Bird and Bat Management Plan

Dugald River Windfarm Optimised Design

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Document Control and History

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V1.1	06/03/2026	Amended final version	Harry Bonnell	

WTS acknowledge the work of EcoSmart Ecology for their ongoing commitment to ecological survey and monitoring at MMGs Dugald River Mine and for the preparation of a summary of survey effort since 2013 to support this report.

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Definitions

Term	Definition
BBMP	Bird and Bat Management Plan
DRM	Dugald River Mine
EA	Environmental Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
ERM	Environmental Resources Management Pty Ltd
LOM	Life of Mine
ML	Mining Lease
MMG	MMG Limited
MNES	Matters of National Environmental Significance
MSES	Matters of State Environmental Significance
NCA	*Nature Conservation Act 1992*
PMST	Protected Matters Search Tool
RE	Regional Ecosystem
RSA	Rotor-swept Area
WTS	Wulguru Technical Services
SOC	Species of concern
CRA	Collision risk assessment

1. Introduction

MMG Dugald River Pty Ltd (MMG) is proposing to develop the Dugald River Wind Farm Project (the Project) which comprises the construction and operation of up to 24 X 6 MW Wind Turbine Generators (WTGs) and associated ancillary infrastructure.

1.1. Scope and Objectives

Wulguru Technical Services Pty Ltd (WTS) was engaged by Environmental Resources Management Pty Ltd (ERM), on behalf of MMG, to prepare a Bird and Bat Management Plan (BBMP) with regard to the proposed Project.

The purpose of this report is to:

- assess the potential for impacts of the proposed Project to bird and bat species identified within the Project area, and conservation significant species deemed to have the potential to occur within the project area; and
- to identify management actions to avoid, manage and mitigate these impacts.

1.2. Project Description

1.2.1. Project Overview

The Project comprises the construction and operation of up to 24 X 6 MW Wind Turbine Generators (WTGs) and associated ancillary infrastructure. The Project has a Disturbance Footprint of up to 135.31 ha, which comprises both permanent and temporary disturbance (**Error! Reference source not found.**).

The Project includes the following elements:

- Up to 24 X 6 MW WTGs;
- Up to 4 Meteorological Masts (Met Masts);
- Access tracks;
- Hardstand areas;
- Supporting infrastructure (including underground and overhead powerlines, and a BESS);
- Material laydown areas;
- Construction areas; and
- An operations and maintenance facility.

The project will consist of a clearing phase, a construction phase, an operation phase, and a decommissioning phase.

Table 1: Property description

Company Name	MMG Dugald River Mine Pty Ltd
Local Government Area	Cloncurry Shire
Bioregion/Subregion	Mount Isa Inlier of the Northwest Highlands
Drainage basin/sub-area	Leichhardt Basin and Flinders Basin
Lot on Plan	Lot 92 on SP303378, Lot 36 on AP23793 and Lot 1 on AP23793
Proposed disturbance of the Project	135.3 hectares

1.2.2. Project Details

The proposed candidate WTG Model is the 'Goldwind DW 165-5.2/5.6/6.0MW' which has the following features and dimensions:

- Hub height: 130m
- Rotor diameter: Up to 165m
- Rotor-swept area (RSA): 21,382 m2 between 47.5m and 212.5m above the WTG pad. This was delineated to provide the necessary bounds for pre-construction or control survey sites where a physical turbine is not present for reference

Hardstand Pads

The Disturbance Footprint includes an area designed to accommodate crane pads, temporary laydown areas as well as WTG assembly and erection. An area of approximately 5 Ha of hardstand area has been proposed for each WTG.

The area of disturbance for each WTG will vary in response to civil design requirements and therefore, the actual area of disturbance between each WTG will vary.

Access and Infrastructure Corridor

The Disturbance Footprint includes a defined access and infrastructure corridor which will be developed to facilitate access to the proposed hardstand areas. The proposed access and infrastructure corridor has a nominal width of 40 m however the actual width will vary depending on manoeuvring requirements and topographical considerations subject to detailed design.

Where possible, existing light vehicle tracks will be used and widened to reduce the creation of additional disturbance. The access and infrastructure corridor will be created through a program of earthworks deigned to achieve the required geometrical alignment for the movement of WTG components.

It is anticipated that the access tracks will be created through the stripping of vegetation and scraping of topsoil which will be stockpiled for future rehabilitation requirements. Where required, fill material, primarily comprised of Non Acid Forming (NAF) material generated by the mining operation and earthen fill from existing borrow pits associated with the mining operation may also be used.

Waterway crossings will be constructed at locations that minimise the extent of disturbance and vegetation clearing. Bed level crossings will be the preferred construction method to allow unobstructed surface water flows to occur during periods of incidental flow.

Powerlines (33kV) will be installed to transfer power from each WTG to a collection substation. The powerline system will be installed as a combination of underground and overhead lines where appropriate to minimise ground disturbance and ensure safe construction and operation procedures. Where necessary, the above ground lines would be supported by poles.

Collection Substation

The Disturbance Footprint includes a dedicated area which will accommodate a substation and future Battery Energy Storage System (BESS) for the Dugald River Wind Farm. The substation will be the terminal point for electrical infrastructure associated with the WTGs and will be connected to electrical infrastructure (Dugald River Switch Yard) located on the Dugald River Mine via an overhead transmission line. The Dugald River Mine has an established connection to overhead high-voltage electrical infrastructure linked to the NWPS.

Transmission Line

The Disturbance Footprint includes a 220kV transmission line which links the Dugald River Wind Farm substation to the Dugald River Mine Switch Yard. The transmission line has a conservative width of 20m however will only comprise clearing for access to power poles which will be created as extensions to existing tracks.

2. Bird and Bat Surveys

2.1. Desktop Analysis

A review of available information was undertaken as per Level One investigation protocols described in the *Wind Farms and Birds: Interim Standards for Risk Assessment* (Brett Lane & Associates Pty Ltd, 2005). This was undertaken to provide insight on the potential occurrence of bird and bat species surrounding and within the proposed Project area.
A comprehensive desktop analysis was undertaken to identify potential environmental values, constraints, and potential impacts within the Project area, and to enhance understanding of the ecology of the area and its relationship to and connectivity with the surrounding landscape.

NC and EPBC Act listed species identified during the desktop analysis as having the potential to occur within the Project area are discussed in Appendix C – Collision Risk for NC and EPBC Act Listed Species. One bird species listed as Migratory under the EPBC Act, the Glossy Ibis (*Plegadis falcinellus*), is known from a single record within the proposed Project area. A Collision Risk Assessment (CRA) has been undertaken in Section 3.4.2. for all NC and EPBC Act listed species deemed as having a likelihood of occurrence of 'possible' or above to determine the individual level of risk for each species.

2.2. Survey Effort and Sites

Surveys utilise a Before and After Control Impact (BACI) survey design as is recommended in Appendix 1 of *Wind Farms and Birds: Interim Standards for Risk Assessment* (Brett Lane & Associates Pty Ltd, 2005). A BACI design includes control sites placed at a sufficient distance (>500m), from the proposed turbine locations to obtain data outside the zone of influence of the turbines. As per the above standards, prior to commencement of construction and operation impact and control sites are to be monitored twice yearly, once in the post-wet season and once in the pre-wet season.

Two rounds of Bird and Bat Utilisation surveys (BBUS) were undertaken across the Knapdale Range by EcoSmart Ecology in May and September 2023 at eight survey sites.

Two subsequent rounds of BBUS were performed by WTS across the Knapdale Range in April and September 2024. Four additional survey sites were included during these campaigns to provide a more comprehensive coverage of the Project area, bringing the total to 12 survey sites (Figure 1) in line with an expanded project design. The addition of new survey sites prompted an extension of survey effort to meet the requirements of State code 23 which resulted in another round of monitoring in 2025. Surveys were completed by WTS in 2024 and 2025 across all of the 12 survey sites meeting the guideline requirement, with EcoSmart's 2023 providing an additional year of data for the eight original sites. The survey effort of each site is summarized in Table 2.

In line with the amended design as of March 2026, six BBUS sites are located within or immediately adjacent to the Disturbance Footprint; once construction commences, these sites will be used as impact sites.

Sites are generally consistently windy or at the least gusty throughout the year. Cloud cover varies, generally being clear-low cover during pre-wet season surveys, and low-moderate cover during post-wet season surveys. The sites are described in depth in Table 3.

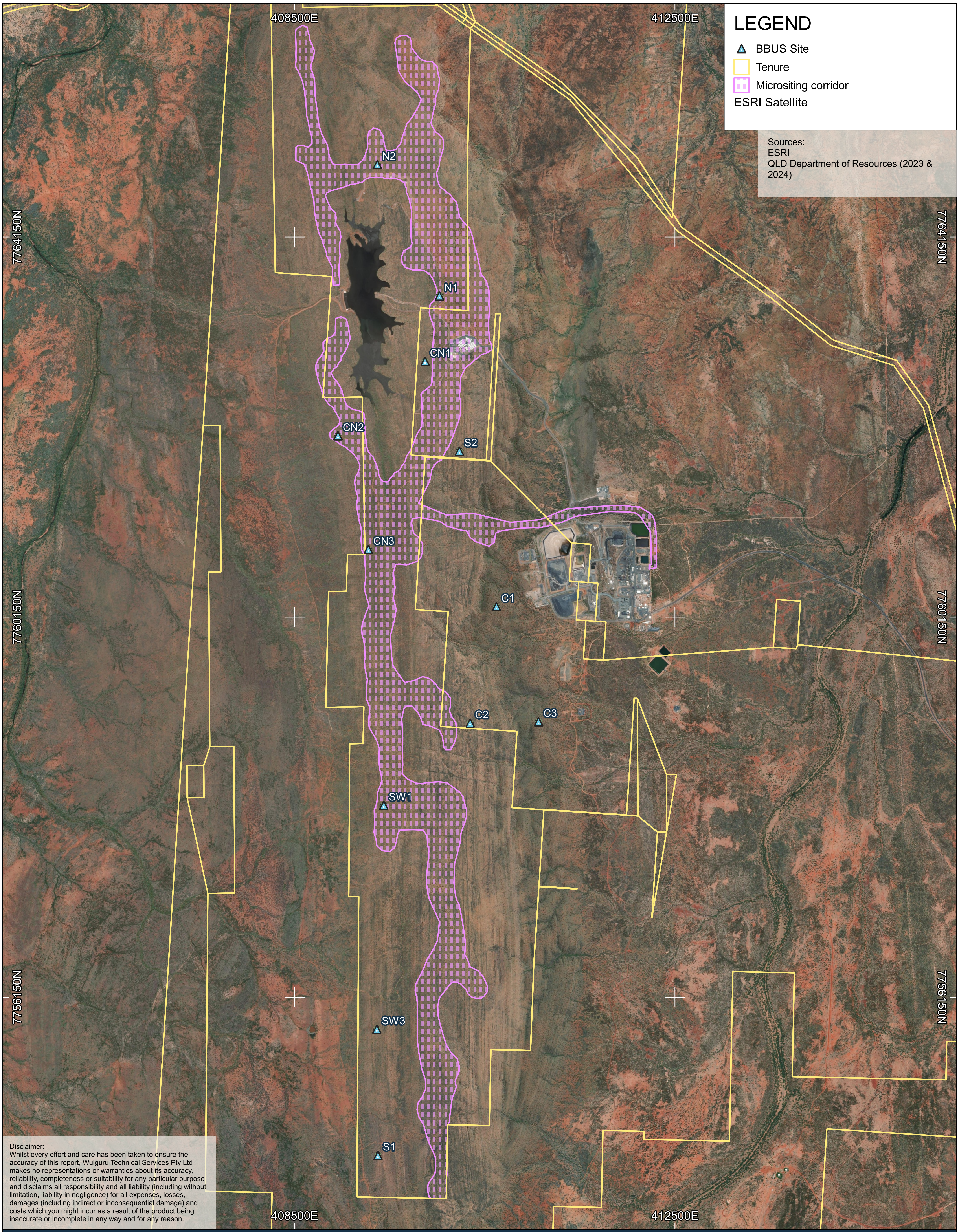
Two person days of roaming surveys have been conducted thus far. The results of the surveys are described below in Section 2.3 and 2.4. The results of the surveys have been utilised to develop this management plan.

Table 2. Complete Survey Effort of Control and Impact BBUS sites

Site (status)	Survey Periods					
	EcoSmart Ecology		WTS			
	March 2023	September 2023	April (16th – 21st) 2024	September (11th –16th) 2024	March (18th –22nd) 2025	September (24th – 29th) 2025
C1 (control)	X	X	X	X	X*	X
C2 (Impact)	X	X	X	X	X*	X
C3 (Control)	X	X	X	X	X*	X
CN1 (Control)	X	X	X	X	X*	X
CN2 (Impact)	X	X	X	X	X*	X
CN3 (Impact)	X	X	X	X	X*	X
N1 (Control)	-	-	X	X	X*	X

Site (status)	Survey Periods					
	EcoSmart Ecology		WTS			
	March 2023	September 2023	April (16th – 21st) 2024	September (11th –16th) 2024	March (18th –22nd) 2025	September (24th – 29th) 2025
N2 (impact)	X	X	X	X	X*	X
S1 (Control)	X	X	X	X	X	X
S2 (Control)	-	-	X	X	X	X
SW1 (impact)	-	-	X	X	X	X
SW3 (impact)	-	-	X	X	X	X

*sites not completely surveyed due to adverse weather conditions. Survey effort not undertaken in March 2025 is as follows:
C sites – Midday
CN sites – Midday
N sites- Sunrise and Sunset
It should be noted that the S and SW sites (added in 2024) were fully surveyed and therefore every site meets the survey requirement specified in the standards.



DRM WINDFARM OPTIMISED DESIGN - BBMP

FIG 1. BBUS SITES

0.75 0 0.75 1.5 km

CRS: GDA2020 / MGA zone 54
Scale: 1:35,000 @A3

Date: 25 November 2024
Author: A. Fletcher
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WULGURU TECHNICAL SERVICES

Project Number: 2024.11004
Client: MMG Dugald River Pty Ltd

Table 3: BBUS survey site locations

Site (status)	Description	Regional Ecosystem	Representative photograph (North)
C1 (Control)	Low woodland of *Eucalyptus leucophloia* with *Corymbia capricornia, Grevillea striata* and *Acacia monticola*. A significant subcanopy of *Acacia monticola* is present with a mixed shrub layer predominantly of *Acacia sp*, *Grevillea striata, Carissa lanceolata* and *Santalum lanceolatum*. The ground layer is largely *Triodia pungens*. Provides suitable nesting habitat for both small and large birds, excluding raptors and waterbirds. Provides suitable foraging habitat for most bird species, excluding waterbirds. Larger eucalypts may provide roosting opportunities for some bat species.	1.11.2a	

C2 (Impact)	Low open woodland of *Eucalyptus leucophloia* and *Corymbia capricornia*. A significant subcanopy of *Acacia monticola* is present with some *Acacia humifusa*. The ground layer is largely *Triodia pungens*. Provides suitable nesting habitat for small and large birds, excluding raptors and waterbirds. Provides suitable foraging habitat for most bird species, excluding waterbirds. Larger eucalypts may provide roosting opportunities for some bat species.	1.11.2a	
C3 (Control)	Low open woodland of *Eucalyptus leucophloia* and *Corymbia capricornia* with rare *Eucalyptus leucophylla*. The shrub layer is largely made up of *Tephrosia sp*, *Acacia humifusa* and *Acacia monticola*. The ground layer is largely *Triodia pungens*. Provides suitable nesting habitat for small and large birds, excluding raptors and waterbirds. Provides suitable foraging habitat for most bird species, excluding waterbirds. Larger eucalypts may provide roosting opportunities for some bat species.	1.11.2a	

CN1 (Control)	Low shrubby woodland of *Acacia monticola* with some *Eucalyptus leucophloia*. A sparse shrub layer of *Santalum lanceolatum, Acacia humifusa* and *Eremophila latrobei* is present. The ground layer is largely *Triodia pungens*. Provides suitable nesting habitat for small birds only. Provides suitable foraging habitat for most bird species, excluding waterbirds. It is unlikely that the few eucalypts present provide roosting opportunities for any bat species.	1.11.2a	
CN2 (Impact)	Low open woodland primarily of *Eucalyptus leucophloia*. A significant subcanopy of *Acacia monticola* is present with some *Acacia humifusa*. The ground layer is largely *Triodia pungens* with some *Grevillea dryandri*. Provides suitable nesting habitat for small birds only. Provides suitable foraging habitat for most bird species, excluding waterbirds. It is unlikely that the few eucalypts present provide roosting opportunities for any bat species.	1.11.2a	

CN3 (Impact)	Low open woodland primarily of *Eucalyptus leucophloia*. A significant subcanopy of *Acacia monticola* is present with some *Acacia holosericea* and *Santalum lanceolatum*. The ground layer is largely *Triodia pungens* with some *Grevillea dryandri*. Provides suitable nesting habitat for small birds only. Provides suitable foraging habitat for most bird species, excluding waterbirds. It is unlikely that the few eucalypts present provide roosting opportunities for any bat species.	1.11.2a	
N1 (Control)	Low open woodland of *Eucalyptus leucophloia* with some *Corymbia capricornia*. A subcanopy of *Acacia monticola* and *Acacia holosericea* is present with a shrub layer of juvenile canopy and subcanopy species as well as *Eremophila latrobei and Santalum lanceolatum*. The ground layer is largely *Triodia pungens*. Provides suitable nesting habitat for small and large birds, excluding raptors and waterbirds. Provides suitable foraging habitat for most bird species, excluding waterbirds. Larger eucalypts may provide roosting opportunities for some bat species.	1.11.2a	

N2 (Impact)	Low open woodland of *Corymbia capricornia* and *Eucalyptus leucophloia*. A subcanopy of *Acacia monticola* is present with a shrub layer of *Acacia humifusa*. The ground layer is dominated by *Triodia pungens* and *Grevillea dryandri*. Provides suitable nesting habitat for small and large birds, excluding raptors and waterbirds. Provides suitable foraging habitat for most bird species, excluding waterbirds. Larger eucalypts may provide roosting opportunities for some bat species.	1.11.2a	
S1 (Control)	Low open woodland of *Eucalyptus leucophloia*. A shrub layer primarily consisting of *Acacia humifusa* is present. The ground layer is *Triodia pungens*. Provides suitable nesting habitat for small birds only. Provides suitable foraging habitat for most bird species, excluding waterbirds. It is unlikely that the few eucalypts present provide roosting opportunities for any bat species.	1.11.2a	

S2 (Control)	Low open woodland of *Corymbia capricornia* and *Eucalyptus leucophloia*. A significant subcanopy of *Acacia monticola* is present with a shrub layer including *Acacia humifusa, Acacia monticola* and *Grevillea striata*. The ground layer is dominated by *Triodia pungens* and *Grevillea dryandri*. Provides suitable nesting habitat for small and large birds, excluding raptors and waterbirds. Provides suitable foraging habitat for most bird species, excluding waterbirds. Larger eucalypts may provide roosting opportunities for some bat species.	1.11.2a	
SW1 (Impact)	Low open woodland of *Eucalyptus leucophloia* with a significant subcanopy of *Acacia monticola* also present. The ground layer is dominated by *Triodia pungens*. Provides suitable nesting habitat for small birds only. Provides suitable foraging habitat for most bird species, excluding waterbirds. It is unlikely that the few eucalypts present provide roosting opportunities for any bat species.	1.11.2a	

SW3 (Impact)	Low open woodland of *Eucalyptus leucophloia* and *Acacia monticola*. A shrub layer of *Acacia monticola, Acacia humifusa* and *Santalum lanceolatum* is present. The ground layer is dominated by *Triodia pungens*. Provides suitable nesting habitat for small and medium birds only. Provides suitable foraging habitat for most bird species, excluding waterbirds. It is unlikely that the few eucalypts present provide roosting opportunities for any bat species.	1.11.2a	

2.3. Bird Survey

2.3.1. Bird Survey Methodology

Level One bird surveys have been conducted as per the approved method outlined in *Wind Farms and Birds: Interim Standards for Risk Assessment* (Brett Lane & Associates Pty Ltd, 2005). Level one surveys are a minimum requirement to assess the potential impacts of a wind farm on birds during the pre-construction phase.

BBUS were performed to collect quantitative data on bird use of the potential windfarm site. This can be used to estimate potential collision rates and provide a ranked abundance of species use of the site at varying heights. The BBUS involved a "Fixed-point Count" methodology where an observer is stationed at a fixed survey point for 20 minutes. During the 20 minutes, all bird species and number of birds observed were recorded. Observations of birds (and theoretically diurnally flying bats) during the survey periods were broken into BBUS and incidental observations. BBUS observations are those which include individuals observed to be flying above the predominant canopy. These observations do not include individuals that briefly fly out of the canopy layer at a low height. All other observation not conforming to BBUS records, including positively identified bird calls were recorded as incidental observations. The BBUS method provides the following information:

- species;
- number of individuals;
- estimated distance from observer;
- estimated height above observer;
- bearing to record;
- direction of flight;
- behaviour; and
- notes on wind speed, cloud cover, rain, and other conditions that may affect bird activity.

Level One roaming surveys have been conducted sporadically by suitably qualified WTS ecologists across the Project area. The roaming survey method used provides the following information:

- geolocated record;
- species;
- number of individuals; and
- microhabitat.

2.3.2. Bird Survey Results

Birds recorded during the BBUS were initially characterised as either occurring within or outside of the RSA. For the September 2024 surveys, the methodology was adjusted to specifically record an estimated maximum and minimum flight height for each record to provide finer scale data should it be required for further investigation. For the purpose of summarising the findings of the surveys, a determination of either within or outside the RSA, was used. These records are shown below in Table 4.

Section 2.4 of *Wind Farms and Birds: Interim Standards for Risk Assessment* (Brett Lane & Associates Pty Ltd, 2005) defines any species that exhibit behaviour that puts them at risk of regular collision with operating wind turbines as a species of concern (SOC).

As such, several species shown below (Table 4) can be defined as SOC. A CRA has been undertaken in Section 3.4 for each SOC to determine the individual level of risk for each species.

Table 4. BBUS Bird Species Records for each survey round

Within/Outside Rotor-swept Area (RSA)	Common Name (*Scientific Name*)	Status		Count						
		NCA	EPBC	May-23	Sep-23	Apr-24	Sep-24	Mar- 25	Sept 2025	Total
Within RSA	Australasian Darter (*Anhinga novaehollandiae*)	LC				2				2
	Black Kite (*Milvus migrans*)	LC			1	1	25	7		34
	Black-faced Woodswallow (*Artamus cinereus*)	LC			18	15			5	38
	Black-shouldered Kite (*Elanus axillaris*)	LC		1				2		3
	Brown Falcon (*Falco berigora*)	LC		2	1		7			10
	Dusky Woodswallow (*Artamus cyanopterus)*	LC							3	3
	Fairy Martin (*Petrochelidon ariel*)	LC			12		4			16
	Falco sp.	-							1	1
	Grey-headed Honeyeater (*Ptilotula keartlandi*)	LC							3	3
	Little Woodswallow (*Artamus minor*)	LC		5	28	36	14			83
	Masked Woodswallow (*Artamus personatus*)	LC				200				200
	Nankeen Kestrel (*Falco cenchroides*)	LC				2				2
	Rainbow Bee-eater (*Merops ornatus*)	LC	M			9				9
	Varied Lorikeet (*Psitteuteles versicolor*)	LC			1				5	6
	Wedge-tailed Eagle (*Aquila audax*)	LC		1		4				5
	Whistling Kite (*Haliastur sphenurus*)	LC		1		1	15			17
	White-faced Heron (*Egretta novaehollandiae*)	LC				1				1
	White-necked Heron (*Ardea pacifica*)	LC		2						2
	Willie Wagtail (*Rhipidura leucophrys*)	LC				1				1
	Woodswallow sp	-							7	7
Outside RSA	Australian Magpie (*Gymnorhina tibicen*)	LC					2			2
	Australian Raven (*Corvus coronoides*)	LC		1	1					2
	Black Kite (*Milvus migrans*)	LC					4			4
	Black-breasted Buzzard (*Hamirostra melanosternon*)	LC			2					2
	Black-faced Cuckoo-shrike (*Coracina novahollandiae*)	LC		1	11	8	5			25

Within/Outside Rotor-swept Area (RSA)	Common Name (*Scientific Name*)	Status		Count						
		NCA	EPBC	May-23	Sep-23	Apr-24	Sep-24	Mar- 25	Sept 2025	Total
	Black-faced Woodswallow (*Artamus cinereus*)	LC		1	1		6		15	23
	Black-shouldered Kite (*Elanus axillaris*)	LC			1		1			2
	Brown Falcon (*Falco berigora*)	LC		2						2
	Brown Goshawk (*Accipiter fasciatus*)	LC		2						2
	Budgerigar (*Melopsittacus undulatus*)	LC		22	15			43		80
	Cockatiel (*Nymphicus hollandicus*)	LC			7					7
	Diamond Dove (*Geopelia cuneata*)	LC			43					43
	Dusky woodswallow (*Artamus cyanopterus*)	LC						1		1
	Eastern Great Egret (*Ardea alba*)	LC		2						2
	Fairy Martin (*Petrochelidon ariel*)	LC		1	18		10			29
	Fork-tailed swift (*Apus pacificus*)	LC	M					15	2	16
	Galah (*Eolophus roseicapilla*)	LC			2		3			5
	Grey-fronted Honeyeater (*Ptilotula plumula*)	LC		7	7		1			15
	Grey fantail (*Rhipidura albiscapa*)	LC							3	3
	Grey-headed Honeyeater (*Ptilotula keartlandi*)	LC		2	3					5
	Little Friarbird (*Philemon citreogularis*)	LC		7	3	3	1			14
	Little Woodswallow (*Artamus minor*)	LC		4	21	39	17	15	6	104
	Masked Woodswallow (*Artamus personatus*)	LC					3			3
	Mistletoebird (*Dicaeum hirundinaceum*)	LC		1	8		1			10
	Nankeen Kestrel (*Falco cenchroides*)	LC				1				1
	Painted Finch (*Emblema pictum*)	LC		2						2
	Pied Butcherbird (*Cracticus nigrogularis*)	LC		1		1				2
	Rainbow Bee-eater (*Merops ornatus*)	LC	M		1	1	2	4		8
	Rufous-throated Honeyeater (*Conopophila rufogularis*)	LC			2					2
	Silver-crowned Friarbird (*Philemon argenticeps*)	LC		1			1			2
	Spotted Bowerbird (*Chlamydera maculata*)	LC					1			1
	Sulphur-crested Cockatoo (*Cacatua galerita*)	LC					3			3

Within/Outside Rotor-swept Area (RSA)	Common Name (*Scientific Name*)	Status		Count						
		NCA	EPBC	May-23	Sep-23	Apr-24	Sep-24	Mar- 25	Sept 2025	Total
	Torresian Crow (*Corvus orru*)	LC					7	1		8
	Varied Lorikeet (*Psitteuteles versicolor*)	LC		6	18	27	21	89	7	168
	Wedge-tailed Eagle (*Aquila audax*)	LC				1	2			3
	Whistling Kite (*Haliastur sphenurus*)	LC							4	4
	Willie Wagtail (*Rhipidura leucophrys*)	LC			1					1
	Woodswallow sp. (*Artamus sp.*)	-						5	3	8
	Zebra Finch (*Taeniopygia guttata*)	LC		6	1					7

An additional 76 species of bird have been historically recorded from the site. These are recorded as incidental observations and are shown in Appendix A – Incidental Species Bird species commonly entering RSA height can be broken into two main groups, raptors and aerial insectivores. Raptors include all species within the Accipitriformes and Falconiformes Orders, while aerial insectivores include woodswallows, martins and the rainbow bee-eater. One listed Marine species, the rainbow bee-eater was recorded during BBUS. A single listed Migratory species, the glossy ibis, has historically been recorded from the Dugald River Project Area but has not been recorded during BBUS. Records from roaming surveys are characterised as incidental sightings and are shown in Appendix A.

2.4. Bat Survey

2.4.1. Bat Survey Methodology

Bats are monitored at each BBUS site using Anabat Chorus passive high-frequency sound recorders to capture microbat calls. One Anabat Chorus bat detector was installed at each of the 12 survey sites for two nights. These passive detectors were set to record in full spectrum .wav files from one hour before sunset to one hour after sunrise. Bat call analysis to identify microbat species present was undertaken by Greg Ford of Balance Environmental for EcoSmart Ecology's two initial rounds of surveying. Bat call analysis in 2024 was undertaken for WTS by Professor Simon Robson.

As no bat species listed under the NC or EPBC Acts were determined to have a likelihood of occurrence above 'unlikely' no harp trapping is proposed.

2.4.2. Bat Survey Results

The following bat species have been recorded during BBUS surveys of the Project Area, either by EcoSmart Ecology or WTS (Table 5). As bat presence is measured entirely by call monitoring, relative abundance of bats species is not able to be accurately estimated. Many factors influence the detectability of bat calls, including flight height, distance from recorder, weather and other variables. Additionally, repeated recordings of singular or small numbers of individuals flying close to the bat detector can significantly skew abundance data. As such, for this report bat call records are considered as a confirmation of presence only and not a determinant of relative bat abundance.

Section 2.4 of Wind Farms and Birds: Interim Standards for Risk Assessment (Brett Lane & Associates Pty Ltd, 2005) defines any species that exhibit behaviour that puts them at risk of regular collision with operating wind turbines as SOC. Whilst this standard was developed to assess the risk of impact of wind farms on birds specifically, it has been adapted within this report so that bats can be similarly assessed. Several species shown below (Table 5) can be defined as SOC. A CRA has been undertaken in Section 3.8 for each SOC to determine the individual level of risk for each bat species.

Table 5. Bat Species Records

Confidence	*Scientific Name* Common Name	Status*		Presence of calls					
		NCA	EPBC	May-23 (EcoSmart)	Sep-23 (EcoSmart)	Apr-24 (WTS)	Sep-24 (WTS)	Apr-25 (WTS)	Sep-25 (WTS)
Positive Identification	*Chalinolobus gouldii* Gould's Wattled Bat	LC		YES	YES	YES	YES	YES	YES
	Taphozous sp.			YES	YES				
	Taphozous georgeanis Common Sheathtail Bat	LC				YES	YES		
	Chaerephon jobensis Northern Freetail Bat	LC		YES	YES	YES	YES	YES	YES
	Saccolaimus flaviventris Yellow-bellied Sheathtail Bat	LC		YES	YES	YES	YES	YES	YES
	Scotorepens greyii Little Broad-nosed Bat	LC		YES	YES		YES		
	Setirostris eleyri Bristle-faced Free-tailed Bat	LC				YES	YES	YES	YES
	Vespadelus baverstocki Inland Forest Bat	LC		YES	YES		YES		
	Chalinolobus nigrogriseus Hoary Wattled Bat	LC		YES	YES	YES	YES	YES	YES
	Vespadelus finlaysoni Finlayson's Cave Bat	LC		YES	YES	YES			
	Ozimops lumsdenae Northern Free-tailed Bat	LC		YES	YES	YES	YES	YES	
	Scotorepens balstoni Inland Broad-nosed Bat	LC		YES	YES	YES	YES		
	Ozimops sp.			YES	YES				
	Austronomus australis White-striped Freetail Bat	LC		YES	YES	YES	YES		
	Nyctophilus geoffroyi Lesser Long-eared Bat					YES	YES		
	Nyctophilus sp.			YES	YES				
Uncertain Identification	*C. gouldii* or *Ozimops* sp.			YES	YES				
	C. nigrogriseus or *S. greyii*			YES	YES				

Confidence	*Scientific Name* Common Name	Status*		Presence of calls					
		NCA	EPBC	May-23 (EcoSmart)	Sep-23 (EcoSmart)	Apr-24 (WTS)	Sep-24 (WTS)	Apr-25 (WTS)	Sep-25 (WTS)
	S. greyii or *V. baverstocki*			YES	YES				
	C. gouldii or *S. balstoni*			YES	YES				
	O. lumsdenae or *Taphozous* sp.			YES	YES				
	S. balstoni or *Ozimops* sp.			YES	YES				
	S. balstoni and/or *Scotorepens greyii*							YES	YES
	T. georgianus and/or *T. troughtoni*							YES	YES

3. Pre-Management Collision Risk Assessment

A review of relevant guidelines and similar approvals issued by the State and Federal Governments informed the development of this CRA.

The framework provided in the Australian standard for risk management and related guidelines, AS/NZS 4360 (Anon, 2004a) (Anon, 2004b), and the associated guide for environmental risk management HB203:2000 (Anon, 2000), assesses risk using a combination of consequence (or impact) and the likelihood of occurrence of the impact (Brett Lane & Associates Pty Ltd, 2005).

For the purposes of this report, flight height is presented as below, at or above RSA height:

- A = Below RSA (< 47.5 metres above ground)
- B = At RSA (47.5 – 212.5 metres above ground)
- C = Above RSA (> 212.5 metres above ground)

3.1. Bird Collision Likelihood

Collision likelihood of birds previously identified on site, as well as potentially occurring *Nature Conservation Act 1992* (NCA) or *Environment Protection and Biodiversity Conservation Act 1999 (*EPBC) listed species, was determined through the results of the surveys and through review of the ecology of each species. A number of characteristics of bird behaviours were considered including:

- Distribution, biology and foraging, dispersal and territorial behaviours;
- Flight height patterns; and
- Size of birds and flight manoeuvrability.

Of the key collision likelihood characteristics, flight height pattern was given the larger weighting over the other characteristics. Table 6 below outlines the criteria evaluated to assess the collision likelihood for each species or group of birds assessed.

Table 6. Bird Collision Likelihood Characteristics

Likelihood Characteristics	Criteria	Likelihood Score
Flight height Expected frequency a species enters the RSA.	Never – BBUS records and species ecology determine species not expected to enter RSA	0
	Occasional – BBUS records and species ecology show species is primarily present outside of RSA but may enter infrequently	5
	Regular – BBUS records show species frequently enters the RSA but species ecology and incidental records determine that it is not likely to spend the majority of its flight time there	10
	Predominant – BBUS and incidental records, and species ecology determine species likely to spend large majority of flight time within RSA	15
Movements and biology Annual presence of a species within the Project Area.	Rare – Present once or twice per year	0
	Intermittent – Present <1 month of the year	2
	Seasonal/migration – Present for 1-5 months of the year	5
	Resident – Present throughout most of the year (>5 months)	10
Manoeuvrability Size and relative manoeuvrability of the bird species	Small size, highly manoeuvrable	0
	Small size, constrained manoeuvrability or medium size, highly manoeuvrable	2
	Medium size, constrained manoeuvrability or large size, highly manoeuvrable	4
	Large size, constrained manoeuvrability	6

Scores for each of the criteria in the above table were combined to produce an overall value for the Collision Likelihood in Table 7. Species expected to never fly in the RSA are all considered to have a very rare collision likelihood regardless of other criteria.

Table 7. Bird Collision Likelihood

Collision Likelihood Score	Overall Collision Likelihood
0 – 7	Very rare
8 – 15	Rare
16 – 23	Possible
24 – 31	Probable

3.2. Bird Collision Consequence

An evaluation of the potential collision consequences for birds is outlined in Table 8.

Table 8. Bird Collision Consequence

Collision Consequence	Collision Consequence Criteria
Insignificant	Occasional loss of individuals or small numbers of individuals but no reduction in local or regional population viability.
Minor	Repeated loss of small numbers of individuals but no reduction in local or regional population viability.
Moderate	Repeated loss of small numbers of individuals that may contribute to a reduction in local or regional population viability.
Significant	Repeated loss in numbers of individuals, leading to minor reduction in localised or regional population viability for between one and five years.
Catastrophic	Consistent loss in large numbers of individuals, leading to reduction in regional or state population viability for a period of at least five years.

3.3. Bird Collision Risk Matrix

The collision likelihood and consequence are used to determine the final collision risk using the following matrix (Table 9) – Table 1 from *Wind Farms and Birds: Interim Standards for Risk Assessment* (Brett Lane & Associates Pty Ltd, 2005).

Table 9. Bird Collision Risk Matrix

Likelihood	Consequence				
	Insignificant	Minor	Moderate	Significant	Catastrophic
Very rare	L	L	L	M	H
Rare	L	L	L	M	H
Possible	L	L	M	H	H
Probable	L	M	H	H	H

Where: L = Low risk
M = Medium risk
H = High risk

3.4. Bird Collision Risk Assessment

3.4.1. General Order Risk Assessment

General risk assessments have been made at the Order or Family (for some passerine birds) level for all species found on site, this assessment can be found in Appendix B - General Collision Risk Assessment For Bird Orders/Families. The most at-risk Orders of birds known to occur within the project area are the Accipitriformes, the Coraciiformes (in part), the Falconiformes, and the Families *Artamidae* and *Hirundinidae* of the Passeriformes Order. Many individuals belonging to these orders have been recorded within the proposed RSA of the Project area. This assessment was undertaken precautionarily to cover non-listed species that have not been identified during surveys but have the potential to occur within the project area.

3.4.2. Listed Species Risk Assessment

EPBC Act listed species deemed as having a 'possible' or above likelihood of occurrence in WTS's MNES Ecological Assessment Report (Wulguru Technical Services, 2024) have been assessed at a species level in Appendix C – Collision Risk for NC and EPBC Act Listed Species
All EPBC Act listed species assessed are considered to have a low collision risk.

Onshore Wind Farm Guidance – Best practice approaches when seeking approval under Australia's national environment law (DCCEEW, 2024) requires that mathematical Collision Risk Modelling (CRM) be undertaken where risks to listed threatened species are identified. As all listed threatened species assessed in this CRA have a level of risk of low, no CRM is required. Evidence supporting this is in Appendix C – Collision Risk for NC and EPBC Act Listed Species.

3.4.3. Bird Species of Concern Risk Assessment

Analysis of the collision risks for non-listed bird SOC (performed in Table 10) identified the following species as having a medium collision risk as a result of the proposed Project:

- Black kite (*Milvus migrans*)
- Whistling kite (*Haliastur sphenurus*)
- Black-faced woodswallow (*Artamus cinereus*)
- Little woodswallow (*Artamus minor*)
- Masked woodswallow (*Artamus personatus*)
- Rainbow bee-eater (*Merops ornatus*)

All other bird species recorded within the RSA are considered to have a low collision risk.

Table 10. Collision Risk for Birds Recorded Within Rotor Swept Area

Species	Description and behaviour	Total Records	Records within RSA	% within RSA	Collision Likelihood	Collision Consequence	Collision Risk
Raptors							
Black kite (*Milvus migrans*)	A dark-coloured kite with a distinct fish-tailed appearance from below. The black kite is common across much of the country, often appearing in high abundance in response to favourable foraging conditions, such as bushfires, locust, and mouse plagues (Pizzey & Knight, 2012). The black kite is abundant around the mine and camp area, a typical trait of this species. It is likely this species will occur along the Knapdale Range in higher abundance when conditions are suitable. Recorded soaring within the RSA.	31	27	87	29 – Probable	Minor	Medium
Black-shouldered kite (*Elanus axillaris*)	A small, predominantly white kite with black shoulders. The black-shouldered kite is present across most of mainland Australia and may be irruptive in areas in response to prey availability (Pizzey & Knight, 2012). Observed foraging within the RSA	3	1	33	22 – Possible	Insignificant	Low
Brown falcon (*Falco berigora*)	The brown falcon is a large species of falcon with distinct dark double teardrop markings descending from either side of the eye. This species is fairly common across most of Australia, often irruptive in response to high prey abundance (Pizzey & Knight, 2012). This species is known to fly within the RSA.	10	8	80	27 – Probable	Insignificant	Low
Nankeen kestrel (*Falco cenchroides*)	A small falcon, light brown to rufous from above with distinct black wing tips. The nankeen kestrel is often seen hovering above grasslands searching for prey to dive on (Pizzey & Knight, 2012). It has been observed foraging within the RSA.	3	2	67	25 – Probable	Insignificant	Low

Species	Description and behaviour	Total Records	Records within RSA	% within RSA	Collision Likelihood	Collision Consequence	Collision Risk
Wedge-tailed eagle (*Aquila audax*)	Australia's largest bird of prey with an unmistakeable diamond-shaped tail from below. The wedge-tailed eagle is typically varying shades of brown, with older individuals darker than the light brown immatures. Often scavenges on carrion but also a very proficient predator, capable of taking large prey items including macropods (Pizzey & Knight, 2012). Typically seen flying within the RSA, often soaring on thermal air currents of the Knapdale Range. Nests have been sighted immediately to the west of the Knapdale Range.	8	5	62.5	26 – Probable	Insignificant	Low
Whistling kite (*Haliastur sphenurus*)	A medium-sized raptor typically sandy-brown in colouration. The whistling kite has a rounded tail from below, with a distinct pale band on each underwing. A regular species across most of Australia, the whistling kite feeds on carrion as well as captured prey (Pizzey & Knight, 2012). Typically flies within the RSA, observed soaring on thermal currents over the Knapdale Range.	17	17	100	29 – Probable	Minor	Medium
Aerial Insectivores							
Black-faced woodswallow (*Artamus cinereus*)	A common and widespread species, the black-faced woodswallow is regularly seen swooping from powerlines and other vantage points (Pizzey & Knight, 2012). It is abundant around the main mine area, as well as on the Knapdale Range. This species forages at or below RSA height.	42	33	78.5	25 – Probable	Minor	Medium
Little woodswallow (*Artamus minor*)	The smallest species of woodswallow. It is chocolate-brown in colour within a blueish bill (Pizzey & Knight, 2012). It is the most abundant aerial insectivore within the Project area for most of much of the year, though may be outnumbered by the masked woodswallow on seasonal migration. Forages at or below RSA height.	164	83	50.6	25 – Probable	Minor	Medium

Species	Description and behaviour	Total Records	Records within RSA	% within RSA	Collision Likelihood	Collision Consequence	Collision Risk
Masked woodswallow (*Artamus personatus*)	A distinct woodswallow with a large black mask extending from above the eye to the top of the breast. Considered a part-migratory species, the masked woodswallow typically arrives in northern Australia from its breeding habitat in the south in Autumn (Pizzey & Knight, 2012). These dispersive events often see the species travelling in expansive flocks which may be at a high risk of collision with turbines. Travels and forages at RSA height.	203	200	98.5	25 – Probable	Minor	Medium
Rainbow bee-eater (*Merops ornatus*)	An unmistakable, vibrantly coloured bird with a finely curved bill. The rainbow bee-eater is a proficient predator of bees, wasps, flies, and similar insects which it catches on the wing (Pizzey & Knight, 2012). Large groups may forage at RSA height in periods of high insect activity.	22	18	82	25 – Probable	Minor	Medium
Fairy martin (*Petrochelidon ariel*)	A small martin with a distinct ginger cap. The fairy martin undertakes a regular migration to the north from its breeding habitat in southeastern Australia, typically arriving in the north from March to April before leaving in September to October (Pizzey & Knight, 2012). Recorded foraging at RSA height.	45	16	35.5	20 – Possible	Insignificant	Low
Other Birds							
Australasian Darter (*Anhinga novaehollandiae*)	A unique cormorant-like bird with a distinct long, pointed bill and long neck. The Australasian darter is a proficient semi-aquatic predator of fish and invertebrates (Pizzey & Knight, 2012). This species is probably a regular inhabitant of watercourses in the vicinity of the Project area. Flies at RSA height but likely limited to rare passes from dispersing individuals.	2	2	100	16 – Possible	Insignificant	Low
Varied Lorikeet (*Psitteuteles versicolor*)	A small, predominantly green lorikeet with a pinkish cap and upper breast. The varied lorikeet is nomadic in response to the flowering patterns of *Eucalyptus* and *Melaleuca* species (Pizzey & Knight, 2012). It is very abundant across the project area but rarely enters the RSA. Most individuals or flocks fly quickly at around or just above canopy height.	73	1	1.4	15 – Rare	Insignificant	Low

Species	Description and behaviour	Total Records	Records within RSA	% within RSA	Collision Likelihood	Collision Consequence	Collision Risk
White-faced Heron (*Egretta novaehollandiae*)	A medium-sized, mostly grey heron with a white face and yellow legs. It is likely a regular inhabitant of watercourses within the greater Project area. Flies at RSA height but likely limited to rare passes from dispersing individuals.	1	1	100	16 – Possible	Insignificant	Low
White-necked Heron (*Ardea pacifica*)	A moderately large heron with a predominantly white head and neck and a slatey grey body. This species is probably a regular inhabitant of watercourses in the vicinity of the Project area. Flies at RSA height but likely limited to rare passes from dispersing individuals.	2	2	100	16 – Possible	Insignificant	Low

3.5. Bat Collision Likelihood

Collision Likelihood of bat species previously identified on site through call detection was determined through the review of available literature, with particular reference to flight heights. The collision likelihood for bats are explained in Table 11.

Table 11: Bat Collision Likelihood

Likelihood Characteristic	Criteria	Collision Likelihood
Flight height Expected frequency a species enters the RSA.	Never –Species ecology determines species not expected to enter RSA	Very rare
	Occasional – Species ecology determines species is primarily present outside of RSA but may enter infrequently	Rare
	Regular –Species ecology determines species frequently enters the RSA but that it is not likely to spend the majority of its flight time there	Possible
	Predominant – Species ecology determines species likely to spend large majority of flight time within RSA	Probable

3.6. Bat Collision Consequence

The collision consequences used for bats in this CRA are the same as those used for birds (Table 8).

3.7. Bat Collision Risk Matrix

The collision risk matrix used for bats in this CRA is the same as that used for birds (Table 9).

3.8. Bat Species of Concern Collision Risk Assessment

Analysis of the collision risks for bat SOC (Table 12) identified all bat species recorded at the BBUS sites to have a low collision risk.

Table 12: Collision Risk for Bat Species Identified During BBUS Surveys

Species	RSA utilisation	General Description	Flight speed and Manoeuvrability (slow, medium, highly agile)	General flight height	Collision Risk Susceptibility	Collision Consequence	Collision Risk
Finlayson's Cave Bat (*Vespadelus finlaysoni*)	Not expected	This species forms colonies that occupy caves or cavities within rocky terrain and will take residence in abandoned mining operations. This species forages for prey near water (Menkhorst & Knight, 2011).	Rapid flight with high mobility suited to foraging over water	<15m	Very Rare	Insignificant	Low
Gould's Wattled Bat (*Chalinolobus gouldii*)	Foraging	*C. gouldii* is insectivorous; in much of its range, moths are the most common food item. Other known prey includes cockroaches, flies, stoneflies, orthopterans, hemipterans, hymenopterans and other lepidopterans, including caterpillars. Grass seeds and twig fragments are occasionally ingested as well (Chruszcz & Barclay, 2002). In wooded areas, they are mostly arboreal, though they have also been found in the stumps and hollow limbs of trees or in bird nests.	Rapid flight with limited manoeuvrability	May fly to RSA height	Rare	Insignificant	Low
Hoary Wattled Bat (*Chalinolobus nigrogriseus*)	Not expected	These bats prefer to roost in the hollows of eucalypt trees, and occasionally rock crevices. They like to fly fast below the canopy layer and therefore live in areas where the undergrowth is naturally sparse. They can commonly be found in a range of habitats, including Forests, woodlands, vine thickets, coastal scrub and open grasslands, across the coastal hinterland regions of Queensland (Churchill, Australian bats, 2008) (Hall, 2009).	Rapid flight with high mobility suited to foraging below the canopy	<15m	Very Rare	Insignificant	Low
Inland Broad-nosed Bat (*Scotorepens balstoni*)	Not expected	Foraging is achieved using echolocation whilst in continuous flight, keeping within 15 metres of the ground, with rapid diversions to pursue prey. Foraging mainly occurs between trees, not going above the tree canopy, as well as at the edges of forests venturing into open	Rapid flight with high mobility suited to foraging below the canopy	<25m	Very Rare	Insignificant	Low

Species	RSA utilisation	General Description	Flight speed and Manoeuvrability (slow, medium, highly agile)	General flight height	Collision Risk Susceptibility	Collision Consequence	Collision Risk
		areas. Foraging locations in the drier distribution areas appear to depend on nearness to water points and roosting sites (Churchill, Australian bats, 2008).					
Inland Forest Bat (*Vespadelus baverstocki*)	Not expected	The flight of the species is fluttery and rapid, sharply turning as it forages over water.	Rapid flight with high mobility suited to foraging over water	<15m	Very Rare	Insignificant	Low
Little Broad-nosed Bat (*Scotorepens greyii*)	Foraging	The Little broad-nosed bat is an insectivore which feed and drink while in flight. They forage for prey close to treetops, over water, open grassland and other open habitat. They are characteristically fast fliers which make abrupt darts and turns to catch prey (Churchill, 2009) (Van Dyck & Strahan, 2008) (Menkhorst & Knight, 2011).	Rapid flight with high mobility suited to foraging over water and canopy	May fly to RSA height	Rare	Insignificant	Low
Northern Freetail Bat (*Chaerophon jobensis*)	Foraging	They will fly and forage in groups of two or more individuals. Its foraging style utilizes fast, direct flight suited for open areas or above canopies. It is insectivorous, consuming beetles, bugs, moths, lacewings, grasshoppers, cockroaches, flies and leafhoppers (Kutt, Milne, & Richards, 2008).	Rapid flight with limited manoeuvrability	May fly to RSA height	Rare	Insignificant	Low
Northern Free-tailed Bat (*Ozimops lumsdenae*)	Not expected	*O. lumsdenae* is associated with permanent water, agricultural dams, and watercourses in semi-arid regions, where it resides and forages in eucalypt woodland (Reardon & Armstrong, 2020). Roosts in tree hollows.	Rapid flight with high mobility suited to foraging below the canopy	<15m	Very Rare	Insignificant	Low
White-striped Freetail Bat (*Austronomus australis*)	Foraging	This free-tailed bat is a specialized high altitude, fast flying interceptor insectivore. Their diet consists principally of moths, beetles and bugs. This species can be found in most habitats from closed forest to open flood plain, and occurs in	Rapid flight with high manoeuvrability	Flies at RSA height	Probable	Insignificant	Low

Species	RSA utilisatio n	General Description	Flight speed and Manoeuvrability (slow, medium, highly agile)	General flight height	Collision Risk Susceptibility	Collision Consequence	Collision Risk
		urban areas, in regions across temperate and subtropical Australia.					
Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventris*)	Not expected	Yellow-bellied sheath-tailed bats are canopy feeders, meaning that they are capable of fast flight, but inefficient at rapid manoeuvring. They generally feed at heights of 20–25 m, unless feeding in open spaces or at forest edges, where they forage lower (Churchill, Australian bats, 2008) (Rhodes, Hall, & Parish, 1997).	Rapid flight with low manoeuvrability	<25m	Very Rare	Insignificant	Low
Bristle-faced Free-tailed Bat (*Setirostris eleyri*)		Bristle-faced Free-tailed Bats are locally uncommon across inland Australia, and only known to inhabit riparian zones and floodplains. During the day these bats roost in tree hollows of mature eucalypts, but are noted as squeezing themselves into other tiny crevices. The observations are along drainage lines and open channels, flying with slow fluttering movements below the canopy at a low altitude of 3 to 4 metres (Pennay, 2006).	Rapid flight with high mobility suited to foraging below the canopy	<15m	Very Rare	Insignificant	Low
Common Sheathtail Bat (*Taphozous georgeanis*)		Common Sheathtail Bats roost in caves, old mines and cracks in rocks. They often rest on rocks during the night's feeding. They hunt alone, flying slowly in a straight line while following a grid pattern over the feeding ground. They feed over bushes and water catching and eating insects while flying (Australian Museum, 2020).	Slow flight with low manoeuvrability	May fly to RSA height	Rare	Insignificant	Low

4. Potential Impacts

The construction phase of the proposed Project poses the single potential impact of loss or degradation of habitat through clearing of turbine pads and tracks, introduction and/or spread of weed species due to vehicle and machinery movements across the landscape, and noise, dust, light pollution, and vibrations (particularly during night-time works).

The majority of potential impacts of the proposed Project to birds and bats lie within the operation phase, and have been listed below:

- Wind turbine structures, primarily rotor blades and associated RSA, causing;
    - Collisions between flying fauna and wind turbine rotor blades or other structures, or barotrauma as a result of flight close to rotor blades, resulting in injury or fatality. The likelihood of a collision is dependent on a range of factors, including:
        - Design characteristics, such as:
            - the type of wind turbine; and
            - the layout of the wind farm;
        - Site characteristics, including:
            - the ecosystems on the wind farm site;
            - proximity to bird concentrations;
            - the numbers of birds moving across the wind farm site;
            - the behaviours of birds and bats (e.g. soaring at RSA height); and
            - weather conditions (Brett Lane & Associates Pty Ltd, 2005).
    - Displacement and barrier effects resulting in greater energetic cost to fauna flying through the area;
- Noise pollution, pressure, and vibrations from the operation of the wind turbines;
    - Light confusing/disorientating aerial fauna increasing risk of collision (risk has been nullified by design adjustments – lighting will not be present on the turbines); or
    - Disturbing surrounding habitat making it less preferable for native species or conditioning avoidance and affecting normal distribution patterns.

5. Monitoring

Operation phase monitoring protocols are derived from *Wind Farms and Birds: Interim Standards for Risk Assessment* (Brett Lane & Associates Pty Ltd, 2005). The results of the following monitoring will be used as necessary in the adaptive management of the wind farm.

5.1. Ongoing BBUS and Roaming Surveys

BBUS and roaming surveys will be continued throughout the construction and operation phase, for at least the first 24 months of operation, with the same methodology and timing as those undertaken already. Six BBUS sites located within or immediately adjacent to the Disturbance Footprint, specifically within 500 m of WTGs, will become impact sites upon operation beginning in line with the BACI framework.

Ongoing BBUS during operation, compared to pre-construction surveys, should also monitor avoidance behaviours defined below:

- Avoidance – involves birds remaining within the Project area but flying around, over or under operating wind turbines as it is a commonly observed behaviour at wind farms.
- Diversion – involves birds remaining within the area around a wind farm but avoiding the wind farm site entirely.
- Displacement – involves birds being displaced through disturbance from the area around the wind farm.

Bi-annual BBUS reports will be prepared that will examine each species abundance within and outside of the RSA.

5.2. Carrion monitoring

Carrion monitoring involves surveying of the areas immediately under or around the turbines for carcasses of birds and bats.

For each turbine in the proposed windfarm, a 220 m radius area will be searched surrounding the turbine initially, as surveys in the first instance should cover an area out to a distance equivalent to the height of the wind turbine. The distance can be altered if carcass locations indicate this is supported (Brett Lane & Associates Pty Ltd, 2005). Searches will be conducted once per month, on a random day, until searchers are satisfied, they have found what they can/what is present. Information on each carcass or feather spot found should be recorded as follows:

- date;
- species;
- signs of injury and likelihood of death due to collision;
- signs of scavenging;
- distance and bearing from turbine tower base;

- ground conditions (e.g. height and density of vegetation, presence of stock, etc.); and
- aerosphere conditions (e.g. visibility conditions such as fog, wind, rain, current and previous 24 hr weather conditions).

Carrion monitoring should occur for at least the first 48 months of the windfarms operation phase. If a significant level of bird or bat mortality to a regional species or species population is measured, then the monitoring should continue (Brett Lane & Associates Pty Ltd, 2005). Outside of the scavenging trial, carcasses should be removed when located to prevent unnecessary attraction of scavengers to the area potentially resulting in higher bird mortality.

The number of carcasses found during surveys is an underestimated measure of the true mortality rate, as it is affected by two major biases: the overlooking of carcasses present in the field; and carcass disappearance before being counted due to removal by scavengers or other means (Barrientos, et al., 2018; Wood, 2017).

A scavenging trial should be undertaken at least twice during the first 48 months of operation during different times of the year. The aim of this trial is to determine the typical rate of removal of carcasses by scavengers, and therefore estimate the likelihood a carcass is detected during carrion monitoring and provide more accurate estimates of bird and bat fatality rate from the wind farm.

Carcasses collected during carrion monitoring, or incidentally from the roads, should be frozen and kept for use in the scavenging trial, with an even ratio of small birds or bats and large birds if available. One carcass should be placed within the carrion monitoring radius at each turbine, along with an appropriately placed camera trap to capture scavenging birds and monitor the condition of the carcass. Chicken or mice sourced from pet food suppliers may be used as surrogates for bird and bat carcasses where required Carcasses should be checked weekly until there is no flesh left for scavenging. It is important to note the condition (wholeness) of the carcass upon initial collection, the size (small or large carcass), and the time taken for partial (~50%) and complete (~100%) removal or decomposition of the carcass, as well as the species observed scavenging.

A searcher efficiency trial should be run in the same season as the scavenger trial, twice per year, to determine the proportion of bird and bat fatalities that the observer undertaking the searches actually finds. Four to eight additional carcasses collected during carrion monitoring, or incidentally from the roads, should be frozen and kept for use in the searcher trial, with an even ratio of small and large birds if available. Chicken or mice sourced from pet food suppliers may be used as surrogates for bird and bat carcasses if required. Carcasses should be placed within a 50m radius surrounding a random wind turbine by a member of staff not involved in the searcher efficiency trial, ensuring that carcasses are placed in a stratified random manner that reflects a natural carcass resting place, and that they reflect the habitat of the full carrion monitoring area including different vegetation types/densities, crevices, gullies, and flat areas. An approximate 50/50 split should be used of carcasses in cover and in the open, with an even ratio of small and large birds in each if available. The searcher efficiency trial search should be performed to the same thoroughness as the carrion monitoring, that is until searchers are satisfied they have found what they can/what is present.

Correction factors for scavenging and observer efficiency should be developed from these trials and applied to the monitored number of dead birds in order to derive an estimate of collision rate (Brett Lane & Associates Pty Ltd, 2005).

It is assumed that a fauna collision with the turbine will be fatal. However, injured wildlife will be referred to local wildlife carers:

- Western Qld Wildlife Rehabilitation Centres: Cloncurry – 0419 422 900

6. Management

As the Project has been determined through a Level One investigation (Brett Lane & Associates Pty Ltd, 2005) to have a medium level of risk, the following management practices are proposed with the aim of reducing the level of risk to low. Of primary importance is the bottom row referring to the direct impacts of the wind turbine structures and associated RSA.

Table 1213: General Management Strategies

Threat	Impact	Controls/Management				
		Avoid	Minimise	Mitigate	Monitor	Timing
Introduction and/or spread of weed species due to vehicle and machinery movements across the landscape.	Modification of native habitats.	Where possible, activities must be planned to avoid movement of vehicles or machinery between properties, corridors, or areas with weed infestations. All equipment that enters site must be washed down on each occasion (including vehicles, earthmovers, generators, etc.)	General vehicle and machinery hygiene procedures will be implemented to minimise spreading of seeds.	Weed management and control methods will be implemented based on infestation size, location, and species of which it is comprised.	Monitoring and management performed as per Weed and Pest Species Management Plan (WPMP).	During design, construction, and operation.
Introduction of pest species or increase of their populations in the project area.	Competing with, predating on, or otherwise harming native species. Facilitating the infection of native species with diseases/parasites Indirectly modifying the habitat of native species. Indirect harm to native fauna through	All waste generated must be stored, handled, and transported in sealed containers.	Not applicable.	Green waste produced may be used on site for rehabilitation, sediment, or erosion control. Implement a Weed and Pest Species Management Plan (WPMP).	Monitoring and management performed as per Weed and Pest Species Management Plan (WPMP).	During design, construction, and operation.

	degradation of their habitat.					
Noise, dust, light pollution, and vibrations (particularly during night-time works).	Confusion of birds by light causing increased risk of interactions.	Not applicable.	Hours and amount of artificial light will be minimised, and lights will be directed away from habitat or shields used to block light from habitat where practical.	Not applicable.	Light meters can be used to monitor light pollution and ensure it stays at or below acceptable levels during works.	During construction and operation
	Disturbing surrounding habitat making it less preferable for native species or conditioning avoidance and affecting normal distribution patterns	Not applicable.	Hours and amount of artificial light will be minimised, and lights will be directed away from habitat or shields used to block light from habitat where practical. Noisy machine operation will be minimised wherever practical to reduce impact on surrounding habitat. Watering down and implementation of sensible driving speeds on the access roads will minimise dust generation and reduce impact on surrounding habitat.		Light meters can be used to monitor light pollution and ensure it stays at or below acceptable levels during works. Development of an Air Quality, Noise and Vibration Management Plan.	

Construction or clearing activities.	Injury/fatality of fauna.	Pre-clearance surveys to be undertaken by qualified fauna spotter/catchers to avoid unintentional tampering of animal breeding places. Clearing will be performed sequentially to direct fauna towards adjacent habitat and away from work sites.	All people driving on site to stay on roads to lower risk of hitting an animal, and follow vehicle speed limits to further lower risk. Speed limit along turbine access roads will be 40 km/h or less.	Fauna spotter/catchers operating under an approved rehabilitation permit to check areas prior to work commencing, and to be present during clearing. Fauna will preferably be allowed to move on their own accord, but if this does not occur and access is required immediately then fauna spotter/catchers operating under an approved rehabilitation permit will relocate them. Injured wildlife can be brought to local wildlife carers: **Western Qld Wildlife Rehabilitation Centres: Cloncurry – 0419 422 900**	Maintaining records of any fauna interactions on site as per permitting requirements to inform management adjustments.	During design and construction
	Destruction of native habitat	Where possible, avoid the clearing of areas of habitat	Not applicable.	Rehabilitate cleared areas that are no longer required after construction has finished.	Monitor and maintain rehabilitated sites to ensure they are progressing as required (control of weeds, etc.).	
Wind turbine structures, primarily rotor blades and associated RSA.	Collisions between flying fauna and wind turbine rotors or other structures, or barotrauma as a result of flight close to rotors, resulting in injury or fatality.	Not applicable.	Installation of lights atop turbines should be avoided where possible, and those that are installed should be flashing lights, as these have been shown to reduce attraction of birds (Gehring, Kerlinger, & Manville, 2009). Maintain slashed grass transitioning into low	Follow impact triggers and associated adaptive management strategies.	Follow impact triggers and associated adaptive management strategies.	Through the operational phase.

			shrub cover surrounding turbine pad to minimise bird and bat foraging and to facilitate carcass counts/removal. Removal of carcasses during carrion monitoring to minimise foraging opportunities.			

7. Impact Triggers and Adaptive Management

As the Project has been determined through a Level One investigation (Brett Lane & Associates Pty Ltd, 2005) to have a 'medium' level of risk, the following impacts triggers and adaptive management practices are proposed with the aim of reducing the risk level to 'low'. *Onshore Wind Farm Guidance – Best practice approaches when seeking approval under Australia's national environment law* (DCCEEW, 2024) requires impact triggers be species specific, these are shown for each identified SOC in Table 1314, however general impact triggers have also been precautionarily prepared by listing to cover any species not identified during CRA. The impact triggers below are in accordance with *Wind Farms and Birds: Interim Standards for Risk Assessment* (Brett Lane & Associates Pty Ltd, 2005):

- An impact trigger for threatened species occurs where a carcass (or recognisable part) of a threatened bird or bat species (listed under the NC or EPBC Act) is found under or in close proximity to a turbine during any carcass search or incidentally during commissioning or operation.
- For non-threatened species, an impact trigger is where two or more of the same species, in two successive searches at the same or immediately adjacent turbine/s is recorded (i.e. a total of four or more carcasses of the same species in two successive searches).

Upon an impact trigger being met, the following information will be made available to the administering authority upon request, and within 5 business days of the discovery of any impact trigger thresholds being met or exceeded:

- animal species of the discovery of any fauna mortality;
- number of animals;
- location (specific turbine/s); and
- likely cause of impact and cause of death.

Table 1314: Impacts and Mitigation Measures

Species	Impact trigger	Potential causes of impact	Mitigation Measure in response to impact trigger
Black kite (*Milvus migrans*) Whistling kite (*Haliastur sphenurus*) Black-faced woodswallow (*Artamus cinereus*) Little woodswallow (*Artamus minor*) Masked woodswallow (*Artamus personatus*) Rainbow bee-eater (*Merops ornatus*)	Two or more of the same species, in two successive searches at the same or immediately adjacent turbine/s is recorded (i.e. a total of four or more carcasses of the same species in two successive searches)	Foraging source identified that attracts 'at risk' species to impact areas (e.g. flowering eucalypts, carrion associated with road kills, or spawning of insects). Bushfire, low pressure systems and storm fronts creating favourable conditions for aerial foragers. Low visibility due to wind/rain/fog.	Trial acoustic and/or visual deterrents at turbine/s responsible for impact trigger.

Potential options for acoustic deterrents for bats and birds respectively are:

- The NRG ultrasonic acoustic Bat Deterrent System – which showed a 50% reduction in bat fatalities between turbines with 5 modules and turbines with none over a two year study in Texas (NRG Systems, 2020); and

  The Scarecrow 180™ - a well-researched bio-acoustic bird dispersal system. When coupled with a Scarecrow 360™ ‘slave’ unit it creates a system that provides 360° of dispersal.

If a collision event is considered a potentially regular occurrence (based on assessment of survey data), or likely to lead to an impact to the population (at the appropriate scale i.e. Local, Regional, State, National); species specific monitoring may be required to determine potential causes and appropriate mitigation measures.

This management plan will be reviewed annually to evaluate the effectiveness of the management measures presented herein. The review will consider additional data as it is made available, to ensure all management measures are effective at minimising potential impact to bird and bat species. Management controls will be adjusted, as required, based on the most current information.

8. Post-Management Collision Risk Assessment

Wind Farms and Birds: Interim Standards for Risk Assessment (Brett Lane & Associates Pty Ltd, 2005) states that if the risk level is low, or can be reduced to that level through the incorporation of mitigation measures and siting and/or design alterations, then further investigation of bird impact risk at the site is not warranted.

The following SOC were assessed as having a level of risk of ‘medium’ prior to the incorporation of monitoring and management strategies:

- Black kite (*Milvus migrans*)
- Whistling kite (*Haliastur sphenurus*)
- Black-faced woodswallow (*Artamus cinereus*)
- Little woodswallow (*Artamus minor*)
- Masked woodswallow (*Artamus personatus*)
- Rainbow bee-eater (*Merops ornatus*)

Each of the above SOC has been given a ‘medium’ risk level due to having a ‘probable’ likelihood of turbine collision as a result of their flight habits. Each species however demonstrates a collision consequence of ‘minor’ due to their large distributions and commonness throughout them.

It is logical to first attempt to reduce the likelihood of collision through siting and/or design alterations. The following alteration has already been confirmed. The Knapdale Range has been selected to maximise the productivity of each turbine, thus leading to fewer turbines being required to meet the desired energy output.

It is not feasibly possible to lower a species collision likelihood through the implementation of mitigation measures. Impact triggers and adaptive management have been implemented with the aim of instead lowering the collision consequence for each SOC. The adherence to impact triggers and the implementation of mitigation measures (discussed in Section 7) will reduce the level of risk by limiting the impact to a SOC. Impact triggers are reliant on the carrion monitoring discussed in Section 5.2. Carrion monitoring itself provides additional risk reduction through the removal of carcasses from the area underneath the turbines, reducing foraging opportunities for scavengers such as the black kite and whistling kite.

The data from ongoing carrion monitoring and BBUS monitoring (discussed in Section 5.1), with the addition of avoidance behaviour monitoring, will be used to adapt management practices or management intensity.

Through the adherence to impact triggers and the implementation of mitigation measures, the collision consequence of the above SOC can be lowered from ‘minor’ to ‘insignificant’ as individual collision events will be responded to with appropriate management.

The remaining risk after the incorporation of mitigation measures and siting and/or design alterations is defined as residual risk. With a residual risk level of low, no further investigations are required.

Appendix A – Incidental Species Records

Common Name (*Scientific Name*)	Order	Status*	
		NCA	EPBC
Collared Sparrowhawk (*Accipiter cirrocephalus*)	Accipitriformes	LC	NL
Spotted Harrier (*Circus assimilis*)	Accipitriformes	LC	NL
Black Swan (*Cygnus atratus*)	Anseriformes	LC	NL
Australian Owlet-nightjar (*Aegotheles cristatus*)	Caprimulgiformes	LC	NL
Spotted Nightjar (*Eurostopodus argus*)	Caprimulgiformes	LC	NL
Tawny Frogmouth (*Podargus strigoides*)	Caprimulgiformes	LC	NL
Black-fronted Dotterel (*Elseyornis melanops*)	Charadriiformes	LC	NL
Pied Stilt (*Himantopus leucocephalus*)	Charadriiformes	LC	NL
Little Button-quail (*Turnix velox*)	Charadriiformes	LC	NL
Diamond Dove (*Geopelia cuneata*)	Columbiformes	LC	NL
Peaceful Dove (*Geopelia placida*)	Columbiformes	LC	NL
Spinifex Pigeon (*Geophaps plumifera*)	Columbiformes	LC	NL
Crested Pigeon (*Ocyphaps lophotes*)	Columbiformes	LC	NL
Common Bronzewing (*Phaps chalcoptera*)	Columbiformes	LC	NL
Red-backed Kingfisher (*Todiramphus pyrrhopygius*)	Coraciiformes	LC	NL
Pallid Cuckoo (*Heteroscenes pallidus*)	Cuculiformes	LC	NL
Pheasant Coucal (*Centropus phasianinus*)	Cuculiformes	LC	NL
Horsefield's Bronze Cuckoo (*Chalcites basalis*)	Cuculiformes	LC	NL
Common Koel (*Eudynamys orientalis*)	Cuculiformes	LC	NL
Australian Hobby (*Falco longipennis*)	Falconiformes	LC	NL
Black Falcon (*Falco subniger*)	Falconiformes	LC	NL
Brown Quail (*Synoicus ypsilophorus*)	Galliformes	LC	NL
Australian Bustard (*Ardeotis australis*)	Otidiformes	LC	NL
Spiny-cheeked Honeyeater (*Acanthagenys rufogularis*)	Passeriformes	LC	NL
Yellow-rumped Thornbill (*Acanthiza chrysorrhoa*)	Passeriformes	LC	NL
Kalkadoon Grasswren (*Amytornis ballarae*)	Passeriformes	LC	NL
Dusky Woodswallow (*Artamus cyanopterus*)	Passeriformes	LC	NL
White-browed Woodswallow (*Artamus superciliosus*)	Passeriformes	LC	NL
Pied Butcherbird (*Cracticus nigrogularis*)	Passeriformes	LC	NL
Pied Honeyeater (*Certhionyx variegatus*)	Passeriformes	LC	NL
Spotted Bowerbird (*Chlamydera maculata*)	Passeriformes	LC	NL
Great bowerbird (*Chlamydera nuchalis*)	Passeriformes	LC	NL
Banded Honeyeater (*Cissomela pectoralis*)	Passeriformes	LC	NL
Black-tailed Treecreeper (*Climacteris melanurus*)	Passeriformes	LC	NL
Grey Shrike-thrush (*Colluricincla harmonica*)	Passeriformes	LC	NL
Little Shrike-thrush (*Colluricincla megarhyncha*)	Passeriformes	LC	NL
White-bellied Cuckoo-shrike (*Coracina papuensis*)	Passeriformes	LC	NL
Grey Butcherbird (*Cracticus torquatus*)	Passeriformes	LC	NL
Varied Sittella (*Daphoenositta chrysoptera*)	Passeriformes	LC	NL
Mistletoebird (*Dicaeum hirundinaceum*)	Passeriformes	LC	NL

Crimson Chat (*Epthianura tricolor*)	Passeriformes	LC	NL
Singing Honeyeater (*Gavicalis virescens*)	Passeriformes	LC	NL
Western Gerygone (*Gerygone fusca*)	Passeriformes	LC	NL
Magpie Lark (*Grallina cyanoleuca*)	Passeriformes	LC	NL
Australian Magpie (*Gymnorhina tibicen*)	Passeriformes	LC	NL
Pictorella Mannikin (*Heteromunia pectoralis*)	Passeriformes	LC	NL
White-winged Triller (*Lalage tricolor*)	Passeriformes	LC	NL
White-plumed Honeyeater (*Lichenostomus penicillatus*)	Passeriformes	LC	NL
Brown Honeyeater (*Lichmera indistincta*)	Passeriformes	LC	NL
Purple-backed Fairy-wren (*Malurus assimilis*)	Passeriformes	LC	NL
Variegated Fairy-wren (*Malurus lamberti*)	Passeriformes	LC	NL
Red-backed Fairy-wren (*Malurus melanocephalus*)	Passeriformes	LC	NL
Yellow-throated Miner (*Manorina flavigula*)	Passeriformes	LC	NL
Rufous Songlark (*Megalurus mathewsi*)	Passeriformes	LC	NL
Northern Inland Hooded Robin (*Melanodryas cucullata picata*)	Passeriformes	LC	NL
Brown-headed Honeyeater (*Melithreptus brevirostris*)	Passeriformes	LC	NL
Black-chinned Honeyeater (*Melithreptus gularis*)	Passeriformes	LC	NL
Jacky Winter (*Microeca fascinans*)	Passeriformes	LC	NL
Paperbark Flycatcher (*Myiagra nana*)	Passeriformes	LC	NL
Crested Bellbird (*Oreoica gutturalis*)	Passeriformes	LC	NL
Olive-backed Oriole (*Oriolus sagittatus*)	Passeriformes	LC	NL
Rufous Whistler (*Pachycephala rufiventris*)	Passeriformes	LC	NL
Red-browed Pardalote (*Pardalotus rubricatus*)	Passeriformes	LC	NL
Striated Pardalote (*Pardalotus striatus*)	Passeriformes	LC	NL
Red-capped Robin (*Petroica goodenovii*)	Passeriformes	LC	NL
Long-tailed Finch (*Poephila acuticauda*)	Passeriformes	LC	NL
Grey-crowned Babbler (*Pomatostomus temporalis*)	Passeriformes	LC	NL
Spinifexbird (*Poodytes carteri*)	Passeriformes	LC	NL
Yellow-tinted Honeyeater (*Ptilotula flavescens*)	Passeriformes	LC	NL
Grey-headed Honeyeater (*Ptilotula keartlandi*)	Passeriformes	LC	NL
Grey-fronted Honeyeater (*Ptilotula plumula*)	Passeriformes	LC	NL
Grey Fantail (*Rhipidura fuliginosa*)	Passeriformes	LC	NL
Willie Wagtail (*Rhipidura leucophrys*)	Passeriformes	LC	NL
Weebill (*Smicrornis brevirostris*)	Passeriformes	LC	NL
Double-barred Finch (*Taeniopygia bichenovii*)	Passeriformes	LC	NL
Zebra Finch (*Taeniopygia castanotis*)	Passeriformes	LC	NL
Glossy Ibis (*Plegadis falcinellus*)	Pelicaniformes	SL	M
Australasian Grebe (*Tachybaptus novaehollandiae*)	Podicepediformes	LC	NL
Red-winged Parrot (*Aprosmictus erythropterus*)	Psittaciformes	LC	NL
Cloncurry Ringneck (*Barnardius zonarius macgilvrayi*)	Psittaciformes	LC	NL
Sulphur-crested Cockatoo (*Cacatua galerita*)	Psittaciformes	LC	NL
Southern Boobook (*Ninox boobook*)	Strigiformes	LC	NL

Eastern Barn Owl (*Tyto alba*)	Strigiformes	LC	NL
Emu (*Dromaius novaehollandiae*)	Struthioniformes	LC	NL

* NCA = *Nature Conservation Act 1992*; EPBC = *Environment Protection and Biodiversity Conservation Act 1999*; CR = Critically Endangered; EN = Endangered; VU = Vulnerable; NT = Near Threatened; SLC = Special Least Concern; LC = Least Concern; M = Migratory; Ma = Marine

Appendix B - General Collision Risk Assessment For Bird Orders/Families

Order	RSA Utilisation	General description	Flight speed and Manoeuvrability (slow, medium, highly agile)	General Flight height	Size (small/ medium/ large)	Total Records within Project area	Collision Likelihood	Collision Consequence	Collision Risk
Accipitriformes	Foraging and dispersing	Accipitriformes is an order of birds that includes most of the diurnal birds of prey, including hawks, eagles, vultures, and kites, but not falcons (Atlas of Living Australia, n.d.).	Fast flight with medium manoeuvrability	Within RSA	Medium to large	16	29 – Probable	Insignificant	Medium
Anseriformes	Dispersal	Anseriformes is an order of birds also known as waterfowl that comprises about 180 living species of birds in three families. Most modern species in the order are highly adapted for an aquatic existence at the water surface. (Atlas of Living Australia, n.d.)	Slow with low manoeuvrability	Typically below RSA height, other than migration.	Large		11 – Rare	Insignificant	Low
Caprimulgiformes	Dispersal	Caprimulgiformes are soft-plumaged birds, the major groups of which are called nightjars, nighthawks, potoos, frogmouths, and owlet-frogmouths. Most are twilight- or night-flying birds (Schwartz, 2008).	Medium speed with medium manoeuvrability	Typically below RSA height, other than dispersal.	Medium		9 – Rare	Insignificant	Low

Order	RSA Utilisation	General description	Flight speed and Manoeuvrability (slow, medium, highly agile)	General Flight height	Size (small/ medium/ large)	Total Records within Project area	Collision Likelihood	Collision Consequence	Collision Risk
Charadriiformes	Dispersal	Charadriiformes is a diverse order of small to medium-large birds. Most charadriiform birds live near water and eat invertebrates or other small animals; however, some are pelagic (seabirds), others frequent deserts, and a few are found in dense forest. Members of this group can also collectively be referred to as shorebirds (Atlas of Living Australia, n.d.).	Slow to medium speed with low manoeuvrability	Foraging activities occur under RSA height, but dispersal flight height is within the RSA	Small to medium		11 – Rare	Insignificant	Low
Columbiformes	Not likely	Columbiformes is an order of birds containing the pigeons and doves in one family, and the extinct dodo and solitaire in another. The pigeon family (Columbidae) contains about 316 species (Murton, 2023).	Medium speed with medium manoeuvrability	Typically below RSA height	Small to medium	43	12 – Rare	Insignificant	Low
Coraciiformes	Dispersal and foraging for some species	Coraciiformes is an order of usually colourful birds including kingfishers and bee-eaters. The members of this order are linked by their “slamming” behaviour in which they thrash their prey into surfaces (Rand, 2023).	Medium speed with high manoeuvrability	Dispersal flight height is within the RSA. Foraging may occur in the RSA for some species	Small to medium	11	27 – Probable	Insignificant	Medium
Cuculiformes	Dispersal	Cuculiformes is an order of birds containing the cuckoos and the hoatzin. Most cuckoos are solitary, often furtive birds that are inconspicuous even when relatively common, and they do not form flocks (Friedmann, 2024).	Medium speed with medium manoeuvrability	May fly within height of RSA	Small to medium		12 – Rare	Insignificant	Low

Order	RSA Utilisation	General description	Flight speed and Manoeuvrability (slow, medium, highly agile)	General Flight height	Size (small/ medium/ large)	Total Records within Project area	Collision Likelihood	Collision Consequence	Collision Risk
Falconiformes	Foraging and dispersal	Falconiformes is an order of birds containing falcons; diurnal raptors but not included in the order Accipitriformes with the others. Although rarely abundant, falcons are widespread and live in diverse habitats (Gill & Brown, falconiform, 2016).	Fast flight with high manoeuvrability	Within RSA	Medium	8	27 – Probable	Insignificant	Medium
Galliformes	Not likely	Galliformes is an order of fowl-like birds containing 290 species including turkeys, chickens, quail, pheasant, and peacock (Haverschmidt, 2023).	Fast flight but rarely sustained for long distances. Low manoeuvrability	Typically below RSA height	Small to large		6 – Very rare	Insignificant	Low
Otidiformes	Not likely	Otidiformes is an order of large birds containing bustards, floricans, and korhaans. They are highly terrestrial, often seen walking slowly or staying motionless among the vegetation. They don't fly very often but can sustain strong flight when they do (Bouglouan, n.d.).	Fast flight with low manoeuvrability	Typically below RSA height	Large		6 – Very rare	Insignificant	Low
Passeriformes *Artamidae*	Foraging and dispersal	The *Artamidae* family of the Order Passeriformes includes the woodswallows, butcherbirds and the Australian magpie. Most are predatory, feeding on a vast array of prey items, from insects to reptiles and other birds.	Variable. Some species fast and agile.	Some species frequently within RSA	Small to medium	292	22 – Possible	Insignificant	Low

Order	RSA Utilisation	General description	Flight speed and Manoeuvrability (slow, medium, highly agile)	General Flight height	Size (small/ medium/ large)	Total Records within Project area	Collision Likelihood	Collision Consequence	Collision Risk
Passeriformes *Hirundinidae*	Foraging and dispersal	The *Hirundinidae* family of the Order Passeriformes includes swallows and martins. These passerine birds are specifically adapted for aerial feeding on insects.	Fast flight with high manoeuvrability.	Within the RSA	Small	31	20 – Possible	Insignificant	Low
Passeriformes *Other families*	Foraging and dispersal	Passeriformes is the largest order of birds and the dominant avian group comprised of approximately 5700 species. Passeriformes are true perching birds characterised by their four toes, three directed forward and one backward. The majority are insectivorous, some being aerial feeders and others gleaning insects from surfaces (Austin, Clench, & Gill, 2024).	Variable. Some species fast and agile.	May fly within height of RSA	Small to medium	174	20 – Possible	Insignificant	Low
Pelecaniformes	Dispersal	Pelecaniformes is an order of large aquatic birds with webbing or partial webbing between all four toes, including pelicans, egrets, ibises, and spoonbills. The various groups of Pelecaniformes are specialized for different feeding methods, however they all feed at bodies of water (Ashmole, 2022).	Medium speed with low manoeuvrability	May fly within height of RSA	Large	5	16 – Possible	Insignificant	Low
Podicipediformes	Dispersal	Podicipediformes is an order comprised of a single family of foot-propelled diving birds called Grebes. Grebes feed and breed on still or slow-moving bodies of water (Storer, 2023).	Medium speed with low manoeuvrability	May fly within height of RSA	Medium		14 – Rare	Insignificant	Low

Order	RSA Utilisation	General description	Flight speed and Manoeuvrability (slow, medium, highly agile)	General Flight height	Size (small/ medium/ large)	Total Records within Project area	Collision Likelihood	Collision Consequence	Collision Risk
Psittaciformes	Dispersal	Psittaciformes is an order of more than 360 species of generally bright coloured, noisy birds. Typically, parrots are gregarious and noisy, often forming small groups, sometimes huge flocks, flying rapidly high overhead and screeching. Parrots feed almost entirely on plant materials. The smaller species tend to utilize grass seeds, berries, fruits, and the juices of blossoms; the larger forms obtain fruits and nuts from trees and bulbs, tubers, and roots from the ground (Gill & Woolfenden, 2024).	Medium speed with medium manoeuvrability	May fly within height of RSA	Medium	98	19 – Possible	Insignificant	Low
Strigiformes	Foraging and dispersing	Strigiformes is an order of primarily nocturnal raptors known as owls. Owls often attain higher population densities than hawks, the distribution and density of most species seem to be limited by the availability of suitable nesting sites, rather than by the number of potential prey animals. Owls that hunt over grassland hunt by sustained flight, dropping into the grass to catch rodents. Many woodland owls secure prey by dropping from perches at the edges of forest openings. The nocturnal routine of most owls involves peaks of activity at dusk and dawn (Marshall & Gill, 2024).	Fast flight with high manoeuvrability	May fly within height of RSA	Medium to large		12 – Rare	Insignificant	Low

Order	RSA Utilisation	General description	Flight speed and Manoeuvrability (slow, medium, highly agile)	General Flight height	Size (small/ medium/ large)	Total Records within Project area	Collision Likelihood	Collision Consequence	Collision Risk
Struthioniformes	Not likely	Struthioniformes is an order of large flightless birds of which there are approximately 15 species. In Australia this refers to Emus and Cassowaries. They are omnivorous, and often good runners due to their long muscular legs (Bollich, n.d.).	Flightless	Flightless	Large		Very rare	Insignificant	Low
Suliformes	Dispersal	Suliformes is a relatively new order of birds that includes cormorants, anhingas, frigatebirds, and boobies. These birds are adapted for life in the water and are generally large, with long wings and webbed feet. Suliformes are social animals and can often be found in large groups (Ocean Animals, 2023).	Medium speed with medium manoeuvrability	May fly within height of RSA	Large	2	21 – Possible	Insignificant	Low

Appendix C – Collision Risk for NC and EPBC Act Listed Species

Common name (*Scientific name*)	Status*		Likelihood of occurrence	RSA Utilisation	Flight Habits	General Flight height	Size (small/ medium/ large)	Behaviour, habitat and feeding	Records on site	Collision Likelihood	Collision Consequence	Collision Risk
	NCA	EPBC										
Cattle Egret (*Bubulcus ibis*)	LC	Ma	Possible	Dispersing	Capable of flying large distances. Is not considered highly mobile in the air	Would fly within the RSA.	Medium	The cattle egret has undergone one of the most rapid and wide-reaching natural expansions of any bird species (Telfair II, 2006). Cattle egret populations can be both sedentary and migratory (Maddock, 1990). If migrating, migration takes place from the south during spring. The cattle egret feeds on a wide range of prey, particularly insects, especially grasshoppers, crickets, flies (adults and maggots), and moths, (Seedikkoya, Azeez, & Shukkur, 2007)	Nil	21 – Possible	Insignificant	Low
Sharp-tailed Sandpiper (*Calidris acuminata*)	SL	M, Ma, V	Possible	Dispersing	Capable of flying great distance during migration.	Likely to fly within RSA height during migration	Medium	The Sharp-tailed sandpiper prefers the grassy edges of shallow inland freshwater wetlands. It is also found around sewage farms, flooded fields, mudflats, mangroves, rocky shores and beaches. Its breeding habitat in Siberia is the peat hummock and lichen tundra of the high Arctic. The Sharp-tailed	Nil	21 – Possible	Insignificant	Low

Common name (*Scientific name*)	Status*		Likelihood of occurrence	RSA Utilisation	Flight Habits	General Flight height	Size (small/ medium/ large)	Behaviour, habitat and feeding	Records on site	Collision Likelihood	Collision Consequence	Collision Risk
	NCA	EPBC										
								sandpiper feeds on aquatic insects and their larvae, as well as worms, molluscs, crustaceans and sometimes, seeds. It is often found in large flocks, often with other waders, foraging in shallow waters (Pringle, 1987) (Simpson & Day, 1999).				
Black-eared Cuckoo (*Chalcites osculans*)	LC	Ma	Possible	Dispersing	Mobile agile flyer	May fly within height of RSA, but not normally at this height	Small	The Black-eared cuckoo is a parasitic breeder, that is, it lays its eggs in the nests of other birds. By preference, the Black-eared cuckoo chooses the domed or enclosed nests of species such as the Speckled Warbler, or the Redthroat (Birdlife Australia, 2024) It is migratory, moving into the sub-coastal areas of south-east and south-west Australia for the summer. The Black-eared Cuckoo perches on a shrub or tree, and drops from its perch to forage for insects on the ground. Would generally forage within canopy height (Birdlife Australia, 2024).	Nil	5 – Very rare	Insignificant	Low

Common name (*Scientific name*)	Status*		Likelihood of occurrence	RSA Utilisation	Flight Habits	General Flight height	Size (small/ medium/ large)	Behaviour, habitat and feeding	Records on site	Collision Likelihood	Collision Consequence	Collision Risk
	NCA	EPBC										
Latham's Snipe (*Gallinago hardwickii*)	SL	M, Ma, V	Possible	Dispersing	Capable of flying great distance during migration. Moderate mobility	May fly to RSA during migration	Medium	Latham's Snipe is a migratory wader, travelling to Australia during the warmer months, typically arriving in Australia in September. Birds may fly directly between Japan and Australia, stopping at a few staging areas. They leave their breeding areas from August to November, arriving in Australia mainly in September. They leave the south-east by the end of February, moving northwards along the coast. Most have left Queensland by mid-April (Pringle, 1987) (Higgins & Davies, 1996). Latham's snipes are omnivorous, eating seeds and plant material, worms, spiders and insects, some molluscs, isopods and centipedes (Higgins & Davies, 1996) (Lane, 1987).	Nil	19 – Possible	Insignificant	Low
White-bellied Sea-Eagle (*Haliaeetus leucogaster*)	LC	Ma	Possible	Dispersing	Capable of flying great distance. Moderate mobility	Likely to fly within RSA height	Large	Inhabits a variety of habitats including coasts, islands, estuaries, inlets, large rivers, inland lakes, reservoirs. Widespread along all Australian coasts,	Nil	19 – Possible	Insignificant	Low

Common name (*Scientific name*)	Status*		Likelihood of occurrence	RSA Utilisation	Flight Habits	General Flight height	Size (small/ medium/ large)	Behaviour, habitat and feeding	Records on site	Collision Likelihood	Collision Consequence	Collision Risk
	NCA	EPBC										
								travels inland along large rivers or to large water sources. (Pizzey & Knight, 2012). The White-bellied Sea-Eagle feeds opportunistically on a variety of fish, birds, reptiles, mammals and crustaceans, and on carrion and offal (Rose, 2001). The White-bellied Sea-Eagle hunts its prey from a perch, or whilst in flight (by circling slowly, or by sailing along 10–20 m above the shore). When a prey item is located, the sea-eagle usually launches into a dive or shallow glide to snatch its prey, usually in one foot, from the ground or water surface (Clunie, 1994) (del Hoyo, Elliott, & Sargatal, Handbook of the Birds of the World. Volume 2: New World Vultures to Guineafowl, 1994) (Ferguson-Lees & Christie, 2001) (Marchant & Higgins, 1993).				
Caspian tern (*Hydroprogne caspia*)	SL	M, Ma	Possible	Dispersing	Capable of flying great distance	May fly to RSA during migration	Medium	A large, part-migratory to migratory species of tern with a	Nil	19 – Possible	Insignificant	Low

Common name (*Scientific name*)	Status*		Likelihood of occurrence	RSA Utilisation	Flight Habits	General Flight height	Size (small/ medium/ large)	Behaviour, habitat and feeding	Records on site	Collision Likelihood	Collision Consequence	Collision Risk
	NCA	EPBC										
					during migration. Moderate mobility			cosmopolitan distribution. In Australia, this species is primarily coastal, though travels inland to visit large bodies of water (Pizzey & Knight, 2012). The Caspian Tern's diet consists predominantly of fish (5–25 cm in length) as well as the eggs and young of other birds, carrion, aquatic invertebrates (e.g. crayfish), flying insects and earthworms (Birdlife International 2010a). They forage diurnally, mostly early to mid-morning, patrolling in slow lazy flight, 3–15 m above the water. The species may forage up to 60 km from their nesting site (BirdLife International, 2023) (Higgins & Davies, 1996).				
Purple-crowned Fairy-wren (*Malurus coronatus*)	V		Possible	Foraging	Highly agile	Unlikely to fly within the RSA	Small	The species occurs from the Kimberly region to the gulf of Carpentaria drainage of western Queensland and north-eastern Northern Territory (TSSC, 2015). The species is restricted to a narrow band around well-	Nil	0 – Very rare	Insignificant	Low

Common name (*Scientific name*)	Status*		Likelihood of occurrence	RSA Utilisation	Flight Habits	General Flight height	Size (small/ medium/ large)	Behaviour, habitat and feeding	Records on site	Collision Likelihood	Collision Consequence	Collision Risk
	NCA	EPBC										
								vegetated river channels. They prefer thick riparian vegetation, typically of cane grass and/or pandanus, but also dense patchy shrubs up to 3 m (Ward & Woinarski, 2012). Purple-crowned fairy-wrens are territorial and sedentary, feeding in loose groups in the undergrowth or on the ground. The species is mainly insectivorous, consuming a range of small invertebrates such as beetles, ants, bugs, wasps, grasshoppers, moths, larvae, spiders, and worms and small quantities of seeds. They forage for their prey amongst foliage and in the leaf litter on the ground that may have accumulated as debris during floods.				
Glossy ibis (*Plegadis falcinellus*)	SL	Ma, M	Known	Dispersing	Capable of flying large distances. Is not considered highly mobile in the air	Would fly within the RSA.	Medium	Prefers well-vegetated wetlands, floodplains, irrigated pastures, sewage ponds, mangroves, mudflats though may occur in dry grasslands further inland, particularly during good rainfall	One (prelim. surveys)	23 – Possible	Insignificant	Low

Common name (*Scientific name*)	Status*		Likelihood of occurrence	RSA Utilisation	Flight Habits	General Flight height	Size (small/ medium/ large)	Behaviour, habitat and feeding	Records on site	Collision Likelihood	Collision Consequence	Collision Risk
	NCA	EPBC										
								years. The migratory and nomadic species breeds in southern Australia between October to December and in north Australia between February to April (Pizzey & Knight, 2012). Glossy Ibis feed mainly on aquatic invertebrates/insects such as freshwater snails, mussels, crabs and crayfish. The species will also, however, eat fish, frogs and tadpoles, dryland invertebrates (such as beetles and grasshoppers), lizards, small snakes and nestling birds (del Hoyo, Elliot, & Sargatal, 1992) (Gowland, 1988) (Marchant & Higgins, 1990) (Vestjens, 1977).				
Australian Painted Snipe (*Rostratula australis*)	E	E, Ma	Possible	Dispersing	Capable of flying great distances. Moderate mobility	No reference to flight height.	Medium	The Australian painted snipe occurs in shallow freshwater (occasionally brackish) waters, both ephemeral and permanent, such as lakes, swamps, claypans, inundated or waterlogged grassland, dams, rice crops, sewage farms and bore drains, generally with a good	Nil	19 – Possible	Insignificant	Low

Common name (*Scientific name*)	Status*		Likelihood of occurrence	RSA Utilisation	Flight Habits	General Flight height	Size (small/ medium/ large)	Behaviour, habitat and feeding	Records on site	Collision Likelihood	Collision Consequence	Collision Risk
	NCA	EPBC										
								cover of grasses, rushes and reeds, low scrub, *Muehlenbeckia* spp. (lignum), open timber or samphire (Reader's Digest, 1997) (Marchant & Higgins, 1993). This species feeds on insects, freshwater snails and worms from dusk to early morning, mostly in shallow water.				
Common Greenshank (*Tringa nebularia*)	SL	Ma, M, E	Possible	Dispersing	Capable of flying great distances. Highly agile.	Would fly within the RSA.	Medium	Inhabits mudflats, estuaries, saltmarshes, lake and pond margins, wetlands. Generally found in coastal environments, but present inland where habitat is suitable. Widespread summer migrant, with some overwintering. (Pizzey & Knight, 2012). The Common Greenshank is carnivorous. In Australia is has been recorded eating molluscs, crustaceans, insects, and occasionally fish and frogs. Elsewhere, it has also been recorded eating annelids, lizards, and rodents. The species feeds during both day and nighttime. It is active and agile, finding prey by sight	Nil	19 – Possible	Insignificant	Low

Common name (*Scientific name*)	Status*		Likelihood of occurrence	RSA Utilisation	Flight Habits	General Flight height	Size (small/ medium/ large)	Behaviour, habitat and feeding	Records on site	Collision Likelihood	Collision Consequence	Collision Risk
	NCA	EPBC										
								or, occasionally, by touch (Higgins & Davies, 1996).				