



# Preliminary biodiversity impact assessment – Lake Wendouree Light Installation

Prepared for City of Ballarat

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# 1. Introduction

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## 1.1 Purpose

Biosis Pty Ltd was commissioned by City of Ballarat to undertake a preliminary biodiversity impact assessment for the proposed installation of lights around Lake Wendouree. This report aims to identify the ecological values and constraints within the investigation area, in order to inform City of Ballarat of potential ecological concerns with the installation of lights around Lake Wendouree.

## 1.2 Scope of this report

This report outlines the ecological values, opportunities and constraints of the study area and includes:

- The project context relating to the ecological values and the methodology undertaken to make the assessment.
- A description of the relevant ecological legislation and policy.
- The key ecological findings.
- The implications of legislation and policies on the project based on the key findings.
- The actions required based on the findings of the report.

## 1.3 Methodology

A desktop assessment was undertaken to identify and highlight ecological values and any associated potential risks or constraints for the project.

The following methodology was used for the development of this report:

- Review of the following databases and tools:
  - The Department of Environment, Land, Water and Planning (DELWP) Victorian Biodiversity Atlas (VBA).
  - DELWP NatureKit mapping tool.
  - Protected Matters Search Tool of the Australian Government Department of Agriculture, Water and the Environment (DAWE) for matters of national environmental significance protected by the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).
  - DELWP Native Vegetation Information Management (NVIM) system.
- Review of relevant literature.
- Consideration of submissions to Council by community members.

## 2. Project Description

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### 2.1 Project Context

The City of Ballarat is planning to install lighting along the Steve Moneghetti track which is situated around Lake Wendouree.

It is understood there are a number of environmental concerns raised by members of the public in regard to the effect the lights will have on insects and other fauna that utilise the surrounding area.

### 2.2 Project Area

Lake Wendouree is situated in the centre of Ballarat and is roughly 238 hectares in size (Kraaijeveld et al. 2004). The area was originally a swamp which has been subject to modification since European settlement. Works undertaken on the lake stretch back to 1869 when the lake completely dried out and the lake bed was deepened by prisoners (Biosis 2016). Since then numerous alterations to the lake and surrounding area have been made including; the raising of the banks of the lake, construction of footpaths, trenching of the foreshore, filling and excavation work, creation of promontories, jetty construction, removal of dead Eucalyptus trees, construction of sewers, cultivation of reed beds, numerous plantings of exotic trees (Cypress, Willows, Birch and Oak) and sowing areas with exotic grass species (Biosis 2016).

The project area is approximately 400 hectares in size and includes Lake Wendouree and the surrounding Public Park and Recreation Zone. The land within the Public Park and Recreation Zone surrounding Lake Wendouree encompasses the Steve Moneghetti track which today is very popular for walkers, runners and cyclists, providing connections between restaurants, boat sheds, playgrounds and car parks. The lake itself is used for recreation activities including rowing, sailing, fishing and bird watching.

Despite past disturbances, extensive use for recreation and surrounding residential development, the Lake still contains large areas of emergent vegetation and harbours numerous native bird, fish and insect species.

The lake is stocked with trout (Brown Trout *Salmo trutta* and Rainbow Trout *Oncorhynchus mykiss*), and is an important fishery for locals and visitors. Other non-native fish species have been released in the lake, and have established breeding populations, including Redfin *Perca fluviatilis*, Tench *Tinca tinca* and European Carp *Cyprinus carpio*.

The lake is relatively shallow, and has dense growth of aquatic plants including Water-milfoil *Myriophyllum* spp., Water Ribbons *Cyanogeton procerum*, Bulrushes *Typha* spp., Tall Spike-rush *Eleocharis sphacelata* and a range of other species. The majority of the lake is periodically mown with an aquatic weed harvester to maintain areas of open water, and aquatic plant material is removed by purpose built machinery. Without this mowing the surface of the lake would gradually revert to a marshland with dense submerged and emergent vegetation.

## 3. Findings

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### 3.1 Site context

The project area is located within the city of Ballarat approximately 1 kilometre from the CBD. The lake is surrounded on all sides by residential development, including housing, streets and parklands. The Ballarat Botanic Gardens and North Gardens are located on the western side of the Lake, and Victoria Park is located to the south of the lake, approximately 200 metres away at the closest point. Victoria Park is a large area of open space, consisting of sports fields, wetlands, plantings of exotic trees, and large areas of grassland including some areas of remnant native grassland.

There are limited ecological values within 5 kilometres of the project area. Most of the project area contains the residential and industrial area of Ballarat which generally contains little ecological values except for planted shrubs and trees which provide habitat for some native bird species. However, larger areas of native vegetation may be found in Victoria Park, Winters Swamp, Yarrowee River, Ballarat Town Common, and Nerrina reserve.

Besides Lake Wendouree the only other significant nearby waterways are Winters Swamp and the Yarrowee River.

### 3.2 Assessment of existing significant environmental values

#### Vegetation

The project area is within the Victorian Volcanic Plain Bioregion. Two Ecological Vegetation Classes (EVCs) Plains Sedgey Wetland and Plains Grassy Woodland – are modelled as occurring within the project area. Threatened or rare flora species that are predicted to occur within 5 kilometres of the project area are listed in Appendix 1.

#### Matters of National Environmental Significance

The EPBC Act Protected Matters search lists five threatened ecological communities with the potential to occur within 5 kilometres of the project area:

- **Grassy Eucalypt Woodland of the Victorian Volcanic Plain**  
This community is known to occur within 5 kilometres of the project area.
- **Grey Box (*Eucalyptus microcarpa*) Grassy Woodlands and Derived native Grasslands of South-eastern Australia**  
This community may occur within 5 kilometres of the project area.
- **Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains**  
This community is likely to occur within 5 kilometres of the project area.
- **Natural Temperate Grassland of the Victorian Volcanic Plain**  
This community may occur within 5 kilometres of the project area.
- **White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland**  
This community is likely to occur within 5 kilometres of the project area.

Due to the majority of the project area being highly modified (i.e. containing large areas of exotic grassland and exotic trees), it is unlikely that any of these communities would be directly impacted by potential installation of artificial light sources around Lake Wendouree.

There are 14 EPBC Act listed flora species and 20 EPBC Act listed fauna species recorded or predicted to occur within 5 kilometres of the study area. Of these species, the desktop assessment considered the following EPBC Act listed species with the greatest potential to occur within the study area:

- River Swamp Wallaby-grass *Amphibromus fluitans*
- Australian Painted Snipe *Rostratula australis*
- Australasian Bittern *Botaurus poiciloptilus*
- Swift Parrot *Lathamus discolor*
- White-throated Needletail *Hirundapus caudacutus*
- Eastern Curlew *Numenius madagascariensis*
- Curlew Sandpiper *Calidris ferruginea*
- Grey-headed Flying-fox *Pteropus poliocephalus*
- Growling Grass Frog *Litoria raniformis*

There is one VBA record of River Swamp Wallaby-grass 3 kilometres east of the study area near Nerrina. Although the species could potentially occur within the vicinity of Lake Wendouree the installation of lights at Lake Wendouree is unlikely to impact upon this species.

Australian Painted Snipe, Australasian Bittern, Eastern Curlew and Curlew Sandpiper are all water bird species which could potentially occur within Lake Wendouree on occasion, but none of these species are regular or resident within the area. These species are not likely to be impacted by the lighting project.

Swift Parrot and Grey-headed Flying-fox are both mobile arboreal fauna species which have the potential to forage on large trees within the study area on occasion. A significant impact on these species is unlikely as this is not important resident habitat for either of the species.

White-throated Needletail is an almost completely aerial species which has the potential to fly over the study area. The installation of lights is highly unlikely to significantly impact this species.

Growling Grass Frog occupies a variety of permanent or semi-permanent waterbodies, typically with emergent vegetation, throughout south-eastern Australia. Lake Wendouree contains potential habitat for this species, although it is not regularly recorded within the lake.

### **Flora and Fauna Guarantee Act 1988**

There is one *Flora and Fauna Guarantee Act 1988* (FFG Act) listed flora species and 13 FFG Act listed fauna species recorded or predicted to occur within 5 kilometres of the study area. The likelihood of these species being present within the study area is provided in Appendix 1 for flora and Appendix 2 for fauna.

## 4. Potential impacts of the lighting project

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Below is a discussion of some potential impacts of the lighting project. The assessment is based on the designs and project description provided by the City of Ballarat, and the assumption that the period of lighting will be limited. The lighting has been designed to ensure that there is minimum light spillage in terms of upwards illumination and lateral illumination (spread) away from the track. The assessment is also based on the context of the project, where the surrounding streets, both immediately adjacent to the lake and the wider city, are an existing lit landscape, with numerous sources of artificial light.

### Aquatic invertebrates

Lake Wendouree is known to be a world class trout fishery. Introduced Brown and Rainbow Trout are regularly stocked within the lake for recreational fishing purposes and the aquatic invertebrate population of the lake is the primary food source for the trout. The Lake also hosts illegally introduced populations of English Perch (Redfin), European Carp and Tench. Fishing at the lake is undertaken by a wide range of community members, including occasional anglers and enthusiasts, and the lake has also hosted competitive fly-fishing competitions. While the trout population itself is unlikely to be directly impacted by the lights, there is some potential for interruption to the life-cycles of aquatic insects.

It is well known that a wide range of flying invertebrate species are attracted to artificial light sources (Perkin, E, Holker, F, & Tockner, K 2014). Several aquatic flying species such as mayflies, midges and caddisflies may also be drawn to artificial light sources. Aquatic insects exhibit dispersal inland from water sources which have consequences for colonisation and gene flow (Bohonak, A & Jenkins, G 2003, Kovats, Z, Ciborowski, J, & Corkum, L 1996). The dispersal inland of adult aquatic invertebrates has been shown to be negatively impacted by artificial light sources such as street lights (Perkin, E, Holker, F, & Tockner, K 2014).

There is potential for the lighting project to impact upon aquatic insects with terrestrial emergence patterns at particular times of the year. The level of impact would be very difficult to quantify without detailed studies. However, the project involves a minor increase in lighting for a limited time each night, in a landscape which is already subject to artificial lighting in both the immediate and the broader areas.

### Bogong moth

Potential impacts to Bogong Moth *Agrotis infusa* migration have been specifically raised by community members in relation to the lighting project.

Bogong Moths migrate from southern Queensland, western New South Wales and Western Victoria to the Australian Alps during spring, where they provide an important food source for the endangered Mountain Pygmy-possum *Burramys parvus*. The moths are active at night and can be attracted to the lights of cities (Zoos Victoria 2019). Zoos Victoria released a statement in August 2019 to encourage people to turn off their lights in September and October to avoid negatively affecting the migration of the Bogong Moths to the Alpine areas (Zoos Victoria 2019).

While Bogong Moths have been recorded in southern Victorian cities such as Ballarat and Melbourne, these areas are not thought to be key sites for moth migration, as the majority of the population is moving from dry inland areas to the Australian Alps. Observations in southern cities are likely to be from moths blown off course. Additionally, the moths do not have an aquatic life phase or aquatic habitat requirement, so Lake Wendouree is not expected to provide important habitat. The additional lighting proposed to be provided by the Lake Wendouree lighting project is negligible when considered in the context of the level of artificial lighting within the broader Ballarat suburban area.



## Wildlife

Lake Wendouree provides important habitat for a diverse range of wildlife, with over 150 vertebrate species known to occur in the area. The key habitats are aquatic, including open water, reed beds within the lake, and riparian vegetation around the edge of the lake. The parklands around the lake are highly modified and maintained, with areas of mown grassland and planted exotic trees covering most of the area.

Lake Wendouree supports a wide range of wetland bird species, including some rare or threatened species, and is also known to support a large population of Water Rat *Hydromys chrysogaster*.

The proposed lighting project is not expected to impact upon the habitat quality of the majority of the aquatic area, due to the size of the lake and the distance between the running track and the aquatic habitats.

There is likely to be increased insect activity around the lights, which may lead to changes in the foraging patterns of nocturnal insectivorous foragers such as microbats, but this is likely to be already occurring in the area due to the existing street lighting and lights from housing.

## Threatened fauna species

The likelihood of occurrence of threatened fauna species occurring within the lake and surrounds is provided in Appendix 2, and summarised in Section 3.2.

Lake Wendouree provides potential habitat for a range of rare or threatened species. Most of these species only occur in the area irregularly or on occasion. Several species are regular visitors or residents, including:

- Musk duck *Biziura lobata* (considered vulnerable within Victoria (DSE 2013))
- Blue-billed Duck *Oxyura australis* (considered endangered within Victoria, listed under the FFG Act)
- Hardhead *Aythya australis* (considered vulnerable within Victoria (DSE 2013))
- Whiskered Tern *Childonias hybrida* (considered near threatened within Victoria (DSE 2013))

These species are all diurnal foragers, and their persistence within Lake Wendouree is dependent on water quality and healthy aquatic vegetation and aquatic insect populations.

## 4.1 Conclusion and recommendations

This review has identified potential impacts to the populations of aquatic insects that have aerial emergence patterns. The aquatic insect populations are important for the general health of the Lake Wendouree system, and are an important source of food for the introduced Trout population and a range of waterbird species.

The level of impact is difficult to predict without detailed monitoring studies. It is expected, however, that impacts would be minor, after consideration of the location and timing of the lighting, and the level of additional light in the context of the existing lighting.

The following recommendations, most of which are already part of the project design, may help to minimise any impacts on insect populations:

- Consider a monitoring program to examine the attraction of aquatic insects to the new lighting and existing lighting around the Lake. This program would also need to monitor the general aquatic insect community within the lake, in order to detect changes that may have flow-on effects to other species.
- Limit the duration of lighting. The dusk period is important for insect emergence, and it may be advisable to delay the turning off of lighting until complete darkness.

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- Ensure light brightness is the minimum required, and that there is minimum spillage away from the track.
  - Orient lights downward so that bright lights are not visible from aquatic habitats within the Lake.

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## Appendix 1 Flora

Notes to tables:

<p><b>EPBC Act:</b>  CR - Critically Endangered  EN - Endangered  VU - Vulnerable</p> <p>PMST – Protected Matters Search Tool</p>	<p>(DEPI 2014):  e - endangered  v - vulnerable  r - rare  k - poorly known</p>
<p><b>FFG Act:</b>  L - listed as threatened under FFG Act  P - protected under the FFG Act (public land only)</p>	<p><b>Noxious weed status:</b>  SP - State prohibited species  RP - Regionally prohibited species  RC - Regionally controlled species  R - Restricted species</p> <p># - Native species outside natural range</p>

## A1.1 Listed flora species

The following table includes the listed flora species that have potential to occur within the study area. The list of species is sourced from the Victorian Biodiversity Atlas and the Protected Matters Search Tool (DAWE; accessed on 11.02.2020).

Scientific name	Conservation status			Most recent database record	Habitat description	Likely occurrence in study area	Rationale for likelihood ranking
	EPBC	VIC	FFG				
<b>National significance</b>							
River Swamp Wallaby-grass <i>Amphibromus fluitans</i>	VU		I	2006, PMST	Swampy areas, mainly along the Murray River between Wodonga and Echuca with scattered records from southern Victoria.	<b>Medium</b>	Potentially suitable habitat, recorded within Ballarat region.
Ornate Pink-fingers <i>Caladenia ornata</i>	VU	v	L	PMST	Heathy and grassy woodlands.	<b>Negligible</b>	No suitable habitat.
Matted Flax-lily <i>Dianella amoena</i>	EN	e	L	1770, PMST	Lowland grassland and grassy woodland, on well-drained to seasonally waterlogged fertile sandy loam soils to heavy cracking clays.	<b>Negligible</b>	No suitable habitat.
Black Gum <i>Eucalyptus aggregata</i>	VU	e	L	PMST	Riparian woodland, primarily on floodplains but occasionally extending up adjacent lower slopes.	<b>Negligible</b>	No suitable habitat.
Clover Glycine <i>Glycine latrobeana</i>	VU	v	L	PMST	Grasslands and grassy woodlands, particularly those dominated by Kangaroo Grass.	<b>Negligible</b>	No suitable habitat.
Adamson's Blown-grass <i>Lachnagrostis adamsonii</i>	EN	v	L	PMST	Low-lying, seasonally wet or swampy areas of plains communities, often in slightly saline conditions.	<b>Low</b>	Potentially suitable habitat, not recorded within 5km of study area.
Hoary Sunray <i>Leucochrysum albicans</i> var. <i>tricolor</i>	EN	e	L	PMST	Grasslands of the Victorian Volcanic Plains, primarily on acidic clay soils derived from basalt, with occasional occurrences on adjacent sedimentary, sandy-clay soils.	<b>Negligible</b>	No suitable habitat.

Scientific name	Conservation status			Most recent database record	Habitat description	Likely occurrence in study area	Rationale for likelihood ranking
	EPBC	VIC	FFG				
Spiny Rice-flower <i>Pimelea spinescens</i> subsp. <i>spinescens</i>	CR	e	L	PMST	Primarily grasslands featuring a moderate diversity of other native species and inter-tussock spaces, although also recorded in grassland dominated by introduced perennial grasses.	<b>Negligible</b>	No suitable habitat.
Maroon Leek-orchid <i>Prasophyllum frenchii</i>	EN	e	L	PMST	Grassland and grassy woodland environments on sandy or black clay loam soils that are generally damp but well drained.	<b>Negligible</b>	No suitable habitat.
Sturdy Leek-orchid <i>Prasophyllum validum</i>	VU			PMST	Drier woodland habitats, generally with a low sparse understorey.	<b>Negligible</b>	No suitable habitat.
Button Wrinklewort <i>Rutidosis leptorrhynchoides</i>	EN	e	L	PMST	Higher quality Plains Grassland and Grassy Woodland in Western Victoria, particularly those with fertile soil and light timber cover.	<b>Negligible</b>	No suitable habitat.
Swamp Fireweed <i>Senecio psilocarpus</i>	VU	v		PMST	Seasonally inundated herb-rich swamps, growing on peaty soils or volcanic clays.	<b>Negligible</b>	No suitable habitat.
Spiral Sun-orchid <i>Thelymitra matthewsii</i>	VU	v	L	PMST	Typically on well-drained soils on slightly elevated sites, but also on coastal sandy flats. Often in open situations following disturbance.	<b>Negligible</b>	No suitable habitat.
Swamp Everlasting <i>Xerochrysum palustre</i>	VU	v	L	PMST	Sedge-swamps and shallow freshwater marshes and swamps in lowlands, on black cracking clay soils.	<b>Negligible</b>	No suitable habitat.
<b>State significance</b>							
Wavy Swamp Wallaby-grass <i>Amphibromus sinuatus</i>		v		2008	Confined to permanent swamps in cool sites.	<b>Medium</b>	Potentially suitable habitat, recorded within Ballarat region.
Velvet Apple-berry <i>Billardiera scandens</i> s.s.		r		1875	Common in heathland, woodland and forests from near sea level to the subalpine region.	<b>Negligible</b>	No suitable habitat.

Scientific name	Conservation status			Most recent database record	Habitat description	Likely occurrence in study area	Rationale for likelihood ranking
	EPBC	VIC	FFG				
Green-top Sedge <i>Carex chlorantha</i>		k		1905	Open sites on permanently moist to wet and relatively fertile soils.	<b>Negligible</b>	No suitable habitat.
Mugga <i>Eucalyptus sideroxylon</i> subsp. <i>sideroxylon</i>		r		2006	Typically found on poor, shallow soils, including sands, gravels, ironstones and clays.	<b>Negligible</b>	No suitable habitat.
Yarra Gum <i>Eucalyptus yarraensis</i>		r	l	2010	Valley flats and along stream on soils subject to periodic inundation or waterlogging.	<b>Negligible</b>	No suitable habitat.
Rough Eyebright <i>Euphrasia scabra</i>		e	L	1770	Grassy woodlands and clearings in subalpine woodlands or sclerophyll forests.	<b>Negligible</b>	No suitable habitat.
Ivy-leaf Duckweed <i>Lemna trisulca</i>		k		1993	Aquatic environments.	<b>Medium</b>	Potentially suitable habitat, previous records within study area.
Native Peppergrass <i>Lepidium pseudohyssopifolium</i>		k		1993	Dry woodlands and open-forest; scattered occurrences in Plains Grassland west of Melbourne.	<b>Negligible</b>	No suitable habitat.
Giant Honey-myrtle <i>Melaleuca armillaris</i> subsp. <i>armillaris</i>		r		2011	Near coastal heath/scrub, rocky coast and foothill outcrops.	<b>Negligible</b>	No suitable habitat.

## Appendix 2 Fauna

Notes to tables:

**EPBC Act:**

EX - Extinct  
 CR - Critically Endangered  
 EN - Endangered  
 VU - Vulnerable  
 CD - Conservation dependent

**(DSE 2013, DSE 2009):**

ex - extinct  
 cr - critically endangered  
 en - endangered  
 vu - vulnerable  
 nt - near threatened  
 dd - data deficient  
 rx - regionally extinct

**FFG Act:**

L - listed as threatened under FFG Act  
 N - nominated for listing as threatened  
 I - determined ineligible for listing

**Introduced species**

PS - pest species listed under the CaLP Act  
 \* - introduced species

Most recent database records are from the Victorian Biodiversity Atlas unless otherwise specified as follows

PMST – Protected Matters Search Tool

BA – Birds Australia



## A2.1 Listed fauna species

The following table includes a list of the listed fauna species that have potential to occur within the study area. The list of species is sourced from the Victorian Biodiversity Atlas and the Protected Matters Search Tool (DAWE; accessed on 11.02.2020).

**Table A2.1 Listed fauna species recorded, or predicted to occur, within 5 km of the study area**

Species	Conservation status			Most recent database record	Habitat description	Likely occurrence in study area	Rationale for likelihood ranking
	EPBC	VIC	FFG				
<b>National significance</b>							
Plains-wanderer <i>Pedionomus torquatus</i>	CR	e	L	1911, PMST	Native grassland with a sparse, open structure.	<b>Negligible</b>	No suitable habitat.
Australian Painted-snipe <i>Rostratula australis</i>	EN	cr	L	PMST	Generally found in shallow, terrestrial freshwater wetlands with rank, emergent tussocks of grass, sedges and rushes. Australian Painted Snipe can occur in well-vegetated lakes, swamps, inundated pasture, saltmarsh and dams.	<b>Medium</b>	Potential suitable habitat within study area.
Australasian Bittern <i>Botaurus poiciloptilus</i>	EN	en	L	PMST	Occurs in wetlands with tall, dense vegetation where it forages in shallow water at the edges of pools or waterways. Prefers permanent freshwater habitats, particularly when dominated by sedges, rushes and reeds.	<b>Medium</b>	Potential suitable habitat within study area.
Red-tailed Black-Cockatoo (south-eastern) <i>Calyptorhynchus banksii graptogyne</i>	EN	e	L	1896, PMST	Red-tailed Black-Cockatoos generally forage within seed producing Desert Stringybark, Brown Stringybark and Buloke trees.	<b>Negligible</b>	No suitable habitat.
Swift Parrot <i>Lathamus discolor</i>	CR	en	L	PMST	A range of forests and woodlands, especially those supporting nectar-producing tree species. Also well-treed urban areas.	<b>Medium</b>	Potential suitable habitat within study area.
White-throated Needletail <i>Hirundapus caudacutus</i>	VU	v	L	2000, PMST	An almost exclusively aerial species within Australia, occurring over most types of habitat, particularly wooded areas.	<b>Medium</b>	Could potentially fly over study area, but is unlikely to rely on the study area for habitat.

Species	Conservation status			Most recent database record	Habitat description	Likely occurrence in study area	Rationale for likelihood ranking
	EPBC	VIC	FFG				
Eastern Curlew <i>Numenius madagascariensis</i>	CR	vu	L	PMST	Large intertidal sandflats, banks, mudflats, estuaries, inlets, sewage farms, saltworks, harbours, coastal lagoons and bays.	<b>Low</b>	Potential suitable habitat within study area.
Curlew Sandpiper <i>Calidris ferruginea</i>	CR	e	L	2010, PMST	Large intertidal intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons, and also around non-tidal swamps, lakes and lagoons near the coast, and ponds in saltworks and sewage farms.	<b>Medium</b>	Potential suitable habitat within study area and recorded within last 10 years.
Painted Honeyeater <i>Grantiella picta</i>	VU	vu	L	PMST	A migratory species that breeds in southern Australia, it occupies dry open woodlands and forests located on the inland foothills of the Great Dividing Range.	<b>Low</b>	Limited suitable habitat.
Regent Honeyeater <i>Anthochaera phrygia</i>	CR	e	L	1980, PMST	A range of dry woodlands and forests dominated by nectar-producing tree species.	<b>Low</b>	Limited suitable habitat.
Spot-tailed Quoll <i>Dasyurus maculatus maculatus</i> (SE mainland population)	EN	en	L	PMST	Rainforest and wet and dry sclerophyll forests and woodlands.	<b>Negligible</b>	No suitable habitat.
Long-nosed Potoroo (SE mainland) <i>Potorous tridactylus tridactylus</i>	VU	nt	L	PMST	Forest, heathy woodlands and heathlands.	<b>Negligible</b>	No suitable habitat.
Southern Greater Glider <i>Petauroides volans</i>	VU	vu	L	PMST	Wet and damp sclerophyll forest with large hollow-bearing trees.	<b>Negligible</b>	No suitable habitat.
Grey-headed Flying-fox <i>Pteropus poliocephalus</i>	VU	vu	L	PMST	Rainforest, wet and dry sclerophyll forest, woodland and urban areas.	<b>Medium</b>	Potential roosting sites in large trees around Lake Wendouree.
Striped Legless Lizard <i>Delma impar</i>	VU	en	L	PMST	Natural temperate grassland, grassy woodland and exotic grassland.	<b>Negligible</b>	No suitable habitat.
Growling Grass Frog <i>Litoria raniformis</i>	VU	e	L	2010, PMST	Occupies a variety of permanent and semi-permanent water bodies generally containing abundant submerged and emergent vegetation, within lowland grasslands, woodlands and open forests.	<b>Medium</b>	Potential habitat within study area, known to occur within region, recorded in last 10 years within 5km of study area.

Species	Conservation status			Most recent database record	Habitat description	Likely occurrence in study area	Rationale for likelihood ranking
	EPBC	VIC	FFG				
Australian Grayling <i>Prototroctes maraena</i>	VU	vu	L	PMST	Adults inhabit cool, clear, freshwater streams.	<b>Low</b>	No streams or slow flowing water within study area.
Dwarf Galaxias <i>Galaxiella pusilla</i>	VU	en	L	PMST	Occurs in relatively shallow still or slow flowing water bodies including streams, wetlands, drains, that in many instances are ephemeral and partially dry up over summer.	<b>Low</b>	No streams or slow flowing water within study area.
Macquarie Perch <i>Macquaria australasica</i>	EN	e	L	1970, PMST	Streams with clear water and deep, rocky holes with abundant cover.	<b>Low</b>	No streams within study area, no recorded in area for 50 years.
Golden Sun Moth <i>Synemon plana</i>	CR	e	L	2011, PMST	Natural temperate grassland, grassy woodland and pasture supporting spear grasses and wallaby grasses and exotic grassland dominated by Chilean needle grass.	<b>Negligible</b>	No suitable habitat.
<b>State significance</b>							
Lewin's Rail <i>Lewinia pectoralis</i>		v	L	1995, PMST	Inhabits densely vegetated wetlands, including swamps, farm dams, saltmarshes, lakes and small pools that can range from fresh to saline water. May also use riverine forest.	<b>Medium</b>	Suitable habitat, known to occur within region.
Baillon's Crake <i>Porzana pusilla</i>		v	L	2011, PMST	Well-vegetated permanent and temporary fresh and brackish wetlands.	<b>High</b>	Suitable habitat, known to occur within region and has been recorded within study area in last 10 years.
Pied Cormorant <i>Phalacrocorax varius</i>		nt		2010, PMST	Primarily marine environments and coastal waters including beaches, coastal lagoons, estuaries and rock platforms. Also, found in terrestrial wetlands with open expanses of permanent water including rivers, inland lakes and billabongs.	<b>High</b>	Suitable habitat, known to occur within region and has been recorded within study area in last 10 years.
Latham's Snipe <i>Gallinago hardwickii</i>		nt		2010, PMST	A migrant to Australia from July to April occurring in a wide variety of permanent and ephemeral wetlands. Prefers open freshwater wetlands with nearby cover, but also recorded on the edges of creeks and rivers, river-pools and floodplains.	<b>High</b>	Suitable habitat, known to occur within region and has been recorded within study area in last 10 years.

Species	Conservation status			Most recent database record	Habitat description	Likely occurrence in study area	Rationale for likelihood ranking
	EPBC	VIC	FFG				
Glossy Ibis <i>Plegadis falcinellus</i>		nt		2011, PMST	Freshwater wetlands especially permanent or ephemeral water bodies on floodplains, including wet pasture environments. Also sheltered coastal environments.	<b>High</b>	Suitable habitat, known to occur within region and has been recorded within study area in last 10 years.
Royal Spoonbill <i>Platalea regia</i>		nt		2006, PMST	Permanent and ephemeral wetlands and wet grassland areas, particularly large expanses of water such as lakes, swamps or lagoons. Also utilises rivers for its feeding activities and has regularly been recorded in coastal habitats such as estuaries, inlets and intertidal mudflats.	<b>Medium</b>	Suitable habitat, known to occur within region, but has not been recorded within the study in over 10 years.
Plumed Egret <i>Ardea intermedia plumifera</i>		e	L	2006, PMST	Densely-vegetated freshwater wetlands including lakes, swamps and billabongs. Breeds in trees standing in water.	<b>Medium</b>	Suitable habitat, known to occur within region, but has not been recorded within the study in over 10 years.
Eastern Great Egret <i>Ardea alba modesta</i>		v	L	2006, PMST	Prefer shallow water, particularly when flowing, but may be seen on any watered area, including damp grasslands.	<b>Medium</b>	Suitable habitat, known to occur within region, but has not been recorded within the study in over 10 years.
Nankeen Night Heron <i>Nycticorax caledonicus</i>		nt		2012, PMST	A variety of estuarine and terrestrial wetlands where it forages on the margins in shallow still or slow-moving water or exposed banks, mudflats and swamp vegetation of these environments.	<b>High</b>	Suitable habitat, known to occur within region and has been recorded within study area in last 10 years.
Australian Little Bittern <i>Ixobrychus dubius</i>		e	L	2011, PMST	Inhabits terrestrial wetlands, preferably with dense emergent vegetation.	<b>High</b>	Suitable habitat, known to occur within region and has been recorded within study area in last 10 years.

Species	Conservation status			Most recent database record	Habitat description	Likely occurrence in study area	Rationale for likelihood ranking
	EPBC	VIC	FFG				
Brolga <i>Grus rubicunda</i>		v	L	2017, PMST	Prefers shallow marshland areas, usually less than 50 cm deep with emergent vegetation. Most commonly found in south-west Victoria, the Northern Plains and associated parts of the Murray River.	<b>Medium</b>	Suitable habitat, known to occur within region and has been recorded within study area in last 10 years.
Australasian Shoveler <i>Spatula rhynchotis</i>		v		2008, PMST	Prefers large, permanent lakes and swamps with deep water, stable conditions and abundant aquatic vegetation. Less commonly recorded in small or shallow waters, such as billabongs, sewage ponds, freshwater rivers and densely vegetated farm dams.	<b>Medium</b>	Suitable habitat, known to occur within region, but has not been recorded within the study in over 10 years.
Freckled Duck <i>Stictonetta naevosa</i>		e	L	2007, PMST	Large freshwater wetlands, generally with dense vegetation.	<b>Medium</b>	Suitable habitat, known to occur within region, but has not been recorded within the study in over 10 years.
Hardhead <i>Aythya australis</i>		v		2015, PMST	A mainly aquatic species preferring large, deep freshwater environments with abundant aquatic vegetation, including slow moving areas of rivers. Also occurs in brackish wetlands and may be found in deep dams and water storage ponds.	<b>High</b>	Regularly recorded within Lake Wendouree.
Blue-billed Duck <i>Oxyura australis</i>		e	L	2013, PMST	A largely aquatic species preferring deep, large permanent wetlands with stable conditions and abundant aquatic vegetation, including Melaleuca swamps.	<b>High</b>	Regularly recorded within Lake Wendouree.
Musk Duck <i>Biziura lobata</i>		v		2015, PMST	A largely aquatic species preferring deep water on large, permanent swamps, lakes and estuaries with abundant aquatic vegetation. Often occurs in areas of dense vegetated cover within a wetland.	<b>High</b>	Regularly recorded within Lake Wendouree.
Spotted Harrier <i>Circus assimilis</i>		nt		1985, PMST	Inhabits open and wooded country of inland and sub-inland Australia, where they hunt over flat or undulating country with low vegetation cover.	<b>Low</b>	Limited suitable habitat.

Species	Conservation status			Most recent database record	Habitat description	Likely occurrence in study area	Rationale for likelihood ranking
	EPBC	VIC	FFG				
Grey Goshawk <i>Accipiter novaehollandiae</i>		v	L	2010, PMST	Favours tall, wet forests in gullies but can occur in woodlands, dry forests, wooded farmlands and suburban parks. Relies on mature forests for breeding.	<b>Medium</b>	Could potentially use large trees around Lake Wendouree for roosting. Known to occur in Ballarat region.
Square-tailed Kite <i>Lophoictinia isura</i>		v	L	1990, PMST	Typically inhabits coastal forested and wooded lands of tropical and temperate Australia. In NSW it is often associated with ridge and gully forests dominated by <i>Eucalyptus longifolia</i> , <i>Corymbia maculata</i> , <i>E. elata</i> , or <i>E. smithii</i> .	<b>Low</b>	Could potentially fly over study area. However, only two old records (>20 years) near Brown Hill within the Ballarat region.
Powerful Owl <i>Ninox strenua</i>		v	L	2008, PMST	Eucalypt forests and woodlands, well-treed urban areas.	<b>Low</b>	Known to occur within the Ballarat region, however limited potential habitat within the study area.
Whiskered Tern <i>Chlidonias hybrida</i>		nt		2010, PMST	A breeding migrant to Australia from September to March where it occurs in wetlands, lakes, swamps, rivers, and other water bodies with submerged and emergent vegetation such as grasses, sedges, reeds and rushes.	<b>High</b>	Can frequently be seen flying over lake Wendouree in summer months.
Caspian Tern <i>Hydroprogne caspia</i>		nt	L	2004, PMST	Occurs on exposed ocean beaches or in sheltered coastal embayments including harbours, lagoons, inlets and estuaries.	<b>Low</b>	Typically found in coastal areas, although old records (>15 years) from within the Ballarat region.
Wood Sandpiper <i>Tringa glareola</i>		v		2010, PMST	Well-vegetated shallow freshwater wetlands with emergent aquatic plants and dense fringing vegetation.	<b>High</b>	Suitable habitat, known to occur within region and has been recorded within study area in last 10 years.

Species	Conservation status			Most recent database record	Habitat description	Likely occurrence in study area	Rationale for likelihood ranking
	EPBC	VIC	FFG				
Common Sandpiper <i>Actitis hypoleucos</i>		v		1988, PMST	Migrates to Australia from Eurasia in August where it inhabits a wide variety of coastal and inland wetlands with muddy margins before departing north in March.	<b>Medium</b>	Suitable habitat, known to occur within region, but has not been recorded within the study in over 10 years.
Common Greenshank <i>Tringa nebularia</i>		v		2010, PMST	A variety of ephemeral and permanent inland wetlands and sheltered coastal wetlands.	<b>High</b>	Suitable habitat, known to occur within region and has been recorded within study area in last 10 years.
Marsh Sandpiper <i>Tringa stagnatilis</i>		v		2010, PMST	Permanent or ephemeral wetlands, mudflats and saltmarshes in coastal and inland environments.	<b>High</b>	Suitable habitat, known to occur within region and has been recorded within study area in last 10 years.
Pectoral Sandpiper <i>Calidris melanotos</i>		nt		PMST	A variety of wetland habitats with fringing mudflats including bays, coastal lagoons, lakes, swamps, creeks, inundated grasslands, saltmarshes and artificial wetlands.	<b>Low</b>	Suitable habitat, but no confirmed records within region.
Brush-tailed Phascogale <i>Phascogale tapoatafa</i>		v	L	1991, PMST	Occurs in dry foothill forest, which is open with sparse ground cover. Favours areas dominated by box, ironbark and Stringybark eucalypts.	<b>Negligible</b>	No suitable habitat.
Eastern Pygmy-possum <i>Cercartetus nanus</i>		nt	I	1970, PMST	Occurs throughout south-eastern Australia in a variety of vegetation communities including subalpine woodland, wet forest, Box Ironbark Forest, coast scrub, heathy woodland and subalpine heath.	<b>Negligible</b>	No suitable habitat.
Western Burrowing Crayfish <i>Engaëus merozetosus</i>		e		2006, PMST	Primarily occurring along creeklines within the Geelong to Ballarat region, this species has also been recorded from the upper reaches of the Werribee River and the upper reaches of the Loddon and Tullaroop drainages.	<b>Low</b>	No creeks or streams within the study area.

## A2.2 Migratory species (EPBC Act listed)

**Table A2.2 Migratory fauna species recorded or predicted to occur within 5 km of the study area**

Scientific name	Common name	Most recent record
<b>Migratory species</b>		
<i>Gallinago hardwickii</i>	Latham's Snipe	2010
<i>Plegadis falcinellus</i>	Glossy Ibis	2011
<i>Hirundapus caudacutus</i>	White-throated Needletail	2000
<i>Apus pacificus</i>	Fork-tailed Swift	PMST
<i>Philomachus pugnax</i>	Ruff	2010
<i>Hydroprogne caspia</i>	Caspian Tern	2004
<i>Numenius madagascariensis</i>	Eastern Curlew	PMST
<i>Tringa glareola</i>	Wood Sandpiper	2010
<i>Actitis hypoleucos</i>	Common Sandpiper	1988
<i>Tringa nebularia</i>	Common Greenshank	2010
<i>Tringa stagnatilis</i>	Marsh Sandpiper	2010
<i>Calidris ferruginea</i>	Curlew Sandpiper	2010
<i>Calidris acuminata</i>	Sharp-tailed Sandpiper	2010
<i>Calidris melanotos</i>	Pectoral Sandpiper	PMST
<i>Motacilla flava</i>	Yellow Wagtail	PMST
<i>Rhipidura rufifrons</i>	Rufous Fantail	2010
<i>Myiagra cyanoleuca</i>	Satin Flycatcher	PMST
<i>Monarcha melanopsis</i>	Black-faced Monarch	PMST