the construction footprint in Autumn (April-May) 2021 to identify whether the species is present and to update avoidance and mitigation measures to address impacts to this species.
- Additional targeted surveys for EPBC Act and FFG Act species may be required to support Federal and State approval processes.
- 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 Gannawarra Shire Council Planning Scheme.



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 comprehensive Construction Environmental Management Plan (CEMP) will 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 would be developed as part of the CEMP which includes the avoidance, minimisation and mitigation measures as specified in section 9. The CEMP would 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).

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 Catchment and Land Protection Act 1994
СМА	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 Environment Effects Act 1978
EPBC Act	Commonwealth Environment Protection and Biodiversity Conservation Act 1999
EVC	Ecological Vegetation Class
FFG Act	Victorian Flora and Fauna Guarantee Act 1988
GHD	GHD Pty Ltd
GIS	Geographic Information System
LGA	Local Government Authority
MDBA	Murray-Darling Basin Authority
MNES	Matters of National Environmental Significance
North Central CMA	North Central Catchment Management Authority
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 Advisory List of Rare or Threatened Plants in Victoria (DEPI, 2014), the Advisory List of Threatened Vertebrate Fauna in Victoria (DSE, 2013) or the Advisory List of Threatened Invertebrate Fauna in Victoria (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. R8 is not responsible for achievement of the project's desired operational ecological outcomes.

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 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. All effort has been made to consider previous mapping, however there are some minor and understandable discrepancies between the various vegetation mapping exercises undertaken.



- Did not include a comprehensive on ground assessment of the vegetation and fauna habitat present along proposed access tracks. Additional areas have been accounted for using known nearby ecological values until further on ground assessment can be completed in future.
- 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 responders 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. Updates to threatened and protected species listings in Victoria are planned as a result of these amendments. Updated listings are likely to be in place towards the end of 2020. Updates to this report may be required once the updated listings take effect.

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 Guttrum and Benwell Forests Floodplain Restoration 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.

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 1,149 ha of highecological-value Murray River floodplain within Guttrum and Benwell Forests, through the construction of new infrastructure and the modification of existing infrastructure within the River Murray Reserve (Figure 1-1 and Figure 1-2). This will protect and enhance the ecological values within the Guttrum and Benwell Forests, restoring healthy floodplain communities to ensure that indigenous plant and animal species and communities survive and flourish (North Central CMA 2014a). These forests are of significant ecological importance in the Murray-Darling Basin, with a combined area of 1,930 hectares they comprise considerable areas of floodplain forest that support rare and threatened species and stands of large old trees. River regulation has modified the inundation regimes of these high value floodplain habitats, with the frequency and duration of inundation events now halved on average compared to natural conditions. The significant reduction in natural inundation events has lowered the biodiversity values, reducing the extent of wetlands, and the productivity and habitat value of the River Red Gum forest (North Central CMA 2014a, North Central CMA 2014b).

1.2 Project location

The project is located on the mid-Murray floodplain of northern Victoria. Guttrum and Benwell Forests form part of a wider regional ecosystem with Campbells Island directly opposite in New South Wales and the Gunbower-Koondrook-Perricoota Forest icon site immediately upstream. 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 floods. The managed inundation aims to replicate a natural inundation regime of between 24,000 to 26,000 ML/d flows in the Murray River. 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 pumping to deliver water to target areas in the floodplain, whilst still achieving a similar degree of inundation as a natural event.

The proposed works for the Guttrum and Benwell Forests floodplains are designed to provide pumped inflows of up to 125 ML/d of water from each pump station on the Murray River into the forests. The pumping will result in inundation of approximately 668 ha of Guttrum Forest and 481 ha of Benwell Forest (Figure 1-2).

Environmental works areas

Guttrum and Benwell Forests act independently to each other and are unique systems comprised of River Red Gum floodplain forests and woodlands interspersed with swamp low-lying habitats including complexes of semipermanent wetlands. The key project areas that will be targeted for managed inundation through pumped inflows of up to 125 ML/d of water at each pump station on the Murray River include:

 Guttrum Forest – inundation of approximately 668 ha of River Red Gum floodplain forest containing permanent and semi-permanent wetland complexes:



- Upper wetland complex containing Reed Bed Swamp and Little Reed Bed Swamp
- Lower wetland complex comprising Guttrum Swamp
- Benwell Forest inundation of approximately 481 ha of River Red Gum floodplain forest containing semipermanent wetland complexes:
 - Benwell Swamp wetland complex representing a large portion of the Forest
 - South West Benwell Swamp wetland complex in the south-west corner of the forest, separated by a higher ridge and track

The broader study area includes all land within 10 km of the area of investigation and inundation area, including public land, private properties and roadsides. This covers a more extensive area than the expected zone of impact but this additional information provides context for the significance of any ecological features recorded from the project site (for example, whether they are part of a larger area, or whether impacts could extend to ecological features outside the project site). Biodiversity values in the broader project area were only assessed at a desktop level.

Figure 1-1 Construction footprint of Guttrum and Benwell Forests



 $Path: J: IE\Projects \oldsymbol{03} Southern \oldsymbol{15} IS 297700\Spatial \oldsymbol{16} AcPro\oldsymbol{16} AcPro\oldsymbol{16} Southern \oldsymbol{16} Southern \oldsy$



Figure 1-2 Inundation area of Guttrum and Benwell Forests



 $Path: J: IE\ Projects\ 03_Southern\ IS297700\ Spatial\ ArcPro\ AGP\ Ecology\ Guttrum\ Benwell_Ecology_Updated.aprx$



1.3 Proposed works

The main components of the project include environmental water delivery infrastructure and access tracks are described below. The current design, as assessed in this report and described below, involves the construction of one large and six small regulators, seven pipelines, two drop structures, three pump stations, erosion control works and a series of containment banks to divert, retain and release water in the Guttrum and Benwell Forests.

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 potential impacts.

Key design elements that are subject to change include the design and location of power supply and extent of levee works required as these have not yet been confirmed. The existing levees within the forests are subject to further risk assessment to confirm any works required and VMFRP area 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 and the kiosk stations associated with the pump station have been included in the development for tor completeness.

Given the design of the proposed environmental water delivery infrastructure is evolving as part of the design and approvals process, the information in this section will need to be reviewed and updated in response to design changes. Findings from on-site assessments particularly ecology fieldwork have and will continue to be progressively fed into the design, with modifications made to avoid and minimise environmental impacts.

1.3.1 Infrastructure

The proposed infrastructure at Guttrum and Benwell Forests include:

Guttrum

- Guttrum Main Regulator Small regulator at the western end of the site and the lowest point of connectivity with the Murray River. Regulator would enable the water to be contained in the swamp (when closed) and released at a controlled rate once the duration of planned inundation has been achieved (when opened). The regulator would generally remain open to avoid obstructions on the natural floodplain and would only be closed during environmental watering events. The regulator would also be open during natural flooding conditions to allow water to enter the forest and be closed if required to increase the duration of the natural inundation.
- Reed Bed Swamp Regulator (North and South) Two small regulators to prevent backflow to the Murray River from the pipe supply outlet into the flood runner on the wetland side of River Track. The regulator would generally remain open to avoid obstructions on the natural floodplain and would only be closed during environmental watering events. The regulators would also be open during natural flooding conditions to allow water to enter the forest. An outlet at the end of the Guttrum East Pipeline would be located adjacent to both regulators.
- Little Reed Bed Swamp Regulator Small regulator (box culvert) to prevent backflow from entry into Little Reed Bed Swamp to the River Murray (when closed). The regulator would generally remain open to avoid obstructions on the natural floodplain and would only be closed during environmental watering events. The regulator would also be open during natural flooding conditions to allow water to enter the forest. An outlet at the end of the Guttrum East Pipeline would be located adjacent to both regulators.
- Guttrum East Pipeline The pipeline system would be located along an existing River Track from Guttrum East Pump Station north to three locations within the Reed Bed Swamp Complex of wetlands, via three separate pipelines; Little Reed Bed Swamp flood runner, Reed Bed Swamp northern flood runner and Reed Bed Swamp southern flood runner.



- Guttrum West Pipeline A pipeline from the Guttrum West Pump Station and discharge into the Guttrum Main outfall Channel, on the forest side of the Guttrum Main Regulator. The alignment to follow the containment bank.
- Little Reed Bed Swamp Outlet location of end of Guttrum East Pipeline and distribution of flow into the local floodrunner adjacent to the Little Reed Bed Swamp Regulator area, with erosion protection and rock beaching.
- Reed Bed Swamp North Outlet location of end of Guttrum East Pipeline and distribution of flow into the local floodrunner adjacent to the Reed Bed Swamp North Regulator area, with erosion protection and rock beaching.
- Reed Bed Swamp South Outlet location of end of Guttrum East Pipeline and distribution of flow into the local floodrunner adjacent to the Reed Bed Swamp South Regulator area, with erosion protection and rock beaching.
- Guttrum West Pipeline Outlet location of end of Guttrum West Pipeline and distribution of flow into the local channel adjacent to the Guttrum Main Regulator area, with erosion protection and rock beaching.
- Guttrum Main Drop Structure Designed to transfer flows between Guttrum Main Regulator and the Murray River, passing planned inundation flow out of the forest to the river. Structure proposed is a gabion weir and rock beaching construction with extensive reno mattresses at the edge of the river and flood runner confluence to provide erosion control. The structure will also allow for natural high flows from the river to enter the forest.
- Guttrum West Pump Station Enables pumping of water from Murray River via short pipeline to Guttrum Swamp via Guttrum Forest. Pumping rate ranges from 50 ML/d for semi-permanent wetland planned inundation to 125 ML/d for river red gum forest planned inundation. All pumps will contain screens on the pump inlets with a 2 mm hole aperture, a screen approach velocity of 0.12 m/s and automatic screen cleaning mechanisms.
- Guttrum East Pump Station Enables pumping of water from River Murray via Guttrum East Pipeline to Reed Bed Swamp and Little Reed Bed Swamp either simultaneously or individually through offtake control. Pumping rate ranges from 25 ML/d for semi-permanent wetland planned inundation to 125 ML/d for full river red gum forest planned inundation. All pumps will contain screens on the pump inlets with a 2 mm hole aperture, a screen approach velocity of 0.12 m/s and automatic screen cleaning mechanisms.
- Guttrum Main Containment Bank –Containment bank located at and around Guttrum Main Regulator and along the river bank to hold the maximum design water level and form public access between Millar Road and River Track as well as all-weather access to the Guttrum West Pump Station.
- Little Reed Bed Swamp Containment Bank minor localised containment bank around Guttrum East Pipeline outlet and regulator.
- Reed Bed Swamp North Containment Bank minor localised containment bank around Guttrum East Pipeline outlet and regulator.
- Reed Bed Swamp South Containment Bank minor localised containment bank around Guttrum East Pipeline outlet and regulator.
- Spillway one spillway on Guttrum Main Regulator Containment Bank to protect the regulator during natural flooding.

Benwell

 Benwell Main Regulator – Large regulator to allow natural flows into the forest (when opened) and enable water to be returned to the Murray River during planned inundation events and natural flooding events at a controlled rate (from closed to opened) once the duration of planned inundation has been achieved. The regulator would generally remain open to avoid obstructions on the natural floodplain and would only be closed during environmental watering events.



- Benwell East Regulator Small regulator designed to allow natural flows into the forest (when opened), enable water to be contained in the swamp (when closed) and to pass planned inundation flows out of the forest to the Murray River at a controlled rate (from closed to opened). The regulator would generally remain open to avoid obstructions on the natural floodplain and would only be closed during environmental watering events.
- South West Natural Flood Conveyance Regulator Small regulator designed to exclude water from Benwell Main Swamp from entering the South West Benwell Swamp. The regulator would generally remain open to avoid obstructions on the natural floodplain and would only be closed during environmental watering events.
- Main Pump Station Discharge Pipeline pipeline along an existing access track extending from Benwell Pump Station to Benwell Regulator Track Regulator to enable separate delivery of water to Benwell Main Swamp and South West Benwell Swamp. Water spreading and erosion control works required at discharge location.
- South West Station Discharge Pipeline –pipeline along an existing access track extending from the Benwell Regulator Track Regulator to the discharge point in the South West Benwell Swamp
- Emergency Outlet Pipeline Gated pipeline along an existing access track designed to enable emergency
 removal of water from the upper part of the Forest (South West Benwell Swamp) to the Benwell drainage
 system, in the event of extreme flooding or water quality issues.
- Benwell Main Outlet location at end of the Main Pump Station Discharge Pipeline discharge point and distribution of flow into the local existing channel adjacent, with erosion protection and rock beaching.
- Benwell South West Outlet location at end of South West Discharge Pipeline for discharge and distribution
 of flow into the South West forest area, with erosion protection and rock beaching.
- Emergency Outlet location at end of the emergency pipeline to enable emergency flows to discharge into the Benwell Drainage System, adjacent to the edge of the forest.
- Benwell Main Drop Structure Designed to transfer flows between the Benwell Main Regulator and the Murray River, allowing natural flows into the forest and to pass planned inundation flow out of the forest. Structure proposed is a gabion weir and rock beaching construction with extensive reno mattresses at the edge of the river and flood runner confluence to provide erosion control. The structure will also allow for natural high flows from the river to enter the forest.
- Benwell Pump Station Located adjacent to the Murray River at the far north-western end of the site and enables pumping of water from Murray River into Benwell Forest for delivery of water to Benwell main swamp and South West Benwell Swamp either simultaneously or individually (through offtake control). Pumping rate ranges from 10 ML/d for South West Benwell Swamp to 125 ML/d for full river red gum forest planned inundation. Fish screens to be included on pump offtake. All pumps will contain screens on the pump inlets with a 2 mm hole aperture, a screen approach velocity of 0.12 m/s and automatic screen cleaning mechanisms
- Benwell Containment Bank 1 Containment bank extending to and past the Benwell Main Regulator to hold the maximum design water level. Containment Bank will be trafficable to allow access to the Benwell Main Regulator and Benwell Drop Structure during managed inundation events.
- Benwell Containment Bank 2 Containment bank designed to enable water to be separated between the Benwell Main Swamp area and Benwell South West Swamp area and enables some continuity of access along Regulator Track during managed inundation events.
- Spillway two spillways on Benwell Containment Bank 1, one adjacent to Benwell Main Regulator and one further south of Benwell Main Regulator. Spillways would include erosion protection works where containment bank meets existing low points/flood runners.

Fish passage

The design of all regulators and drop structures allows for passive fish passage. Guttrum Main Regulator, Benwell Main Regulator and Benwell East Regulator are all dual leaf gate regulators and therefore will be



designed to regulate and pass outflows at different water levels (i.e. they will not just be open or closed). This will ensure that passive fish passage can be achieved in overshot mode with water passing over the gates. A plunge pool at these three regulators will also be provided immediately downstream of the gate for safe fish passage. All other regulator structures would 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 also been designed to have flow velocities appropriate for fish passage (based on O'Connor et. al, 2015).

The project specifically 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 stations

1.3.2 Ancillary components of the project

Containment banks / access tracks

If determined as required based on the outcomes of further levee risk assessment, the location of containment banks will be a combination of 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 number of short sections of new access tracks between existing access tracks and proposed infrastructure and associated with containment banks would also need to be constructed. A few short lengths of non-trafficable bank would be required at tie in locations where the bank needs to match the natural river bank. VMFRP is in the process of undertaking a levee risk assessment process and therefore the works associated with the containment banks have not been confirmed.

Some of these tracks would need to be upgraded as part of the project, the extent of which would be confirmed following outcomes from 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, with the objective of selecting locations as close as possible to the project, on private land outside of the Guttrum-Benwell Forest, 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 sought.

Power supply

New power supply connections are required to facilitate operation of the pump stations at both Guttrum and Benwell Forests. The key design components include new poles, stays, cables and substations. The cable line will be directly buried (or bored depending on requirements) within the State Forest boundary, following the alignment of containment banks or existing access tracks to minimise the area of impact. Upgrades to existing overhead power lines within private property are required and new lines, both above ground and below ground, are proposed through private property. Consultation with relevant private landholders is currently being undertaken.

The project is working with Powercor to confirm the preferred alignment and develop preliminary footprints and designs for the power supplies to each pump station. These alignments will be selected to minimise impacts to native vegetation and cultural heritage values.



Preliminary designs have been developed by Powercor for Benwell Pump Station and Guttrum West Pump Station. The Guttrum West Pump Station power supply is likely to include an updated of existing powerlines across a number of private properties, new underground high voltage cable from this existing supply line, across private property and into Guttrum Forest to supply Guttrum West Pump Station. The cable will follow the alignment of the proposed Guttrum Main Containment Bank to minimise the impact area, in particular, removal of native vegetation. The Benwell Pump Station power supply is likely to include a new overhead line constructed through private property to the boundary of Benwell Forest, a pole mounted substation located outside of Benwell Forest and a low voltage underground cable will be constructed in Benwell Forest to supply Benwell Pump Station.

There are several options for power supply to Guttrum East Pump Station still being considered. These options will undergo a multi-criteria assessment to identify the preferred option. The criteria will include how the proposed option minimises the impact to native vegetation and cultural heritage values.

As the preferred option for power supply to Guttrum East Pump Station is unknown at this stage and due to the preliminary nature of designs for the Guttrum West and Benwell Pump Stations, the power supply infrastructure requirements for the project are currently not included in the construction footprint. However, an indicative location for the substation at each pump station has been included in the area of investigation and construction footprint, assuming that this would be located opposite the pump stations. Following selection of the preferred option, the infrastructure requirements will be included within the construction footprint and potential impacts assessed completed.

Concrete batching

Commercially sourced concrete for construction of the proposed works would be transported to the project area with 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 map attached. 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

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

Importation of construction materials, including regulators and imported soils, would comply with DELWP and Parks Victoria consent under Section 27 of the *National Parks Act 1975* and the future *Environment Protection Act 2017* (this was due to commence on 1 July 2020 however has now been postponed until 1 July 2021 (or earlier by proclamation) due to the COVID-19 emergency.

A Construction Environmental Management Plan (CEMP) would be prepared for the works and would detail the measures to avoid and minimise impacts during construction. Once construction of regulators, stop banks and all associated works are complete, all waste and spoil will be removed from the sites and disposed of in accordance with measures outlined in the CEMP.

Construction in the Murray River

All pump stations and drop structures would require construction works within the Murray River. For the pump stations this would include excavation and construction of intake pipes which will draw from inundation area water levels down to the minimum river water level. The portion of the intake pipes near the edge of the bank profile will be concrete encased serving as an anchor for the suction pipes and protection for bank scouring/ erosion.

Construction of the drop structures requires modifying (re-shaping and re-grading) of the existing outlet channel and extending sections of rock mattress erosion protection into the Murray River. Installation of a rock mattress would involve excavating to ensure that the finished surface is flush with the natural surface/bed. Lengths of 6 m x 2 m mattress would be fabricated on the bank, complete with geotextile and lifting points. They



would be lifted into place with a purpose built lifting frame. The top ends of each mattress would be secured at the top end to a gabion beam on the bank. Mattresses placed below water would not be tied at the sides.

It is likely that a cofferdam would be temporarily installed in the Murray River to allow the rock mattress to be placed and tied together. Works are proposed to occur when the river level is low. The coffer dam would likely comprise sheet piles and would only extend into the Murray River as far as necessary to safely and efficiently construct the works. The cofferdam would not extend across the full width of the river (i.e. likely to be less than half way across) and would therefore allow fish passage to be maintained while works are being undertaken.

Construction laydown areas

The investigation area (proposed construction footprint) includes a working area (approx. 10 m) around the development footprint for proposed infrastructure to accommodate movement of vehicles and machinery and some limited storage of equipment and materials.

Construction laydown areas included in the construction footprint are proposed within proximity to Guttrum Main Pump Station (location directly north), Benwell Pump Station (location directly south) and at the end of South West Regulator near the South West Benwell Swamp. The locations are currently under review by VMFRP and it is proposed to move these laydown areas to private land outside of the forests to minimise and avoid impacts. Consultation with relevant landholders is currently being undertaken.

Laydown areas would provide the primary location for site offices, amenities, vehicle manoeuvres / parking, storage of equipment and materials, etc.

Smaller, more localised laydown areas would also be provided at or within proximity to the other regulator structures.

Project area rehabilitation

Following completion of works, rehabilitation of construction areas would be undertaken in accordance with DELWP and Parks Victoria consent under the *Crown Land (Reserves) Act 1978* and *Forests Act 1958*. 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.

Details of rehabilitation will be included in the CEMP

1.3.4 Key operational activities

The proposed works are intended to inundate areas of the Guttrum and Benwell Forest floodplain with pumped inflows from the Murray River through a series of Pump Station on the river.

Three operating scenarios have been identified for water delivery to the Guttrum and Benwell Forests:

- Forest floodplain watering broader floodplain (River Red Gum flood dependent understorey and semipermanent wetlands). The flooding would replicate a 26,000 ML/day natural event in Guttrum Forest and a 24,000 ML/day event in Benwell Forest. The target frequency for forest floodplain watering based on water regime requirements is on average eight years in 10 for between three to five months. Pumping would be required on average three years in 10 to achieve the target eight years in 10 years inundation frequency, with inundation in other years provided through natural inundation and Basin Plan 2750 flows.
- Semi-permanent wetland watering targeted water delivery to wetlands only. The target inundation regime for semi-permanent wetlands is nine years in 10 for a duration of six months. Top up watering events after natural inflow events (under Basin Plan 2750 flows) to semi-permanent wetlands would be required on average seven years in 10 to achieve this inundation regime. This pumping would be in addition to the forest floodplain watering scenario which would also inundate the semi-permanent wetlands on average three years in 10. Both scenarios combined would require pumping to semi-permanent wetlands every year, which would achieve the target nine years in 10 years inundation frequency.



- Hybrid events topping up natural flow events for the forest floodplain and semi-permanent wetland
 watering due to natural flood duration deficits. There are three options for extending the duration of natural
 floods that inundate the broader forest and semi-permanent wetlands:
 - Follow up watering of the forest floodplain following natural flow peaks and/or flood capture to achieve required flooding extent and/or duration where natural flood event extent or duration is inadequate to achieve ecological objectives.
 - Top-up watering of the semi-permanent wetlands following natural flow peaks to achieve required flooding duration where natural flood event duration is inadequate to achieve ecological objectives.
 - Delivering a waterbird breeding scenario in association with environmental cues including topping up wetlands to support natural bird breeding events when required.

There are two options for extending the duration of natural floods that inundate the broader forest:

- Flood capture to retain floodwater on the floodplain for the required duration by closing the outlet regulators and low-lying inlet regulators from the River Murray after the river flow peak has passed
- Pumped deliveries of up to 125 ML/ day at each of the three pump stations to top up the natural inflows with additional volume of water from the river.

Forest floodplain watering

Watering the forest floodplain includes inundating the River Red Gum forests with flood dependent understorey and the lower lying semi-permanent wetland systems. The proposed watering will include three phases:

- Filling phase: Gradual ramp up with filling at peak flows of 125 ML/day at each pump station to achieve the desired inundation extent
- Maintenance phase: Reducing inflows from 125 ML/day to between 45 to 90 ML/day from the pump stations only to offset losses and provide return flows to the Murray. Continue providing maintenance inflows to meet the duration requirements of either the River Red Gum forests or semi-permanent wetlands (with approx. 25 ML/day return flows to the River Murray during this period)
- Ramp down phase: gradual ramp down of inflows.

The proposed operation of infrastructure to deliver water (from dry) to Guttrum and Benwell Forests under this scenario is outlined below.

Guttrum Forest

Water will be delivered via two pump stations situated on the Murray River in both the east and west of the forest. The eastern pump station (Guttrum East) will have three outlet points that facilitate filling of the eastern semi-permanent wetlands as well as the forest floodplain. All of these outlets would typically be used to fill the forest from dry, with a maximum inflow capacity of 125 ML/d. An additional 125 ML/d will be delivered from Guttrum West pump station, totalling 250 ML/d flow rate to fill the forest from dry (North Central CMA, 2020).

To achieve an equivalent inundation extent of an approximate 26,000ML/day River Murray inflow, the pump stations would be allowed to run until the level at the forest outlet (Guttrum Main Regulator) reaches 75.8 m AHD (DHI 2020). At this level, hydraulic modelling shows there are no return flows to the River Murray via the other natural inlet points along the River Murray (DHI 2014). Therefore, only the Main Regulator would need to be closed during the operation (assuming water levels remain at 75.8 m AHD at the outlet). However, depending on which environmental water inlets are utilised during a full forest watering event, three small regulators (Little Reed Bed Swamp Regulator, Reed Bed Swamp North Regulator and Reed Bed Swamp South Regulator) will be built on these effluents along River Track in the eastern part of the forest. These regulators would be closed if required to contain water on the floodplain and direct it into the forest (North Central CMA, 2020).

Once the maximum environmental watering level of 75.80 mAHD is reached at the Guttrum Regulator, the Guttrum West Pump Station would be turned off and the Guttrum Regulator would commence automatic modulation to maintain the desired water level. The Guttrum East Pump Station would continue to operate at a high to maximum flow rate to maintain the maximum inundation extent possible for the east and south parts of the forest. The Guttrum East Pump Station would then reduce its flow rate to provide "maintenance flows" and



the forest will be operated as a through-flow system. Maintenance flows aim to maintain the extent for the optimal duration to support the ecological objectives; provide freshening inflows that will assist with managing water quality; and return continuous carbon and nutrient-rich outflows to the Murray River. Outflows would occur through the Main Regulator and water would drain from the forest floodplain to the River Murray as occurs naturally (North Central CMA, 2020).

Benwell Forest

Water will be delivered via a pump station situated on the Murray at the western end of Benwell forest at a maximum rate of 125 ML/d. To achieve an equivalent inundation extent of a 24,000 ML/day River Murray inflow, water would be delivered from the pump station via two outlets (one main one to central and eastern forest, and one smaller one to south west area) while regulators at low points along the Murray River would be closed during the filling stage (i.e. Benwell Main Regulator and Benwell East Regulator) (DHI 2014; R8, 2020b). The ground profile along the western bank of the river at the downstream end of the forest mostly utilising the existing alignment of River Track will be raised as part of infrastructure works, which will contain water on the floodplain and prevent outflows during delivery (DHI 2014). Further investigation is ongoing to determine if additional infrastructure is required within the containment bank along River Track so that natural flow paths remain uninhibited as much as possible (North Central CMA, 2020).

Once the maximum desired inundation extent and depth is achieved, the Benwell Main Regulator and Benwell East Regulator will be opened (partially or fully, depending on river conditions) to create a throughflow, with maintenance flows provided at lower flow rates to match losses within the forest and enable return flows. The regulators would actively operate to maintain the target water level. This water delivery would continue to maintain the area of inundation for the required duration. Towards the end of the watering event, larger volumes of outflows would be released by opening the outlet regulators, and water would drain from the forest floodplain to the River Murray as occurs naturally (North Central CMA, 2020).

Semi-permanent wetland watering

The semi-permanent wetlands in each forest include:

- Guttrum Forest Reed Bed Swamp, Little Reed Bed Swamp and the Guttrum Swamp wetland complex.
- Benwell Forest Benwell Swamp and Southwest Benwell Swamp.

The proposed watering will include two phases:

- Filling phase: In winter or early spring, gradual ramp up with filling at peak flows of between 12 100 ML/day to achieve the desired inundation extent in semi-permanent wetlands
- Maintenance phase: In late spring, deliver one or more top-ups to the wetlands (as required) by ramping up again to up to between 25 -50 ML/d until desired water level is reached. Flows can be held steady to maintain water levels under nests if required. This flow rate will depend on climatic conditions and will need to account for losses through evaporation.

The proposed operation of infrastructure to deliver water (from dry) to semi-permanent wetlands in Guttrum and Benwell Forests under this scenario is outlined below.

Guttrum Forest

For semi-permanent wetland watering into a dry system, independent of the River Red Gum forest floodplain, water will be delivered via the Guttrum East and Guttrum West Pump Stations. The east pump station will water Reed Bed Swamp and Little Reed Bed wetland. The west pump station will water the Guttrum Swamp complex (DHI 2017). To inundate the eastern wetlands, water will be pumped through a pipeline following the alignment of River Track and will be released into three different flood runners to fill Reed Bed Swamp and Little Reed Bed Swamp (North Central CMA, 2020).

Small regulators are proposed for these flood runners to block water from running back towards the Murray River or inundating River Track, and instead will direct it west or southwest towards the wetlands and broader forest. These small regulators will be formed by gated culvert crossings of River Track at the locations of the existing flood runners. The Guttrum East Pump Station will provide for wetland fills up to a full supply level of 75.7 m AHD for the Reed Bed southern inlet (DHI 2020) and 75.5 mAHD for the main Reed Bed Swamp (DHI



2020). As water is held within the wetlands, the outlet (Main Regulator) would not be required. Water would eventually infiltrate and evaporate until the wetlands dried out.

To inundate the western wetlands, water will be pumped from the Guttrum west pump station and follow the natural flow paths to fill Guttrum Swamp complex. The wetland system would gradually fill from the north to the central / eastern and then southern end. The Main Regulator outlet is located close to the east pump station and will be closed during filling of the wetlands to full supply level (North Central CMA, 2020).

Benwell Forest

For semi-permanent wetland watering into a dry system, independent of the River Red Gum forest floodplain, water will be delivered via the Benwell West Pump Station. Water will travel via a short pipeline to two outfall locations that target the central Benwell Swamp and the South West Benwell Swamp, enabling the two wetlands to be filled independently (R8 2020b). Water will be delivered at a flow rate of approximately 50 ML/d in total, with 22 ML/d directed to the central Benwell Swamp and 28 ML/d towards the South West Benwell Swamp (DHI 2017).

Both wetlands will be filled to a full supply level of approximately 74.6 mAHD. At this level, some water will pool against the containment bank along River Track for central Benwell Swamp and against a section of the outer levee for Benwell South West Swamp. The Benwell Main Regulator would be closed prior to operations commencing, but may be opened again if a high river peak was expected that would result in natural inflows. The wetlands would gradually evaporate and infiltrate over a four to six-month period. Flows to top-up the wetlands or maintain water levels may be delivered if required to meet ecological objectives, such as supporting a waterbird breeding event.

A summary of the proposed operating scenarios for Guttrum and Benwell Forests is provided in the table below.

Operating Scenario	Peak filling inflow rate (ML/d)	Optimal watering regime (frequency under natural conditions)	Frequency of infrastructure operation *	Duration	Required timing
Forest Floodplain – Guttrum Forest	250 (125 ML/d at each pump station)	8 years in 10	3 years in 10**	4 months	Winter/Spring
Forest Floodplain – Benwell Forest	125	8 years in 10	3 years in 10**	4 months	Winter/Spring
Semi-permanent wetland watering – Guttrum Forest	25 - eastern wetland 100 - western wetlands	9 years in 10	7 years in 10***	6 months	Spring – eastern wetland Late winter/ Spring – western wetland
Semi-permanent wetland watering – Benwell Forest	22 – Benwell Swamp 28 – South West Benwell Swamp	9 years in 10	7 years in 10***	6 months	Late winter/ Spring

Table 1-1 Modelled frequency of operational scenarios for the Guttrum and Benwell Forests Floodplain Restoration Project

* Operating regime based on Basin Plan 2750 flows. Depending on natural inflows, operating regime for River Red Gum Forest may be between 3-7 years in 10.

** Inundation in other years provided through natural inundation to achieve the 8 in 10 year inundation frequency

*** On top of River Red Gum watering scenario which would also inundate the semi-permanent wetlands 3 years in 10 to achieve the 9 in 10 years inundation frequency, with inundation in other years provided through natural inundation.



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 was informed by the following previous studies undertaken for the project:

- GHD (2017). Guttrum and Benwell State Forests 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 Guttrum and Benwell Forests. 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.
- Bennetts (2014). Preliminary Vegetation Assessment of Benwell and Guttrum Forests. Report for North Central CMA. In 2014, Kate Bennetts of Fire, Flood & Flora was engaged to complete an ecological appraisal of the Guttrum and Benwell Forests to inform management and environmental flow planning. The report included an assessment of vegetation condition and EVC mapping as well as flora and fauna species recorded.
- Biosis (2014a). 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.
- Biosis (2014b). Mapping and condition assessment of the Guttrum & Benwell State Forests. Report
 prepared for the North Central CMA. In 2014, Biosis were engaged to undertake a vegetation condition
 assessment of Guttrum and Benwell State Forests, establishing baseline data (quadrats and transects) at
 monitoring sites to guide hydrological management.
- North Central CMA (2014a). Guttrum Forest: Ecological Objectives and Hydrological Requirements
- North Central CMA (2014b). Benwell Forest: Ecological Objectives and Hydrological Requirements
- North Central CMA (2014c). Guttrum Forest and Benwell Forest Environmental Works Project: Ecological Risks and Mitigation
- Ecological Associates (2013). The Ecological Justification for Works and Measures for the Guttrum and Benwell State Forests. Report prepared for the North Central CMA

A summary of previous ecological assessments, including methods, key findings and recommendations is presented in Appendix B, 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 10 km of the project area, i.e. the study area
- Summarise the previous ecological assessments (Ecological Associates 2013, Biosis 2014a, Biosis 2014b, North Central CMA 2014a, North Central CMA 2014b, North Central CMA 2014c, GHD 2017) 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, 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)



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 though the blocking of over flow channels. The South West Benwell Swamp occurs in an area originally established as the 'Benwell Reserve', an irrigation impoundment established in the 1890's covering 566 ha and storing 1200 ML for use in the local irrigation district. Elements of this former reservoir are considered to still influence local drainage and the duration of inundation in the south western area of the state forest.

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 the more flood 'tolerant' terrestrial species that have limited inundation on the periphery of such systems
- 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. Trees enable terrestrial fauna to move
 into the inundated areas.
- **Understorey**: The obligate wetland understorey associated with several of the vegetation communities within Guttrum and Benwell Forests does 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.
- Waterbirds: Flooding acts as the primary stimulus for breeding waterbirds, increasing reproductive performance as the flood pulse stimulates productivity in the wetlands
- Fish: Flooding may trigger spawning or migration to suitable breeding habitat
- **Frogs**: Flooding promotes a rapid response in frog activity, including calling, spawning, and tadpole development and metamorphosis providing a food source to other species, 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 may move the salinity issue to another place)



The most extensive and severe drought 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 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.

2.1 Ecological benefits – Guttrum and Benwell Forests

It is reported (North Central CMA 2014a, North Central CMA 2014b) that the ten years prior to the 2010-11 flooding (the millennial drought) resulted in below average inflows and general flooding availability within the Guttrum and Benwell Forests system. The riparian forest system operates on a water deficit, given water loss through evapotranspiration is in the order 1,700 mm/y, while rainfall input is in the order of 400 mm/yr (North Central CMA 2014a, North Central CMA 2014b). Flooding makes up the difference, so where flooding does not occur for several consecutive years, environmental stress results. Spell analyses completed by Ecological Associates (2013) and Gippel (2014) report that flows that inundate the semi-permanent wetlands now occur 61% of years rather than the 90% of years that is considered the normal historical flooding frequency.

With a lack of required infrastructure to manage flooding delivery or management within the forest environmental watering programs were not considered viable at the time of previous high flow events. General observations of the forest in response to lack of flooding found:

- Encroachment of terrestrial vegetation into areas previously occupied by flood dependant wetland species
- Benwell Forest had reverted to a much younger and denser forest (presumably in areas of new river red gum establishment)
- 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

The Guttrum and Benwell Forests received extensive flooding in the 2010-11 inundation event. Vegetation assessment undertaken in 2014 identified considerable areas of native vegetation associated with the flood plain forest re-establishing an intact understorey, maintaining remaining rare and endangered species and improving the health of stands of large, old trees persisting. However, it was identified that the structure of the forest ecosystem had diminished through a number of degrading processes in operation during periods of stress brought on by the prolonged dry period. Of specific concern were:

Cattle grazing impacts to wetlands, trampling and pugging to wetland pond/pool areas and the destruction
of dormant vegetation propagules there



- Regrowth river red gums (cohort < 50 cm dbh) encroaching on wetland areas
- Loss of macrophyte diversity, with Phragmites being present as monocultured stands in areas where diverse macrophyte communities should be
- Forestry activities further reducing the presence of ecologically important (habitat) trees
- The plight of the large old mature trees, many of which are now showing stress from the frequency of droughts, or in some cases, prolonged inundation effectively drowning them in recent times

The flooding response to fauna could not be assessed, although it was expected to be due to the loss of wetland habitat within the forest and the loss of large old habitat trees.

The key environmental objectives of the Guttrum and Benwell Forests Floodplain Restoration Project are to reinstate a more natural inundation regime that protects and enhances the ecological values within the Guttrum (North Central CMA 2014a) and Benwell (North Central CMA 2014b) Forests. The specific ecological objectives of the project are to:

Semi-permanent Wetlands

- Overarching: Improve the health of semipermanent wetlands
- Achieve an appropriate cover and diversity of species characteristic of the Plant Functional Groups found in the semi-permanent wetlands.
- Reduce River Red Gum encroachment in semi-permanent wetland areas.
- Achieve an appropriate cover and diversity of species characteristic of the Plant Functional Groups found in the River Red Gum forest flood dependent understorey.
- Provide suitable habitat for the threatened (EPBC listed) Growling grass frog.
- Maintain and where possible increase the current diversity of threatened species.
- Reduce the area of high threat weed species.

Native birds

- Overarching: Healthy wetland bird community across Guttrum and Benwell Forests through improved access to food and habitat that promotes breeding and recruitment
- Support a suite of waterbirds including waterfowl, colonial waterbirds and other wetland dependent species.
- Provide foraging and breeding areas for colonial nesting waterbirds in Guttrum Forest (Reed Bed Swamp) and Benwell Forest and foraging areas for waterbirds potentially elsewhere (e.g. lower Gunbower Forest).
- Provide suitable habitat for the threatened (EPBC listed) Australasian Bittern in the Guttrum Forest.
- Maintain and where possible increase the current diversity of threatened wetland bird species.

River Red Gum

- Overarching: Healthy River Red Gum communities.
- Achieve an appropriate cover and diversity of species characteristic of the Plant Functional Groups found in the River Red Gum forest understorey.
- Maximise the proportion of trees with healthy canopy condition in the River Red Gum forests.
- Maintain and where possible increase the current diversity of threatened flora species.
- Reduce the area of high threat weed species.

Native fish

• Overarching: Promote recruitment of the local River Murray channel specialist native fish community by increasing opportunities to access productive floodplain outflows from Guttrum and Benwell Forests.



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 includes a typical access track width of approximately 5 m, which is a 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 = provides 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) and includes a conservative buffer to allow for possible design changes to avoid significant values where required without having to undertake further environmental and heritage 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 1149 ha (Guttrum Forest = 668 ha, Benwell Forest = 481 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.

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:

- Protected Matters Search Tool (PMST) for the EPBC Act, maintained by DAWE¹
- 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
- GHD (2017). *Guttrum and Benwell State Forests Flora and Fauna Assessment*. Report prepared for the North Central Catchment Management Authority
- Bennetts (2014). Preliminary Vegetation Assessment of Benwell and Guttrum Forests. Report prepared for the North Central Catchment Management Authority
- Biosis (2014a). Flora and fauna assessment of the Gunbower National Park and Guttrum and Benwell State Forests. Report prepared for the North Central Catchment Management Authority
- Biosis (2014b). Mapping and condition assessment of the Guttrum & Benwell State Forests. Report
 prepared for the North Central Catchment Management Authority
- North Central CMA (2014a). Guttrum Forest: Ecological Objectives and Hydrological Requirements
- North Central CMA (2014b). Benwell Forest: Ecological Objectives and Hydrological Requirements
- North Central CMA (2014c). Guttrum Forest and Benwell Forest Environmental Works Project: Ecological Risks and Mitigation
- Ecological Associates (2013). The Ecological Justification for Works and Measures for the Guttrum and Benwell State Forests. Report prepared for the North Central Catchment Management Authority

A VBA and PMST search was undertaken for the study area.

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

¹ http://www.environment.gov.au/epbc/protected-matters-search-tool (accessed on 30/03/2020)

² http://www.environment.gov.au/biodiversity/invasive/weeds/weeds/lists/wons.html (accessed 30/03/2020)

³ https://www.environment.vic.gov.au/biodiversity/victorian-biodiversity-atlas (accessed on 30/03/2020)

⁴ http://maps.biodiversity.vic.gov.au/viewer/?viewer=NatureKit (accessed on 30/03/2020)

⁵ https://nvim.delwp.vic.gov.au/ (accessed on 30/03/2020)



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 study area. Resources utilised to assist in determining likelihood of occurrences included VBA and PMST searches undertaken for 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 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.

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 biodiversity values within the inundation area has been considered using:

- Previous assessments completed within the Guttrum and Benwell Forests, as described in section 1.4.
- Ecological Vegetation Class (EVC) and Water Regime Class (WRC) mapping completed for condition monitoring of Guttrum and Benwell Forests (Biosis 2014b)
- Rare and threatened species based on VBA records and previous assessments within the inundation area (Ecological Associates 2013, Bennetts 2014, Biosis 2014b)
- 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 (Biosis 2014b) 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

3.4.1 Vegetation condition assessment

A field assessment was undertaken in the area of investigation by R8 Senior Botanists (David Endersby and Andrew Stephens) and Ecologist (Tao Lee) between 14-18 October and 19-20 November 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 the full list of Habitat hectare assessment is provided in Appendix G.

3.4.2 Targeted threatened flora surveys

Targeted threatened flora surveys were undertaken between 14-18 October and 19-20 November 2019 R8 Senior Botanists (David Endersby and Andrew Stephens) and Ecologist (Tao Lee) in the area of investigation. 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).

Targeted surveys were not undertaken in the construction footprint at Benwell Forest around the South-west regulator and Outlet 2 (approximately 700 m length) as design changes occurred following the completion of field surveys. Further surveys in this area are recommended as part of the design and approvals process for the project.

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 Previous fauna surveys

A number of previous fauna assessments in Guttrum and Benwell Forests have been undertaken (Bennetts 2014, Biosis 2014a, GHD 2017), using a variety of survey methods including 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 B and further detail on survey methods should be reviewed in previous reports.

Current R8 surveys focussed on previously identified threatened fauna species reported in Biosis (2014a) and recommended for targeted surveys (GHD 2017). 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 faun

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 14-17 and 22-25 October 2019 by R8 Senior Zoologist Briony Mitchell, Senior Ecologist Rebecca Sutherland and Ecologists Leo McComb and Mike Timms. The surveys were conducted in the area of investigation, as shown in Figure 5-1.

Targeted surveys were not undertaken in the construction footprint at Benwell Forest around the South-west regulator and Outlet 2 (approximately 700 m length) as design changes to these components occurred following the completion of field surveys. Further surveys in this area are recommended as part of the design and approvals process for the project.

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 Guttrum and Benwell Forests, River Red Gum makes up the majority of the canopy species and is the overstorey component of the following EVCs in the project area where targeted surveys were focused: Grassy Riverine Forest (EVC 106), Riverine Grassy Woodland (EVC 295), Riverine Swamp Forest (EVC 814) and Sedgy Riverine Forest (EVC 816).

These general habitats contain many mature trees and typically include a substantial understorey of Silver Wattle (*Acacia dealbata*), Black Wattle (*Acacia mearnsii*) or Golden Wattle (*Acacia pycnantha*). These shrub species are common feeding trees of the species. 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

No records of this species exist within the Guttrum and Benwell Forests, however 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 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, including 33 records (VBA) within the inundation area and additional records of the species identified in previous assessments (Biosis 2014a; GHD 2017). Suitable Grey-crowned Babbler habitat comprising dry, open River Red Gum forest and woodland 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 entire construction footprint, 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 5-1.



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 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 floodplain forest habitat with logs and woody debris where surveys were undertaken for Greycrowned 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 H. 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 I.

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 nonvascular 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 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 whist 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 EPBC Act and the FFG Act list 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 one or more of these 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 WONS. All such weed species are listed in Appendix J.

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) previously mapped within the Guttrum and Benwell Forests (Biosis 2014b) and those present within the construction footprint and the inundation area are shown below in Table 4-1. Water Regime Classes as defined in previous hydrological studies (Ecological Associates 2013) and their associated EVCs are shown below and in Figure 4-1.

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

Water Regime Class	Ecological Vegetation Class	Construction footprint (ha)	Inundation area (ha)
Permanent Wetlands	Aquatic Herland (EVC 653)		0.09
Semi-permanent	Floodway Pond Herbland (EVC 810)	0.10	
Wetlands	Spike-sedge Wetland (EVC 819)		24.03
	Tall Marsh (EVC 821)		21.67
Red Gum Forest	Riverine Swamp Forest (EVC 814)	3.46	705.05
with Flood- dependent Understorey Forest Complex (EVC 945)		0.13	208.79
Red Gum Forest	Grassy Riverine Forest (EVC 106)		128.92
with Flood- tolerant	Riverine Grassy Woodland (EVC 295)	6.16	22.49
Understorey	Sedgy Riverine Forest (EVC 816)	3.87	38.52
	Total	13.70*	1,149*

*rounding error produces 13.72 ha and 1,150 ha respectively

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 18,000ML/d required to over top the banks as a minimum input (Ecology Associates, 2013) for the communities most reliant on flooding. The forests of the riparian zone are 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 (Figure 4-2). 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 32,000 ML/d flow rate (Ecology Associates, 2013), that drive canopy tree recruitment.

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. Biosis (2014) has compared the suggested inundation requirement of the EVCs present in the Guttrum – Benwell forest (Table 4-2).



Table 4-2 Suggested flood frequencies for the relevant EVCs of the Guttrum - Benwell forests (Ecological Associates (2013) and Fitzsimons et al. 2011.

Water Regime Class	Ecological Vegetation Class	Ecological Associates, 2013	Fitzsimons et al. 2011
Semi- permanent Wetlands	Floodplain Wetland Aggregate (EVC 172)	9 in 10 years frequency. Duration 3–6 months.	*3–4 in 4 years frequency. Critical interval 2 years. Minimum duration 6–12 months.
	Billabong Wetland Aggregate (EVC 334)	Flooding frequent. Duration 1–3 months.	Variable frequency. Critical interval 2 years. Minimum duration >6 months
	Floodway Pond Herbland (EVC 810)	9 in 10 years frequency. Duration 3–6 months.	3–4 in 4 years frequency. Critical interval 2 years. Minimum duration 6– 12 months.
	Spike-sedge Wetland (EVC 819)	9 in 10 years frequency. Duration 3–6 months.	2–4 in 4 years frequency. Critical interval 4 years. Minimum duration 1–4 months.
	Tall Marsh (EVC 821)	9 in 10 years frequency. Duration 3–6 months.	3–4 in 4 years frequency. Critical interval 2 years. Minimum duration 6– 12 months.
Red Gum Forest with Flood- dependent Understorey	Riverine Swamp Forest (EVC 814)	8 in 10 years. Duration 2– 5 months.	3–4 in 5 years frequency. Critical interval 3 years. Minimum duration 4–7 months.
	Floodway Pond Herbland/Riverine Swamp Forest Complex (EVC 954)	8 in 10 years. Duration 2– 5 months.	3–4 in 5 years frequency. Critical interval 3 years. Minimum duration 4–7 months.
Red Gum Forest with Flood-tolerant	Floodplain Riparian Woodland (EVC 56)	8 in 10 years. Duration 2– 5 months.	3–5 in 10 years frequency. Critical interval 7 years. Minimum duration <1 month.
Understorey	Grassy Riverine Forest (EVC 106)	8 in 10 years. Duration 2– 5 months.	2–4 in 4 years frequency. Critical interval 4 years. Minimum duration 1–4 months.
	Riverine Grassy Woodland (EVC 295)	5 in 10 years frequency. Duration 1–3 months.	2–3 in 10 years frequency. Critical interval 7 years. Minimum duration <1 month.
	Riverine Swampy Woodland (EVC 815)	4–5 in 10 years frequency. Duration 1–3 months.	2–3 in 10 years frequency. Critical interval 7 years. Minimum duration <1 month.
	Sedgy Riverine Forest (EVC 816)	8 in 10 years. Duration 2– 5 months.	1–3 in 5 years. Critical interval 5 years. Minimum duration 1–2 months.

Figure 4-1 Guttrum and Benwell Water Regime Classes (Biosis 2014b)



 $Path: J: IE\ Projects\ 03_Southern\ IS297700\ Spatial\ ArcPro\ AGP\ Ecology\ Guttrum\ Benwell_Ecology_Updated.aprx$



Red Gum with Flood-dependent Understorey

Red Gum with Flood-tolerant Understorey

Drainage Line

— Major Road

Legend

 $\overline{}$

Minor Road

Waterbody

Cadastre

IS297705



DATA SOURCES

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© Commonwealth of Australia (Geoscience Australia) 2006 Geodata Topo 250k Series 3; Vicmap Data © State of Victoria 2019; Jacobs & GHD 2019-2020.

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Figure 4-2 Hillshade Guttrum and Benwell Forests



 $Path: J: IE\Projects\03_Southern\IS297700\Spatial\ArcPro\AGP\Ecology\Guttrum\GuttrumBenwell_Ecology_Updated.aprx$



These figures of course present the situation in which such systems evolved, and where likely common prior to European development, particularly in recent times. However, in the context of the changes to river flow associated with the myriad of anthropogenic impacts previously discussed, such volumes and inundation frequencies are now rarely achieved, noting natural flow series provides almost annual flow events from 15,000 to 25,000 ML/d. Flows of 15,000 ML/d occur 80% of years and 25,000 ML/d occur 50% of years (Ecology Associates, 2013).

While the forests are generally a wetland forest system, they are almost completely dependent on the riparian contribution to maintain their aquatic elements. North Central CMA (2014) identified the large deficit between the annual rainfall input (400 mm/y) and the evapotranspiration loss (1,700 mm/yr), demonstrating the importance of riparian flow input to maintain the Guttrum – Benwell wetland forest system.

While the annual flooding associated with the late winter snow melt maintained the wetter elements of the forest wetland system and the associated obligate wetland species at lower elevations in the forest, larger weather events provided the periodic flooding in the higher terraces of the riparian unit, with corresponding flood tolerant (rather than dependant) species maintained. There was a similar inverse pattern associated with the drought cycles which are also a fundamental driver of local biodiversity. Many of the obligate wetland species have evolved to survive periods of drought through various adaptations to avoid periods of stress, many with above ground elements dying off during adverse conditions, rapidly regrowing in suitable conditions from below ground propagules. These have evolved over the millennia for the stable state condition associated with this environment, climate change impacts will further stretch the ability of these systems to maintain functionality, as the frequency of drought cycles is expected to increase, and the intensity of flood events may also increase (MDBA, 2019).

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 (refer Figure 4-3). Changes in land use within Guttrum and Benwell State Forests through forestry, grazing, visitation, horse riding, 4WD/dirt bikes have also modified vegetation types adding to the difficulty in determining EVCs. The vegetation of the Guttrum – Benwell 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. Results of previous mapping within the project area is provided in Table 4-3.

EVC #	EVC Name	Conservation status (DELWP)	Ecological Associates 2013	Biosis 2014	GHD 2017	R8 2019
56	Floodplain Riparian Woodland	Depleted	X	Х	Х	
106	Grassy Riverine Forest	Depleted	X	Х		Х
295	Riverine Grassy Woodland	Vulnerable	X	Х	Х	Х
653	Aquatic Herbland	Depleted		Х		
810	Floodway Pond Herbland	Depleted			Х	х
814	Riverine Swamp Forest	Depleted	Х	Х	Х	Х
815	Riverine Swampy Woodland	Vulnerable		х		
816	Sedgy Riverine Forest	Depleted	X	Х	Х	Х
819	Spike-sedge Wetland	Vulnerable	X	Х		
821	Tall Marsh	Least Concern	Х			

Table 4-3 EVCs detected by recent vegetation assessments in the project area





Figure 4-3 A paleo-channel within the forest that has not been engaged by floods for some time. The area may support Floodway Pond Herbland if regularly flooded.

4.2 Ecological Vegetation Classes (EVCs)

A total of 5 EVCs were identified during the field assessment (2019). It is noted that much of the forest system had lacked significant inundation since the 2017 flooding event. Parts of Guttrum forest had been subject to prolonged inundation since the 2017 event likely due to drainage issues and the Little Reed Bed Swamp in Guttrum Forest was subject to an artificial flooding program, all of which have a pronounced bearing on the ecological state of the forest system.

4.2.1 EVC 106: Grassy Riverine Forest

Grassy Riverine Forest is described as occurring on the floodplain of major rivers, in a slightly elevated position where floods are infrequent (DELWP,2020). In the context of the Guttrum – Benwell Forests EVC 106 is generally associated with the natural levee systems that form along the banks of the main riparian conduits or remain along the edges of relatively recent paleo-channels (Figure 4-4).

EVC 106 was recorded along the edge of the Murray River in the north and was intersected in the south where the construction footprint crossed the outer edge of a paleo-channel. EVC 106 is a *Eucalyptus camaldulensis* dominated community generally over a sparse shrub layer (commonly *Exocarpus stricta* and *Acacia dealbata*) on a graminoid dominated ground cover (*Carex, Poa, Panicum* and *Juncus* species.). It is a narrow strip usually around 10 m wide, although this varies throughout the forests. The natural levee systems upon which EVC 106 generally occur are usually the last places in the forest to be inundated, at around the 32,000 ML/d flood level (Ecology Associates, 2013).



Water regime data (Table 4-2) suggests a critical flood interval of 4 years, frequency 8 in 10 years and minimum duration if 1 – 4 months (Ecology Associates, 2013). The overstory is likely to be watered from the adjoining river, resulting in relatively stable canopy health irrespective of drought conditions, creating a crucial fauna refuge during dry period for arboreal animals.

Much of the area supporting EVC 106 is heavily utilised for camping, resulting in loss of ground cover and removal of understorey species (Figure 4-5). The area mapped as EVC 106 in the southern portion of Guttrum is currently treeless, possibly an artefact of grazing management within the forest, where such areas provide good grazing and more importantly flood refuge for cattle.



Figure 4-4 Grassy Riverine Forest in the vicinity of the Benwell pump station location, grassy understory in the foreground and modified through vehicle access in the background, which characterises much of EVC 106.





Figure 4-5 A regrowth area of Grassy Riverine Forest where access has been restricted. A grassy ground cover has established and understorey redeveloping.

4.2.2 EVC 295: Riverine Grassy Woodland

Riverine Grassy Woodland is described as occurring on the floodplain of major rivers, in a slightly elevated position where floods are rare (DELWP,2020). In the context of the Guttrum – Benwell Forests this EVC tends to occupy the higher terraces away from the River, with a slightly lower *Eucalyptus camaldulensis* overstorey similar to EVC 106. EVC 295 includes the transition to Black Box Chenopod shrubland and includes chenopod as well as graminoid elements. EVC 295 is considered to be more associated with the riparian alluvial plains, rather than the elevated natural levees.

Species that define the local extent of EVC 295 include various *Chenopodium* and *Atriplex* species with a sparse covering of graminoids including *Rytidosperma*, *Austrostipa* and *Juncus* species (Figure 4-6).

EVC 295 recorded on the outer edge of the Guttrum – Benwell forest systems is dominated by *Eucalyptus camaldulensis* overstorey graduating to *E. largiflorens* in one small area in the southern portion of the Guttrum system with a more pronounced chenopod groundcover. Areas of this EVC are significantly stressed throughout the forest, most likely due to lack of recent flooding in most areas, resulting in a sparse to absent graminoid cover. It is also noted that in the southern section of Guttrum forest there is a decline in condition of this EVC, particularly in the canopy species present, which based on field observations appears to be associated with saline conditions (Figure 4-7).

There are large extents of EVC 295 throughout the forest systems, which appear to be inundated at flows well above 26,000 ML/d, appearing to be almost completely inundated by 32,000ML/d (Ecology Associates, 2013). Table 4-2 suggest flood frequency is in the order of 5 in 10 years (Ecology Associates, 2013) or 2-3 years in 10 years with duration requirement being from less than a month's (Fitzsimons et al., 2011) to 1-3 months (Ecology Associates, 2013), although EVC 295 would appear to be a flood tolerant, rather than obligate system.





Figure 4-6 Riverine Grassy Woodland outside of the constructed levee system, and likely to have not been subjected to required flooding for the recruitment of over storey species.





Figure 4-7 Riverine Grassy Woodland in the southern area of Guttrum Forest with significant declines in tree health likely to be impacted from a lack of flooding and possible salinity issues.

4.2.3 EVC 810 Floodway Pond Herbland

Floodway Pond Herbland is described as a low (<0.3 m) tall, with occasional emergent life forms, with a large proportion of ephemeral species, associated with the floors of ponds associated with floodway systems. Floodway Pond Herbland are generally smaller wetlands with a more regular flooding and drying cycle than the otherwise similar Lake Bed Herblands. In the context of the Guttrum – Benwell forests EVC 810 is particularly associated with the small inlet channels off the Murray River where floods enter the forest, and the connected, smaller paleo-channels within the forests (Figure 4-8).

There are only small extents of EVC 810 throughout the forest systems, which would be the first areas inundated at over bank events at flows above 18,000 ML/d (Ecology Associates, 2013). Table 4-2 suggest flood frequency is in the order of 9 in 10 years (Ecology Associates, 2013) or 2-3 years in 4 years with duration requirement being from 6 -12 months (Fitzsimons et al., 2011) to 3 - 6 months (Ecology Associates, 2013), making EVC 810 an obligate wetland community or flood dependant system.

When present, the obligate wetland species include a sedgy element of *Carex*, *Eleocharis* and *Juncus* species, then *Persicaria*, *Ranunculus*, *Cycnogeton* and *Azolla* species (Figure 4-9).





Figure 4-8 Floodway Pond Herbland lacking inflow.





Figure 4-9 Inundated(albeit from an irrigation channel to the south) Floodway Pond Herbland

4.2.4 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 cover primarily leaf-litter (Figure 4-10), black water or exposed alluvium. 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 Guttrum – Benwell most areas of EVC 814 were in a dry phase, with no understorey apparent. A highquality patch was recorded just outside the constructed levee in the south, maintained by a leaking irrigation channel. EVC 814 was the treed EVC with the lowest elevation, occurring above the Pond Herbland and transitioning into the Sedgy Riverine Forest. EVC 814 appears to be flooded around the 22,000 ML/d flow (Ecology Associates, 2013), and is reported to require flooding 8 in 10 years for 2 – 5 months (Ecology Associates, 2013), or 2 – 4 years engagement in 4 years, inundated for 4 – 7 months with a critical interval of 3 years (Fitzsimons, et. al., 2011).

When present, the obligate wetland species include a sedgy element of *Carex* and *Juncus* species, then *Persicaria*, *Ranunculus*, *Poa* and *Nardoo* (Figure 4-11-).

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.





Figure 4-10 Area of Riverine Swamp Forest, lacking the obligate wetland groundcover, but showing the heavy leaf litter cover that characterises this EVC during dry periods.





Figure 4-11- Obligate wetland understorey including elements of Riverine Swamp Forest (also refer to Figure 4-9)

4.2.5 EVC 816 Sedgy Riverine Forest

Eucalypt forest to 25 m with a sedge dominated understorey dependant on occasional shallow flooding on heavy soils usually saturated in winter. EVC 816 (Figure 4-12) is a transition EVC between the Riverine Swamp Forest and the Riverine Grassy Woodland in areas of infrequent flooding subject to short periods of inundation.





Figure 4-12 Under dry conditions only the Carex sedge element persists.

There are large extents of EVC 816 throughout the forest systems, sitting between the higher grassy forests and lower swampy forest structures. EVC 816 appears to be inundated at flows around 26,000 ML/d (Ecology Associates, 2013). Table 4-2 suggest flood frequency is in the order of 8 in 10 years (Ecology Associates, 2013) or 1-3 years in 5 years with duration requirement being from 2-5 months (Fitzsimons, et. al., 2011) to 1-3 months (Ecology Associates, 2013).





Figure 4-13 Sedgey element apparent in areas currently under environmental watering in the Guttrum forest.

4.3 Large Old Trees (LOTs)

Large Old Trees are prescribed in the Benchmark relevant to each treed EVC assessed. Large old trees are 80 – 90 cm (dbh) for the treed EVCs assessed throughout the forest. The majority of the Guttrum – Benwell forest lacks large old trees, noting a number of very large old trees (described below) remain, but the specific age class associated with the 80 – 90 cm dbh seem rare. This is likely a function of historic logging activities undertaken throughout the forests.

However, there are a disproportionate number of LOTs mapped in the Guttrum – Benwell Forests 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 creating the density of LOTs on the levees recorded. A germination event of River Red Gums associated with an early fill of the system, resulting in a large cohort of Large Old Trees occurring on the levees (Figure 4-14). 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 219 LOTs were identified and mapped within the construction footprint. (It is important to note a section of the west Guttrum system has yet to be included

Each LOT 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 K).





Figure 4-14 Large Old Trees along an existing constructed levee, all from the same recruitment cohort along the inside of the historic levee.

4.4 Very Large Old Trees (VLOTs)

A number of Very Large Old Trees persist within the Guttrum – Benwell forest system. Although not specifically required as a criteria under the current Guidelines, VLOTS were a part of the original Native Vegetation Framework (DSE, 2003). VLOTS were defined as 1.5 x LOT DBH. VLOTS were picked up in this assessment as trees with a DBH > 150cm, to indicate those considered to have outstanding natural heritage significance (Figure 4-15).

VLOTs are exceptional natural heritage remnants of pre-European landscapes, providing enormous value to biodiversity in the provision of numerous habitats features not apparent in a sub-mature tree, including a number of tree hollows of varying size and orientation, bark fissures, and large internal hollows. Without core samples it is difficult to determine the age of these trees, but ages in the realms of 1,000 years is entirely possible (CSIRO, 2020). Many of these VLOTs have significant indigenous values and are detailed further in the cultural heritage reporting.

Large old trees were selectively removed, initially due to the provision of large volumes of timber for the steam boilers that powered much of the early transport and power of the period of early European settlement, then later, removed for the perceived competition to other individual trees during the commercial forestry period. Several ring-barked standing stags in the Guttrum forest remain, still providing the habitat value.

A total of 47 VLOTs were identified and mapped within development footprint.





Figure 4-15: Very Large Old Tree identified during the field assessment, DBH of 3.6 m and circumference of 12 metres.

4.5 Threatened Communities

4.5.1 EPBC-listed threatened communities

The PMST identified five ecological communities with potential to occur within the study area (Table 4-4)

None of these communities is consistent with vegetation mapped or modelled within either the construction footprint or inundation area. None of these communities were identified during the field assessment or in previous assessments (Biosis 2014; GHD 2017) within the Guttrum Forest and Benwell Forest project area.

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

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, <i>et. al.</i> , 2011).
Grey Box (<i>Eucalyptus</i> <i>microcarpa</i>) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia	Endangered	Not Present . Not detected in 2019 and no matching vegetation communities identified in previous assessments. Key diagnostic species (<i>Eucalyptus microcarpa</i>) not encountered.
Natural Grasslands of the Murray Valley Plains	Critically Endangered	Not Present . Not detected in 2019 and no matching vegetation communities identified in previous



Community	Conservation Status	Likelihood of Occurrence
		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).
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).

The EVCs previously mapped within the project area also do not correspond with the descriptions of any threatened communities listed under the FFG Act (DELWP 2018).

4.5.2 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 Guttrum and Benwell Forests project area

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.

4.6 Wetlands

4.6.1 Wetlands of international significance

According to a PMST Search, the Ramsar Wetlands Gunbower Forest, NSW Central Murray Forests and Kerang Wetlands are all within 10 km. An additional four Ramsar Wetlands were identified 150-400 km downstream of the Guttrum and Benwell Forests project area (Hattah-kulkyne lakes, Banrock Station Wetland Complex, Riverland and the Coorong, and Lakes Alexandrina and Albert Wetland).

The closest and most relevant is the NSW Central Murray Forests Ramsar Wetland which occurs across the Murray River from the Guttrum and Benwell Forests. The specific boundary of the Ramsar site is not clearly defined, but is assumed to follow the northern bank of the Murray river based on mapping available from the Australian Wetland Database (DAWE, 2020c). The NSW Central Murray Forest Ramsar site is considered discrete from the Guttrum-Benwell forest system and more specifically the construction footprint.

4.6.2 DELWP mapped wetlands

Eleven DELWP mapped wetlands occur within the Guttrum and Benwell forest system (Table 4-5). 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 the nature of works aimed at restoring 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.



Table 4-5 DELWP Mapped Wetlands (DELWP, 2020a)

Wetland ID	Name	Comment on wetland characteristics	Area (Ha)
45201	Benwell Swamp (South)	Apparently engaged by high flow events over an internal rise and possibly historic infrastructure associated with the former Benwell Reservoir, this area appears to hold water for prolonged periods of time. The terrain model (Figure 4-2) suggests this wetland was engaged from the paleo-channel from the south west, now blocked by the boundary levee.	22.09
45202	Benwell Swamp	Engaged directly from the Murray at moderate flows.	16.73
45208	Benwell State Forest	Refers to the entire Benwell State Forest and all the associated wetland/vegetation systems. Engaged directly from the Murray River through high flow events.	648.33
45212	(Guttrum North West)	Low point on upper western boundary engaged from flood runner within forest.	16.27
45213	(Guttrum West)	Low point on middle western boundary engaged from flood runner within forest.	6.83
45215	(Guttrum South West)	Low point on lower western boundary engaged from flood runner within forest.	22.97
45218	Guttrum Swamp	Low point in middle north of Guttrum engaged from Murray.	63.43
45221	Guttrum State Forest	Refers to the entire Guttrum State Forest and all the associated wetland/vegetation systems. Engaged directly from the Murray River through high flow events.	1204.16
45226	Little Reed Bed	Small open pond system, usually holding water most of time, encountering only short periods of dryness under natural regimes.	4.61
45228	Reed Bed	Large open pond system, usually holding water most of time, encountering only short periods of dryness under natural regimes.	42.88
45230	(Guttrum East)	Cut-off billabong capturing over bank events. Outside area of project influence project.	3.5



5. Targeted Threatened Species Surveys

Targeted surveys for rare or threatened species were undertaken in October to November 2019 within areas of the area of investigation where potential habitat was identified, these areas contained intact native vegetation and it was considered possible that they supported suitable habitat of varying qualities for rare or threatened species.

Targeted surveys were not undertaken in the construction footprint at Benwell Forest around the South-west regulator and Outlet 2 (approximately 700 m length) as design changes to these components occurred following the completion of field surveys. Further surveys in this area are recommended as part of the design and approvals process for the project.

5.1 Threatened Flora Assessment

5.1.1 Desktop Assessment and Likelihood of Occurrence

VBA and PMST searches as well as previous studies in the project area (Bennetts 2014, Biosis 2014b, GHD 2017) identified nine EPBC and/or FFG listed flora species that have been recorded within the study area, and a further eleven species listed as rare or threatened on the Advisory list of Rare and Threatened Plants in Victoria (DEPI 2014).

Each of these species has been assessed for their likelihood of occurrence and impact within the construction footprint (Appendix C) and inundation area (Appendix D), taking into account factors such as the habitat requirements of each species and comparing those to the habitats encountered within the Guttrum Forest and Benwell Forest construction footprint, and also the number of recent records within the study area

Some species have been identified as 'possibly occurring' within the construction footprint but as having a low likelihood of being impacted. This has arisen in situations where even though preferred habitat is present (meaning likelihood of occurrence is possible), an impact on these species has been deemed as unlikely, as the species has not been recorded during targeted surveys at the appropriate time of the year. However, it should be noted that due to the prevailing drought conditions, the response of many ephemeral species has been muted, and absence during the 2019 targeted surveys does not necessarily imply that the species is not present – it may still reside in the soil as underground tubers, rootstock or seed, waiting for appropriate moisture to trigger germination.

Number of rare or	Cor	Construction Footprint			Inundation Area		
threatened flora	Total	EPBC	FFG	Total	EPBC	FFG	
Present	4			9*	1	1	
Possible	10	2	1	5	1	1	
Unlikely	3	3	1	3	3		
Highly Unlikely	3	3		3	3		
Total	20^	8	2	20^	8	2	

Table 5-1 Overview of likelihood of occurrence assessments for rare or threatened flora

* Determined from previous assessments within the inundation area (Bennetts 2014, Biosis 2014b)

^Includes DELWP Advisory listed rare and threatened flora

5.1.2 Field survey results

No EPBC listed or FFG listed threatened flora species were recorded during the current surveys. Three species listed as rare or threatened in Victoria under the DELWP Advisory list of rare or threatened plants were recorded.



These included Leek Flax-lily (*Dianella porraceae*) listed as vulnerable and two rare species Bulging Fireweed (*Senecio campylocarpus*) and Branching Groundsel (*Senecio cunninghamii var. cunninghamii*) listed as rare (DEPI 2014) were identified in the construction footprint, as summarised in Table 5-2. The location of threatened species identified during the 2019 surveys and in previous assessments are shown in Figure 5-1.

Table 5-2 Summary of threatened flora recorded during 2019 surveys

Species Name	Conservation Status	Location
Bulging Fireweed (Senecio campylocarpus)	Rare – DELWP Advisory List	Relatively common throughout forests.
Branching Groundsel (Senecio cunninghamii var. cunninnghamii)	Rare – DELWP Advisory List	Near Benwell Pump Station and Guttrum East Pump Station
Leek Flax-lily (<i>Dianella porraceae</i>) – formally known as <i>Dianella</i> sp af. <i>longifolia</i> (Riverina)	Vulnerable – DELWP Advisory List	3 individuals in the east of Guttrum Forest

5.1.3 Presence of EPBC Act-listed flora

No EPBC listed flora species were identified during R8 targeted surveys within the area of investigation or other previous surveys within areas of the construction footprint (Biosis 2014a, GHD 2017). However, one species, River Swamp Wallaby-grass is known to occur within the inundation area, and another, Winged Peppercress is considered to have the potential to occur within the inundation area under more favourable flooding conditions.

Of the eight EPBC Act-listed flora species that were identified by the PMST (10 km radius), the likelihood of occurrence for listed flora species in the construction footprint is detailed in Appendix C. None of the flora species identified during the desktop assessment are considered likely to occur within the Construction Footprint:

- One species, Amphibromus fluitans (River Swamp Wallaby-grass) is considered possible to occur in the construction footprint. The species has been recorded within the inundation area along watercourses and swamps (Biosis 2014b). Limited suitable habitat is present within the construction footprint and targeted surveys did not record the presence of the species.
- One species, *Lepidium monoplocoides* (Winged Peppercress) is considered **possible** to occur in the construction footprint. A small area of suitable habitat within the area of investigation was identified where Black Box occurs on the upper terraces. Targeted surveys did not record the presence of the species in the construction footprint.
- Three species are considered **unlikely** due to the absence of suitable habitat within the construction footprint and/or inundation area, and the lack of records within 50 km of Guttrum-Benwell: *Sclerolaena napiformis* (Turnip Copperburr) and *Swainsona murrayana* (Slender Darling-pea), and 20 km of Guttrum-Benwell, *Maireana cheelii* (Chariot Wheels).
- One is considered **highly unlikely** due to the absence of suitable habitat within the construction footprint and/or inundation area, and the lack of any records within 150 km of Guttrum-Benwell: *Caladenia tensa* (Greencomb Spider-orchid)
- Two are considered **highly unlikely** to occur as they are species only known to occur in NSW: *Austrostipa wakollica* (Spear Grass) and *Austrostipa metatoris* (Spear Grass)

River Swamp Wallaby-grass (Amphibromus fluitans)

River Swamp Wallaby-grass, listed as Vulnerable under the EPBC Act, is considered 'possible' to occur within parts of the project area, and has been previously located in four locations (Biosis 2014b) within the wetland forests:

Reed Bed



- Little Reed Bed
- Benwell Swamp; and Benwell Swamp South

The locations where River Swamp Wallaby-grass was located are areas of prolonged waterlogging/inundation (as evidenced by the location of local records). River Swamp Wallaby-grass is considered relatively common in the small area of remaining habitat (NSW OEH 2013) in the low-lying areas of northern Victoria. River Swamp Wallaby-grass has been specifically impacted by the damage hard-hooved animals, particularly cattle, have had on the wetland environments across its relatively large range (DAWE, 2020a).

Winged Peppercress (Lepidium monoplocoides)

Winged Peppercress, listed as Endangered under the EPBC Act, is considered 'possible' to occur within the project area, but has not been previously recorded in the Guttrum-Benwell Forest system. If present, Winged Peppercress is likely to occur on the upper alluvial terraces, where it is exposed to periodic inundation under large flooding events. It is associated with Blackbox Chenopod shrubland (understorey dominated by *Atriplex*, *Maireana* and/or *Nitraria* species (Mavromihalis, 2010) which is only apparent in one small area in the far south of the Guttrum Forest.

Winged Peppercress has suffered a similar, but more severe decline to River Swamp Wallaby-grass, where loss of exposure to flooding events and the impact of hard-hooved herbivores have impacted the species resulting in an Endangered listing under the EPBC Act. While it is likely the species occurred within the Guttrum – Benwell forests, it has not been detected. Given the species is known from upstream areas it follows that the species has occupied the site in the past and could recolonise as suitable conditions (flooding of upper terraces and removal of cattle) are restored. The mid Murray forests occur in the south east edge of the species distribution, with its natural range extending into the arid zone to the north west (DAWE, 2020b).

Winged Peppercress is also listed under the FFG Act and recorded on the Victoria Advisory List (Endangered).

Inundation Area

The likelihood of occurrence and impact for threatened flora in the inundation area has been assessed at a desktop level only. Of the eight EPBC Act listed species, only two are considered likely to occur in the inundation area (see Table 7-1 and Appendix D). River Swamp Wallaby-grass (known – previously recorded by Biosis 2014b in low-lying swampy areas) and Winged Peppercress (possible), as flood responders, are likely to benefit from the restoration of a more natural inundation cycle.

A conservative approach to EPBC listed species has been taken for this assessment and all eight species above have been assessed as possibly occurring within the inundation area only. These species have also been considered further to demonstrate that they are unlikely be adversely impacted by the proposed project.

5.1.4 Presence of FFG Act-listed and DELWP Advisory-listed threatened flora

Species listed as threatened under the FFG Act along with species considered rare or threatened under the DELWP Victorian Advisory List for Rare or Threatened Species (DEPI 2014) were recorded within the area of investigation during the current surveys (section 3.4.2).

No FFG listed flora species were identified during the 2019 R8 targeted flora surveys within the area of investigation, however one species, Wavy Marshwort (*Nymphoides crenata*) has previously been recorded (Biosis 2014, VBA 1989) within 100m of the current construction footprint at the proposed regulator site at Benwell Forest. The other FFG Act listed species, Winged Peppercress assessed is also to considered to have the potential to occur, as discussed above in section 7.2.1.

Seven species listed under the DELWP Advisory list of rare or threatened plants identified in searches of the VBA were considered as Possible to occur within the project area. Three of these were confirmed as occurring within the construction footprint during R8 2019 surveys and one was confirmed during previous surveys of the construction footprint (Biosis 2014a):



- Bulging Fireweed (Senecio campylocarpus)
- Branching Groundsel (Senecio cunninghamii var. cunninnghamii)
- Leek Flax-lily (*Dianella porraceae*) formally known as *Dianella sp af. longifolia* (Riverina)
- Riverina Bitter-cress (*Cardamine moirensis*) identified during previous surveys (Biosis 2014a)

Inundation Area

The likelihood of occurrence for threatened flora in the inundation area has been assessed at a desktop level only based on VBA records and previous assessments within the inundation area (Ecological Associates 2013, Bennetts 2014, Biosis 2014b). Of the nineteen FFG Act and DELWP Advisory listed flora species, all are considered to be flood-dependent or flood-tolerant species and area likely to benefit from the restoration of a more natural inundation cycle (see Table 7-1 and Appendix D).

5.1.5 Presence of FFG Act-protected flora

During R8 surveys in 2019, twelve flora listed as protected under the FFG Act were recorded within the area for investigation. These species and their approximate abundance within the construction footprint is provided in Table 5-3.

The populations of some of these species will vary from year to year. Some of these species are annuals, and/or may be dormant and unidentifiable during any one season, therefore it is difficult to estimate the exact number of each species that will be directly impacted by the vegetation removal associated with the proposed works when construction commences. However, an estimate of the number of individuals that will likely be impacted based on the construction footprint is provided below, taking in to account the data from the 2019 surveys.

The protected flora outlined below are also likely to be present within the inundation area.

Scientific Name	Common Name	Approximate abundance within the construction footprint
Acacia dealbata	Silver Wattle	10-20
Azolla rubra	Pacific Azolla	10-20
Calocephalus sonderi	Pale Beauty-heads	5-10
Calotis scapigera	Tufted Burr-daisy	5-10
Centipeda cunninghamii	Common Sneezeweed	100-200
Euchiton involucratus s.l.	Common Cudweed	200-300
Marsilea drummondii	Common Nardoo	300-500
Senecio campylocarpus	Bulging Fireweed	20-50
Senecio cunninghamii var. cunninnghamii	Branching Groundsel	5-10
Senecio quadridentatus	Cotton Fireweed	200-300
Vittadinia cuneata	Fuzzy New Holland Daisy	50-100
Xerochrysum bracteatum	Golden Everlasting	100-200

Table 5-3 FFG Act protected flora recorded in the construction footprint 2019



5.2 Threatened Fauna Assessment

5.2.1 Desktop assessment and Likelihood of Occurrence

VBA and PMST search identified 61 rare or threatened fauna species previously recorded or with the potential to occur within the study area, that are EPBC Act listed (20) and/or FFG Act listed (38). A further 20 species are listed as rare or threatened on the Advisory list of Rare and Threatened Fauna in Victoria (DSE 2013).

Each of these species has been assessed for their likelihood of occurrence and impact within the construction footprint (Appendix E) and inundation area (Appendix F), taking into account factors such as the habitat requirements of each species and comparing those to the habitats encountered within the Guttrum Forest and Benwell Forest construction footprint, and also the number and frequency of records within the study area.

Forty-nine (49) of these species are considered possible to occur within the construction footprint or inundation area (see Appendix E and Appendix F for rationale). These species are summarised in Table 7-3.

Number of rare or threatened fauna	Cons	Construction Footprint		Inundation Area		
	Total	EPBC	FFG	Total	EPBC	FFG
Present	8	1	3	7	0	3
Possible	21	4	17	42	8	26
Unlikely	21	4	10	2	2	1
Highly Unlikely	11	11	8	10	10	8
Total	61^	20	38	61^	20	38

Table 5-4 Overview of likelihood of occurrence assessments for rare or threatened fauna

^Includes DELWP Advisory listed rare and threatened flora

5.2.2 Field survey results

During field surveys of the Guttrum and Benwell construction footprint between October 14-17 and 22-25, 2019, R8 Ecologists identified a total of 56 fauna species, including one FFG Act listed threatened species, one listed as endangered and three listed as near threatened on the Advisory list of Rare and Threatened Fauna in Victoria (DSE 2013). A summary of all fauna species recorded during the surveys, including targeted Squirrel Glider and Grey-crowned Babbler surveys is provided in Appendix I and summarised below.

A single White-bellied Sea Eagle (*Haliaeetus leucogaster*, FFG listed and DELWP Advisory listed vulnerable) was observed flying overhead the project area, however is expected to use the Murray River (outside the construction footprint) primarily for foraging and nesting. Two Lace Monitors (*Varanus varius*, DELWP Advisory listed endangered) were observed whilst driving across the project area. The Brown Treecreeper (DELWP Advisory listed near threatened) was abundant across dried floodplain woodland in the project area, and other near threatened species observed, the Emu (5) and Glossy Ibis (2) are highly mobile species, the latter observed at the artificially-inundated Reed Bed Swamp in 2019.

Table 5-5 Summary	of threatened	fauna recorded	during 2019 surveys
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Species Name	Conservation Status	Location(s)
Brown Treecreeper (Climacteris picumnus)	DELWP Advisory list – near threatened	Multiple individuals across the Guttrum and Benwell Forests project area



Species Name	Conservation Status	Location(s)
Emu (Dromaius novaehollandiae)	DELWP Advisory list – near threatened	Access tracks to Benwell East regulator A group of 5 were recorded
Glossy Ibis (Plegadis falcinellus)	DELWP Advisory list – near threatened EPBC Migratory	Reed Bed (500 m from the Reed Bed Swamp Regulator) Two individuals seen during the artificial flooding of Reed Bed Swamp in 2019.
Lace Monitor (<i>Varanus varius</i>)	DELWP Advisory list – endangered	Access tracks to Benwell East regulator Two individuals seen on separate days
White-bellied Sea Eagle (<i>Haliaeetus leucogaster</i>)	FFG – listed threatened DELWP Advisory list - vulnerable	Benwell East regulator One individual seen flying overhead

General observations of habitats within the Guttrum and Benwell construction footprint consisted of areas of dried floodplain forest containing large old River-Red Gum providing many hollows, cracks, fissures and loose bark which provide many fauna habitat vales. Many trees throughout the project area appear stressed.

5.2.3 Squirrel Glider arboreal remote-sensor camera survey results

Targeted arboreal camera surveys undertaken for Squirrel Glider did not confirm the presence of the species across the area of investigation. A total of 23 species (15 birds, 7 mammals and 1 reptile) were recorded across the 30 cameras, including the related Sugar Glider (*Petaurus breviceps*) recorded on three cameras (Appendix L). A full list of species recorded during camera surveys is provided in Appendix H and the location of arboreal cameras shown in. Figure 5-1.

The absence of this species during targeted surveys and given there are no previous records, suggests the construction footprint is unlikely to support critical habitat for the Squirrel Glider, however it does not rule out the species from occurring. Camera survey locations were chosen on the best available habitat in the Area of investigation. Suitable hollow-bearing, habitat trees for the species are present throughout the project area, including areas in the construction footprint that were not subject to targeted surveys. Targeted survey locations were mainly along levee banks on the outer edge of the forest, which due to edge effects for this small-ranging gliding marsupial, is likely to provide less suitable habitat than the majority of the broader project area. Limited wattle (important foraging trees) species and density were recorded across the Area of investigation, also indicating the dryer outer forest may not provide suitable habitat, however this may change with a returned flooding regime.

Potential impacts to the species, along with avoidance and mitigation measures are further discussed in Section 7.3 and Section 9.

5.2.4 Grey-crowned Babbler targeted survey results

Targeted surveys for the Grey-crowned Babbler in October 2019 did not detect the species or any nests within the construction footprint and survey locations within the Area of investigation, shown in Figure 5-1. A total of 45 bird species were recorded during the morning surveys across three days, which targeted areas of suitable habitat for the Grey-crowned Babbler. A full list of species recorded is shown in Appendix I.

The Grey-crowned Babbler is a social and highly-mobile species that live in territorial groups of up to 15 birds and have a very large home-range. Many records of the species exist within the Guttrum and Benwell Forests, most notably between 1996 and 1997 (32 VBA records) occurring from surveys undertaken by Chris Tzaros (Birdlife Australia). Fewer recent records exist, but notably the species was recorded by Biosis (2014a) along the western levee bank at Benwell Forest, Bennetts (2014) in Guttrum Forest and GHD (2017) in Benwell Forest.



Given the size of Guttrum and Benwell Forests, it is likely that multiple territorial colony groups of Grey-crowned Babbler occur in the surrounding forest of the construction footprint. The absence of any nests and individuals during targeted surveys, suggests the construction footprint is unlikely to support critical habitat for the species.

Potential impacts to the species, along with avoidance and mitigation measures are further discussed in Section 7.3 and Section 9.

5.2.5 Likely presence of EPBC Act listed fauna species within the proposed construction footprint

No EPBC Act listed fauna species were recorded during targeted surveys in 2019 or in previous assessments within the project area (Biosis 2014a; GHD 2017).

Five EPBC Act listed fauna species were identified as possibly occurring within the construction footprint and/or inundation area:

- Painted Honeyeater (Grantiella picta)
- Superb Parrot (Polytelis swainsonii)
- South-eastern Long-eared Bat (Nyctophilus corbeni)
- Murray Cod (Maccullochella peelii)
- Silver Perch (Bidyanus bidyanus)

A conservative approach to EPBC listed species has been taken for this assessment and a further three species, have been assessed as possibly occurring within the inundation area only

- Growling Grass Frog (Litoria raniformis)
- Australasian Bittern (Botaurus poiciloptilus)
- Australian Painted Snipe (*Rostratula australis*)

Painted Honeyeater (Grantiella picta) (Vulnerable)

The Painted Honeyeater is nomadic and occurs at low densities throughout its range. The species is sparsely distributed from south-eastern Australia to north-western Queensland and eastern Northern Territory. The greatest concentrations and almost all records of breeding come from south of 26°S, on inland slopes of the Great Dividing Range between the Grampians, Victoria and Roma, Queensland (Higgins et al., 2001). During the winter it is more likely to be found in the north of its distribution. This species generally uses the following habitats:

- Inhabits Boree/ Weeping Myall (Acacia pendula), Brigalow (A. harpophylla) and Box-Gum Woodlands and Box-Ironbark Forests.
- A specialist feeder on the fruits of mistletoes growing on woodland eucalypts and acacias. Prefers mistletoes of the genus *Amyema*.
- Insects and nectar from mistletoe or eucalypts are occasionally eaten.
- Nest from spring to autumn in a small, delicate nest hanging within the outer canopy of drooping eucalypts, she-oak, paperbark or mistletoe branches.

The species exhibits seasonal north-south movements governed principally by the fruiting of mistletoe, with which its breeding season is closely matched (Barea and Watson, 2007). Many birds move after breeding to semi-arid regions such as north-eastern South Australia, central and western Queensland, and central Northern Territory. Considering its dispersive habits, the species is considered to have a single population (Garnett et al., 2011).

Painted Honeyeater is considered to have potential to utilise habitats within the proposed construction footprint and broader inundation area. This species has not been previously recorded within the study area, and very few records exist across the local landscape. They are known to be highly mobile and have the potential to rarely forage in the Guttrum and Benwell Forests.



Superb Parrot (*Polytelis swainsonii*) (Vulnerable)

The Superb Parrot is found in NSW and northern Victoria, where it occurs on the inland slopes of the Great Divide and on adjacent plains, especially along the major river systems. In Victoria, it is confined to the north of the state with the majority of records and known breeding locations in Barmah State Forest/State Park.

The species inhabits the following forests and woodlands:

- Large, mature River Red Gums (*E. camaldulensis*) or Blakely's Red Gum (*E. blakelyi*) close to watercourses
- Occasionally nesting or foraging in Yellow Box (*E. melliodora*), Grey Box (*E. microcarpa*) or Red Box (*E. polyanthemos*)

Superb Parrot is considered to have potential to utilise habitats within the proposed construction footprint and broader inundation area. Although extensive suitable Red Gum forest habitat exists, this species has not been previously recorded within the study area, with the closest and main population known from Barmah State Forest 50-100 km further east upstream of the Murray River. The Superb Parrot is a well-studied species, which has undergone significant range contractions over the last 100 years due to habitat loss and competition for nesting sites, trapping for the pet industry and road collisions (Baker-Gabb 2011).

South-eastern Long-eared Bat (Nyctophilus corbeni) (Vulnerable)

The South-eastern or Corben's Long-eared Bat is considered unlikely to occur within the construction footprint or inundation area of the Guttrum and Benwell Forests, and has not been recorded previously within the study area. It has however been considered further due to its relatively poorly understood status in Victoria in regards to habitat preferences and use. This species has a scattered distribution, mostly within the Murray-Darling Basin, but with some records outside of this area. It is known to inhabit a variety of vegetation types, but is distinctly known to occur in Box / Ironbark / Cypress-pine vegetation along the western slopes and plains of NSW. It roosts in tree hollows, crevices and under loose bark, and is a slow flying agile bat that hunts for non-flying prey, especially caterpillars and beetles (OEH 2012). Threats to the species include habitat loss and fragmentation, fire and reduction of hollow availability.

The species has not been recorded in the project area and was not recorded during bat surveys in the construction footprint in 2017 (GHD 2017). The closest records in Victoria to the project area are in old growth mallee vegetation around the Hattah township and Hattah-Kulkyne National Park, over 150 km to the north/west. It is considered unlikely that this species utilises Red Gum forests and woodland habitats within the Guttrum-Benwell project area, and that if it does occur, it is likely to be in extremely low numbers.

Murray Cod (Maccullochella peelii peelii) (Vulnerable)

The Murray Cod (*Maccullochella peelii peelii*; EPBC Act listed Vulnerable) is known to occur in the Murray River alongside the project area and is considered a main channel specialist. Murray Cod occurs naturally in the waterways of the Murray-Darling Basin (ACT, SA, NSW and Vic) and is known to live in a wide range of warm water habitats from clear, rocky streams to slow flowing turbid rivers and billabongs (TSSC, 2003). The closest records for Murray Cod are located within the Murray River upstream of the project area at less than 1 km from Guttrum Forest and a further three records upstream within 6km of the project area at Barham, Koondrook and on the edge of the Gunbower State Forest (VBA, 2020). The species may enter the forest areas during inundation events, but seasonally inundated semi-permanent forest wetlands do not provide suitable long term habitat. Regardless of the records, presence within the main channels adjacent the site should be assumed.

Silver Perch (Bidyanus bidyanus) (Critically Endangered)

The Silver Perch (*Bidyanus bidyanus*; EPBC Act listed Critically Endangered) are known to occur in the Murray River alongside the project area. Silver perch are endemic to the Murray-Darling system, utilising a diversity of habitats but with a preference for faster-flowing water including rapids and races, and more open sections of a river (DoE, 2013a).

Silver Perch is known to occur in the River Murray, with the closest VBA (2020) record approximately 5 km south east of the project area and upstream of the Koondrook Weir. They are regularly encountered in the Murray River upstream and downstream of the project area and the Murray River in vicinity of project area has been mapped



as possible habitat by NSW Fisheries. They are a main channel specialist and are expected to be present in the Murray River in the project area from time to time. Although the species has not been recorded within the semipermanent wetlands of the project area, they may enter the forest areas during natural inundation events, but the seasonally inundated semi-permanent forest wetlands do not provide suitable long term habitat. As such, the species is considered as a possible occurrence within the construction area and inundation extent

Australasian Bittern (Botaurus poiciloptilus) (Endangered)

The Australasian Bittern occurs in terrestrial freshwater wetlands and, rarely, estuarine habitats (Marchant and Higgins 2004). It favors wetlands with tall, dense vegetation, where it forages in still, shallow water up to 0.3 m deep, often at the edges of pools or waterways, or from platforms or mats of vegetation over deep water (Marchant and Higgins 2004). The species favors permanent freshwater habitats, particularly those dominated by sedges, rushes and/or reeds (e.g. *Phragmites, Cyperus, Eleocharis, Juncus, Typha, Baumea, Bolboschoenus*) or cutting grass (*Gahnia*) growing over muddy or peaty substrate (Marchant & Higgins 1990; within DoE 2016c).

In Victoria the species is recorded mostly in the southern coastal areas and in the Murray River region of central northern Victoria (Jaensch 2005, as cited in DSEWPaC 2011). The species was last recorded in Guttrum Forest in Reed Bed Swamp in 1985, and two records occur within the study area at McDonald Swamp Wildlife Reserve from 2018, approximately 9 km south of the project area. The decline in wetland quality in Guttrum-Benwell Forests with the absence of sedges and rushes is indicative of an absence of this species, and a return of a naturally occurring flooding regime will enhance the future habitat availability for the Australasian Bittern.

Limited data are available about breeding requirements for this species but available data indicate that the Australasian Bittern breeds in relatively deep, densely vegetated freshwater swamps and pools, building its nests in deep cover over shallow water (Marchant & Higgins 1990; within DOE 2020a). In rush land, it may avoid breeding in the densest areas (Marchant & Higgins 1990; within DOE 2020a); alternatively, this may simply reflect the location of the few nests that have been found in wetlands that are difficult to access (Jaensch 2005, as cited in DoE 2020a).

The likelihood of this species using the project area as more than an occasional visitor is considered low given the bulk of the project area lacks the required habitat features for this species (tall, dense aquatic vegetation) and is comprised predominately of dry Red Gum forest and woodlands.

Australian Painted Snipe (Rostratula australis) (Endangered)

The Australian Painted Snipe is a rare, nomadic bird species that may turn up at any suitable wetland across Australia, when conditions are favourable. This species is widespread but rare throughout most of eastern Australia.

The Australian Painted Snipe generally inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans. They also use inundated or waterlogged grassland or saltmarsh, dams, rice crops, sewage farms and bore drains. Typical sites include those with emergent tussocks of grass, sedges, rushes or reeds, or samphire; often with scattered clumps of lignum *Muehlenbeckia* or canegrass or sometimes tea-tree (*Melaleuca*). The Australian Painted Snipe sometimes utilises areas that are lined with trees, or that have some scattered fallen or washed-up timber (Marchant & Higgins 1993 within DOE 2020b).

The species is reported to have been mainly recorded in the Murray-Darling region however in Victoria and NSW, known records (VBA, Atlas of NSW and ebird) indicate this to be more accurate for the region east of Swan Hill (DOE 2020b). Within the study area, there are no records of the species, and similar to the Australasian Bittern, the long absence is characteristic of the decline in wetland habitat within the Guttrum and Benwell Forests due to the lack of recent natural flooding.

The likelihood of this species using the project area as more than an occasional visitor is considered low given the majority of the project area lacks the required habitat features for this species (tall, dense aquatic vegetation) and is comprised predominately of dry Red Gum forest and woodlands.

Growling Grass Frog (Litoria raniformis) (Vulnerable)

The Growling Grass Frog is one of the largest frog species in Australia, and was once distributed across a large area of south-eastern Australia, including Tasmania. The species was previously widespread across Victoria and



absent only from the western desert regions and the eastern alpine regions (Littlejohn 1963, 1982; Hero et al. 1991 in Mahony 1999). The species has disappeared from most of its former range across Victoria, and persists in isolated populations in the greater Melbourne area, in the south-west of Victoria and a few sites in central Victoria and Gippsland (Atlas of Victorian Wildlife database cited in Clemann and Gillespie 2004).

Major watercourses such as the Murray River within the species' range have been substantially altered by impoundments, river regulation and irrigation release schemes. Alterations to the timing, frequency and extent of flooding events have resulted in dramatic changes to many natural processes, such as preventing or greatly reducing spring flood events across natural floodplains. Cold water releases from impoundments have had a considerable impact on downstream ecological processes and native fish populations (MDBC 2003), and are likely to adversely affect the development rates and survivorship of eggs and tadpoles. Natural flooding of floodplains probably triggered breeding activity in semi-arid areas in the past (Wassens 2006), and altered hydrological regimes have grossly modified natural processes around extant populations.

The Growling Grass Frog is considered to have potential to utilise habitats within the broader inundation area. The species has been recorded once in the project area but not within the last 30 years. It has been recorded four times previously within the study area, most recently in 2009 on a farm dam 5 km to the south-west of the project area. Despite the long absence of records of this species, the presence of suitable habitat, and the ability of this species to recolonise areas suggest that it has potential to occur in the area, and a reintroduction of more suitable ecological watering regimes may help facilitate this.

A broad analysis of potential Growling Grass Frog habitat (i.e. Ecological Vegetation Classes (EVC) across the Guttrum and Benwell Forests project area that have potential to support this species) was undertaken, specifically assessing the extent of wetland and associated EVCs within the inundation area. The analysis returned an area of potential habitat of 244 ha (includes wetland-dependent EVCs: EVC 819 Spike-sedge wetland , EVC 821 Tall Marsh, EVC 945 Floodway Pond Herbland/Riverine Swamp Forest Complex) This analysis at least at a broad level demonstrates that there is a very large area of potential habitat that may support this species when the appropriate episodic wetland conditions occur.

5.2.6 Likely presence of EPBC Act Migratory Species

Eleven species listed as migratory under the EPBC Act are predicted to occur, or were previously recorded from a VBA/PMST search of the study area (10 km buffer of the project area). None of these species were considered as likely to occur within the construction footprint during the time of the survey, mostly due to the lack of recent records within the construction footprint and/or a lack of suitable habitat present (see Table 7-3 and Appendix E for rational).

It is highly unlikely that the construction footprint supports habitat that will be considered important for migratory species foraging or breeding activity or support an ecologically significant proportion of a population of migratory species.

Similarly, from a desktop assessment, 11 EPBC Act listed Migratory Species were predicted to occur within the inundation extent and the broader study area (Table 5-6). One of these species, Glossy Ibis (*Plegadis falcinellus*) was recorded during field surveys at Reed Bed Swamp within the inundation area during artificial watering in 2019.

Scientific Name	Functional Group	Source	Construction Footprint	Inundation Area
Fork-tailed Swift (Apus pacificus)	Aerial bird	PMST / VBA		
Yellow Wagtail <i>(Motacilla flava)</i>	Aerial bird	PMST		
Satin Flycatcher (Myiagra cyanoleuca)	Aerial bird	PMST		
Common Sandpiper (Actitis hypoleucos)	Shorebird	PMST		

Table 5-6 Summary of EPBC listed migratory species known or with the potential to occur in the study area based on the PMST and VBA search and their associated likelihood of occurring in the project area



Sharp-tailed Sandpiper (<i>Calidris acuminate</i>)	Shorebird	PMST / VBA	
Curlew Sandpiper (Calidris ferruginea)	Shorebird	PMST / VBA	
Pectoral Sandpiper (Calidris melanotos)	Shorebird	PMST / VBA	
Eastern Curlew (Numenius madagascariensis)	Shorebird	PMST	
Common Greenshank (Tringa nebularia)	Shorebird	PMST / VBA	
Latham's Snipe (Gallinago hardwickii)	Wetland bird	PMST / VBA	Х
Glossy Ibis (Plegadis falcinellus)	Wetland bird	VBA	Х



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6. Overview of potential impacts

This section provides an overview of the proposed project construction and operational activities and an outline of the potential impacts that may be associated with them. The potential for impacts on listed threatened flora and fauna and native vegetation is assessed in Sections 7 and 8. Impact mitigation measures are discussed in Section 9.

6.1 Construction

It will be necessary to construct and/or upgrade a variety of water regulating structures and ancillary infrastructure in order to achieve the proposed environmental watering regimes and objectives (refer Sections, 1.3.1, 1.3.2 and 1.3.3). Construction activities would be undertaken in accordance with a CEMP and a variety of sub plans which consider the management of water, soils, flora and fauna.

Construction activities will include:

- Establishment of construction sites, including removal of vegetation, stripping and stockpiling of topsoil, establishing temporary parking and truck turnaround areas, laydown and stockpiling areas
- Removal of existing structures / block banks where required
- Construction / installation of new structures
- Rehabilitation of disturbed areas post-construction.

Construction activities may result in direct and indirect impacts (some permanent and some temporary) associated with:

- Removal, disturbance and lopping of native vegetation
- Borrow, import, excavation and placement of soil, clay, gravel and rock materials
- Movement of machinery, equipment and people
- Works in or adjacent to waterways and wetland areas
- Indirect impacts, e.g. noise, light, dust, etc. associated with construction.

6.2 Operation

Operational activities may also result in a range of positive and negative impacts associated with the managed inundation activities. These activities would be undertaken in accordance with the operating plan. Adaptive management is proposed in order to maximise the benefits and minimise the impacts of environmental watering activities. Direct and indirect impacts are potentially associated with:

- Inundation of vegetation communities
- Changed hydraulic regime with consequent changes to aquatic and terrestrial flora and fauna habitat (including pest species)
- Changes in water quality within the floodplain and associated with return flows to the River and main channels
- Changes to groundwater levels, quality and mobilisation of salt, noting these issues are regarded as being low risk due to the low to moderate salt store in the area and generally fresh to moderately saline groundwater (R8, 2020).



7. Impacts to threatened species and communities

The following chapter outline the impacts to threatened flora, fauna and communities resulting from the construction works proposed to be undertaken.

7.1 Potential impacts to threatened vegetation communities

7.1.1 Impacts to EPBC Act listed Threatened Ecological Communities

No communities listed as threatened under the EPBC Act have been identified within the proposed construction footprint or within the inundation extent, and therefore impacts to threatened ecological communities are considered unlikely.

7.2 Potential impacts to threatened flora

Modelling and previous assessments, both undertaken for this project and for other endeavours have identified several threatened flora species within the project area. Many of the species are cryptic flood responders by nature, these species were not detected during the 2019 field survey, likely due to the dry conditions and elapsed time since inundation. Generally speaking, the flood responding species are rare due to the widespread plight of wetland communities in Australia where land use change, river regulation and increasing influences of climate change are affecting the natural habitat where such species persist. It is also the general conclusion of this assessment that such species will benefit from an artificial flooding program that attempts to mimic the natural conditions such species require and the restoration of the wetland habitat to which they are associated.

The following assessment of likelihood of occurrence and impact to threatened flora considers the potential to occur at the construction footprint and inundation area, based on the VBA and PMST searches, the habitat requirements of the species, and the flora habitat values observed within these areas. This table summarises those species considered possible, likely or present at ONE OR BOTH of the construction footprint and inundation area. An assessment of likelihood of occurrence and impact to all threatened flora is provided in Appendix C for the construction footprint and Appendix D for the inundation area.



Table 7-1 Threatened flora considered possible or present within either the construction footprint or inundation area, as developed from VBA and PMST searches within the study area and the associated likelihood of occurrence and impact

Scientific and Common name	EPBC Act	FFG Act	DELWP Advisory	Most Recent and Number of Records	Source	Likelihood of Occurrence and Impact: Construction footprint	Likelihood of Occurrence and Impact: Inundation area
Amphibromus fluitans River Swamp Wallaby- grass	VU			2014 (4)	PMST Biosis 2014b	Possible : may occur in small areas of intersection with low lying wetland areas. Impact Possible . Unlikely to adversely affect habitat critical for the species or reduce the area of occupancy.	Present : Species previously recorded in low lying swamp areas in Guttrum Forest. Impact Unlikely. Species likely to benefit from a return to a more natural flooding regime and increase area of potential occupancy.
Asperula gemella Twin-leaf Bedstraw			r	2014 (1)	Biosis 2014b	 Possible: Records of this species occur within the study area and suitable riparian woodland habitat is available in construction footprint. Impact Possible: Not recorded during targeted flora surveys but small area of potential habitat likely impacted. 	Present: Species previously recorded in low lying swamp areas. Impact Unlikely. Species likely to benefit from a return to a more natural flooding regime and increase area of potential occupancy.
Cardamine moirensis Riverina Bitter-cress			r	2014 (1)	VBA Biosis 2014a, Biosis 2014b	 Present: Recorded by Biosis in construction footprint in Benwell Forest and suitable riparian woodland habitat available in construction footprint. Impact Possible: Potential impact to some individuals. Impacts will be minimised where practicable. 	 Present: Species previously recorded in seasonally wet areas. Impact Unlikely. Species likely to benefit from a return to a more natural flooding regime and increase area of potential occupancy.
Dianella longifolia var. grandis – formally known as Dianella sp af. longifolia (Riverina) Leek Flax-lily			vu	2019 (3)	R8 2019	 Present: A few individuals recorded near the construction footprint in Guttrum Forest near Reed Bed Swamp regulator. Impact Possible: Potential impact to some individuals. Impacts will be minimised where practicable. 	 Possible: Records of this species occur within the study area and suitable riparian woodland habitat within inundation area. Impact Unlikely. Species likely to benefit from a return to a more natural flooding regime and increase area of potential occupancy.
Eleocharis plana Flat Spike-sedge			vu	2001 (1)	VBA	Possible : Records of this species occur within the study area and suitable riparian woodland habitat is available in construction footprint.	Possible : Records of this species occur within the study area and suitable riparian woodland habitat within inundation area.



						Impact Possible: Not recorded during targeted flora surveys but small area of potential habitat likely impacted.	Impact Unlikely. Species likely to benefit from a return to a more natural flooding regime and increase area of potential occupancy.
Lepidium monoplocoides Winged Peppercress	EN	L	en	-	PMST	Possible : may occur in small areas of intersection with outer flood plain terrace (Black Box woodland). Impact Possible : Not recorded during targeted flora surveys but small area of potential habitat likely impacted.	Possible : may occur in small areas of intersection with outer flood plain terrace (Black Box woodland). Impact Unlikely . Species likely to benefit from a return to a more natural flooding regime and increase area of potential occupancy.
Nymphoides crenata Wavy Marshwort		L	en		Biosis 2014a, Biosis 2014b	Unlikely : Species requires semi-permanent waterways which are not present in construction footprint.	Present : Species previously recorded in low lying swamp areas in Guttrum Forest. Impact Unlikely. Species likely to benefit from a return to a more natural flooding regime and increase area of potential occupancy.
Paspalidium flavidum Yellow Watercrown Grass			en	2009 (1)	VBA	Possible: Records of this species occur within the study area and suitable riparian woodland habitat is available in construction footprint. NOTE: Species not native to local areas Impact Possible: Not recorded during targeted flora surveys but small area of potential habitat likely impacted.	Possible : Records of this species occur within the study area and suitable riparian woodland habitat within inundation area. Impact Unlikely. Species likely to benefit from a return to a more natural flooding regime and increase area of potential occupancy.
Rorippa eustylis Dwarf Bitter-cress			r	2014 (1)	VBA Biosis 2014b	 Possible: Records of this species occur within the study area and suitable riparian woodland habitat is available in construction footprint. Impact Possible: Not recorded during targeted flora surveys but small area of potential habitat likely impacted. 	Present: Species previously recorded in seasonally wet areas. Impact Unlikely. Species likely to benefit from a return to a more natural flooding regime and increase area of potential occupancy.
Senecio campylocarpus Bulging Fireweed			r	2019 (1)	R8 2019	Present : Recorded during field assessment occurring Impact Possible : Potential impact to some individuals. Impacts will be minimised where practicable.	 Possible: Records of this species occur within the study area and suitable riparian woodland habitat within inundation area. Impact Unlikely. Species likely to benefit from a return to a more natural flooding regime and increase area of potential occupancy.



Senecio cunninghamii var. cunninngham Branching Groundsel		r	2019 (1)	R8 2019, Biosis 2014b	Present : small number of individuals likely present throughout sedgy/grassy forest interface. Impact Possible : Potential impact to some individuals. Impacts will be minimised where practicable.	 Possible: Records of this species occur within the study area and suitable riparian woodland habitat within inundation area. Impact Unlikely. Species likely to benefit from a return to a more natural flooding regime and increase area of potential occupancy.
Senecio longicollaris Riverina Fireweed		vu	2014b (1)	Biosis 2014b	 Possible: Records of this species occur within the study area and suitable riparian woodland habitat is available in construction footprint. Impact Possible: Not recorded during targeted flora surveys but small area of potential habitat likely impacted. 	 Possible: Records of this species occur within the study area and suitable riparian woodland habitat within inundation area. Impact Unlikely. Species likely to benefit from a return to a more natural flooding regime and increase area of potential occupancy.
Vittadinia cuneata var. hirsuta Fuzzy New Holland Daisy		r	2014 (1)	Biosis 2014b	Possible: Records of this species occur within the study area and suitable riparian woodland habitat is available in construction footprint.Impact Possible: Not recorded during targeted flora surveys but small area of potential habitat likely impacted.	 Possible: Records of this species occur within the study area and suitable riparian woodland habitat within inundation area. Impact Unlikely. Species likely to benefit from a return to a more natural flooding regime and increase area of potential occupancy.



7.2.1 Impacts to EPBC Act-listed flora

No EPBC listed flora species were identified during R8 targeted surveys within the area of investigation or other previous surveys within areas of the construction footprint (Biosis 2014a, GHD 2017). However, two species, River Swamp Wallaby-grass is known to occur within the inundation area, and another, Winged Peppercress is are still considered to have the potential to occur within the inundation area under more favourable flooding conditions.

An assessment of the EPBC Act significant impact criteria for each EPBC Act listed flora species considered for the Project is provided in Appendix M. A summary of the outcomes of this assessment for the two species with potential to occur within the Project area is provided in Table 7-2.



Scientific Name	Status	Habitat	Likelihood of Occurrence/Potential Impact	Assessment of Significance under EPBC Act
Amphibromus fluitans River Swamp Wallaby-grass	VU	Largely confined to permanent swamps, principally along the Murray River between Wodonga and Echuca, uncommon to rare in the south (e.g. Casterton, Moe, Yarram), probably due to historic drainage of wetlands (RBGV 2016).	Construction footprint Possible. No previous records, but suitable habitat present within project area. Cryptic species responding to inundation events, occurs in low lying areas (ponds), and near flood ways, species was not evident during current survey, but has been previously recorded inundation area (Biosis, 2014). Potential Impact: Areas of potential habitat may be cleared. Inundation area Present. Recorded by Biosis 2014b within the inundation area confined to swamps and waterways. Potential Impact: Removal of cattle and the restoration of more natural inundation conditions are considered to be beneficial to the species	It is unlikely that the proposed works will have a significant impact on this species. The removal of cattle and the restoration of more natural inundation conditions are considered to be beneficial to the species. Listed as Vulnerable under the EPBC Act, impacts are considered at the population level. Given the relative abundance in remaining areas of suitable habitat, no important populations are listed in the assessment advice and no recovery plan has been commenced. It is not considered that the project will have a significant impact on this species.
Lepidium monoplocoides Winged Peppercress	EN	Uncommon in north western quarter of state, mostly on heavy soils near lakes and watercourses. Flowers mostly spring-summer (Walsh & Entwisle 1996).	Construction Footprint: Possible. Records within study area (10 km from project area in Lower Gunbower Forest) and potential habitat present in the outer areas of forest where Black Box chenopod vegetation occurs. Potential Impact: Areas of potential habitat may be cleared. Inundation Area: Possible. Records within study area (10 km from project area in Lower Gunbower Forest) and potential habitat present in the outer areas of forest where Black Box chenopod vegetation occurs. Potential Impact: Removal of cattle and the restoration of more natural inundation conditions are considered to be beneficial to the species	 It is unlikely that the proposed works will have a significant impact on this species. The species has not been recorded at Guttrum-Benwell Forests, and the closest population is 10 km south-east in the Lower Gunbower Forest. The species was not recorded during targeted surveys and limited habitat exists within the construction footprint. It is therefore unlikely that an important population of the species is present or likely to be impacted by the proposed works. The operational phase of the project is likely to improve habitat quality in the project area and any potential unrecorded populations. The Threatened Species Recovery Plan (Mavromihalis, 2010) details six 'important populations' within Victoria, none of which are in close proximity to the Guttrum-Benwell Forest system. Even if the species is assumed present, the only impacts associated with the application of the Significant Impact Criteria relevant to listed Endangered species are considered to be positive, with the restoration of a more natural inundation cycle and the removal of cattle from the forest system. It is not considered that the project will have a significant impact on this species.

Table 7-2 Significant impact assessment for EPBC listed flora species with potential of occurring within the project area.



7.2.2 Impacts to FFG Act and DELWP Advisory listed threatened flora

Species listed as threatened under the FFG Act along with species considered rare or threatened under the DELWP Victorian Advisory List for Rare or Threatened Species (DEPI 2014) were recorded within the area of investigation during the current surveys.

No FFG Act listed species were identified within the area of investigation during recent field surveys, however a small number of Wavy Marshwort (FFG Act listed included in the DELWP Advisory List) have previously been recorded (Biosis 2014a, VBA 1989) near the proposed regulator site at Benwell Forest (Benwell site B13) included in the Business Case. This area is no longer in the construction footprint as design has progressed and removed the need for this regulator, therefore it is only present in the inundation area and has additionally been recorded within semi-permanent wetlands in both Guttrum and Benwell Forests (Bennetts 2014, Biosis 2014b). As an obligate wetland species Wavy Marshwort is likely to benefit from the environmental watering. The other FFG Act listed species, Winged Peppercress assessed is also to considered to have the potential to occur, and is discussed above in section 7.2.1.

The location of flora species listed as rare or threatened under the DELWP Advisory list of rare or threatened plants (DEPI 2014) should be taken into consideration when finalising the construction footprint and efforts should be made to avoid listed species where possible (Figure 5-1). Additional avoidance and mitigation measures outlined in this report should be followed where possible to minimise the impacts on these species.

These species are considered rare or threatened, however they are common in suitable habitat under the correct conditions, and it is considered that impacts to these species' would be minor and localised, and that the proposed works would be unlikely to impact a significant population of these species or impact the range/distribution of any of these species.

7.2.3 Impacts to FFG Act-protected flora

During R8 surveys in 2019, twelve flora listed as protected under the FFG Act were recorded within the area for investigation. It is anticipated that a number of individuals of each species will require removal to enable the project to proceed. It is not expected that the loss of these individuals will have any long term impact on the species of these protected flora.

However, as the protected flora outlined below are also likely to be present within the inundation area, it is expected that any impacts to these species will be offset by the broader benefits to these species across the inundation area.

7.3 Potential impacts to threatened fauna

The following assessment of likelihood of occurrence and impact to threatened fauna considers the potential to occur at the construction footprint and inundation area, based on the VBA and PMST searches, the habitat requirements of the species, and the fauna habitat values observed within these areas. This table summarises those species considered possible, likely or present at ONE OR BOTH of the construction footprint and inundation area. An assessment of likelihood of occurrence and impact to all threatened fauna is provided in Appendix E for the construction footprint and Appendix F for the inundation area. These species are summarised in Table 7-3 below.



Table 7-3: Threatened fauna considered possible or present within either the construction footprint or inundation area, as developed from VBA and PMST searches within the study area

Scientific name	EPBC Act	FFG Act	DELWP Advisory	Most Recent and Number of Records	Source	Likelihood of Occurrence and Impact: Construction footprint	Likelihood of Occurrence and Impact: Inundation area
Birds							
Brolga Antigone rubicunda		L	vu	2018 (2)	VBA	Unlikely. Suitable habitat not present in construction footprint	Possible . Species habitat present within inundation area Impact Unlikely . Species likely to benefit from environmental watering when present
Great Egret Ardea alba		L	vu	2001 (7)	VBA	Unlikely. Suitable habitat not present in construction footprint	Possible . Species habitat present within inundation area Impact Unlikely. Species likely to benefit from environmental watering when present
Intermediate Egret Ardea intermedia plumifera		L	en	2000 (1)	VBA	Unlikely. Suitable habitat not present in construction footprint	Possible . Species habitat present within inundation area Impact Unlikely. Species likely to benefit from environmental watering when present
Hardhead Aythya australis			vu	2010 (10)	VBA	Unlikely. Suitable habitat not present in construction footprint	Possible . Species habitat present within inundation area Impact Unlikely . Species likely to benefit from environmental watering when present
Musk Duck Biziura lobata			vu	2007 (3)	VBA	Unlikely. Suitable habitat not present in construction footprint	Possible . Species habitat present within inundation area Impact Unlikely. Species likely to benefit from environmental watering when present
Australasian Bittern Botaurus poiciloptilus	EN	L	en	2018 (2)	PMST, VBA	Unlikely. Suitable habitat not present in construction footprint	Possible . Species habitat present within inundation area Impact Unlikely. Species likely to benefit from environmental water when present
Bush Stone-curlew Burhinus grallarius		L	en	2008 (4)	VBA	Possible. Suitable foraging habitat present within construction footprint Impact Unlikely. Species mobile and wide-ranging, suitable surrounding habitat widespread.	Possible. Suitable foraging and nesting habitat present within inundation area Impact Unlikely. Species mobile and wide-ranging, suitable surrounding habitat widespread. Species unlikely to be impacted during spring nesting and likely to benefit from improved habitat condition following environmental water



Scientific name	EPBC Act	FFG Act	DELWP Advisory	Most Recent and Number of Records	Source	Likelihood of Occurrence and Impact: Construction footprint	Likelihood of Occurrence and Impact: Inundation area
Azure Kingfisher <i>Ceyx azureus</i>			nt	2003 (4)	VBA	Possible . Suitable swamp forest habitat present in construction footprint Impact Unlikely. Species mobile and wide-ranging, suitable surrounding habitat widespread.	Possible. Suitable foraging habitat present within inundation area Impact Unlikely. Species mobile and wide-ranging, suitable surrounding habitat widespread. Species likely to benefit from improved habitat condition following environmental water
Whiskered Tern Chlidonias hybrida			nt	1999 (1)	VBA	Unlikely. Suitable habitat not present in construction footprint	Possible. Species habitat present within inundation area. Impact Unlikely. Species likely to benefit from environmental water when present
Brown Treecreeper Climacteris picumnus			nt	2019 (58)	R8 2019, VBA	 Present. Species observed and suitable habitat present within construction footprint Impact Unlikely. Species mobile and wide-ranging, suitable surrounding habitat widespread. Losses to relatively small area of foraging and potential nesting habitat proposed from the removal of trees, however the species is highly mobile and wide-ranging, suitable surrounding habitat widespread. 	Present. Species observed and suitable habitat present within inundation area Impact Unlikely. Species mobile and wide-ranging, suitable surrounding habitat widespread. Species likely to benefit from improved habitat condition following environmental
Emu Dromaius novaehollandiae			nt	2019 (5)	R8 2019, VBA	Present. Species observed and suitable foraging habitat present within construction footprint Impact Unlikely. Species mobile and wide-ranging, suitable surrounding habitat widespread	 Present. Species observed and suitable foraging habitat present within inundation area Impact Unlikely. Species mobile and wide-ranging, suitable surrounding habitat widespread. Species likely to benefit from improved habitat condition following environmental
Little Egret Egretta garzetta		L	en	2000 (1)	VBA	Unlikely. Suitable habitat not present in construction footprint Impact Unlikely. Species mobile and wide-ranging, suitable surrounding habitat widespread.	Possible. Species habitat present within inundation area Impact Unlikely. Species likely to benefit from environmental watering when present



Scientific name	EPBC Act	FFG Act	DELWP Advisory	Most Recent and Number of Records	Source	Likelihood of Occurrence and Impact: Construction footprint	Likelihood of Occurrence and Impact: Inundation area
Painted Honeyeater Grantiella picta	VU	L	vu	PMST	PMST	Possible. Suitable foraging habitat present within construction footprint	Possible. Suitable foraging habitat present within inundation area
						Impact Unlikely. Species mobile and wide-ranging, suitable surrounding habitat widespread.	Impact Unlikely. Species likely to benefit from environmental watering when present
White-bellied Sea- Eagle		L	vu	2019 (1)	R8 2019,	Present. Recorded within project area and/or within close proximity to project area.	Present. Recorded within project area and/or within close proximity to project area.
Haliaeetus leucogaster					VBA	Impact Unlikely. Species mobile and wide-ranging, suitable surrounding habitat widespread.	Impact Unlikely. Species likely to benefit from environmental watering when present
Australian Little Bittern		L	en	1993 (4)	VBA	Unlikely. Suitable habitat not present within construction footprint	Possible. Suitable foraging habitat present within inundation area
Ixobrychus dubius							Impact Unlikely. Species likely to benefit from environmental watering when present
Square-tailed Kite Lophoictinia isura		L	vu	2018 (1)	VBA	Possible. Suitable foraging habitat present within construction footprint	Possible. Suitable foraging habitat present within inundation area
						Impact Unlikely. Species mobile and wide-ranging, suitable surrounding habitat widespread.	Impact Unlikely. Species mobile and wide-ranging, suitable surrounding habitat widespread.
Barking Owl Ninox connivens		L	en	2009 (1)	VBA	Possible. Suitable foraging habitat present within construction footprint	Possible. Suitable foraging habitat present within inundation area
						Impact Unlikely. Species mobile and wide-ranging, suitable surrounding habitat widespread.	Impact Unlikely. Species mobile and wide-ranging, suitable surrounding habitat widespread.
Nankeen Night- Heron			nt	2003 (3)	VBA	Unlikely. Suitable habitat not present within construction footprint	Possible. Species habitat present within inundation area
Nycticorax caledonicus							environmental watering when present
Pied Cormorant Phalacrocorax varius			nt	2003 (2)	VBA	Unlikely. Suitable habitat not present within construction footprint	Possible. Species habitat present within inundation area Impact Unlikely. Species likely to benefit from environmental watering when present



Scientific name	EPBC Act	FFG Act	DELWP Advisory	Most Recent and Number of Records	Source	Likelihood of Occurrence and Impact: Construction footprint	Likelihood of Occurrence and Impact: Inundation area
Royal Spoonbill Platalea regia			nt	2000 (1)	VBA	Unlikely. Suitable habitat not present within Construction footprint	Possible. Species habitat present within Inundation area Impact Unlikely. Species likely to benefit from environmental watering when present
Glossy Ibis Plegadis falcinellus	м		nt	2019 (9)	R8 2019, VBA	Unlikely. Suitable habitat not present within Construction footprint	 Present. Recorded within inundation area during artificially flooding of Red Bed Swamp and suitable seasonally inundated habitat present. Impact Unlikely. Species likely to benefit from environmental watering when present
Superb Parrot Polytelis swainsonii	VU	L	en	PMST	PMST	Possible. Suitable habitat present within construction footprint Impact Unlikely. Species mobile and wide-ranging, suitable surrounding habitat widespread.	Possible. Species habitat present within Inundation area Impact Unlikely. Species likely to benefit from environmental watering when present
Ballion's Crake Porzana pusilla		L	vu	1981 (3)		Unlikely. Suitable habitat not present within Construction footprint	Possible. Species habitat present within Inundation area Impact Unlikely. Species likely to benefit from environmental watering when present
Grey-crowned Babbler Pomatostomus temporalis		L	en	2017 (38)	GHD 2017, Biosis 2014, VBA	 Present. Species known to occur within project area and suitable foraging habitat present in construction footprint (Bennetts 2014, Biosis 2014a, GHD 2017) Impact Unlikely. Targeted surveys within the construction footprint did not record any individuals or nests. Losses to relatively small area of foraging and potential nesting habitat proposed from the removal of trees, however the species is highly mobile and wide-ranging, suitable surrounding habitat widespread. 	 Present. Species known from previous assessments to occur inundation area (Bennetts 2014, Biosis 2014a, GHD 2017). Impact Unlikely. Species is highly mobile and wide-ranging with suitable habitat widespread throughout the Inundation area. Species likely to benefit from broadly improved habitat condition following environmental water.
Australian Painted- snipe Rostratula australis	EN	L	cr	PMST	PMST	Unlikely. Suitable habitat not present within Construction footprint	Possible. Species habitat present within Inundation area Impact Unlikely. Species likely to benefit from environmental watering when present



Scientific name	EPBC Act	FFG Act	DELWP Advisory	Most Recent and Number of Records	Source	Likelihood of Occurrence and Impact: Construction footprint	Likelihood of Occurrence and Impact: Inundation area
Australasian Shoveler Spatula rhynchotis			vu	2018 (17)	VBA	Unlikely. Suitable habitat not present within Construction footprint	Possible. Species habitat present within Inundation area Impact Unlikely. Species likely to benefit from environmental watering when present
Diamond Firetail Stagonopleura guttata		L	nt	2007 (2)	VBA	Present. Species known to occur within project area and suitable foraging habitat present in construction footprint (Bennetts 2014).	Present. Species known to occur within project area and suitable foraging habitat present in inundation area (Bennetts 2014).
						Impact Unlikely. Species mobile and wide-ranging, suitable surrounding habitat widespread.	Impact Unlikely. Species mobile and wide-ranging, suitable surrounding habitat widespread. Species likely to benefit from improved habitat condition following environmental water
Freckled Duck Stictonetta naevosa		L	en	1999 (4)	VBA	Unlikely. Suitable habitat not present within Construction footprint	Possible. Species habitat present within Inundation area Impact Unlikely. Species likely to benefit from environmental watering when present
Apostlebird Struthidea cinerea		L		1999 (2)	VBA	Possible. Suitable foraging habitat present within Construction footprint Impact Unlikely. Species mobile and wide-ranging, suitable surrounding habitat widespread.	Possible. Suitable foraging habitat present within Inundation area Impact Unlikely. Species mobile and wide-ranging, suitable surrounding habitat widespread. Species likely to benefit from improved habitat condition following environmental water
Red-backed Kingfisher Todiramphus pyrrhopygius			nt	1998 (1)	VBA	Possible. Suitable swamp forest habitat present in construction footprint Impact Unlikely. Species mobile and wide-ranging, suitable surrounding habitat widespread.	Possible. Suitable foraging habitat present within Inundation area Impact Unlikely. Species mobile and wide-ranging, suitable surrounding habitat widespread. Species likely to benefit from improved habitat condition following environmental water
Common Greenshank Tringa nebularia	м		vu	2002 (2)	VBA	Unlikely. Suitable habitat not present within Construction footprint	Possible. Species habitat present within Inundation area Impact Unlikely. Species likely to benefit from environmental watering when present



Scientific name	EPBC Act	FFG Act	DELWP Advisory	Most Recent and Number of Records	Source	Likelihood of Occurrence and Impact: Construction footprint	Likelihood of Occurrence and Impact: Inundation area
Marsh Sandpiper Tringa stagnatilis	Μ		vu	2003 (1)	VBA	Unlikely. Suitable habitat not present within Construction footprint	Possible. Species habitat present within Inundation area Impact Unlikely. Species likely to benefit from environmental watering when present
Fish							
Silver Perch Bidyanus bidyanus	CR	L	vu	1994 (3)	PMST, VBA	 Possible. The species is a main-channel specialist with core suitable habitat limited to the Murray River. Impact Possible. Localised impacts possible, consideration of coffer dam construction, dewatering works, and any potential for sediment/ contaminant run-off into wet areas from construction footprint must consider aquatic fauna. A construction specific aquatic fauna management plan should be developed for all works around waterways. 	Possible. May enter forest areas during inundation events, but seasonally inundated semi-permanent forest wetlands do not provide suitable long term habitat. Impact Possible. The operation of the project has been designed to exclude fish from the floodplain wetlands through fish exclusion screens and a pumping only mechanism. It is unlikely that large numbers of fish will enter the floodplain. A staged and managed drawdown regime will be implemented to monitor water quality of return flows and provide cues for native fish to exit the wetlands to prevent stranding. Release rates of return flows enable suitable mixing to occurs with the Murray River if water quality in return water is low. There is an overall assessment of low likelihood of impact to Silver Perch during the operation phase of the project (Appendix P).



Scientific name	EPBC Act	FFG Act	DELWP Advisory	Most Recent and Number of Records	Source	Likelihood of Occurrence and Impact: Construction footprint	Likelihood of Occurrence and Impact: Inundation area
Unspecked Hardyhead Craterocephalus stercusmuscarum fulvus		L		1999 (1)	VBA	 Possible. Preferred habitat is margins of slow flowing rivers, backwaters and wetlands (Lintermans, 2007). Has been recorded from Little Murray River and Gunbower Creek in the past 10 years, so it is possible that individuals are present in the Murray River. Impact Possible. Localised impacts possible, consideration of coffer dam construction, dewatering works, and any potential for sediment/ contaminant run-off into wet areas from construction footprint must consider aquatic fauna. A construction specific aquatic fauna management plan should be developed for all works around waterways. 	Possible. Suitable floodplain/wetland habitat in inundation area may become present following natural flooding and the operating phase of the project. Impact Possible. The operation of the project has been designed to exclude fish from the floodplain wetlands through fish exclusion screens and a pumping only mechanism. It is unlikely that large numbers of fish will enter the floodplain . A staged and managed drawdown regime will be implemented to monitor water quality of return flows and provide cues for native fish to exit the wetlands to prevent stranding. Release rates of return flows enable suitable mixing to occurs with the Murray River if water quality in return water is low. There is an overall assessment of low likelihood of impact to Unspecked Hardyhead during the operation phase of the project (Appendix P).
Murray Cod Maccullochella peelii	VU	L	vu	1993 (4)	PMST, VBA	 Present. The species is are a main-channel specialist with suitable habitat limited to the Murray River. Has been frequently recorded from the Murray River upstream and downstream of the project area. Presence in the Murray River at the project area should be assumed. Impact Possible. Localised impacts possible, consideration of coffer dam construction, dewatering works, and any potential for sediment/ contaminant run-off into wet areas from construction footprint must consider aquatic fauna. A construction specific aquatic fauna management plan should be developed for all works around waterways. 	Possible. May enter forest areas during inundation events, but seasonally inundated semi-permanent forest wetlands do not provide suitable long term habitat. Impact Possible. The operation of the project has been designed to exclude fish from the floodplain wetlands through fish exclusion screens and a pumping only mechanism. It is unlikely that large numbers of fish will enter the floodplain. A staged and managed drawdown regime will be implemented to monitor water quality of return flows and provide cues for native fish to exit the wetlands to prevent stranding. Release rates of return flows enable suitable mixing to occurs with the Murray River if water quality in return water is low. There is an overall assessment of low likelihood of impact to Murray Cod during the operation phase of the project (Appendix P).



Scientific name	EPBC Act	FFG Act	DELWP Advisory	Most Recent and Number of Records	Source	Likelihood of Occurrence and Impact: Construction footprint	Likelihood of Occurrence and Impact: Inundation area
Golden Perch Macquaria ambigua			nt	1994 (6)	VBA	 Present. The species is are a main-channel specialist with suitable habitat limited to the Murray River. Has been frequently recorded from the Murray River upstream and downstream of the project area. Presence in the Murray River at the project area should be assumed. Impact Possible. Localised impacts possible, consideration of coffer dam construction, dewatering works, and any potential for sediment/ contaminant run-off into wet areas from construction specific aquatic fauna management plan should be developed for all works around waterways. 	Possible. May enter forest areas during inundation events, but seasonally inundated semi-permanent forest wetlands do not provide suitable long term habitat. Impact Possible. The operation of the project has been designed to exclude fish from the floodplain wetlands through fish exclusion screens and a pumping only mechanism. It is unlikely that large numbers of fish will enter the floodplain. A staged and managed drawdown regime will be implemented to monitor water quality of return flows and provide cues for native fish to exit the wetlands to prevent stranding. Release rates of return flows enable suitable mixing to occurs with the Murray River if water quality in return water is low. There is an overall assessment of low likelihood of impact to Golden Perch during the operation phase of the project (Appendix P).
Murray Darling Rainbowfish Melanotaenia fluviatilis		L	vu		R8 2020	 Possible. Preferred habitat is margins of slow flowing rivers, backwaters and wetlands (Lintermans, 2007). Has been recorded from Little Murray River and nearby tributaries of the Murray River in the past 10 years, so it is possible that individuals are present in the Murray River. Impact Possible. Localised impacts possible, consideration of coffer dam construction, dewatering works, and any potential for sediment/ contaminant run-off into wet areas from construction specific aquatic fauna management plan should be developed for all works around waterways. 	Possible. Suitable floodplain/wetland habitat in inundation area may become present following natural flooding and the operating phase of the project. Impact Possible. The operation of the project has been designed to exclude fish from the floodplain wetlands through fish exclusion screens and a pumping only mechanism. It is unlikely that large numbers of fish will enter the floodplain. A staged and managed drawdown regime will be implemented to monitor water quality of return flows and provide cues for native fish to exit the wetlands to prevent stranding. Release rates of return flows enable suitable mixing to occurs with the Murray River if water quality in return water is low. There is an overall assessment of low likelihood of impact to Murray-Darling Rainbowfish during the operation phase of the project (Appendix P).



Scientific name	EPBC Act	FFG Act	DELWP Advisory	Most Recent and Number of Records	Source	Likelihood of Occurrence and Impact: Construction footprint	Likelihood of Occurrence and Impact: Inundation area
Freshwater Catfish Tandanus tandanus		L	en		R8 2020	Possible. A benthic species that prefers slow-flowing streams and lake habitats (Lintermans, 2007). Has been recorded from Little Murray River and Gunbower Creek wetlands in the past 10 years. The Murray River in vicinity of project area has been mapped as possible habitat by NSW Fisheries. It is possible that individuals are present in the Murray River. Impact Possible. Localised impacts possible, consideration of coffer dam construction, dewatering works, and any potential for sediment/ contaminant run-off into wet areas from construction footprint must consider aquatic fauna. A construction specific aquatic fauna management plan should be developed for all works around waterways.	 Possible. Suitable floodplain/wetland habitat in inundation area may become present following natural flooding and the operating phase of the project. Impact Possible. The operation of the project has been designed to exclude fish from the floodplain wetlands through fish exclusion screens and a pumping only mechanism. It is unlikely that large numbers of fish will enter the floodplain. A staged and managed drawdown regime will be implemented to monitor water quality of return flows and provide cues for native fish to exit the wetlands to prevent stranding. Release rates of return flows enable suitable mixing to occurs with the Murray River if water quality in return water is low. There is an overall assessment of low likelihood of impact to Freshwater Catfish during the operation phase of the project (Appendix P).
Invertebrates							



Scientific name	EPBC Act	FFG Act	DELWP Advisory	Most Recent and Number of Records	Source	Likelihood of Occurrence and Impact: Construction footprint	Likelihood of Occurrence and Impact: Inundation area
Murray Crayfish Euastacus armatus		L			R8 2020	Possible. Species seems to be tolerant of a wide variety of habitats, including deep flowing water proximal to clay banks, wood or rock cover, as well as tributary streams and shallow riparian habitats (for smaller individuals) (Fisheries Scientific Committee 2013). The Murray River in vicinity of project area has been mapped as possible habitat by NSW Fisheries (NSW DPI (accessed 2020). It is possible that individuals are present in the Murray River within and adjacent to the Project Area. Impact Possible. Localised impacts possible, consideration of coffer dam construction, dewatering works, and any potential for sediment/ contaminant run-off into wet areas from construction footprint must consider aquatic fauna. A construction specific aquatic fauna management plan should be developed for all works around waterways.	Possible. Suitable floodplain/wetland habitat in inundation area may become present following natural flooding and the operating phase of the project. Impact Possible. A staged and managed drawdown regime will be implemented to monitor water quality of return flows and provide cues for native fish and invertebrates to exit the wetlands to prevent stranding. Release rates of return flows enable suitable mixing to occurs with the Murray River if water quality in return water is low. There is an overall assessment of low likelihood of impact to Murray Crayfish during the operation phase of the project.
Reptiles							
Broad-shelled Turtle <i>Chelodina expansa</i>		L	en	2015 (3)	VBA	 Possible. This species resides in permanent, deep water limited to the Murray River. Recent records within study area and may utilise river banks for nesting. Impact Possible. Localised impacts possible, consideration of coffer dam construction, dewatering works, and any potential for sediment/ contaminant run-off into wet areas from construction footprint must consider aquatic fauna. A construction specific aquatic fauna management plan should be developed for all works around waterways. Consider timing of works to avoid breeding season (spring to summer) where turtles may nest along river banks. 	Possible. Species habitat present within inundation area Impact Unlikely. Species likely to benefit from improved habitat conditions following environmental watering.



Scientific name	EPBC Act	FFG Act	DELWP Advisory	Most Recent and Number of Records	Source	Likelihood of Occurrence and Impact: Construction footprint	Likelihood of Occurrence and Impact: Inundation area
Murray River Turtle Emydura macquarii			vu	2016 (3)	VBA	 Possible. This species resides in permanent, deep water limited to the Murray River. Recent records within study area and may utilise river banks for nesting. Impact Possible. Localised impacts possible, consideration of coffer dam construction, dewatering works, and any potential for sediment/ contaminant run-off into wet areas from construction footprint must consider aquatic fauna. A construction specific aquatic fauna management plan should be developed for all works around waterways. Consider timing of works to avoid breeding season (spring to summer) where turtles may nest along river banks. 	Possible. Species habitat present within Inundation area Impact Unlikely. Species likely to benefit from improved habitat conditions following environmental watering.
Carpet Python Morelia spilota metcalfei		L	en		Seran BL&A	 Possible. Species not previously recorded, but habitat present along floodplain forest of Murray River. Impact Possible. Localised impacts possible during large tree removal and sub-surface impacts in Construction footprint. An on-site ecologist with Management Authorisation under the <i>Wildife Act 1975</i> must be present during large tree removal and construction works. 	Possible. Species habitat present within Inundation area Impact Unlikely. Species likely to benefit from improved habitat conditions following environmental watering.
Bearded Dragon Pogona barbata			vu	2002 (1)	VBA	 Possible. Species habitat present within construction footprint. Impact Possible. Localised impacts possible during large tree removal and sub-surface impacts in Construction footprint. An on-site ecologist with Management Authorisation under the <i>Wildife Act 1975</i> must be present during large tree removal and construction works. 	Possible. Species habitat present within Inundation area Impact Unlikely. Species likely to benefit from improved habitat conditions following environmental watering.



Scientific name	EPBC Act	FFG Act	DELWP Advisory	Most Recent and Number of Records	Source	Likelihood of Occurrence and Impact: Construction footprint	Likelihood of Occurrence and Impact: Inundation area
Lace Monitor Varanus varius			en	2019 (2)	R8, VBA	 Present. Species recorded incidentally in project area and suitable habitat exists throughout construction footprint. Impact Possible. Localised impacts possible during large tree removal and sub-surface impacts in Construction footprint. An on-site ecologist with Management Authorisation under the <i>Wildife Act 1975</i> must be present during large tree removal and construction works. 	Present. Species recorded incidentally in project area and suitable habitat exists throughout inundation area. Impact Unlikely. Species likely to benefit from improved habitat conditions following environmental watering.
Amphibians							
Growling Grass Frog Litoria raniformis	VU	L	en	2009 (1)	PMST, VBA	Unlikely. No recent records exist in project area, and no suitable habitat in construction footprint.	Possible. No recent records exist in project area, but suitable aquatic habitat along waterways. Impact Unlikely . Species almost certain to benefit directly from greatly expanded habitat when environmental water is present, and indirectly from improved habitat condition following environmental water.
Brown Toadlet Pseudophryne bibronii		L	en	1982 (5)	VBA	Possible. Records within study area, and suitable seasonally inundated forest present in construction footprint. Impact Possible. Targeted surveys recommended for Brown Toadlet in Autumn (April-May) 2021 in seasonally inundated riparian forest habitat within the construction footprint to identify whether the species is present and to update avoidance and mitigation measures to address impacts to this species.	Possible. No recent records exist in project area, but suitable aquatic habitat along waterways. Impact Unlikely. Species almost certain to benefit directly from greatly expanded habitat when environmental water is present, and indirectly from improved habitat condition following environmental water.

Mammals



Scientific name	EPBC Act	FFG Act	DELWP Advisory	Most Recent and Number of Records	Source	Likelihood of Occurrence and Impact: Construction footprint	Likelihood of Occurrence and Impact: Inundation area
Southern Myotis Myotis Macropus			nt	2009 (1)	VBA	 Possible. Bat surveys undertaken did not record the species (GHD 2017), but species is likely to occur along Murray River with limited survey effort across the landscape for this species. Impact Possible. Localised impacts possible during large tree removal in construction footprint. An on-site ecologist with Management Authorisation under the <i>Wildife Act 1975</i> must be present during large tree removal and construction works. 	Possible. Suitable foraging habitat present within Inundation area Impact Unlikely. Species mobile and wide-ranging, suitable surrounding habitat widespread.
South-eastern Long-eared Bat Nyctophilus corbeni	VU	L	en	PMST	PMST	 Possible. Bat surveys undertaken did not record the species (GHD 2017), but species is likely to occur along Murray River with limited survey effort across the landscape for this species. Impact Possible. Localised impacts possible during large tree removal in construction footprint. An on-site ecologist with Management Authorisation under the <i>Wildife Act 1975</i> must be present during large tree removal and construction works. 	Possible. Suitable foraging habitat present within Inundation area Impact Unlikely. Species mobile and wide-ranging, suitable surrounding habitat widespread.
Squirrel Glider Petaurus norfolcensis		L	en	No previous reco Potential habitat during previous assessments (Bio GHD 2017)	ords. : identified osis 2014,	 Possible. Species not recorded during targeted surveys or with nearby records, but may still occur in areas not assessed in construction footprint. Impact Possible. Localised impacts possible during large tree removal in construction footprint. An on-site ecologist with Management Authorisation under the <i>Wildife Act 1975</i> must be present during large tree removal and construction works. 	Possible. Species not recorded during targeted surveys or with nearby records, but may occur across inundation area. Impact Unlikely. No tree removal is expected within inundation area. Species likely to benefit from improved habitat condition following environmental water.



7.3.1 Impacts to EPBC Act listed fauna species

No EPBC Act listed fauna species were recorded during targeted surveys in 2019 or in previous assessments within the project area (Biosis 2014a; GHD 2017).

Five EPBC Act listed fauna species were identified as possibly occurring within the construction footprint and/or inundation area: Painted Honeyeater, Superb Parrot, South-eastern Long-eared Bat, Murray Cod and Silver Perch.

A conservative approach to EPBC listed species has been taken for this assessment and a further three species, Growling Grass Frog, Australasian Bittern and Australian Painted Snipe have been assessed as possibly occurring within the inundation area only. These species have also been considered further to demonstrate that they are unlikely be adversely impacted by the proposed project.

An assessment of the EPBC Act significant impact criteria for each EPBC Act listed flora species considered for the Project is provided in Appendix N. A summary of the outcomes of this assessment for the eight species with potential to occur within the Project area is provided in Table 7-4.



Scientific Name	Status	Habitat	Likelihood of Occurrence/Potential Impact	Assessment of Significance under EPBC Act
Painted Honeyeater (Grantiella picta)	VU	Inhabits Boree/ Weeping Myall (<i>Acacia</i> <i>pendula</i>), Brigalow (<i>A.</i> <i>harpophylla</i>) and Box- Gum Woodlands and Box-Ironbark Forests. The species exhibits seasonal north-south movements governed principally by the fruiting of mistletoe.	Construction footprint Possible. Painted Honeyeater is considered to have potential to utilise habitats within the proposed construction footprint and broader inundation area. This species has not been previously recorded within the study area, and very few records exist across the local landscape Potential Impact: Removal of small discrete areas of rarely used habitat	It is unlikely that the proposed works will have a significant impact on this species. The Painted Honeyeater is known to be highly mobile and have the potential to rarely forage in the Guttrum and Benwell Forests. The proposed construction footprints are not likely to significantly impact any areas of important habitat to this extremely mobile nomadic species, which forages widely over large areas in pursuit of mistletoe and flowering eucalypts. The project is highly unlikely to result in the fragmentation of important Painted Honeyeater habitat (large trees supporting abundant mistletoe) as Guttrum and Benwell Forests consists of 1,149 ha of contiguous habitat, with the proposed construction footprint located on existing tracks and disturbed areas. The proposed construction footprint will not adversely affect habitat critical to the survival of this species, as it represents small, isolated and discrete areas of habitat within an extensive area of rarely used habitats for this highly mobile and infrequently recorded species. Impacts are considered unlikely as the Painted Honeyeater is a highly mobile species that may infrequently utilise the project area and if present, would be expected to benefit from environmental watering.
Superb Parrot (<i>Polytelis swainsonii</i>)	VU	In Victoria, species is confined to the north of the state with the majority of records and known breeding locations in Barmah State Forest/State Park. The species inhabits large, mature River Red Gums or Blakely's Red Gum (<i>E. blakelyi</i>) close to watercourses	Construction footprint Possible. Superb Parrot is considered to have potential to utilise habitats within the proposed construction footprint and broader inundation area. Although extensive suitable Red Gum forest habitat exists, this species has not been previously recorded within the study area, with the closest and main population known from Barmah State Forest 50-100 km further east upstream of the Murray River. Potential Impact: Removal of small discrete areas of rarely used habitat	It is unlikely that the proposed works will have a significant impact on this species. The project is highly unlikely to result in the fragmentation of important Superb Parrot habitat (nesting trees) as the species has not been recorded in the study area. Guttrum and Benwell Forests consists of 1,149 ha of contiguous habitat, with the proposed construction footprint located on existing tracks and disturbed areas. The proposed construction footprint will not adversely affect habitat critical to the survival of this species, as it represents small, isolated and discrete areas of habitat within an extensive area of rarely used habitats for this highly mobile and infrequently recorded species. Impacts are considered unlikely as the Superb Parrot is a highly mobile species that may infrequently utilise the project area and if present, would be expected to benefit from environmental watering.

Table 7-4 Significant impact assessment for EPBC listed fauna species with potential of occurring within the project area.



Scientific Name	Status	Habitat	Likelihood of Occurrence/Potential Impact	Assessment of Significance under EPBC Act
South-eastern Long- eared Bat (<i>Nyctophilus corbeni</i>)	VU	This species has a scattered distribution, mostly within the Murray-Darling Basin, but with some records outside of this area. Inhabits a variety of vegetation types, but is distinctly known to occur in Box / Ironbark / Cypress-pine vegetation along the western slopes and plains of NSW (OEH 2012).	Construction footprint Unlikely to occur. The species has not been recorded in the project area and was not recorded during bat surveys in the construction footprint in 2017 (GHD 2017). The closest records in Victoria to the project area are in old growth mallee vegetation around the Hattah township and Hattah-Kulkyne National Park, over 150 km to the north/west. It is considered unlikely that this species utilises Red Gum forests and woodland habitats within the Guttrum-Benwell project area, and that if it does occur, it is likely to be in extremely low numbers Potential Impact: likely to be in extremely low numbers that would not be impacted by the proposed works or could be mitigated by preclearance surveys and hollow-bearing tree management protocols in the highly unlikely event that an <i>N.</i> <i>corbeni</i> is encountered during site development.	It is unlikely that the proposed works will have a significant impact on this species. In the unlikely occurrence of this species occurring in the construction footprint, impacts as a result of vegetation removal and potential habitat loss will be localised, and therefore resultant impacts to the species are expected to be very low. However, broader mitigation measures for hollow-dependent species as outlined in Section 9 will also apply to threatened bats including South-eastern Long-eared Bat, including pre-clearance surveys and hollow-bearing tree management. No Significant impacts are expected for South-eastern Long-eared Bat, particularly given the core 'important population' for the species occurs in the western slopes and plains in NSW.
Murray Cod (Maccullochella peelii peelii)	VU	Known to occur in the Murray River alongside the project area	Construction Footprint Present. The species occurs in a range of flowing and standing waters, from small, clear, rocky streams to large, turbid, meandering slow-flowing rivers, as well as and lakes and larger billabongs. While it will make use of inundated floodplain channels, it is considered a main-channel specialist (National Murray Cod Recovery Team, 2010). It has been frequently recorded from the Murray River upstream and downstream of the project area. Presence in the Murray River at the project area should be assumed. Potential Impact. Consideration of any in-stream works such as coffer dam construction, dewatering works, and any potential for sediment/ contaminant run-off into wet areas from construction footprints must consider this species. A construction specific aquatic fauna management plan will be developed for all works around waterways. Inundation Areas	It is unlikely that the proposed works will have a significant impact on this species. The proposed works would be undertaken in predominantly dry areas of the floodplain adjacent the River, which will not remove any critical habitat or adversely affect habitat critical to the survival of this species. Some works would occur within the Murray River associated with construction and dewatering of small, temporary coffer dams enabling construction of the drop structures and inlet pipes. A CEMP will be developed and applied to all works around waterways, including strategies that seek to minimise construction footprints and manage potential sediment / contaminant runoff from the site to mitigate possible water quality impacts. A construction specific aquatic fauna management plan will also be developed, containing requirements for monitoring and translocating of any fish trapped in coffer dams prior to dewatering. Any capture, handling or translocation of fish that is required (e.g. during construction works) would be carried out by a qualified aquatic ecologist in accordance with the requirements of the <i>Fisheries Act 1995</i> .



Scientific Name	Status	Habitat	Likelihood of Occurrence/Potential Impact	Assessment of Significance under EPBC Act
			 Possible. May enter forest areas during inundation events, but seasonally inundated semi-permanent forest wetlands do not provide suitable long term habitat. Has the potential to enter the floodplain during inundation events, although the likelihood is low as pumping will be used to water the floodplain. Potential Impact: This species is considered likely to benefit from expanded habitat during, and improved habitat condition following environmental water. If species moves onto the floodplain, the ability for fish to exit back to the Murray River is of importance to avoid impacts due to stranding. Fish Management Plans have been prepared for R8 sites located within the Mallee CMA region (see DELWP 2018), which provide details of the recommended operational regime to minimise the risk of stranding during drawdown events. The staged drawdown regime recommended is likely to be applicable to the Guttrum-Benwell site. 	Fine fish screens will be fitted to pipe inlets used to water the floodplain, preventing the introduction of species to the floodplain. A staged and managed drawdown regime will be implemented to monitor water quality of return flows and provide cues for native fish to exit the wetlands to prevent stranding. Outlet regulators will provide for unrestricted fish passage during manged drawdown and natural floodplain inundation events. Low return flows during the maintenance and drawdown periods of environmental watering are planned to range from 25 ML/d for both Guttrum and Benwell (DHI 2014, cited in (North Central CMA 2020) to reduce any potential blackwater impacts to the main Murray River channel. There is an overall assessment of low likelihood of impact to Murray Cod during the operation phase of the project following the above mitigation measures during the operation phase of the project (Appendix P).
Silver Perch (<i>Bidyanus bidyanus</i>);	CE	Known to occur in the Murray River alongside the project area	Construction Footprint Possible. The species is a main-channel specialist with suitable habitat limited to the Murray River. While they have been recorded in a wide range of habitats, they have been noted to prefer fast flowing waters, and open waters more than heavily snagged (DSE, 2005). While there are no recent records from the immediate vicinity of the project area, they are regularly encountered in the Murray River upstream and downstream of the project area and the Murray River in vicinity of project area has been mapped as possible habitat by NSW Fisheries. They are expected to be present Murray River in the project area from time to time. Potential Impact. Consideration of any in-stream works such as coffer dam construction, dewatering works, and any potential for sediment/ contaminant run-off into wet areas from construction footprints must consider this species. A	It is unlikely that the proposed works will have a significant impact on this species. The proposed works would be undertaken in predominantly dry areas of the floodplain adjacent the River, which will not remove any critical habitat or adversely affect habitat critical to the survival of this species. Some works would occur within the Murray River associated with construction and dewatering of small, temporary coffer dams enabling construction of the drop structures and inlet pipes. A CEMP will be developed and applied to all works around waterways, including strategies that seek to minimise construction footprints and manage potential sediment / contaminant runoff from the site to mitigate possible water quality impacts. A construction specific aquatic fauna management plan will also be developed, containing requirements for monitoring and translocating of any fish trapped in coffer dams prior to dewatering. Any capture, handling or translocation of fish that is required (e.g. during construction works) would be carried out by a qualified aquatic ecologist in accordance with the requirements of the <i>Fisheries Act 1995</i> .



Scientific Name	Status	Habitat	Likelihood of Occurrence/Potential Impact	Assessment of Significance under EPBC Act
			 construction specific aquatic fauna management plan will be developed for all works around waterways. Inundation Areas Possible. Has the potential to enter the floodplain during inundation events, although the likelihood is low as pumping will be used to water the floodplain. Potential Impact: This species is considered likely to benefit from expanded habitat during, and improved habitat condition following environmental water. If species moves onto the floodplain, the ability for fish to exit back to the Murray River is of importance to avoid impacts due to stranding. Fish Management Plans have been prepared for R8 sites located within the Mallee CMA region (see DELWP 2018), which provide details of the recommended operational regime to minimise the risk of stranding during drawdown events. The staged drawdown regime recommended is likely to be applicable to the Guttrum-Benwell site. 	During operations, the project area will receive water via pumping meaning there is a very low likelihood of large numbers of Murray Cod entering the floodplain. Fine fish screens will be fitted to pipe inlets used to water the floodplain, preventing the introduction of species to the floodplain. A staged and managed drawdown regime will be implemented to monitor water quality of return flows and provide cues for native fish to exit the wetlands to prevent stranding. Outlet regulators will provide for unrestricted fish passage during manged drawdown and natural floodplain inundation events. Low return flows during the maintenance and drawdown periods of environmental watering are planned to range from 25 ML/d for both Guttrum and Benwell (DHI 2014, cited in North Central CMA 2020) to reduce any potential blackwater impacts to the main Murray River channel. There is an overall assessment of low likelihood of impact to Silver Perch during the operation phase of the project following the above mitigation measures during the operation phase of the project (Appendix P).
Australasian Bittern (<i>Botaurus</i> <i>poiciloptilus</i>)	EN	Occurs in terrestrial freshwater wetlands and, rarely, estuarine habitats. It favors wetlands with tall, dense vegetation, where it forages in still, shallow water up to 0.3 m deep, often at the edges of pools or waterways, or from platforms or mats of vegetation over deep water (Marchant and Higgins 2004).	Construction Footprint Unlikely to occur. The proposed construction footprint is in predominantly dry areas. Potential Impact: Removal of small discrete areas of rarely used habitat Inundation Areas Possible. The species was last recorded in Guttrum Forest in Reed Bed Swamp in 1985, and two records occur within the study area at McDonald Swamp Wildlife Reserve from 2018, approximately 9 km south of the project area. The decline in wetland quality in Guttrum-Benwell Forests with the absence of sedges and rushes is indicative of an absence of this species.	It is unlikely that the proposed works will have a significant impact on this species. The likelihood of this species using the project area as more than an occasional visitor is considered low given the majority of the project area lacks the required habitat features for this species (tall, dense aquatic vegetation) and is comprised predominately of dry Red Gum forest and woodlands. Impacts are considered unlikely as the Australasian Bittern would only infrequently utilise the inundation area and is expected to benefit from environmental watering.



Scientific Name	Status	Habitat	Likelihood of Occurrence/Potential Impact	Assessment of Significance under EPBC Act
			Potential Impact: A return of a naturally occurring flooding regime will enhance the future habitat availability for the Australasian Bittern.	
Australian Painted Snipe (Rostratula australis)	EN	Inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans. Typical sites include those with emergent tussocks of grass, sedges, rushes or reeds, or samphire; often with scattered clumps of lignum <i>Muehlenbeckia</i> or canegrass or sometimes tea-tree (<i>Melaleuca</i>) (Marchant & Higgins 1993 within DOE 2020b).	Construction Footprint Unlikely to occur. The proposed construction footprint are in predominantly dry areas. Potential Impact: Removal of small discrete areas of rarely used habitat Inundation Areas Possible. The species is reported to have been mainly recorded in the Murray-Darling region however in Victoria and NSW, known records (VBA, Atlas of NSW and ebird) indicate this to be more accurate for the region east of Swan Hill (DOE 2020b). Within the study area, there are no records of the species, and similar to the Australasian Bittern, the long absence is characteristic of the decline in wetland habitat within the Guttrum and Benwell Forests due to the lack of recent natural flooding. Potential Impact: A return of a naturally occurring flooding regime will enhance the future habitat availability for the Australian Painted Snipe	It is unlikely that the proposed works will have a significant impact on this species. The likelihood of this species using the project area as more than an occasional visitor is considered low given the majority of the project area lacks the required habitat features for this species (tall, dense aquatic vegetation) and is comprised predominately of dry Red Gum forest and woodlands. Impacts are considered unlikely as the Australasian Painted Snipe would only infrequently utilise the inundation area and is expected to benefit from environmental watering.
Growling Grass Frog (<i>Litoria raniformis</i>)	VU	This species is mostly found amongst emergent vegetation (Robinson 1993), including <i>Typha</i> sp. (bullrush), <i>Phragmites</i> <i>sp.</i> (reeds) and <i>Eleocharis sp.</i> (sedges), in or at the edges of still or slow-flowing	Construction Footprint Unlikely to occur. The proposed construction footprint are in predominantly dry areas. Potential Impact: Removal of small discrete areas of rarely used habitat. Indirect impacts from the proposed works may include the introduction or spread of Chytrid Fungus. Transmission of the disease from vehicle is unlikely, however, hygiene protocols for Chytrid Fungus will be included in a site specific EMP	It is unlikely that the proposed works will have a significant impact on this species. Impacts are considered unlikely Growling Grass Frog would only infrequently utilise the inundation area during years or prolonged flooding and is expected to benefit from environmental watering. Potential impacts will be mitigated through the implementation of hygiene measures and sediment and erosion controls.



Scientific Name	Status	Habitat	Likelihood of Occurrence/Potential Impact	Assessment of Significance under EPBC Act
		water bodies such as lagoons, swamps, lakes, ponds and farm dams (NSW DEC 2005).	Inundation Areas Possible. The Growling Grass Frog is considered to have potential to utilise habitats within the broader inundation area. The species has been recorded once in the project area but not within the last 30 years. It has been recorded four times previously within the study area, most recently in 2009 on a farm dam 5 km to the south-west of the project area. Despite the long absence of records of this species, the presence of suitable habitat, and the ability of this species to recolonise areas suggest that it has potential to occur in the area. Potential Impact: A return of a naturally occurring flooding regime will enhance the future habitat availability for the Growling Grass Frog.	


7.3.2 Impacts to EPBC Act Migratory Species

It is highly unlikely that the construction footprint supports habitat that will be considered important for migratory species foraging or breeding activity or support an ecologically significant proportion of a population of migratory species.

Reinstating historical environmental flows within project area will almost certainly improve the quality of habitat present for water dependent avifauna. Such enhancements correspond to increased productivity of the swamp forest communities, increased vegetation diversity and structure from more drought-tolerant species and increase the overall health and integrity of the area, which will likely improve potential breeding, foraging and refuge resources for listed migratory species.

There is potential for the introduction of environmental water to lead to an increase in abundance of feral predators (cats, foxes), herbivores (e.g. goats) and omnivores (e.g. pigs) due to the associated increase in productivity. Some of the species such as cats and foxes could potentially prey on migratory waterbirds. An accompanying feral animal management and control program will need to be implemented within the inundation extent.

An assessment of the project against the EPBC Act Significant Impact Guidelines 1.1 on migratory species is provided in Appendix R. It was determined that the project is unlikely to have a Significant Impact on migratory species.

7.3.3 Impacts to FFG Act and DELWP Advisory listed fauna and communities

Forty-nine (49) FFG Act listed species (32 birds, three mammals, five reptiles, two amphibians, one invertebrate and six fish species) are considered to have the potential to occur within the construction footprint and/or inundation area (Table 7-3). All species have been recorded within the study area, or have potential habitat within the project area. One FFG Act listed species, the White-bellied Sea Eagle (*Haliaeetus leucogaster*) was observed during the field assessment in 2019. Two other species, Grey-crowned Babbler (*Pomatostomus temporalis*) and Diamond Firetail (*Stagonopleura guttata*) have been recorded in the project area during previous assessments (Bennetts 2014, Biosis 2014a, GHD 2017)

Most of these FFG Act listed species possibly occurring in the construction footprint are highly mobile bird species and all have access to large areas of suitable habitat in the immediate surrounding areas in which to disperse. From a landscape perspective the proposed construction footprint represents a small area of around 13.70 ha, centred on existing tracks and degraded areas, within a very large intact area of over 1149 ha of high quality native vegetation within the Guttrum and Benwell Forests. All structures are proposed to be centred on and adjacent to existing tracks and degraded areas, within a very large intact area of high quality native vegetation along the Murray River corridor. For these reasons the proposed construction impacts are considered unlikely to significantly impact threatened fauna species.

One FFG Act listed species, the Grey-crowned Babbler is known to occur within the Guttrum and Benwell Forests, with many records, including recent observations by Biosis (2014a) and GHD (2017). Given the size of Guttrum and Benwell Forests, it is likely that multiple territorial colony groups of Grey-crowned Babbler occur in the surrounding forest of the construction footprint. The species was not recorded during targeted R8 surveys, nor were any nests identified in the area of investigation. It is unlikely that the construction footprint along existing access tracks and degraded areas supports critical habitat for the species. However, mitigation measures outlined in section 9 are required to ensure no indirect impacts to the species occurs.

Another species, the FFG Act listed Brown Toadlet or Bibron's Toadlet (*Pseudophryne bibronii*) was historically recorded within Guttrum and Benwell Forests, with a single record from 1982 (VBA, 2020). The species is found in a wide variety of habitats including forests, woodlands, grasslands and swamps and shelters in damp areas under leaf litter, logs and rocks. The Guttrum and Benwell Forests provide extensive areas of potential habitat, particularly in seasonally inundated areas of forest which is present in the construction footprint. Targeted surveys for the species are recommended for autumn 2021 to identify whether the species is present and to update avoidance and mitigation measures to address impacts to this species.



Direct impacts as a result of habitat removal, e.g. the removal of hollow bearing trees or nesting trees for birds, should be mitigated for acute impacts to species such as the Squirrel Glider and Lace Monitor (refuges in hollowbearing trees). Large hollow bearing trees should be prioritised for retention during both the design phase through the implementation of No Go zones and at Construction Phase through the preparation and implementation of a Tree Protection Plan to seek to retain additional trees where works are in close proximity. An on-site ecologist with Management Authorisation under the Wildife Act 1975 should be present during vegetation removal and sub-surface construction works to readily relocate any fauna found within larger trees or disturbed underground. Additionally, all hollow-bearing trees proposed for removal should be thoroughly inspected prior to removal for refuging wildlife and at risk of harm from felling. A Fauna Management Plan (FMP) or equivalent should be developed and implemented during the works associated with the project to mitigate impacts to all native fauna that may result from removal of vegetation during works. This may be incorporated as a sub-document of a Construction Environmental Management Plan (CEMP) and would contain detailed requirements on the approach to pre-clearance surveys, timing of surveys and clearing, clearing methods, options to enhance surrounding habitat using removed vegetation (e.g. hollow bearing trees/limbs), and other measures to mitigate impacts to fauna. The plan would be required to include particular consideration to the threatened fauna (ie. those listed under the EPBC Act, FFG Act and/or the DELWP Advisory List of Threatened Fauna). All native animals encountered during the pre-clearance and other vegetation clearance activities must be treated humanely, ethically, and in accordance with relevant codes under the Victorian Wildlife Act 1975 and Wildlife Regulations 2002.

An Aquatic Fauna Management Plan would be developed and implemented to manage impacts to aquatic values. Localised impacts as a result of habitat removal and construction works along river banks could occur to turtles, in particular the FFG Act listed Broad-shelled Turtle (*Chelodina expansa*) and DELWP Advisory listed Murray River Turtle (*Emydura macquarii*). Any construction activities that could lead to entrapment of fauna or temporary loss of habitat (e.g. due to the use of coffer dams and dewatering) should be considered. It should also consider the timing of works to where practicable avoid the breeding season of turtles (spring to summer) where turtles may nest along river banks.

The inundation of currently dry (at the time of survey), but water-dependent EVCs may present some landscape impacts to terrestrial dependent species, including the Lace Monitor, Bearded Dragon and Bush Stone-curlew. The return of a flooding regime to these dry forests will need to be managed (including the rate of flow and inundation extent) so these less-mobile species are able to disperse and avoid potential detrimental impacts of an artificially flooded system.

Several other threatened fauna species either known or have the potential to occur within the inundation extent either have a broad foraging/dispersal range and are unlikely to be adversely impacted by occasional periods of inundation (e.g. Grey-crowned Babbler) or would have the ability to continue utilising these habitats during inundation (e.g. Broad-shelled Turtle).

Many threatened species will see improvements of habitat quality and availability during flooding conditions including; Brolga (*Antigone rubicunda*), Great Egret (*Ardea alba*), Little Egret (*Egretta garzetta*) and Whitebellied Sea-Eagle, all FFG Act listed. The application of episodic environmental water would be expected to maintain and enhance the conditions of these woodland communities in the face of future water extraction and climate change scenarios rather than a 'do nothing' approach to leaving these habitats in their current ecological state.

FFG Act listed fauna communities

Two FFG-listed fauna communities were identified in the project area, Victorian Temperate Woodland Bird Community (VTWBC) and Lowland Riverine Fish Community of the Murray-Darling Basin (LRFC). The VTWBC was identified as occurring throughout the Guttrum and Benwell Forests project area, due to the presence of significant River Red Gum open woodland and forest with an abundance of tree hollows for nesting sites and fallen timber. This determination is consistent with previous assessments within the project area (Biosis 2014a; GHD 2017).



Bird species of this FFG-listed fauna community are highly mobile and impacts as a result of the Project are expected to be negligible in the short-term to species of these communities, with a long-term improvement in habitat expected from environmental watering. Further information is provided in Section 6.3.3.

The VTWBC is defined by a suite of 24 bird species mainly associated with drier woodlands on the slopes and plains of the Great Dividing Range that have experienced significant declines in numbers. The community is typically present in drier woodlands dominated by box, stringybark, ironbark, yellow gum or river red gum eucalypts and consists of an open woodland over a light shrubby and grassy understorey. There is typically an abundance of tree hollows for nesting sites and fallen timber.

Eight of the 24 bird species characteristic to the community were identified in the desktop assessment (Table 7-5). Two species, Brown Treecreeper (*Climacteris picumnus victoriae*) and Jacky Winter (*Microaca facinans*) were observed in high abundance incidentally and during early-morning Grey-crowned Babber targeted surveys in the project area. The Diamond Firetail has been recorded in previous assessments (Bennetts 2014), and the Grey-crowned Babbler, the subject of targeted surveys was not observed by R8 ecologists, however is known to occur throughout the project area (see section 5.2.4 for further details).

Hollow-bearing trees and tree with fissures (dead or alive) are essential for some species within the VTWBC, which rely on hollow-bearing trees for nesting. Acute, short term impacts to species of this community as a result of the unavoidable removal of hollow-bearing trees should be mitigated. It is recommended that if the removal of hollow-bearing trees is unavoidable, seasonal restrictions should be implemented for vegetation clearing to avoid breeding periods when these species are more vulnerable to impacts. Overall, impacts to this community are likely to be negligible as the Guttrum and Benwell project area is comprised of largely intact vegetation and the proposed construction of floodplain infrastructure is unlikely to impact on habitat connectivity or remove habitat important for the VTWBC. The proposed inundation of floodplain and wetland habitats however, is likely to provide important future benefits to the VTWBC particularly under climate change scenarios of longer, dryer conditions in a semi-arid environment. While the project would remove around 219 large old trees (trees that are likely to contain suitable refuge hollows for native fauna), 768 large old trees recorded within the Area of investigation will remain. Furthermore, numerous hollow bearing trees occur within contiguous habitat within the broader project area.

Common name	Scientific name	Project area (including buffer)
Apostlebird	Struthidea cinerea	X
Brown Treecreeper	Climacteris picumnus victoriae	х
Bush Stone-curlew	Burhinus grallarius	Х
Diamond Firetail	Stagonopleura guttata	X
Grey-crowned Babbler	Pomatostomus temporalis	X
Jacky Winter	Microeca fascinans	X
Red-capped Robin	Petroica goodenovii	X
Western Gerygone	Gerygone fusca	X

Table 7-5 Fauna species listed in the VTWBC and previously recorded or predicted to occur (VBA) within the project area

The Lowland Riverine Fish Community of the Southern Murray-Darling Basin (LRFC) describes a suite of native fish taxa that is typical of and largely restricted to the geographical area of the lowland river reaches and associated floodplains of the Murray River tributaries. Many of these species have undergone significant reductions in range and abundance since European settlement, particularly due to the introduction of alien fish species. The LRFC was identified as occurring in the project area as described in the Fish Assessment (Appendix P).



An assessment of risks (Appendix P) to threatened fish and fish communities as a result of construction activities and operations of the proposed scheme identified potential for the loss of some Murray River bank habitat associated with the construction of pump inlets and outfall regulators. Operation of the scheme has the potential to entrain fish in pumps, strand fish on floodplains during managed drawdown and expose fish to poor water quality in return flows to the Murray River.

The following mitigation measures are recommended for the project to reduce potential fish impacts:

Construction mitigation measures

- Include the use of only partial coffer dams to isolate small areas of back from construction works, relocation
 of any habitat within works areas to the same river reach and adoption of sediment control and accidental
 spill measures. 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. Any capture of fish must be carried out by a
 qualified aquatic ecologist.
- Mitigation measures associated with construction of the project need to be documented in an Aquatic Fauna Management Plan as part of the Construction Environmental Management Plan to manage impacts to aquatic values – with emphasis on threatened fish species that may be present in vicinity of construction sites or which access floodplain environments.

Operational mitigation measures

- Include the installation and maintenance of appropriately sized fish screens on inlet pumps, management
 of inundation and drawdown to minimise the likelihood of fish stranding on the floodplain by ensuring
 opportunities for fish movement during managed drawdown, management of the timing of inundation and
 drawdown to minimise blackwater risks and to ensure appropriate dilution of return flows if low dissolved
 oxygen is evident.
- Mitigation measures associated with operation of the project need to be documented in a fish exit strategy to manage risk associated with fish stranding on the floodplain. This will include requirements for pump design to include fish screens to minimise impacts to fish during pumping events. The project's Operating Plan will also need to include measures to reduce the potential for poor water quality of return flows.

Mitigation measures built into the design, construction and operation of the project to manage potential impacts will reduce the risks to fish species of the LRFC to low during both construction and operation of the project.

7.4 Wetlands of International Importance

While reinstating a wetting and drying regime of appropriate frequency, duration and extent to the broader Guttrum and Benwell Forests is likely to impart significant ecological benefits for the project area, large infrastructure projects such as this can also have environmental risks, particularly localised, short-term impacts during the construction phase. The PMST outputs note that the Ramsar Wetlands Gunbower Forest (upstream), NSW Central Murray State Forests (upstream) and the Kerang Wetlands (downstream but disconnected) are all within 10 km of the search area. An additional four Ramsar Wetlands were identified 150-400 km downstream of the Guttrum and Benwell Forests project area (Hattah-kulkyne lakes, Banrock Station Wetland Complex, Riverland and the Coorong, and Lakes Alexandrina and Albert Wetland).

The closest and most relevant is the NSW Central Murray State Forests Ramsar Wetland which occurs across the Murray River from the Guttrum and Benwell Forests. Whilst impacts to the NSW Central Murray State Forests is expected to be negligible an Environmental Management Framework will be developed that identifies potential environmental risks and puts in place mitigation strategies to avoid or minimise these risks. Any impacts will be localised and site rehabilitation will occur following completion. The Environmental Management Framework will require development of a CEMP that sets out specific measures that will be employed to minimise impacts during construction.

Black-water events may also occur following floodplain inundation due to breakdown of leaf litter and terrestrial vegetation by bacteria, which releases nutrients into the water, but again, this is not considered a significant risk



associated with the works, as black-water events are a natural process. Operation of the proposed works may actually reduce the incidence of black-water events by restoring more frequent floods to the system and reducing the accumulation of leaf litter and nutrient loads between inundation events, therefore blackwater incidence is likely to diminish in the future.

Overall, the project is likely to significantly benefit the environment, reinstating appropriate wetting and drying regimes to over 1149 ha of wetlands and floodplain. This will increase the extent and condition of habitat for aquatic and floodplain fauna, including waterbirds, fish, frogs, turtles and terrestrial species reliant on floodplain habitats, such as woodland birds, bats, small/medium mammals and reptiles.

7.5 FFG Act threatening processes

Potentially threatening processes are listed in accordance with Section 10 of the *Flora and Fauna Guarantee* (*FFG*) *Act 1988*. There are a number of threatening processes that are relevant to the project that have the potential to be exacerbated by either the construction process or proposed inundation of 1,149 ha of floodplain and wetlands:

Construction Phase:

- Degradation of native riparian vegetation along Victorian rivers and streams.
- Loss of hollow-bearing trees from Victorian native forests.
- Habitat fragmentation as a threatening process for fauna in Victoria.
- Increase in sediment input into Victorian rivers and streams due to human activities.
- Infection of amphibians with Chytrid Fungus, resulting in chytridiomycosis.
- Invasion of native vegetation by 'environmental weeds'.
- Loss of coarse woody debris from Victorian native forests and woodlands (flooded or removed from site re-purpse)
- Reduction in biodiversity resulting from Noisy Miner (*Manorina melanocephala*) populations in Victoria. -(increased gaps and fragments, leading to increased edge effects and invasion of noisey miner)
- Predation of native wildlife by the introduced Cat, *Felis catus*.
- Predation of native wildlife by the introduced Red Fox Vulpes vulpes.
- The spread of *Phytophthora cinnamomi* from infected sites into parks and reserves, including roadsides, under the control of a state or local government authority.

The construction footprint should be refined through the design process to minimise impacts to native vegetation, habitat and hollow bearing trees. A qualified ecologist will need to be on-site to manage the removal of any fauna habitat and capture and relocate fauna observed within the construction area. It is still possible that hollow-bearing trees will be removed as part of the project, however the broader objective to inundate 1,149 ha of riverine forest and wetland vegetation is likely to be critical to contribute to the maintenance of hollow-bearing trees into the future.

Any construction activity that requires works within waterways has the potential to temporarily prevent passage of biota and to alter flow regimes. These impacts are likely to be relatively short-term and an aquatic fauna management plan for the project should be prepared to minimise impacts to aquatic fauna. This may incorporated as a sub-document of a CEMP.

An Environmental Management Framework will be prepared as part of the project and require development of a CEMP that includes measures such as vehicle hygiene protocols to mitigate the potential spread of weeds and *Phytophthora cinnamomi* and measures to minimise sedimentation or toxic substance i (e.g. fuel) inputs to waterways.

Operation Phase:



- Predation of native wildlife by the introduced Cat, *Felis catus*.
- Predation of native wildlife by the introduced Red Fox *Vulpes vulpes*.
- Soil degradation and reduction of biodiversity through browsing and competition by Feral Goats (*Capra hircus*).

There is potential for the introduction of environmental water to lead to an increase in abundance of feral predators (Cats, Foxes), herbivores (e.g. Goats) and omnivores (e.g. Pigs) due to the associated increase in productivity. Some of the species such as cats, foxes and pigs could potentially prey on migratory waterbirds, woodland birds, small mammals, reptiles and frogs that may respond to the application of water to floodplains/wetlands. An accompanying pest animal management and control program would need to be implemented within the inundation extent.



8. Impacts to native vegetation

This section summarises the likely impacts to native vegetation associated with the proposed works within the construction footprint. The impacts described in this section incorporate assessments undertaken at Guttrum and Benwell by R8 ecologists and previous assessments (Biosis 2014a; GHD 2017). The combined Vegetation Quality Assessment (Habitat Hectare) results are outlined in Appendix G for all of the native vegetation proposed to be impacted. Further assessment will be completed to map Large Trees in the construction footprint in Benwell Forest around the South-west regulator and Outlet 2 (approximately 700 m length).

8.1 Objective of the Guidelines

The Guidelines for the removal, destruction or lopping of native vegetation (the Guidelines) were incorporated into the Victorian Planning Provisions and all planning schemes in Victoria in December 2017 (DELWP, 2017).

The purpose of the Guidelines is to guide how impacts on biodiversity should be considered when assessing an application for a permit to remove, destroy or lop native vegetation. The Guidelines set out the rules and tools for how the responsible authority (Gannawarra Shire Council) and referral authority (DELWP) should consider biodiversity when assessing an application. Adherence to the practices and procedures outlined in the Guidelines will help protect native vegetation. They aim to ensure that the proposed removal of native vegetation is appropriately assessed, that opportunities to avoid and minimise removal are considered, and that appropriate offsets are secured (DELWP, 2017).

When native vegetation removal is permitted, an offset must be secured that achieves a no net loss outcome for biodiversity. To achieve this, the offset needs to make a contribution to Victoria's biodiversity that is equivalent to the contribution made by the native vegetation that was removed. Therefore, the type and amount of offset required depends on the native vegetation being removed and the contribution it makes to Victoria's biodiversity.

8.2 Proposed construction impacts to native vegetation

8.2.1 Ecological Vegetation Classes

The proposed works will involve impacts to 13.70 ha of native vegetation, including 6.16 ha of vegetation classified as vulnerable and 7.56 ha of vegetation classified as depleted, as assessed during R8 field assessment. This does not include native vegetation clearance associated with power supply and levee works which are subject to further risk assessment. If levee works are required, this would involve works along approximately 1.5 - 3 kilometres of existing, previously disturbed, levee banks. It is anticipated that any impacts to EVCs associated with the proposed works, will be greatly outweighed by the benefits and improvements that these same EVCs will achieve through environmental watering within the area of inundation. The inundation area is expected to cover 1,149 ha of Guttrum and Benwell Forests and will directly benefit 46.52 ha classified as vulnerable, 1,081.37 ha classified as depleted and 21.67 ha of vegetation classified as least concern.

Water Regime Class (Biosis 2014b)	Ecological Vegetation Class	Construction footprint (ha)	Inundation area (ha)
Permanent Wetlands	Aquatic Herland (EVC 653)		0.09
Semi-permanent Wetlands	Floodway Pond Herbland (EVC 810)	0.10	
	Spike-sedge Wetland (EVC 819)		24.03
	Tall Marsh (EVC 821)		21.67
	Riverine Swamp Forest (EVC 814)	3.46	705.05

Table 8-1 Water Regime Class (Biosis 2014b) and Ecological Vegetation Class of native vegetation proposed to be impacted from construction and inundated during operation.



Water Regime Class (Biosis 2014b)	Ecological Vegetation Class	Construction footprint (ha)	Inundation area (ha)
Red Gum Forest with Flood-dependent Understorey	Floodway Pond Herbland/Riverine Swamp Forest Complex (EVC 945)	0.13	208.79
Red Gum Forest with Flood-tolerant Understorey	Grassy Riverine Forest (EVC 106)		128.92
	Riverine Grassy Woodland (EVC 295)	6.16	22.49
	Sedgy Riverine Forest (EVC 816)	3.87	38.52
	Total	13.70*	1,149*

The proposed direct loss of native vegetation for the project is 13.70 ha, within an extensive surrounding area of high-quality native vegetation within the 1,930 ha Guttrum and Benwell State Forests. All of the impacts are associated with the installation of infrastructure, and efforts have been made during each iteration of the design, to avoid and minimise impacts to native vegetation and fauna habitat (including large trees where present).

Of the 13.70 ha of native vegetation that is proposed to be removed, 7.74 ha is potentially impacted by the development footprint of proposed structures, hardstands and laydown areas, and 5.96 ha is associated with potential maintenance works along existing access tracks Table 8-2.

The scope and requirement for works along access tracks is still to be confirmed and will be designed to avoid and minimise native vegetation removal. The current estimate of potential vegetation removal along tracks is conservative, and assumes a minimum 5 metre buffer where vegetation removal has been accounted for along existing tracks. In some instances these works may be limited to minor maintenance and upgrades that require minimal if any vegetation clearance. Vegetation is not currently proposed to be cleared within this 5 m buffer, however it is acknowledged that use of the tracks by heavy machinery during the construction phase of the project may require some track maintenance that could impact trees. R8 has recommended that once the construction footprint and required track access has been confirmed, that a qualified arborist is engaged to undertake an assessment along the existing tracks, with a project engineer and construction contractor, to confirm the extent of works required (if any) and any potential losses to trees along the existing tracks either directly (through removal) or indirectly (through encroachment of their TPZs, or the removal of >30% of their canopy). Once this assessment has been undertaken, the extent of impacts to native vegetation for the project will be confirmed. It is anticipated that the actual impacts to native vegetation along the existing access tracks will be significantly lower than the conservative estimate (5.96 ha) that has been currently accounted for.

The total proposed impacts to each individual EVC within the construction areas is outlined in Table 8-2.

Table 8-2 Proposed impacts to each Ecological Vegetation Class (EVC)

EVC	Area (ha) impacted by infrastructure	Area (ha) impacted by tracks*
295 Riverine Grassy Woodland	2.03	4.13
810 Floodway Pond Herbland	0.09	0.01
814 Riverine Swamp Forest	3.33	0.13
816 Sedgy Riverine Forest	2.31	1.56
945 Floodway Pond Herbland/Riverine Swamp Forest Complex		0.13
Total	7.74	5.96



8.2.2 Canopy Trees

During the field assessments 768 trees were recorded within the area of investigation. The DBH of each stem of each tree has been recorded at approximately 1.3 m above ground level to determine the size class (as per the guidelines, DELWP 2017). Of these 768 trees, 219 large trees are located within the construction footprint, either directly or due to their TPZs being impacted >10%. Further assessment will be completed to map Large Trees in the construction footprint in Benwell Forest around the South-west regulator and Outlet 2 (approximately 700 m length). Following field survey in spring 2020 this total number is likely to increase.

A qualified arborist will 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 in to account direct impacts to trees (tree removal) and indirect impacts to trees (through encroachment of their TPZs). Whilst the size class of a tree is determined by measuring the DBH at 1.3 m under the Guidelines, the TPZs of a tree are calculated by recording the DBH of a tree at 1.4 m (and for multi-stemmed trees such as some eucalypts, the TPZ is determined by combining the DBH measurements of each individual stem). An arborist assessment would also consider the individual tree location and habit, as well as specific characteristics of certain tree 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).

It is expected that approximately 219 Large Trees will be impacted by the current design (Appendix K).

8.2.3 Proposed operational impacts to native vegetation

An assessment of the potential impacts to vegetation within the inundation area as a result of environmental watering has not been assessed from field assessments undertaken by R8 and instead relies upon previous EVC mapping within the inundation area (Biosis 2014b). The project aims to deliver the preferred hydrological regime for native vegetation communities within the inundation area and this is expected to benefit the native vegetation within the inundation areas.

All EVCs listed below are wetland, flood-dependent or flood-tolerant vegetation communities that are expected to positively respond to the proposed inundation. A summary of the vegetation communities making up the 1,149 ha of vegetation proposed for inundation is outlined in Table 8-3.

Water Regime Class	EVC	Mapped EVC extent within inundation area (ha)
Guttrum Forest		
Seasonal Wetland	Spike-sedge Wetland (EVC 819)	13.48
	Tall Marsh (EVC 821)	21.67
	Floodway Pond Herbland/Riverine Swamp Forest Complex (EVC 945)	4.79
Red Gum with Flood-dependent Understorey	Riverine Swamp Forest (EVC 814)	396.80
	Floodway Pond Herbland/Riverine Swamp Forest Complex (EVC 945)	160.52
Red Gum with Flood-tolerant Understorey	Grassy Riverine Forest (EVC 106)	18.60
	Riverine Grassy Woodland (EVC 295)	22.29
	Sedgy Riverine Forest (EVC 816)	32.37
Benwell		

Table 8-3 Mapped EVC extent (ha) within managed inundation area (Biosis 2014b)



Water Regime Class	EVC	Mapped EVC extent within inundation area (ha)
Semi-permanent Wetland	Aquatic Herbland (EVC 653)	0.09
Seasonal Wetland	Spike-sedge Wetland (EVC 819)	10.55
Red Gum with Flood-dependent Understorey	Riverine Swamp Forest (EVC 814)	308.25
	Floodway Pond Herbland/Riverine Swamp Forest Complex (EVC 945)	43.48
Red Gum with Flood-tolerant	Grassy Riverine Forest (EVC 106)	110.32
Understorey	Riverine Grassy Woodland (EVC 295)	0.20
	Sedgy Riverine Forest (EVC 816)	6.15
	Total	1,149*

*rounding error produces 1,150 ha

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 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.

The return of a natural flooding regime to Guttrum and Benwell Forests aims to achieve the following:

- 1) Improve the health of semi-permanent wetlands
- 2) Healthy wetland bird community across Guttrum Forest through improved access to food and habitat that promotes breeding and recruitment
- 3) Healthy River Red Gum communities
- 4) Promote recruitment of the local River Murray channel specialist native fish community[^] by increasing opportunities to access productive floodplain outflows from Guttrum Forest.

The return of a flooding regime which replicates a more natural state to the Guttrum and Benwell Forests during the operational phase of the project is expected to achieve the above aims as indicated by the inundation extents in section 8.2.3. The ecological benefits of environmental watering listed above have and continue to be demonstrated through a rigorous monitoring program at the neighbouring The Living Murray (TLM) program Gunbower Forest icon site, which aligns closely with the ecological character and hydrological requirements of Guttrum and Benwell Forests. As such, many of the demonstrated outcomes at Gunbower Forest are expected to also result from environmental watering at Guttrum and Benwell Forests.

Long-term monitoring results at Gunbower Forest for example show that River Red Gum areas that have received the combination of water for the environment and natural floods over the past 10 years, typically have healthier canopies, faster tree growth and supported more native floodplain plants, than areas that only received natural floods and those that remained dry over the same period. At monitoring sites that have received no flooding since 2005, less than half of the River Red Gum trees had at least 50 per cent intact canopy (a measure of tree condition), and these trees continue to suffer from the Millennium Drought and lack of natural flooding. At sites that received only natural flooding since 2005, the trees are in slightly better condition with almost 60 per cent with at least 50 per cent intact canopy. However, the greatest improvement is seen at sites that received both natural floods and water for the environment, where 75 per cent of trees are now considered healthy (Bennetts and Jolly 2019). A range of surveys are also undertaken to monitor the direct response of water-dependent flora and fauna to environmental water delivery, including but not limited to fish monitoring (Bloink et al. 2019), frog monitoring (Durkin and Howard 2020) wetland productivity monitoring including the response of vegetation, micro and macroinvertebrates, fish and birds (Brown 2020), and water quality monitoring of return flows to improve instream productivity for native fish (Baldwin 2019). While there is



some variability in ecological responses to environmental water due to the complexity of the systems and multiple contributing factors (e.g. the impact of carp on aquatic vegetation), the results of this monitoring overall show a positive response of water-dependent flora and fauna to the environmental water deliveries.

8.3 Assessment Pathway

Applications to remove native vegetation are categorised into one of three assessment pathways with corresponding application requirements and decision guidelines. The assessment pathway for an application to remove native vegetation reflects its potential impact on biodiversity and it is determined from the location and extent of the native vegetation to be removed (DELWP, 2017). The three assessment pathways recognised by DELWP are:

- Basic: limited impacts on biodiversity
- Intermediate: could impact on large trees, endangered EVCs, and sensitive wetlands and coastal areas
- *Detailed*: could impact on large trees, endangered EVCs, sensitive wetlands and coastal areas, and could significantly impact on habitat for rare or threatened species

The assessment pathway determines the information that is required to accompany an application to remove, lop or destroy native vegetation. There are three location categories that indicate the potential risk to biodiversity from removing a small amount of native vegetation: Location 1, 2 and 3 and play a role in determining the assessment pathway. The higher category is used if native vegetation proposed to be removed includes more than one location category. The process for determining the assessment pathway is summarised in Table 8-4.

The construction footprint is located within a broad area that has mapped as Location 3. Given the scale of the project and both the extent of native vegetation and the number of large trees identified within the Guttrum and Benwell Forests project area, it is considered likely that the project will follow the Detailed Assessment pathway.

Table 8-4 Risk matrix for determining the assessment pathway that an application to remove native vegetation will take

Extent of Native Vegetation	Location Category		
	Location 1	Location 2	Location 3
< 0.5 hectares (ha) and not including any Large Trees	Basic	Intermediate	Detailed
< 0.5 hectares (ha) and including one or more Large Trees	Intermediate	Intermediate	Detailed
0.5 hectares (ha) or more	Detailed	Detailed	Detailed

8.4 Summary of Vegetation Impacts

Despite the efforts outlined in Section 8 below to avoid and minimise impacts to native vegetation during the design and planning phase of the project, the current construction footprint estimates that **13.70** ha of native vegetation removal will be required for the project. Further efforts will be made during design refinement to further avoid and minimise impacts to native vegetation and fauna habitat.

Using the current construction footprint, a total of approximately 13.70 ha of native vegetation including Large Trees is proposed to be removed. The total proposed impacts to each individual EVC within the Construction footprint is outlined in Table 6.

219 Large Trees (i.e. canopy trees within patches with a DBH that meets the threshold to be considered Large for a particular EVC) would be impacted by the current design. No Scattered Trees will be impacted as a part of the project.



Table 8-5 summarises the proposed impacts to native vegetation, as outlined in the NVR report prepared on 8 May 2020, see Appendix Q.

Table 8-5 Summary of impacts to native vegetation for the project

Summary of Impacts	
Assessment Pathway	Detailed Assessment Pathway
Extent of proposed vegetation removal	13.70 ha
Number of Large Trees to be removed	219
Location Category	Location 3 The native vegetation is in an area mapped as an endangered EVC, sensitive wetland or coastal area. Removal of less than 0.5 hectares of vegetation could have a significant impact on any habitat for rare or threatened species.

8.4.1 Offset requirements

The NVR report outlines the offset requirements for the project, including specific species offsets for 9 species of rare and threatened flora and fauna, and 219 Large Trees (Appendix K) (To be confirmed against final design). Offsets will be sought in accordance with the requirements of the Guidelines for removal, destruction or lopping of native vegetation (DELWP 2017) or through an alternate arrangement agreed with the Secretary to DELWP. 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 area resulting from environmental watering. The method for confirming this offset would be developed in consultation with DELWP.



9. Avoidance, minimisation and mitigation measures

Efforts have been made throughout the planning and design phases for the proposed construction to avoid and minimise impacts to ecological values including native vegetation and fauna habitat, threatened flora, fauna and communities. All areas of native vegetation that are proposed to be impacted are adjacent to existing vehicle tracks and areas of previous human disturbance, and represent inferior areas of habitat to those which surround them. From a landscape perspective the proposed construction footprint represent a small area within a very large intact area of high quality native vegetation.

9.1.1 General mitigation measures

The following should be considered during the construction, planning approval phase and implementation of the project:

- Avoid where practical, the removal of hollow bearing trees and large old trees (including removal of limbs) within the construction footprint with regards to fauna
- Avoid where possible, areas of native vegetation not approved for removal, areas of high quality vegetation and areas of vegetation that support rare and threatened flora species (e.g. FFG threatened flora)
- Retain as many Large Trees as practicable where there are potential impacts to Tree Protection Zones for the construction footprint area
- Flag areas of native vegetation adjacent to the proposed works that have not been approved for removal as no-go zones. All vegetation clearing extents to be approved by site environmental officer.
- Use existing disturbed areas or areas of non-native vegetation for lay-downs and stockpiling
- Where practical, avoid areas of high quality vegetation and vegetation that supports rare or threatened flora
- Include the above points to develop and implement mitigation measures for incorporation into an EMP to minimise the potential for ecological impacts within and around the site before, during and after the construction process. These may also include:
 - Minimise and adhere to the approved footprint and supervise construction activities to ensure that activities do not encroach on retained native vegetation
 - Avoid and minimise disturbance to the State Forest where practicable
 - Standard vehicle hygiene measures to prevent the spread and introduction of weed species, particularly the weeds of national significance and noxious weeds listed under the Catchment and Land Protection Act 1994 (CaLP Act)
 - Standard vehicle hygiene measures to prevent the spread or transmission of Chytrid Fungus as per Murray et al (2011)
 - Management of run-off, spills and sediment to avoid impacts on the Murray River any other waterways
 - Delineation of areas of remnant native vegetation to be retained from those areas to be removed as nogo zones to avoid encroachment into areas of retained vegetation
 - EPA construction erosion and sediment control measures to be employed.
- Develop and implement a Flora and Fauna Management Plan as part of the EMP that contains requirements to avoid, mitigate and manage impacts to flora and fauna values and particularly threatened species and describing the habitat preclearance and clearance process. As a minimum the plan must address the requirements described in measures described within this technical report.

9.1.2 Design phase

The following mitigation measures have been and should continue to be implemented during the design phase to minimise and mitigate impacts to threatened flora and fauna identified in previous ecological surveys within the construction footprint (Biosis 2014; GHD 2017):



- Siting of proposed structures primarily along or immediately adjacent to existing access tracks and other previously disturbed areas
- Avoid where possible mapped rare and threatened flora species
- Design project infrastructure to enable fish migration and manipulation to provide fish exit cues
- Design of pump stations to provide appropriately sized fish screens on inlet pipes
- Micro-aligning construction footprint to avoid impacting hollow-bearing trees to reduce impacts to hollow-dependent fauna (such as species within the FFG Act Listed community, VTWBC)
- Refinement of the design and construction methods to minimise the construction footprint (including access track and laydown areas)

9.1.3 Construction phase

The following mitigation measures are recommended to minimise and avoid impacts upon the identified threatened flora, fauna and community values (FFG Act listed threatened species):

- Follow the avoid, minimise protocol in determining the construction works footprint at each site (i.e. make every effort to avoid threatened flora species loss as a high priority)
- Areas of remnant native vegetation to be retained should be delineated from those areas to be removed as 'no-go zones', to avoid encroachment into areas of retained vegetation
- Locations for stockpiles should be within existing cleared or areas of non-native vegetation where practicable
- Manage potential impacts to tree root zones during construction
- For the protection of threatened flora:
 - Species listed under the FFG Act and EPBC Act that are not permitted to be removed, must be fenced off with temporary one metre high orange barrier mesh medium-heavy weight prior to construction commencing
 - Fencing must be checked on a weekly basis and the population monitored on a monthly basis
 - All staff onsite should be made aware through inductions and/ or signage of the presence of threatened species and how to identify the species. Locations for stockpiles should be within existing cleared or areas of non-native vegetation where practicable
- If any threatened flora species additional to those already identified in site plans (i.e. listed as threatened under the EPBC Act, or the FFG Act) are found within the construction area the Project Ecologist will be notified. The number and location of individuals will be recorded and DELWP will be advised
- Manage the removal of hollow-bearing trees within the construction footprint (if required, based on final footprints and potential impacts to tree root zones from track establishment, setdown areas) where construction may impact habitat trees of native fauna, particularly FFG Act listed fauna species and communities and species protected under the Wildlife Act (all wildlife);
 - Avoiding tree removal during the breeding season of hollow-dependant species (spring summer) is
 recommended, however where this is not practical, a suitably qualified ecologist must undertake hollowchecks. If juveniles, or eggs, are observed within a hollow a protocol will be devised for removal of the
 fauna (if possible) by the onsite ecologist on a tree-by-tree basis. In some cases, fauna may not be able
 to be removed and staged tree removal may follow. In some instances, DELWP will need to be contacted.
 Where nocturnal wildlife can be removed, they will be kept in cages and released at dusk.
 - Prior to tree removal, complete pre-clearance surveys for any large and hollow-bearing trees to be removed. A hollow-bearing tree is defined as a tree over 60 cm DBH (can adjust within each EVC). Pre-clearance surveys should be conducted prior to (within 24 hours) the hollow-bearing trees being



removed. If fauna are located within hollows, or are nesting in a tree the onsite ecologist will follow the Flora and Fauna Management Plan.

- For the protection of fish species:
 - Use only partial coffer dams to isolate small areas of back from construction works
 - Relocate any habitat within works areas to the same river reach and adoption of sediment control and accidental spill measures.
 - 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*. Any capture of fish must be carried out by a qualified aquatic ecologist.
- An initial briefing of construction works crews by a qualified ecologist and subsequent planning of safe work distances and establishment of each site
- Manage the impact of noise and light pollution for fauna during construction. Where night-time works are unavoidable, measures must be implemented to limit the impact to nocturnal fauna. These would include
 - Downward angles or directional lights to avoid unnecessary light spill across a broader area than required
 - Light wavelengths selected (yellow/orange LED) to avoid insect attraction, and therefore reducing indirect impacts to bat and nocturnal bird behaviour
 - Works should be undertaken away from known nesting areas, or done out of season.
 - Avoiding periods of high insect/bird/bat activity so as to minimise disturbance to faunal communication
 - Ensure areas of quiet remain in connected/adjacent habitat that can act as a refuge while other areas are subject to higher temporary noise levels.
 - Avoid where possible equipment which emit noise at known animal communication frequencies (generally higher frequencies above 500Hz)
- Develop and implement a Construction Environmental Management Plan (CEMP) for the construction phase. The CEMP should provide appropriate measures to avoid or minimise indirect impacts such as erosion, sedimentation and the accidental spill of oils or other chemicals. It would also provide a protocol for minimising impacts in ecologically sensitive areas such as creek lines. The EMP should be audited during and following the construction process to check that works have been conducted appropriately, including complying with the Flora and Fauna Management Plan.
- Develop and implement a Flora and Fauna Management Plan as part of the CEMP that contains requirements, including those listed in this section of the referral, to avoid, mitigate and manage impacts to flora and fauna values and particularly threatened species and describing the habitat preclearance and clearance process
- Develop and implement an Aquatic Fauna Management Plan as part of a broader CEMP to manage impacts to aquatic values – with emphasis on threatened fish species that may be present in vicinity of construction sites. Any construction activities that could lead to entrapment of fauna or temporary loss of habitat (e.g. due to the use of coffer dams and dewatering) should be considered. 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*. Any capture of fish must be carried out by a qualified aquatic ecologist.
 - Recommended construction mitigation measures include the use of only partial coffer dams to maintain fish passage and isolate small areas of river bank from construction works, relocation of any



habitat within works areas to the same river reach and adoption of sediment control and accidental spill measures.

- Implement sediment control measures according to the CEMP to control the mobilisation of sediments that may discharge into wetland habitats during rainfall events.
- Standard vehicle hygiene measures are to be implemented to prevent the spread and introduction of weed species, particularly the weeds of national significance and noxious weeds listed under the Catchment and Land Protection Act 1994 (CaLP Act), and to prevent the spread or transmission of Chytrid Fungus as per Murray et al (2011)
- Develop and implement a Weed Management Plan to manage weeds during and after the construction phase within the project area.
- On completion of works, rehabilitate the construction footprint, including:
 - Setting aside topsoil to reinstate when works are complete and compacting to original levels.
 - If native vegetation must be removed, re-spreading of stored topsoil should occur, followed by monitoring to assess germination in the following year.
 - If the site is not naturally recolonised by locally indigenous species, planting of locally indigenous species appropriate to that particular position in the landscape may be undertaken in the following year.
 - Ground debris (logs/litter) that is temporarily removed to allow construction activities, should be reinstated.
- All vehicles and plant must only operate on existing tracks and in areas marked as parking areas or construction zones.
- Minimise the need to create new tracks and use existing tracks as much as possible.

9.1.4 Operation phase

The following mitigation measures are recommended to minimise and avoid impacts upon the identified threatened flora, fauna and community values. These measures are general across the inundation area footprint and are not site specific.

- Mitigation measures associated with operation of the project need to be documented in a fish exit strategy
 to manage risk associated with fish stranding on the floodplain. The project's Operating Plan will also need
 to include measures to reduce the potential for poor water quality of return flows.
 - Installation and maintenance of appropriately sized fish screens on inlet pumps, management of inundation and drawdown to minimise the likelihood of fish stranding on the floodplain by ensuring opportunities for fish movement during managed drawdown
 - Management of the timing of inundation and drawdown to minimise blackwater risks and to ensure appropriate dilution of return flows if low dissolved oxygen is evident.
- Implement pest animal management and control within the inundation area (and ideally surrounding areas), this may require DELWP and Parks Victoria to expand current pest control programs within the forests to target these areas during inundation events
- Timing water delivery to down seedling, minimise growth, germination and seed set of pest species. Time water delivery to promote native species



10. Legislative and policy requirements

There are a number of ecological values present within the construction footprint as discussed within this report, with the potential to trigger the requirement to obtain permits or approvals if impacted. Table 10-1 below outlines the potential legislative implications for the project that may result from the removal of native vegetation and/or fauna habitat within the construction footprint.

Table 10-1	Summary of probable legislative requirements
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Federal legislation	Relevance to project
Environment	Threatened Ecological Communities
Protection and Biodiversity	No ecological communities were identified during this assessment or are considered likely to be impacted by the proposed works.
1999	Threatened flora
1999	<i>River Swamp Wallaby-grass</i> - Previous survey located a small number of individuals of this species in several low-lying areas where inundation events are to be provided. The flooding works are considered to be a beneficial impact to the species across the wider forest landscape. It has been determined that the proposed works will not have a significant impact to this species.
	<i>Winged Peppercress</i> - is considered to have the potential to occur in a small area on the upper terraces of the outer area of Guttrum forest. While not located, likely due to the current poor condition of the area, the potential for future restored inundation events is likely to benefit the species. It has been determined that the proposed works will not have a significant impact to this species.
	Threatened fauna
	No listed fauna have been identified within the construction footprint during the field assessment in 2019 by R8 ecologists and in previous assessments (GHD 2017; Bennetts 2014; Biosis 2014a).
	Painted Honeyeater and Superb Parrot - have not been recorded in Guttrum and Benwell Forests but are considered to have potential to utilise habitats within the project area. Impacts to these species are considered unlikely as they are highly mobile species that may infrequently utilise the project area and are expected to benefit from environmental watering. It has been determined that the proposed works will not have a significant impact to either species.
	Australasian Bittern - recorded in the study area as recently as 2018 is likely to benefit from environmental watering and a return to natural flooding in Guttrum and Benwell Forests. Impacts to this species are considered unlikely as they are highly mobile species and impacts to entirely aquatic EVCs are expected to be negligible. It has been determined that the proposed works will not have a significant impact to this species.
	Australian Painted Snipe – has not been recorded in Guttrum and Benwell Forests within the last 40 years and is likely to benefit from environmental watering and a return to natural flooding. Impacts to this species are considered unlikely as they are highly mobile species and impacts to entirely aquatic EVCs are expected to be negligible. It has been determined that the proposed works will not have a significant impact to this species.
	<i>Growling Grass Frog</i> - suitable habitat for this species is limited in the Guttrum and Benwell Forests due to the loss of seasonal flooding, particularly in Reed Bed Swamp and Benwell Swamp. Impacts to Growling Grass Frog are unlikely, but localised impacts in wet areas may occur, and consideration of coffer dam construction, dewatering works, and any potential for sediment/ contaminant run-off into wet areas from construction footprint



Federal legislation	Relevance to project
	must be taken. It has been determined that the proposed works will not have a significant impact to this species
	<i>South-eastern Long-eared Bat</i> - has not been recorded in Guttrum and Benwell Forests but are considered to have potential to utilise habitats within the project area. In the unlikely occurrence of this species occurring in the construction footprint, impacts as a result of vegetation removal and potential habitat loss will be localised, and therefore resultant impacts to the species are expected to be very low. However, broader mitigation measures for hollow-dependent species as outlined in Section 9 will also apply to threatened bats including South-eastern Long-eared Bat, including pre-clearance surveys and hollow-bearing tree management. It has been determined that the proposed works will not have a significant impact to either species.
	<i>Murray Cod and Silver Perch</i> - potential to occur in the Murray River alongside the project area. Consideration of any in-stream works such as coffer dam construction, dewatering works, and any potential for sediment/ contaminant run-off into wet areas from construction footprint must consider these species. A construction specific aquatic fauna management plan will be developed for all works around waterways. With these mitigation measures impacts are considered unlikely. It has been determined that the proposed works will not have a significant impact to this species
	Migratory Species Eleven (11) migratory species were identified as having the potential to occur within the project area (PMST and VBA). Most of these species are either highly unlikely to occur (e.g. Curlew Sandpiper, Eastern Curlew) or would very rarely use airspace over these footprints (e.g. White-throated Needletail). It is highly unlikely that the construction footprint supports habitat that would be considered important for migratory species foraging or breeding activity or support an ecologically significant proportion of a population of migratory species. It has been determined that the proposed works will not have a significant impact on migratory species.
	Ramsar Wetland The Ramsar Wetland NSW Central Murray State Forests Ramsar Wetland occurs across the Murray River from the project area. It is unlikely that the project will negatively impact on the character of the Ramsar site. Whilst impacts to the NSW Central Murray State Forests Ramsar Wetland are unlikely an Environmental Management Plan (EMP) should be developed that identifies potential environmental risks and puts in place mitigation strategies to avoid or minimise these risks (e.g. sediment runoff). It has been determined that the proposed works will not have a significant impact to this Ramsar Wetland. Determination It is unlikely that the project will result in a significant impact to any MNES. However, a referral is to be submitted to the Department of Agriculture, Water and the Environment (DAWE) to provide VMFRP with certainty as to their obligations under the EPBC Act.
State legislation	Relevance to project
Environment Effects (EE) Act 1978	 Extent of native vegetation clearing will exceed 10 ha. It is currently estimated that up to 13.70 ha of native vegetation will require removal with 219 Large Trees potentially impacted. Impact to species listed as threatened under the FFG Act (Grey-crowned Babbler, Diamond Firetail and White-bellied Sea-eagle) should not result in loss of a significant proportion of habitat or the population. Potential impacts on habitat values of wetland area supporting migratory bird species, however this is not a significant effect in the context of the wetland of the Guttrum and Benwell Forests



Federal legislation	Relevance to project
	No loss of FFG-listed community. Two FFG-listed fauna communities was identified in the project area, Victorian Temperate Woodland Bird Community (VTWBC) and Lowland Riverine Fish Community of the Southern Murray-Darling Basin (LRFC). The VTWBC was identified as occurring throughout the Guttrum and Benwell Forests project area. Bird species of this FFG-listed fauna community are highly mobile and impacts as a result of the Project are expected to be negligible in the short-term to species of these communities, with a long-term improvement in habitat expected from environmental watering. The LRFC was identified as occurring entirely within the Murray River as no semi-permenent wetlands present in the project area would support these fish species. With mitigation measures as outlined in section 9, including use of only partial coffer dams to maintain fish passage and sediment control detailed in a specific Aquatic Fauna Management Plan Consideration, it is unlikely that there will be any significant impacts to the community.
Planning and Environment Act 1987 (P&E Act)	The construction footprint indicates that 13.70 ha of native vegetation will require removal with 219 Large Trees potentially impacted for the project. Approval under the P&E Act will be required for the removal of any native vegetation unless exemptions (as specified in Clause 52.17) apply. Given the extent of native vegetation identified within the construction footprint, as well as the presence of scattered native individuals (<25% cover) within areas considered to be non-native vegetation, it is considered that planning permission under the P&E Act will be required for the project.
Guidelines for the removal, destruction or lopping of native vegetation (DELWP 2017) – the Guidelines.	The location mapping for the project area identifies that the construction areas are classified as Location Risk 3. Given the scale of the project and both the extent of native vegetation and the number of trees identified within the project area, it is considered likely that the project would need to follow the Detailed Assessment pathway. For this reason, habitat hectare assessments were undertaken in all areas of construction footprint. The results of this are presented in Appendix G.
Flora and Fauna	Flora species
Guarantee Act 1988	 No FFG Act listed threatened flora species were recorded during targeted surveys in 2019, however two are considered to be possible as occurring in the construction footprint: Wavy Marshwort Winged Peppercress
	These species have the potential to be impacted by the proposed works, and an FFG Act Permit would be required for their removal.
	During R8 surveys in 2019, twelve flora listed as protected under the FFG Act were recorded within the area for investigation and their approximate abundances are provided in section 7.2.3.
	A permit should be sought for the removal of these species.
	Fauna species and communities
	One FFG Act listed species was observed during the field assessment in 2019 (White- bellied Sea-eagle), although many records of the Grey-crowned Babbler exist within the project area including from recent assessments (GHD 2017; Bennets 2014; Biosis 2014a). In total 49 species are predicted as possible to occur, or previously recorded within the construction footprint or inundation area (VBA, PMST, GHD 2017; Biosis 2014a). All species have been recorded within the study area, and utilise habitats such as those found within the construction footprint. None of these species are considered likely to be
	hollow-dependent species such as the Squirrel Glider are possible. Most are highly mobile



Federal legislation	Relevance to project
	bird species and all have access to large areas of suitable habitat in the immediate surrounding areas in which to disperse. General mitigation measures to avoid the removal of hollow bearing trees, and the presence of an on-site ecologist with Management Authorisation under the <i>Wildife Act 1975</i> will reduce impacts to any threatened fauna species present.
	One species, the FFG Act listed Brown Toadlet or Bibron's Toadlet (<i>Pseudophryne bibronii</i>) was historically recorded within Guttrum and Benwell Forests, and extensive suitable seasonally inundated riparian forest habitat exists for this species. Targeted surveys recommended for species in Autumn (April-May) 2021 to identify whether the species is present and to update avoidance and mitigation measures to address impacts to this species.
	Two FFG Act listed fauna communities are considered to occur within the project area: The VTWBC and LRFC.
	Impacts to the VTWBC are likely to be negligible as Guttrum and Benwell Forests project area is comprised largely of intact vegetation and the proposed construction of floodplain infrastructure is unlikely to impact on habitat connectivity or remove important habitat for the VTWBC. The proposed inundation of floodplain and wetland habitats however, is likely to provide important future benefits to the VTWBC particularly under climate change scenarios of longer, dryer conditions in a semi-arid environment. Other than VTWBC, no other threatened fauna communities listed under the FFG Act are likely to occur within the construction footprint or inundation area.
	It is recommended that efforts should be made to avoid and minimise impacts to any species and/or communities listed as threatened or protected under the FFG Act during the design and construction phases of the project. General mitigation measures to avoid the removal of hollow bearing trees, and the presence of an on-site ecologist with Management Authorisation under the <i>Wildife Act 1975</i> will reduce impacts to any FFG Act listed fauna species.
	The LRFC was identified as occurring entirely within the Murray River as no semi- permenent wetlands present in the project area would support these fish species. With mitigation measures as outlined in section 9, including use of only partial coffer dams to maintain fish passage and sediment control detailed in a specific Aquatic Fauna Management Plan Consideration, it is unlikely that there will be any significant impacts to the community.
Wildlife Act 1975	Any persons engaged to remove, salvage, hold or relocate native fauna during construction must hold a current Management Authorisation under the <i>Wildlife Act 1975</i> (e.g. if hollow-bearing trees are removed or fauna are rescued from open trenches during construction). The permit needs to be obtained prior to construction, and the name of the ecologists/ company who are undertaking fauna management for the Project.
Catchment and Land Protection Act 1994	Seven weeds listed under the CaLP Act have been recorded within the construction footprint (refer Appendix J).
	Mitigation measures to prevent the spread of these species (and any other WONS or CaLP Act listed weed species) will need to be incorporated into a CEMP.
Fisheries Act 1995	The <i>Fisheries Act 1995</i> (Fisheries Act) provides a legislative framework for the regulation, management and conservation of Victorian fisheries. A person must not take fish from marine waters or inland waters; or use or possess recreational fishing equipment in or next to Victorian water unless authorised to do so by a licence.



Federal legislation	Relevance to project
	Section 119 of the Fisheries Act requires that a person must not create an obstruction across a watercourse or water body that would obstruct the free passage of fish, leave fish stranded, or destroy immature fish without authorisation under the Act.
	Design, construction and operation of the project should seek to avoid creating obstructions to fish passage, otherwise authorisation may be required under the Fisheries Act.
	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.
Environment Protection Act 1970	The <i>Environment Protection Act 1970</i> empowers the Environment Protection Authority Victoria (EPA Victoria) to implement regulations, maintain State Environment Protection Policies (SEPPs) and protect the environment from pollution and the management of wastes.
	The <i>Environmental Protection Act</i> (1970) allowed for the establishment of the <i>State</i> <i>Environmental Protection Policy (Waters) (SEPP Waters)</i> , which applies to all surface waters, estuarine and marine waters and groundwaters across the State (Vic. Gov. 2018).
	Relevant clauses of this policy must be adhered to. The following clauses (with a brief description of relevant aspects) are applicable to the project.
	 A person undertaking works in or adjacent to surface waters must minimise risks to beneficial uses.
	• Minimise unnatural erosion, sediment re-suspension and other risks to aquatic habitat.
	• Ensure that existing and new in situ structures do not pose a barrier to fish movement.
	Clause 42 - Construction activities
	 Minimise soil erosion, land disturbance and discharge of sediment and other pollutants to surface waters
	 Where construction activities impinge on surface waters, construction managers need to monitor affected surface waters to assess whether beneficial uses are being protected
	Clause 45 – Native vegetation protection and rehabilitation
	 Minimise the removal of and rehabilitate native vegetation within or adjacent to surface waters.
Water Act 1989	The <i>Water Act 1989</i> provides legislative framework for the allocation and management of water. A Works-on-Waterways permit is required to construct works on a waterway identified under section 67 of the Water Act. The permit must be approved by North Central CMA.



11. Recommendations

The proposed Guttrum and Benwell Forests Restoration project aims to inundate approximately 1,149 ha of floodplain and wetland habitats that support water dependent vegetation threatened by river regulation, on-going drought and a drying climate.

11.1 Next steps

R8 recommends the following next steps:

- Refine the construction footprint within the bounds of the 13.70 ha footprint utilising the existing
 ecological values mapping to avoid and minimise impacts to native vegetation and threatened flora/fauna
 and communities within the construction footprint
- Complete additional field survey in spring 2020, including targeted threatened flora surveys and Large Tree mapping for the construction footprint in Benwell Forest around the South-west regulator and Outlet 2 (approximately 700 m length) as design changes occurred following the completion of field survey in 2019.
- Targeted surveys recommended for FFG Act listed Brown Toadlet in seasonally inundated areas of riparian forest present in the construction footprint in Autumn (April-May) 2021 to identify whether the species is present and to update avoidance and mitigation measures to address impacts to this species.
- Additional targeted surveys for EPBC Act and FFG Act species may be required to support Federal and State approval processes.
- 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 design phases of the project
- The Habitat Hectare assessments were undertaken at the time of the fieldwork in 2019 using the construction footprint that was current at the time. It is expected that minor design changes to the construction footprint assessed in 2019 will occur. Once the design process is complete and the construction footprint has been finalised, it is recommended that a Vegetation Quality Assessment (Habitat Hectares) is undertaken in these areas to confirm the condition and extent of native vegetation within these areas. The results of this will update the current Habitat Hectare data presented in Appendix G.
- 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 in to account direct impacts to trees (tree
 removal) and indirect impacts to trees (through encroachment of their 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 obtaining offsets for the project and whether the
 conservation works exemption, or an alternative offset approach may apply to the works at Guttrum and
 Benwell Forests. 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 comprehensive Construction Environmental Management Plan (CEMP) will 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 would be developed as part of the CEMP which includes the avoidance, minimisation and mitigation measures as specified in section 9. The CEMP would 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).



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Appendix A. Ecological Vegetation Classes (EVCs) and Large Old Trees mapping in the construction footprint

Appendix A: EVCs and Large Old Trees in construction footprints at Guttrum-Benwell, Overview - Benwell State Forest



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Appendix A: EVCs and Large Old Trees in construction footprints at Guttrum-Benwell, Overview - Guttrum State Forest



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Appendix A: EVCs and Large Old Trees in construction footprints at Guttrum-Benwell, Page 1 of 18



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Appendix A: EVCs and Large Old Trees in construction footprints at Guttrum-Benwell, Page 8 of 18






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Appendix A: EVCs and Large Old Trees in construction footprints at Guttrum-Benwell, Page 14 of 18



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Appendix A: EVCs and Large Old Trees in construction footprints at Guttrum-Benwell, Page 15 of 18



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Appendix A: EVCs and Large Old Trees in construction footprints at Guttrum-Benwell, Page 17 of 18 HZq1 GUTTRUM STATE FOREST URRAY RIVE HZF1

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Appendix A: EVCs and Large Old Trees in construction footprints at Guttrum-Benwell, Page 18 of 18



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Appendix B. Summary of previous ecological studies



Report	Methods	Key findings	Recor
GHD (2017). Guttrum and Benwell State Forests Flora and Fauna Assessment. Report prepared for the North Central Catchment Management Authority.	 Review of existing information EVC mapping Habitat Hectare assessment Large old trees (LOT) mapping Fauna surveys (February – March 2017) Bird surveys Bat surveys (Bat harp trapping and Anabat recording) Active searching Spotlight surveys Remote sensing fauna cameras Recording of incidental observations 	 SDL Construction footprint contains: Five EVCs: Floodplain Riparian Woodland (EVC 56), Riverine Grassy Woodland (EVC 295), Floodway Pond Herbland (EVC 810), Riverine Swamp Forest (EVC 814) and Sedgy Riverine Forest (EVC 816) 866 LOTs 114 flora species recorded 2 species of rare/threatened flora: Branching Groundsel (Senecio cunninghamii var. cunninghamii, DELWP Advisory rare) Pale Flax-lily (Dianella sp. af longifolia Riverina, DELWP Advisory vulnerable) 57 terrestrial fauna species recorded 1 species of rare/threatened fauna: Grey-crowned Babbler (Pomatostomus temporalis, FFG Act listed) Victorian Temperate Woodland bird Community (VTWBC). 	 Ta un Wa Ta Gro
Bennetts (2014). Preliminary Vegetation Assessment of the Benwell and Guttrum Forests. Report prepared for the North Central Catchment Management Authority.	 Review of existing information Field surveys (July 2014) 	 Guttrum and Benwell Forests support over 2000 ha of Red Gum Forest and semi- permanent wetlands supporting: Six EVCs: Floodplain Riparian Woodland (EVC 56), Grassy Riverine Forest (EVC 106), Riverine Grassy Woodland (EVC 295), Floodway Pond Herbland (EVC 810), Riverine Swamp Forest (EVC 814) and Sedgy Riverine Forest (EVC 816) 6 species of rare/threatened flora: Black Rolypoly Saltbush (<i>Sclerolaena muricate</i>, DELWP Advisory rare) Branching Groundsel (<i>Senecio cunninghamii var. cunninghamii</i>, DELWP Advisory rare) Dwarf Bitter-cress (<i>Rorippa eustylis</i>, DELWP Advisory rare) Floodplain Fireweed (<i>Senecio campylocarpus</i>, DELWP Advisory rare) Riverina Bitter-cress (<i>Cardamine moirensis</i>, DELWP Advisory rare) Wavy Marshwort (<i>Nymphoides crenata</i>, FFG Act listed) 3 rare/threatened bird species: Brown Treecreeper (<i>Climacteris picumnus</i>, DELWP Advisory near threatened) Diamond Firetail (<i>Stagonopleura guttata</i>, FFG Act listed) Impacts: altered flooding regime, cattle grazing, timber harvesting, weed invasion and recreational vehicles 	Report experi lncreaterm of to reso and w
Biosis (2014a). Flora and fauna assessment of the Gunbower National Park and Guttrum and Benwell State Forests. Report prepared for the North Central Catchment Management Authority.	 Review of existing information Field surveys of Gunbower NP and Guttrum and Benwell State Forests (July 2014) EVC mapping Habitat Hectare assessment Large old trees (LOT) mapping Fauna surveys 	 A total of 150 flora species and 70 fauna species were recorded across all three Forests. The following ecological values were recorded for Guttrum and Benwell Forests Four EVCs: Floodplain Riparian Woodland (EVC 56), Floodway Pond Herbland (EVC 810), Riverine Swamp Forest (EVC 814) and Sedgy Riverine Forest (EVC 816) Potential habitat for EPBC-listed species: River Swamp Wallaby-grass, Winged Peppercress, Stiff Groundsel, Growling Grass Frog and Superb Parrot One species of rare/threatened flora: 	 Ta un Wa De veg Av ha wc

mmendations

argeted surveys for threatened flora should be ndertaken, in particular for EPBC-listed River Swamp /allaby-grass and Winged Pepper-cress

argeted surveys should be undertaken for FFG-listed rey-crowned Babbler and Squirrel Glider

ort describes Guttrum and Benwell Forests have rienced drier conditions over the past decade. asing the level of flooding is likely to improve the longcondition of the forest, but is unlikely in the short term serve the significant structural changes due to grazing weeds.

argeted surveys for threatened flora should be ndertaken, in particular for EPBC-listed River Swamp /allaby-grass and Winged Pepper-cress

esign works to avoid and minimise impacts to native egetation

void/minimise removal of terrestrial and/or aquatic abitat by designing to avoid or minimise instream orks.

Flora and Fauna Assessment - Guttrum and Benwell Forests Floodplain Restoration Project



Report	Methods	Key findings	Recor
	 Bird surveys Active searching Spotlight surveys including the use of call-playback Recording of incidental observations 	 Branching Groundsel (Senecio cunninghamii var. cunninghamii, DELWP Advisory rare) Floodplain Fireweed (Senecio campylocarpus, DELWP Advisory rare) Riverina Bitter-cress (Cardamine moirensis, DELWP Advisory rare) Wavy Marshwort (Nymphoides crenata, FFG Act listed) One species of rare/threatened fauna: Grey-crowned Babbler (Pomatostomus temporalis, FFG Act listed) Victorian Temperate Woodland bird Community (VTWBC) 	 Av tre to Conductorial Conductorial
Biosis (2014b). Mapping and condition assessment of the Guttrum & Benwell State Forests. Report prepared for the North Central Catchment Management Authority.	 Review of existing information Field assessment (October 2014) Mapping the distribution of EVCs Determining the current condition of wetlands, trees and understorey species Establishment of long-term monitoring locations (transects and quadrats) for guiding hydrological management and maintaining ecological values 	 Guttrum and Benwell Forests contain: Seven EVCs, two EVC aggregates and one EVC complex: Riverine Grassy Woodland, Aquatic Herbland, Floodplain Riparian Woodland, Grassy Riverine Forest, Riverine Swamp Forest, Sedgy Riverine Forest, Spike-sedge Wetland, Billabong Wetland Aggregate, Floodplain Wetland Aggregate and Floodway Pond Herbland/Riverine Swamp Forest Complex. These vegetation types have varying hydrological requirements to maintain their characteristic composition Baseline vegetation data indicates that vegetation communities are drier than expected Seven species of rare/threatened flora: Branching Groundsel (Senecio cunninghamii var. cunninghamii, DELWP Advisory rare) Dwarf Bitter-cress (Rorippa eustylis, DELWP Advisory rare) Fuzzy New Holland Daisy (Vittadinia cuneata var. hirsuta, DELWP Advisory rare) River Swamp Wallaby-grass (Amphibromus fluitans, EPBC Act listed) Riverina Bitter-cress (Cardamine moirensis, DELWP Advisory rare) Twin-leaf Bedstraw (Asperula gemella, DELWP Advisory rare) Wavy Marshwort (Nymphoides crenata, FFG Act listed) 	 As Aq in a c Th an Riv flo du veg gra a c a c Ta by (20 with to ne
North Central Catchment Management Authority (2014a). Guttrum Forest: Ecological Objectives and Hydrological Requirements	 Summarises the ecological values, objectives and targets of the Guttrum Forest Environmental Works Project Provides justification for the corresponding hydrological requirements 	Reports on and summarises the findings of Ecological Asscoates (2013) below	Two w propo - Sco - - - - - - - - -

mmendations

void hollow tree removal where possible. Supervised ree removal by a suitably qualified zoologist if stags are b be removed.

duct tree removal during late summer and early autumn roid the breeding season of most fauna species.

s a priority, all areas of Floodplain Wetland Aggregate, quatic Herbland and Sedge Wetland should be flooded winter and inundated where possible during spring to depth of 0.5 m in the central zone of each wetland.

he recommended water regime prescription for forest nd woodland (excluding Riverine Grassy Woodland and iverine Swampy Woodland) is for 80% seasonal ooding frequency within a 10 year period with a uration of 1–4 months. For herb-dominated wetland egetation including those dominated by larger raminoids, the recommended regime is for 90% easonal flooding frequency within a 10 year period, with duration of 3–6 months.

argets for flood frequency and duration recommended y Ecological Associates (2013) and Fitzsimons et al 2011) should be adopted as a management objective, ith application for water allocation in the first instance o meet at least half of these requirements within the ext 10 years.

watering regimes to meet the ecological objectives are osed:

cenario 1 – River Red Gum floodplain:

Frequency: 8 years in 10

Duration of inundation: 4 months (to be adapted depending on monitoring results)

Timing: Winter/spring

cenario 2 – Semi-permanent wetland watering:

Frequency: 9 years in 10

Duration of inundation: 6 months

Timing: Winter/spring, with drying (drawdown of water level) in late summer/autumn.

Depth: fluctuate over time, inundate to Full Supply Level in some years.



Report	Methods	Key findings	Reco
North Central Catchment Management Authority (2014b). Benwell Forest: Ecological Objectives and Hydrological	 Summarises the ecological values, objectives and targets of the Guttrum Forest Environmental Works Project 	 Reports on and summarises the findings of Ecological Asscoates (2013) below 	Two prop ■ S
Requirements	 Provides justification for the corresponding hydrological requirements 		- - - S
			- - Dept some
North Central Catchment Management Authority (2014c). Guttrum Forest and Benwell Forest Environmental Works Project: Ecological Risks and Mitigation	 Summarises the main ecological risks associated with previous studies at nearby Gunbower Forest and how they might apply to the Guttrum Forest and Benwell Forest Environmental Works Project 	 Some of the key ecological risks include: River Red Gum encroachment Giant rush colonisation Fish stranding Pest fish introductions Waterbirds abandoning nests Aquatic weeds Blackwater 	Miti <u>c</u> previ
Ecological Associates (2013). The Ecological Justification for Works and Measures for the Guttrum and Benwell State Forests. Report prepared for the North Central Catchment Management Authority	 Desktop hydrological analysis of Guttrum and Benwell Forests Flow analysis of the following scenarios: natural, benchmark and Basin Plan 2750 	 Flows to inundate the semi-permanent wetlands now occur in 61% of years rather than the recommended 90% of years and last for 1 to 4 months interquartile range 21,000 ML/d instead of 3 to 6 months. Reduction in flood duration and frequency and the longer periods between events has made wetlands habitat less persistent and reliable 16 threatened fauna species and one flora species reported in Guttrum and Benwel Forests Impacts from grazing and timber harvesting 	at

watering regimes to meet the ecological objectives are posed:

cenario 1 – River Red Gum floodplain:

Frequency: 8 years in 10

Duration of inundation: 4 months (to be adapted depending on monitoring results)

Timing: Winter/spring

cenario 2 – Semi-permanent wetland watering:

Frequency: 9 years in 10

Duration of inundation: 6 months

Timing: Winter/spring, with drying (drawdown of water level) in late summer/autumn.

th: fluctuate over time, inundate to Full Supply Level in e years.

gation measures are outlined to address all of the vious ecological risks



Appendix C. Likelihood of occurrence / impact - threatened flora - construction footprint

Likelihood of occurrence:

Not all of the threatened species identified during this assessment are equally likely to occur in the project site, due to the geographic location or context of the site, or the habitat type and condition. For each species, the likelihood of occurrence was evaluated using the following rationale:

PRESENT - Species known to occur within the site, or detected during the site visit.

POSSIBLE – Potentially suitable habitat occurs within construction footprint and species' known range encompasses the construction footprint. Species recorded historically in the study area, and generally within the last 30 years.

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



Likelihood of occurrence of listed rare or threatened flora species, as developed from previous assessments and VBA and PMST searches within the study area (10 km buffered search area)

Scientific name	Common Name	EPBC	FFG	DELWP Advisory	Habitat	Most Recent Record	Number of Records	Likelihood of Occurrence
Amphibromus fluitans	River Swamp Wallaby-grass	VU			Largely confined to permanent swamps, principally along the Murray River between Wodonga and Echuca, uncommon to rare in the south (e.g. Casterton, Moe, Yarram), probably due to historic drainage of wetlands (RBGV 2016).	Biosis 2014b, PMST		Possible. No previous records, but suitable habitat present within project area. Cryptic species responding to inundation events, occurs in low lying areas (ponds), and near flood ways, species was not evident during current survey, but has been previously recorded inundation area (Biosis, 2014).
Austrostipa metatoris	Spear grass	VU			Grows in sandy, mallee areas of the Murray Valley, NSW. Habitat includes sand hills, sand ridges, undulating plains and flat-open mallee country with red to red-brown clay loam soils (DECC NSW 2005).	PMST		Highly unlikely. No previous records. Suitable sandy mallee habitat not present within project area.
Austrostipa wakoolica	Spear grass	EN			Not recorded in Victoria. Confined to the floodplains of the Murray River tributaries of central-western and south-western NSW. Habitat includes the edges of lignum swampy box and mallee woodlands (NSW OE&H 2019).	PMST		Highly Unlikely. Species recorded in upper tributaries of the Murray River in NSW and limited suitable box woodland present in project area.
Asperula gemella	Twin-leaf Bedstraw			r	Rare in Victoria where known only from moist riparian sites along the Murray River downstream from Kerang, and with an isolated record from the upper Avoca River (RBGV 2019)	Biosis 2014b		Possible . Recorded by Biosis during vegetation condition monitoring within inundation area and suitable habitat present.
Caladenia tensa	Rigid Spider-orchid	EN		vu	Apparently confined to the Wimmera region growing in Yellow Gum and cypress pine woodland, heathy woodland and mallee. Flowers Sep to Nov. (Jeanes and Backhouse 2006)	PMST		Highly unlikely. No previous records. Suitable habitat not present within project area.
Calotis cuneifolia	Blue Burr-daisy			r	Scattered along the Murray River and its floodplain downstream from near Barmah, with occurrences away from the river at Kamarooka and Chiltern. Occurs chiefly on alluvial loam or clay soils, often associated with <i>Eucalyptus camaldulensis</i> (Walsh and Entwisle 1999).	Biosis 2014a		Possible. Suitable Red Gum floodplain habitat present within construction footprint.
Cardamine moirensis	Riverina Bitter-cress			r	In Victoria, occurring in the north and west in seasonally wet areas (RBGV 2019).	Biosis 2014a, 2014b		Present. Small number recorded by Biosis within the Grassy woodlands and forests of the middle to upper terraces of Guttrum-Benwell



Scientific name	Common Name	EPBC	FFG	DELWP Advisory	Habitat	Most Recent Record	Number of Records	Likelihood of Occurrence
Dianella porraceae – formally known as Dianella sp af. longifolia (Riverina)	Leek Flax-lily			v	Apparently recorded on Riverina floodplain, including Barmah Forest, west of state around Horsham and also far north-west inhabiting sandy soils and silty alluvium (RBGV 2019).	2019	Field record	Present: Small number recorded within the Grassy woodlands and forests of the middle to upper terraces of Guttrum-Benwell.
Eleocharis plana	Flat Spike-sedge			vu	In moist areas. Similar to E. acuta. Flowers spring- summer. (Walsh and Entwisle 1994)	2001	1	Possible. Records within study area and potential habitat present in aquatic sedge lands and shallow areas of inundation.
Lepidium monoplocoides	Winged Peppercress	EN	L	en	Uncommon in north-western quarter of State, mostly on heavy soils near lakes and watercourses. Flowers mostly spring-summer. (Walsh and Entwisle 1996)	PMST		Possible. Records within study area and potential habitat present in the outer areas of forest where Black Box chenopod vegetation occurs.
Maireana cheelii	Chariot Wheels	VU	L	vu	Occurs on seasonally wet, heavy red loam or clay soils. Fruits mostly SepNov. (Walsh and Entwisle 1996)	PMST		Unlikely. No previous records. Suitable habitat not present within project area.
Nymphoides crenata	Wavy Marshwort		L	vu	Occurs in fresh, still to slow-flowing water to 1.5 m deep in swamps, lagoons, irrigation channels and streams, also frequent in temporarily inundated depressions. Rare in all regions except RIV (and perhaps now extinct in MID, PROM and WIM from where there have been no contemporary collections) (Walsh, 1999).	Biosis 2014b	1	Possible. Previously recorded by Biosis in the inundation area within 100m of the construction footprint. Habitat consists of the floodway and pond aquatic systems. Cryptic, dies off to roots during dry phases.
Paspalidium flavidum	Yellow Watercrown Grass			en	Recorded a few times in the 1920s from Werribee, Bacchus Marsh and Bundoora, habitat unknown. Flowers Dec.–Mar (RBGV 2016). Local records are indicated as introduced.	2009	1	Possible. Records within study area and potential habitat present. Presumed to be outside area of natural occurrence.
Rorippa eustylis	Dwarf Bitter-cress			r	All mainland states. Restricted to scattered swamps and flood-plains near the Murray River (Walsh and Entwisle 1996).	Biosis 2014b		Possible . Recorded by Biosis during vegetation condition monitoring within inundation area and suitable habitat present.
Sclerolaena napiformis	Turnip Copperburr	EN	L	en	Known only from a few populations in remnant grassland on clay-loam soils in north-central Victoria in the Echuca-Nathalia area, and between Donald and Stawell in the west. Fruits NovMay. (Walsh and Entwisle 1996)	PMST		Unlikely. No previous records. Suitable habitat not present within project area.
Senecio cunninghamii var. cunninghamii	Branching Groundsel			r	Erect or spreading shrub to 1.2m high; grows in heavy, sometimes winter-wet soils as well as dry rock soils, commonly on embankments or escarpments. Occurs widely across western half of state. Flowers Oct-Apr (RBGV 2016).	Biosis 2014b, R8 2019	3 Field record	Present. Small number recorded within the Grassy woodlands and forests of the middle to upper terraces of Guttrum-Benwell.



Scientific name	Common Name	EPBC	FFG	DELWP Advisory	Habitat	Most Recent Record	Number of Records	Likelihood of Occurrence
Senecio longicollaris	Riverina Fireweed			vu	Grows on floodplains and by water in forest, woodland and shrubland mainly in the north of the state with scattered occurrences in the south at Portland, Beaumaris and Sandringham (RBGV 2019).	2002	2	Possible. Records within study area and potential habitat present.
Senecio campylocarpus	Bulging Fireweed			r	In Victoria mostly throughout central Victoria and in the north-east in loam to clay soils in forest and woodland, usually in seasonally inundated areas (RBGV, 2018).	R8 2019	Field record	Present: Commonly occurs within the Grassy woodlands and forests of the middle to upper terraces of Guttrum-Benwell.
Swainsona murrayana	Slender Darling-pea	VU	L	en	. Found on heavy soils, especially depressions, on grey and red to brown clay and loamy soils in Black Box (<i>Eucalyptus largiflorens</i>) woodlands and grasslands. Known populations of the species occur in grasslands and on lake margins in the Victorian Riverina across the Patho Plains and Terrick Terrick region (RBGV 2019).	PMST		Unlikely. No previous records and very limited suitable habitat present within project area.
Vittadinia cuneata var. hirsuta	Fuzzy New Holland Daisy			r	Known in Victoria from open woodland within a band extending from the Little Desert to Nathalia area, with a remarkable disjunct occurrence in dry subalpine woodland near Cobungra in the east at about 1000 m altitude (RBGV 2020).	Biosis 2014b		Possible . Recorded by Biosis during vegetation condition monitoring within inundation area and suitable habitat present.



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

This likelihood of occurrence for rare or threatened flora species has been based on a desktop assessment of the inundation area, and detailed assessments of the vegetation and habitat within the inundation area have not yet been undertaken.

Likelihood of occurrence:

Not all of the threatened species identified during this assessment are equally likely to occur in the project site, due to the geographic location or context of the site, or the habitat type and condition. For each species, the likelihood of occurrence was evaluated using the following rationale:

PRESENT - Species known to occur within the site, or detected during the site visit.

POSSIBLE – Potentially suitable habitat occurs within the inundation area and species' known range encompasses the inundation area. Species recorded historically in the study area, and generally within the last 30 years.

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



Likelihood of occurrence of listed rare or threatened flora species, as developed from previous assessments and VBA and PMST searches within the study area (10 km buffered search area)

Scientific name	Common Name	EPBC	FFG	DELWP Advisory	Habitat	Most Recent Record	Number of Records	Likelihood of Occurrence
Amphibromus fluitans	River Swamp Wallaby-grass	VU			Largely confined to permanent swamps, principally along the Murray River between Wodonga and Echuca, uncommon to rare in the south (e.g. Casterton, Moe, Yarram), probably due to historic drainage of wetlands (RBGV 2016).	Biosis 2014b, PMST		Present. Recorded by Biosis 2014b within the inundation area confined to swamps and waterways.
Austrostipa metatoris	Spear grass	VU			Grows in sandy, mallee areas of the Murray Valley, NSW. Habitat includes sand hills, sand ridges, undulating plains and flat-open mallee country with red to red-brown clay loam soils (DECC NSW 2005).	PMST		Highly unlikely. No previous records. Suitable sandy mallee habitat not present within project area.
Austrostipa wakoolica	Spear grass	EN			Not recorded in Victoria. Confined to the floodplains of the Murray River tributaries of central-western and south-western NSW. Habitat includes the edges of lignum swampy box and mallee woodlands (NSW OE&H 2019).	PMST		Highly Unlikely. Species recorded in upper tributaries of the Murray River in NSW and limited suitable box woodland present in project area.
Asperula gemella	Twin-leaf Bedstraw			r	Rare in Victoria where known only from moist riparian sites along the Murray River downstream from Kerang, and with an isolated record from the upper Avoca River (RBGV 2019)	Biosis 2014b		Present Recorded by Biosis during vegetation condition monitoring within inundation area and suitable habitat present.
Caladenia tensa	Rigid Spider-orchid	EN		vu	Apparently confined to the Wimmera region growing in Yellow Gum and cypress pine woodland, heathy woodland and mallee. Flowers Sep to Nov. (Jeanes and Backhouse 2006)	PMST		Highly unlikely. No previous records. Suitable habitat not present within project area.
Calotis cuneifolia	Blue Burr-daisy			r	Scattered along the Murray River and its floodplain downstream from near Barmah, with occurrences away from the river at Kamarooka and Chiltern. Occurs chiefly on alluvial loam or clay soils, often associated with <i>Eucalyptus camaldulensis</i> (Walsh and Entwisle 1999).	Biosis 2014a		Possible. Suitable Red Gum floodplain habitat present within construction footprint.
Cardamine moirensis	Riverina Bitter-cress			r	In Victoria, occurring in the north and west in seasonally wet areas (RBGV 2019).	Biosis 2014a, 2014b		Present. Small number recorded by Biosis within the Grassy woodlands and forests of the middle to upper terraces of Guttrum-Benwell
Dianella porraceae – formally known as Dianella sp af. longifolia (Riverina)	Leek Flax-lily			v	Apparently recorded on Riverina floodplain, including Barmah Forest, west of state around Horsham and also far north-west inhabiting sandy soils and silty alluvium (RBGV 2019).	2019	Field record	Present: Small number recorded within the Grassy woodlands and forests of the middle to upper terraces of Guttrum-Benwell.



Scientific name	Common Name	EPBC	FFG	DELWP Advisory	Habitat	Most Recent Record	Number of Records	Likelihood of Occurrence
Eleocharis plana	Flat Spike-sedge			vu	In moist areas. Similar to E. acuta. Flowers spring- summer. (Walsh and Entwisle 1994)	2001	1	Possible. Records within study area and potential habitat present in aquatic sedge lands and shallow areas of inundation.
Lepidium monoplocoides	Winged Peppercress	EN	L	en	Uncommon in north-western quarter of State, mostly on heavy soils near lakes and watercourses. Flowers mostly spring-summer. (Walsh and Entwisle 1996)	PMST		Possible. Records within study area and potential habitat present in the outer areas of forest where Black Box chenopod vegetation occurs
Maireana cheelii	Chariot Wheels	VU	L	vu	Occurs on seasonally wet, heavy red loam or clay soils. Fruits mostly SepNov. (Walsh and Entwisle 1996)	PMST		Unlikely. No previous records. Suitable habitat not present within project area.
Nymphoides crenata	Wavy Marshwort		L	vu	Occurs in fresh, still to slow-flowing water to 1.5 m deep in swamps, lagoons, irrigation channels and streams, also frequent in temporarily inundated depressions. Rare in all regions except RIV (and perhaps now extinct in MID, PROM and WIM from where there have been no contemporary collections) (Walsh, 1999).	Biosis 2014b	1	Present. Recorded by Biosis 2014b within the inundation area confined to swamps and waterways. Habitat consists of the floodway and pond aquatic systems. Cryptic, dies off to roots during dry phases.
Paspalidium flavidum	Yellow Watercrown Grass			en	Recorded a few times in the 1920s from Werribee, Bacchus Marsh and Bundoora, habitat unknown. Flowers Dec.–Mar (RBGV 2016). Local records are indicated as introduced.	2009	1	Possible . Records within study area and potential habitat present. Presumed to be outside area of natural occurrence.
Rorippa eustylis	Dwarf Bitter-cress			r	All mainland states. Restricted to scattered swamps and flood-plains near the Murray River (Walsh and Entwisle 1996).	Biosis 2014b		Present. Recorded by Biosis during vegetation condition monitoring within inundation area and suitable habitat present.
Sclerolaena napiformis	Turnip Copperburr	EN	L	en	Known only from a few populations in remnant grassland on clay-loam soils in north-central Victoria in the Echuca-Nathalia area, and between Donald and Stawell in the west. Fruits NovMay. (Walsh and Entwisle 1996)	PMST		Unlikely. No previous records. Suitable habitat not present within project area.
Senecio cunninghamii var. cunninghamii	Branching Groundsel			r	Erect or spreading shrub to 1.2m high; grows in heavy, sometimes winter-wet soils as well as dry rock soils, commonly on embankments or escarpments. Occurs widely across western half of state. Flowers Oct-Apr (RBGV 2016).	Biosis 2014b, R8 2019	3 Field record	Present. Small number recorded within the Grassy woodlands and forests of the middle to upper terraces of Guttrum-Benwell.
Senecio longicollaris	Riverina Fireweed			vu	Grows on floodplains and by water in forest, woodland and shrubland mainly in the north of the state with scattered occurrences in the south at Portland, Beaumaris and Sandringham (RBGV 2019).	2002	2	Possible. Records within study area and potential habitat present.



Scientific name	Common Name	EPBC	FFG	DELWP Advisory	Habitat	Most Recent Record	Number of Records	Likelihood of Occurrence
Senecio campylocarpus	Bulging Fireweed			r	In Victoria mostly throughout central Victoria and in the north-east in loam to clay soils in forest and woodland, usually in seasonally inundated areas (RBGV, 2018).	R8 2019	Field record	Present: Commonly occurs within the Grassy woodlands and forests of the middle to upper terraces of Guttrum-Benwell.
Swainsona murrayana	Slender Darling-pea	VU	L	en	. Found on heavy soils, especially depressions, on grey and red to brown clay and loamy soils in Black Box (<i>Eucalyptus largiflorens</i>) woodlands and grasslands. Known populations of the species occur in grasslands and on lake margins in the Victorian Riverina across the Patho Plains and Terrick Terrick region (RBGV 2019).	PMST		Unlikely. No previous records and very limited suitable habitat present within project area.
Vittadinia cuneata var. hirsuta	Fuzzy New Holland Daisy			r	Known in Victoria from open woodland within a band extending from the Little Desert to Nathalia area, with a remarkable disjunct occurrence in dry subalpine woodland near Cobungra in the east at about 1000 m altitude (RBGV 2020).	Biosis 2014b		Present Recorded by Biosis during vegetation condition monitoring within inundation area and suitable habitat present.



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

Likelihood of occurrence:

Not all of the threatened species identified during this assessment are equally likely to occur in the project site, due to the geographic location or context of the site, or the habitat type and condition. For each species, the likelihood of occurrence was evaluated using the following rationale:

PRESENT - Species known to occur within the site, or detected during the site visit.

POSSIBLE – Potentially suitable habitat occurs within construction footprint and species' known range encompasses the construction footprint. Species recorded historically in the study area, and generally within the last 30 years.

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



Likelihood of occurrence of listed rare or threatened fauna species, as developed from previous assessments and VBA and PMST searches within study area (10 km buffered search area)

Scientific name	Common Name	EPBC	FFG	DELWP Advisory	Habitat	Most Recent Records	Number of Records	Likelihood of Occurrence
Anthochaera phrygia	Regent Honeyeater	CR	L	cr	Dry open forest, woodlands, or red ironbark, yellow box, white and yellow gum, mistletoe on river she- oaks, trees in farmlands, streets, gardens. (Pizzey and Knight 2012)	PMST		Highly unlikely. No previous records. No suitable habitat present within construction footprint.
Antigone rubicunda	Brolga		L	vu	Freshwater swamps flooded grasslands, margins of billabongs, lagoons, dry floodplains, irrigated pastures; occasionally estuaries. (Pizzey and Knight 2012)	2018	2	Unlikely. No suitable habitat within construction footprint
Ardea alba	Great Egret		L	vu	Shallows of rivers, estuaries, tidal mudflats, freshwater wetlands; sewage ponds, irrigation areas, larger dams etc. (Pizzey and Knight 2012)	2001	7	Unlikely. No suitable habitat within construction footprint
Ardea intermedia plumifera	Plumed Egret		L	en	Freshwater wetlands, pastures and croplands, tidal mudflats, floodplains. (Pizzey and Knight 2012)	2000	1	Unlikely. No suitable habitat within construction footprint
Aythya australis	Hardhead			vu	Deep, permanent wetlands, large open waters, brackish coastal swamps, farm dams, ornamental lakes , sewage ponds. (Pizzey and Knight 2012)	2010	10	Unlikely. No suitable habitat within construction footprint
Bidyanus bidyanus	Silver Perch	CR	L	vu	Rivers, lakes and reservoirs, preferring areas of rapid flow. Swims near surface. (Allen et al. 2002)	1994	3	Possible. Species limited to main-channels of the Murray River which intersects the construction footprint
Biziura lobata	Musk Duck			vu	Well-vegetated swamps, wetlands, both brackish and fresh, lakes, reservoirs, shallow bays, inlets; occasionally at sea. (Pizzey and Knight 2012)	2007	3	Unlikely. No suitable habitat within construction footprint
Botaurus poiciloptilus	Australasian Bittern	EN	L	en	Narrow habitat preferences, preferring shallow, vegetated freshwater or brackish swamps. (Pizzey and Knight 2012)	2018	2	Unlikely. No suitable habitat within construction footprint
Burhinus grallarius	Bush Stone-curlew		L	en	Open woodland, dry watercourses with fallen branches, leaf-litter, sparse grass; sandplains with spinifex and mallee; coastal scrub, mangrove fringes, golf-courses, rail reserves; timber remnants on roadsides; orchards, plantations; suburbs, towns. (Pizzey and Knight 2012)	2008	4	Possible. Records within study area and suitable habitat within construction footprint
Calidris ferruginea	Curlew Sandpiper	CR	L	en	Tidal mudlfats; saltmarsh, saltfields; fresh, brackish or saline wetlands; sewage ponds. (Pizzey and Knight 2012)	PMST		Highly Unlikely. No suitable habitat within construction footprint



Ceyx azureus	Azure Kingfisher			nt	Root-festooned banks of fresh or tidal creeks, rivers and streams in rainforest, lakes, swamps, estuaries, mangroves. (Pizzey and Knight 2012)	2003	4	Possible Suitable habitat present in construction footprint
Chelodina expansa	Broad-shelled Turtle		L	en	Found in Murray/Darling River systems in SA, Vic, NSW and Qld. Inhabits permanent streams and waterholes throughout its range, but essentially a river tortoise. Lies concealed in debris on the bottom or among root mats in silty rivers, streams and waterholes (Wilson and Swan 2008).	2015	3	Possible. Species limited to main-channels of the Murray River which intersects the construction footprint
Chlidonias hybrida	Whiskered Tern			nt	Vegetated and open wetlands; brackish, saline lakes; saltfields, irrigated lands, sewage ponds; occasionally offshore. (Pizzey and Knight 2012)	1999	1	Unlikely. No suitable habitat within construction footprint
Climacteris picumnus	Brown Treecreeper			nt	Drier forests/woodlands/scrubs, with fallen branches; particularly River Red Gum lined water courses. (Pizzey and Knight 2012)	2019	58	Present. Recorded within project area and/or within close proximity to construction footprint
Craterocephalus fluviatilis	Murray Hardyhead	EN	L	cr	This species inhabits the margins of slow, lowland rivers, and lakes, billabongs and backwaters. It is found amongst aquatic plants and over gravel beds in both fresh and highly saline waters (Wager & Jackson 1993). Adults are fairly saline tolerant, but (Allen et al. 2002)	PMST		Highly Unlikely. No suitable habitat within construction footprint. Species known to occur in permanent saline lakes and wetlands which are not present in the project area.
Craterocephalus stercusmuscarum fulvus	Unspecked Hardyhead		L		Found around the margins of large, slow-flowing, lowland rivers, and in lakes, brackwaters and billabongs. It prefers slow-flowing or still habitats with aquatic vegetation and sand, gravel or mud substrates. (Allen et al. 2002)	1999	1	Possible. Preferred habitat is margins of slow flowing rivers, backwaters and wetlands (Lintermans, 2007). Has been recorded from Little Murray River and Gunbower Creek in the past 10 years, so it is possible that individuals are present in the Murray River.
Delma impar	Striped Legless Lizard	vu	L	en	Has a patchy distribution in grasslands of south- eastern Australia, with the majority of the known population occurring in the west of Melbourne on the volcanic plain. Habitat consists of tussock grasses with surface rock or soil cracks (Cogger 2014)	PMST		Highly Unlikely. Outside known range of the species and no habitat within construction footprint
Dromaius novaehollandiae	Emu			nt	Found in plains, scrublands, open woodlands, coastal heaths, alpine pastures, semi-deserts, margins of lakes, pastoral and cereal growing areas. Mostly absent from closely settled parts, common in pastoral and cropping regions, state forests and national parks (Pizzey and Knight 2012).	2017	5	Present. Recorded within project area and/or within close proximity to construction footprint
Egretta garzetta	Little Egret		L	en	Tidal mudflats, saltmarshes, mangroves, freshwater wetlands, sewage ponds. (Pizzey and Knight 2012)	2000	1	Unlikely. No suitable habitat within construction footprint
Emydura macquarii	Murray River Turtle			vu	Restricted to larger rivers and associated large waterholes on the floodplains. (Cogger 2014)	2016	3	Possible. Species limited to main-channels of the Murray River which intersects the construction footprint



Euastacus armatus	Murray Crayfish		L		Species seems to be tolerant of a wide variety of habitats, including deep flowing water proximal to clay banks, wood or rock cover, as well as tributary streams and shallow riparian habitats (for smaller individuals) (Fisheries Scientific Committee 2013).			Possible. The Murray River in vicinity of project area has been mapped as possible habitat by NSW Fisheries (NSW DPI (accessed 2020). It is possible that individuals are present in the Murray River within and adjacent to the Project Area.
Galaxias rostratus	Flat-headed Galaxias	CR		vu	Shoals in mid-water. Usually below 150 m altitude in Murray system in still or gently flowing waters, lakes, billabongs and backwaters. Depth 1 m, substrate of coarse sand and mud, and debris. (Allen et al. 2002)	PMST		Unlikely. No suitable habitat within construction footprint. Species known to occur in permanent saline lakes and wetlands which are not present in the project area.
Grantiella picta	Painted Honeyeater	VU	L	vu	Mistletoes in eucalypt forests/woodlands; black box on watercourses; box-ironbark-yellow gum woodlands; paperbarks, Casuarinas; mulga, other acacias; trees on farmland; gardens. (Pizzey and Knight 2012)	PMST		Possible. No previous records. Suitable habitat within the construction footprint
Haliaeetus leucogaster	White-bellied Sea- Eagle		L	vu	Coasts, inlands, estuaries, inlets, large rivers, inland lakes, reservoirs. (Pizzey and Knight 2012)	1999	1	Present. Recorded within project area and/or within close proximity to construction footprint
Ixobrychus dubius	Australian Little Bittern		L	en	Dense reedbeds in freshwater swamps, lakes and rivers; tussocks in wetland areas. (Pizzey and Knight 2012)	1993	4	Unlikely. No suitable habitat not present within construction footprint
Lathamus discolor	Swift Parrot	CR	L	en	Open grassy woodland, with dead trees, near permanent water and forested hills, coastal heaths, pastures with exotic grasses, weeds, roadsides, orchards. (Pizzey and Knight 2012)	PMST		Highly Unlikely. No previous records. No suitable Box-Ironbark habitat within the project area.
Leipoa ocellata	Malleefowl	VU	L	en	Mallee, acacia, paperback, she oak, and other scrubs; eucalypt woodland; coastal heaths; mostly on sandy or gravel soils. (Pizzey and Knight 2012)	PMST		Highly Unlikely. No previous records. No suitable Mallee habitat within the project area.
Litoria raniformis	Growling Grass Frog	VU	L	en	A largely aquatic species found among vegetation within or at the edges of permanent water – streams, swamps, lagoons, farm dams and ornamental ponds. Often found under debris on low, often flooded river flats. Frequently active by day. (Cogger 2014)	2009	1	Unlikely. One record within study area, but limited suitable habitat within construction footprint
Lophoictinia isura	Square-tailed Kite		L	vu	Heathlands, woodlands, forests, rainforest, timbered water courses, hills and gorges. (Pizzey and Knight 2012)	2018	1	Possible. Records within study area and suitable habitat within construction footprint
Maccullochella peelii	Murray Cod	VU	L	vu	Slow flowing turbid water of rivers and streams at low elevations. Also fast-moving clear, rocky upland streams. Favours deeper water around boulders, longs, undercut banks and overhanging vegetation. (Allen et al. 2002)	1993	4	Present. Species limited to main-channels of the Murray River which intersects the construction footprint
Macquaria ambigua	Golden Perch			nt	Occurs in a variety of riverine habitats but prefers warm, slow moving turbid sections of streams. (Allen et al. 2002)	1994	6	Present Species limited to main-channels of the Murray River which intersects the construction footprint



Macquaria australasica	Macquarie Perch	EN	L	en	Cool, clear water of rivers, lakes and reservoirs. Prefers slow-flowing, deep rocky pools. (Allen et al. 2002)	PMST		Highly Unlikely. Known from upper tributaries of the Murray River
Melanotaenia fluviatilis	Murray Darling Rainbowfish		L	en	Preferred habitat is margins of slow flowing rivers, backwaters and wetlands (Lintermans, 2007).			Possible. Has been recorded from Little Murray River and nearby tributaries of the Murray River in the past 10 years, so it is possible that individuals are present in the Murray River.
Morelia spilota metcalfei	Carpet Python		L	en	Found under an enormous variety of conditions, from rainforest on the east and northeast coasts to a variety of semi-arid coastal and inland habitats. Often arboreal, but in many areas lives in burrows mad by other animals (Cogger 2014)	Seran BL&A		Possible. No records but known to occur along Murray River. Suitable habitat present within construction footprint
Myotis macropus	Southern Myotis			nt	Found in caves, mines or tunnels, under bridges and buildings and even in dense foliage in the tropical part of its range. (Van Dyck and Strahan 2008)	2009	1	Possible Records within study area and suitable habitat present within construction footprint.
Ninox connivens	Barking Owl		L	en	Open forests, woodlands, dense scrubs, foothills, river red gums, other large trees near water courses, penetrating otherwise open country, and paperbark woodlands. (Pizzey and Knight 2012)	2009	1	Possible Records within study area and suitable habitat present within construction footprint.
Numenius madagascariensis	Eastern Curlew	CR	L	vu	Estuaries, tidal mudflats, sandspits, saltmarshes, mangroves; occasionally fresh or brackish lakes; bare grasslands near water. (Pizzey and Knight 2012)	PMST		Highly Unlikely. No previous records. No suitable foraging habitat within construction footprint
Nycticorax caledonicus	Nankeen Night- Heron			nt	Shallow margins of rivers, wetlands, mangrove-lined estuaries, offshore islands, floodwaters, garden trees. (Pizzey and Knight 2012)	2003	3	Unlikely. No suitable habitat not present within construction footprint
Nyctophilus corbeni	South-eastern Long- eared Bat	VU	L	en	Inhabits a wide range of inland woodland vegetation types. These include box/ironbark/cypress pine woodlands, Buloke woodlands, river red gum woodlands. This species is more abundant in extensive stands of vegetation in comparison to smaller woodland patches. (Van Dyck and Strahan 2008)	PMST		Possible. No previous records. Suitable habitat present within construction footprint.
Pedionomus torquatus	Plains-wanderer	CR	L	cr	Sparse, treeless, lightly grazed native grasslands/herbfields with bare ground, old cereal crops, short Lucerne, sparse saltbush, low shrubland. (Pizzey and Knight 2012)	PMST		Highly Unlikely. No previous records. Suitable habitat not present within project area.
Petaurus norfolcensis	Squirrel Glider			en	Dry eucalypt forests containing large old trees with hollows with Acacia understorey. (Van Dyck and Strahan 2008)	None	None	Possible . No previous records but habitat identified during previous assessments
Pezoporus occidentalis	Night Parrot	EN		rx	Seeding spinifex on stony rises, breakaway country, sandy lowlands; shrubby glasswort, chenopods, succulents on flats around salt lakes; flooded claypans, saltbush, bluebush, bassia associations. (Pizzey and Knight 2012)	PMST		Highly Unlikely. No previous record. Suitable habitat not present within project area.



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Phalacrocorax varius	Pied Cormorant			nt	Coastal waters with sloping shorelines; estuaries, bays, tidal inlets, large inland lakes and rivers, irrigation ponds, coastal mangroves and offshore islands. (Pizzey and Knight 2012)	2003	2	Unlikely. No suitable habitat not present within construction footprint
Phascolarctos cinereus	Koala	VU			Eucalypt woodlands, particularly consisting of Manna Gum, Blue Gum and Swamp Gum in Victoria (Van Dyck and Strahan 2008)	PMST		Highly Unlikely. No previous records. Suitable habitat not present within project area
Platalea regia	Royal Spoonbill			nt	Larger shallow waters, inland and coastal, well- vegetated shallow freshwater wetlands, saltfields, mangroves, islands, farm dams occasionally. (Pizzey and Knight 2012)	2000	1	Unlikely. No suitable habitat not present within construction footprint
Plegadis falcinellus	Glossy Ibis			nt	Well vegetated wetlands, wet pastures, rice fields, floodwaters, floodplains, brackish or occasionally saline wetlands, mangroves, mudflats; occasionally dry grasslands. (Pizzey and Knight 2012)	2018	9	Unlikely. No suitable habitat not present within construction footprint
Pogona barbata	Bearded Dragon			vu	Semi-arboreal, being seen during the day perched on fallen timber, stumps, fence posts or roadside verges where they forage for insects.	2002	1	Possible. Records within study area, and suitable habitat within the construction footprint
Polytelis swainsonii	Superb Parrot	VU	L	en	River red gums, black box, yellow box, river oak, mostly near rivers; mallee, stubbles, pastures, gardens. (Pizzey and Knight 2012)	PMST		Possible. No previous records. Suitable fhabitat within the construction footprint.
Pomatostomus temporalis	Grey-crowned Babbler		L	en	Live in open forest and woodland, acacia shrubland and adjoining farmland. (Pizzey and Knight 2012)	2017	38	Present. Recorded during previous assessments within project area and/or within close proximity to construction footprint.
Porzana pusilla	Ballion's Crake		L	vu	Vegetated freshwater wetlands, waterside trees and shrubs. (Pizzey and Knight 2012)	1981	3	Unlikely. No suitable habitat not present within construction footprint
Pseudophryne bibronii	Brown Toadlet		L	en	Found below rocks in logs in wet and dry sclerophyll forest, in proximity to seasonally inundated areas. (Cogger 2014)	1982	5	Possible. Records within study area, and suitable habitat within the construction footprint
Rostratula australis	Australian Painted- snipe	EN	L	cr	Well-vegetated shallows and margins of wetlands, dams, sewage ponds; wet pastures, marshy areas, irrigation systems, lignum, tea-tree scrub, open timber (Pizzey and Knight 2012).	PMST		Unlikely. No suitable habitat not present within construction footprint
Spatula rhynchotis	Australasian Shoveler			vu	Larger waters, fresh and saline lakes, well-vegetated freshwater wetlands, coastal inlets, sewage ponds, floodwaters. (Pizzey and Knight 2012)	2018	17	Unlikely. No suitable habitat not present within construction footprint
Stagonopleura guttata	Diamond Firetail		L	nt	Open Eucalypt forests/woodlands; River Red Gum, Mallee, Buloke, Cypress Pine. (Pizzey and Knight 2012)	2007	2	Present. Recorded during previous assessments within project area and/or within close proximity to construction footprint.
Stictonetta naevosa	Freckled Duck		L	en	Large, well vegetated swamps; in dry periods moves to open lakes. (Pizzey and Knight 2012)	1999	4	Unlikely. No suitable habitat not present within construction footprint



Struthidea cinerea	Apostlebird	L		Near water in drier open forests, woodland, scrubs, timber on watercourses, Black Box / River Red Gum forests, Cypress Pine Woodlands, roadside timber, or timbered paddocks. (Pizzey and Knight 2012)	1999	2	Possible. Records within study area and suitable habitat within the construction footprint.
Tandanus tandanus	Freshwater Catfish	L	en	A benthic species that prefers slow-flowing streams and lake habitats (Lintermans, 2007).			Possible. Has been recorded from Little Murray River and Gunbower Creek wetlands in the past 10 years. The Murray River in vicinity of project area has been mapped as possible habitat by NSW Fisheries. It is possible that individuals are present in the Murray River.
Todiramphus pyrrhopygius	Red-backed Kingfisher		nt	Sparse inland woodlands, scrublands; often far from water: gibber spinifex, other grassland; tree-lined dry watercourses; grassy tropical woodlands. (Pizzey and Knight 2012)	1998	1	Possible. Records within study area and suitable habitat within the construction footprint.
Tringa nebularia	Common Greenshank		vu	Mudflats, estuaries, saltmarshes, margins of lakes; wetlands, claypans, fresh and saline; commercial saltfields and sewage ponds. (Pizzey and Knight 2012)	2002	2	Unlikely. No suitable habitat not present within construction footprint
Tringa stagnatilis	Marsh Sandpiper		vu	Salt, brackish or freshwater wetlands; Sewage ponds, commercial saltfields, bore-drains, mangroves, tidal mudflats, estuaries. (Pizzey and Knight 2012)	2003	1	Unlikely. No suitable habitat not present within construction footprint
Varanus varius	Lace Monitor		en	Coast, ranges, slopes and adjacent plains of eastern and south-eastern Australia. It feeds on insects, reptiles and small mammals, but is a major predator of nestling birds. Often forages on the ground, and in trees. Often lays eggs within the protection (Cogger 2014)	R8 2019	2	Present . Species identified during previous assessment



Appendix F. Likelihood of occurrence - threatened fauna - inundation area

Likelihood of occurrence:

Not all of the threatened species identified during this assessment are equally likely to occur in the project site, due to the geographic location or context of the site, or the habitat type and condition. For each species, the likelihood of occurrence was evaluated using the following rationale:

PRESENT - Species known to occur within the site, or detected during the site visit.

POSSIBLE – Potentially suitable habitat occurs within the inundation area and species' known range encompasses the inundation area. Species recorded historically in the study area, and generally within the last 30 years.

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



Likelihood of occurrence of listed rare or threatened fauna species, as developed from previous assessments and VBA and PMST searches within study area (10 km buffered search area)

Scientific name	Common Name	EPBC	FFG	DELWP Advisory	Habitat	Most Recent Records	Number of Records	Likelihood of Occurrence
Anthochaera phrygia	Regent Honeyeater	CR	L	cr	Dry open forest, woodlands, or red ironbark, yellow box, white and yellow gum, mistletoe on river she- oaks, trees in farmlands, streets, gardens. (Pizzey and Knight 2012)	PMST		Highly unlikely. No previous records. No suitable habitat present within inundation area
Antigone rubicunda	Brolga		L	vu	Freshwater swamps flooded grasslands, margins of billabongs, lagoons, dry floodplains, irrigated pastures; occasionally estuaries. (Pizzey and Knight 2012)	2018	2	Possible. Recent records and suitable seasonal habitat present in inundation area
Ardea alba	Great Egret		L	vu	Shallows of rivers, estuaries, tidal mudflats, freshwater wetlands; sewage ponds, irrigation areas, larger dams etc. (Pizzey and Knight 2012)	2001	7	Possible. Recent records and suitable seasonal habitat present in inundation area
Ardea intermedia plumifera	Plumed Egret		L	en	Freshwater wetlands, pastures and croplands, tidal mudflats, floodplains. (Pizzey and Knight 2012)	2000	1	Possible. Recent records and suitable seasonal habitat present in inundation area
Aythya australis	Hardhead			vu	Deep, permanent wetlands, large open waters, brackish coastal swamps, farm dams, ornamental lakes , sewage ponds. (Pizzey and Knight 2012)	2010	10	Possible. Recent records and suitable seasonal habitat present in inundation area
Bidyanus bidyanus	Silver Perch	CR	L	vu	Rivers, lakes and reservoirs, preferring areas of rapid flow. Swims near surface. (Allen et al. 2002)	1994	3	Possible May enter forest areas during inundation events, but seasonally inundated semi-permanent forest wetlands do not provide suitable long term habitat.
Biziura lobata	Musk Duck			vu	Well-vegetated swamps, wetlands, both brackish and fresh, lakes, reservoirs, shallow bays, inlets; occasionally at sea. (Pizzey and Knight 2012)	2007	3	Possible. Recent records and suitable seasonal habitat present in inundation area
Botaurus poiciloptilus	Australasian Bittern	EN	L	en	Narrow habitat preferences, preferring shallow, vegetated freshwater or brackish swamps. (Pizzey and Knight 2012)	2018	2	Possible. Recent records and suitable seasonal habitat present in inundation area
Burhinus grallarius	Bush Stone-curlew		L	en	Open woodland, dry watercourses with fallen branches, leaf-litter, sparse grass; sandplains with spinifex and mallee; coastal scrub, mangrove fringes, golf-courses, rail reserves; timber remnants on roadsides; orchards, plantations; suburbs, towns. (Pizzey and Knight 2012)	2008	4	Possible. Records within study area and suitable habitat within inundation area
Calidris ferruginea	Curlew Sandpiper	CR	L	en	Tidal mudlfats; saltmarsh, saltfields; fresh, brackish or saline wetlands; sewage ponds. (Pizzey and Knight 2012)	PMST		Unlikely. No records and limited saltmarsh or mudflat habitat present in inundation area



Scientific name	Common Name	EPBC	FFG	DELWP Advisory	Habitat	Most Recent Records	Number of Records	Likelihood of Occurrence
Ceyx azureus	Azure Kingfisher			nt	Root-festooned banks of fresh or tidal creeks, rivers and streams in rainforest, lakes, swamps, estuaries, mangroves. (Pizzey and Knight 2012)	2003	4	Possible Suitable habitat present in inundation area
Chelodina expansa	Broad-shelled Turtle		L	en	Found in Murray/Darling River systems in SA, Vic, NSW and Qld. Inhabits permanent streams and waterholes throughout its range, but essentially a river tortoise. Lies concealed in debris on the bottom or among root mats in silty rivers, streams and waterholes (Wilson and Swan 2008).	2015	3	Possible Species limited to main-channels of the Murray River which intersects the construction footprint
Chlidonias hybrida	Whiskered Tern			nt	Vegetated and open wetlands; brackish, saline lakes; saltfields, irrigated lands, sewage ponds; occasionally offshore. (Pizzey and Knight 2012)	1999	1	Possible. Recent records and suitable seasonal habitat present in inundation area
Climacteris picumnus	Brown Treecreeper			nt	Drier forests/woodlands/scrubs, with fallen branches; particularly River Red Gum lined water courses. (Pizzey and Knight 2012)	2019	58	Present. Recorded within project area and/or within close proximity to inundation area
Craterocephalus fluviatilis	Murray Hardyhead	EN	L	cr	This species inhabits the margins of slow, lowland rivers, and lakes, billabongs and backwaters. It is found amongst aquatic plants and over gravel beds in both fresh and highly saline waters (Wager & Jackson 1993). Adults are fairly saline tolerant, but (Allen et al. 2002)	PMST		Highly Unlikely. Species not recorded within study area and unlikely to persist or re-colonise inundation area
Craterocephalus stercusmuscarum fulvus	Unspecked Hardyhead		L		Found around the margins of large, slow-flowing, lowland rivers, and in lakes, brackwaters and billabongs. It prefers slow-flowing or still habitats with aquatic vegetation and sand, gravel or mud substrates. (Allen et al. 2002)	1999	1	Possible. May enter forest areas during inundation events, but seasonally inundated semi-permanent forest wetlands do not provide suitable long term habitat
Delma impar	Striped Legless Lizard	VU	L	en	Has a patchy distribution in grasslands of south- eastern Australia, with the majority of the known population occurring in the west of Melbourne on the volcanic plain. Habitat consists of tussock grasses with surface rock or soil cracks (Cogger 2014)	PMST		Highly Unlikely. Outside known range of the species and no habitat within inundation area
Dromaius novaehollandiae	Emu			nt	Found in plains, scrublands, open woodlands, coastal heaths, alpine pastures, semi-deserts, margins of lakes, pastoral and cereal growing areas. Mostly absent from closely settled parts, common in pastoral and cropping regions, state forests and national parks (Pizzey and Knight 2012).	2017	5	Present. Recorded within inundation area
Egretta garzetta	Little Egret		L	en	Tidal mudflats, saltmarshes, mangroves, freshwater wetlands, sewage ponds. (Pizzey and Knight 2012)	2000	1	Possible. Recent records and suitable seasonal habitat present in inundation area



Scientific name	Common Name	EPBC	FFG	DELWP Advisory	Habitat	Most Recent Records	Number of Records	Likelihood of Occurrence
Emydura macquarii	Murray River Turtle			vu	Restricted to larger rivers and associated large waterholes on the floodplains. (Cogger 2014)	2016	3	Possible Species limited to main-channels of the Murray River which intersects the construction footprint
Euastacus armatus	Murray Crayfish		L		Species seems to be tolerant of a wide variety of habitats, including deep flowing water proximal to clay banks, wood or rock cover, as well as tributary streams and shallow riparian habitats (for smaller individuals) (Fisheries Scientific Committee 2013).			Possible. The Murray River in vicinity of project area has been mapped as possible habitat by NSW Fisheries (NSW DPI (accessed 2020). It is possible that individuals are present in the Murray River within and adjacent to the Project Area.
Galaxias rostratus	Flat-headed Galaxias	CR		vu	Shoals in mid-water. Usually below 150 m altitude in Murray system in still or gently flowing waters, lakes, billabongs and backwaters. Depth 1 m, substrate of coarse sand and mud, and debris. (Allen et al. 2002)	PMST		Unlikely. Species not recorded within study area and unlikely to persist or re-colonise inundation area
Grantiella picta	Painted Honeyeater	VU	L	vu	Mistletoes in eucalypt forests/woodlands; black box on watercourses; box-ironbark-yellow gum woodlands; paperbarks, Casuarinas; mulga, other acacias; trees on farmland; gardens. (Pizzey and Knight 2012)	PMST		Possible. No previous records. Suitable habitat within inundation area
Haliaeetus leucogaster	White-bellied Sea- Eagle		L	vu	Coasts, inlands, estuaries, inlets, large rivers, inland lakes, reservoirs. (Pizzey and Knight 2012)	1999	1	Present. Recorded within inundation area
Ixobrychus dubius	Australian Little Bittern		L	en	Dense reedbeds in freshwater swamps, lakes and rivers; tussocks in wetland areas. (Pizzey and Knight 2012)	1993	4	Possible. Recent records and suitable seasonal habitat present in inundation area
Lathamus discolor	Swift Parrot	CR	L	en	Open grassy woodland, with dead trees, near permanent water and forested hills, coastal heaths, pastures with exotic grasses, weeds, roadsides, orchards. (Pizzey and Knight 2012)	PMST		Highly Unlikely. No previous records. No suitable Box-Ironbark habitat within inundation area
Leipoa ocellata	Malleefowl	VU	L	en	Mallee, acacia, paperback, she oak, and other scrubs; eucalypt woodland; coastal heaths; mostly on sandy or gravel soils. (Pizzey and Knight 2012)	PMST		Highly Unlikely. No previous records. No suitable Mallee habitat within the inundation area
Litoria raniformis	Growling Grass Frog	VU	L	en	A largely aquatic species found among vegetation within or at the edges of permanent water – streams, swamps, lagoons, farm dams and ornamental ponds. Often found under debris on low, often flooded river flats. Frequently active by day. (Cogger 2014)	2009	1	Possible. One record within study area, but suitable habitat within inundation area.
Lophoictinia isura	Square-tailed Kite		L	vu	Heathlands, woodlands, forests, rainforest, timbered water courses, hills and gorges. (Pizzey and Knight 2012)	2018	1	Possible. Records within study area and suitable habitat within inundation area



Scientific name	Common Name	EPBC	FFG	DELWP Advisory	Habitat	Most Recent Records	Number of Records	Likelihood of Occurrence
Maccullochella peelii	Murray Cod	VU	L	vu	Slow flowing turbid water of rivers and streams at low elevations. Also fast-moving clear, rocky upland streams. Favours deeper water around boulders, longs, undercut banks and overhanging vegetation. (Allen et al. 2002)	1993	4	Possible. May enter forest areas during inundation events, but seasonally inundated semi-permanent forest wetlands do not provide suitable long term habitat.
Macquaria ambigua	Golden Perch			nt	Occurs in a variety of riverine habitats but prefers warm, slow moving turbid sections of streams. (Allen et al. 2002)	1994	6	Possible. May enter forest areas during inundation events, but seasonally inundated semi-permanent forest wetlands do not provide suitable long term habitat.
Macquaria australasica	Macquarie Perch	EN	L	en	Cool, clear water of rivers, lakes and reservoirs. Prefers slow-flowing, deep rocky pools. (Allen et al. 2002)	PMST		Highly Unlikely. Known from upper tributaries of the Murray River
Melanotaenia fluviatilis	Murray Darling Rainbowfish		L	en	Preferred habitat is margins of slow flowing rivers, backwaters and wetlands (Lintermans, 2007).			Possible. Has been recorded from Little Murray River and nearby tributaries of the Murray River in the past 10 years, so it is possible that individuals are present in the Murray River.
Morelia spilota metcalfei	Carpet Python		L	en	Found under an enormous variety of conditions, from rainforest on the east and northeast coasts to a variety of semi-arid coastal and inland habitats. Often arboreal, but in many areas lives in burrows mad by other animals (Cogger 2014)	Seran BL&A		Possible. No records but known to occur along Murray River. Suitable habitat present within inundation area
Myotis macropus	Southern Myotis			nt	Found in caves, mines or tunnels, under bridges and buildings and even in dense foliage in the tropical part of its range. (Van Dyck and Strahan 2008)	2009	1	Possible Records within study area and suitable habitat present within inundation area
Ninox connivens	Barking Owl		L	en	Open forests, woodlands, dense scrubs, foothills, river red gums, other large trees near water courses, penetrating otherwise open country, and paperbark woodlands. (Pizzey and Knight 2012)	2009	1	Possible Records within study area and suitable habitat present within inundation area
Numenius madagascariensis	Eastern Curlew	CR	L	vu	Estuaries, tidal mudflats, sandspits, saltmarshes, mangroves; occasionally fresh or brackish lakes; bare grasslands near water. (Pizzey and Knight 2012)	PMST		Highly Unlikely. No previous records. No suitable foraging habitat within inundation area
Nycticorax caledonicus	Nankeen Night- Heron			nt	Shallow margins of rivers, wetlands, mangrove-lined estuaries, offshore islands, floodwaters, garden trees. (Pizzey and Knight 2012)	2003	3	Possible. Recent records and suitable seasonal habitat present in inundation area
Nyctophilus corbeni	South-eastern Long- eared Bat	VU	L	en	Inhabits a wide range of inland woodland vegetation types. These include box/ironbark/cypress pine woodlands, Buloke woodlands, river red gum woodlands. This species is more abundant in extensive	PMST		Possible. No previous records. Suitable habitat present within inundation area



Scientific name	Common Name	EPBC	FFG	DELWP Advisory	Habitat	Most Recent Records	Number of Records	Likelihood of Occurrence
					stands of vegetation in comparison to smaller woodland patches. (Van Dyck and Strahan 2008)			
Pedionomus torquatus	Plains-wanderer	CR	L	cr	Sparse, treeless, lightly grazed native grasslands/herbfields with bare ground, old cereal crops, short Lucerne, sparse saltbush, low shrubland. (Pizzey and Knight 2012)	PMST		Highly Unlikely. No previous records. Suitable habitat not present within inundation area
Petaurus norfolcensis	Squirrel Glider			en	Dry eucalypt forests containing large old trees with hollows with Acacia understorey. (Van Dyck and Strahan 2008)			Possible . No previous records but suitable habitat present within inundation area
Pezoporus occidentalis	Night Parrot	EN		rx	Seeding spinifex on stony rises, breakaway country, sandy lowlands; shrubby glasswort, chenopods, succulents on flats around salt lakes; flooded claypans, saltbush, bluebush, bassia associations. (Pizzey and Knight 2012)	PMST		Highly Unlikely. No previous record. Suitable habitat not present within inundation area
Phalacrocorax varius	Pied Cormorant			nt	Coastal waters with sloping shorelines; estuaries, bays, tidal inlets, large inland lakes and rivers, irrigation ponds, coastal mangroves and offshore islands. (Pizzey and Knight 2012)	2003	2	Possible. Recent records and suitable seasonal habitat present in inundation area
Phascolarctos cinereus	Koala	VU			Eucalypt woodlands, particularly consisting of Manna Gum, Blue Gum and Swamp Gum in Victoria (Van Dyck and Strahan 2008)	PMST		Highly Unlikely. No previous records. Suitable habitat not present within project area
Platalea regia	Royal Spoonbill			nt	Larger shallow waters, inland and coastal, well- vegetated shallow freshwater wetlands, saltfields, mangroves, islands, farm dams occasionally. (Pizzey and Knight 2012)	2000	1	Possible. Recent records and suitable seasonal habitat present in inundation area
Plegadis falcinellus	Glossy Ibis			nt	Well vegetated wetlands, wet pastures, rice fields, floodwaters, floodplains, brackish or occasionally saline wetlands, mangroves, mudflats; occasionally dry grasslands. (Pizzey and Knight 2012)	2018	9	Present. Recorded during 2019 field assessment and suitable seasonal habitat present in inundation area
Pogona barbata	Bearded Dragon			vu	Semi-arboreal, being seen during the day perched on fallen timber, stumps, fence posts or roadside verges where they forage for insects.	2002	1	Possible. Records within study area, and suitable habitat within the inundation area
Polytelis swainsonii	Superb Parrot	VU	L	en	River red gums, black box, yellow box, river oak, mostly near rivers; mallee, stubbles, pastures, gardens. (Pizzey and Knight 2012)	PMST		Possible. No previous records. Suitable habitat within the inundation area
Pomatostomus temporalis	Grey-crowned Babbler		L	en	Live in open forest and woodland, acacia shrubland and adjoining farmland. (Pizzey and Knight 2012)	GHD 2017 Biosis 2014b	38	Present. Recorded during previous assessments within inundation area



Scientific name	Common Name	EPBC	FFG	DELWP Advisory	Habitat	Most Recent Records	Number of Records	Likelihood of Occurrence
Porzana pusilla	Ballion's Crake		L	vu	Vegetated freshwater wetlands, waterside trees and shrubs. (Pizzey and Knight 2012)	1981	3	Possible. Recent records and suitable seasonal habitat present in inundation area
Pseudophryne bibronii	Brown Toadlet		L	en	Found below rocks in logs in wet and dry sclerophyll forest, in proximity to seasonally inundated areas. (Cogger 2014)	1982	5	Possible. Records within study area, and suitable habitat within inundation area
Rostratula australis	Australian Painted- snipe	EN	L	cr	Well-vegetated shallows and margins of wetlands, dams, sewage ponds; wet pastures, marshy areas, irrigation systems, lignum, tea-tree scrub, open timber (Pizzey and Knight 2012).	PMST		Possible. Recent records and suitable seasonal habitat present in inundation area
Spatula rhynchotis	Australasian Shoveler			vu	Larger waters, fresh and saline lakes, well-vegetated freshwater wetlands, coastal inlets, sewage ponds, floodwaters. (Pizzey and Knight 2012)	2018	17	Possible. Recent records and suitable seasonal habitat present in inundation area
Stagonopleura guttata	Diamond Firetail		L	nt	Open Eucalypt forests/woodlands; River Red Gum, Mallee, Buloke, Cypress Pine. (Pizzey and Knight 2012)	2007 Biosis 2014b	2	Present. Recorded during previous assessments within inundation area
Stictonetta naevosa	Freckled Duck		L	en	Large, well vegetated swamps; in dry periods moves to open lakes. (Pizzey and Knight 2012)	1999	4	Possible. Recent records and suitable seasonal habitat present in inundation area
Struthidea cinerea	Apostlebird		L		Near water in drier open forests, woodland, scrubs, timber on watercourses, Black Box / River Red Gum forests, Cypress Pine Woodlands, roadside timber, or timbered paddocks. (Pizzey and Knight 2012)	1999	2	Possible. Records within study area and suitable habitat within inundation area
Todiramphus pyrrhopygius	Red-backed Kingfisher			nt	Sparse inland woodlands, scrublands; often far from water: gibber spinifex, other grassland; tree-lined dry watercourses; grassy tropical woodlands. (Pizzey and Knight 2012)	1998	1	Possible. Records within study area and suitable habitat within inundation area
Tringa nebularia	Common Greenshank			vu	Mudflats, estuaries, saltmarshes, margins of lakes; wetlands, claypans, fresh and saline; commercial saltfields and sewage ponds. (Pizzey and Knight 2012)	2002	2	Possible. Recent records and suitable seasonal habitat present in inundation area
Tringa stagnatilis	Marsh Sandpiper			vu	Salt, brackish or freshwater wetlands; Sewage ponds, commercial saltfields, bore-drains, mangroves, tidal mudflats, estuaries. (Pizzey and Knight 2012)	2003	1	Possible. Recent records and suitable seasonal habitat present in inundation area
Varanus varius	Lace Monitor			en	Coast, ranges, slopes and adjacent plains of eastern and south-eastern Australia. It feeds on insects, reptiles and small mammals, but is a major predator of nestling birds. Often forages on the ground, and in	R8 2019	2	Present . Species identified during field assessment within inundation area.


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Scientific name	Common Name	EPBC	FFG	DELWP Advisory	Habitat	Most Recent Records	Number of Records	Likelihood of Occurrence
					trees. Often lays eggs within the protection (Cogger 2014)			



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

Habi	tat Zone		HZa	HZb	HZc	HZd	HZe	HZf	HZh	HZk	HZI	HZm	HZo	HZq	HZr	HZt	HZw	HZx	HZy	HZa1	HZb1	HZg1	HZm1	HZn1	HZq1	HZr1
Bior	egion		MuF	MuF	MuF	MuF	MuF	MuF	MuF	MuF	MuF	MuF	MuF	MuF	MuF	MuF	MuF	MuF	MuF	MuF	MuF	MuF	MuF	MuF	MuF	MuF
EVC	EVC #: Name		814	810	816	295	816	810	295	295	295	816	816	814	816	816	816	814	810	814	816	295	295	295	295	295
EVC Statu	Conservation	Max Score	E	D	D	V	D	D	V	V	V	D	D	D	D	D	D	D	D	D	D	V	V	V	V	V
	Large Old Trees	10	9	-	7	5	-	8	10	8	6	2	6	10	6	9	5	9	-	6	10	7	7	6	10	10
	Canopy Cover	5	4	-	4	4	-	2	4	4	2	1	5	2	5	4	4	4	-	5	5	4	2	1	5	5
	Understorey	25	15	15	15	10	15	10	10	10	5	5	15	5	15	20	15	20	15	20	20	10	10	10	10	10
tion	Lack of Weeds	15	13	13	2	6	13	13	6	6	6	13	13	13	13	9	13	9	15	13	13	9	9	6	9	2
Condi	Recruitment	10	5	6	6	6	3	5	6	5	5	5	6	3	6	3	6	3	3	6	6	6	3	1	6	3
Site	Organic Litter	5	3	5	3	5	5	3	5	2	2	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4
	Logs	5	5	5	4	4	4	5	5	5	5	4	4	5	4	5	3	5	4	4	5	4	5	4	5	2
	Standardiser	n/a		1.36				1.36											1.36							
	Total	75	54	55	41	40	50	46	46	40	31	35	54	43	54	55	51	55	53	59	64	45	41	33	50	36
ext	Patch size	10	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Conte	Neighbourhood	10	7	7	7	5	6	5	6	6	4	5	6	6	9	9	9	9	9	8	8	5	5	5	5	5
lscape	Distance to Core	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Lanc	Total	25	19	19	19	17	18	17	18	18	16	17	18	18	21	21	21	21	21	20	20	17	17	17	17	17
	Habitat Score	100	73	74	60	57	68	63	64	58	47	52	72	61	75	76	72	76	74	79	84	62	58	50	67	53
Hat	pitat points = #/100	1	0.73	0.74	0.60	0.57	0.68	0.63	0.64	0.58	0.47	0.52	0.72	0.61	0.75	0.76	0.72	0.76	0.74	0.79	0.84	0.62	0.58	0.50	0.67	0.53
Hab	itat Zone area (ha)	(#.###)	3.16	0.013	1.085	0.426	0.027	0.008	1.072	0.42	0.651	0.319	0.128	0.069	1.11	0.063	0.16	0.038	0.09	0.173	1.1	0.422	0.309	0.586	1.475	0.797
	Habitat Hectares	(#.###)	2.31 0	0.010	0.651	0.243	0.018	0.005	0.686	0.244	0.306	0.166	0.092	0.042	0.833	0.048	0.115	0.029	0.067	0.137	0.924	0.262	0.179	0.293	0.988	0.422



Appendix H. Flora recorded during surveys (2019)

Summary of the flora species recorded during surveys by R8 ecologists between October – November, 2019.

<u>Key:</u>

- P FFG Act listed protected
- r DELWP Advisory listed rare
- k poorly known

Scientific Name	Common Name	EPBC	FFG	DELWP Advisory
Acacia dealbata	Silver Wattle		Р	
Acacia paradoxa	Hedge Wattle			
Amphibromus nervosus	Common Swamp Wallaby-grass			
Amyema miquelii	Box Mistletoe			
Asperula conferta	Common Woodruff			
Atriplex semibaccata	Berry Saltbush			
Austrostipa scabra	Rough Spear-grass			
Azolla rubra	Pacific Azolla		Р	
Bromus spp.	Brome			
Calocephalus sonderi	Pale Beauty-heads		Р	
Calotis scapigera	Tufted Burr-daisy		Р	
Carex tereticaulis	Poong'ort			
Centipeda cunninghamii	Common Sneezeweed		Р	
Chloris truncata	Windmill Grass			
Crassula helmsii	Swamp Crassula			
Cycnogeton procerum s.s.	Common Water-ribbons			
Cymbonotus lawsonianus	Bear's-ear			
Cynodon dactylon	Couch			
Dianella porraceae – formally known as Dianella sp af. longifolia (Riverina)	Leek Flax-lily			vu
Eleocharis acuta	Common Spike-sedge			
Eleocharis pusilla	Small Spike-sedge			
Enchylaena tomentosa var. tomentosa	Ruby Saltbush			
Epilobium billardiereanum	Variable Willow-herb			
Eragrostis infecunda	Southern Cane-grass			



Eucoluptus comoldulopsis	Pivor Pod-gum		
Fucalyptus laraiflorens	Black Box		
Fuchiton involucratus s l	Common Cudweed	D	
Execution involucional s.t.	Pale-fruit Ballart	·	
Coronium ratrorsum s l	Graceland Grano's-hill		
Clinus lataidas			
Juncus amabilis	Hollow Rush		
Juncus holoschoenus	Joint-leaf Rush		
Juncus spp.	Rush		
Lepidium pseudohyssopifolium	Native Peppercress		
Lobelia concolor	Poison Pratia		
Lomandra effusa	Scented Mat-rush		
Lythrum hyssopifolia	Small Loosestrife		
Maireana brevifolia	Short-leaf Bluebush		
Maireana spp.	Bluebush		
Marsilea drummondii	Common Nardoo	Р	
Persicaria decipiens	Slender Knotweed		
Phragmites australis	Native Reed		
Plantago hispida	Hairy Plantain		
Poa labillardierei	Common Tussock-grass		
Potamogeton sp.			
Rhagodia spinescens	Hedge Salt-bush		
Rumex brownii	Slender Dock		
Rytidosperma caespitosum	Common Wallaby-grass		
Rytidosperma racemosum var. racemosum	Slender Wallaby-grass		
Rytidosperma spp.	Wallaby Grass		
Sclerolaena muricata	Black Roly-poly		
Senecio campylocarpus	Bulging Fireweed	Р	r
Senecio cunninghamii var. cunninnghamii	Branching Groundsel	Ρ	r
Senecio quadridentatus	Cotton Fireweed	Р	
Sida corrugata	Variable Sida		
Stellaria angustifolia subsp. angustifolia	Swamp Starwort		
Typha orientalis	Broad-leaved Cumbungi		
Vittadinia cuneata	Fuzzy New Holland Daisy	Р	



Wahlenbergia gracilis	Sprawling Bluebell		
Xerochrysum bracteatum	Golden Everlasting	Р	



Appendix I. Fauna species recorded during R8 surveys

Summary of the fauna species recorded during surveys between October 22 – November 1, 2019.

<u>Key:</u>

- L Listed as threatened
- en endangered
- vu vulnerable
- nt near threatened
- * Introduced

^ - Species which make up the FFG-listed Victorian Temperate Woodland Bird Community

Common Name (Scientific Name)	EPBC	FFG	DELWP Advisory	Other
Australian Magpie (Cracticus tibicen)				
Australian Raven (Corvus coronoides)				
Black-faced Woodswallow (Artamus cinereus)				
Black-faced Cuckoo-shrike (Coracina novaehollandiae)				
Blue-faced Honeyeater (Entomyzon cyanotis)				
Brown Falcon (Falco berigora)				
Brown Treecreeper (Climacteris picumnus)			nt	^
Common Bronzewing (Phaps chalcoptera)				
Common Brushtail Possum (Trichosurus vulpecula)				
Common Starling (Sturnus vulgaris)				*
Crested Pigeon (Ocyphaps lophotes)				
Crimson Rosella (<i>Platycercus elegans</i>)				
Eastern Grey Kangaroo (Macropus giganteus)				
Eastern Rosella (<i>Platycercus eximius</i>)				
Emu (Dromaius novaehollandiae)			nt	
Galah (Eolophus roseicapilla)				
Glossy Ibis (Plegadis falcinellus)			nt	
Goat (Capra hircus)				*
Grey Fantail (<i>Rhipidura albiscapa</i>)				
Grey Shrike-thrush (Colluricincla harmonica)				
Jacky Winter (<i>Microeca fascinans</i>)				^



Common Name (Scientific Name)	EPBC	FFG	DELWP Advisory	Other
Lace Monitor (Varanus varius)			en	
Laughing Kookaburra (Dacelo novaeguineae)				
Little Friarbird (Philemon citreogularis)				
Long-billed Corella (Cacatua tenuirostris)				
Magpie-lark (Grallina cyanoleuca)				
Masked Lapwing (Vanellus miles)				
Pacific Black Duck (Anas superciliosa)				
Peaceful Dove (Geopelia striata)				
Pied Butcherbird (Cracticus nigrogularis)				
Red-rumped Parrot (Psephotus haematonotus)				
Restless Flycatcher (Myiagra inquieta)				
Rufous Fantail (Rhipidura rufifrons)				
Sacred Kingfisher (Todiramphus sanctus)				
Spotted Turtle-dove (Streptopelia chinensis)				*
Straw-necked Ibis (Threskiornis spinicollis)				
Striated Pardalote (Pardalotus striatus)				
Sugar Glider (Petaurus breviceps)				
Sulphur-crested Cockatoo (Cacatua galerita)				
Superb Fairy-wren (Malurus cyaneus)				
Swamp Wallaby (Wallabia bicolor)				
Tawny Frogmouth (Podargus strigoides)				
Tree Skink (<i>Egernia striolata</i>)				
Welcome Swallow (Hirundo neoxena)				
Whistling Kite (Haliastur sphenurus)				
White-necked Heron (Ardea pacifica)				
White-throated Treecreeper (Cormobates leucophaeus)				
White-bellied Sea-eagle (Haliaeetus leucogaster)		L	vu	
White-faced Heron (Egretta novaehollandiae)				
White-plumed Honeyeater (Ptilotula penicillatus)				
White-winged Chough (Corcorax melanorhamphos)				
White-winged Triller (Lalage sueurii)				
Willie Wagtail (Rhipidura leucophrys)				
Yellow-footed Antechinus (Antechinus flavipes)				
Yellow-rumped Thornbill (Acanthiza chrysorrhoa)				



Common Name (Scientific Name)	EPBC	FFG	DELWP Advisory	Other
Yellow-billed Spoonbill (Platalea flavipes)				



Appendix J. Weed species recorded in the project area

Species Name		Common Name	Status	VBA	Biosis 2014	GHD 2017	R8
CLASS MAGNOLIOPSIDA							
(Flowering Plants)							
Suborder Lilianae							
(Monocotyledons)							
	Asphodelus fistulosus	Onion Weed	*	*			
ASPARAGACEAE							
	Asparagus asparagoides	Bridal Creeper	*	*			*
	Asparagus officinalis	Asparagus	*	*		*	*
CYPERACEAE							
	Cyperus eragrostis	Drain Flat-sedge	*	*	*	*	*
IRIDACEAE							
	Romulea rosea	Onion Grass	*	*			
JUNCACEAE							
	Juncus acutus subsp. acutus	Spiny Rush	*	*			*
	Juncus articulatus subsp. articulatus	Jointed Rush	*	*			
POACEAE							
	Agrostis gigantea	Red-top Bent	*	*			
	Aira caryophyllea subsp. caryophyllea	Silvery Hair-grass	*	*			
	Alopecurus aequalis	Orange Fox-tail	*	*	*		
	Avena barbata	Bearded Oat	*	*			*
	Avena fatua	Wild Oat	*	*			
	Avena sativa	Oat	*	*			
	Avena spp.	Oat	*	*		*	*
	Avena sterilis	Sterile Oat	*	*			
	Avena sterilis subsp. sterilis	Sterile Oat	*	*			
	Axonopus fissifolius	Carpet Grass	*	*			
	Briza maxima	Quaking Grass	*	*			
	Briza minor	Lesser Quaking Grass	*	*		*	
	Bromus alopecuros	Mediterranean Brome	*	*			
	Bromus catharticus	Prairie Grass	*	*			



Species Name		Common Name	Status	VBA	Biosis 2014	GHD 2017	R8
	Bromus diandrus	Great Brome	*	*	*	*	*
	Bromus hordeaceus	Soft Brome	*	*	*		*
	Bromus madritensis	Madrid Brome	*	*			
	Bromus rubens	Red Brome	*	*			
	Bromus sterilis	Sterile Brome	*	*			
	Cenchrus clandestinus	Kikuyu	*	*			
	Cynodon dactylon	Couch	*			*	*
	Dactylis glomerata	Cocksfoot	*	*			
	Echinochloa colona	Awnless Barnyard- grass	*	*			
	Echinochloa crus-galli	Barnyard Grass	*	*			
	Echinochloa crus-pavonis	South American Barnyard-grass	*	*			
	Ehrharta longiflora	Annual Veldt-grass	*	*	*	*	
	Eragrostis cilianensis	Stink Grass	*	*			
	Festuca arundinacea	Tall Fescue	*	*		*	*
	Glyceria declinata	Manna Grass	*		*		
	Hordeum glaucum	Northern Barley- grass	*	*			
	Hordeum hystrix		*	*			
	Hordeum leporinum	Barley-grass	*	*	*	*	*
	Hordeum marinum		*	*			
	Hordeum murinum s.l.	Barley-grass	*	*			
	Hordeum spp.	Barley Grass	*	*	*		
	Lolium perenne	Perennial Ryegrass	*	*			
	Lolium rigidum	Wimmera Rye-grass	*	*	*	*	*
	Parapholis incurva	Coast Barb-grass	*	*			
	Paspalum dilatatum	Paspalum	*	*		*	
	Paspalum distichum	Water Couch	*	*			
	Phalaris aquatica	Canary Grass	*	*		*	*
	Phalaris minor	Lesser Canary-grass	*	*			
	Phalaris paradoxa	Paradoxical Canary- grass	*	*	*		
	Poa annua	Winter Grass	*	*	*		
	Polypogon littoralis	Perennial Beard- grass	*	*			
	Polypogon monspeliensis	Annual Beard-grass	*		*		

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Species Name		Common Name	Status	VBA	Biosis 2014	GHD 2017	R8
	Sorghum halepense	Johnson Grass	*	*			
	Vicia sativa subsp. sativa	Common Vetch	*	*			
	Vulpia bromoides	Squirrel-tail Fescue	*	*			
	Vulpia muralis	Wall Fescue	*	*	*		
	Vulpia myuros	Rat's-tail Fescue	*	*			
	Vulpia myuros f. myuros	Rat's-tail Fescue	*	*			
	Vulpia spp.	Fescue	*	*		*	
CLASS MAGNOLIOPSIDA							
(Flowering Plants)							
Subclass Magnoliidae							
(Dicotyledons)							
AIZOACEAE							
	Mesembryanthemum crystallinum s.l.	Common Ice-plant	*	*			
	Mesembryanthemum nodiflorum	Small Ice-plant	*	*			
AMARANTHACEAE							
	Amaranthus albus	Stiff Tumbleweed	*	*			
	Amaranthus hybridus	Spleen Amaranth	*	*			
	Amaranthus muricatus	Rough-fruit Amaranth	*	*			
	Amaranthus viridis	Green Amaranth	*	*			
ANACARDIACEAE							
	Schinus molle	Pepper Tree	*	*			
APIACEAE							
	Foeniculum vulgare	Fennel	*	*			
APOCYNACEAE							
	Vinca major	Blue Periwinkle	*	*			
ASTERACEAE							



Species Name		Common Name	Status	VBA	Biosis 2014	GHD 2017	R8
	Arctotheca calendula	Capeweed	*	*	*		*
	Aster subulatus	Aster-weed	*		*	*	
	Carduus spp.	A Slender Thistle	*		*		
	Carduus pycnocephalus	Slender Thistle	*	*			
	Carduus tenuiflorus	Winged Slender- thistle	*	*			
	Carthamus lanatus	Saffron Thistle	*	*			
	Centaurea calcitrapa	Star Thistle	*	*			
	Centaurea melitensis	Malta Thistle	*	*			
	Centaurium tenuiflorum	Slender Centaury	*	*			
	Cichorium intybus	Chicory	*	*		*	
	Cirsium vulgare	Spear Thistle	* R	*	*	*	*
	Chondrilla juncea	Skeleton Weed	*	*			
	Conyza bonariensis	Flaxleaf Fleabane	*			*	
	Conyza sp.	Fleabane	*		*		
	Cotula bipinnata	Ferny Cotula	*	*	*		
	Cotula coronopifolia	Water Buttons	*	*			
	Dittrichia graveolens	Stinkwort	*	*			
	Erigeron bonariense	Flaxleaf Fleabane	*	*			
	Erigeron spp.	Fleabane	*	*			
	Erigeron sumatrensis	Tall Fleabane	*	*			
	Gamochaeta calviceps	Silky Cudweed	*	*			
	Gamochaeta purpurea s.l.	Purple Cudweed	*	*			
	Glyceria declinata	Manna Grass	*	*			
	Glyceria maxima	Reed Sweet-grass	*	*			
	Helminthotheca echioides	Ox-tongue	*	*	*	*	*
	Hypochaeris glabra	Smooth Cat's-ear	*	*	*		
	Hypochaeris radicata	Flatweed	*	*	*	*	*
	Iva axillaris subsp. robustior	Poverty Weed	*	*			
	Lactuca saligna	Willow-leaf Lettuce	*	*	*		
	Lactuca serriola	Prickly Lettuce	*	*	*	*	*
	Leontodon rhagadioloides	Hedypnois	*	*			
	Leontodon saxatilis subsp. saxatilis	Hairy Hawkbit	*	*	*		*
	Onopordum acanthium subsp. acanthium	Scotch Thistle	*	*			



Species Name		Common Name	Status	VBA	Biosis 2014	GHD 2017	R8
	Onopordum acaulon	Stemless Thistle	*	*			
	Rhaponticum repens	Creeping Knapweed	*	*			
	Scorzonera laciniata	Scorzonera	*	*	*		
	Scorzonera laciniata var. laciniata	Scorzonera	*	*			
	Silybum marianum	Variegated Thistle	*	*			
	Sonchus asper subsp. asper	Rough Sow-thistle	*	*	*	*	*
	Sonchus oleraceus	Common Sowthistle	* C	*	*	*	
	Symphyotrichum subulatum	Aster-weed	*	*			
	Taraxacum officinale	European Dandelion	*			*	
	Xanthium orientale	Californian Burr	*	*			
	Xanthium spinosum	Bathurst Burr	*	*			
Xanthium strumarium s.L		Noogoora Burr species aggregate	* C	*			
BORAGINACEAE			*				
	Echium plantagineum	Paterson's Curse	* C	*	*	*	
	Heliotropium europaeum	Common Heliotrope	*	*		*	*
	Heliotropium supinum	Creeping Heliotrope	*		*		
BRASSICACEAE			*				
	Brassica fruticulosa	Twiggy Turnip	*	*			
	Brassica spp.	Turnip	*	*			*
	Capsella bursa-pastoris	Shepherd's Purse	*		*		*
	Carrichtera annua	Ward's Weed	*	*			
	Lepidium africanum	Common Peppercress	*	*	*		
	Lepidium bonariense	Argentine Cress	*	*			
	Sisymbrium officinale	Hedge Mustard	*	*			
	Sisymbrium orientale	Indian Hedge- mustard	*	*	*		
	Sisymbrium spp.	Mustard	*	*			
	Raphanus raphanistrum	Wild Radish	*	*			
	Rorippa palustris	Marsh Yellow-cress	*	*			
CARYOPHYLLACEAE			*				
	Cerastium glomeratum s.l.	Common Mouse-ear Chickweed	*	*	*		
	Petrorhagia dubia	Velvety Pink	*	*			

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Species Name		Common Name	Status	VBA	Biosis 2014	GHD 2017	R8
	Polycarpon tetraphyllum	Four-leaved Allseed	*	*			
	Spergularia rubra s.l.	Red Sand-spurrey	*	*			
	Stellaria media		*	*	*		
CONVOLVULACEAE							
	Convolvulus arvensis	Common Bindweed	*	*			
	Cuscuta campestris	Field Dodder	*	*			
CHENOPODIACEAE							
	Chenopodium album	Fat Hen	*	*			
CUCURBITACEAE							
	Citrullus lanatus	Camel Melon	*	*			
	Cucumis myriocarpus subsp. myriocarpus	Paddy Melon	*	*		*	
EUPHORBIACEAE							
	Euphorbia peplus	Petty Spurge	*	*			
FABACEAE - Faboideae							
	Alhagi maurorum	Camel Thorn	*	*			
	Chamaecytisus palmensis	Tree Lucerne	*	*			
	Genista monospessulana	Montpellier Broom	*	*			
	Glycyrrhiza glabra	Liquorice	*	*			
	Medicago lupulina	Black Medic	*		*		*
	Medicago minima	Little Medic	*	*			
	Medicago polymorpha	Burr Medic	*	*	*		
	Medicago sativa subsp. sativa	Lucerne	*	*			
	Medicago spp.	Medic	*	*			
	Medicago truncatula	Barrel Medic	*	*			
	Trifolium angustifolium var. angustifolium	Narrow-leaf Clover	*	*	*	*	*
	Trifolium arvense var. arvense	Hare's-foot Clover	*	*	*		*
	Trifolium campestre var. campestre	Hop Clover	*	*			
	Trifolium fragiferum var. fragiferum	Strawberry Clover	*	*			
	Trifolium glomeratum	Cluster Clover	*	*	*		
	Trifolium repens var. repens	White Clover	*	*	*		
	Trifolium resupinatum	Shaftal Clover	*	*			



Species Name		Common Name	Status	VBA	Biosis 2014	GHD 2017	R8
	Trifolium resupinatum var. majus	Shaftal Clover	*	*			
	Trifolium spp.	Clover	*	*		*	
	Trifolium striatum	Knotted Clover	*	*			
	Trifolium subterraneum	Subterranean Clover	*	*			
	Trifolium tomentosum var. tomentosum	Woolly Clover	*	*			
	Vicia hirsuta	Tiny Vetch	*	*	*		
	Vicia sativa	Common Vetch	*	*			
	Vicia sativa subsp. sativa	Common Vetch	*	*			
GERANIACEAE							
	Erodium cicutarium	Common Heron's- bill	*	*			
HALORAGACEAE							
	Myriophyllum aquaticum	Parrot's Feather	*	*			
HYPERICACEAE							
	Hypericum perforatum subsp. veronense	St John's Wort	*	*			
LAMIACEAE							
	Marrubium vulgare	Horehound	* C	*	*	*	*
	Mentha pulegium	Pennyroyal	*	*			
	Salvia verbenaca	Wild Sage	*	*			
	Stachys arvensis	Stagger Weed	*	*			
MALVACEAE							
	Malva neglecta	Dwarf Mallow	*	*			
	Malva parviflora	Small-flower Mallow	*	*	*	*	*
	Malvella leprosa	Alkali Sida	*	*			
	Modiola caroliniana	Red-flower Mallow	*	*	*	*	*
OXALIDACEAE							
	Oxalis pes-caprae	Soursob	*	*			
PAPAVERACEAE							
	Fumaria bastardii	Bastard's Fumitory	*	*			
	Fumaria capreolata	White Fumitory	*		*		
	Fumaria indica	Indian Fumitory	*	*			
	Fumaria muralis subsp. muralis	Wall Fumitory	*	*		*	*
PLANTAGINACEAE							



Species Name		Common Name	Status	VBA	Biosis 2014	GHD 2017	R8
	Callitriche brutia var. brutia	Thread Water- starwort	*		*		
	Kickxia elatine	Hairy Toadflax	*			*	
	Plantago coronopus	Buck's-horn Plantain	*	*			
	Plantago lanceolata	Ribwort	*	*			
	Veronica peregrina subsp. xalapensis	Wandering Speedwell	*	*	*		
POLYGONACEAE							
	Polygonum aviculare s.l.	Prostrate Knotweed	*	*	*	*	*
	Rumex conglomeratus	Clustered Dock	*	*			
	Rumex crispus	Curled Dock	*	*		*	*
	Rumex pulcher subsp. pulcher	Fiddle Dock	*	*			
PRIMULACEAE			*				
	Lysimachia arvensis	Pimpernel	*	*	*		
RANUNCULACEAE							
	Ranunculus muricatus	Sharp Buttercup	*	*			
	Ranunculus sceleratus subsp. sceleratus	Celery Buttercup	*	*	*		
ROSACEAE							
	Rosa canina	Dog Rose	*	*			
	Rosa rubiginosa	Sweet Briar	* C	*	*	*	*
	Rubus fruticosus spp. agg.	Blackberry	* C	*		*	
	Rubus ulmifolius var. ulmifolius	Elm-leaf Blackberry	*	*			
RUBIACEAE							
	Galium aparine	Cleavers	*	*	*		
SALICACEAE							
	Salix babylonica s.l.	Weeping Willow	*	*			
SIMAROUBACEAE							
	Ailanthus altissima	Tree of Heaven	*	*			
SOLANACEAE							
	Lycium barbarum	Chinese Box-thorn	*	*			
	Lycium ferocissimum	African Box-thorn	*	*	*		*
	Solanum elaeagnifolium	Silver-leaf Nightshade	*	*			

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Species Name		Common Name	Status	VBA	Biosis 2014	GHD 2017	R8
	Solanum nigrum s.l.	Black Nightshade	*	*	*	*	*
TAMARICACEAE							
	Tamarix ramosissima	Tamarisk	*	*			
URTICACEAE							
	Urtica urens	Small Nettle	*	*	*		*
VERBENACEAE							
	Phyla canescens	Fog-fruit	*	*	*		



Appendix K. Large Old Tree (LOTs) recorded within the construction footprint (combined list from Biosis 2014, GHD 2017 and R8 2019)

Tree ID	Source	Tree Species	DBH (cm)	Very Large
1	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	90	
2	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	86	
3	Biosis 2014	Other	153	Yes
4	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	300	Yes
5	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	158	Yes
6	Biosis 2014	Other	130	
7	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	95	
8	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	145	
9	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	112	
10	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	91	
11	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	82	
12	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	123	
13	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	80	
14	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	124	
15	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	99	
16	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	130	
17	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	142	
18	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	120	
19	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	84	
20	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	94	
21	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	120	
22	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	108	
23	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	90	
24	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	89	
25	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	175	Yes
26	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	88	
27	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	104	
28	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	113	
29	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	95	
30	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	121	
31	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	149	



Tree ID	Source	Tree Species	DBH (cm)	Very Large
32	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	108	
33	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	118	
34	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	110	
35	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	130	
36	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	164	Yes
37	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	148	
38	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	166	Yes
39	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	128	
40	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	133	
41	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	171	Yes
42	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	110	
43	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	93	
44	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	88	
45	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	200	Yes
46	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	88	
47	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	159	Yes
48	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	115	
49	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	91	
50	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	160	Yes
51	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	130	
52	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	130	
53	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	155	Yes
54	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	197	Yes
55	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	114	
56	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	120	
57	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	164	Yes
58	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	140	
59	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	93	
60	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	155	Yes
61	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	112	
62	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	87	
63	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	83	
64	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	144	
65	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	182	Yes



Tree ID	Source	Tree Species	DBH (cm)	Very Large
66	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	108	
67	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	190	Yes
68	Biosis 2014	River Red Gum (Eucalyptus camaldulensis)	88	
69	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	124	
70	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	85	
71	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	98	
72	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	200+ est	Yes
73	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	150+est	Yes
74	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	120 est	
75	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	100 est	
76	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	84	
77	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	80 est	
78	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	90	
79	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	120 est	
80	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	150 est	Yes
81	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	80 est	
82	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	84	
83	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	93 est	
84	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	85 est	
85	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	120	
86	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	110 est	
87	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	80 est	
88	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	140 est	
89	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	81	
90	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	115 est	
91	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	100 est	
92	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	90 est	
93	GHD 2017	River Red Gum (Eucalyptus camaldulensis)		
94	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	95 est	
95	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	90 est	
96	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	110 est	
97	GHD 2017	River Red Gum (Eucalyptus camaldulensis)		
98	GHD 2017	River Red Gum (Eucalyptus camaldulensis)		
99	GHD 2017	River Red Gum (Eucalyptus camaldulensis)		



Tree ID	Source	Tree Species	DBH (cm)	Very Large
100	GHD 2017	River Red Gum (Eucalyptus camaldulensis)		
101	GHD 2017	River Red Gum (Eucalyptus camaldulensis)		
102	GHD 2017	River Red Gum (Eucalyptus camaldulensis)		
103	GHD 2017	River Red Gum (Eucalyptus camaldulensis)		
104	GHD 2017	River Red Gum (Eucalyptus camaldulensis)		
105	GHD 2017	River Red Gum (Eucalyptus camaldulensis)		
106	GHD 2017	River Red Gum (Eucalyptus camaldulensis)		
107	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	100 est	
108	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	90 est	
109	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	120 est	
110	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	130 est	
111	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	200 est	Yes
112	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	120 est	
113	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	80 est	
114	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	180 est	Yes
115	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	250 est	Yes
116	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	100 est	
117	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	200 est	Yes
118	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	120 est	
119	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	80	
120	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	80 est	
121	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	90 est	
122	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	110 est	
123	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	120 est	
124	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	160 est	Yes
125	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	100 est	
126	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	110 est	
127	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	80 est	
128	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	110 est	
129	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	80 est	
130	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	120 est	
131	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	120	
132	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	100	
133	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	90 est	



Tree ID	Source	Tree Species	DBH (cm)	Very Large
134	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	100 est	
135	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	140 est	
136	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	90 est	
137	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	100 est	
138	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	90 est	
139	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	80 est	
140	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	100 est	
141	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	90 est	
142	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	80 est	
143	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	80 est	
144	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	80 est	
145	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	80 est	
146	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	80 est	
147	GHD 2017	River Red Gum (Eucalyptus camaldulensis)	110 est	
148	R8 2019	River Red Gum (Eucalyptus camaldulensis)	90	
149	R8 2019	River Red Gum (Eucalyptus camaldulensis)	123	
150	R8 2019	River Red Gum (Eucalyptus camaldulensis)	132	
151	R8 2019	River Red Gum (Eucalyptus camaldulensis)	160	Yes
152	R8 2019	River Red Gum (Eucalyptus camaldulensis)	247	Yes
153	R8 2019	River Red Gum (Eucalyptus camaldulensis)	203	Yes
154	R8 2019	River Red Gum (Eucalyptus camaldulensis)	150	Yes
155	R8 2019	River Red Gum (Eucalyptus camaldulensis)	96	
156	R8 2019	River Red Gum (Eucalyptus camaldulensis)	125	
157	R8 2019	River Red Gum (Eucalyptus camaldulensis)	188	Yes
158	R8 2019	River Red Gum (Eucalyptus camaldulensis)	125	
159	R8 2019	River Red Gum (Eucalyptus camaldulensis)	147	
160	R8 2019	River Red Gum (Eucalyptus camaldulensis)	245	Yes
161	R8 2019	River Red Gum (Eucalyptus camaldulensis)	118	
162	R8 2019	River Red Gum (Eucalyptus camaldulensis)	158	Yes
163	R8 2019	River Red Gum (Eucalyptus camaldulensis)	111	
164	R8 2019	River Red Gum (Eucalyptus camaldulensis)	122	
165	R8 2019	River Red Gum (Eucalyptus camaldulensis)	110	
166	R8 2019	River Red Gum (Eucalyptus camaldulensis)	129	
167	R8 2019	River Red Gum (Eucalyptus camaldulensis)	95	



Tree ID	Source	Tree Species	DBH (cm)	Very Large
168	R8 2019	River Red Gum (Eucalyptus camaldulensis)	148	
169	R8 2019	River Red Gum (Eucalyptus camaldulensis)	114	
170	R8 2019	River Red Gum (Eucalyptus camaldulensis)	169	Yes
171	R8 2019	River Red Gum (Eucalyptus camaldulensis)	163	Yes
172	R8 2019	River Red Gum (Eucalyptus camaldulensis)	212	Yes
173	R8 2019	River Red Gum (Eucalyptus camaldulensis)	98	
174	R8 2019	River Red Gum (Eucalyptus camaldulensis)	147	
175	R8 2019	River Red Gum (Eucalyptus camaldulensis)	172	Yes
176	R8 2019	River Red Gum (Eucalyptus camaldulensis)	176	Yes
177	R8 2019	River Red Gum (Eucalyptus camaldulensis)	147	
178	R8 2019	River Red Gum (Eucalyptus camaldulensis)	177	Yes
179	R8 2019	River Red Gum (Eucalyptus camaldulensis)	116	
180	R8 2019	River Red Gum (Eucalyptus camaldulensis)	175	Yes
181	R8 2019	River Red Gum (Eucalyptus camaldulensis)	142	
182	R8 2019	River Red Gum (Eucalyptus camaldulensis)	95	
183	R8 2019	River Red Gum (Eucalyptus camaldulensis)	95	
184	R8 2019	River Red Gum (Eucalyptus camaldulensis)	130	
185	R8 2019	River Red Gum (Eucalyptus camaldulensis)	92	
186	R8 2019	River Red Gum (Eucalyptus camaldulensis)	120	
187	R8 2019	River Red Gum (Eucalyptus camaldulensis)	122	
188	R8 2019	River Red Gum (Eucalyptus camaldulensis)	165	Yes
189	R8 2019	River Red Gum (Eucalyptus camaldulensis)	100	
190	R8 2019	River Red Gum (Eucalyptus camaldulensis)	159	Yes
191	R8 2019	River Red Gum (Eucalyptus camaldulensis)	92	
192	R8 2019	River Red Gum (Eucalyptus camaldulensis)	146	
193	R8 2019	River Red Gum (Eucalyptus camaldulensis)	143	
194	R8 2019	River Red Gum (Eucalyptus camaldulensis)	94	
195	R8 2019	River Red Gum (Eucalyptus camaldulensis)	134	
196	R8 2019	River Red Gum (Eucalyptus camaldulensis)	153	Yes
197	R8 2019	River Red Gum (Eucalyptus camaldulensis)	97	
198	R8 2019	River Red Gum (Eucalyptus camaldulensis)	261	Yes
199	R8 2019	River Red Gum (Eucalyptus camaldulensis)	91	
200	R8 2019	River Red Gum (Eucalyptus camaldulensis)	188	Yes
201	R8 2019	River Red Gum (Eucalyptus camaldulensis)	95	



Tree ID	Source	Tree Species	DBH (cm)	Very Large
202	R8 2019	River Red Gum (Eucalyptus camaldulensis)	179	Yes
203	R8 2019	River Red Gum (Eucalyptus camaldulensis)	227	Yes
204	R8 2019	River Red Gum (Eucalyptus camaldulensis)	139	
205	R8 2019	River Red Gum (Eucalyptus camaldulensis)	171	Yes
206	R8 2019	River Red Gum (Eucalyptus camaldulensis)	146	
207	R8 2019	River Red Gum (Eucalyptus camaldulensis)	94	
208	R8 2019	River Red Gum (Eucalyptus camaldulensis)	177	Yes
209	R8 2019	River Red Gum (Eucalyptus camaldulensis)	108	
210	R8 2019	River Red Gum (Eucalyptus camaldulensis)	133	
211	R8 2019	River Red Gum (Eucalyptus camaldulensis)	144	
212	R8 2019	River Red Gum (Eucalyptus camaldulensis)	99	
213	R8 2019	River Red Gum (Eucalyptus camaldulensis)	93	
214	R8 2019	River Red Gum (Eucalyptus camaldulensis)	107	
215	R8 2019	River Red Gum (Eucalyptus camaldulensis)	126	
216	R8 2019	River Red Gum (Eucalyptus camaldulensis)	99	
217	R8 2019	River Red Gum (Eucalyptus camaldulensis)	119	
218	R8 2019	River Red Gum (Eucalyptus camaldulensis)	103	
219	R8 2019	River Red Gum (Eucalyptus camaldulensis)	180	Yes