Victorian Murray Floodplain Restoration Project

Flora and Fauna Assessment - Lindsay Island Floodplain Restoration Project

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Lower Murray Urban and Rural Water Corporation

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Executive Summary

Project understanding and Study Area

The Lindsay Island 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.

VMFRP engaged R8 (GHD Pty Ltd and Jacobs Group (Australia) Pty Ltd partnering as the R8 Joint Venture) to survey the Area of Investigation to identify rare or threatened flora or fauna and communities within (or immediately adjacent to) the Construction Footprint. The Inundation Area was also assessed at a desktop level, with a rapid ground-truthing assessment of any areas where non-flood dependent EVCs had been modelled as occurring by DELWP (or where no modelled EVC data was available) in Victoria.

The project involves works (e.g. construction of regulators, drop structures, containment banks, spillways, channels and temporary pump sites) to facilitate managed inundation of approximately 4,845 ha of high ecological value floodplain in Victoria, mostly located on Lindsay Island and floodplain areas south of the Lindsay River, including Lake Wallawalla. In order to engage inflows to the Lindsay River, operation of the project will involve raising water levels along the Murray River behind Lock 7, which will inundate some lower-lying billabongs and creeks on the New South Wales (NSW) side of the Murray River. Including NSW inundation areas, the total proposed inundation area is approximately 5,108 ha. The project is located entirely within the Victorian local government area of Mildura Rural City Council, except for the minor works and inundation located within the NSW local government area of Wentworth Shire Council. The project is predominantly located within the Murray-Sunset National Park and in the Murray Scroll Belt bioregion.

The project's objective of reinstating a more natural flooding regime to the Lindsay Island floodplain is expected to provide ecological benefits such as maintaining and enhancing the health of more than 4,845 ha of flood dependent native vegetation and wetlands in Victoria. This will increase the extent and condition of habitat for common indigenous and threatened aquatic and floodplain fauna, including waterbirds, small-bodied generalist 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 predicted climate change scenarios.

This flora and fauna assessment has been prepared for the project to support the preparation of referrals under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and Victorian *Environment Effects Act 1978*, and provides a consolidated assessment of findings from previous ecological studies undertaken for the project (Australian Ecosystems 2013, GHD 2013, GHD 2014, GHD 2016), and the findings from recent flora and fauna surveys by R8 undertaken between October 2019 and January 2020, and from targeted ground-truthing surveys of modelled non-flood dependent EVCs within the Inundation Area.

VMFRP is currently engaging with the Murray-Darling Basin Authority (MDBA) around the raising of the Lock 7 weir pool and how the proposed Lock 7 operating regime compares to the current operating regime. Impacts associated with changes to the operating regime of Lock 7 and the resultant inundation area in NSW have therefore not yet been assessed. This report contains a desktop assessment, based on available information, to identify listed threatened species and communities that may be present in the NSW inundation areas. However, further assessment will need to be carried out of the potential for impacts on native vegetation, listed threatened species and communities within the NSW inundation area, that may be associated with operation of Lock 7 for the project, including the effects on Lock 7 fishway operation.

Results

Native vegetation

Native vegetation and fauna habitat was identified within the Area of Investigation that has the potential to be impacted by the proposed works. Efforts have been made to avoid and minimise impacts to native vegetation 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 native vegetation. Native vegetation impacts have been estimated based on the current Construction Footprint. Native vegetation within the Construction Footprint has been subject to desktop and field assessment. Field assessment of native vegetation (Habitat Hectares) and Large Tree data is based on 2015 field assessments of the construction footprint current at that time (GHD 2016). Some changes to the construction footprint have occurred since 2015 such that approximately 8.15 ha of the current construction footprint would require further assessment of native vegetation and Large Trees. Modelled EVC data has been used to estimate native vegetation and Large Tree impacts in this area.

For construction of proposed infrastructure and temporary laydown areas, native vegetation impacts have been assessed as 64.26 ha based on the construction footprint of 28.86 ha[1] and allowance for Tree Protection Zone (TPZ) impacts. The development footprint of permanent infrastructure based on the current design is 13.47 ha and hence it is expected there will be opportunity to further minimise impacts on native vegetation and Large Trees, and to reinstate parts of the construction footprint following construction. For access tracks, native vegetation impacts have been calculated as 41.63 ha based on a 5 m wide impact corridor for minor track works and a 10 m wide corridor for new or more substantial track works. The nature of works required along tracks would be refined to further assess and where possible minimise impacts on native vegetation and Large Trees. This would include consultation with an arborist to identify opportunities to retain trees that are TPZ impacted. Design of the project is being refined, including in response to environmental and heritage studies, which may result in changes to the proposed construction footprints and therefore this estimate of native vegetation clearance.

Threatened fauna species and communities

The Area of Investigation has been subject to targeted fauna surveys. Previous ecological studies (described in Section 12) were used to inform the additional targeted threatened fauna surreys undertaken in November/December 2019 and January 2020. A desktop assessment of potential impacts on listed threatened species and communities, and listed migratory species has been undertaken for the inundation area.

Five fauna species listed under both the EPBC Act and *Flora and Fauna Guarantee Act 1988* (FFG Act) were assessed as present or having a possible occurrence within the Area of Investigation: Regent Parrot (*Polytelis anthopeplus monarchoides*), Painted Honeyeater (*Grantiella picta*), Growling Grass Frog (*Litoria raniformis*), Murray Cod (*Maccullochella peelii*), and Silver Perch (*Bidyanus bidyanus*). Likelihood of occurrence and impact for these species was considered based on the EPBC Act Significance Impact Guidelines 1.1 – Matters of National Environmental Significance (Significant Impact Guidelines).

Impacts to EPBC Act and FFG Act listed fish species (Silver Perch and Murray Cod) are considered to have the potential to occur during construction and operation. Implementation of mitigation measures outlined in Section 11 are likely to mitigate the construction phase impacts. An important population of Murray Cod inhabits the Lindsay-Mullaroo system. The proposed operation of the Berribee Regulator would result in changes to the Mullaroo Creek flow regime, impacting hydraulic habitat for Murray Cod. This is considered to be a significant impact as defined in the Significant Impact Guidelines as it would impact on habitat for an important population. The proposed operation of the Berribee Regulator has also been assessed under the Significant Impact Guidelines as likely to have a significant impact on the Silver Perch as it would impact on a population/habitat of a critically endangered species. Further assessment is proposed to inform refinement of the operating regime, identify opportunities to mitigate/offset impacts and inform development of monitoring, evaluation and reporting requirements to support adaptive management.

Impacts to Regent Parrots, Painted Honeyeater and Growling Grass Frog are not expected to be significant, as defined in the Significant Impact Guidelines.

[1] This is the area of construction footprint for infrastructure and currently identified temporary laydown areas only and does not include tracks

A further 27 fauna species listed under the FFG Act may occur within the Area of Investigation. Impacts to other FFG Act listed fauna species that are considered to have the potential to occur within the Area of Investigation are likely to be low, and mitigation measures are provided.

Two FFG Act listed fauna communities are considered to occur within the Area of Investigation: Victorian Temperate Woodland Bird Community (VTWBC) and Lowland Riverine Fish Community of the Southern Murray-Darling Basin (LRFC). Given that Lindsay Island is comprised of 15,000 ha of largely intact vegetation, the proposed construction of floodplain infrastructure scattered across approximately 30 relatively small and discrete locations is unlikely to impact on habitat connectivity or remove important habitat for the FFG Act listed VTWBC. The project has the potential to both positively and negatively impact the FFG Act listed LRFC, which includes as constituent species, the FFG Act listed Murray Cod, Silver Perch, Murray-Darling Rainbowfish, Unspecked Hardyhead and Freshwater Catfish that are known to occur in the project area. Operation of the project has the potential to restore semi-permanent wetlands that support small-bodied fish and to allow for protection of existing high value fish communities, including threatened fish species. However, operation of the larger inundation scenarios has the potential to impact on the fast-flowing habitat of the Lindsay-Mullaroo system, which would have a significant impact on Murray Cod and Silver Perch, and marginal impacts on other listed threatened fish species that form part of this listed community. Key to protecting the FFG Act listed LRFC, is the operation of the system to maintain the permanent fast-flowing habitats in Mullaroo Creek and the upper Lindsay River. The extent of impacts on the FFG Act listed LRFC would depend on the frequency, duration, timing and magnitude of reduced flow velocities in the Lindsay-Mullaroo system, which would be determined following further assessment and refinements to the draft operating scenarios.

Threatened flora species and communities

Targeted surveys have been undertaken within the Area of Investigation for listed flora species and communities. Previous ecological studies (described in Section 12) and the results of recent desktop assessments were used to inform the targeted surveys undertaken in October 2019. Potential impacts to listed flora and communities in the Inundation Area has been assessed primarily from a desktop perspective, with a ground-truthing assessment of non-flood dependent EVCs also being undertaken in June 2020.

A small area of Semi-arid Chenopod Woodland (EVC 98) was identified at Crankhandle West B2 Regulator and Containment Bank. These areas correspond with the EPBC Act listed community, *Buloke Woodlands of the Riverina and Murray-Darling Depression Bioregions*, and the FFG Act listed Semi-arid Shrubby Pine-Buloke Woodland Community. It is recommended that the Construction Footprint is refined in these locations, so that impacts to listed flora communities can be avoided.

Ground-truthing assessments were undertaken across the Inundation Area where Semi-arid Woodland EVCs (EVC 97 and 98) had been modelled as occurring by DELWP. These areas were targeted as Semi-arid Woodland EVCs are non-flood dependent communities and have the potential to correspond with the EPBC Act listed community, *Buloke Woodlands of the Riverina and Murray-Darling Depression Bioregions*, and the FFG Act listed Semi-arid Shrubby Pine-Buloke Woodland Community. The ground-truthing assessment confirmed that there are no non-flood dependent EVCs within the Inundation Area, and that no impacts to listed flora communities are likely to result from the proposed environmental watering.

During the 2013 flora census (AE 2013) of the broader Lindsay Island floodplain area, one EPBC Act listed flora species was identified: *Eleocharis obicis* (Striate Spike-sedge); along the eastern edge of Lake Wallawalla. This species record has not been registered on the Victorian Biodiversity Atlas (VBA) (the nearest registered record of this species is over 90 km away near Managatang). Targeted surveys were undertaken for this species in 2013, 2015 and 2019, but this species has not been identified within the Area of Investigation. No EPBC Act listed flora species were identified within the Area of Investigation during the 2019 surveys. However, rare or threatened flora were recorded in the Area of Investigation during the 2019 surveys, including some within, or close to, the Construction Footprint. These species include:

- Four FFG Act listed threatened plant species
- Eleven flora species considered rare or threatened in Victoria (DELWP Advisory)

Impacts to EPBC Act and FFG Act listed flora species/communities that are considered to have the potential to occur within the Area of Investigation are likely to be low where mitigation measures outlined in Section 11 are implemented in full.

Whilst the operating regime has not yet been finalised, it is intended to replicate a more natural flooding regime and to therefore improve the quality of floodplain vegetation and habitat across the 4,845 ha Inundation Area targeted for restoration in Victoria. Impacts during operation (i.e. inundation phase) are considered to be largely beneficial to listed terrestrial species. Further assessment would be carried out of ecological benefits, as well as potential impacts and strategies to avoid or mitigate these, to inform the final operating regime and development of monitoring, evaluation and reporting requirements to support adaptive management. A detailed assessment of the Inundation Area where it extends in to NSW has not been undertaken as a part of this assessment.

We understand that VMFRP will use the results of this Flora and Fauna Assessment Report (and other specialist reports) to refine Construction Footprints to avoid and minimise impacts on areas of ecological value. Efforts will be made during the detailed design phase of the project to further avoid and minimise impacts to patches of native vegetation containing habitat for rare or threatened species/communities and large trees (particularly hollow-bearing large trees).

Legislation, permits and approvals

There are a number of ecological values present within the Area of Investigation with the potential to trigger assessments or approvals under various legislation if impacted. Once the Construction Footprint for the project has been finalised, this report will need to be updated to take into account any potential impacts on native vegetation and /or fauna habitat, as well as any additional permit triggers.

The following permits and approvals are likely to be, or may be, required for this project:

- Planning approval to remove native vegetation under the Mildura Planning Scheme in accordance with the Guidelines for the removal, destruction or lopping of native vegetation (DELWP 2017) (the Guidelines). Offsets will need to be sought in accordance with the requirements of the Guidelines or through an alternate arrangement agreed with the Secretary to DELWP such as a conservation exemption under Clause 52.17 of the Mildura 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 resulting from environmental watering in the Inundation Area targeted for restoration in Victoria (approximately 4,845 ha). The method for confirming this offset will be developed in consultation with DELWP. Any offset requirements that cannot be met through environmental watering will need to be purchased by the project.
- A permit under the FFG Act is required where works on public land 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*.

This ecological assessment will support referrals to the:

- Commonwealth Environment Minister under the EPBC Act to determine whether the project is a controlled action requiring approval under this Act.
- Victorian Minister for Planning under the *Environment Effects Act 1978* (EE Act) to determine whether an Environmental Effects Statement is required.

This assessment has determined that it is possible that a significant impact will occur on Matters of National Environmental Significance (MNES) that are protected under the EPBC Act, specifically the listed threatened fauna species Murray Cod (*Maccullochella peelii*) (DELWP 2018) and Silver Perch (*Bidyanus bidyanus*). This impact, which has the potential to result in the long-term loss of a significant portion of known remaining habitat or population of a threatened species, is also a criterion for referral under the EE Act for Murray Cod and Silver Perch. In addition, the project would require the removal of more than 10 hectares of native vegetation, which is also a criterion for referral under the EE Act.

Recommendations and Next Steps

Additional steps that should be taken to further avoid and minimise impacts to ecological values during the design, construction and implementation of the project have been outlined in Section 11, and include, but are not limited to:

- Refine the draft operating scenarios and/or develop and implement other operational measures to reduce the potential significance of the impacts on listed threatened fish species of the Lindsay-Mullaroo system, including measures to maintain core hydraulic habitat attributes for these species. Further work will be carried out by VMFRP to allow for refinement of the operating regime, identify opportunities to mitigate/offset impacts and inform development of monitoring, evaluation and reporting requirements to support adaptive management.

  To reduce the likelihood of impacts to threatened fish during the operational phase, DELWP (2018) provide the following recommendations:

  - Reduce the frequency of the Berribee Maximum inundation scenario (e.g. to one in 10 years), do not implement after an anoxic blackwater event, limit duration (e.g. six weeks), and avoid overlap with Murray Cod spawning season (e.g. preferred timing May-July).
  - Reduce the frequency of the Berribee Intermediate inundation scenario (e.g. to four in 10 years), do not implement after an anoxic blackwater event, limit duration (e.g. eight weeks), and avoid overlap with Murray Cod spawning season (e.g. preferred timing May-July), avoid consecutive year operation.

- To reduce the likelihood of impacts to threatened fish during construction, the following mitigation measures should be adopted during construction of the Berribee Regulator:

  - Construction works should be planned / scheduled to avoid construction of coffer dams during the spawning season for each threatened fish species.
  - Temporary cofferdams (permanent seepage cutoffs) should be constructed by sheet-piling using barges, with consideration given to the timing of pile-driving placement and the pile-driving method to minimise impacts to threatened fish present within the Lindsay River. Construction during spawning season has the potential to impact fish present, but the magnitude of impact is unclear as impacts of noise and vibration on freshwater fish are largely unknown. If in-water construction is required during the spawning season it is recommended that the lowest impact piling method is employed during these periods.
  - Removal of submerged woody habitat should be avoided where practicable, and approval sought for this activity where needed (e.g. under the NSW *Fisheries Management Act 1994*), and if not avoidable, any submerged woody habitat removed should be placed back in the same waterway, as close to its original location as possible.

- Any other in-stream works such as smaller coffer dam installation, dewatering works and any activities that have the potential to increase sediment/contaminant run-off into wet areas from Construction Footprints must be planned considering aquatic fauna. A construction-specific aquatic fauna management plan should be developed for all works around waterways to address the construction-related threatening processes.
- Additional impacts due to operation were identified by DELWP (2018) and included the risk that floodplain inundation will increase carp populations, which may impact native fish species present within the complex. Recommendations to mitigate these impacts include:

  - Implementing a winter fill regime
  - Develop a native fish exit strategy to strand carp
  - Drying of wetlands with high carp density
- Mitigate downstream water quality and hydrological impacts due to return flows during project operation.

- To the extent practicable, refine the Construction Footprint utilising the existing ecological values mapping (**Figure 5**, page 6), to avoid the small area (0.03 ha) of Semi-arid Chenopod Woodland (EVC 98) at Crankhandle West-B2 Regulator and Containment Bank. This vegetation meets the criteria to be considered the EPBC Act listed community: Buloke Woodlands of the Murray Darling Depression Bioregion, and the FFG Act listed flora community, Semi-arid Shrubby Pine-Buloke Woodland Community.
- To the extent practicable, refine the Construction Footprint utilising the existing ecological values mapping to avoid and minimise impacts to native vegetation, particularly hollow-bearing large trees, and threatened flora/fauna species and communities within and adjacent to the Construction Footprint. This should include refining track works and infrastructure in locations where listed flora species have been identified, to avoid impacts to threatened species (including *Eremophila maculata* subsp. *maculata* and *Acacia oswaldii* individuals located within and adjacent to the existing tracks and infrastructure).
- Once the Construction Footprint and required track access has been confirmed, a qualified arborist should be engaged to undertake an assessment along the required tracks, with a project /construction engineer, to confirm the extent of works required (if any) and to identify mitigation measures that can be undertaken prior to construction to avoid and minimise the requirement for potential losses to trees along the required tracks either directly (through removal) or indirectly (through encroachment of their TPZs, or the removal of >30% of their canopy). Particular attention should be paid to areas identified as supporting potential Regent Parrot nesting habitat (e.g. Berribee Regulator (BERR_A) on the Lindsay River), which has never been documented to occur but has a low potential to occur at this location. It may be beneficial to include a cultural heritage representative and a surveyor on this assessment, to enable the centre line of tracks to be accurately recorded to feed directly into the design process. Once this assessment has been undertaken, the extent of impacts to native vegetation for the project can be confirmed. It is anticipated that the actual impacts to native vegetation along the approximately 30 km of existing access tracks requiring minor upgrades may be lower than the estimate that has been currently accounted for.
- 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 at the infrastructure locations (both within and immediately adjacent to the proposed Construction Footprint). This assessment will take in to account direct impacts to trees (tree removal) and indirect impacts to trees (through encroachment of their TPZs). An arborist assessment will 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).
- The Habitat Hectare assessments were undertaken at the time of the fieldwork in 2015 (GHD 2016) using the Construction Footprint that was current at the time. Due to further changes in the Construction Footprint since the 2019 R8 surveys, including a newly proposed section of approximately 5 km of access track, some areas of native vegetation proposed to be impacted have not yet been assessed (8.15 ha), however DELWP modelled condition data has been used to fill these gaps. The combined data from these assessments are presented in Appendix K. Once the design process is complete and the Construction Footprint has been finalised, a Vegetation Quality Assessment (Habitat Hectares) will be undertaken to confirm the condition and extent of native vegetation within these areas, eliminating the need to rely on modelled data in these areas.
- Engage with DELWP:
    - Discuss 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.
    - Discuss the proposed approach for obtaining planning approval and offsets for the project and whether the conservation works exemption or an alternative offset approach may apply to the project. This approach may include the establishment of a vegetation condition monitoring regime within the proposed Inundation Areas that will 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 an application for planning approval to remove native vegetation under Mildura Planning Scheme and the *Planning and Environment Act 1987*.

- A CEMP should be developed for the project and implemented in full to further avoid and minimise impacts to areas of ecological value. The CEMP should be prepared once the footprint and construction methods for the proposed works have been finalised, and should include provisions relevant to protecting the ecological values identified within the Construction Footprints.
- Develop and implement an Aquatic Fauna Management Plan (as part of the CEMP) to manage impacts to aquatic values – with emphasis on threatened fish species, as well as turtles that may be present in vicinity of construction sites. Any construction activities that could lead to entrapment of fauna or temporary loss of habitat or barriers to movement (e.g. due to the use of coffer dams and dewatering) should be considered.
- Develop and implement monitoring and mitigation measures for areas of interest and particularly areas of heightened interest, for potential near-surface salinisation outside the Inundation Area as identified in R8, 2020b.

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

Abbreviations

Abbreviation	Description
ARI	Arthur Rylah Institute
CaLP Act	Victorian *Catchment and Land Protection Act 1994*
CAMBA	China-Australia Migratory Bird Agreement
CMA	Catchment Management Authority
DAWE	Commonwealth Department of Agriculture, Water and Environment (formerly DOEE and DOTE)
DBH	Diameter at Breast Height
DELWP	Department of Environment, Land, Water and Planning (formerly DEPI)
DEPI	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*
EMP	Environmental Management Plan
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
EVC	Ecological Vegetation Class
EWMP	Environmental Water Management Plan
FFG Act	Victorian *Flora and Fauna Guarantee Act 1988*
GHD	GHD Pty Ltd
GIS	Geographic Information System
JAMBA	Japan-Australia Migratory Bird Agreement
MER	Monitoring, Evaluation and Reporting
MNES	Matters of National Environmental Significance
Mallee CMA	Mallee Catchment Management Authority
MDB	Murray Darling Basin
MDBA	Murray Darling Basin Authority
MSB	Murray Scroll Belt Bioregion
PMST	Protected Matters Search Tool
R8	R8 Joint Venture by GHD and Jacobs
RoKAMBA	Republic of Korea–Australia Migratory Bird Agreement
SDL	Sustainable Diversion Limits
sp.	Species
spp.	More than one species
subsp.	Subspecies
TPZ	Tree Protection Zone
var.	Variety
VBA	Victorian Biodiversity Atlas

Abbreviation	Description
VMBC	Victorian Mallee Bird Community
VMFRP	Victorian Murray Floodplain Restoration Project
VTWBC	Victorian Temperate Woodland Bird Community
VROTS	Species listed on DELWP's *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).
WMA	Water management area
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 designs are required to be suitable for construction pricing to inform business case prioritisation. The purpose of this infrastructure is to allow floodplains to be watered at the hydraulic design levels nominated by VMFRP. R8 is also engaged to provide Regulatory Approvals and Cultural Heritage Services. The purpose of these services is to support VMFRP to lodge 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 1.4 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 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, including:

- *An ecological assessment limited to vascular plant species (ferns, conifers and flowering plants). Non-vascular flora (e.g. mosses, liverworts, lichens), fungi and terrestrial invertebrates 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 Ecological Vegetation Class (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.*
- *An ecological assessment limited to terrestrial vertebrate fauna. Freshwater fauna or invertebrate fauna were considered at a desktop level only. Assessment of impacts to aquatic fauna was completed at a desktop level due to the high level of survey effort and regular monitoring that has been applied to the waterways relevant to the project for more than 10 years.*
- *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.*
- *Calculations for impacts to native vegetation for the project assumed there will be no impacts to native vegetation outside the proposed Construction Footprint provided by VMFRP at the time of the preparation of this report. Since the fieldwork was completed there have been some amendments to the Construction Footprint at infrastructure sites and along tracks that extend outside of areas currently mapped (8.15 ha in total), and at this stage modelled condition data (DELWP) has been used to account for impacts in this area. If these areas are proposed to be impacted once the detailed design phase of the project is complete, additional field assessments will be required to document any native vegetation present in these areas and to confirm any additional losses of native vegetation associated with the project.*

- *Did not include an assessment of the potential impacts that may result from changes to groundwater and increased salinity to native vegetation within and immediately adjacent to the Inundation Area. The requirement for any assessments (including the potential collection of baseline condition data) within the Inundation Area and in areas fringing the Inundation Area will be confirmed through consultation with groundwater specialists and VMFRP.*
- *Did not include a comprehensive on ground assessment of the vegetation and fauna habitat present along proposed access tracks. Some access tracks were assessed during the 2015 comprehensive surveys of the site, using the iteration of the Construction Footprint that was current at the time. Some track footprints have since changed, but are not yet finalised, therefore these additional areas have been accounted for using DELWP modelled condition scores until further on ground assessment can be completed in future.*
- *Did not include a detailed assessment of planning implications with relation to legislation outside of those considered from an ecological perspective.*
- *Included flora investigations as part of the ecological assessment during late winter and mid-summer, which is not always an optimal time of year for conducting botanical assessments in the Mallee region, although timing suitability can vary depending on rainfall (surveys later in spring could be appropriate following previous rainfall). Some native flora are difficult or impossible to locate or identify at this time of year, due to a lack of reproductive material and/or the seasonal nature of some species (in particular, annuals and geophytes). Additional native species may be recorded at the site at other times of the year. Therefore, it is considered possible that additional rare or threatened flora may be present, but were not detected during the survey because of the timing of the survey. However, extensive previous surveys and database records partially offset this limitation.*
- *Included fauna field investigations as part of the ecological assessment during spring and summer which is an adequate time of year for conducting fauna assessments for the identified targeted fauna species in the Mallee region. Although the timing of assessments was not optimal for detecting non-target fauna species, e.g. February-March for juvenile and hence more readily detectable small mammals and reptiles, the availability of results from extensive previous surveys and database records partially offset this limitation. This was beyond the scope of this assessment.*
- *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, active searching and incidental observations.*
- *Using the Victorian Biodiversity Atlas (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 primarily been assessed at a desktop level only, with rapid ground truthing having only been undertaken in areas where non-flood dependent EVCs were modelled by DELWP, or where there was no modelled EVC data available.*

- *VMFRP is currently engaging with the Murray-Darling Basin Authority (MDBA) around the raising of the Lock 7 weir pool and how the proposed Lock 7 operating regime compares to the current operating regime. Impacts associated with changes to the operating regime of Lock 7 and the resultant inundation area in NSW have therefore not yet been assessed. This report contains a desktop assessment, based on available information, to identify listed threatened species and communities that may be present in the NSW inundation areas. However, further assessment will need to be carried out of the potential for impacts on native vegetation, listed threatened species and communities within the NSW inundation area, that may be associated with operation of Lock 7 for the project, including the effects on Lock 7 fishway operation.*
- *The Commonwealth Environment Protection and Biodiversity Conservation (EPBC) Act 1999 is undergoing a review that commenced in October 2019. Any changes to the applicable legislation and agreements may affect the recommendations or conclusions of this report.*
- *The Victorian Flora and Fauna Guarantee (FFG) Act Amendment Bill 2019 has passed through Victorian Parliament with amendments taking effect on 1 June 2020. This report has been prepared based on the current requirements of the Act and these may change prior to the construction of the project.*

Acknowledgments

We acknowledge the Traditional Owners across the lands in which this project is based. We recognise the First People of the Millewa-Mallee Aboriginal Corporation as the Registered Aboriginal Party responsible for managing cultural heritage in this region, which includes cultural values of land, wildlife and waterways.

Additionally, 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

The Lindsay Island 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 restore 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.

VMFRP engaged R8 (GHD Pty Ltd and Jacobs Group (Australia) Pty Ltd partnering as the R8 Joint Venture) to survey the Area of Investigation to identify rare or threatened flora or fauna and communities within (or immediately adjacent to) the Construction Footprint. The Inundation Area was also assessed at a desktop level, with a rapid ground-truthing assessment of areas where non-flood dependent EVCs had been modelled as occurring by DELWP (or where no modelled EVC data was available) in Victoria.

1.1 Project overview

The project is located in north west Victoria, approximately 100 km west of Mildura and 30 km east of Renmark, South Australia. The project involves works to facilitate managed inundation of over 5,000 ha, consisting of approximately 4,845 ha of high ecological value floodplain in Victoria, mostly located on Lindsay Island, and over 200 ha in NSW (including the Murray River). Lindsay Island is approximately 28 km long east to west and is enclosed by the Murray River in the north and the Lindsay River anabranch in the south. The project would also involve inundation of floodplain areas south of the Lindsay River, including Lake Wallawalla. In order to engage inflows to the Lindsay River, operation of the project would involve raising water levels along the Murray River behind Lock 7, which would inundate some lower-lying billabongs and creeks on the NSW side of the Murray River.

The Lindsay River is an anabranch that diverges from the Murray River downstream of Lock 8 and re-joins the river upstream of Lock 6, bypassing Lock 7. Lindsay Island is dissected by a number of creeks. Most notably, these include Mullaroo Creek, which diverges from the Murray River just upstream of Lock 7 and crosses Lindsay Island to connect with the Lindsay River just upstream of Berribee Homestead; and Toupnein Creek, which is an anabranch that diverges from the Murray River downstream of Lock 7 and re-joins the river upstream of the Lindsay River's downstream junction.

The project is located approximately 10 km upstream of the Riverland Ramsar site in South Australia. Lindsay Island (along with floodplain areas south of the Lindsay River) and Lake Wallawalla are both listed as nationally important wetlands on A Directory of Important Wetlands in Australia. The project is located about 35 km upstream of the Murray Mallee – Calperum Station and Taylorville Station in South Australia, which is listed for its natural heritage values on the Commonwealth Heritage List.

The majority of the project is located within the Murray-Sunset National Park managed by Parks Victoria. The project adjoins the Toupnein Creek Reference Area and part of the Inundation Area is located in the Lake Wallawalla Reference Area. The project is located entirely within the Victorian local government area of Mildura Rural City Council, except for the minor works and inundation located within the NSW local government area of Wentworth Shire Council. The project is located in the Mallee Catchment Management Authority (CMA) region and the Murray Scroll Belt bioregion.

The Project Area includes infrequently flooded higher floodplain terraces dominated by *Eucalyptus largiflorens* (Black Box) or chenopod shrublands along with more frequently flooded terraces and creeklines that largely support *Eucalyptus camaldulensis* (River Red-gum).

1.2 Assessment areas

Throughout this document, the following terms are used to describe the project:

- **Development Footprint** - this is the area that the project infrastructure (e.g. regulators, drop structures, pump hardstands, containment banks, channels, spillways) would occupy, along with currently identified construction laydown areas. No construction working buffer or access tracks are included in the development footprint.
- **Construction Footprint** - this includes the project infrastructure and currently identified laydown areas as well as the land required to construct the infrastructure (a working buffer). The Construction Footprint includes access tracks. This is the area that has been used to assess potential impacts on ecological values and to calculate the extent of native vegetation removal for the project.
- **Inundation Area** - area of land subject to flooding during managed events, up to a specific design water level. The Inundation Area was subject primarily to a desktop assessment, reviewing the area proposed to be watered during the maximum inundation event, noting there are a range of intermediate inundation events also proposed during the operational phase of the project. Vegetation ground-truthing was undertaken in areas modelled to contain non-flood dependent communities.
- **Area of Investigation -** includes an additional buffer on the Construction Footprint and provides the basis for desktop investigations to identify environmental values relevant to construction of the project.
- **Study Area** - the area within an approximate 10 km radius around the Area of Investigation and Inundation Area. This area was not surveyed in detail but is used for the desktop assessment of databases and provides a context to the proposed Construction Footprint and Inundation Area.

Reference to 'the Project Area' throughout this document includes both the Construction Footprint and the Inundation Area.

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

1.3 Previous ecological assessments

Ecological and biodiversity information has been collected for the project over a number of years. Previous ecological studies for the project that were reviewed as part of this assessment, considered slightly different assessment areas to those described below in Section 6.1 and displayed in **Figure 1**. Over time, the extent and impacts associated with the Construction Footprint at each site has been revised with the overall intent of avoiding and minimising impacts to native vegetation and fauna habitat.

The following previous studies undertaken for the project have been used to help inform the current report:

- GHD (2019) *Floodplain Bat Study. Lindsay & Wallpolla Islands – October-December 2018* Report prepared for Mallee CMA. Mildura, Victoria. February 2019
- DELWP (2018) SDL Fish Management Plan – Lindsay Island. Report prepared for the Mallee CMA
- GHD (2016) *Lindsay Island SDL Project, Ecological Assessment*. Final Report. May 2016
- GHD (2014) *SDL Offsets Fauna Survey Lindsay Island*, Report prepared for Mallee CMA. Mildura, Victoria. January 2014
- Australian Ecosystems (2013) *Lindsay Island Flora Census 2013*. Report prepared for Mallee CMA
- GHD (2013) *Preliminary Ecological Investigations and Targeted Regent Parrot Surveys*. Report prepared for Mallee CMA
- Australian Ecosystems (2010). *Lindsay – Wallpolla Frog and Aquatic Vegetation Surveys 2009-2010*. Report prepared for Mallee CMA
- Australian Ecosystems (2010). *An analysis of 2005-2010 waterbird survey data for Lindsay – Wallpolla Islands and Hattah Lakes.* Report prepared for Mallee CMA

Numerous studies have been completed on the native fish communities of the Lindsay Island complex. The Fish Management Plan summarises existing information on the site.

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

1.4 Purpose of this report

The purpose of this report is to present a preliminary assessment of the potential for impacts on flora and fauna values to inform preparation of referrals under the Commonwealth EPBC Act and Victorian EE Act.

In addition this report documents the findings of targeted surveys completed at the proposed construction sites of the Lindsay Island project for threatened flora and fauna species listed under the Commonwealth EPBC Act, Victorian FFG Act and Victorian DELWP threatened species advisory list. The results of these surveys will be used to assist with avoiding and minimising impacts from the proposed construction on these threatened species and to identify the project planning, EPBC and EE Act referrals and planning approval requirements.

In particular, 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 Area of Investigation and Inundation Area (the 'Study Area').
- Summarise the previous ecological assessments undertaken for the project.
- Describe targeted surveys for populations of flora and fauna and communities, listed under the EPBC Act and the FFG Act undertaken by R8 in late 2019 and early 2020.
- Describe the outcomes of field surveys undertaken by R8 in June 2020 to ground-truth vegetation within specific locations within the proposed inundation area that are mapped by DELWP (2005) (modelled extant EVC mapping) as either non-flood dependent vegetation types (e.g. Semi-arid Woodland) or in locations where no EVC data is available, and update EVC mapping in these areas.
- Assess the potential extent of impacts to native vegetation (including large trees) within the proposed Construction Footprint in accordance with the *Guidelines for the removal, destruction or lopping or native vegetation* (DELWP 2017a).
- Determine the likelihood of occurrence of listed threatened flora and fauna species, listed migratory species and listed threatened ecological communities within the Area of Investigation and Inundation Area. Where listed threatened species, migratory species or ecological communities are identified as occurring or having the potential to occur, determine the likely impact on these listed species and ecological communities by the project within the Construction Footprint and Inundation Area in Victoria (during both the construction and operation phases).
- 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).

1.5 Scope of works

The scope of this assessment and report is to:

- Review botanical values (plant species and vegetation communities) within 10 km of the Area of Investigation and Inundation Area (the Study Area).
- Review recorded fauna values (native species and habitat) within 10 km of the Area of Investigation and Inundation Area (the Study Area).
- Determine the likelihood of occurrence of rare or threatened flora and fauna within the Construction Footprint and Inundation Area.
- Conduct targeted surveys for populations of flora and fauna and communities, listed under the EPBC Act and FFG Act within the Area of Investigation.

- Provide an inventory of all observations of threatened flora and fauna recorded during surveys for the project.
- Discuss potential legislative requirements of the proposed works (with respect to terrestrial flora and fauna impacts).
- Identify potential impacts to threatened species by the construction works during the construction and operation phase of the project, and recommend mitigation measures to minimise these impacts.

1.6 Structure of this report

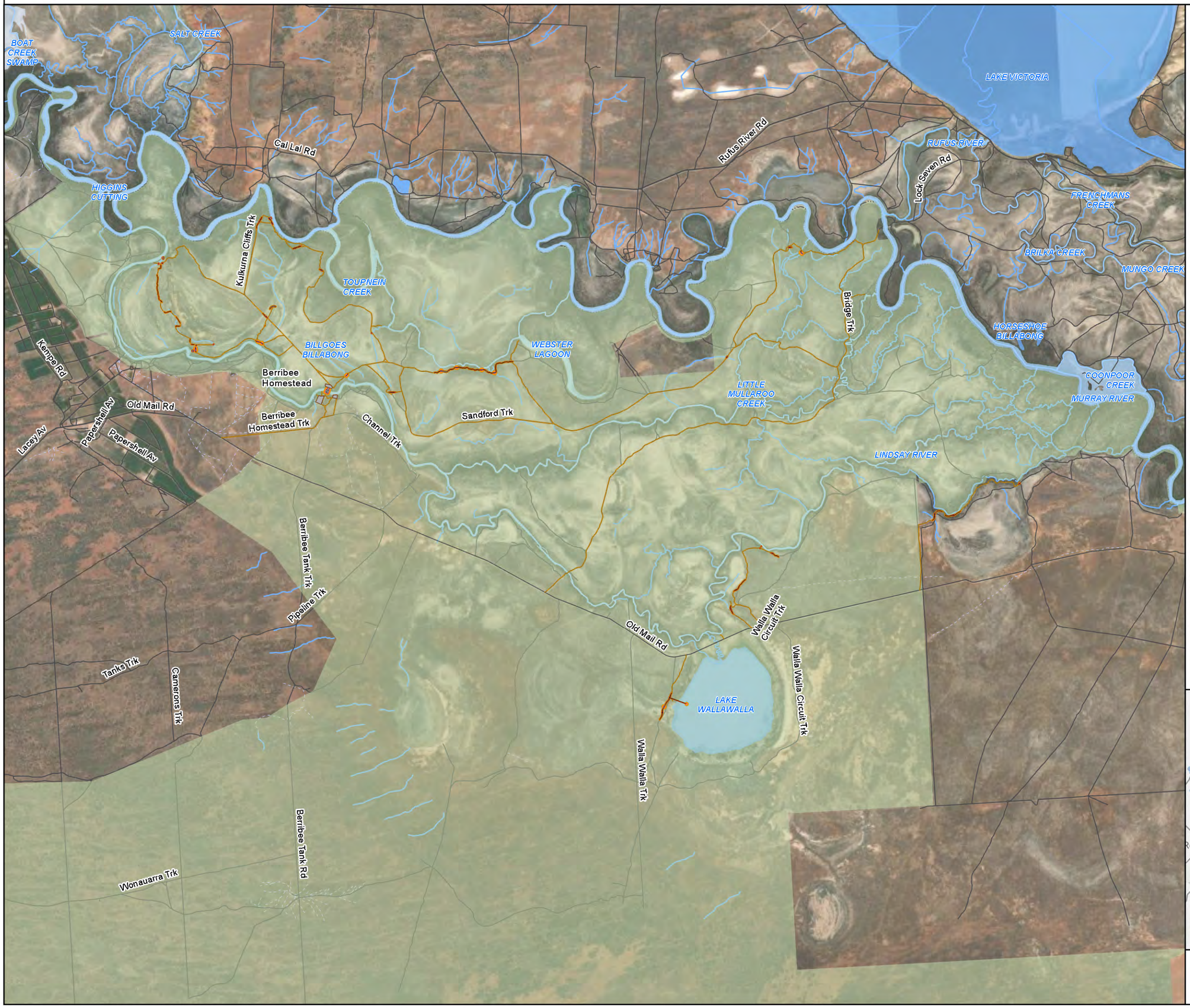
This report is structured as follows:

- Section 1 – provides an overview of the project, identifies previous assessments undertaken and summarises the purpose and scope of work for the report.
- Section 2 – provides a summary of the ecological objectives and benefits associated with environmental watering in order to provide project context.
- Section 3 – presents a description of the project including the location of proposed works, as well as key construction, operational and decommissioning activities.
- Section 4 – describes the desktop and field assessment methods used to inform the impact assessments and recommendations.
- Section 5 – provides an overview of existing ecological conditions and floodplain characteristics.
- Section 6 – describes the results of targeted threatened flora and fauna species surveys undertaken in the areas where works are proposed.
- Section 7 – describes the results of ground-truthing surveys undertaken within the proposed project inundation area.
- Section 8 – provides a summary of potential impacts to flora and fauna during the construction and operational stages of the project.
- Section 9 – assesses the significance of potential impacts to Commonwealth and Victorian listed flora, fauna, communities and wetlands.
- Section 10 – details the anticipated impacts to native vegetation and ecological vegetation classes from project construction and operation.
- Section 11 – provides information on the measures undertaken, or proposed, to avoid, minimise and mitigate impacts to listed flora and fauna species.
- Section 12 – summarises the requirements of relevant Commonwealth and Victorian policy and legislation.
- Section 13 – provides recommendations and outlines the next steps for the project based on the assessment results
- Section 14 – presents the literature reviewed and cited throughout this document.

A number of appendices are provided to this document. These include detailed assessments of the likelihood of occurrence and impact to threatened flora and fauna species, as well as significance assessments for Commonwealth listed flora and fauna species.

Figure 1: Construction Footprint at Lindsay Island

VMFRP



Legend

- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation
- Reserve
- Watercourse
- Flat
- Lake
- River
- Stream
- Drain/Channel/Other
- Arterial
- Collector

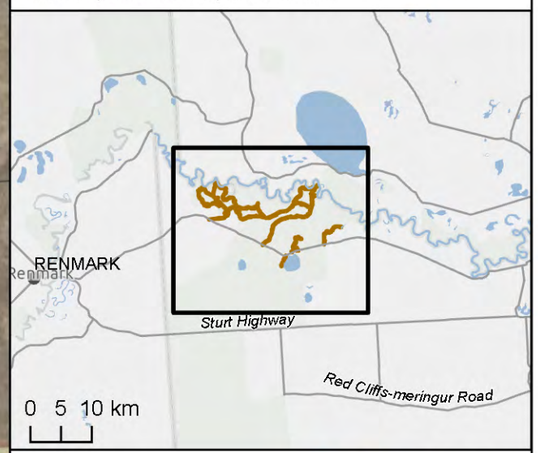
N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 1250 2500
Meters

DATA SOURCES
© Commonwealth of Australia (Geoscience Australia) 2006 Geodata Topo 250k Series 3; Vicmap Data © State of Victoria 2020; GHD 2020.



Path: G:\31\12510225\GIS\Maps\Working\Lindsay_Island\12510225_EcologyFigures_Lindsay\12510225_EcologyFigures_Lindsay.aprx

Figure 2: Inundation extent at Lindsay Island

VMFRP

SALT CREEK
LAKE VICTORIA
Cal Lal Rd
Rufus River Rd
RUFUS RIVER
Lock Seven Rd
HIGGINS CUTTING
MURRAY RIVER
FRENCHMANS CREEK
Kulkurna Cliffs Trk
BRILKA CREEK
MUNGO CREEK
TOUPNEIN CREEK
Bridge Trk
HORSESHOE BILLABONG
BILLCOES BILLABONG
WEBSTER LAGOON
COONPOOR CREEK
LITTLE MULLAROO CREEK
Lacey Av
Old Mail Rd
Papershell Av
Mission Rd
Berribee Homestead Trk
Sandford Trk
Channel Trk
LINDSAY RIVER
Berribee Tank Trk
Pipeline Trk
Old Mail Rd
Walla Walla Circuit Trk
Tanks Trk
Camerons Trk
LAKE WALLAWALLA
Walla Walla Trk
Berribee Tank Rd
Wonauarra Trk

Legend

- Arterial
- Collector road
- River
- Stream
- Drain/Channel/Other
- Watercourse
- Lake
- Inundation Area
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

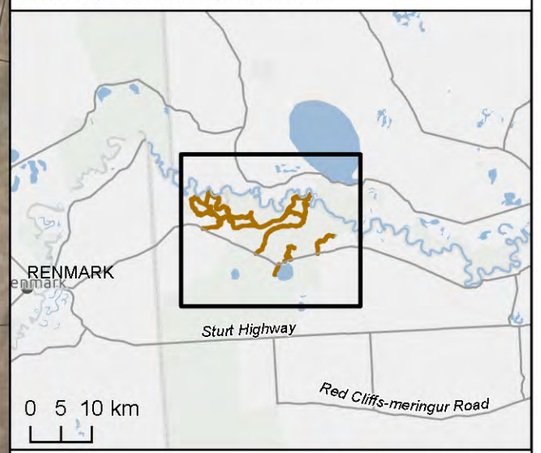
N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 1250 2500
Meters

DATA SOURCES
© Commonwealth of Australia (Geoscience Australia) 2006 Geodata Topo 250k Series 3; Vicmap Data © State of Victoria 2020; GHD 2020.



R8

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2. Project context

2.1 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 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, Kingsford 2000; Kingsford et al. 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.

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 varies between biota. Despite the variability in response, some common themes emerge when the benefits of flooding are examined for different groups of plants and animals:

- **Vegetation:** Hydrological regimes are the major factor responsible for determining the composition, structure, diversity and function of floodplain forest and wetland communities.
- **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.
- **Lignum:** Provides unique floodplain habitat and is dependent on floods for rapid vegetative growth and reproduction.
- **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.

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 (MDBA 2011, DAWE 2013, Moxham et al 2017, Wood et al 2018a).

2.2 Ecological benefits – Lindsay Island

Previous monitoring of the ecological benefits of environmental watering has been completed at Lindsay Island, with environmental watering having been conducted in Lake Wallawalla. Lake Wallawalla is an extension of the Lindsay Island wetlands system and under natural conditions, was periodically fed by the Lindsay River during floods (DENR 1995). On average the lake would fill once every four years and after filling could retain water for a full year (DENR 1995). However, river regulation in the MDB combined with inlet structures changed the frequency, timing and duration of floods that contributed water to the lake (MDBC, 2006). The construction of a regulator funded under The Living Murray program now allows the Mallee CMA to manage flows into areas of Lindsay Island to achieve natural flows.

Recent surveys by GHD (2019) on the Lake Wallawalla aquatic ecosystems and vegetation demonstrated that Lake Wallawalla provides foraging habitat for waterbirds, is utilised by fish for recruitment of fish communities from Lindsay River during periods of connectivity, and that the filling of the lake has promoted substantial recovery of aquatic flora and moisture dependent terrestrial flora, including five species listed as rare or threatened in Victoria (GHD 2019). Previous surveys of ecological values of Lake Wallawalla have identified that when flooded, Lake Wallawalla attracts a regionally significant number of waterbirds (MDBC 2006). The Great Cormorant (*Phalacrocorax carbo*) has been observed breeding in the lake (MDBC 2006) along with important populations of Black Swan (*Cygnus atratus*) and Australian Wood Duck (*Chenonetta jubata*) (DENR 1995). Threatened birds that have been observed include the White-bellied Sea-eagle (*Haliaeetus leucogaster*) and Caspian Tern (*Hydroprogne caspia*), which are both listed under the China– Australia Migratory Bird Agreement (CAMBA) (MDBC 2006). The Great Egret (*Ardea modesta*) and Common Greenshank (*Tringa nebularia*), both listed under both the Japan–Australia Migratory Bird Agreement (JAMBA) and CAMBA, also utilise the lake (MDBC 2006).

Long term investigations of the Lindsay Island environmental watering area have been conducted as part of The Living Murray program from 2007-2018. The park received natural flooding in 2011 and in 2016. The 2017-2018 period received environmental watering to some areas. Following the 2017 monitoring, it was concluded that the overarching ecological objective for Lindsay Island (i.e. “to restore a mosaic of healthy wetland communities”) was being achieved (Wood et al. 2018a).

For some components, e.g. River Red-gum and Black Box, condition rebounded strongly after the breaking of the Millennium drought in 2010-11, and has subsequently been maintained. While responses to floods since then have been more subtle, most likely because the baseline condition is now higher than 2010. Conversely, for other components (e.g. floodplain vegetation, birds and fish), objectives are only partially being met, and there is still work to be done to ensure that these components of the ecosystem are restored so that they meet the benchmark objectives of the program. To summarise, environmental benefits of watering at the Lindsay Island were multiple and included (Bayes et al 2010, Wood et al 2018a):

Vegetation

- Reduction in abundance of plants favouring terrestrial dry habitats (DELWP 2017c) that have colonised the floodplain areas, although this trend was most evident at sites receiving more frequent flooding whereas rarely flooded sites were still dominated by drought tolerant species (Wood et al. 2018a)
- Improved tree canopy cover (and by extension, health) of River Red-gum
- Improved condition of Lignum Swamp
- Improved chance of long-term viability and resilience for flood-dependant species, including threatened species such as Lagoon Nightshade and Lax Flat-sedge

Fish

- Native fish, including Murray Cod, Silver Perch and Golden Perch recruitment within the site

Birds

- High numbers and diversity of water birds within Lake Wallawalla
- Waterbirds make use of environmental watering, and were absent from surveyed wetlands when dry

Amphibians

- Maintenance of breeding population of frogs, including the Growling Grass Frog

The key environmental objectives of the Lindsay Island Project are to restore the environmental functions of this part of the Murray River floodplain, and to restore key indigenous flora and fauna species, communities and habitats through construction of hydrological environments. Specifically, the ecological objectives of the project are to:

- Reduce high threat exotic plant cover
- Maintain plant cover and diversity of target native vegetation groups
- Maintain threatened native flora presence
- Maintain the health of native trees
- Increase native habitat for local populations of fauna by increasing the extent of wetland and riparian vegetation
- Increase the abundance of bats as an indicator species of increased resources resulting from increased floodplain productivity
- Protect and restore mammal populations
- Increase the abundance of reptiles as an indicator species of increased resources resulting from increased floodplain productivity
- Develop seasonal populations of small-bodied native fish
- Maintain local populations of large-bodied native fish
- Maintain migration of medium and small-bodied native fish to maintain populations
- Provide suitable habitat conditions for large-bodied native fish spawning
- Maintain successful breeding for target species of waterbirds
- Provide suitable habitat for thousands of waterbirds
- Develop seasonal populations of native frogs
- Contribute to the carbon requirements of the River Murray channel ecosystem to support system productivity

The Fish Management Plan for the site (DELWP, 2018) also proposed specific ecological objectives for fish, based on an assessment of opportunities that could be realised during operation of the project. The objectives focus on both large-bodied (riverine) and small-bodied native fish:

1. Maintain or improve the hydraulic habitat for Murray Cod and other native fish
2. Utilise Lake Wallawalla as a Golden Perch nursery
3. Restore wetlands that support small-bodied generalist fish

Despite multiple benefits of flooding to a range of biota, altered flow regimes also pose potential risks to the environment and biodiversity, including blackwater events, increased salinity, pest plant and animal proliferation. These risks should be adaptively managed through an Environmental Watering Management Plan and Operating Plan, drawing on experience from previous TLM projects and the outcomes of ecological condition and complementary monitoring programs.

3. Project description

3.1 Overview and works areas

The project is designed to facilitate managed inundation across approximately 4,845 ha of Murray River floodplain within Victoria (and over 200 ha in NSW), comprising six water management areas (WMAs):

- Berribee WMA – Encompasses the Lindsay River east / upstream of the proposed regulator near Berribee Homestead, along with Mullaroo Creek and associated tributaries, Lake Wallawalla and the central parts of the Lindsay River floodplain north to Toupnein Creek (but not including the creek). Includes areas of NSW inundation (approximately 260 ha). Except for Lake Wallawalla, this WMA is located on the northern side of Old Mail Road.
- Crankhandle WMA (upper and lower tiers) – Located on the floodplain in the north west portion of Lindsay Island, north of the Lindsay River and extending to the Murray River, downstream of Berribee Homestead and the Berribee WMA, encompassing Billgoes and Scotties Billabongs.
- Crankhandle West WMA (upper and lower tiers) – Located on the floodplain in the far north west portion of Lindsay Island, north of the Lindsay River but not extending to the Murray River, downstream of the Crankhandle WMA.
- Lindsay South WMA – Located on the floodplain south of the Lindsay River and north of Old Mail Road, connects to the Lindsay South Creek upstream of Wallawalla East WMA, on private land known as Neds Corner.
- Wallawalla East WMA – Located on the floodplain south of the Lindsay River and mostly north of Old Mail Road, connects to the Lindsay River downstream of Lindsay South WMA.
- Wallawalla West WMA – Located on the highest part of the floodplain west of Lake Wallawalla and south of Old Mail Road, connects to the Lindsay River via Lake Wallawalla.

The design and location of all project structures and access track upgrades has not yet been finalised and will be refined through the detailed design process. The final construction footprint for the structures is proposed to be located within the Area of Investigation, utilising recommendations from this report and other specialist studies (including Cultural Heritage) to further refine the design in order to avoid and minimise impacts Therefore, the information in this section is subject to change, and is provided as a basis of assessing the potential impacts of the project during construction and operation to inform referrals under the EE Act and EPBC Act.

3.2 Infrastructure

The project infrastructure within the work areas includes:

Berribee WMA

The Berribee Regulator is the largest structure proposed as a part of the project, and is located on the Lindsay River, downstream of the Berribee Homestead.

- Five, 2.0 m wide combination gate bays to allow a passing flow of 1000 ML/day during managed watering events in accordance with fish passage recommendations by DELWP (2018)
- Seven, 4.9 m wide stoplog bays to provide flow capacity outside of managed watering event periods, including one bay to specifically enable navigable traffic (passing small boats (less than 3.5 m wide), kayaks and canoes)
- A single Vertical Slot Fishway in the south abutment (upper slot and central blockout) in accordance with fish passage recommendations by DELWP (2018)
- A new access track and single lane bridge deck for vehicle access across the regulator
- A 56 m long concrete hardstand for stoplog storage on the northern bank
- Steel rail beams for movement of the rail-mounted excavator required to remove and install stop logs as required

- A secure, 50 m x 50 m compound on the northern bank for storage and operation / maintenance laydown
- Containment banks either side of the regulator

In addition to the Berribee Regulator, six structures are proposed around the northern perimeter of the Berribee WMA to retain water within the WMA as the proposed inundation level is higher than the Murray River downstream of Lock 7, Toupnein Creek and the Crankhandle floodplain at these locations. These six structures comprise combination containment banks and regulators, including

- BERR_B and BERR_C – regulators in these containment banks control movement into floodrunners discharging to the Crankhandle and Crankhandle West WMAs. BERR_B containment bank is 100 m long with a maximum height of 1.4 m and incorporates one 20 m spillway. BERR_C containment bank is 190 m long with a maximum height of 0.9 m and incorporates a 27 m spillway.
- BERR_D – is a 2.2 km long containment bank located along an existing track on the southern bank of Toupnein Creek that is designed to prevent retained environmental floodwaters from breaking into Toupnein Creek. The containment bank has a maximum height of 2.4 m, and incorporates three, 20 m long spillways and passing bays at approx. 250 m intervals. A small regulator is located on a floodrunner to convey flood flows.
- BERR_E and BERR_F – are relatively short containment banks designed to control flow in floodrunners flowing towards the Murray River below Lock 7, conveying flood flows and enabling drawdown of managed inundation events. BERR_E containment bank is 90 m long with a maximum height of 0.8 m and a 27 m long spillway, incorporates a small regulator and is located on an existing track. BERR_F containment bank is 120 m long with a maximum height of 2.7 m and a 10 m long spillway, incorporates a large regulator and is located on an existing track.
- BERR_G – is a 90 m long containment bank with a maximum height of 0.8 m that incorporates an un-gated culvert designed to enable operational access across a waterway on the Sanford Track, while allowing environmental water to enter the short arm of the creek to the west and allowing natural flood flows to pass.

Crankhandle WMA

- CR_A - a single containment bank (240 m long, maximum height 2.7 m, one 20 m long spillway) and large regulator structure to control flows that discharge into the Lindsay River.
- CR_B, CR_C and CR_D - three containment bank and regulator structures located on the north perimeter of the WMA to control flows that interact with the Murray River:
  - CR_B containment bank is 110 m long, with a maximum height 1.6 m and one 20 m long spillway, and incorporates a small regulator.
  - CR_C containment bank is 250 m long, with a maximum height 1.4 m and one 20 m long spillway, and incorporates a small regulator.
  - CR_D containment bank is 220 m long, with a maximum height 1.2 m and one 20 m long spillway, and incorporates a small regulator. As CR_D is located close to the Murray River, a drop structure has been incorporated downstream to minimise erosion. The drop structure extends down the river bank to below the normal operating water level and therefore extends into NSW (Note: Further investigations are being undertaken to determine whether this drop structure is necessary or whether drawdown via CR_A (which discharges into the Lindsay River) provides adequate operational flexibility for the project).
- CR_E - a containment bank (360 m long, maximum height 1.5 m, one 20 m long spillway, passing bays at approx. 250 m intervals) and small regulator structure to control flows discharging to the lower tier.
- CR_F - a small containment bank (25 m long, maximum height 0.9 m, one 20 m long spillway) and small regulator structure at the downstream end of the channel (CR_G) to regulate flows being transferred to the Crankhandle West WMA.
- CR_G - a channel (15 m wide bed width, 1V:3H batters) to provide a more hydraulically efficient connection into the Crankhandle West WMA by lowering a saddle point separating Crankhandle from Crankhandle West to enable a flow of up to 50 ML/day.

- CR_H - a small containment bank (25 m long, maximum height 0.8 m, no spillway) to provide access to the CR_A structure.
- CR_I - a small spillway (20 m long, maximum height 0.3 m) to provide continuity of access to the north east of the Crankhandle wetland complex.

Crankhandle West WMA

- CW_A - a containment bank (300 m long, maximum height 2.6 m, one 20 m long spillway, a short secondary containment bank to block a breakout) and small regulator structure located at the point where the lower tier discharges back into the Lindsay River via a proposed drop structure.
- CW_B1 – a containment bank (140 m long, maximum height 2.7 m, one 20 m long spillway) and large regulator located where natural flood flows either return to the Lindsay River or continue along the Crankhandle West complex, designed to either retain water at the design water level for the upper tier or allow flows to pass into either the lower tier or the Lindsay River via a proposed drop structure.
- CW_B2 - a containment bank (40 m long, maximum height 1.0 m, no spillway) and small regulator structure to regulate flows to the lower tier.
- CW_C – a small containment bank (25 m long) incorporating a short spillway (14 m long) located across a small breakaway to enable water to be retained at the design water level.
- CW_D – seven sections of channel (combined length 1.4 km, 5 m wide, average depth 250 mm, maximum depth 600 mm) to improve hydraulic efficiency through to the lower tier by lowering the invert of high points along the existing flow path to allow the design flow of 30 ML/day.

Lindsay South WMA

- LS_A1 and LS_A2 – two containment banks (combined length 900 m, maximum height 1.6 m, two 20 m spillways, passing bays at approx. 250 m intervals) and small regulator located along the southern bank of the Lindsay South Creek to retain water at the design water level, convey flood flows and release managed floodwaters to the Lindsay South Creek on completion of a managed inundation event.
- LS_B – a containment bank (40 m long, maximum height 1.0 m, no spillway) and small regulator located on a small floodrunner to retain water at the design water level and convey flood flows. The regulator would also be used to convey pumped water from the Lindsay South Creek into the Lindsay South WMA during a managed event.
- LS_C – a pump hardstand (6 m x 6 m crushed rock pad) located adjacent to an existing track near LS_B to enable setup of temporary pumps to pump from the Lindsay South Creek into the Lindsay South WMA.

Wallawalla East WMA

- WE_A – a containment bank (270 m long, maximum height 1.0 m, one 20 m spillway) and small regulator located on a small waterway that is the natural outlet for the wetland area, designed to retain water at the design water level, convey flood flows and release managed floodwaters to the Lindsay River on completion of a managed inundation event.
- WE_B - a containment bank (460 m long, maximum height 0.8 m, one 20 m spillway, passing bays at approx. 250 m intervals) required to prevent breakout flows back to the Lindsay River.
- WE_C – a containment bank (250 m long, maximum height 0.7 m, one 20 m spillway) required to prevent breakout flows back to the Lindsay River.
- WE_D – a pump hardstand (6 m x 6 m crushed rock pad) located adjacent to an existing track to enable setup of temporary pumps to pump from the Lindsay River into the Wallawalla East WMA. A single box culvert would also be installed across the existing track and would be used to convey pumped water into the WMA during a managed event.

Wallawalla West WMA

- WW_A – a containment bank (800 m long, maximum height 2.0 m, one 20 m spillway, passing bays at approx. 250 m intervals) located partly along an existing access track before deviating off track to avoid significant vegetation and cultural heritage on the track alignment. Designed to hold water at the design water level for the WMA, which is higher than the level of Lake Wallawalla (23.2 m AHD) to the east.
- WW_A1 – a small regulator located within the WW_A containment bank on a waterway that is the natural outlet for the WMA area.
- WW_A2 – a small regulator located within the WW_A containment bank that is designed to convey pumped water from the WW_B pump infrastructure into the WMA during a managed event.
- WW_B - pump infrastructure at this site includes a pump hardstand (6 m x 6 m crushed rock pad) located adjacent to an existing access track near Regulator WW_A2, and a permanent sub-surface inlet pipeline extending into Lake Wallawalla, including an inlet sump. An access track may also be required along the pipeline alignment for maintenance of the inlet sump.

Whilst the majority of the design and location of project structures have been confirmed, some additional, generally minor refinements may be required through the design process. Therefore, the information in this section is indicative, but provided as a basis of assessing the potential impacts of the project during construction and operation. Findings from on-site 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 impacts. If any amendments to the Construction Footprint fall outside of the Area of Investigation already assessed, additional surveys will be required and the results would be incorporated in to this report.

Design and construction of the project would need to comply with the mitigation measures outlined in Section 11, and throughout this report.

3.3 Pumping infrastructure

Proposed pump infrastructure includes three temporary pump hardstand areas with associated regulators to convey pumped flows into the Lindsay South WMA, Wallawalla East WMA and the Wallawalla West WMA. The pump hardstand areas would enable the setup of temporary pumping infrastructure to deliver environmental water into these WMAs when required. Temporary pump infrastructure would include a trailer-mounted pump rig with a delivery pipeline, and in the case of the Lindsay South WMA and Wallawalla East WMA, temporary suction pipelines. A permanent suction pipeline would be installed into Lake Wallawalla as part of proposed works at the Wallawalla West WMA.

3.4 Fish passage

The project includes provision for fish passage through regulator bays, across the spillways, and across the containment banks and natural ground when submerged.

The Berribee Regulator provides specifically for fish passage via a vertical slot fishway in the south abutment. The proposed fishway is designed to provide for upstream and downstream passage of small, medium and large fish (30-1400 mm long), along with eggs and larvae, during all hydrological scenarios. The Berribee Regulator design also maintains a 1,000 ML/day passing flow to provide suitable attraction for fish towards the fishway. A review of the Berribee Regulator design by DELWP (2018) determined that the included design features satisfied key fish passage requirements for this location.

The design of all other regulators allows for passive fish passage directly through the regulator structure, but no specific fish passage structures. Medium to small 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 been designed to have flow velocities appropriate for fish passage. During watering events, fish would be able to move across all submerged areas.

3.5 Ancillary components of the project

Boat ramps

To facilitate construction of the Berribee Regulator, an existing boat ramp on the southern bank of the Lindsay River downstream of the proposed regulator is proposed to be upgraded for use during construction and retained for public use following construction. Temporary barge launch/landing facilities would also be required on the northern and southern bank of the Lindsay River, most likely on the downstream side. The exact location of these facilities is yet to be confirmed but are intended to be located in existing disturbed areas within the area of investigation where practicable.

Access tracks and road upgrades

The proposed access arrangements for construction and operation of the project are shown by the Construction Footprint Tracks on **Figure 1** and would involve use of approximately 82 km of existing access tracks and construction of approximately 5 km of new track. The area of investigation provides for a 20 m wide corridor along proposed access tracks for the purpose of desktop investigations. Typical requirements for works along access tracks based on their purpose is summarised in **Table 1**. Provision for the location of standard passing bays would be required along some sections of access tracks. Some refinement of access track locations and extent of required access track works may be required based on the outcomes of geotechnical investigations, cultural heritage assessment and ecological ground-truthing investigations. Where practicable, preference would be given to locating passing bays and track changes in existing disturbed areas and / or other locations to avoid or minimise impacts to environment and heritage values.

Table 1. Summary of access track purpose and indicative works requirements

Type	Purpose	Track / road	Length		Upgrade type	Requirements
1	Operational/maintenance/light construction - dry weather	Track	4.5 km (new) 31.9 km (existing)		Nil	Maintenance of an existing track to provide for construction or operational vehicles Establishment of unformed access for operational vehicles
2	Operational/maintenance/light construction through low lying areas - dry weather	Track	0.5 km (new) 18.5 km (existing)		Moderate	Regrading to create cross fall and match to existing longitudinal drainage with 50 mm wearing course
3	Construction vehicle - dry weather	Track	N/A		Substantial	Regrading to create cross fall and match to existing longitudinal drainage with 200 mm wearing course
4	Heavy construction vehicle - wet weather Operational/maintenance - wet weather	Track	32.5 km (existing)		All weather	Construction of new pavement with 150 mm base course and 200 mm wearing course
5	Public – dry weather Operational/maintenance – dry weather	Road	N/A		Minor	Regrading to create cross fall and match to existing longitudinal drainage

Type	Purpose	Track / road	Length		Upgrade type	Requirements
6	Public – wet weather Operational/maintenance – wet weather	Road	N/A		Substantial	Raising road elevation and reinstatement of road pavement in accordance with relevant authority standards

In addition to the access tracks identified on **Figure 1**, the project would use Old Mail Road for access during construction and operation. Old Mail Road is a dry weather unsealed road typically maintained in fair condition. The road is currently inaccessible in wet conditions. Old Mail Road crosses the entrance to Lake Wallawalla via a causeway having an approximate length of 1.8 km. The length of the causeway is unsealed (except for a short, sealed section at the western end which is designed as a spillway) and has a design surface of approximately 100 mm above the proposed inundation level in Lake Wallawalla. Further investigations are being undertaken to determine whether upgrades to the Wallawalla Causeway and Old Mail Road are required to facilitate the project. The Wallawalla Causeway and Old Mail Road are not currently included in the area of investigation and construction footprint for the project, however any improvement works are expected to be located within existing disturbed areas. Once the Construction Footprint in these areas has been confirmed, ecological surveys will be undertaken and if additional areas of native vegetation or fauna habitat are likely to be impacted then this report will be updated.

Power supply

No new power supply connections are required to facilitate operation of the project. Regulator structures would be operated manually and/or using truck-mounted hydraulic lifting equipment as required. Temporary pump infrastructure would be powered by self-bunded generator and fuel storage imported to the site as required. The potential to use solar power to support any water level or other monitoring requirements is also currently being investigated.

3.6 Key construction activities

Construction of the project is anticipated to require 24 months to complete, including approximately 18 months to complete construction of the Berribee Regulator. General construction activities would include:

- Establishment of construction sites, including removal of vegetation, stripping and stockpiling of topsoil, establishing temporary laydown and access routes
- Installation of cofferdams to enable dewatering of construction excavations / work areas in surface waters or below the water table
- Construction / installation of new structures, including sheet-piling to install seepage cut-offs at the four large regulators (BERR_A (Berribee Regulator), BERR_F, CR_A and CW_B1)
- Rehabilitation of disturbed areas post-construction

Construction would involve use of vehicles and machinery such as trucks, excavators, piling rigs, compaction plant, water carts, cranes and access equipment.

Importation of construction materials, including regulators and imported soils, would comply with Parks Victoria consent under Section 27 of the *National Parks Act 1975* and the *Environment Protection Act 2017* (this was due to commence on 1 July 2020 but has 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 as per Section 11. Once construction of regulators, containment banks and associated works are complete, all waste and spoil would be removed from the sites and disposed of as required by the proposed CEMP.

Specific construction activities include:

Cofferdams and dewatering

Cofferdams are likely to be required at a number of work sites, including those sites located in the Lindsay River (including Berribee Regulator) and Murray River along with other sites where necessary to prevent inundation of the work sites during rainfall or flood flows.

The Berribee Regulator would extend across the full width of the Lindsay River. Design of the Berribee Regulator incorporates a permanent cut-off extending to 6 m below the structure foundation and approximately 16 m laterally past the end of the structure to provide seepage control and protection against piping and heave. These permanent cut-offs installed in the Lindsay River at Berribee Regulator would be constructed by sheet piling using barges and would function as cofferdams during construction of the regulator to enable dewatering of the work areas. It is proposed that the Berribee Regulator would be constructed in multiple stages so that at least a quarter of the width of the Lindsay River would provide for passing flows and fish passage throughout construction of the regulator.

Temporary cofferdams for the drop structures at Regulator CW_A and Regulator CW_B1 on the Lindsay River and Regulator CR_D (if required) on the Murray River would only extend into these waterways as far as necessary to safely and efficiently construct the works. The temporary cofferdams would not extend across the full width of the rivers and would therefore not impact on flow or fish passage while works are being undertaken.

In addition to the temporary cofferdams required for construction works in the Lindsay River and Murray River, temporary cofferdams may also be required at a number of other sites along flow paths where necessary to prevent inundation of the work sites during rainfall or flood flows. Details of the type, location and extent of required cofferdams have yet to be finalised but may include sheet piles and earthen embankments.

Dewatering of work areas, particularly for deeper excavations, is likely to necessitate the disposal of saline groundwater.

Construction laydown areas

The proposed construction footprint includes a working area (approx. 10-20 m) around the development footprint for proposed infrastructure to accommodate movement of vehicles and machinery and some limited storage of equipment and materials.

Three large construction laydown areas are proposed near the Berribee Regulator, two on the southern side of the Lindsay River and one on the northern side of the Lindsay River (to be converted into the permanent storage compound). Following further investigations after defining the current construction footprint, it is unlikely that the project would use the area around Berribee Homestead for construction laydown or other construction purposes. However, potential impacts associated with construction laydown in this area are considered in this report for completeness. The two remaining sites identified near the Berribee Regulator would provide the primary location for site offices, vehicle parking, storage of equipment and materials, etc.

Additional smaller construction laydown areas are likely to be required at other work sites, particularly given the travel distances between many work sites and the primary work site at Berribee Regulator. Where practicable, these additional construction laydown areas would be located within the current construction footprint or existing disturbed areas. Noting that the Berribee Homestead is not likely to be used for construction purposes, there is not expected to be a net increase in the construction footprint associated with any additional laydown areas required at other locations.

Temporary pump stations

Temporary pump stations are expected to be required at a number of locations to supply water for construction purposes including: dust suppression, moisture conditioning of embankment material, inclusion in any site concrete works, washdown of concrete trucks / equipment, and amenities.

VMFRP is in the process of confirming the need and identifying possible temporary pump station sites, with the objective of selecting locations as close as possible to the proposed construction areas, while also avoiding and minimising environmental and heritage impacts. The preferred pump sites will be based at locations immediately adjacent to structure sites or at existing disturbed sites (such as Mullaroo and Webster Lagoon regulators). Once locations are confirmed, necessary assessments would be undertaken, and the permits and approvals required would be sought.

Borrow pits / quarry sites

Construction of the project would require the import of material (clay for banks and rock for roads/tracks). VMFRP is in the process of identifying possible borrow pits to acquire this material, with the objective of selecting locations on private land, as close as possible to the project, while also avoiding and minimising environmental and heritage impacts. As the location of quarry/borrow sites is yet to be confirmed, potential impacts associated with these activities have not yet been assessed, and quarry/borrow sites are not included in the current construction footprint.

Rock (rock beaching for erosion protection works) would be sourced from an existing commercial quarry.

Concrete batching

There will be no requirements for concrete batching on site as a part of the project, all concrete will come from off-site commercial concrete facilities.

3.7 Key operational activities

Inundation of the proposed inundation areas requires to the coordinated operation of the Lock 7 weir pool and the proposed Berribee Regulator. To achieve the design maximum water level at Berribee WMA, the Lock 7 weir pool needs to be raised by up to 1.1 m to provide the necessary driving head of water. All other WMAs are filled from the inundation area of the Berribee WMA either by gravity release (Crankhandle, Crankhandle West) or pumping (Lindsay South, Wallawalla East, Wallawalla West).

Berribee WMA

During filling, all structures bounding the Berribee WMA would be closed. During natural floods, the gates on all Berribee structures would be open, but may be closed at the flood peak to retain water on the floodplain, and possibly provide water for filling (or partially filling) surrounding WMAs depending on ecological objectives. Drawdown following a managed event commences with opening the Berribee Regulator or Lock 7, followed by progressively opening remaining structures to drain remaining floodplain water.

Crankhandle WMA

The Crankhandle WMA would be filled by controlled releases from the Berribee WMA via Regulators BERR_B. During filling, the structures around the Crankhandle WMA would be closed, with inflows continuing for the planned watering duration to maintain the inundation at the target level. Inflows to the Berribee WMA would need to be sufficient to fill the Crankhandle WMA, as well as to maintain the inundation level in the Berribee WMA. CR_E is used to transfer water from the Upper Tier to the Lower Tier (Scotties Billabong). Managed floodwaters from the Crankhandle WMA Lower Tier are retained in the WMA and are not returned to the Murray River.

Crankhandle West WMA

The Crankhandle West WMA would be filled by controlled releases from the Crankhandle WMA via Regulator CR_F. During filling, the structures around the Crankhandle West WMA would be closed, with inflows continuing for the planned watering duration to maintain the inundation at the target level. Inflows to the Berribee WMA would need to be sufficient to fill the Crankhandle West WMA, as well as to maintain the inundation level in the Berribee WMA and the Crankhandle WMA CW_B2 is used to transfer water from the Upper Tier to the Lower Tier (via Channel CW_D).

Lindsay South WMA

Managed inundation of this WMA is achieved via pumping from the Lindsay South Creek which would only occur in conjunction with operation of the Berribee Regulator. During filling, the LS_A and LS_B structures would be closed, with pumped inflows continuing for the planned watering duration to maintain inundation at the target level.

Wallawalla East WMA

Managed inundation of this WMA is achieved via pumping from the Lindsay River which would only occur in conjunction with operation of the Berribee Regulator. During filling, the WE_A structure would be closed, with pumped inflows continuing for the planned watering duration to maintain inundation at the target level.

Wallawalla West WMA

Managed inundation of this WMA is achieved via pumping from Lake Wallawalla which would only occur in conjunction with operation of the Berribee Regulator and the filling of Lake Wallawalla. During filling, the WW_A1 and WW_A2 structures would be closed with pumped inflows continuing for the planned watering duration to maintain inundation at the target level. Managed floodwaters would be retained in the WMA and not returned to Lake Wallawalla following a managed event.

A summary of the draft operating scenarios is provided in **Table 2** and in conjunction with the proposed inundation areas, have provided the basis for assessing potential operational impacts described in this assessment. Further assessment and refinement of the draft operating scenarios is proposed to further avoid or mitigate potential impacts, including those described in this assessment, while maximising ecological benefits to vegetation communities and listed threatened species.

Table 2 Summary of proposed inundation for each water management area *

Water management area	Proposed frequency	Proposed duration	Proposed timing	Maximum interval between events	Water regime class
Seasonal Fresh	Annual	3 months	September to December	1 year	Watercourses
Berribee – Intermediate (22.1 mAHD to 23.1 m AHD) (Flood Capture or Regulated)	4 in 10 years (excludes Berribee - Maximum)	Maintain at target water level for 2 months (for 1 event) and 4.5 months (for 3 events). After two months, drawdown water levels to Crankhandle WMA or the Lindsay River. Close Wallawalla Regulators when receding below 22.35 mAHD to retain water in Lake Wallawalla and allow to fall through evaporation and seepage.	June to February	3 years	Semi-permanent Wetlands Temporary Wetlands
Berribee – Maximum (23.2 mAHD) (Flood Capture or Regulated)	3 in 10 years	Maintain at target water level for two months. After two months, drawdown water levels to Crankhandle WMA or the Lindsay River. Close Wallawalla Regulators when receding below 22.35 mAHD to retain water in Lake Wallawalla and allow to fall through evaporation and seepage.	June to February	7.5 years	Semi-permanent Wetlands Temporary Wetland Red Gum Forest and Woodland Black Box Woodland Alluvial Plain

Water management area	Proposed frequency	Proposed duration	Proposed timing	Maximum interval between events	Water regime class
Crankhandle (Upper - 22.6 mAHD Lower – 21.6 mAHD) (Flood Capture or Regulated)	5 in 10 years	Maintain at target water level for 2.5 months, then drawdown water levels in Crankhandle (Upper Tier) to Crankhandle West WMA or Lindsay River. Water is retained in Crankhandle (Lower Tier) and allowed to fall through evaporation and seepage.	June to February	5 years	Temporary Wetlands Red Gum Forest and Woodland Lignum Shrubland and Woodland Black Box Woodland Alluvial Plain
Crankhandle West (Upper – 22.2 mAHD Lower – 21.7 mAHD) (Flood Capture or Regulated)	5 in 10 years	Maintain at target water level for 2.5 months, then drawdown water levels to Lindsay River.	June to February	5 years	Temporary Wetlands Red Gum Forest and Woodland Lignum Shrubland and Woodland Black Box Woodland Alluvial Plain
Wallawalla East (25.2 mAHD) (Flood Capture or Pumped)	2 in 10 years	Maintain at target water level for one month, then drawdown water levels to the Lindsay River.	September to February	15 years	Black Box Woodland Alluvial Plain
Lindsay South (24.4 mAHD) (Flood Capture or Pumped)	2 in 10 years	Maintain at target water level for one month, then drawdown water levels to the Lindsay South Creek.	September to February	15 years	Black Box Woodland Alluvial Plain
Wallawalla West (24.7 mAHD) (Flood Capture or Pumped)	2 in 10 years	Maintain at target water level for one month, then allow to fall through evaporation and seepage.	September to February	15 years	Black Box Woodland Alluvial Plain
Seasonal Fresh	Annual	Three months	September to December	1 year	Watercourses

*Note that further assessment is proposed to inform refinement of the operating regime and development of monitoring, evaluation and reporting requirements to support adaptive management of the site. Consideration of recommendations provided in the Lindsay Island Fish Management Plan (DELWP, 2018) will be included in this refinement process.

3.8 Key decommissioning activities

No redundant structures have been identified as requiring to be removed or decommissioned.

The design life of the structures is 100 years. If the structures are no longer required at the end of life, all structures would be removed to a practical extent from the site by the operator, and the area rehabilitated to the satisfaction of Parks Victoria, and to Neds Corner (Trust for Nature) where structures works are proposed on land they manage.

4. Methods

4.1 Desktop assessment

A review of available biodiversity databases was undertaken to identify terrestrial flora, and terrestrial and aquatic fauna with potential to occur in 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 (modelled vegetation for Inundation Areas and/or field assessed vegetation for the Area of Investigation).

The following databases and reports were used:

- Protected Matters Search Tool (PMST) for the EPBC Act, maintained by DAWE[2]
- Weeds of National Significance database[3]
- Victorian Biodiversity Atlas (VBA), maintained by DELWP[4]
- NatureKit, which provides GIS mapping, maintained by DELWP[5,] including modelled mapping of extant (2005) and pre-1750 Ecological Vegetation Classes (EVCs), Current Wetlands, Location Category mapping and known threatened species records
- Native Vegetation Information Management tool (NVIM), maintained by DELWP[6]
- NSW State Vegetation Type Mapping (SVTM) (Western Region)[7]
- NSW BioNet-Atlas database, maintained by NSW Department of Planning, Industry and Environment (DPIE)[8]
- eBird, An online database of bird distribution and abundance [web application]. eBird, Cornell Lab of Ornithology, Ithaca, New York.[9]
- Australian Ecosystems (2013) *Lindsay Island Flora Census 2013*. Report prepared for the Mallee Catchment Management Authority
- GHD (2014) *SDL Offsets Fauna Survey Lindsay Island*. Report prepared by GHD for Mallee CMA. Mildura, Victoria. January 2014
- GHD (2016) *Lindsay Island SDL Project, Ecological Assessment*. Final Report. May 2016
- GHD (2019) *Floodplain Bat Study. Lindsay & Wallpolla Islands – October-December 2018*. Report prepared by GHD for Mallee CMA. Mildura, Victoria. February 2019
- R8 2020b Desktop Groundwater Report. Draft report prepared for Lower Murray Urban and Rural Water Corporation. July 2020

A VBA and PMST search was undertaken for a 10 km radius around the Area of Investigation and Inundation Area.

4.1.1 Inundation Area mapping and impact assessment

The potential impact on native vegetation within the Inundation Area (in Victoria) has been considered using:

- DELWP's modelled EVC mapping
- Rare and threatened species based on VBA records

[2] http://www.environment.gov.au/epbc/protected-matters-search-tool (accessed on 18/09/2019)
[3] http://www.environment.gov.au/biodiversity/invasive/weeds/weeds/lists/wons.html (accessed 09/01/2020)
[4] https://www.environment.vic.gov.au/biodiversity/victorian-biodiversity-atlas (accessed on 17/09/2019)
[5] http://maps.biodiversity.vic.gov.au/viewer/?viewer=NatureKit (last accessed by GHD November 2019)
[6] https://nvim.delwp.vic.gov.au/ (accessed on 09/01/2020)
[7] https://geo.seed.nsw.gov.au/Public_Viewer/index.html?viewer=Public_Viewer&locale=en-AU&runWorkflow=AppendLayerCatalog&CatalogLayer=SEED_Catalog.245.NSW%20Formations.SEED_Catalog.245.NSW%20Classes.SEED_Catalog.245.Labels.SEED_Catalog.245.Plant%20Community%20Type (accessed 7/07/2020)
[8] http://www.bionet.nsw.gov.au/ (accessed Juen 2020)
[99] https://ebird.org/home (accessed June 2020)

An assessment was then undertaken to determine whether species are considered likely to occur within the modelled vegetation communities. If it was considered possible that a flora or fauna species may occur within the Inundation Area, an assessment has been made on whether any impacts are likely to be positive, neutral or detrimental. The EVCs that are modelled to occur within the proposed Inundation Area are also shown in **Figure 3**.

Whilst the operating regime for the project has not yet been finalised, it is intended to replicate a more natural flooding regime and to therefore improve the quality of floodplain vegetation and habitat across the 4,845 ha Inundation Area targeted for restoration in Victoria. The assessment of potential impacts on native vegetation and listed threatened species in the inundation area presented in this report is preliminary only, and based on the assumption that the proposed frequency, duration and timing of managed inundation for each EVC / water regime class will more closely align with the frequency, duration and timing of flooding experienced by each EVC/ water regime class under natural conditions. Further assessment will need to be carried out of ecological benefits, as well as potential impacts and strategies to avoid or mitigate these, to inform the final operating regime and development of monitoring, evaluation and reporting requirements to support adaptive management.

The Inundation Area extends in to NSW across approximately 260 ha, this area encompasses the Murray River, 129 ha of modelled native vegetation and areas of no native vegetation. A detailed assessment of these areas was outside of the scope for this assessment, however a desktop overview was undertaken using the NSW State Vegetation Type Mapping (SVTM) (Western Region)[10] to identify the communities modelled to be present.

4.2 Field assessments

The results of a number of field assessments have been incorporated into this report, and a description of the methods for each of these is outlined below. A summary of methods used for field assessments undertaken as part of previous ecological studies is provided in Appendix A.

4.2.1 Vegetation Condition Assessment

4.2.1.1 Vegetation Quality Assessment (Habitat Hectares) - Construction Footprint

A site assessment was undertaken in late 2015 for the proposed Construction Footprint current at that time as well as a 16 m buffer along existing access tracks (8 m either side of centreline) and included:

- Mapping the extent and condition of native vegetation present within the proposed Construction Footprints 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 fauna and threatened flora 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.

[10] https://geo.seed.nsw.gov.au/Public_Viewer/index.html?viewer=Public_Viewer&locale=en-AU&runWorkflow=AppendLayerCatalog&CatalogLayer=SEED_Catalog.245.NSW%20Formations,SEED_Catalog.245.NSW%20Classes,SEED_Catalog.245.Labels,SEED_Catalog.245.Plant%20Community%20Type (accessed 7/07/2020)

It is noted that Habitat Hectare assessments were undertaken at the time of the fieldwork in 2015 using the Construction Footprint that was current at the time (GHD 2016). Due to changes in the Construction Footprint since the 2015 survey and again since the 2019 R8 surveys of the updated Construction Footprint, some areas of native vegetation proposed to be impacted have not yet been assessed, however modelled data has been used to fill these gaps. The results of the Habitat Hectare assessments are presented in Appendix K. The gaps in mapped vegetation includes a new section of track, approximately 5 km in length that has been accounted for with DELWP modelled condition data. Once the design and Construction Footprint has been finalised, a Vegetation Quality Assessment (Habitat Hectares) will be undertaken in these areas to confirm the condition and extent of native vegetation within the Construction Footprint, and the results of these assessments will be incorporated into an updated version of this report.

4.2.2 Targeted ground-truthing for non-flood dependent EVCs - Inundation Area

Field surveys were undertaken on 17 June 2020 by R8 Botanist Greg Cranston and Ecologist Shelley Thompson. The fieldwork was undertaken after a desktop review to identify locations within the proposed Inundation Area that contained modelled vegetation mapping (DELWP 2005) indicating the presence of non-flood dependent ecosystems (Semi-arid Woodland (EVC 97) (2.24 ha) and Semi-arid Chenopod Woodland (EVC 98) (19.14 ha)) and areas where there was no modelled EVC data (270.22 ha).

Most of the areas where modelled EVC data was not available (approximately 260 ha) were located in NSW. About half of this area in NSW is located within the Murray River and its tributaries, and has therefore been classified as waterbodies. For the remaining area in NSW (approximately 129 ha), a desktop review using NSW State Vegetation Type Mapping (SVTM) (Western Region)[11] was undertaken to identify vegetation communities modelled to occur in these areas. No ground-truthing field surveys have been undertaken for vegetation in NSW inundation areas. Approximately 8.52 ha of the area where modelled EVC data was not available occurred in areas of vegetation in Victoria.

Field survey were undertaken in areas of vegetation modelled as containing non-flood dependent ecosystems and areas of vegetation in Victoria where modelled EVC data was not available. These areas were dispersed throughout the Inundation Area in Victoria, across 14 discrete locations (individual points or clusters of points) (see **Figure 6**). These areas were accessed on foot, and a determination was made of the EVC present in each of these intercept areas, and photos were taken of each location and the correct EVC mapped. The purpose of this targeted field assessment was to determine presence or absence of non-flood dependent ecosystems and did not include a Vegetation Quality Assessment, which is likely to be undertaken to inform the project's native vegetation offset management strategy and/or as part of monitoring undertaken as part the project's monitoring and evaluation framework currently being developed.

The results of targeted ground-truthing in Inundation Areas are shown on **Figure 7** and discussed in Section 7. The potential impact on native vegetation within the Inundation Area has been considered using the results of the ground-truthing vegetation mapping assessment (see **Figure 7**) and DELWP modelled EVCs. The potential impact on rare and threatened species within the Inundation Area has been based on VBA records and an assessment of whether species are likely to occur within the known or modelled EVCs to be inundated, and whether any impact is likely to be positive, neutral or detrimental.

4.2.3 Targeted threatened flora assessments

Field surveys were undertaken on 21-25 October 2019 by R8 Senior Botanist (Tim Wills) and Botanist (Greg Cranston). Field surveys were undertaken in the Construction Footprint and adjacent areas, including targeted surveys for rare or threatened flora (EPBC Act, FFG Act and DELWP Advisory listed threatened flora), to update the results of assessments undertaken in the original Construction Footprint assessed previously (GHD 2016).

The surveys involved two field staff walking parallel linear transects 10 m apart over the extent of the Construction Footprint and adjacent areas, 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. Targeted threatened flora assessments along existing access tracks were undertaken from a slow moving car, with threatened flora species observed again GPS marked and details recorded.

[11] https://geo.seed.nsw.gov.au/Public_Viewer/index.html?viewer=Public_Viewer&locale=en-AU&runWorkflow=AppendLayerCatalog&CatalogLayer=SEED_Catalog.245.NSW%20Formations,SEED_Catalog.245.NSW%20Classes,SEED_Catalog.245.Labels,SEED_Catalog.245.Plant%20Community%20Type (accessed 7/07/2020)

The location of threatened flora recorded during these surveys was then combined with records of threatened flora recorded during previous surveys (GHD 2016) to produce consolidated mapping of threatened flora records within and nearby to proposed construction areas (**Figure 4**). The results of the threatened flora assessment are discussed in Section 6.

4.2.4 Flora species

During the 2015 surveys, an inventory of both native and non-native flora incidentally recorded in the Construction Footprints at each site, together with conservation status, origin and weed status was compiled (Appendix A) (GHD 2016). Observations were recorded of existing or potential threats, impacts and management requirements that may arise during construction. These inventories were combined with an inventory of native and non-native flora incidentally recorded during the R8 surveys in 2019/2020 to compile the consolidated flora survey inventory provided in Appendix B.

4.2.5 Targeted threatened fauna assessments

Field surveys were undertaken on 23 October 2019, 14, 18, 22 November 2019 and 15 January 2020 by R8 Senior Zoologists Alex Holmes, Dan Eyles, Dr Richard Retallick and Ecologist Shelley Thompson. The surveys were conducted within the proposed Construction Footprints and adjacent areas to confirm the condition and extent of fauna habitats and to conduct targeted surveys for threatened fauna known to occur in the Construction Footprints and broader area (Wildlife Profiles 2006, Australian Ecosystems 2010, Australian Ecosystems 2011, Wildlife Profiles 2011, Australian Ecosystems 2013, GHD 2014, GHD 2016, MDFRC 2016a, and GHD 2019). Particular focus was given to the eastern subspecies of Regent Parrot (*Polytelis anthopeplus monarchoides*) and Growling Grass Frog (*Litoria raniformis*) which are known from Lindsay Island, and have been recorded at one or more of the Construction Footprints previously, and are both listed as Vulnerable under both the EPBC Act and FFG Act.

A search of the VBA and PMST indicated that 64 threatened fauna species are either known or are predicted to occur within the Study Area. Of the 64 species, 39 terrestrial species were considered to have the potential to occur in the Construction Footprints and/or Inundation Area based on habitat requirements and the number and period since last recorded (Appendix D). These 39 terrestrial species made up the target threatened species list for the field surveys and include Major Mitchell's Cockatoo (*Lophochroa leadbeateri*), Painted Honeyeater (*Grantiella picta*), Regent Parrot (*Polytelis anthopeplus monarchoides*), Growling Grass Frog (*Litoria raniformis*), Carpet Python (*Morelia spilota metcalfei*), Giles' Planigale (*Planigale gilesi*) and other threatened mammals, birds, and reptiles listed in **Table 3** and Appendix D.

The surveys included:

- Targeted surveys for the Regent Parrot and its potential breeding habitat, including using the prescribed Two Hour Point Survey (THPS) technique in areas of suitable habitat.
- Recording all identified fauna, and their observed behaviour (e.g. feeding, roosting, breeding), abundance and conservation status.
- Recording and identifying pest fauna posing a threat to native vegetation and/or fauna.
- Active searching of appropriate habitats (logs, tree hollows, tussocks, deep litter etc.) and food plants (i.e. fruit and/or nectar bearing) for mammals, birds, reptiles and frogs and habitat assessments for threatened fauna.
- Assessments of potentially suitable habitat for threatened fauna.
- Migratory terrestrial or migratory wetland species were considered as part of this assessment.

Survey methods and effort, and species targeted are summarised below in **Table 3**. It should also be noted that methods described in '*Survey guidelines for Australia's threatened birds, Guidelines for detecting birds listed as threatened under the Environment Protection and Biodiversity Conservation Act 1999*' (Department of the Environment, Water, Heritage and the Arts 2010), '*Survey guidelines for Australia's threatened mammals: Guidelines for detecting mammals listed as threatened under the EPBC Act* (Department of the Environment, Water, Heritage and the Arts 2011)', '*Survey guidelines for Australia's threatened reptiles: Guidelines for detecting reptiles listed as threatened under the EPBC Act* (Department of Sustainability, Environment, Water, Population and Communities 2011)' and '*Survey guidelines for Australia's threatened frogs: Guidelines for detecting frogs listed as threatened under the EPBC Act* (Department of the Environment, Water, Heritage and the Arts 2010)' were consulted and employed for all targeted threatened species surveys.

Table 3 Summary of survey methods and effort employed for Lindsay Island fauna survey

Survey Type	Survey Effort	Species targeted
Habitat assessment	Conducted over approximately 2-3 person-hours per site, investigating Construction Footprints through various survey methods.	All
Regent Parrot Two-Hour Point Survey (THPS)	Targeting Construction Footprints with potential habitat of large River Red-gum with hollows (Sites – Berribee regulator (Berr_A), Toupnein Creek containment bank (Berr_D), Little Mullaroo West regulator (Berr_E) and Little Mullaroo regulator (Berr_F) with 32 separate Two-Hour Point Counts to detect Regent Parrot breeding activity.	Regent Parrot
Bird Surveys	At least 2 x 20 minute, 2 ha diurnal surveys at each Construction Footprint (two ecologists distributed across sites undertaking survey concurrently). Approximately 25 surveys undertaken.	All threatened birds but particularly: Apostlebird, Black Falcon, Grey-crowned Babbler, Hooded Robin, Major Mitchell's Cockatoo, Painted Honeyeater, Regent Parrot, White-bellied sea-eagle and threatened waterbirds.
Active searches	Conducted opportunistically by two ecologists concurrently at each Construction Footprint for a period of 30-60 mins. Approximately 26 surveys conducted.	Carpet Python, Growling Grass Frog and all threatened species.
Nocturnal active searches	Conducted opportunistically by two to four ecologists concurrently at Construction Footprint for a period of 20-40 mins. Approximately 26 surveys conducted.	Carpet Python, Growling Grass Frog, Barking Owl, Bush-stone Curlew and all threatened species.

Survey Type	Survey Effort	Species targeted
Scat / hair / bone / skin / pellet analysis	Assessed / collected opportunistically.	All
Opportunistic observations	Two to three ecologists over the entire survey period, including four 8-hour days to Construction Footprints inside of park. Minimum of 75 person-hours of opportunistic observation.	All

The results of the threatened fauna assessments are discussed in Section 6.

Regent Parrot targeted nest surveys

The Regent Parrot is listed as threatened under the FFG Act and as Vulnerable under the EPBC Act. The Regent Parrot is a highly mobile species which typically nests within suitable hollows of River Red-gum, with the male initially travelling up to 20 km to forage within Mallee habitats, returning to feed the female (when incubating eggs) and later the nestlings. There are records of this species from across much of the Lindsay Island Project Area, including at a number of the Construction Footprints. Breeding activity has only been confirmed on two occasions within the Project Area, both close to Lock 7 (potentially the same birds in the same tree) in 1983 and 1984 (VBA).

Potential Regent Parrot breeding habitat was identified close to four proposed Construction Footprints - Berribee regulator (Berr_A), Toupnein Creek containment bank (Berr_D), Little Mullaroo West regulator (Berr_E) and Little Mullaroo regulator (Berr_F). These areas were all subsequently targeted for further investigation with targeted Regent Parrot nest surveys completed using a well-established method for this species.

Surveys were completed on 23 October and 14, 18 and 22 November 2019, using the THPS technique adapted from GHD (2009; 2017; 2018) and Robertson and Hurley (2010). Surveys were undertaken by two ecologists experienced in Regent Parrot survey and behaviour. The survey techniques are specific to the detection of Regent Parrot nesting activity and were developed and refined with the Living Murray Hattah Lakes Floodplain Management Project in recent years.

Surveys were completed at observation points across each of the four Construction Footprints where suitable habitat has been identified for Regent Parrot nesting (Berribee regulator (Berr_A), Toupnein Creek containment bank (Berr_D), Little Mullaroo West regulator (Berr_E) and Little Mullaroo regulator (Berr_F)). At least four THPS were completed at each Construction Footprint containing potential nesting habitat (large old River Red-gums) during the survey period. THPS are an effective technique to locate and confirm Regent Parrot nests. The technique was developed by GHD (2009) (One Hour Point Survey) and later tested and modified by Robertson and Hurley (2010) and involves experienced observers stationed quietly for two hours at each observation point. The locations of the THPS were selected so as to effectively cover all of the proposed Construction Footprint and its immediate surrounds of the Berribee regulator (Berr_A), Toupnein Creek containment bank (Berr_D), Little Mullaroo West regulator (Berr_E) and Little Mullaroo regulator (Berr_F), all areas considered to have potential Regent Parrot breeding habitat.

During the THPS, the observer closely observes the trees and records all Regent Parrot activity in the immediate vicinity. During a THPS, the following information was documented as a minimum:

- Start and finish time
- Location (confirmed using GPS)
- Observer Name/s and number of observers
- Weather details
- Details of Regent Parrot activity

The priority was to record any behaviour that is most closely associated with Regent Parrot breeding activity, including:

- Use of hollows by male and/or female birds
- Adults feeding nestlings
- Copulation between individuals
- Hollow inspection
- Males feeding females
- Defending a tree or hollow by a pair of birds

Suspected breeding activity is documented and the position recorded using a handheld GPS. Nests are listed as 'confirmed' only using the strict criteria outlined below. Some behaviours described above are deemed insufficient on their own to 'confirm' nesting activity, they are indicative that nesting is likely to be occurring. These surveys were completed at an ideal time, in the mid-to late period of the breeding season for Regent Parrot, when activity is likely to be at its peak with adult birds regularly feeding chicks and some birds beginning to fledge.

Criteria used to confirm an active Regent Parrot nest

The criteria used to confirm that a hollow contains an active Regent Parrot nest are similar to those used and described previously by Webster and Belcher (2008) with later explanations provided from GHD (2009). Nesting is therefore said to be **confirmed** if any **one** or more of the following was recorded:

A male Regent Parrot is observed entering and/or leaving a hollow

Evidence indicating the presence of breeding can be confirmed by observing a male perched in a potential nest tree softly calling to a female who then emerges from a hollow and subsequently is fed by the male. Alternatively, observing a male escorting a female to a tree and the female entering a hollow and remaining inside after the male leaves the area is strong evidence of an active nest. Conclusive proof of nesting can be provided by direct observation of the hollow chamber revealing eggs or nestlings or observing nestlings at the entrance to a hollow.

A pair of Regent Parrots is observed entering and/or leaving a hollow

A pair of Regent Parrots observed aggressively defending a tree could potentially be defending a nest hollow. Observations suggest that the pair may perch near the nest hollow and defend the area from other birds / pairs of birds when these birds perch too closely. The defending pair of birds will sometimes perch in a nearby tree, but often appear to return to the same tree particularly when other birds approach. Close observation of these birds may eventually result in the observation of one or both birds attending the nest, although aggressive behaviour on its own is not sufficient to confirm an active nest.

Later in the breeding season both male and female Regent Parrots may leave the nest to forage prior to returning to feed their nestlings. The parents may feed the nestlings by briefly (5 -10 seconds) dipping their foreparts into the nest to feed the nestlings, which are often heard begging in between feeds.

A female is observed entering a hollow after being fed by a male

A female Regent Parrot that has been observed within a tree hollow (i.e. clearly visible and present within the hollow without leaving) for the duration of a THPS on at least two separate occasions could be deemed as occupying an active nest. It is considered highly unlikely that a female would be present within a hollow for a prolonged period of time unless she were brooding eggs / nestlings.

Nestlings are heard begging after an adult bird enters a hollow or is observed at the nest entrance.

Timing of surveys

Surveys should be undertaken during the breeding season for Regent Parrots (within the period of September to January, inclusive), with a preference for October through December, depending on seasonal conditions such as winter/spring rainfall. These surveys were completed through October and November which are suitable times for survey as per the DAWE guidelines (DEWHA 2010).

Regent Parrot activity appears to be reduced during the middle (warmer) part of the day, therefore it is preferable to perform THPS from the early morning (sunrise) until no later than midday (or 11:00 am on hotter days). Temperatures during these surveys were mild throughout.

Field Equipment

The following field equipment was used for Regent Parrot surveys:

- Good quality binoculars for making detailed observations, determining sex of birds and checking for activity within nest hollows
- Global Positioning System (GPS) for recording the coordinates of nest trees and bird observations
- Compass for recording flight direction of birds
- Camera – both compact digital with wide angle and telephoto capability (for photographs of nest trees), and an SLR with high quality telephoto lens (for photographs of Regent Parrots)

4.3 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 fauna and flora data collected during the surveys are submitted to the Atlas of Victorian Wildlife database and the Victorian Biodiversity Atlas (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.

4.4 Nomenclature

4.4.1 Flora

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).

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 cover12 is native.
- Any area with three or more native canopy trees13 where the drip line14 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 (available on DELWP online mapping tools).

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).
- 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.

4.4.2 Vegetation communities

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

Other vegetation types that may occur in Victoria include flora communities listed as threatened under the EPBC Act and/or the FFG Act. These have separate vegetation classification systems, each of which is also separate to the EVC classification system. As such, any single patch of native vegetation occurring within 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.

4.4.3 Tree Protection Zones (TPZs)

In addition to the native vegetation patches, trees are present outside of the Construction Footprint that could be impacted indirectly through encroachment of their Tree Protection Zones[15] (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 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 are calculated by recording the DBH of a tree at 1.4 m (and for multi-stemmed trees such as Mallee Eucalypts, the TPZ is determined by combining the DBH measurements of each individual stem). A second DBH measurement at 1.3 m is also required to determine the size class of a tree (under the Guidelines).

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

13 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.

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

[15] 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)

4.4.4 Fauna species and communities

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

Fauna conservation significance was determined in accordance with the Commonwealth EPBC Act, Victorian FFG Act and DELWP's Advisory Lists (DSE 2009; DSE 2013).

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 Study Area are only considered if they are listed under one or more of these Acts.

4.4.5 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 Project Area was created. This includes environmental weeds, noxious weeds listed under the *Catchment and Land Protection Act 1994* and Weeds of National Significance. All such weed species are listed in Appendix A and Appendix B.

Figure 3: Lindsay Floodplain Restoration Project - Ecological Vegetation Classes within inundation Area

VMFRP

Ecological Vegetation Classes

- 102 Low Chenopod Shrubland
- 103 Riverine Chenopod Woodland
- 104 Lignum Swamp
- 106 Grassy Riverine Forest
- 107 Lake Bed Herbland
- 158 Chenopod Mallee
- 200 Shallow Freshwater Marsh
- 806 Alluvial Plains Semi-arid Grassland
- 807 Disused Floodway Shrubby Herbland
- 808 Lignum Shrubland
- 810 Floodway Pond Herbland
- 811 Grassy Riverine Forest/Floodway Pond Herbland Complex
- 813 Intermittent Swampy Woodland
- 818 Shrubby Riverine Woodland
- 820 Sub-saline Depression Shrubland
- 823 Lignum Swampy Woodland
- 86 Woorinen Sands Mallee
- 97 Semi-arid Woodland
- 98 Semi-arid Chenopod Woodland
- 992 Water Body - Fresh
- 993 Bare Rock/Ground
- 824 Woorinen Mallee

Legend

- Arterial
- Collector
- River
- Stream
- Drain/Channel/Other
- Area of Investigation
- Inundation Area

Cal Lal Rd
Kulkuma Cliffs Trk
Old Mail Rd
Mission Rd
Papershell Av
Berribee Homestead Trk
Sandford Trk
Bridge Trk
Channel Trk
Berribee Tank Trk
Pipeline Trk
Old Mail Rd
Walla Walla Circuit Trk
Walla Walla Circuit Trk
Walla Walla Trk
Tanks Trk
Camerons Trk
Berribee Tank Rd
Wonauarra Trk

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

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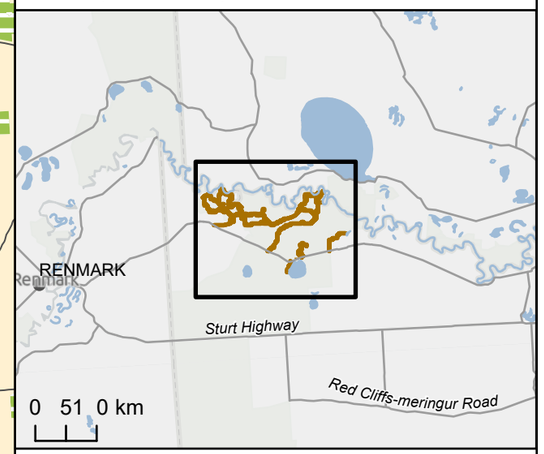
Meters



R8

Path: G:\31\12510225\GIS\Maps\Working\Lindsay_Island\12510225_EcologyFigures_Lindsay\12510225_EcologyFigures_Lindsay.aprx

5. Overview of existing conditions

The ecological significance of the Lindsay Island floodplain complex is underpinned by its unique location, providing longitudinal connection to the Murray River and its floodplains, as well as lateral connection into the semi-arid mallee environment.

The island supports intact remnants of *Eucalyptus camaldulensis* (River Red-gum) forest and woodland associated with the many creeks and anabranches across the island (including Lindsay River, Mullaroo Creek, Little Mullaroo Creek and Toupnein Creek) and large areas of *Eucalyptus largiflorens* (Black Box) and lignum shrubland communities associated with the higher elevated areas (Ecological Associates, 2014).

The floodplain incorporates a diverse range of landforms, water bodies and vegetation communities including creeks, temporary anabranches, wetlands, woodlands and grasslands, providing a mosaic of habitat types. This, in turn, supports a vast array of fauna species including 55 fauna species of conservation significance listed under the EPBC Act (10), the FFG Act (39), the DELWP Advisory List (43), and potentially up to 111 flora species of conservation significance (EPBC Act, FFG Act, and DELWP Advisory List) (GHD 2016).

Wetland habitat covers more than 2,000 ha of Lindsay Island and is important to the value of the site as a wetland of national significance (Environment Australia 2001). Flooded trees near wetlands and watercourses provide nesting habitat for colonial nesting waterbirds including Egrets, Glossy Ibis, Spoonbills, Cormorants and Night Herons (Ecological Associates 2007), (Porter and Kingsford 2011). Frequently flooded low-lying wetlands support populations of wetland-dependent fish species including Murray-darling Rainbow Fish, Gudgeon species and Flat-headed Galaxias (Ecological Associates, 2014).

The Lindsay Island floodplain is contiguous with the broader Murray-Sunset National Park. Many mammals, birds and reptiles including Giles' Planigale (*Planigale gilesi*), Lace Monitor (*Varanus varius*), Carpet Python (*Morelia spilota metcalfei*), Regent Parrot (*Polytelis anthopeplus monarchoides*), Hooded Robin (*Melanodryas cucullata*), Major Mitchell's Cockatoo (*Lophochroa leadbeateri)*, micro bats and bush birds, live in both the floodplain and terrestrial landscapes (Ecological Associates, 2014).

Further detail on the flora and fauna present within the Lindsay Island floodplain complex is provided in Section 6.

6. Targeted species surveys

Targeted surveys for rare or threatened species were undertaken from October 2019 – January 2020 within the proposed Construction Footprint and adjacent areas. Whilst efforts have been made to locate proposed structures and works in existing disturbed areas, given the quality and extent of native vegetation throughout the Project Area, most of the Construction Footprints around structures contain at least some areas of intact native vegetation and it was considered possible that they supported suitable habitat for rare or threatened species (**Figure 5**).

6.1 Targeted threatened flora assessment

6.1.1 Desktop assessment and likelihood of occurrence

VBA and PMST searches identified 129 threatened flora species, including four EPBC listed flora species, and/or 27 FFG listed threatened flora species and/or 128 DELWP Advisory listed threatened flora species that have been recorded or have the potential to occur within the Study Area.

Each of these 133 species were then assessed for their likelihood of occurrence within the Construction Footprint (Appendix E), taking into account factors such as the habitat requirements of each species and comparing those to the habitats encountered within the Construction Footprint and adjacent areas, and also the number of recent records within the Study Area.

These 133 species were also assessed for their likelihood of occurrence within the Inundation Area (Appendix E). The modelled EVC mapping within the Inundation Area indicated the potential presence of small patches of Semi-arid Woodland and Semi-arid Chenopod Woodland. These areas were ground-truthed in June 2020 and found to be dominated by Black Box woodland and Lignum communities. It is considered highly unlikely that Semi-arid Woodland or Semi-arid Chenopod Woodland would be present in the Inundation Area in locations where water-dependent EVCs have been modelled as occurring. Therefore, a determination has been made in the likelihood of occurrence and impact for rare and threatened flora species within the Inundation Area, taking into account the absence of Semi-arid Woodland and Semi-arid Chenopod Woodland. The results of this assessment are outlined in Section 7.

Whilst targeted surveys have not yet been undertaken in the Inundation Area, it is considered likely that the species identified as being present/possibly occurring within the Construction Footprint could also be present in the Inundation Area.

In determining presence / likelihood of occurrence, consideration has also been given to threatened species records from AE (2013), which included parts of the Inundation Area, and incidental observations of threatened species during targeted ground-truthing of EVCs in the Inundation Areas (see Section 7.3.2). As species tolerant to periodic inundation, these species would be expected to show a positive or neutral response to environmental watering (**Table 4**).

Table 4 Summary of likelihood of occurrence assessments for rare or threatened flora

	Construction Footprint	Inundation Area
Present	11	4
Possible	91	100
Unlikely	31	29
Total	133	133

EPBC and FFG Act listed flora

Thirty of the listed species identified in the desktop assessment as potentially occurring within the Study Area are listed under the EPBC Act and/or FFG Act. It is considered unlikely that seven of these species would be present within the Construction Footprint or Inundation Area, and the remaining 23 species have either been identified during the field assessments of the Construction Footprint, or it is considered possible that they may occur within either the Construction Footprint and/or the Inundation Area of inundation due to the known or potential presence of suitable habitat.

Some species have been identified as 'possibly occurring' within the Construction Footprint and/or Inundation Area, 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 2016 and 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.

A detailed assessment of all of these species' likelihood of occurrence and impact is included in Appendix E.

6.1.2 Threatened flora survey (2019) results

No EPBC Act listed flora were recorded during the surveys, however 11 species listed as threatened under the DELWP Advisory List, including four species listed as threatened under the FFG Act were recorded (**Table 5** and **Table 7**).

A summary of the listed threatened flora species recorded during the 2019 targeted surveys is provided in **Table 5**. The location of significant populations of rare or threatened species identified during surveys at the site are shown in **Figure 4**.

Table 5 Rare and threatened flora identified within or adjacent to the Construction Footprint during October 2019 surveys

Scientific Name	Common Name	Status	Location of recent records
Acacia oswaldii	Umbrella Wattle	L, vu	11 individuals/clusters (Page 13, 14, 39, 40 **Figure 4),** including in construction footprint
Asperula gemella	Twin-leaf Bedstraw	r	>20 individuals/clusters scattered within the area of investigation area, including in construction footprint (**Figure 4**)
Atriplex lindleyi subsp. *conduplicata*	Baldoo	r	1 individual/cluster, in area of investigation but not in construction footprint (Page 41 and 42 **Figure 4**)
Atriplex nummularia subsp. *omissa*	Dwarf Old-man Saltbush	r	4 individuals/clusters, in area of investigation but not in construction footprint (Page 9, 10, 14, 20 **Figure 4**)
Calotis cuneifolia	Blue Burr-daisy	P, r	>5 individuals/clusters scattered within the area of investigation, but not in construction footprint (**Figure 4**)
Crinum flaccidum	Darling Lily	L, vu	5 individuals/clusters within area of investigation, outside but immediately adjacent to construction footprint (Page 5, 6, 10, 40 **Figure 4**)
Eremophila bignoniiflora	Bignonia Emu-bush	L, vu	>10 individuals/clusters scattered within the area of investigation, including in construction footprint (**Figure 4**)
Eremophila divaricata subsp. *divaricata*	Spreading Emu-bush	r	>20 individuals/clusters scattered within the area of investigation, including in construction footprint adjacent to an existing track (**Figure 4)**
Eremophila maculata subsp. *maculata*	Spotted Emu-bush	L, r	1 individual/cluster within construction footprint adjacent to an existing track (Page 34 **Figure 4)**

Scientific Name	Common Name	Status	Location of recent records
Senecio cunninghamii var. *cunninghamii*	Branching Groundsel	r	>50 individuals/clusters scattered within the area of investigation, including in construction footprint (**Figure 4**)
Tecticornia triandra	Desert Glasswort	r	>30 indviduals/clusters scattered within the area of investigation, including in construction footprint (**Figure 4**).

KEY
L Listed as threatened under the FFG Act
P Protected under the FFG Act
vu Listed as vulnerable under the DELWP Advisory threatened species list
r Listed as rare under the DELWP Advisory threatened species list

Plate 1 - *Crinum flaccidum* (Darling Lily) identified in the Area of Investigation

Plate 2 - *Eremophila bignoniiflora* (Bignonia Emu-bush) identified in the Area of Investigation

Plate 3 - *Tecticornia triandra* (Desert Glasswort) identified in the Area of Investigation

6.2 Significant weed species

Six weeds listed under the CaLP Act were detected

- *Carthamus lanatus* (Saffron Thistle); Restricted
- *Chondrilla juncea* (Skeleton Weed); Restricted
- *Cirsium vulgare* (Spear Thistle); Restricted
- *Cuscuta campestris* (Field Dodder); Restricted
- *Dittrichia graveolens* (Stinkwort); Restricted
- *Xanthium spinosum* (Bathurst Burr); Restricted

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.

6.3 Threatened fauna assessment

6.3.1 Desktop assessment and likelihood of occurrence

VBA and PMST searches identified 64 threatened fauna species that have been recorded or have the potential to occur within the Study Area. Of these species, 18 are listed as threatened under the EPBC Act, 52 are listed under the FFG Act, and 55 are DELWP Advisory listed threatened species. A number of species are listed under one or more of these lists.

Each of these species has been assessed for their likelihood of occurrence and impact within the Construction Footprints 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 Construction Footprints and Inundation Area, and also the number and recency of records within the Study Area.

Based on this assessment, 27 FFG listed fauna species and five EPBC listed fauna species were assessed as having a possible or higher likelihood of occurrence within the Construction Footprints, while 38 FFG listed fauna species and nine EPBC listed fauna species were assessed as having a possible or higher likelihood of occurrence within the Inundation Areas (see **Table 6** for a summary of threatened fauna, and **Table 11** for a full list of threatened fauna).

Table 6 Summary of likelihood of occurrence assessments for threatened fauna

	Construction Footprint	Inundation Area
Present	8	13
Possible	20	33
Unlikely	28	11
Highly unlikely	8	7
Total	65	64

6.3.2 Threatened fauna survey results

Fauna habitat assessments, targeted surveys and opportunistic surveys were completed across all Construction Footprints and adjacent areas, with opportunistic threatened fauna observations also recorded for the broader Project Area while travelling between sites. A summary of all fauna species recorded during the surveys is provided in Appendix C, with results of the Regent Parrot THPS shown in detail in Appendix F.

An overview of the results of these surveys is provided below, along with specific summaries of the key fauna habitat values and threatened species recorded at each of the Construction Footprints. Regent Parrot THPS survey results are summarised in Section 6.3.3.

Overview

One EPBC Act / FFG Act listed species (Regent Parrot) and one additional FFG Act listed species (Great Egret) were recorded from the targeted fauna surveys in 2019/2020.

The eastern subspecies of the Regent Parrot (*Polytelis anthopeplus monarchoides*) is listed as Vulnerable under the EPBC Act and is also listed under the FFG Act and as vulnerable under the DELWP Advisory List of threatened fauna. This species was observed on one occasion 100 m east of the proposed location of the Berribee Regulator (Berr-A) construction site, and the species has been recorded previously in low numbers scattered across Lindsay Island.

The FFG Act listed Eastern Great Egret (*Ardea alba modesta*) is listed as vulnerable under the DELWP Advisory List, and was recorded on two occasions, both close to the proposed location of the Berribee Regulator (Berr-A) construction site.

Berribee Regulator (Berr_A)

Situated on the permanent water of the lower Lindsay River, the Berribee Regulator (Berr_A) Construction Footprint contains, and is surrounded by, many high quality fauna habitats including large old River Red-gum and Black Box trees with many hollows, along with deep leaf litter beds and much coarse woody debris.

Extensive surveys of the Berribee Regulator (Berr_A) Construction Footprint and broader site (e.g. GHD 2013, GHD 2014, and the current surveys) have recorded the EPBC Act listed Regent Parrot a number of times passing through and around the broader area, and once at the Construction Footprint. Twelve targeted surveys for nesting of this species in 2019 and 14 surveys in 2012 (GHD 2013) across the Construction Footprint did not record any likely or potential nesting activity. Two individuals of the FFG Act and DELWP Advisory listed Eastern Great Egret (*Ardea alba modesta*) were also observed at this Construction Footprint.

The many large trees with hollows throughout this Construction Footprint and surrounding area also provide important habitat for many native species, likely including threatened species such as Lace Monitor (*Varanus varius*) and potentially Carpet Python (*Morelia spilota metcalfei*).

Toupnein Creek containment bank (Berr_D)

Situated adjacent to the permanent water of the substantial Toupnein Creek, the Toupnein Creek containment bank (Berr_D) Construction Footprint contains, and is surrounded by many high quality fauna habitats including large old River Red-gum and Black Box trees with many hollows, areas of dense medium shrub cover, deep leaf litter beds and much coarse woody debris.

Extensive surveys of the Toupnein Creek containment bank (Berr_D) site (e.g. GHD 2013, GHD 2014, and the current surveys) recorded the EPBC Act listed Regent Parrot passing through and around the Construction Footprint a number of times in 2012. Eight targeted surveys for nesting of this species in 2019 and four in 2012 (GHD 2013) across the Construction Footprint did not record any likely or potential nesting activity.

Surveys in 2012 (GHD 2013) during a small flooding event recorded a number of EPBC Act listed Growling Grass Frog at the western end of the Toupnein Creek containment bank (Berr_D) site. Further surveys since have not recorded the species, and it was not clear specifically where they had dispersed from before the flooding event, or to following it.

The many large trees with hollows and areas of dense shrubs throughout this Construction Footprint and surrounding area also provide important habitat for many native species, likely including threatened species such as Lace Monitor and potentially Carpet Python and Spotted Bowerbird (*Ptilonorhynchus maculatus*).

Little Mullaroo West regulator (Berr_E)

Situated on the upper reaches of the Little Mullaroo Creek, the Little Mullaroo West regulator (Berr_E) Construction Footprint contains, and is surrounded by moderate to high quality fauna habitats including large old River Red-gum and Black Box trees with many hollows, deep leaf litter beds and coarse woody debris.

Surveys of the Little Mullaroo West regulator (Berr_E) Construction Footprint and broader site (e.g. GHD 2013, GHD 2014, and the current surveys) recorded the EPBC Act listed Regent Parrot in 2012, passing through and around the broader area. Four targeted surveys for nesting of this species in 2019 and two in 2012 (GHD 2013) across the Construction Footprint did not record any likely or potential nesting activity.

The scattered large trees with hollows throughout this Construction Footprint and surrounding area also provide important habitat for many native species, likely including threatened species such as Lace Monitor and potentially Carpet Python.

Little Mullaroo regulator (Berr_F)

Situated on the upper reaches of the Little Mullaroo Creek, the Little Mullaroo regulator (Berr_F) Construction Footprint contains, and is surrounded by moderate to high quality fauna habitats including large old River Red-gum and Black Box trees with many hollows, leaf litter beds and coarse woody debris.

Surveys of the Little Mullaroo regulator (Berr_F) Construction Footprint and broader site (e.g. GHD 2013, GHD 2014, and the current surveys) recorded the EPBC Act listed Regent Parrot in 2012, passing through and around the broader area. Eight targeted surveys for nesting of this species in 2019 and two in 2012 (GHD 2013) across the Construction Footprint did not record any likely or potential nesting activity.

The scattered large trees with hollows throughout this Construction Footprint and surrounding area also provide important habitat for many native species, likely including threatened species such as Lace Monitor and potentially Carpet Python.

Crankhandle Complex

The Crankhandle Complex contains a number of Construction Footprint sites across a large area of north-western Lindsay Island, and includes sites close to and within the Murray and Lindsay Rivers. The area is surrounded by many high quality fauna habitats including large old River Red-gum and Black Box trees with many hollows, along with deep leaf litter beds and much coarse woody debris.

Extensive surveys of the Crankhandle Complex Construction Footprints and broader area (e.g. GHD 2013, GHD 2014, and the current surveys) have recorded the EPBC Act listed Regent Parrot a number of times passing through and around the broader area, but no potential breeding habitat was identified at any of the Construction Footprints.

The scattered large trees with hollows throughout this complex and surrounding area also provide important habitat for many native species, likely including threatened species such as Lace Monitor and potentially Carpet Python. The open woodland of this site and the surrounding area provides habitats for threatened species such as Hooded Robin (*Melanodryas cucullata*).

Lake Wallawalla Complex

The Lake Wallawalla Complex contains a number of Construction Footprint sites across a large area south of Lindsay Island, around Lake Wallawalla and the Lindsay River. The area is surrounded by small areas of high quality fauna habitats and larger areas of lower quality, degraded open Black Box woodlands. High quality habitats include large old River Red-gum and Black Box trees with many hollows, leaf litter beds and coarse woody debris, along with some areas of dense shrub cover.

Extensive surveys of the Lake Wallawalla Complex Construction Footprints and broader site (e.g. GHD 2013, GHD 2014, and the current surveys) did not record any EPBC Act listed species. Of regional significance – the FFG Act listed and DELWP Advisory listed endangered Bush Stone-curlew (*Burhinus grallarius*) was recorded in 2013 surveys on the western side of Lake Wallawalla (GHD 2014). The open woodland of this complex provides habitat for many common species as well as threatened species such as Hooded Robin.

Lindsay South Complex

Situated on the upper reaches of the Lindsay South Creek, the Lindsay South Complex contains a number of Construction Footprint sites. The area contains some small areas of higher quality fauna habitats and larger areas of lower quality, degraded very open Black Box woodland and low chenopod and samphire shrubland. Higher quality habitats include large old River Red-gum trees with hollows along the Lindsay South Creek and scattered Black Box trees with hollows and leaf litter beds.

Surveys of the Lindsay South Complex Construction Footprints and broader site (e.g. GHD 2013, GHD 2014, and the current surveys) did not record any EPBC Act or FFG Act listed species. The open woodland of this complex provides habitat for many common species such as Noisy Miner (*Manorina melanocephala*), Crested Pigeon (*Ocyphaps lophotes*) and Blue Bonnet (*Northiella haematogaster*), and potentially threatened species such as Hooded Robin.

6.3.3 Regent Parrot two-hour point surveys (THPS) summary

A total of 32 targeted surveys for Regent Parrot nests using the standardised THPS method were completed at Construction Footprints identified as containing habitat with potential for Regent Parrot nesting – specifically large River Red-gum trees with hollows (**Table 7**). This was in addition to 22 surveys completed in 2012 (GHD 2013), at these sites using the same method, which did not detect Regent Parrot breeding activity at any proposed Construction Footprints.

During the combined 64 hours and 32 THPS of surveys completed across the four key Construction Footprint areas, Regent Parrot activity was only observed on one occasion, with two birds observed flying through the site and into a nearby tree 100 m east of the Berribee Regulator (Berr_A) Construction Footprint. Surveys in 2012 (GHD 2013) recorded Regent Parrots at five Construction Footprint sites (Berribee Regulator A, D, E, F; Crankhandle C and D). Throughout all targeted surveys, no behaviour conducive to breeding has been observed. Nor were any young Regent Parrots (notable due to their short tails and drab plumage) observed within the survey areas during the surveys. Results of the surveys are provided in detail in Appendix F.

Across all targeted threatened fauna surveys just one record of two Regent Parrots were recorded, close to the Berribee Regulator (Berr_A) Construction Footprint (Appendix F). This species is extremely mobile and wide ranging, and in areas with greater populations it is typically observed regularly throughout the broader area, including while travelling to and between survey sites, as has been experienced during surveys for VMFRP projects at Hattah North and Belsar-Yungera. It is also worth noting that potential Regent Parrot breeding habitat is present within the Inundation Area, and that this breeding habitat (large old River Red-gums) is likely to have its condition improved, and therefore future breeding habitat for Regent Parrot sustained by environmental watering. The Regent Parrot is likely to benefit from broadly improved habitat condition following environmental watering, and environmental water is essential to sustain the River Red-gums this species requires for breeding habitat.

Table 7 Summary of survey effort - Regent Parrot THPS

Site	Date and number of THPS	Total THPS
Berribee regulator (Berr_A)	23/10/19 (x2). 14/11/19 (x2). 18/11/19 (x4) 22/11/19 (x4)	12
Toupnein Creek containment bank (Berr_D)	23/10/19 (x2). 14/11/19 (x2). 18/11/19 (x2). 22/11/19 (x2)	8
Little Mullaroo West regulator (Berr_E)	23/10/19 (x2). 18/11/19 (x2)	4
Little Mullaroo regulator (Berr_F)	23/10/19 (x2). 14/11/19 (x2). 18/11/19 (x2). 22/11/19 (x2)	8
TOTAL		32

Figure 4: Threatened Flora and Fauna at Lindsay Island

VMFRP

Legend

- Collector road
- Stream
- Drain/Channel/Other
- Watercourse
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

Threatened Flora Species

- Tecticornia triandra

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 130 260
Meters

DATA SOURCES
© Commonwealth of Australia (Geoscience Australia) 2006 Geodata Topo 250k Series 3; Vicmap Data © State of Victoria 2020; GHD 2020.

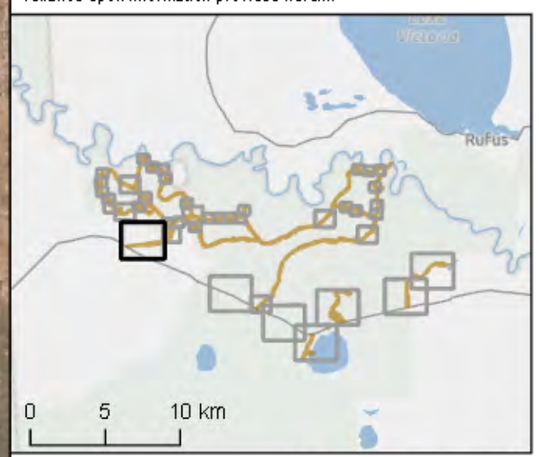


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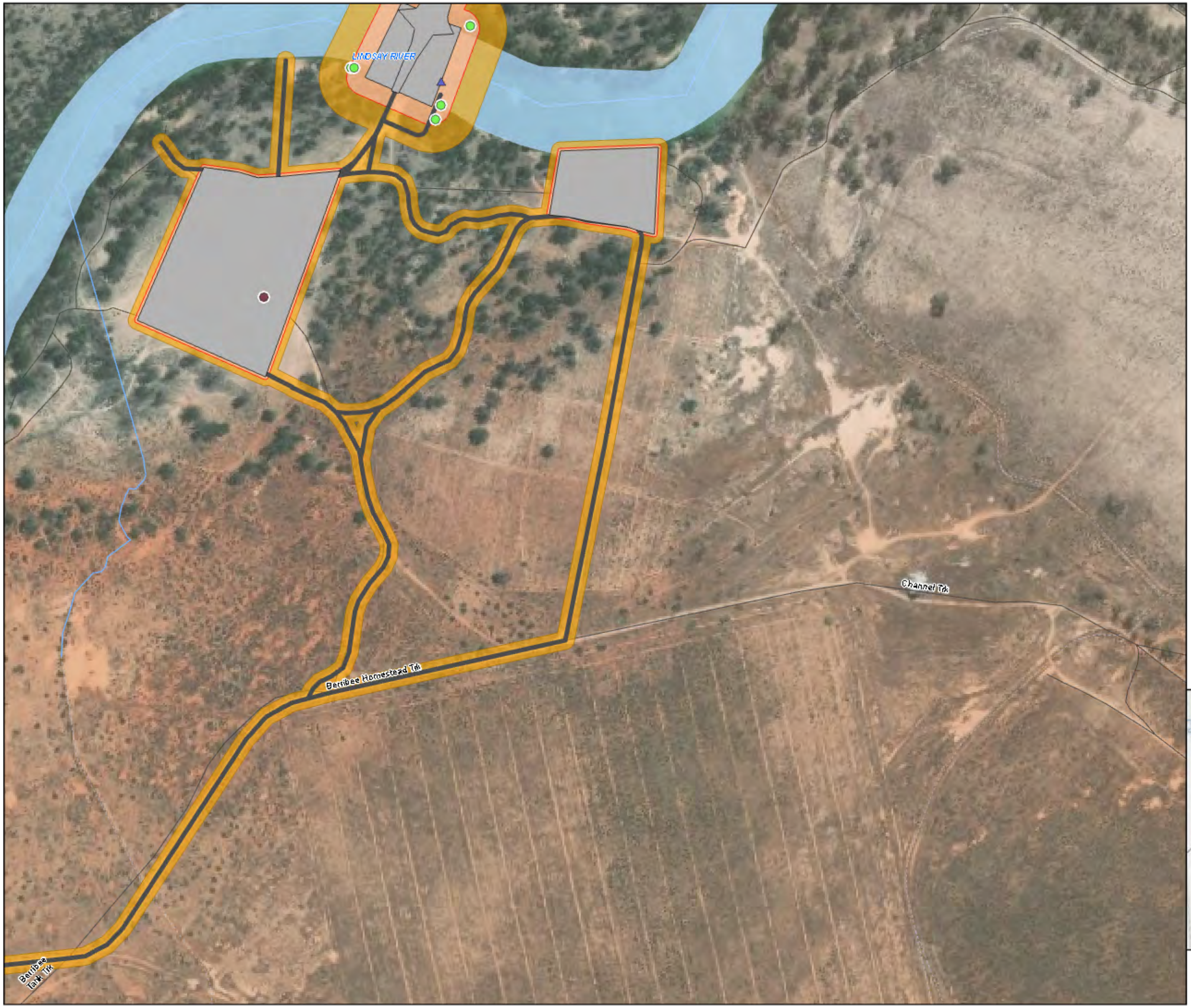
Figure 4: Threatened Flora and Fauna at Lindsay Island

VMFRP



Legend

- Collector road
- Stream
- Drain/Channel/Other
- Watercourse
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

Threatened Flora Species

- Asperula gemella
- Eremophila bignoniiflora

Threatened Fauna Species

- Great Egret

N

Spatial Reference
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Datum: GDA 1994
Projection: Transverse Mercator

IS297701

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Meters

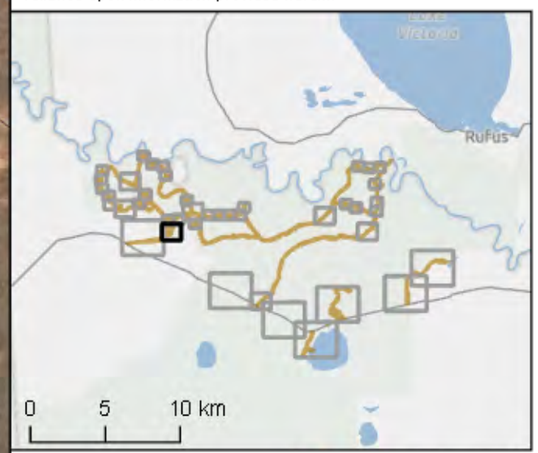

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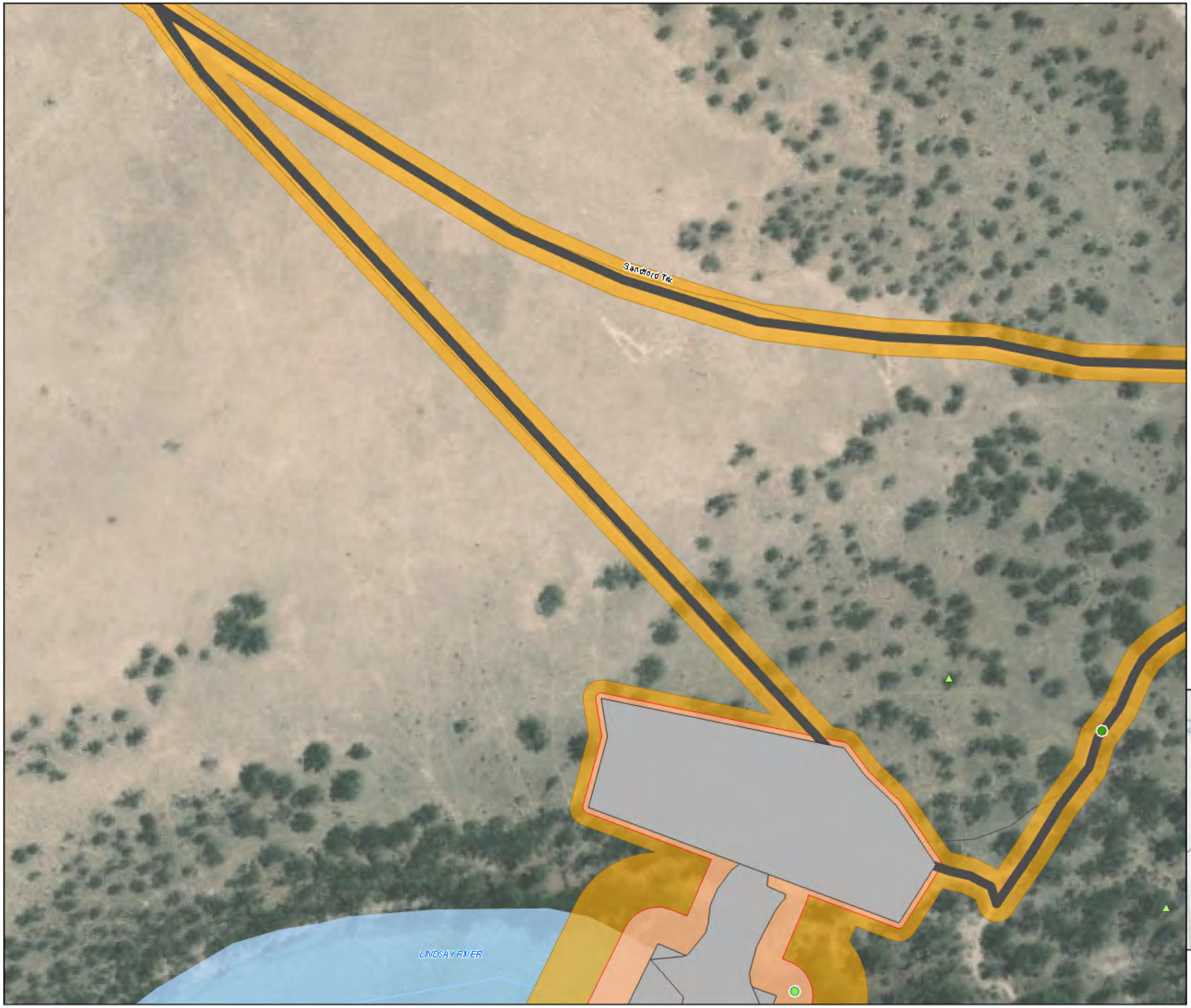
Figure 4: Threatened Flora and Fauna at Lindsay Island

VMFRP



Legend

- Collector road
- Stream
- Watercourse
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

Threatened Flora Species

- Asperula gemella
- Tecticomia triandra

Threatened Fauna Species

- Regent Parrot

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

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Meters

DATA SOURCES
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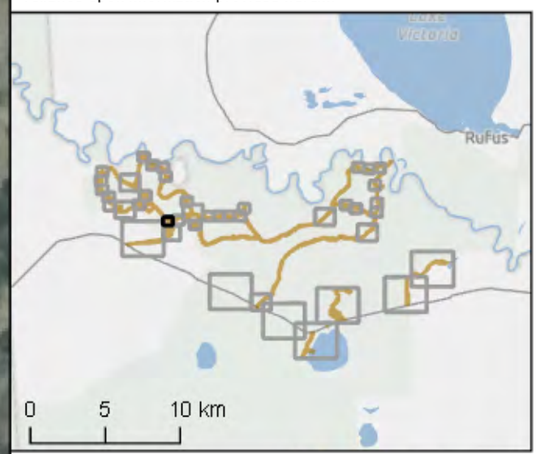

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Figure 4: Threatened Flora and Fauna at Lindsay Island

VMFRP

Legend

- Collector road
- Stream
- Watercourse
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

Threatened Flora Species

- Calotis cuneifolia
- Eremophila divaricata subsp. divaricata

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

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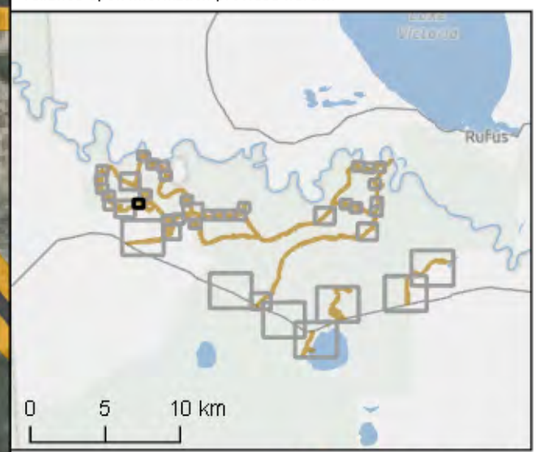

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Figure 4: Threatened Flora and Fauna at Lindsay Island

VMFRP

Legend

- Collector road
- Stream
- Drain/Channel/Other
- Watercourse
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

Threatened Flora Species

- Crinum flaccidum

Threatened Fauna Species

- Regent Parrot

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 55 110
Meters

DATA SOURCES
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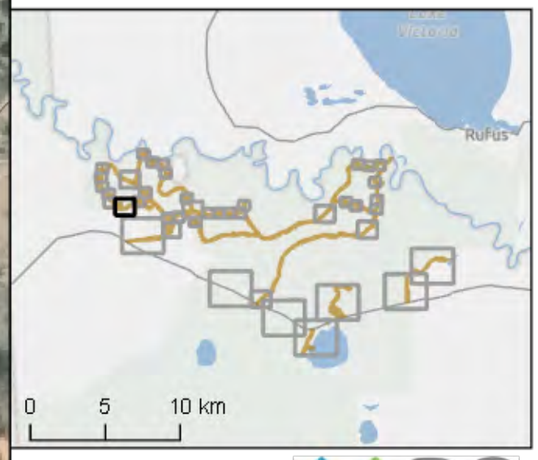

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Figure 4: Threatened Flora and Fauna at Lindsay Island

VMFRP

Legend

- Collector road
- Stream
- Watercourse
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

Threatened Flora Species

- Calotis cuneifolia
- Crinum flaccidum

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

DATA SOURCES
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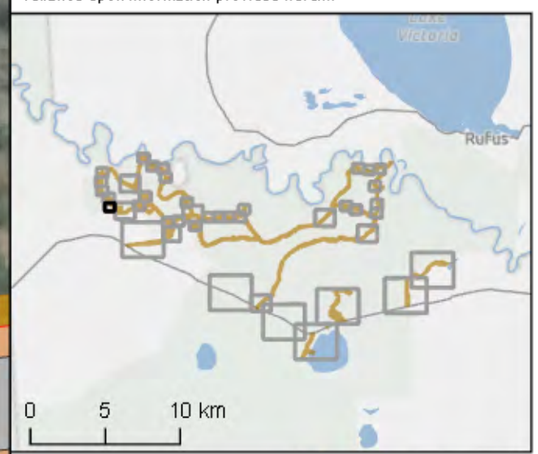

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Figure 4: Threatened Flora and Fauna at Lindsay Island

VMFRP

Legend

- Stream
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

Threatened Flora Species

- Calotis cuneifolia
- Minuria cunninghammii
- Senecio cunninghamii var. cunninghamii

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

DATA SOURCES
© Commonwealth of Australia (Geoscience Australia) 2006 Geodata Topo 250k Series 3; Vicmap Data © State of Victoria 2020; GHD 2020.

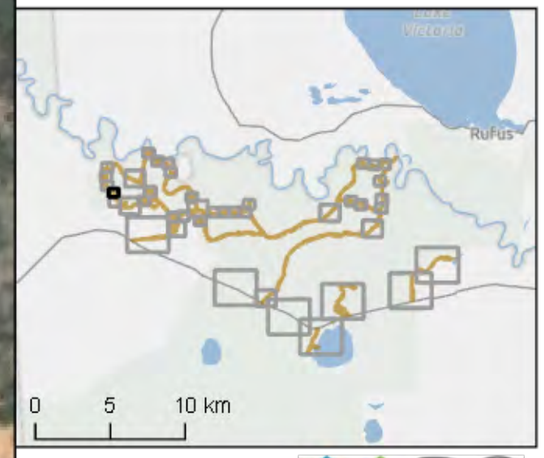

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Figure 4: Threatened Flora and Fauna at Lindsay Island

VMFRP

Legend

- Stream
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

DATA SOURCES
© Commonwealth of Australia (Geoscience Australia) 2006 Geodata Topo 250k Series 3; Vicmap Data © State of Victoria 2020; GHD 2020.

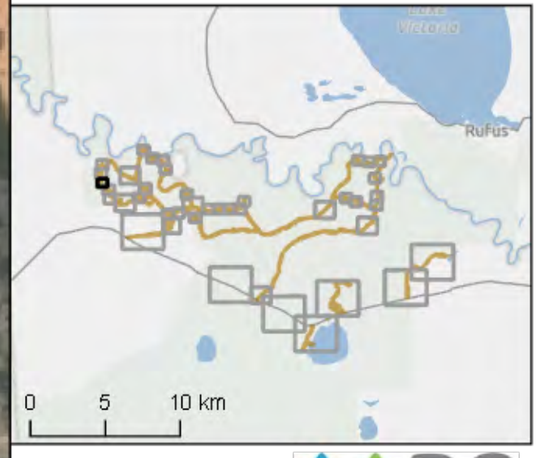

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Figure 4: Threatened Flora and Fauna at Lindsay Island

VMFRP

Legend

- Stream
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

Threatened Flora Species

- Atriplex nummularia subsp. omissa

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

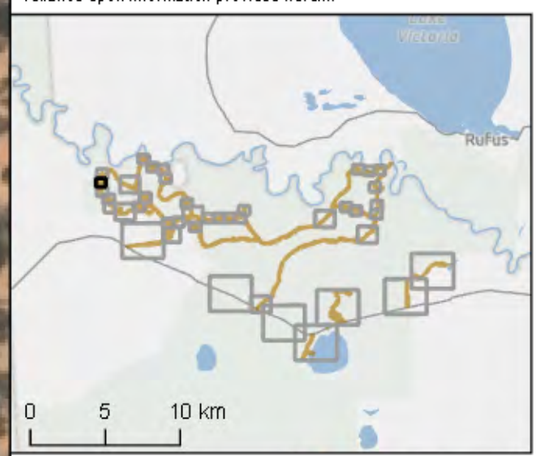

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Figure 4: Threatened Flora and Fauna at Lindsay Island

Legend

- Collector road
- Stream
- Watercourse
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

Threatened Flora Species

- Asperula gemella
- Atriplex nummularia subsp. omissa
- Crinum flaccidum
- Minuria cunninghammii
- Senecio cunninghamii var. cunninghamii
- Swainsona greyana

Threatened Flora Species

- Senecio cunninghamii var. cunninghamii

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

DATA SOURCES
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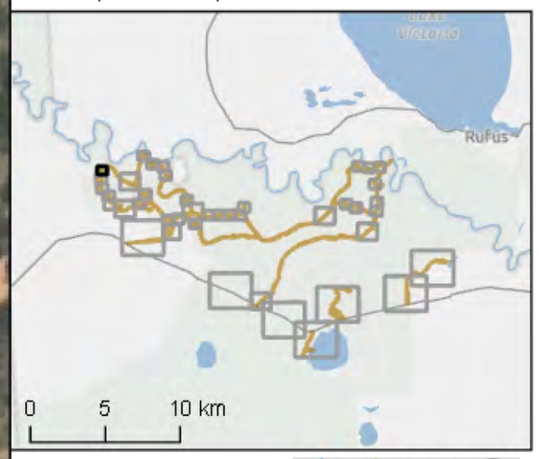

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Figure 4: Threatened Flora and Fauna at Lindsay Island

VMFRP

Legend

- Collector road
- Construction Footprint Tracks
- Area of Investigation

Threatened Flora Species

- Tecticomia triandra

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 55 110
Meters

DATA SOURCES
© Commonwealth of Australia (Geoscience Australia) 2006 Geodata Topo 250k Series 3; Vicmap Data © State of Victoria 2020; GHD 2020.

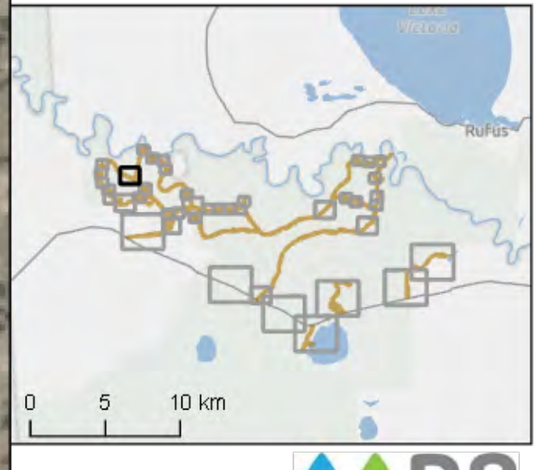

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Figure 4: Threatened Flora and Fauna at Lindsay Island

Legend

- Collector road
- Stream
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

DATA SOURCES
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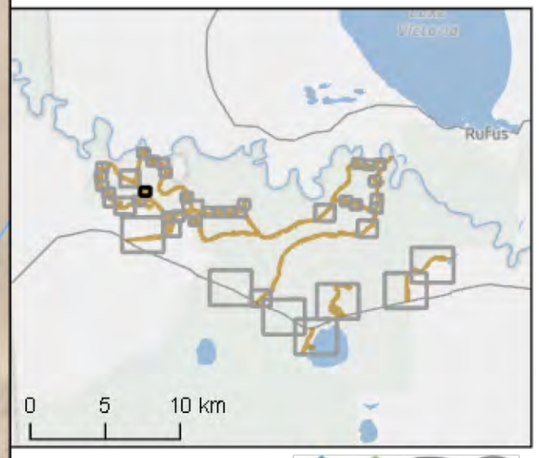

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Figure 4: Threatened Flora and Fauna at Lindsay Island

Legend

- Collector road
- Stream
- Watercourse
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

Threatened Flora Species

- Acacia oswaldii
- Calotis cuneifolia
- Eremophila divaricata subsp. divaricata
- Minuria cunninghammii
- Senecio cunninghamii var. cunninghamii

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

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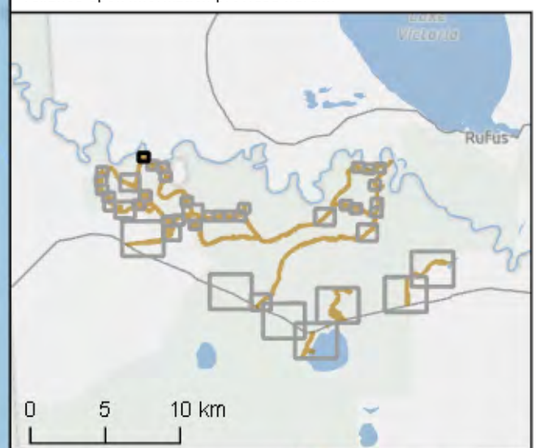

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Figure 4: Threatened Flora and Fauna at Lindsay Island

Legend

- Stream
- Watercourse
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

Threatened Flora Species

- Acacia oswaldii
- Atriplex nummularia subsp. omissa
- Minuria cunninghammii
- Senecio cunninghamii var. cunninghamii
- Tecticornia triandra

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

DATA SOURCES
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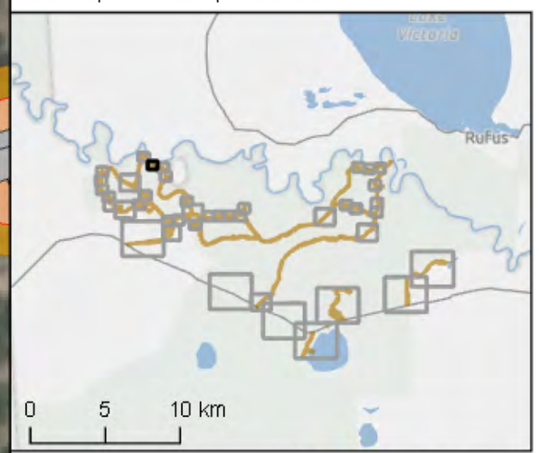

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Figure 4: Threatened Flora and Fauna at Lindsay Island

VMFRP

Legend

- Stream
- Watercourse
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

Threatened Flora Species

- Senecio cunninghamii var. cunninghamii

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

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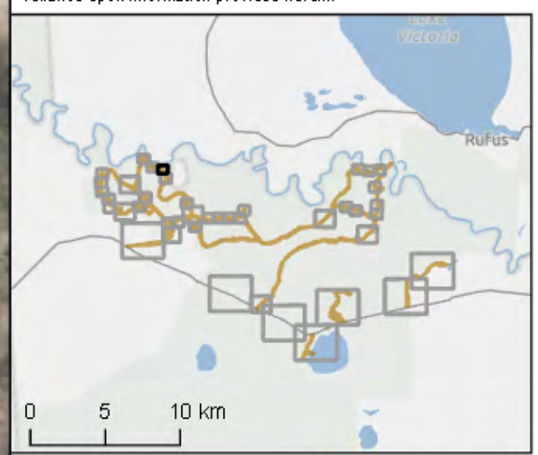

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Figure 4: Threatened Flora and Fauna at Lindsay Island

Legend

- Stream
- Watercourse
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

Threatened Flora Species

- Eremophila divaricata subsp. divaricata
- Senecio cunninghamii var. cunninghamii

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

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Figure 4: Threatened Flora and Fauna at Lindsay Island

Legend
- Stream
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

N

Spatial Reference
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Datum: GDA 1994
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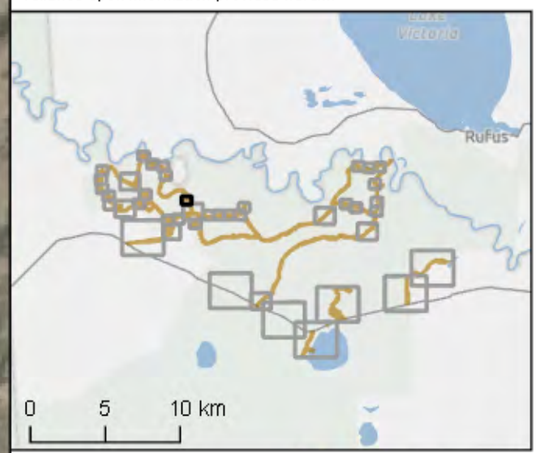

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Figure 4: Threatened Flora and Fauna at Lindsay Island

Legend

- Collector road
- Stream
- Construction Footprint Tracks
- Area of Investigation

Threatened Flora Species

- Tecticornia triandra

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 55 110
Meters

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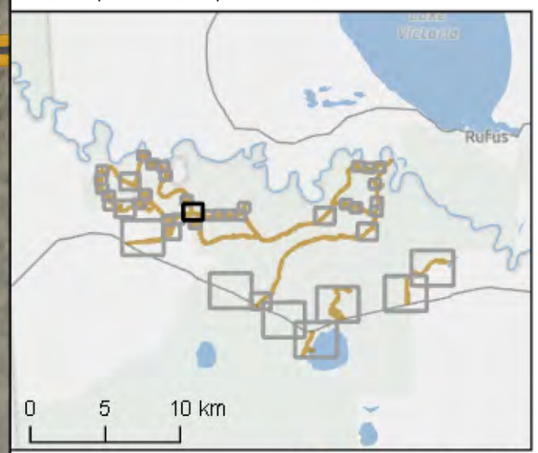

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Figure 4: Threatened Flora and Fauna at Lindsay Island

Legend

- Collector road
- Stream
- Watercourse
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

Threatened Flora Species

- Tecticornia triandra

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50 Meters

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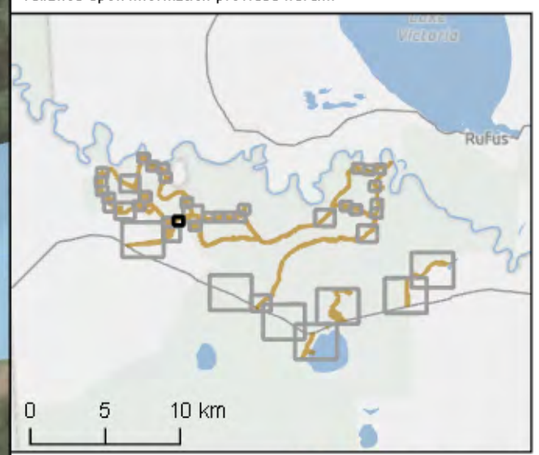

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Figure 4: Threatened Flora and Fauna at Lindsay Island

VMFRP

Legend

- Collector road
- Stream
- Watercourse
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

Threatened Flora Species

- Atriplex nummularia subsp. omissa
- Tecticornia triandra

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

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Meters

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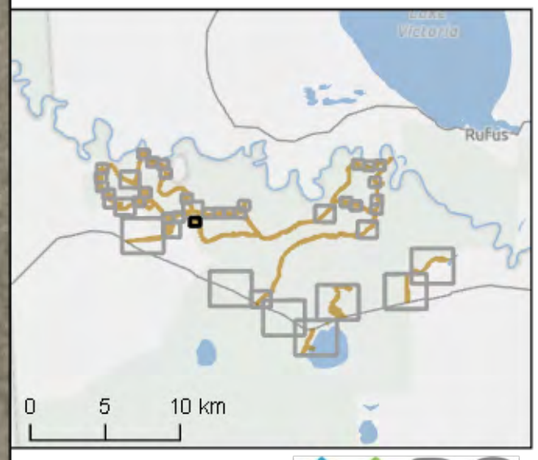

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Figure 4: Threatened Flora and Fauna at Lindsay Island

Legend

- Collector road
- Stream
- Watercourse
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

Threatened Flora Species

- Tecticornia triandra

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

DATA SOURCES
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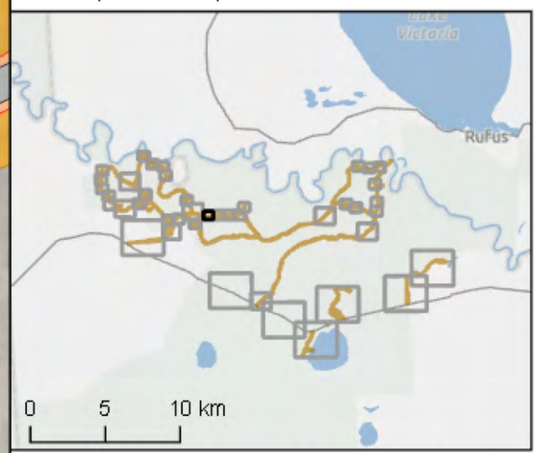

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Figure 4: Threatened Flora and Fauna at Lindsay Island

VMFRP

Legend

- Collector road
- Stream
- Watercourse
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

Threatened Flora Species

- Asperula gemella
- Minuria cunninghammii
- Senecio cunninghamii var. cunninghamii

Threatened Flora Species

- Senecio cunninghamii var. cunninghamii

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50 Meters

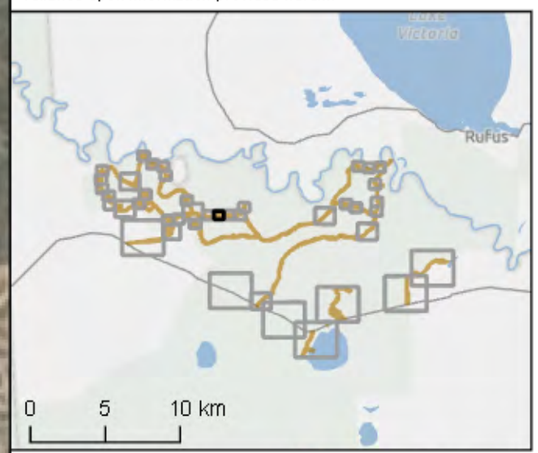

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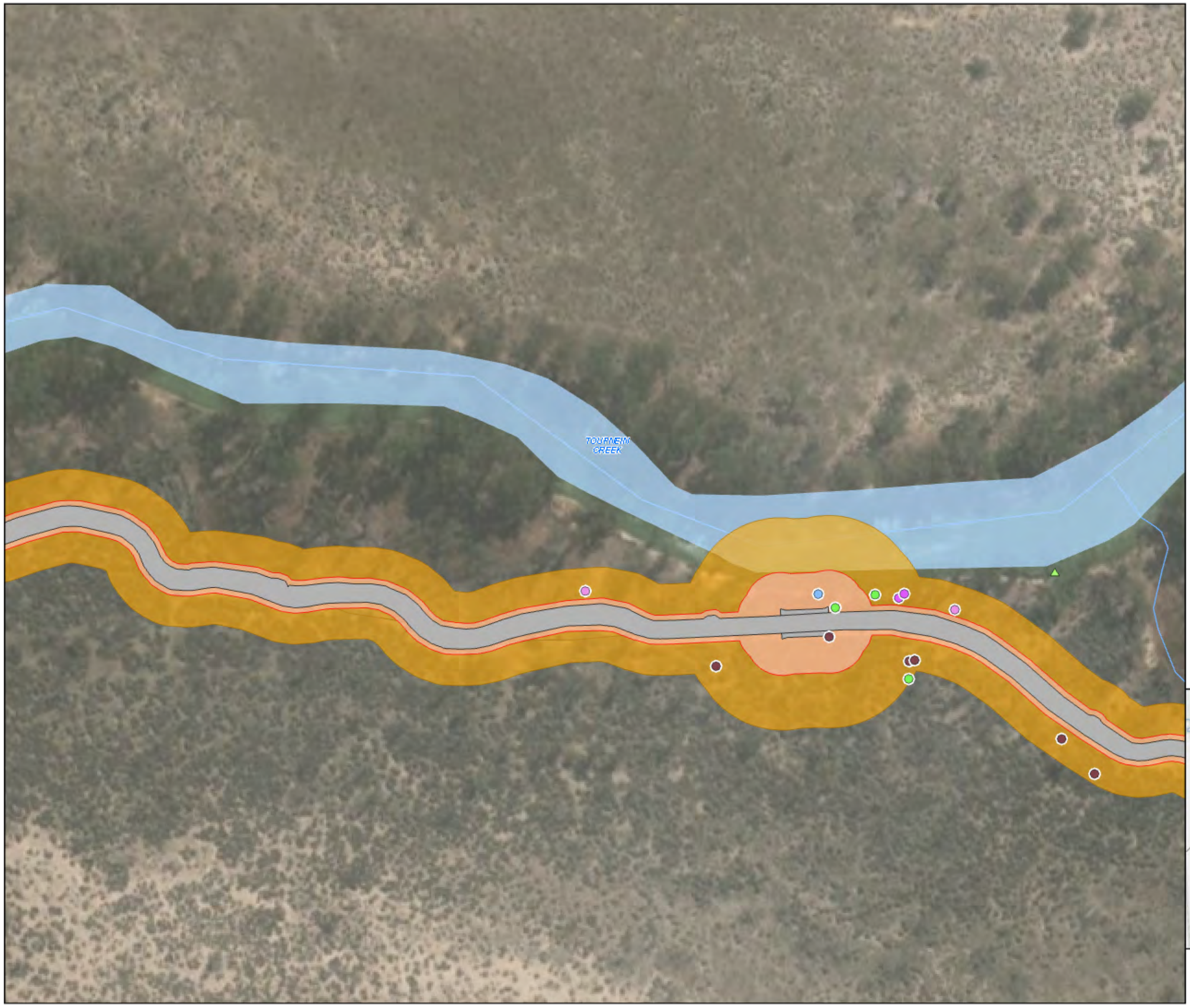
Figure 4: Threatened Flora and Fauna at Lindsay Island



Legend

- Collector road
- Stream
- Watercourse
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

Threatened Flora Species

- Asperula gemella
- Calotis cuneifolia
- Eremophila bignoniiflora
- Minuria cunninghammii
- Senecio cunninghamii var. cunninghamii

Threatened Fauna Species

- Regent Parrot

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

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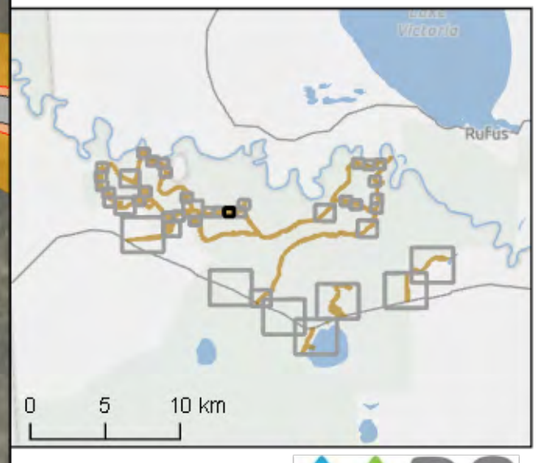

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Figure 4: Threatened Flora and Fauna at Lindsay Island

Legend

- Collector road
- Stream
- Watercourse
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

Threatened Flora Species

- Eremophila bignoniiflora
- Minuria cunninghammii

N

Spatial Reference
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Datum: GDA 1994
Projection: Transverse Mercator

IS297701

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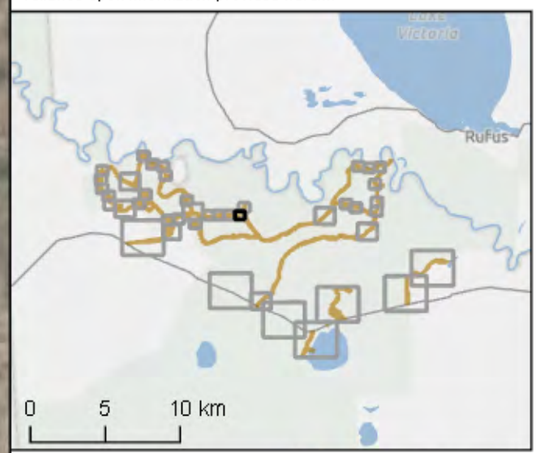

Figure 4: Threatened Flora and Fauna at Lindsay Island

VMFRP

Legend

- Collector road
- Stream
- Watercourse
- Construction Footprint Tracks
- Area of Investigation

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

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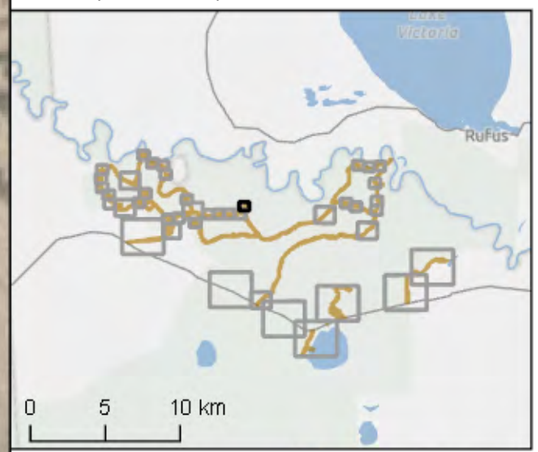

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Figure 4: Threatened Flora and Fauna at Lindsay Island

Legend

- Collector road
- Stream
- Watercourse
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

N

Spatial Reference
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Datum: GDA 1994
Projection: Transverse Mercator

IS297701

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Meters

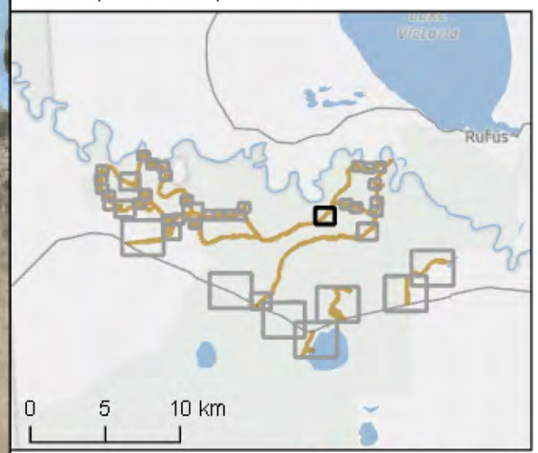

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Figure 4: Threatened Flora and Fauna at Lindsay Island

VMFRP

Legend

- Collector road
- Stream
- Construction Footprint Tracks
- Area of Investigation

Threatened Flora Species

- Eremophila bignoniiflora

Threatened Flora Species

- Eremophila bignoniiflora

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

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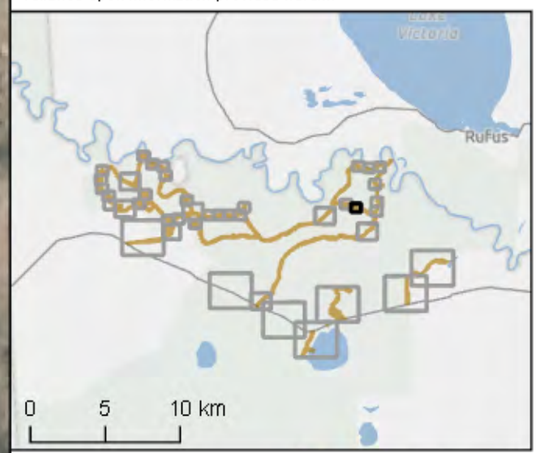

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Figure 4: Threatened Flora and Fauna at Lindsay Island

Legend

- Collector road
- Stream
- Watercourse
- Construction Footprint Tracks
- Area of Investigation

Threatened Flora Species

- Senecio cunninghamii var. cunninghamii

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50 Meters

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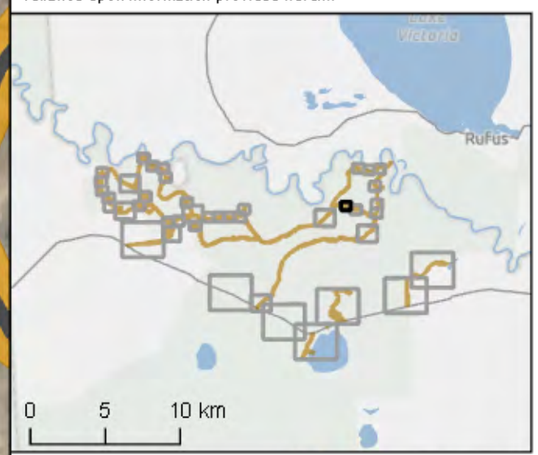

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Figure 4: Threatened Flora and Fauna at Lindsay Island

Legend

- Collector road
- Stream
- Watercourse
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

Threatened Flora Species

- Senecio cunninghamii var. cunninghamii

Threatened Flora Species

- Senecio cunninghamii var. cunninghamii

N

Spatial Reference
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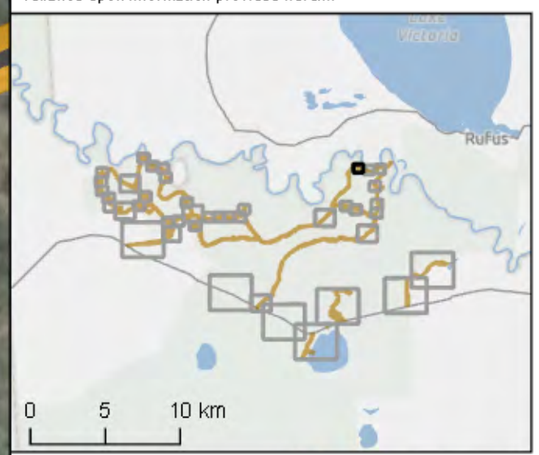

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Figure 4: Threatened Flora and Fauna at Lindsay Island

VMFRP

Legend

- Stream
- Watercourse
- Construction Footprint Tracks
- Area of Investigation

Threatened Flora Species

- Eremophila divaricata subsp. divaricata

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

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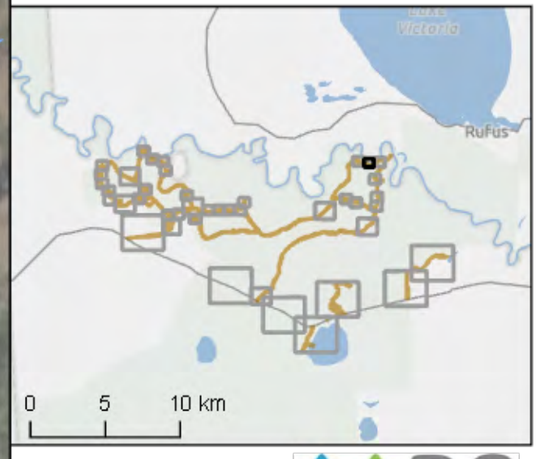

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Figure 4: Threatened Flora and Fauna at Lindsay Island

Legend

- Collector road
- Stream
- Watercourse
- Construction Footprint Tracks
- Area of Investigation

Threatened Flora Species

- Senecio cunninghamii var. cunninghamii

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

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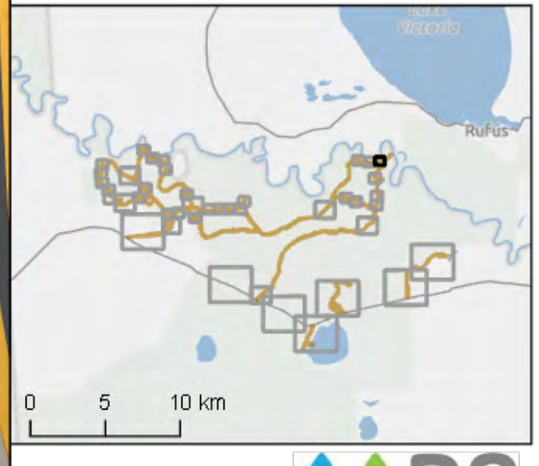

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Figure 4: Threatened Flora and Fauna at Lindsay Island

Legend

- Collector road
- Stream
- Construction Footprint Tracks
- Area of Investigation

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

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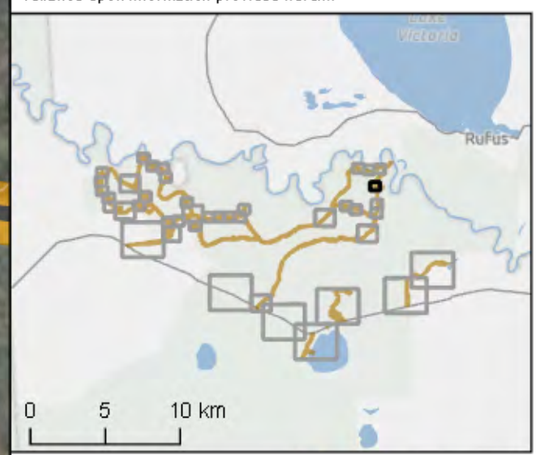

R8

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Figure 4: Threatened Flora and Fauna at Lindsay Island

VMFRP

Legend

- Collector road
- Stream
- Watercourse
- Construction Footprint Tracks
- Area of Investigation

Threatened Flora Species

- Senecio cunninghamii var. cunninghamii

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50 Meters

DATA SOURCES
© Commonwealth of Australia (Geoscience Australia) 2006 Geodata Topo 250k Series 3; Vicmap Data © State of Victoria 2020; GHD 2020.

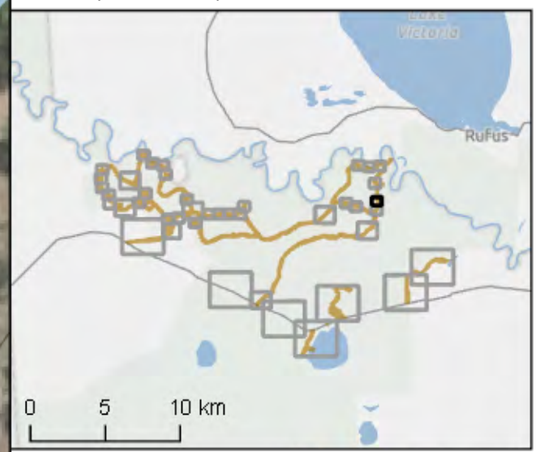

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Figure 4: Threatened Flora and Fauna at Lindsay Island

Legend

- Collector road
- Stream
- Watercourse
- Construction Footprint Tracks
- Area of Investigation

Threatened Flora Species

- Eremophila divaricata subsp. divaricata
- Eremophila maculata subsp. maculata

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

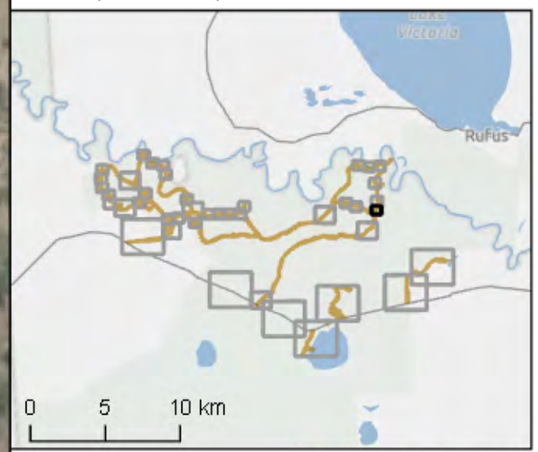

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Figure 4: Threatened Flora and Fauna at Lindsay Island

Legend

- Collector road
- Stream
- Watercourse
- Construction Footprint Tracks
- Area of Investigation

Threatened Flora Species

- Eremophila divaricata subsp. divaricata
- Senecio cunninghamii var. cunninghamii

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 55 110
Meters

DATA SOURCES
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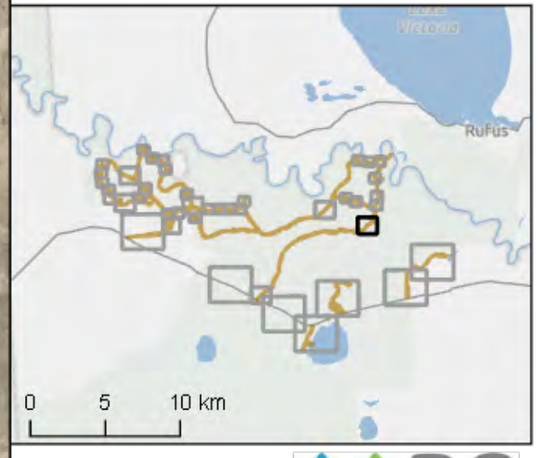


Figure 4: Threatened Flora and Fauna at Lindsay Island

Legend

- Collector road
- Stream
- Watercourse
- Construction Footprint Tracks
- Area of Investigation

Threatened Flora Species

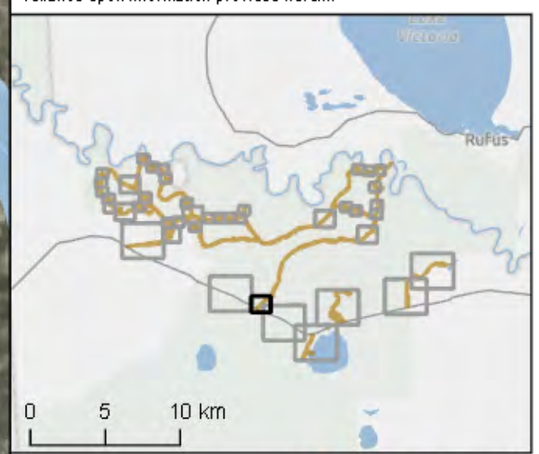
- Tecticomia triandra

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 55 110
Meters



R8

Figure 4: Threatened Flora and Fauna at Lindsay Island

VMFRP

Legend

- Collector road
- Stream
- Watercourse

Threatened Flora Species

- Tecticomia triandra

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 130 260
Meters

DATA SOURCES
© Commonwealth of Australia (Geoscience Australia) 2006 Geodata Topo 250k Series 3; Vicmap Data © State of Victoria 2020; GHD 2020.

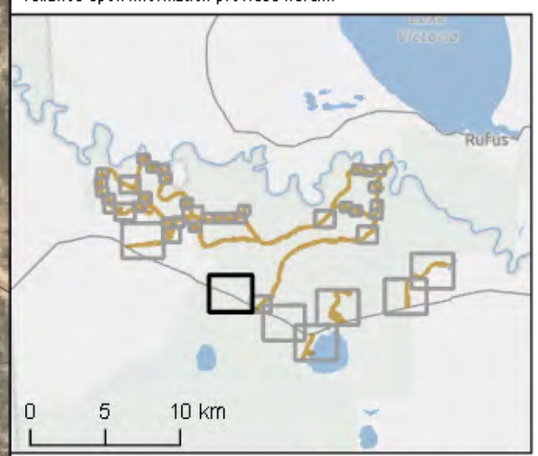


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Figure 4: Threatened Flora and Fauna at Lindsay Island

Legend

- Collector road
- Stream
- Watercourse

Threatened Flora Species

- Tecticornia triandra

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 130 260
Meters

DATA SOURCES
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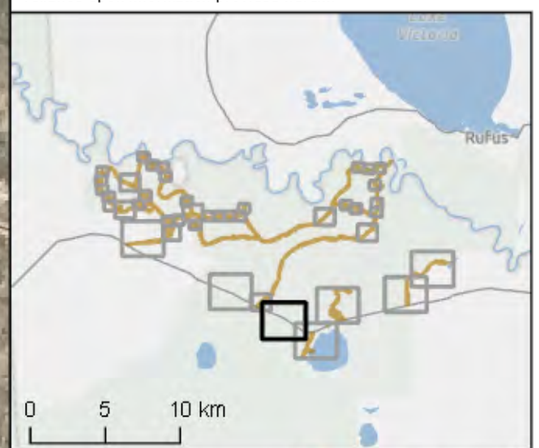

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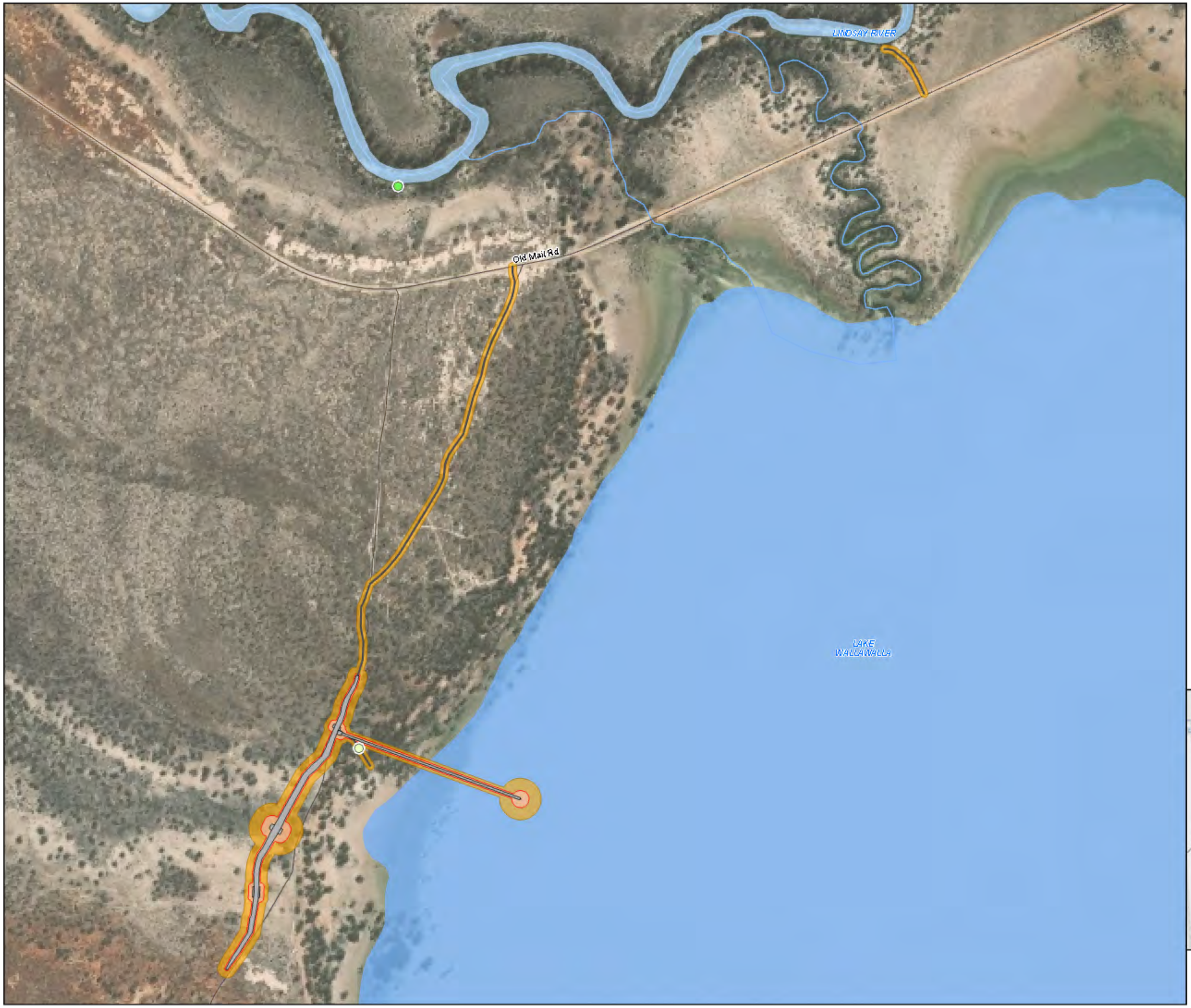
Figure 4: Threatened Flora and Fauna at Lindsay Island



Legend

- Collector road
- Stream
- Watercourse
- Lake
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

Threatened Flora Species

- Acacia oswaldii
- Asperula gemella

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 130 260
Meters

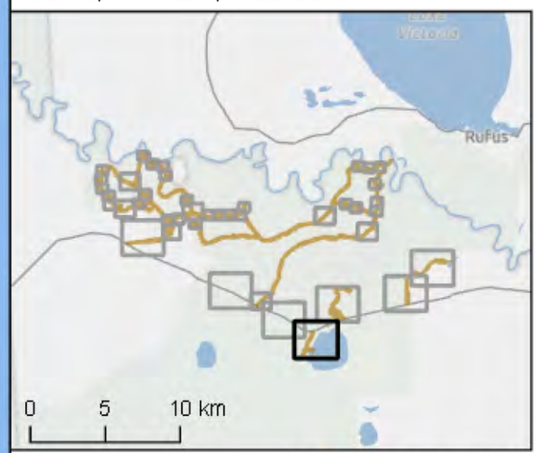


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Figure 4: Threatened Flora and Fauna at Lindsay Island

Legend

- Collector road
- Stream
- Drain/Channel/Other
- Watercourse
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

Threatened Flora Species

- Acacia oswaldii
- Asperula gemella
- Tecticornia triandra

Threatened Flora Species

- Crinum flaccidum

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 130 260
Meters

DATA SOURCES
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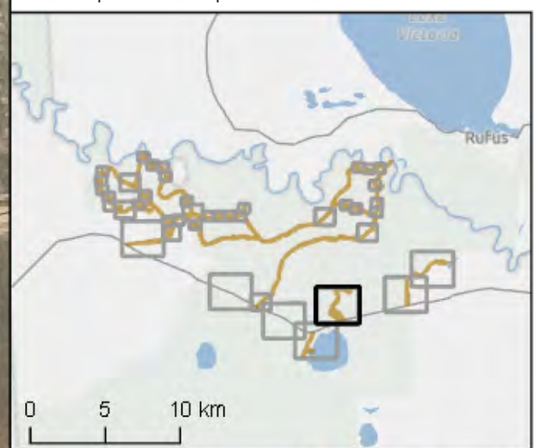

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Figure 4: Threatened Flora and Fauna at Lindsay Island

VMFRP

Legend

- Collector road
- Stream
- Drain/Channel/Other
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

Threatened Flora Species

- Asperula gemella
- Atriplex lindleyi subsp. conduplicata
- Senecio cunninghamii var. cunninghamii
- Tecticornia triandra

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 130 260
Meters

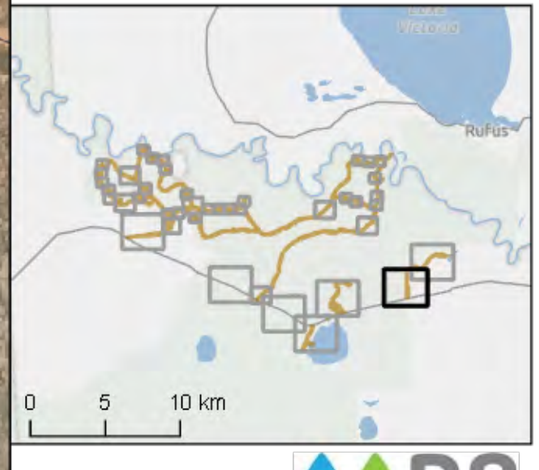

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Figure 4: Threatened Flora and Fauna at Lindsay Island

VMFRP

Legend

- Collector road
- Stream
- Drain/Channel/Other
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

Threatened Flora Species

- Asperula gemella
- Atriplex lindleyi subsp. conduplicata
- Calotis cuneifolia
- Eremophila bignoniiflora
- Senecio cunninghamii var. cunninghamii
- Swainsona greyana

Threatened Flora Species

- Senecio cunninghamii var. cunninghamii

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 130 260
Meters

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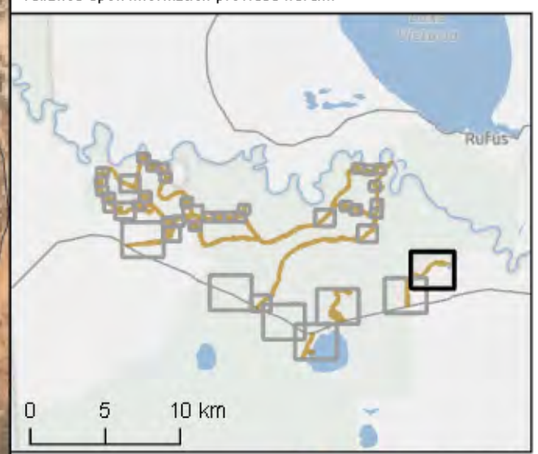

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Figure 5: Ecological Values at Lindsay Island

Legend

- Canopy Tree
- Collector road
- Stream
- Drain/Channel/Other
- Watercourse
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 102 Low Chenopod Scrubland
- 818 Shrubby Riverine Woodland
- Bare ground

Threatened Flora Species

- Tecticornia triandra

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 130 260
Meters

DATA SOURCES
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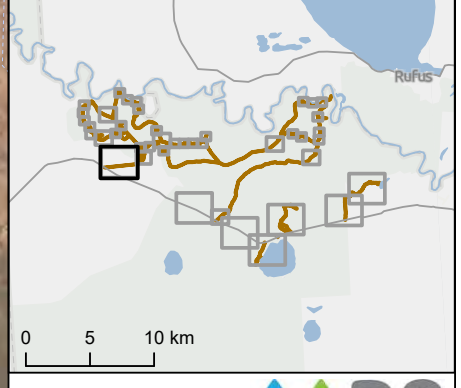

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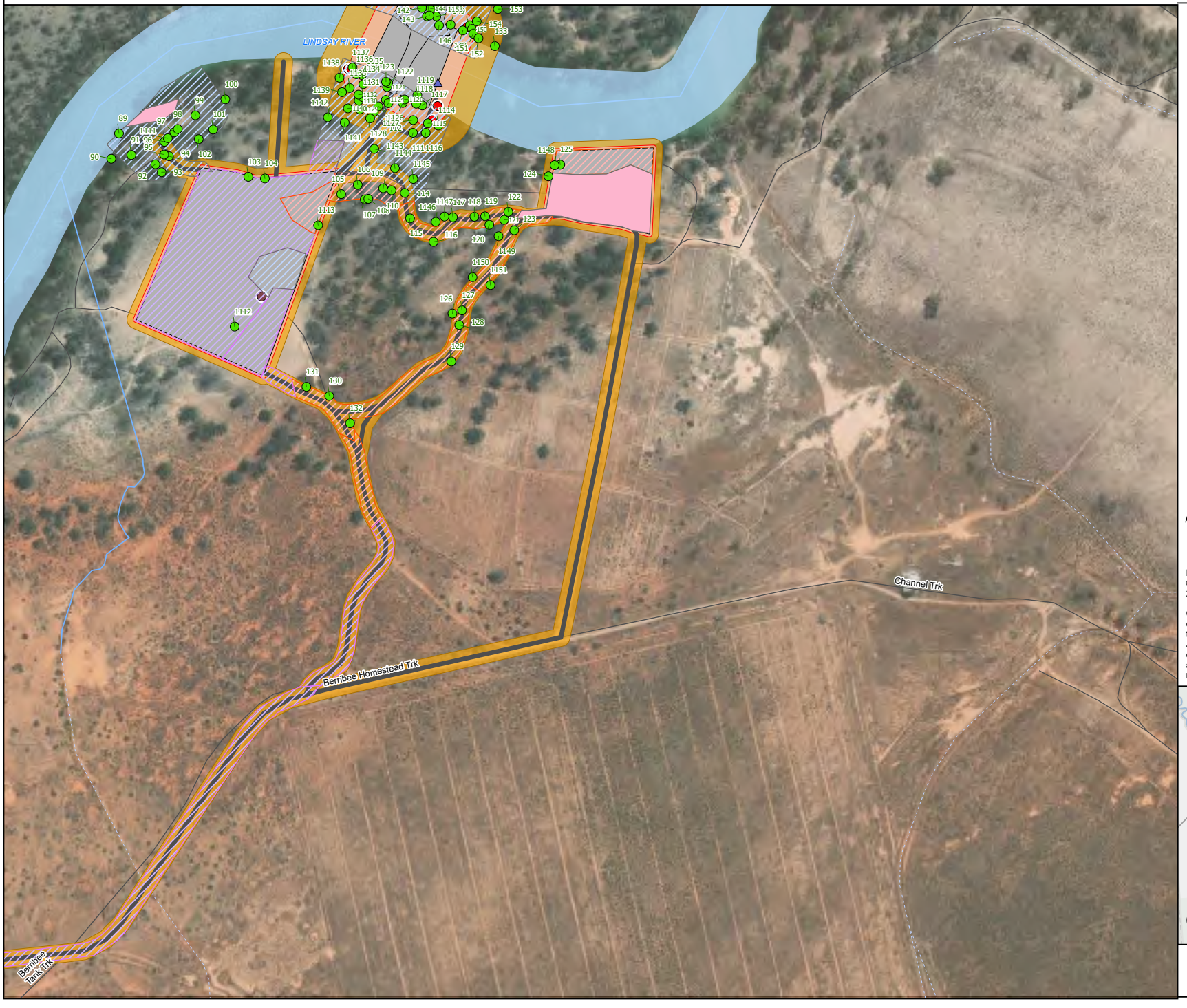


Legend

- Canopy Tree
- Collector road
- Stream
- Drain/Channel/Other
- Watercourse
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 102 Low Chenopod Scrubland
- 103 Riverine Chenopod Woodland
- 818 Shrubby Riverine Woodland
- Bare ground

Threatened Flora Species

- Asperula gemella
- Eremophila bignoniiflora

Threatened Fauna Species

- Great Egret

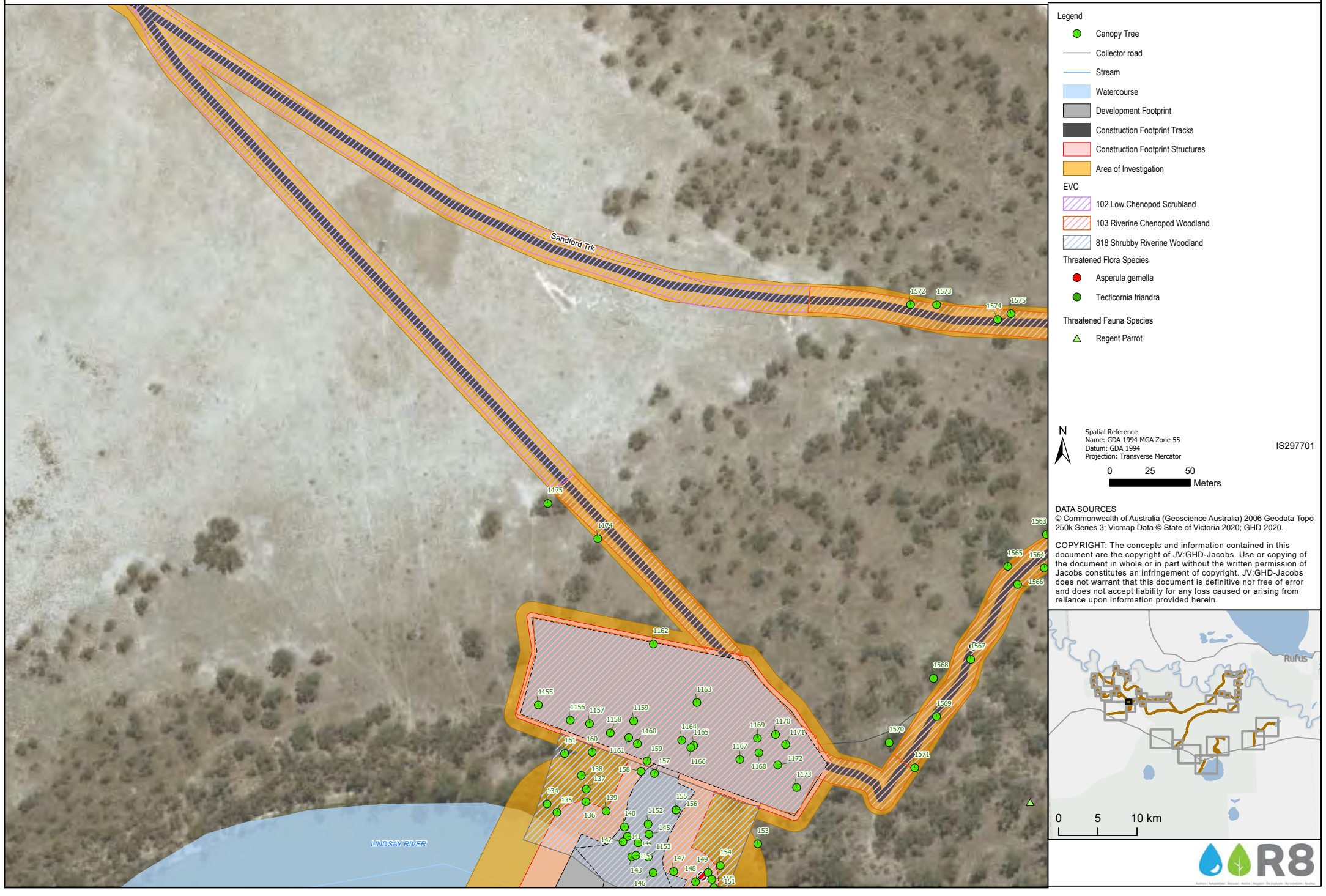
N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 55 110
Meters

Figure 5: Ecological Values at Lindsay Island



Legend

- Canopy Tree
- Collector road
- Stream
- Watercourse
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 102 Low Chenopod Scrubland
- 103 Riverine Chenopod Woodland
- 104 Lignum Swamp
- 808 Lignum Shrubland
- 813 Intermittent Swampy Woodland
- Bare ground at time of assessment (<1%cover)

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 55 110
Meters

DATA SOURCES
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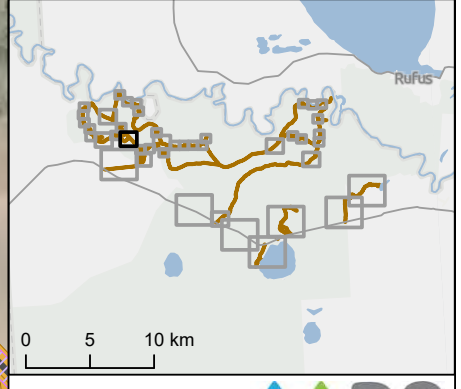


R8

Legend

- Canopy Tree
- Collector road
- Stream
- Watercourse
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 103 Riverine Chenopod Woodland
- 104 Lignum Swamp
- 813 Intermittent Swampy Woodland

Threatened Flora Species

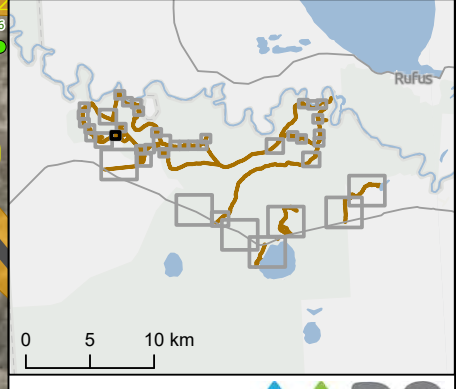
- Calotis cuneifolia
- Eremophila divaricata subsp. divaricata

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters



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Legend

- Canopy Tree
- Collector road
- Stream
- Drain/Channel/Other
- Watercourse
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 813 Intermittent Swampy Woodland
- 98 Semi-arid Chenopod Woodland

Threatened Flora Species

- Crinum flaccidum

Threatened Fauna Species

- Regent Parrot

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 55 110
Meters

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Legend

- Canopy Tree
- Collector road
- Stream
- Watercourse
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 813 Intermittent Swampy Woodland
- 818 Shrubby Riverine Woodland
- 98 Semi-arid Chenopod Woodland

Threatened Flora Species

- Calotis cuneifolia
- Crinum flaccidum

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

Figure 5: Ecological Values at Lindsay Island

Legend

- Canopy Tree
- Stream
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 103 Riverine Chenopod Woodland
- 813 Intermittent Swampy Woodland
- 823 Lignum Swampy Woodland
- 98 Semi-arid Chenopod Woodland

Threatened Flora Species

- Calotis cuneifolia
- Minuria cunninghammii
- Senecio cunninghamii var. cunninghamii

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

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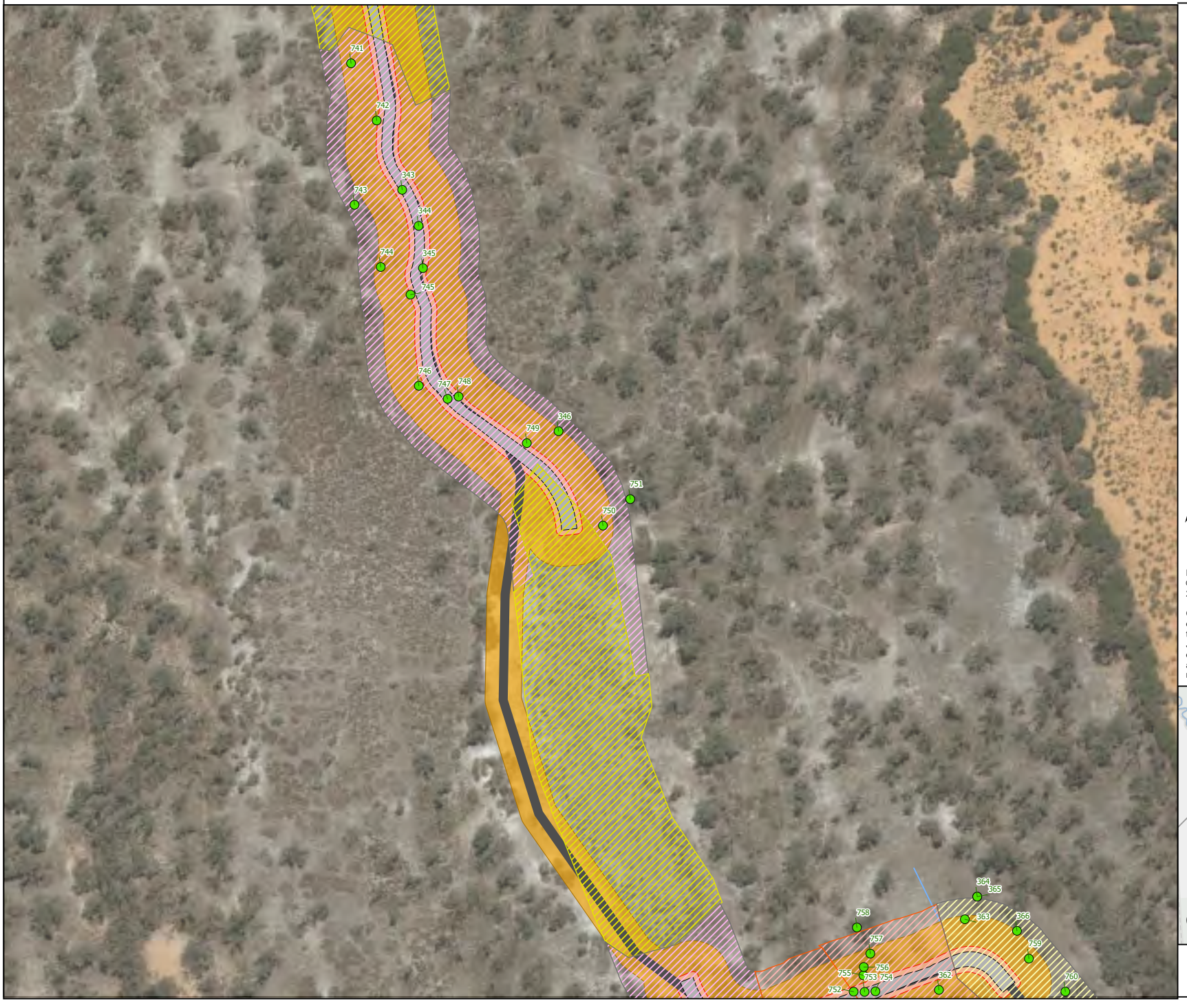

Legend

- Canopy Tree
- Stream
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 103 Riverine Chenopod Woodland
- 104 Lignum Swamp
- 813 Intermittent Swampy Woodland
- 823 Lignum Swampy Woodland

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

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Legend

- Canopy Tree
- Stream
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 104 Lignum Swamp
- 818 Shrubby Riverine Woodland
- 823 Lignum Swampy Woodland

Threatened Flora Species

- Atriplex nummularia subsp. omissa

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

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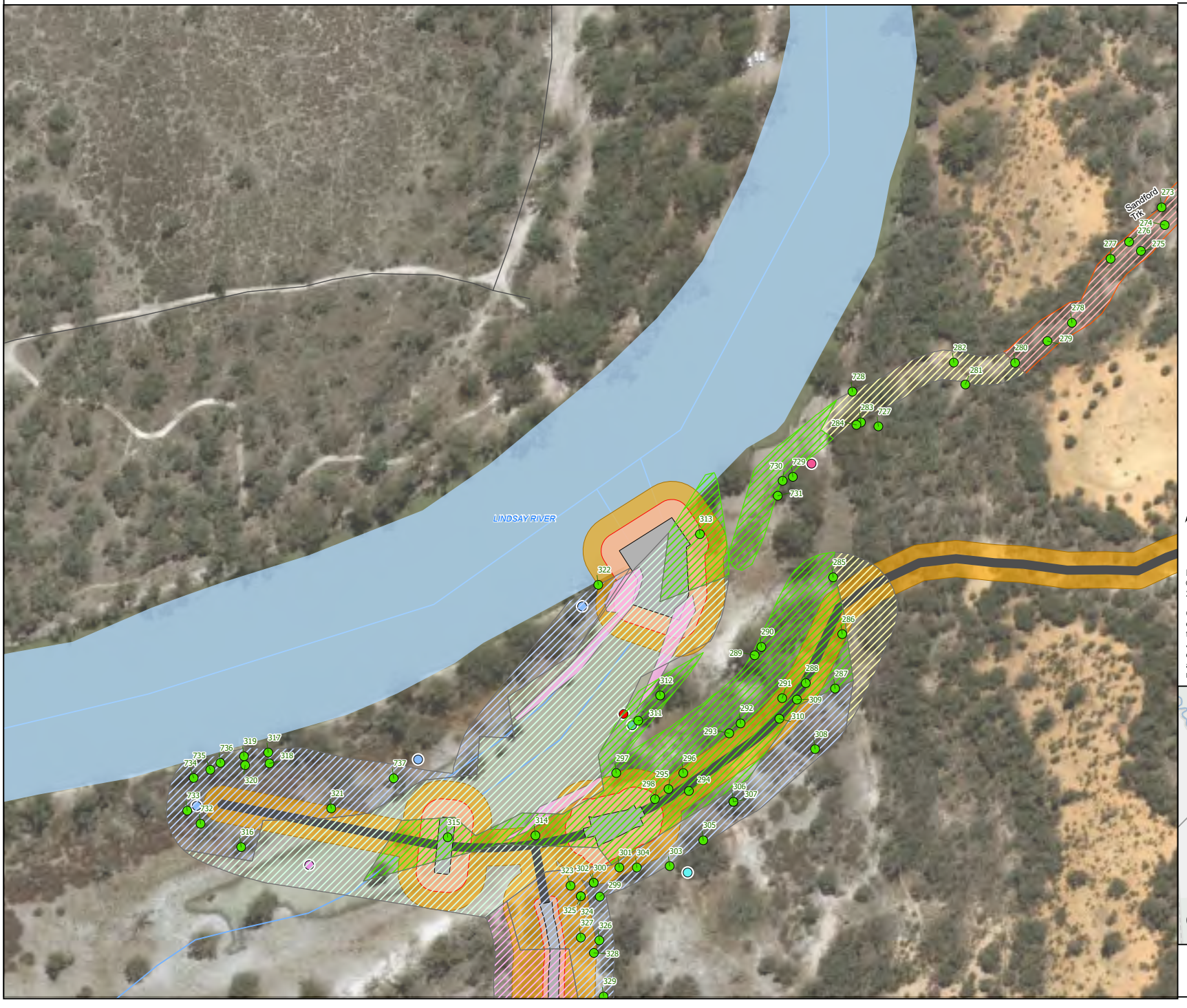

Legend

- Canopy Tree
- Collector road
- Stream
- Watercourse
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 103 Riverine Chenopod Woodland
- 106 Grassy Riverine Forest
- 810 Floodway Pond Herbland
- 813 Intermittent Swampy Woodland
- 818 Shrubby Riverine Woodland
- 823 Lignum Swampy Woodland

Threatened Flora Species

- Asperula gemella
- Atriplex nummularia subsp. omissa
- Crinum flaccidum
- Minuria cunninghammii
- Senecio cunninghamii var. cunninghamii

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

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R8

Legend

- Canopy Tree
- Collector road
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 102 Low Chenopod Scrubland
- 103 Riverine Chenopod Woodland
- 808 Lignum Shrubland

Threatened Flora Species

- Eremophila divaricata subsp. divaricata

Threatened Fauna Species

- Regent Parrot

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

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Legend

- Canopy Tree
- Collector road
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 102 Low Chenopod Scrubland
- 103 Riverine Chenopod Woodland
- 808 Lignum Shrubland

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

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Figure 5: Ecological Values at Lindsay Island

Legend

- Collector road
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 102 Low Chenopod Scrubland
- 103 Riverine Chenopod Woodland
- 104 Lignum Swamp
- 808 Lignum Shrubland

Threatened Flora Species

- Tecticornia triandra

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 55 110
Meters

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Legend

- Canopy Tree
- Collector road
- Stream
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 103 Riverine Chenopod Woodland
- 104 Lignum Swamp
- Bare ground at time of assessment (<1%cover)

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

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Figure 5: Ecological Values at Lindsay Island

Legend

- Canopy Tree
- Collector road
- Stream
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 102 Low Chenopod Scrubland
- 103 Riverine Chenopod Woodland
- 104 Lignum Swamp

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 55 110
Meters

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Legend

- Canopy Tree
- Collector road
- Stream
- Watercourse
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 103 Riverine Chenopod Woodland
- 813 Intermittent Swampy Woodland
- 823 Lignum Swampy Woodland

Threatened Flora Species

- Acacia oswaldii
- Calotis cuneifolia
- Eremophila divaricata subsp. divaricata
- Minuria cunninghammii
- Senecio cunninghamii var. cunninghamii

N

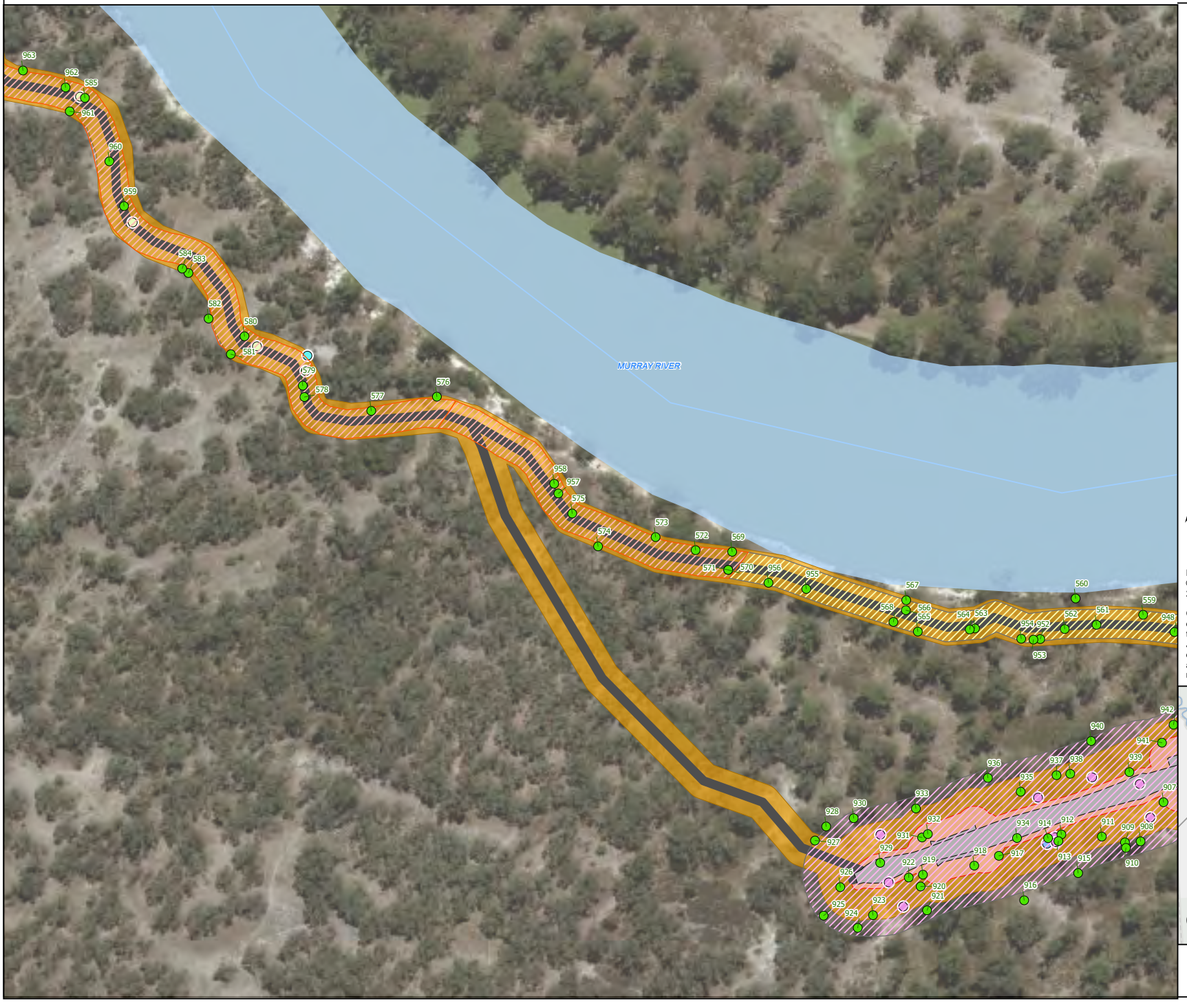
Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

DATA SOURCES
© Commonwealth of Australia (Geoscience Australia) 2006 Geodata Topo 250k Series 3; Vicmap Data © State of Victoria 2020; GHD 2020.

R8



Legend

- Canopy Tree
- Stream
- Watercourse
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 103 Riverine Chenopod Woodland
- 813 Intermittent Swampy Woodland
- 823 Lignum Swampy Woodland

Threatened Flora Species

- Acacia oswaldii
- Atriplex nummularia subsp. omissa
- Minuria cunninghammii
- Senecio cunninghamii var. cunninghamii
- Tecticornia triandra

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

Figure 5: Ecological Values at Lindsay Island

Legend

- Canopy Tree
- Stream
- Watercourse
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 103 Riverine Chenopod Woodland
- 810 Floodway Pond Herbland
- 813 Intermittent Swampy Woodland
- 823 Lignum Swampy Woodland

Threatened Flora Species

- Senecio cunninghamii var. cunninghamii

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

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Path: G:\31\12510225\GIS\Maps\Working\Lindsay_Island\12510225_EcologyFigures_Lindsay\12510225_EcologyFigures_Lindsay.aprx

Legend

- Canopy Tree
- Stream
- Watercourse
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 103 Riverine Chenopod Woodland
- 813 Intermittent Swampy Woodland
- 823 Lignum Swampy Woodland

Threatened Flora Species

- Eremophila divaricata subsp. divaricata
- Senecio cunninghamii var. cunninghamii

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

DATA SOURCES
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Legend

- Canopy Tree
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 103 Riverine Chenopod Woodland
- 104 Lignum Swamp
- 823 Lignum Swampy Woodland

Threatened Flora Species

- Eremophila divaricata subsp. divaricata

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

Legend

- Canopy Tree
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 102 Low Chenopod Scrubland
- 103 Riverine Chenopod Woodland
- 104 Lignum Swamp

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

DATA SOURCES
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Legend

- Canopy Tree
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 102 Low Chenopod Scrubland
- 104 Lignum Swamp
- 808 Lignum Shrubland
- 823 Lignum Swampy Woodland

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

DATA SOURCES
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Legend

- Canopy Tree
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 102 Low Chenopod Scrubland
- 104 Lignum Swamp
- 823 Lignum Swampy Woodland

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

DATA SOURCES
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Legend

- Canopy Tree
- Stream
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 102 Low Chenopod Scrubland
- 104 Lignum Swamp
- 823 Lignum Swampy Woodland

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

DATA SOURCES
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Legend

- Canopy Tree
- Collector road
- Stream
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 102 Low Chenopod Scrubland
- 103 Riverine Chenopod Woodland
- 104 Lignum Swamp

Threatened Flora Species

- Tecticornia triandra

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 55 110
Meters

DATA SOURCES
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Legend

- Canopy Tree
- Collector road
- Stream
- Watercourse
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 103 Riverine Chenopod Woodland
- 104 Lignum Swamp

Threatened Flora Species

- Tecticornia triandra

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

DATA SOURCES
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Legend

- Canopy Tree
- Collector road
- Stream
- Watercourse
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 101 Samphire Shrubland
- 102 Low Chenopod Scrubland
- 103 Riverine Chenopod Woodland
- 808 Lignum Shrubland
- 823 Lignum Swampy Woodland

Threatened Flora Species

- Atriplex nummularia subsp. omissa
- Tecticornia triandra

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

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Legend

- Canopy Tree
- Collector road
- Stream
- Watercourse
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 102 Low Chenopod Scrubland
- 103 Riverine Chenopod Woodland
- 808 Lignum Shrubland

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

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Legend

- Canopy Tree
- Collector road
- Stream
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 102 Low Chenopod Scrubland
- 103 Riverine Chenopod Woodland
- 104 Lignum Swamp

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

Legend

- Canopy Tree
- Collector road
- Stream
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 102 Low Chenopod Scrubland
- 103 Riverine Chenopod Woodland

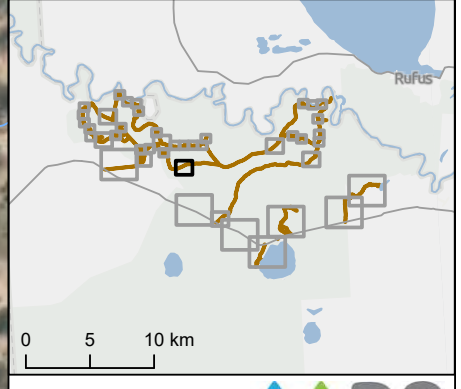
N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 55 110
Meters

DATA SOURCES
© Commonwealth of Australia (Geoscience Australia) 2006 Geodata Topo 250k Series 3; Vicmap Data © State of Victoria 2020; GHD 2020.



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Legend

- Canopy Tree
- Collector road
- Stream
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 102 Low Chenopod Scrubland
- 103 Riverine Chenopod Woodland
- 813 Intermittent Swampy Woodland

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

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Meters

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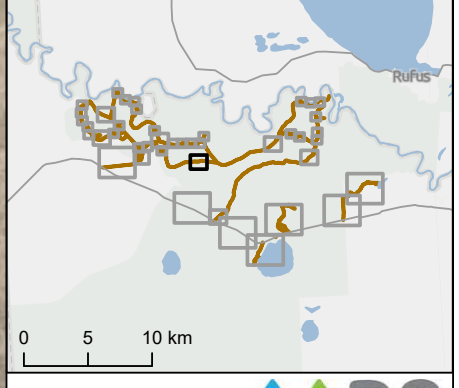

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Legend

- Canopy Tree
- Collector road
- Stream
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 101 Samphire Shrubland
- 102 Low Chenopod Scrubland
- 103 Riverine Chenopod Woodland

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 55 110
Meters

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Legend

- Canopy Tree
- Collector road
- Stream
- Watercourse
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 102 Low Chenopod Scrubland
- 103 Riverine Chenopod Woodland
- 813 Intermittent Swampy Woodland

Threatened Flora Species

- Tecticornia triandra

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

DATA SOURCES
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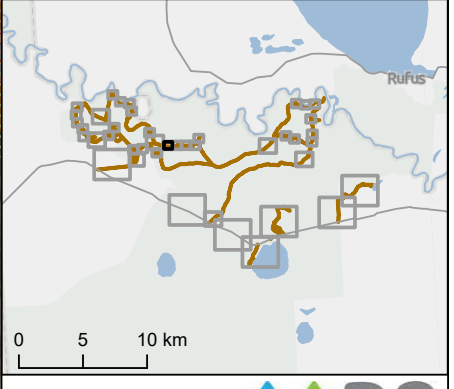

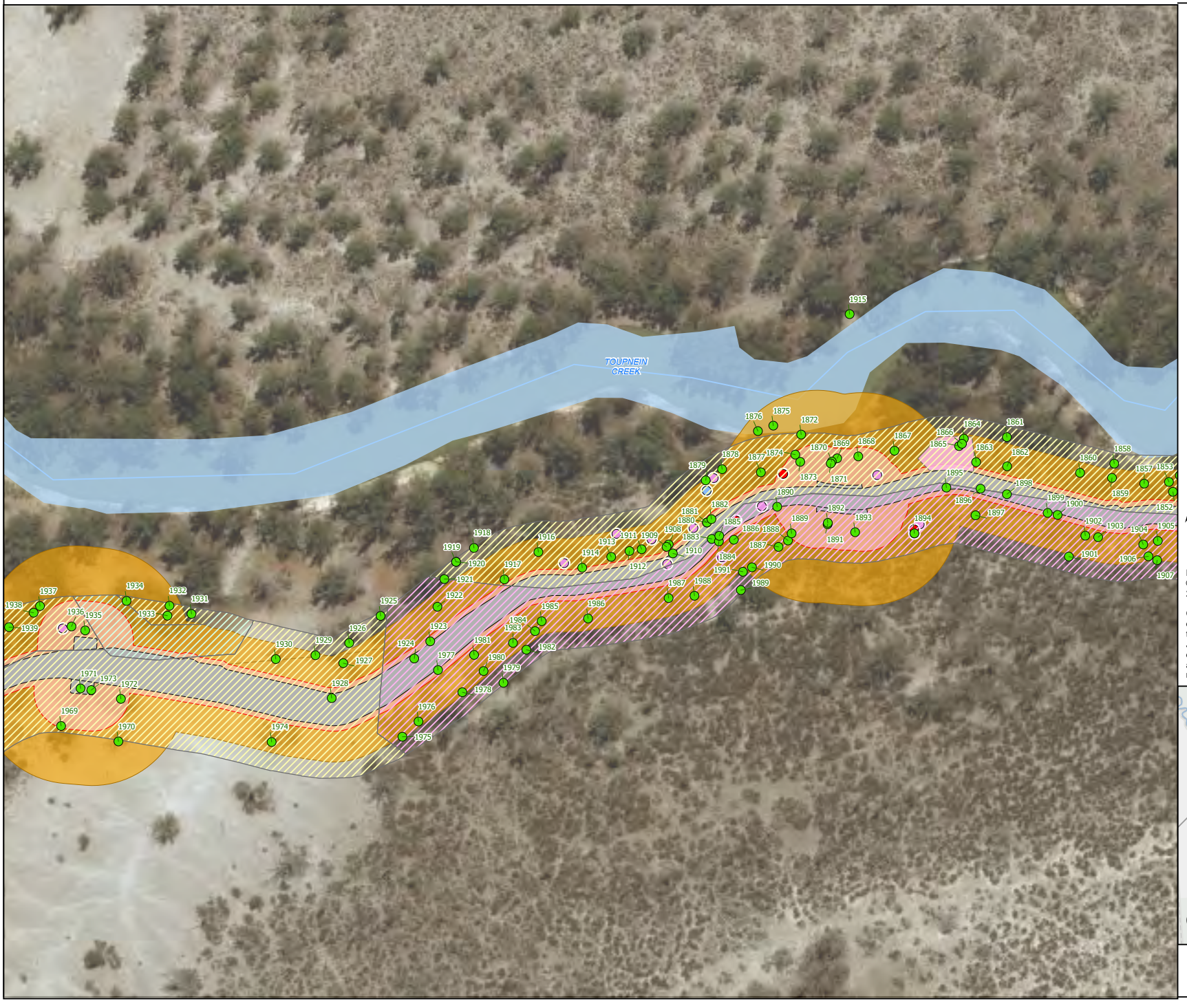

Legend

- Canopy Tree
- Collector road
- Stream
- Watercourse
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 810 Floodway Pond Herbland
- 813 Intermittent Swampy Woodland
- 823 Lignum Swampy Woodland

Threatened Flora Species

- Asperula gemella
- Minuria cunninghammii
- Senecio cunninghamii var. cunninghamii

Threatened Flora Species

- Senecio cunninghamii var. cunninghamii

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

DATA SOURCES
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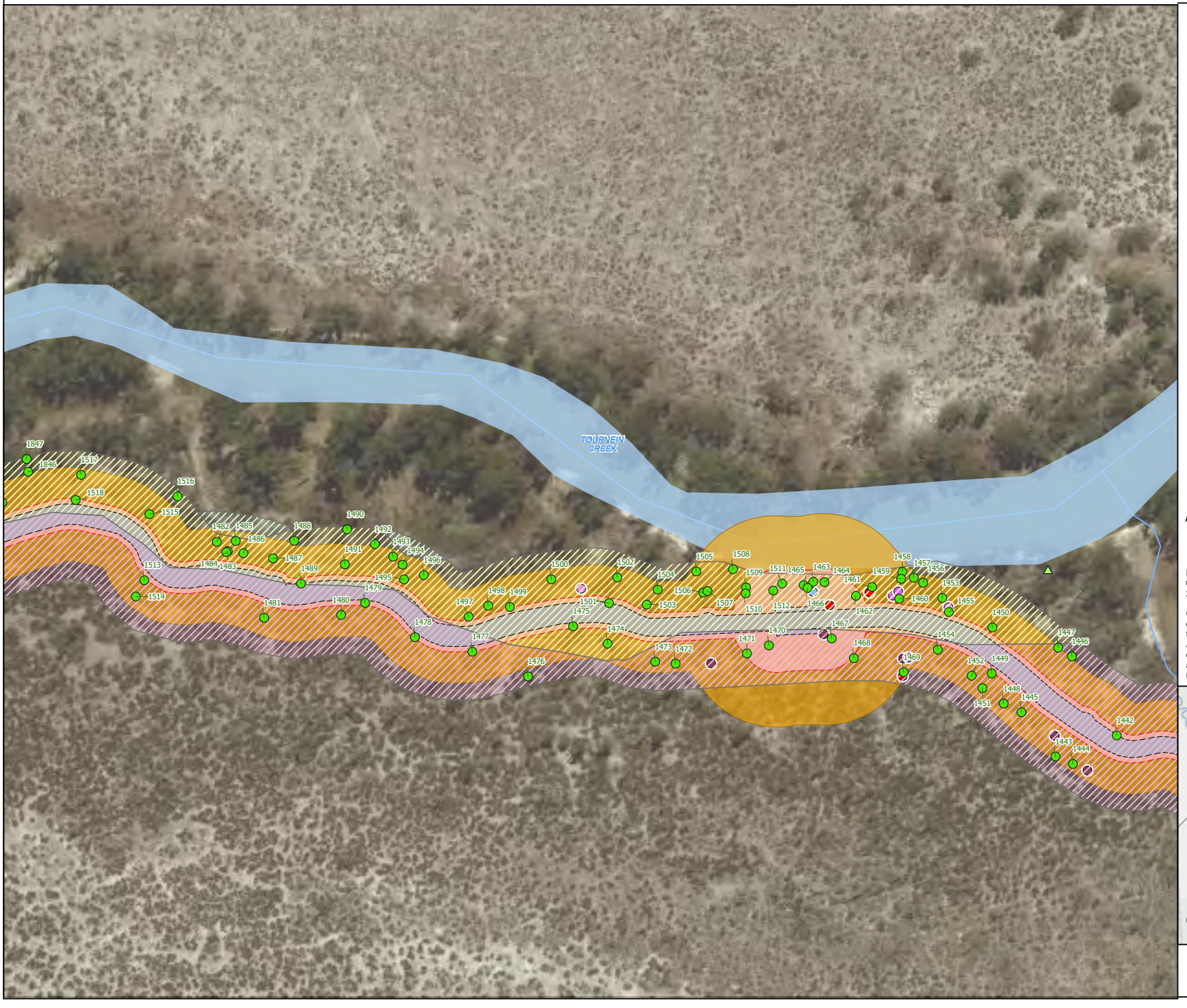


Legend

- Canopy Tree
- Collector road
- Stream
- Watercourse
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 810 Floodway Pond Herbland
- 813 Intermittent Swampy Woodland
- 823 Lignum Swampy Woodland

Threatened Flora Species

- Asperula gemella
- Calotis cuneifolia
- Eremophila bignoniiflora
- Minuria cunninghammii
- Senecio cunninghamii var. cunninghamii

Threatened Fauna Species

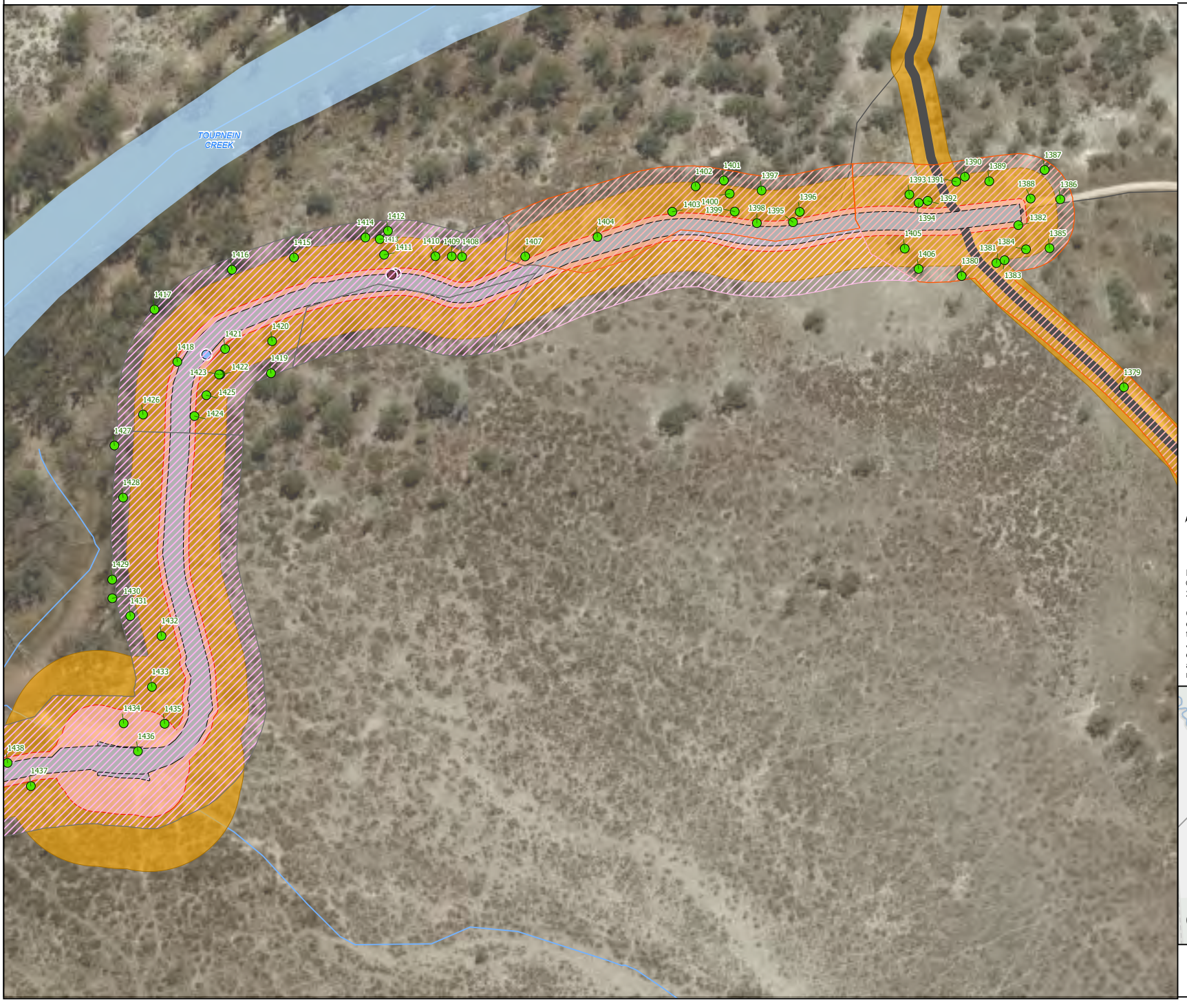
- Regent Parrot

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters



Legend

- Canopy Tree
- Collector road
- Stream
- Watercourse
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 103 Riverine Chenopod Woodland
- 808 Lignum Shrubland
- 823 Lignum Swampy Woodland

Threatened Flora Species

- Eremophila bignoniiflora
- Minuria cunninghammii

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

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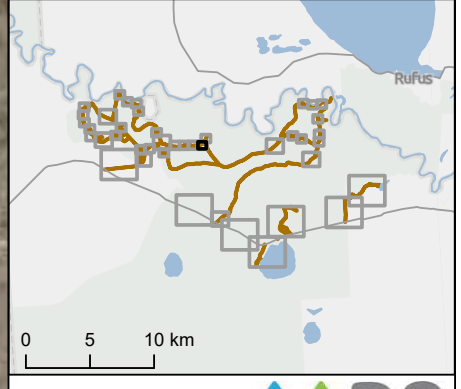

Legend

- Collector road
- Stream
- Watercourse
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

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0 25 50
Meters

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Legend

- Canopy Tree
- Stream
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 101 Samphire Shrubland
- 103 Riverine Chenopod Woodland

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

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Legend

- Canopy Tree
- Collector road
- Stream
- Watercourse
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 102 Low Chenopod Scrubland
- 103 Riverine Chenopod Woodland

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

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Legend

- Canopy Tree
- Collector road
- Stream
- Watercourse
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 103 Riverine Chenopod Woodland

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

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Figure 5: Ecological Values at Lindsay Island

Legend

- Canopy Tree
- Collector road
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 102 Low Chenopod Scrubland
- 103 Riverine Chenopod Woodland

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

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Figure 5: Ecological Values at Lindsay Island

Legend

- Canopy Tree
- Collector road
- Stream
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 102 Low Chenopod Scrubland
- 104 Lignum Swamp
- 823 Lignum Swampy Woodland

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

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Legend

- Canopy Tree
- Collector road
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 104 Lignum Swamp
- 823 Lignum Swampy Woodland

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

DATA SOURCES
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Legend

- Canopy Tree
- Collector road
- Stream
- Watercourse
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 103 Riverine Chenopod Woodland
- 104 Lignum Swamp
- 823 Lignum Swampy Woodland
- Bare ground at time of assessment (<1% cover of chenopods)

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 55 110
Meters

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Legend

- Canopy Tree
- Collector road
- Stream
- Watercourse
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 101 Samphire Shrubland
- 103 Riverine Chenopod Woodland
- 104 Lignum Swamp
- 823 Lignum Swampy Woodland

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

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Figure 5: Ecological Values at Lindsay Island

Legend

- Canopy Tree
- Collector road
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 102 Low Chenopod Scrubland
- 103 Riverine Chenopod Woodland
- 104 Lignum Swamp
- 823 Lignum Swampy Woodland

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

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Legend

- Canopy Tree
- Collector road
- Stream
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 102 Low Chenopod Scrubland
- 103 Riverine Chenopod Woodland
- 104 Lignum Swamp
- 823 Lignum Swampy Woodland

Threatened Flora Species

- Eremophila bignoniiflora

Threatened Flora Species

- Eremophila bignoniiflora

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 25 50
Meters

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Legend

- Canopy Tree
- Collector road
- Stream
- Watercourse
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 102 Low Chenopod Scrubland
- 104 Lignum Swamp
- 106 Grassy Riverine Forest
- 810 Floodway Pond Herbland
- 823 Lignum Swampy Woodland

Threatened Flora Species

- Senecio cunninghamii var. cunninghamii

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

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0 25 50
Meters

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Legend

- Canopy Tree
- Collector road
- Stream
- Development Footprint
- Construction Footprint Tracks
- Construction Footprint Structures
- Area of Investigation

EVC

- 101 Samphire Shrubland
- 102 Low Chenopod Scrubland
- 103 Riverine Chenopod Woodland

N

Spatial Reference
Name: GDA 1994 MGA Zone 55
Datum: GDA 1994
Projection: Transverse Mercator

IS297701

0 55 110
Meters

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