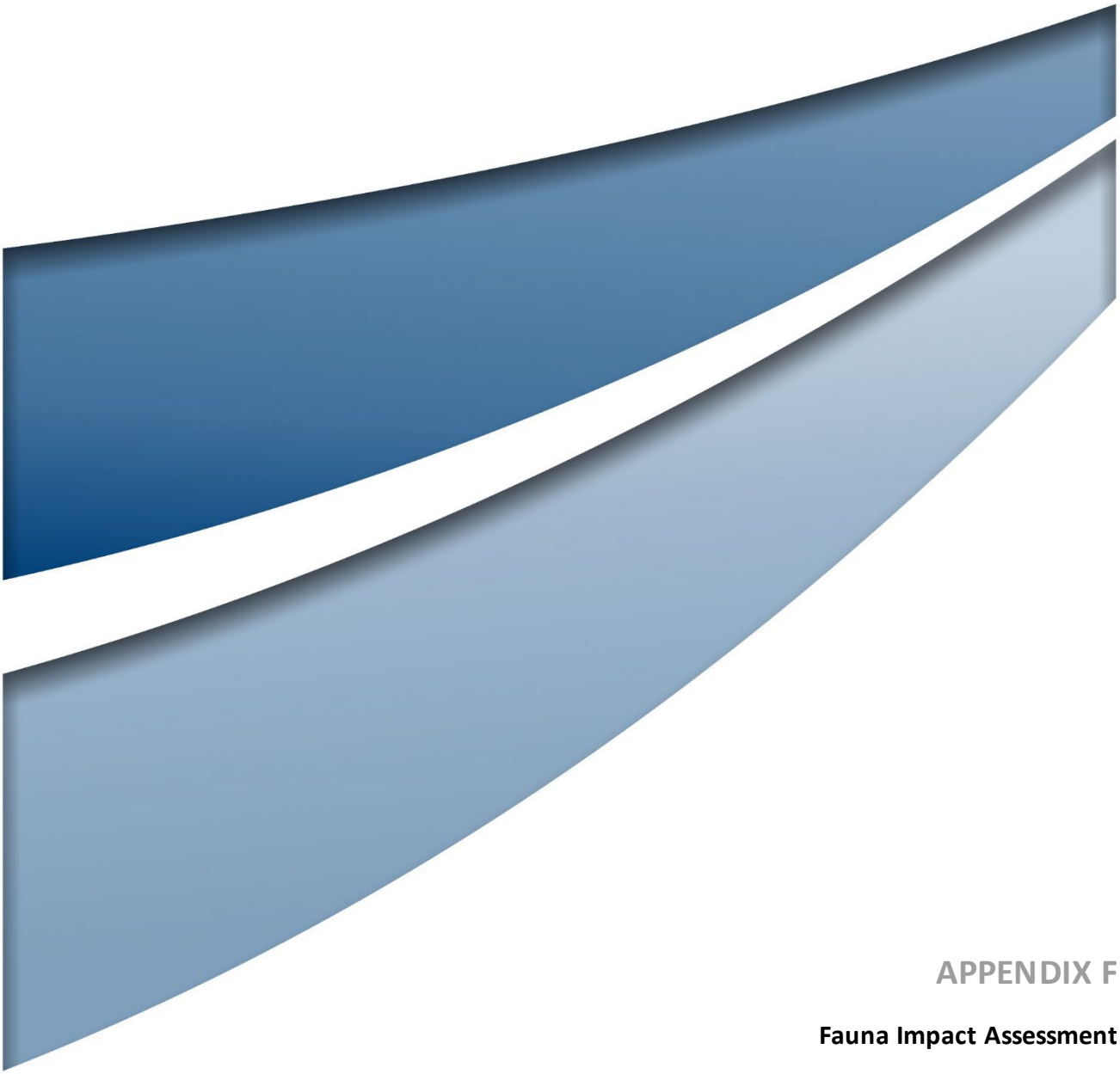
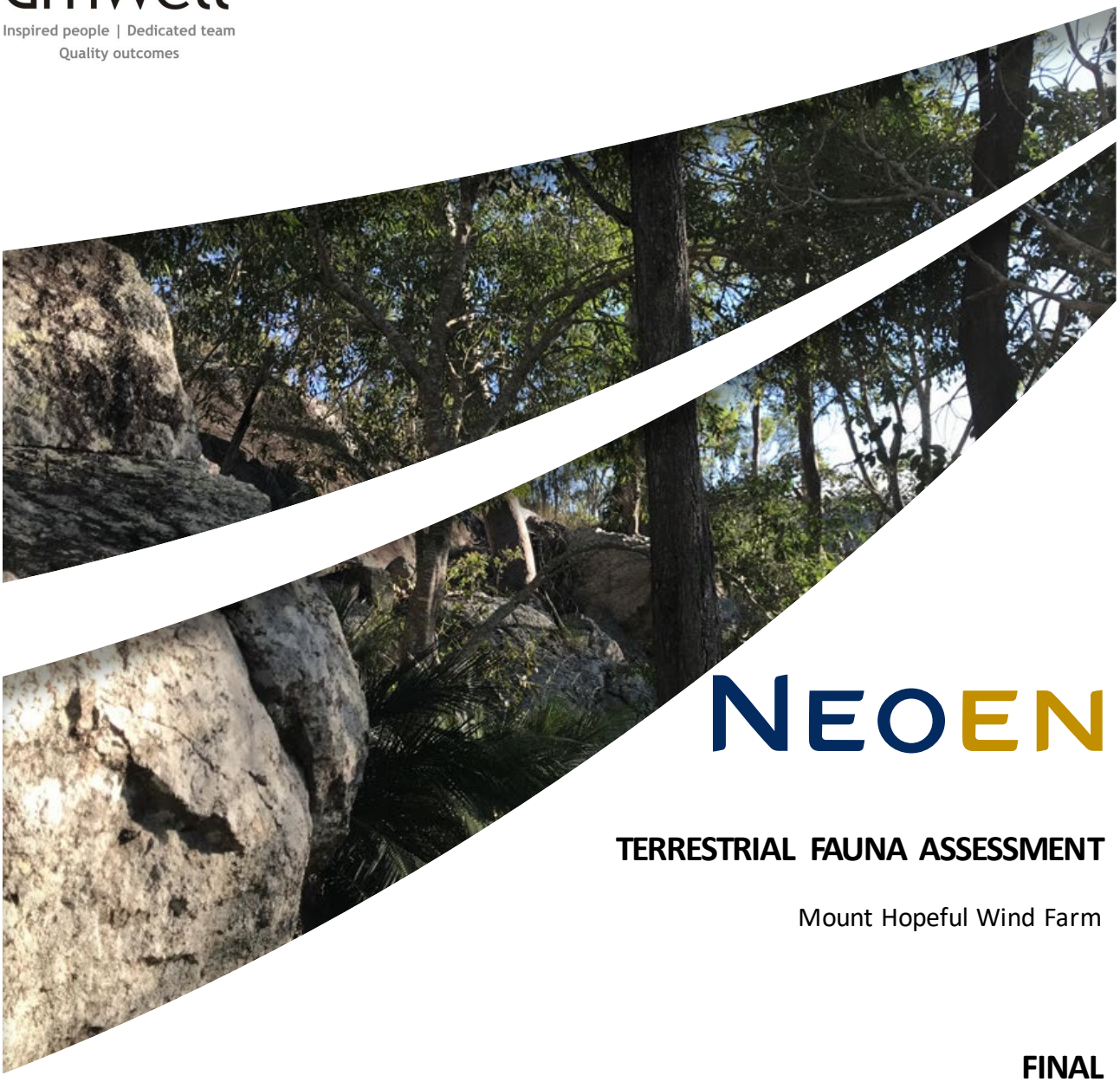


APPENDIX F

Fauna Impact Assessment

umwelt

Inspired people | Dedicated team
Quality outcomes



NEOEN

TERRESTRIAL FAUNA ASSESSMENT

Mount Hopeful Wind Farm

FINAL

May 2023

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Abbreviations

Abbreviation	Description
agl	above ground level
ALA	Atlas of Living Australia
asl	above sea level
BBUS	bird and bat utilisation survey
BBAMP	Bird and Bat Adaptive Management Plan
BPA	Biodiversity Planning Assessment
CEMP	Construction Environment Management Plan
DA	development application
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DES	Department of Environment and Science
DEWHA	Department of the Environment, Water, Heritage and the Arts
DoR	Department of Resources
DSEWPaC	Department of Sustainability, Water, Populations and Communities
EO Act	*Environmental Offsets Act 2014* (QLD)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cth)
km	kilometre
m	metre
MSES	Matter of State Environmental Significance
NC Act	*Nature Conservation Act 1992*
Neoen	Neoen Australia Pty Ltd
PO	performance outcomes
Qld	Queensland
RSA	rotor swept area
SDAP	State Development Assessment Provisions
SPRAT	Species Profile and Threats
SRI	Significant Residual Impact
State code 23	*State code 23: Wind farm development*
Umwelt	Umwelt (Australia) Pty Ltd
VM Act	*Vegetation Management Act 1999* (QLD)

1.0 Introduction

Umwelt (Australia) Pty Ltd (Umwelt) was commissioned by Neoen Australia Pty Ltd (Neoen) to undertake a terrestrial fauna survey and impact assessment of the proposed Mount Hopeful Wind Farm (the Project). If approved, the Project will involve the construction and operation of up to 63 wind turbine generators (WTGs) and associated infrastructure.

1.1 Project Locality

The Project is situated approximately 45 kilometres (km) south of Rockhampton and 65 km west of Gladstone, Queensland. The Project occurs across two local government areas, being the Banana Shire Council and the Rockhampton Regional Council. The Project is located on the Ulam Range between Mount Hopeful (on the Dee Range) and Mount Alma (on the Mount Alma Range). It is surrounded by mountain ranges and is in a largely rural and sparsely settled landscape mostly used for light grazing and livestock production.

The Project and its position in the region are depicted on **Figure 1.1.**

1.2 Ecology Study Boundaries

For the purposes of this assessment four distinct boundaries are presented, including:

- **Study Area**: represents the boundaries of the involved land parcels where consent has been granted for development (**Section 1.2.1**).
- **Ground-truthed Mapping Extent**: represents the area of interest within the Study Area for which field surveys were conducted, and the extent of coverage within the Study Area for ground-truthed vegetation mapping (**Section 1.2.2**).
- **Development Corridor**: refers to spatial bounds in which all Project infrastructure will be located (**Section 1.2.3**).
- **Disturbance Footprint**: represents the maximum extent of direct impacts and the indicative location of proposed Project infrastructure (**Section 1.2.4**).

These areas are described below and depicted on **Figure 1.1**.

1.2.1 Study Area

The Study Area refers to the boundaries of 17 land parcels where consent has been granted for development. The area covers 16,758hectares (ha) and extends approximately 25 km north to south and up to 16 km east to west at its widest point.

Table 1.1 below details the lot plan code for land parcels contained within the Study Area.

Table 1.1 Study Area Land Parcels

Land Parcels		
100 SP289441	2057 RAG4059	24 RN34
148 DS151	21 RN1345	25 RN25
15 RN1089	21 RN46	30 RN72
1933 RAG4058	2345 DT4077	33 DT40123
50 DT40144	23 RN25	38 DT40131
2039 RAG4056	2420 DT4077	

1.2.2 Ground-truthed Mapping Extent

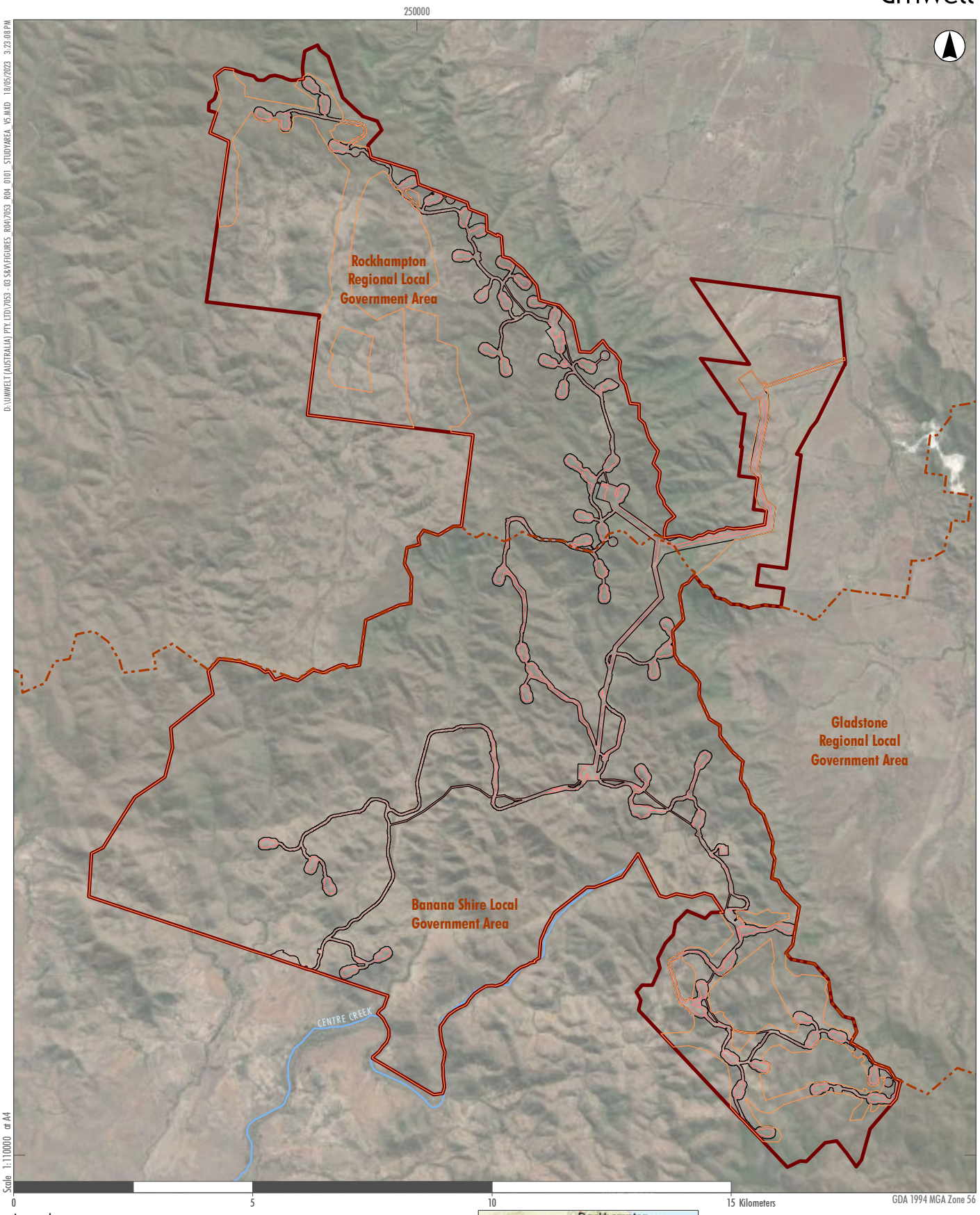
The Ground-truthed Mapping Extent covers approximately 12,924.1 ha and represents the limit of the vegetation mapped within the Study Area. Due to the dynamic nature of the Project's design development, some areas surveyed no longer fall within the Study Area boundary, and not all parcels within the Study Area were surveyed in their entirety. It should be noted that this boundary does not represent the spatial bounds in which all Project field surveys have been conducted (this area being larger and including areas outside of the Study Area).

1.2.3 Development Corridor

For the purposes of this report, the Development Corridor refers to the area within which all Project infrastructure will be located. The Development Corridor includes a variable width buffer around the infrastructure of up to 100 m and covers an area of approximately 1,347.4 ha.

1.2.4 Disturbance Footprint

The Disturbance Footprint covers approximately 877.5 ha and represents the maximum extent of clearing works and the indicative locations of Project infrastructure. It is a 'worst-case' scenario in terms of the extent of clearing works. The impact assessment on fauna values (see **Section 7.1.1** and **Appendix E**) refers to clearing areas that are based on the Disturbance Footprint. As infrastructure will be micro-sited within the Development Corridor, the final clearing areas are anticipated to be lower than detailed in this assessment (described further in **Section 6.0**).



Legend

- Study Area
- Ground Truthed Survey Extent
- Development Corridor
- Disturbance Footprint
- Local Government Area (LGA)
- Town
- Road

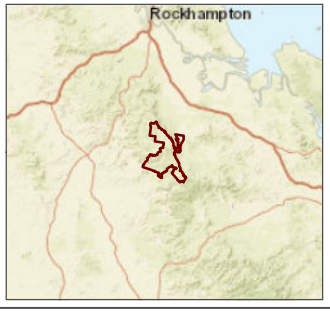


FIGURE 1.1

Study Area and Ground Truthed Survey Extent

Image Source: ESRI Basemap (2021) Data source: Queensland Spatial (2020)

1.3 Assessment Aim and Scope of Works

The aim of the assessment was to characterise terrestrial fauna values within the Study Area (including threatened fauna and their habitat), assess the impacts of the Project on these values, and present strategies to avoid, minimise or mitigate potential impacts.

- A desktop assessment of relevant database searches and literature to identify threatened fauna species which may be present within the Study Area.
- Field surveys within the Study Area employing standard survey techniques to:
    - Document condition, extent and value of vegetation communities, habitat types and other ecological values within the Study Area.
    - Target potentially occurring threatened fauna listed under the *Nature Conservation Act 1992* (NC Act).
    - Identify habitat resources for known and potentially occurring threatened fauna and Special Least Concern (SLC) fauna species.
- Utilise field-based data in conjunction with aerial imagery and desktop data to determine the likely extent of vegetation communities, habitat types and associated Matters of State Environmental Significance (MSES) values across the Study Area.
- Undertake a likelihood of occurrence assessment to confirm known or potentially present fauna species listed under the NC Act within the Study Area.
- An impact assessment against the *Significant Residual Impact Guideline: For matters of state environmental significance and prescribed activities under the Sustainable Planning Act 2009* (The Department of State Development, Infrastructure and Planning, 2014) to determine whether the Project is likely to have a significant residual impact on a relevant MSES (i.e. prescribed environmental matter). This impact assessment is inclusive of recommended mitigation and management measures.

2.0 Legislative Context

State and Commonwealth legislation relevant to the Project has been summarised in **Table 2.1** below.

Table 2.1 Summary of Relevant Legislation

Relevant Legislation	Governing Agency	Summary	Project Relevance
Commonwealth Legislation			
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)	Department of Climate Change, Energy, the Environment and Water (DCCEEW)	The EPBC Act is Australia's key piece of environmental legislation. It outlines nine Matters of National Environmental Significance (MNES). Actions that adversely affect MNES may be deemed to be a controlled action under the EPBC Act.	Two MNES are relevant to the Project: • Threatened Species and Ecological Communities. • Migratory Species.
State Legislation			
Nature Conservation Act 1992 (NC Act)	Department of Environment and Science (DES)	The purpose of the NC Act is to conserve biodiversity by creating and managing protected areas, managing and protecting native wildlife, and managing the spread of non-native wildlife.	Where a proposed development will result in such impacts to flora and or fauna protected under the NC Act, authorisation from the Director General of the DES is required. The following fauna values under the NC Act are relevant to the Project: • Threatened fauna species. • Connectivity areas. • Waterways for waterway barrier works.
Vegetation Management Act 1999 (VM Act)	Department of Resources (DoR)	The VM Act establishes the vegetation management framework for Queensland which applies to all vegetation with the exception of State forests, National parks, forest reserves and certain other tenures defined under the NC Act and the *Forestry Act 1959*.	Essential habitat is vegetation in which threatened species listed under the NC Act have been known to occur is. Essential habitat is regulated under the VM Act. Where clearing cannot be reasonably avoided or minimised, an offset may occur.
Biosecurity Act 2014	Department of Agriculture and Fisheries	The *Biosecurity Act 2014* lists fauna and flora pest species as either a prohibited or restricted biosecurity matter.	The *Biosecurity Act 2014* defines specific requirements for notification and management actions for all listed biosecurity matters, including specific requirements for the disposal of restricted matters.

Relevant Legislation	Governing Agency	Summary	Project Relevance
Environmental Offsets Act 2014	Department of Environment and Science (DES)	An environmental offset condition may be imposed under certain Queensland legislation that applies to development assessment where the activity is a prescribed activity under the *Environmental Offsets Act 2014* Activities which have an impact on a Matter of State Environmental Significance (MSES) may require offsetting under the Act.	Consideration of offsetting requirements for the Project will need to be determined once a fixed design for the Project is completed. Requirements will also need to be considered in conjunction with overlapping EPBC Act requirements. Environmental offsets are therefore not discussed as part of this report.
State Code 23: Wind Farm Development (State code 23)	Department of State Development, Infrastructure, Local Government and Planning	State code 23 is contained within the State Development Assessment Provisions (SDAP) and applies to a material change of use for a new or expanding wind farm. Development that is a material change of use for a wind farm should demonstrate compliance with 13 performance outcomes (PO) and associated acceptable outcomes within the code.	The PO relevant to this assessment is PO5 – Flora and Fauna: *Development ensures that impacts on flora, fauna and associated ecological processes are avoided, or minimised and mitigated, through effective siting, design and operation of the development.*

3.0 Methods

3.1 Desktop Assessment

A desktop assessment of publicly available data sources was initially completed in 2019 to determine the preliminary status of fauna values within the Study Area. Database searches were re-run in 2021, 2022 and 2023 as the Project progressed. These data sources represent both government and private industry databases and documents relevant to the Study Area. The following sources were interpreted to complete the desktop assessment:

- DCCEEW EPBC Protected Matters Search Tool (PMST) database.
- DCCEEW Species Profile and Threats (SPRAT) database.
- Department of Environment and Science (DES) Wildlife Online database.
- DES WetlandInfo Wetland Summary Information.
- DES Protected Plants Flora Survey Trigger Map.
- Department of Resources (DoR) Regulated Vegetation Management Map.
- DoR Vegetation Management Supporting Map, including Essential Habitat mapping.
- DoR Reservoirs Map.
- DoR Queensland resources web map service.
- Queensland Herbarium Regional Ecosystem Description Database (REDD).
- Atlas of Living Australia (ALA) records database.
- Available published and unpublished reports concerning the ecology of the Study Area, including:
    - eBird and Birdlife Australia databases
    - Published and unpublished ecology reports where available.

For the purposes of the database searches, a 10 km buffer was applied to the Study Area boundary.

3.2 Field Survey

3.2.1 Field Survey Timing and Weather Conditions

The fauna data presented herein has been collected within the Study Area and neighbouring land parcels, across thirteen field surveys from July 2019 to October 2022. Intensive fauna survey trapping effort was focused during two trips in May and June 2020 with a final fauna survey being conducted in September / October 2021. Opportunistic fauna data was collected during all surveys including flora surveys (**Table 3.1**).

Due to the remoteness of the Study Area and the absence of a local weather station, field survey weather conditions have been extracted from the DES SILO weather model (Queensland Government 2022). The data was extracted from the model using the coordinates central to the Study Area (-23.85, 150.55). Variation in weather data results reflect the seasonality of field surveys.

Table 3.1 Field Survey Weather Conditions

Field Survey	Survey Dates	Survey Length (Days)	Rainfall (mm)	Temperature (°C)	
				Min	Max
Initial Site Scoping	9–12 July 2019	4	0.7	6.0	24.4
Flora Survey^	6–12 August 2019	7	0	1.6	26.7
Bird and Bat Utilisation Survey	25 February–5 March 2020	10	57.1	19.5	31.8
Fauna Survey	14–23 May 2020	10	18.1	9.3	25.1
Fauna Survey	1–8 June 2020	8	0	3.9	24.3
Bird and Bat Utilisation Survey	3–11 November 2020	9	0.6	14.7	32.4
Fauna Survey	3–13 November 2020	11	0.6	14.7	32.4
Flora Survey^	7–11 November 2020	5	0	14.7	28.6
Flora Survey^	20–24 January 2021	4	0.6	18.3	32.5
Fauna Survey	30 September–6 October 2021	7	23.5	10.2	32.4
Bird and Bat Utilisation Survey	8–5 October 2021	8	1.8	14.5	31.3
Bird and Bat Utilisation Survey	14–21 February 2022	8	6.1	18.9	32.9
BioCondition and Habitat Quality Assessment	24–28 October 2022	5	37.4	17.1	33.7

^ Opportunistic fauna surveys also undertaken.

3.2.2 Approach and Survey Effort

Threatened fauna species were identified from the desktop assessments and targeted during the field survey within representative habitat types. Fauna surveys were conducted in accordance with the Terrestrial Fauna Survey Guidelines for Queensland (Eyre *et al.* 2018). Fauna survey methods specifically targeting EPBC listed fauna species were developed based on the Commonwealth survey guidelines for Australia's threatened animals, including:

- Survey Guidelines for Australia's Threatened Mammals (DSEWPaC 2011a).
- Survey Guidelines for Australia's Threatened Bats (DEWHA 2010a).
- Survey Guidelines for Australia's Threatened Birds (DEWHA 2010b).
- Survey Guidelines for Australia's Threatened Reptiles (DSEWPaC 2011b).
- Survey Guidelines for Australia's Threatened Frogs (DEWHA 2010c).

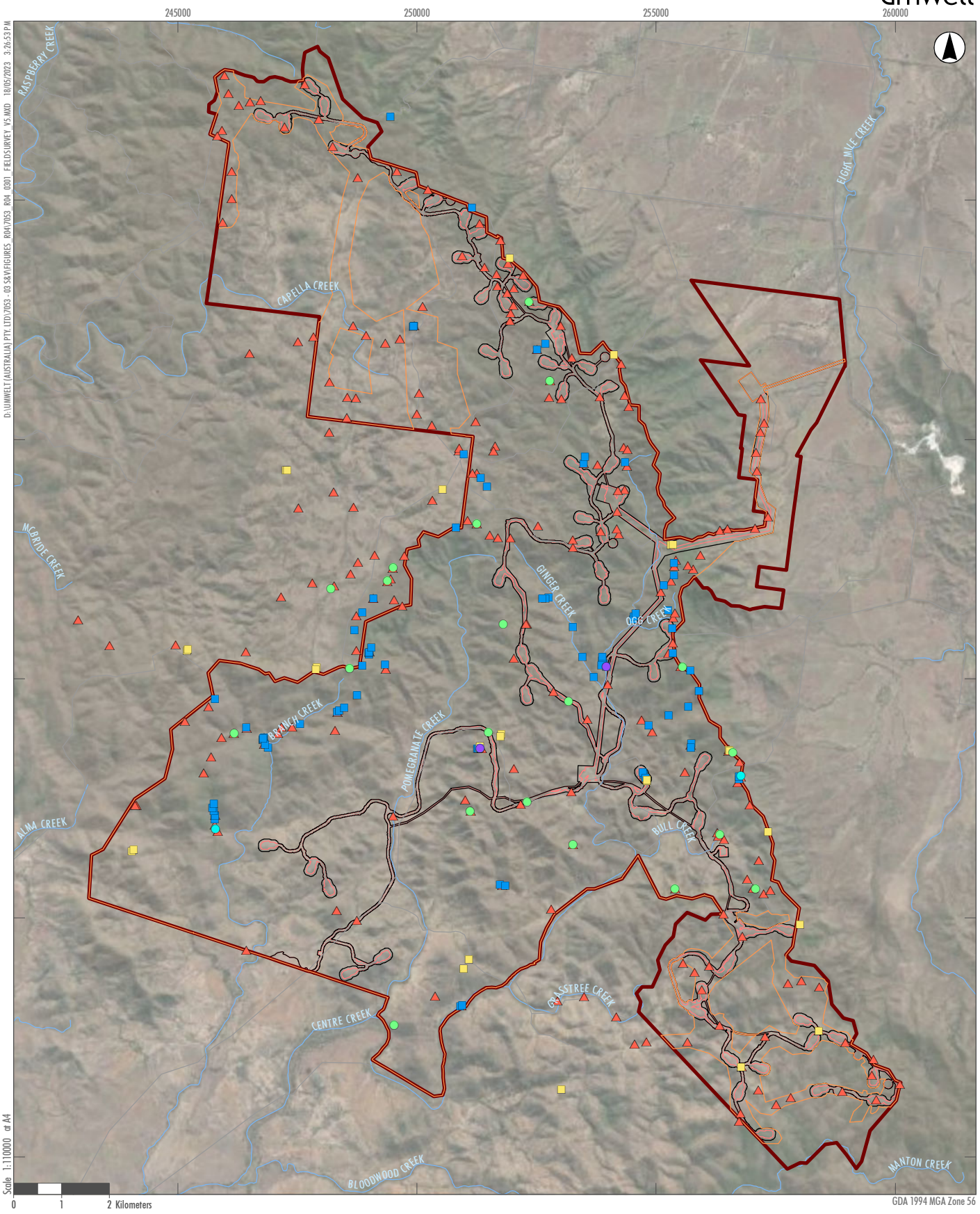
As ecological information was collected, the constraints map for the Project and subsequently the Project boundary has evolved. As a result, significant survey effort has been undertaken within the reported Study Area as well as within adjacent land parcels.

The fauna effort presented below includes ecology surveys completed adjacent to the Study Area boundary. Field survey techniques employed to assess the presence of fauna species within the Study Area, including survey effort, are detailed in **Table 3.2** below. Field survey locations are depicted in **Figure 3.1**.

Table 3.2 Field Survey Techniques and Survey Effort

Technique	Description	Survey Effort
Bird Survey (General)	Diurnal birds were sampled using an area census method, supplemented by broad observational surveys throughout the Study Area. Sampling was also undertaken at each trapping site during early morning trap checks.	99 person-hours
Spotlighting	Spotlighting was undertaken on foot using head torches and hand-held spotlights within areas of suitable and representative habitat. Spotlighting was also undertaken from the passenger window of a slow-moving vehicle while travelling between spotlighting sites.	60 person-hours
Mammal Trapping	Type A aluminium Elliot traps targeting small mammals and reptiles were placed at approximately 10 m intervals along two transects. Traps were baited with a mixture of rolled oats, peanut butter, honey and vanilla essence, and checked each morning to identify and release captured fauna.	320 trap nights
Pitfall Trapping	Pitfall trapping was undertaken using 20 L buckets dug into the ground until the top of the bucket is flush with the surface of the ground. Three buckets are used at each site separated by approximately 10 m. Between each bucket is a drift fence approximately 30 cm high used to direct small animals towards the pitfall traps.	27 trap nights
Call Playback	Call playback for nocturnal bird species was undertaken in conjunction with spotlight surveys and targeted a range of species depending on habitat type present. Calls were played for several minutes, followed by a period of quiet listening for responses, scanning the night sky for silhouettes and spotlighting adjacent to vegetation.	6 hours
Active Searches	Active diurnal searches were undertaken within suitable microhabitat across the broad range of habitat types for reptiles, amphibians and small mammals. This involved searching beneath microhabitat such as rocks and fallen timber, digging through leaf litter and soil at tree bases and identifying tracks and traces such as scats and tree scratches.	58 person-hours
Camera Trapping	Camera traps were deployed in strategic positions including fauna corridors and watering points such as dams and creek lines to record visitation by nocturnal and diurnal animals. Camera traps comprised baited set-ups using honey oat mix and/or sardines as an attractant.	490 trap nights
Acoustic Monitoring	Anabat devices were deployed in strategic positions including in natural flyways and at bird and bat utilisation survey (BBUS) vantage points to record visitation by bats.	111 trap nights
Harp Trapping	Two-bank harp traps were deployed in natural flyways and checked each morning before dawn to identify and release captured fauna.	14 trap nights
Koala SAT	At each site, 30 trees greater than 10 cm diameter at breast height (dbh) were searched at the base for koala scats.	20 sites

Technique	Description	Survey Effort
Fauna Habitat Assessment	Habitat assessments were undertaken within areas of representative habitat, capturing variation in condition and vegetation types. The relative abundance of key habitat attributes was recorded at each location, including hollow bearing trees or stags, coarse woody debris, surface rocks, soil cracks, leaf litter and vegetated cover. Disturbances or threats such as erosion, invasive weeds and pests were also noted. These assessments were used to inform habitat modelling for the impact assessment.	224 sites
Incidental Observations	All fauna observed incidentally throughout the Study Area were recorded. Observations of wildlife recorded outside of the main sampling sites were noted according to the habitat in which they were observed.	NA



Legend

- Study Area
- Ground Truthed Survey Extent
- Development Corridor
- Disturbance Footprint

Field Survey Locations

- Anabat
- Camera
- Elliot Trapping
- Koala SAT
- Pitfall Trapping
- Fauna Habitat Assessment

FIGURE 3.1

Field Survey Locations

Image Source: ESRI Basemap (2021) Data source: Queensland Spatial (2020)

3.2.3 Bird and Bat Utilisation

Umwelt ecologists conducted an extensive bird and bat utilisation survey program for the Project. Bird utilisation surveys were initially conducted in 2019 during winter (9 to 12 July 2019 and 7 to 12 August 2019) to establish vantage point locations and begin collecting a baseline avifaunal data set. A total of 16 vantage survey points were selected on the ridgelines and peaks of the Study Area based on the degree of visibility of surrounding areas.

Following initial surveys in 2019, four replicate surveys were conducted to capture seasonal variation in birds present within the Study Area. These surveys were conducted during the following periods:

- Autumn 2020 (23 February to 5 March 2020)
- Late spring 2020 (5 to 12 November 2020)
- Spring 2021 (8 to 15 October 2021)
- Summer 2022 (14 to 21 February 2022).

The timing of these surveys coincided with the seasonal migration of listed threatened and/or migratory bird species, including white-throated needletail (*Hirundapus caudacutus*) and fork-tailed swift (*Apus pacificus*).

During each survey event generally 13 of the 16 vantage points were selected for sampling. Each vantage point was surveyed for one hour during three sampling windows per day:

- Morning (between 6.00 am and 10.00 am)
- Midday (between 10.00 am and 2.00 pm)
- Afternoon (between 2.00 pm and 6.00 pm).

Vantage points were surveyed twice during each sampling window such that individual surveys were undertaken on six occasions at each vantage point. At each vantage point, a single observer recorded the following information for each observation:

- Species and abundance.
- Observation type (visual or aural).
- Distance and direction from the observer (to the nearest 10 m and 10° respectively).
- Approximate height AGL of the observed bird/s (to the nearest 10 m).
- Direction of flight (to the nearest 10°).
- Flight pattern (i.e. not flying, local movement, directional flight, circling, swooping, varied, other).
- Behaviour (i.e. flight, foraging, perching, mating, aggressive interactions, hollow inspection, nesting, on station).

Bat utilisation surveys were undertaken in July 2019 (winter), February to March 2020 (autumn), November 2020 (spring), October 2021 (spring) and February 2022(summer). Microchiropteran bat (microbat) echolocation calls were sampled using Anabat Swift recording devices at each vantage point location. Devices were placed approximately 2 m AGL facing a cleared area or flyway and left for between two to five nights. In addition, two Anabat Swift devices were deployed on the meteorological mast at approximately 50 m AGL, for a combined total of three nights.

The likelihood that bat species detected in the Study Area fly at-risk (i.e. at RSA height) was inferred based on calls detected from the elevated Anabat Swift device and on literature relevant to the flight behaviour of recorded species.

3.2.4 Limitations

Patterns of faunal activity and estimates of relative abundance or presence-absence of species, varies temporally in response to the time of day (day versus night), seasonal changes (e.g. spring versus winter) as well as between years (e.g. rainy year versus drought year) (Eyre et al. 2018).

The COVID-19 pandemic caused delays in the survey schedule due to Government regulated travel restrictions and commercial fight availability from March to June 2020. These delays pushed the fauna survey from late in the autumn fauna survey window and into early winter. These surveys were subsequently undertaken during a cooler, drier period.

Restricted access and safety mitigation measures meant that many ecological trapping methods were unable to be deployed (harp traps, Elliot traps and pitfall traps) intensively across the Study Area.

3.3 Likelihood of Occurrence Assessment

The assessed likelihood of occurrence of threatened species was based on a review of previous sighting records, a review of known habitat preferences and the broad habitats provided by verified vegetation communities mapped across the Study Area. Based upon the analysis of habitats, records and known species habitat preferences, species were assigned to one of the following categories:

- **Known to Occur:** this category includes all species previously recorded in the Study Area.
- **High Potential to Occur:** This category includes species previously recorded in the Study Area or in the immediate vicinity and details on presence are reliable. The Study Area contains preferred habitat resources which may support a population of the species.
- **Moderate Potential to Occur:** The species is known from the broader area (desktop search extent) and some of the preferred habitat is present within the Study Area. Aerial foragers and other migratory birds that may overfly the Study Area are also included.
- **Low Potential to Occur:** The Study Area supports some suitable habitat, often marginal. The species may disperse through the Project infrequently and is unlikely to depend on the habitat for their survival.
- **Unlikely to Occur:** This category includes those species for which the Study Area offers limited or no potential habitat, is outside their known range and/or is without broader habitat requirements.

3.4 Significant Residual Impact Assessment

The Project comprises a wind farm development and as such requires approval under the Queensland *Planning Act 2016*. An assessment against the *Significant Residual Impact Guideline: For matters of state environmental significance and prescribed activities under the Sustainable Planning Act 2009* (The Department of State Development, Infrastructure and Planning, 2014) has been undertaken to determine whether the Project is likely to have a significant residual impact on a relevant Matter of State Environmental Significance (MSES) (i.e. prescribed environmental matter).

If after all reasonable avoidance and mitigation measures have been taken by the Project, if there is still a significant residual impact on an MSES, an offset may be required.

4.0 Results

4.1 Desktop Assessment

4.1.1 Threatened Species

The desktop search identified 31 threatened fauna species listed under the NC Act and/or EPBC Act as having potential to occur within the Study Area including 16 birds, 9 mammals and 6 reptiles. Identified species are outlined in **Table 4.1**.

Table 4.1 Desktop Search Results: Threatened Species

Common Name	Scientific Name	EPBC Act Status	NC Act Status
Birds			
Australian painted snipe	*Rostratula australis*	Endangered	Vulnerable
black-breasted buttonquail	*Turnix melanogaster*	Vulnerable	Vulnerable
Coxen's fig-parrot	*Cyclopsitta diophthalma coxeni*	Endangered	Endangered
curlew sandpiper	*Calidris ferruginea*	Critically Endangered, Migratory	Endangered
Diamond firetail	*Stagonopleura guttata*	Vulnerable	Vulnerable
eastern curlew	*Numenius madagascariensis*	Critically Endangered, Migratory	Endangered
glossy black-cockatoo	*Calyptorhynchus lathami*	-	Vulnerable
greater sand plover	*Charadrius leschenaultii*	Vulnerable, Migratory	Vulnerable
grey falcon	*Falco hypoleucos*	Vulnerable	Vulnerable
painted honeyeater	*Grantiella picta*	Vulnerable	Vulnerable
red goshawk	*Erythrotriorchis radiatus*	Vulnerable	Endangered
southern black-throated finch	*Poephila cincta cincta*	Endangered	Endangered
squatter pigeon (southern)	*Geophaps scripta scripta*	Vulnerable	Vulnerable
star finch (eastern, southern)	*Neochmia ruficauda ruficauda*	Endangered	Endangered
white-throated needletail	*Hirundapus caudacutus*	Vulnerable, Migratory	Vulnerable
yellow chat (Dawson)	*Epthianura crocea macgregor*	Critically Endangered	Endangered
Mammals			
Corben's long-eared bat	*Nyctophilus corbeni*	Vulnerable	Vulnerable
ghost bat	*Macroderma gigas*	Vulnerable	Endangered
greater glider (southern and central)	*Petauroides volans*	Endangered	Vulnerable
yellow-bellied glider (south-eastern)	*Petaurus australis australis*	Vulnerable	Vulnerable
grey-headed flying-fox	*Pteropus poliocephalus*	Vulnerable	-

Common Name	Scientific Name	EPBC Act Status	NC Act Status
koala (combined populations of Qld, NSW and the ACT)	*Phascolarctos cinereus*	Endangered	Endangered
large-eared pied bat	*Chalinolobus dwyeri*	Vulnerable	Vulnerable
long-nosed potoroo (SE mainland)	*Potorous tridactylus tridactylus*	Vulnerable	Vulnerable
northern quoll	*Dasyurus hallucatus*	Endangered	-
Reptiles			
collared delma	*Delma torquata*	Vulnerable	Vulnerable
Dunmall's snake	*Furina dunmalli*	Vulnerable	Vulnerable
Fitzroy river turtle	*Rheodytes leukops*	Vulnerable	Vulnerable
ornamental snake	*Denisonia maculata*	Vulnerable	Vulnerable
southern snapping turtle	*Elseya albagula*	Critically Endangered	Endangered
yakka skink	*Egernia rugosa*	Vulnerable	Vulnerable

4.1.2 Special Least Concern Species

The desktop search identified 15 fauna species listed Migratory under the EPBC Act and Special Least Concern under the NC Act as having potential to occur within the search extent. Also identified during this search was the short-beaked echidna (*Tachyglossus aculeatus*) which is listed Special Least Concern under the NC Act (but is not Migratory).

Of the 16 species identified, two species, white-throated needletail and greater sand plover, are also listed as Vulnerable under both the EPBC Act and NC Act. These species are herein assessed as Vulnerable being the higher level of classification graded for this species. Identified species are outlined in **Table 4.2**.

Table 4.2 Desktop Search Results: Special Least Concern Species

Common Name	Scientific Name	EPBC Act Status	NC Act Status
Special Least Concern Mammal			
short-beaked echidna	*Tachyglossus aculeatus*	-	Special Least Concern
Marine Birds			
fork-tailed swift	*Apus pacificus*	Migratory	Special Least Concern
greater sand plover	*Charadrius leschenaultia*	Vulnerable, Migratory	Vulnerable
Marine Bird Species			
salt-water crocodile	*Crocodylus porosus*	Migratory	Special Least Concern
Terrestrial Bird Species			
black-faced monarch	*Monarcha melanopsis*	Migratory	Special Least Concern
oriental cuckoo	*Cuculus optatus*	Migratory	Special Least Concern
rufous fantail	*Rhipidura rufifrons*	Migratory	Special Least Concern
satin flycatcher	*Myiagra cyanoleuca*	Migratory	Special Least Concern

Common Name	Scientific Name	EPBC Act Status	NC Act Status
spectacled monarch	*Monarcha trivirgatus*	Migratory	Special Least Concern
white-throated needletail	*Hirundapus caudacutus*	Vulnerable, Migratory	Vulnerable
yellow wagtail	*Motacilla flava*	Migratory	Special Least Concern
Wetlands Bird Species			
common sandpiper	*Actitis hypoleucos*	Migratory	Special Least Concern
Latham's snipe	*Gallinago hardwickii*	Migratory	Special Least Concern
osprey	*Pandion haliaetus*	Migratory	Special Least Concern
pectoral sandpiper	*Calidris melanotos*	Migratory	Special Least Concern
sharp-tailed sandpiper	*Calidris acuminata*	Migratory	Special Least Concern

4.1.3 Essential Habitat

The Study Area does not contain any essential habitat areas for listed fauna species, as shown on the DoR (2023) Vegetation Management essential habitat map (version 11.05).

4.1.4 Biodiversity Planning Assessment

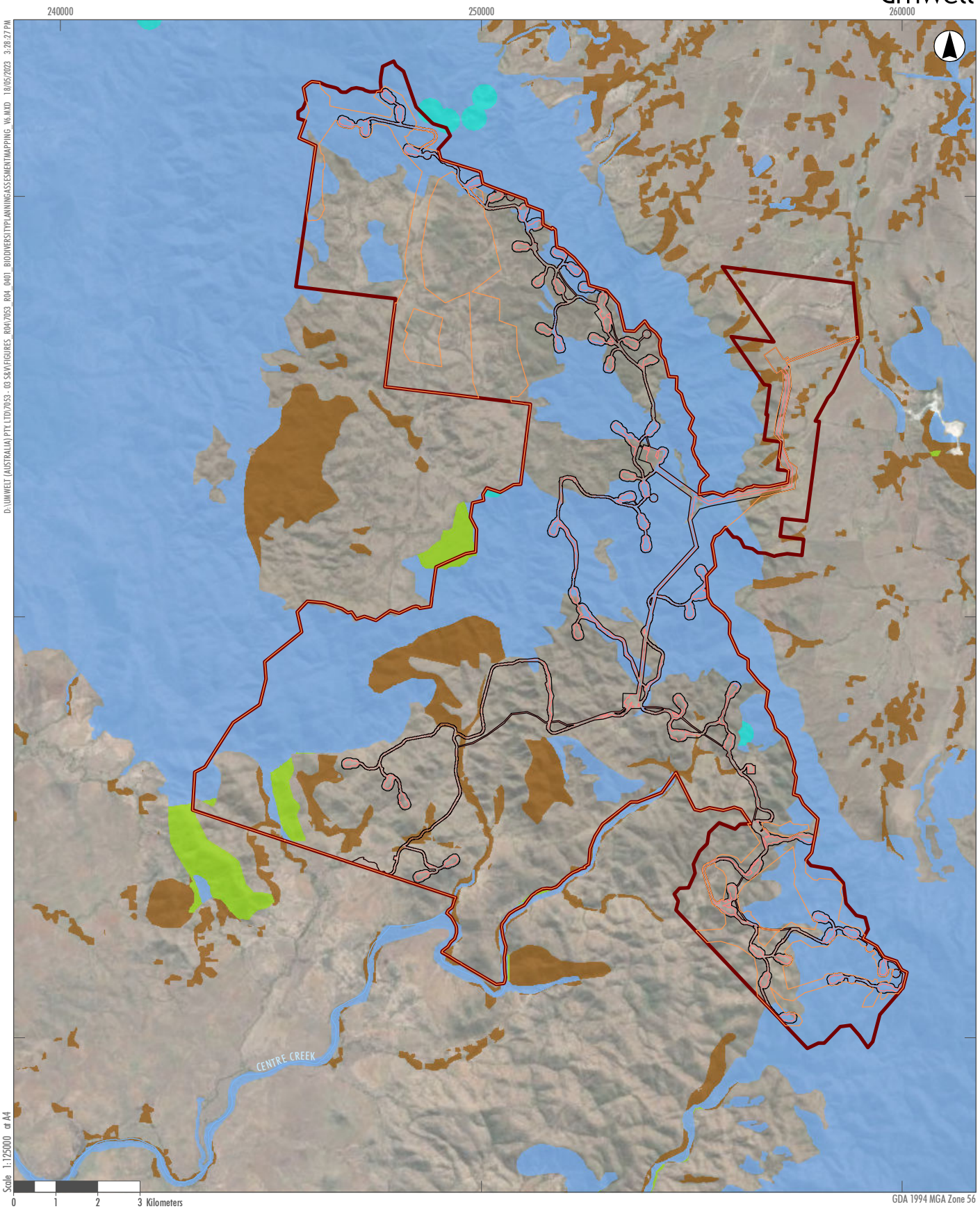
Biodiversity significance is attributed by DES on a bioregional scale through a Biodiversity Planning Assessment (BPA). BPAs assign three levels of overall biodiversity significance:

1. **State significance** – areas assessed as being significant for biodiversity at the bioregional or state scales. They also include areas assessed by other studies/processes as being significant at national or international scales.

2. **Regional significance** – areas assessed as being significant for biodiversity at the subregional scale. These areas have lower significance for biodiversity than areas assessed as being of State significance.

3. **Local significance** and/or **other values** – areas assessed as not being significant for biodiversity at state or regional scales. Local values are of significance at the local government scale.

The BPA mapping identifies all three levels within the Study Area, with state significant corridors dominating the eastern range, including northern areas of connected vegetation. The BPA mapping is presented in **Figure 4.1.**



Legend

- Study Area
- Ground Truthed Survey Extent
- Development Corridor
- Disturbance Footprint

Biodiversity Significance

- State Habitat for Endangered, Vulnerable or Near Threatened (EVNT) Taxa
- State
- Regional
- Local or Other Values

FIGURE 4.1

Biodiversity Planning Assessment Mapping

Image Source: ESRI Basemap (2021) Data source: Queensland Spatial (2020)

4.2 Field Results

4.2.1 Study Area Characteristics

The Study Area extends across the Ulam Range surrounded on each side by agricultural properties and local dwellings. East of the Study Area, the Ulam Range ends and the landscape flattens to a plain where the dominant land use is cattle grazing. The southwestern extent of the Study Area also extends to a cleared, flatter landscape with two water courses flowing south-west into Centre Creek.

A large section of the Ulam Range has been cleared for cattle grazing and is localised within the centre of the range. This section exists within the northern section of the Study Area, extending further north. This section is associated with a slightly flatter landscape with various vegetated creeks throughout.

Large stands of remnant vegetation exist within the Study Area separated by partly cleared regrowth areas used primarily for livestock grazing. Due to the steep topography of the Study Area, uncleared riverine vegetation communities are common, often with a dense mid-story of vine thicket or dense shrubs. These areas sprawl through the Study Area connecting various habitat types and providing local connectivity for fauna species. Non-riverine vine thickets are also common on the upper slopes of the steep hills and ridges of the Study Area. These thickets trend along a northern ridgeline in the Study Area and extend down into the creeks and gullies.

4.2.2 Fauna Diversity

A total of 211 fauna species from 156 genera were identified during the field survey program, comprising 148 birds, 37 mammals, 19 reptiles and 7 amphibians. Of the species recorded, 6 are introduced, representing 2.8% of the total fauna assemblage recorded.

The following sections describe the fauna species which are of significance to the Project. The full list of fauna species identified during the field surveys is provided in **Appendix B.**

4.2.2.1 Threatened Species

Field surveys identified six fauna species listed as threatened under the EPBC Act and/or NC Act.
A breakdown of these species is provided in **Table 4.3** and record locations are provided in **Figure 4.2**.

Table 4.3 Threatened Fauna Species Recorded within the Study Area

Common Name	Scientific Name	EPBC Act Status	NC Act Status
glossy black-cockatoo	*Calyptorhynchus lathami*	-	Vulnerable
greater glider (southern and central)	*Petauroides volans*	Vulnerable	Vulnerable
northern quoll	*Dasyurus hallucatus*	Endangered	Least Concern
squatter pigeon (southern)	*Geophaps scripta scripta*	Vulnerable	Vulnerable
white-throated needletail	*Hirundapus caudacutus*	Vulnerable, Migratory	Vulnerable
Yellow-bellied glider (south-eastern)	*Petaurus australis australis*	Vulnerable	Vulnerable

Plate 4.1 Northern quoll (*Dasyurus hallucatus*) detected on a camera trap in the central-east portion of the Study Area

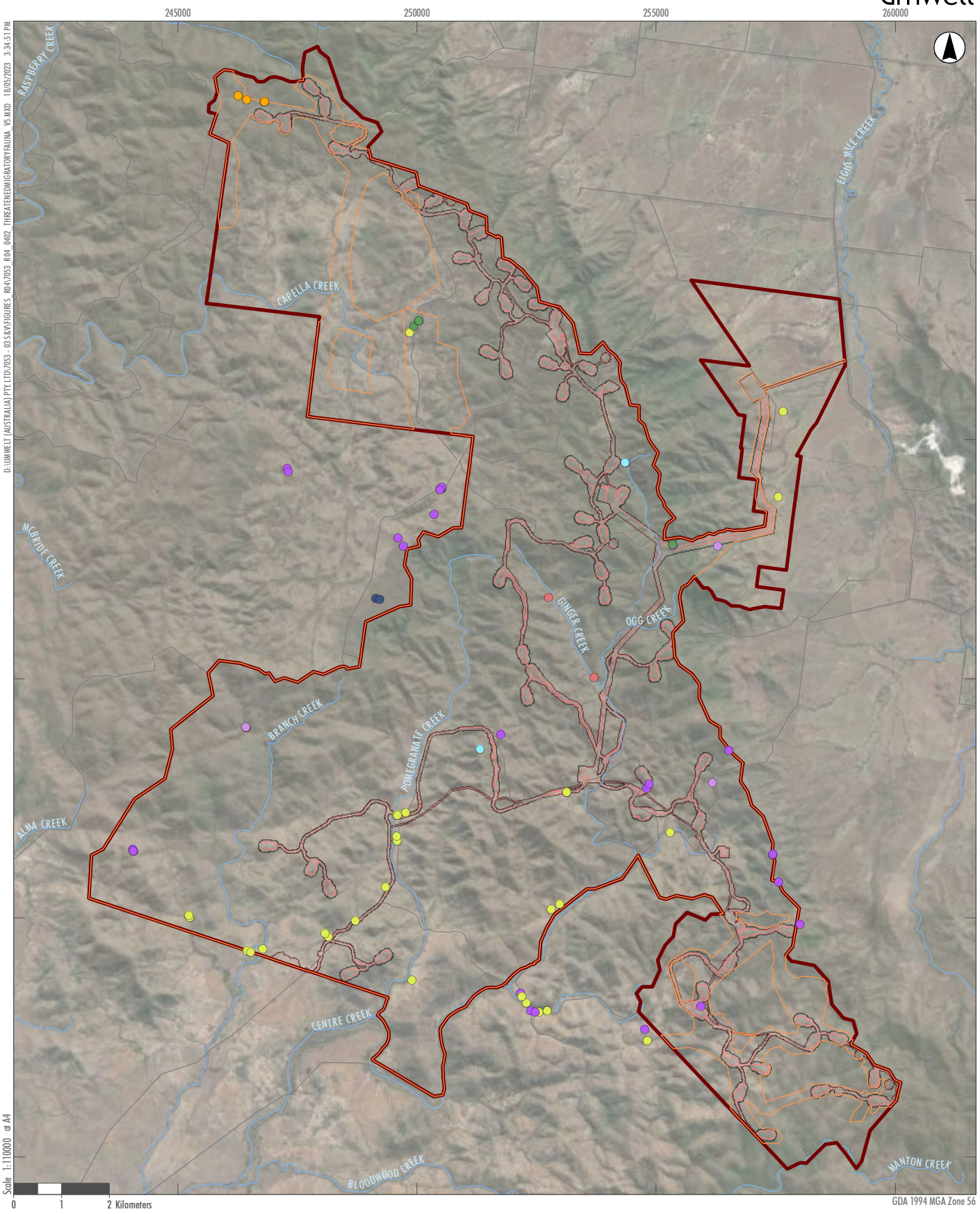
Plate 4.2 Male glossy black-cockatoo (*Calyptorhynchus lathami*) feeding on forest she-oak (*Allocasuarina torulosa*) adjacent to the Study Area

4.2.2.2 Migratory and Species Least Concern Species

Field survey identified four fauna species listed as Migratory under the EPBC Act and/or Special Least Concern under the NC Act. This includes one species, white-throated needletail, which is also listed as Vulnerable under the EPBC Act and NC Act and has also been considered in the section above. A breakdown of these species is provided in **Table 4.4** and record locations are provided in **Figure 4.2**.

Table 4.4 Migratory and Special Least Concern Species Recorded within the Study Area

Common Name	Scientific Name	EPBC Act Status	NC Act Status
rufous fantail	*Rhipidura rufifrons*	Migratory	Special Least Concern
spectacled monarch	*Symposiarchus trivirgatus*	Migratory	Special Least Concern
short-beaked echidna	*Tachyglossus aculeatus*	-	Special Least Concern
White-throated needletail	*Hirundapus caudacutus*	Vulnerable / Migratory	Vulnerable



Legend

- Study Area
- Ground Truthed Survey Extent
- Development Corridor
- Disturbance Footprint

Threatened and Migratory Fauna Record Locations

- Glossy black-cockatoo *(Calyptorhynchus lathami)*
- Greater glider *(Petauroides volans)*
- Northern quoll *(Dasyurus hallucatus)*
- Rufous fantail *(Rhipidura rufifrons)*
- Spectacled monarch *(Symposiachrus trivirgatus)*
- Squatter pigeon (southern) *(Geophaps scripta scripta)*
- White-throated needletail *(Hirundapus caudacutus)*
- Yellow-bellied glider (south-eastern) *(Petaurus australis australis)*

FIGURE 4.2

Threatened and Migratory Fauna Record Locations

Image Source: ESRI Basemap (2021) Data source: Queensland Spatial (2020)

4.2.2.3 Introduced Species

Field surveys identified six introduced fauna species, four of which are listed as Restricted Invasive biosecurity matters under the *Biosecurity Act 2014*. A breakdown of these species is provided in **Table 4.5**.

Table 4.5 Introduced Species Recorded within the Study Area

Common Name	Scientific Name	*Biosecurity Act 2014* Status
cane toad	*Rhinella marina*	Invasive
horse	*Equus caballus*	Invasive
feral cat	Felis catus	Restricted Invasive
feral pig	Sus scrofa	Restricted Invasive
black rat	*Rattus rattus*	Restricted Invasive
brown hare	*Lepus capensis*	Restricted Invasive

EPBC Act 'key threatening processes' are processes which threaten the survival, abundance or evolutionary development of a native species or ecological community (DAWE 2021). Key threatening processes are linked to three of the above introduced species and include:

- The biological effects, including lethal toxic ingestion, caused by cane toads (*Rhinella marina*).
- Predation by feral cats.
- Predation, habitat degradation, competition and disease transmission by feral pigs.

4.2.3 Bird and Bat Utilisation Survey Results

A total of 148 bird species were recorded within the Study Area; 88 were recorded during vantage point surveys while the remaining 60 were heard or observed incidentally during travel between vantage points or during other surveys within the Study Area.

A total of 18 bat species were recorded within the Study Area across the field survey program, either acoustically recorded by Anabat devices or caught via harp trapping. Nine of the 18 species were recorded during each BBUS. None of the bat species recorded during the field survey program are listed under the NC Act or EPBC Act.

The full list of bird and bat species identified during the field surveys is provided in **Appendix B**.

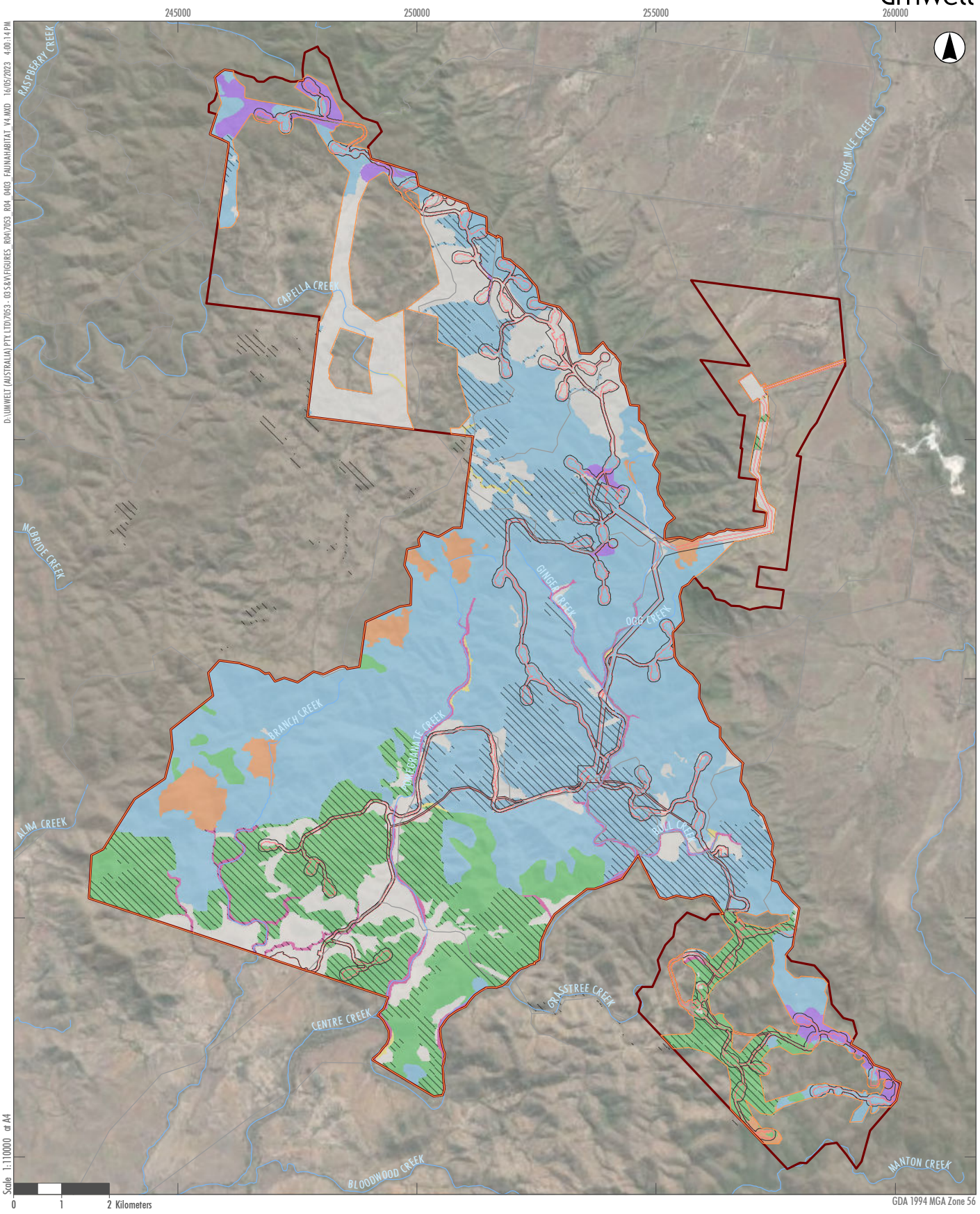
4.2.4 Fauna Habitat Types

The Study Area supports seven broad fauna habitat types, ranging from eucalypt woodland to dense microphyll vine forest (**Table 4.6**). The various habitat types support habitat resources for multiple threatened and migratory fauna species which are known to occur within the Study Area or have a moderate or high likelihood of occurring. A profile for each fauna habitat type is provided in **Appendix C.** These fauna habitat types have been mapped based on ground-truthed RE mapping and are shown on **Figure 4.3**.

Table 4.6 Fauna Habitat Types within the Study Area (Ground-truthed Mapping Extent)

Fauna Habitat Type	Habitat Description	Associated Regional Ecosystems	Ground-truthed Mapping Extent (ha)[1]
Mixed eucalypt woodland on steep slopes	Mixed eucalypt woodland on steep slopes and crests, commonly with *Corymbia citriodora* and/or *Eucalyptus crebra* +\- *E. acmenoides*, *E. tereticornis*	11.11.3, 11.11.4, 11.11.4a, 11.11.4b, 11.12.6	7,264.3
Eucalyptus crebra woodland	*Eucalyptus crebra* +\- *Corymbia erythrophloia* woodland on slopes and crests	11.11.15, 11.12.1	2,575.5
Eucalyptus moluccana woodland	*Eucalyptus moluccana* woodland on slopes and crests	11.11.3c, 11.11.4c	241.8
Semi-evergreen vine thicket	Vine thicket on upper slopes and gullies with various floristics including *Euroschinus falcatus* var. *falcatus*, *Brachychiton australis*, *Flindersia* spp., *Ficus* sp., *Jasminum* sp., *Alyxia* sp., etc.	11.11.5, 11.11.5a, 11.12.4	330.8
Riparian *Melaleuca* woodland	*Melaleuca fluviatilis* woodland +\- *Eucalyptus tereticornis* fringing a watercourse	11.3.25b	240.8
Alluvial eucalypt woodland	*Eucalyptus tereticornis* +\- *Corymbia tessellaris* woodland on alluvial soils sometimes with *Casuarina cunninghamiana* as dominant	11.3.4, 11.3.25	36.9
Non-remnant pasture	Areas containing pasture comprising native and non-native grasses, scattered native trees and various infrastructure including tracks and dams	-	2,234.1

[1]: Areas reported are inclusive of regrowth where present.



Legend

- Study Area
- Ground Truthed Survey Extent
- Development Corridor
- Disturbance Footprint

Fauna Habitat Type

- Alluvial eucalypt woodland
- *Eucalyptus crebra* woodland
- *Eucalyptus moluccana* woodland
- Mixed eucalypt woodland on steep slopes
- Non-remnant pasture
- Riparian Melaleuca woodland
- Semi-evergreen vine thicket
- Regrowth Vegetation

Image Source: ESRI Basemap (2021) Data source: Queensland Spatial (2020)

FIGURE 4.3

Fauna Habitat Mapping

4.2.5 Aquatic Habitat

The aquatic ecological values assessed during the field survey relate to the ephemeral creek systems of the Study Area. These creeks include many watercourses mapped under the VM Act comprising stream order four, three, two and one watercourses. Given the highly ephemeral nature of watercourses in the Study Area, they were generally dry at the time of field surveys with small pools persisting after rain where the channel substrate comprised bedrock. The longest major watercourse within the Study Area is Centre Creek, a stream order four watercourse situated along the central, southern boundary. One mapped high ecological value watercourse associated with the Callide Creek Catchment is mapped approximately 50 m into the north western-most extent of the Study Area. There are no wetlands mapped within the Study Area.

In-stream aquatic habitat included rocky substrates, varying in complexity from pebbles/stones to large boulders upon bedrock. All watercourses supported in-stream snags such as fallen branches, logs, trees and shrubs. Stream banks comprised grasses consistent with the adjacent woodlands, although riparian species such as spiny-head mat-rush (*Lomandra longifolia*) were also present. Watercourses showed evidence of disturbance, often associated with cattle impacts such as the presence of weeds e.g. lantana (*Lantana camara*) and rubber vine (*Cryptostegia grandiflora*), and ground disturbance. No watercourses of high ecological significance exist within the Study Area. However, several mapped watercourses are considered relevant waterways for waterway barrier works. Associated risk levels range from 'Major' to 'Low'. Only small areas of 'Major' watercourses are present in the Study Area where stream bends meander into the edge of the area, however none intersect the Disturbance Footprint or Development Corridor.

Fringing riparian vegetation was generally similar throughout the Study Area, generally dominated by weeping tea-tree (*Melaleuca fluviatilis*) and/or river she-oak (*Casuarina cunninghamiana*), although vine thicket habitat types which formed a dense canopy was also present. Eucalypts also featured along watercourses, predominately on stream order three and stream order four watercourses. Dominant eucalypt species including Queensland blue gum (*Eucalyptus tereticornis*) and Moreton Bay ash (*Corymbia tessellaris*).

During brief periods of inundation, the aquatic environment within the Study Area may support marginal assemblages of aquatic fauna species such as native fish and freshwater crustaceans. No aquatic flora species were recorded within the Study Area due to an absence of water. However, numerous macrophyte species were recorded in and around the watercourses. These species were represented within alluvial woodlands dominated by *Eucalyptus tereticornis*, *Melaleuca fluviatilis* and *Casuarina cunninghamiana*.

Plate 4.3 Stream order 3 waterway with bedrock substrate and fringed by vine thicket

Plate 4.4 Stream order 4 waterway, 'Centre Creek', fringed by *Casuarina cunninghamiana* and *Melaleuca fluviatilis*

4.3 Likelihood of Occurrence Assessment

4.3.1 Threatened Species

The likelihood of occurrence assessment determined that six threatened species are known from the Study Area based on field surveys and two species have a moderate likelihood of occurrence within the Study Area (**Table 4.7**). No species were identified as having a high likelihood of occurrence. Threatened species that have a low likelihood of occurrence or are unlikely to occur were excluded from further assessment. The full likelihood of occurrence assessment, including a habitat assessment and justification of likelihood, is provided in **Appendix A**.

One species, the yellow-bellied glider (south-eastern), was listed after the Project's development application was properly made to the State Assessment and Referral Agency on 6 October 2021 and as such has not been considered further in this assessment. However, this species has been considered in the Commonwealth approval process.

Table 4.7 Likelihood of Occurrence Assessment Results: Threatened Species

Common Name	Scientific Name	EPBC Act Status	NC Act Status
Known			
glossy black-cockatoo	*Calyptorhynchus lathami*	-	Vulnerable
greater glider (southern and central)	*Petauroides volans*	Vulnerable	Vulnerable
northern quoll	*Dasyurus hallucatus*	Endangered	Least Concern
squatter pigeon (southern)	*Geophaps scripta scripta*	Vulnerable	Vulnerable
white-throated needletail	*Hirundapus caudacutus*	Vulnerable, Migratory	Vulnerable
yellow-bellied glider	*Petaurus australis australis*	Vulnerable	Vulnerable
Moderate			
collared delma	*Delma torquata*	Vulnerable	Vulnerable
koala	*Phascolarctos cinereus*	Vulnerable	Vulnerable

4.3.2 Species Least Concern Species

The likelihood of occurrence assessment determined that three Special Least Concern species are known to occur within the Study Area based on field surveys, one species has a high likelihood of occurrence and three species have a moderate likelihood of occurrence (**Table 4.8**). Migratory species that have a low likelihood of occurrence or are unlikely to occur were excluded from further assessment. The full likelihood assessment and justification of likelihood is provided in **Appendix A**.

Table 4.8 Likelihood of Occurrence Assessment Results: Migratory and Species Least Concern Species

Common Name	Scientific Name	EPBC Act Status	NC Act Status
Known			
rufous fantail	*Rhipidura rufifrons*	Migratory	Special Least Concern
spectacled monarch	*Symposiarchus trivirgatus*	Migratory	Special Least Concern
short-beaked echidna	*Tachyglossus aculeatus*	-	Special Least Concern
High			
fork-tailed swift	*Apus pacificus*	Migratory	Special Least Concern
Moderate			
black-faced monarch	*Monarcha melanopsis*	Migratory	Special Least Concern
oriental cuckoo	*Cuculus optatus*	Migratory	Special Least Concern
satin flycatcher	*Myiagra cyanoleuca*	Migratory	Special Least Concern

4.4 Threatened and Migratory Fauna Habitat Modelling

Habitat for threatened and Migratory fauna species known or potentially occurring within the Study Area was mapped based on each species unique habitat requirements, and the occurrence of such features within the Ground-truthed Mapping Extent. Habitat criteria used to inform the mapping of each species is provided in **Table 4.9** along with the area of habitat within the Ground-truthed Mapping Extent**.** Habitat mapping developed for listed threatened fauna is presented in **Appendix E**.

Table 4.9 Habitat Modelling Criteria for Threatened and Migratory Fauna

Species	Habitat Criteria	Area within the Ground-truthed Mapping Extent (ha)	Area Total
Threatened and Special Least Concern Fauna Species			
glossy black-cockatoo (*Calyptorhynchus lathami*)	Breeding: Regional ecosystem 11.11.3c was considered suitable for breeding based on the presence of large hollow-bearing trees.	152.1	2,752.2
	Foraging: Remnant or regrowth regional ecosystem supporting foraging tree species including those from the genera *Casuarina* and *Allocasuarina* (11.3.25, 11.3.25b, 11.11.3, 11.11.4).	2,600. 1	
Greater Glider (southern and central) (*Petauroides volans*)	Breeding and Denning: Select areas of seven REs (RE 11.3.4, 11.3.25b, 11.12.6, 11.11.3, 11.11.3c, 11.11.4a and 11.11.4b) were considered suitable for breeding and denning based on the presence of suitable hollow-bearing trees. Areas of mature regrowth were only included where the hollows were confirmed present and the EDL height was >14m.	2,339.5	9,900.5
	Foraging and Dispersal: Excluding areas found to provide breeding and denning habitat, all relevant REs (as per DES 2022) were considered to comprise foraging and dispersal habitat. Areas of mature regrowth were only included where the EDL height was >14m and canopy cover was not very open.	7,560.9	
northern quoll (*Dasyurus hallucatus*)	Denning and Refuge: Vegetation, watercourse, and 10-metre contour mapping was examined in conjunction with survey data (including floristics and habitat assessments) and high-quality Queensland Globe satellite imagery to manually identify hilly and rocky habitats including gullies, creeklines and structurally diverse woodlands.	1,449.4	8,394.0

Species	Habitat Criteria	Area within the Ground-truthed Mapping Extent (ha)	Area Total
	Foraging and Dispersal: All remnant and regrowth vegetation communities within 1 km of shelter habitat (mapped within and surrounding the Study Area) were identified as foraging and dispersal habitat.	6,944.6	
squatter pigeon (southern) (*Geophaps scripta scripta*)	Breeding: Although no land zone 5 or 7 occurs, woodland communities associated with land zone 3 are present and, in places, are within 1 km of a suitable water source (i.e. farm dams, lacustrine wetlands and watercourses with a stream order of 3 or higher).	184.0	6,925.6
	Foraging: Although no land zone 5 or 7 occurs, woodland communities associated with land zone 3 are present and, in places, are within 3 km of a suitable water source (i.e. farm dams, lacustrine wetlands and watercourses with a stream order of 3 or higher).	57.7	
	Dispersal: Breeding, foraging and suitable water sources within the Study Area and adjacent all largely occur within 1 km of each other. Based on this, all woodlands and areas of cleared land less than 100 m within 1 km of breeding and foraging were included.	6,683.9	
white-throated needletail (*Hirundapus caudacutus*)	Roosting and Foraging: Remnant vegetation occurring within areas above 400 m AHD.	2,866.1	10,690.0
	Foraging and Dispersal: All remaining vegetation communities in remnant or regrowth condition.	7,823.9	
collared delma (*Delma torquata*)	Breeding and Foraging: Open-forest, woodlands and adjacent exposed rocky areas in Queensland on land zones 3 (i.e. REs 11.3.25b and 11.3.4) with some suitable microhabitat. Some patches of above REs excluded based on confirming lack of microhabitat from field data. No land zone 9 or 10 communities present.	249.8	249.8
Koala (*Phascolarctos cinereus*)	Breeding, Foraging and Dispersal: All vegetation communities except SEVT in remnant or regrowth condition included.	11,128.2	11,405.9

Species	Habitat Criteria	Area within the Ground-truthed Mapping Extent (ha)	Area Total
	Climate Refugia: All eucalypt woodlands on land zone 3 are considered potential climate refugia.	277.7	
short-beaked echidna (*Tachyglossus aculeatus*)	Foraging, Breeding and Dispersal: All remnant and non-remnant vegetation communities included	12,924.1	12,924.1
Migratory Fauna Species			
rufous fantail (*Rhipidura rufifrons*)	Breeding: No breeding habitat has been identified as the Study Area is outside of the breeding range and does not support preferred habitat.	-	6,971.2
	Foraging and Dispersal: All vegetation in remnant condition. Regrowth and non-remnant vegetation excluded due to unsuitable structure or connectivity.	6,971.2	
spectacled monarch (*Symposiarchus trivirgatus*)	Foraging and Dispersal: Dense vegetation as confirmed during the field surveys, associated with gullies and steep slopes. Regrowth and non-remnant vegetation excluded due to unsuitable structure or connectivity.	1,037.5	1,037.5
fork-tailed swift (*Apus pacificus*)	Foraging and Dispersal: All remnant and non-remnant vegetation communities included.	12,924.1	12,924.1
black-faced monarch (*Monarcha melanopsis*)	Foraging and Marginal Breeding: Dense, semi-evergreen vine thicket vegetation as confirmed during the field surveys, associated with gullies and steep slopes. Regrowth and non-remnant vegetation excluded due to unsuitable structure or connectivity.	1,037.5	7,021.0
	Foraging and Dispersal: Excluding areas considered foraging and marginal breeding, all vegetation communities in remnant condition. Regrowth and non-remnant vegetation excluded due to unsuitable structure or connectivity.	5,983.5	

Species	Habitat Criteria	Area within the Ground-truthed Mapping Extent (ha)	Area Total
oriental cuckoo (*Cuculus optatus*)	Foraging and Dispersal: All vegetation communities are regarded as suitable, where they exist in remnant condition.	6,971.2	6,971.2
satin flycatcher (*Myiagra cyanoleuca*)	Breeding: No breeding habitat has been mapped for this species as the Study Area is outside of the species' breeding range.	-	6,640.4
	Foraging and Dispersal: All vegetation communities except two (REs 11.11.5a and 11.12.4) in remnant condition included. Regrowth and non-remnant vegetation not found to support suitable structure or connectivity.	6,640.4	

4.5 Matters of State Environmental Significance

The following MSES (i.e. prescribed environmental matters) that relate to fauna are mapped and/or have been identified through the field survey or via desktop assessment within the Study Area:

- Protected wildlife habitat for an animal that is endangered or vulnerable wildlife:
    - glossy black-cockatoo (*Calyptorhynchus lathami*)
    - greater glider (southern and central) (*Petauroides volans*)
    - yellow-bellied glider (south-eastern) (*Petaurus australis australis*)[1]
    - squatter pigeon (southern) (*Geophaps scripta scripta*)
    - white-throated needletail (*Hirundapus caudacutus*)
    - collared delma (*Delma torquata*)
    - koala (*Phascolarctos cinereus*).
- Protected wildlife habitat for a special least concern animal:
    - short-beaked echidna (*Tachyglossus aculeatus*).
- Connectivity areas.

[1] As discussed previously, as this species was not listed under the NC Act prior to the initial assessment of the DA, it has not been considered further in this report. Yellow-bellied glider (south-eastern) will be assessed under the Commonwealth approval process.

5.0 Potential Impacts

This section identifies the potential impacts on fauna that may occur during the Project's construction, operation and maintenance, and decommissioning and rehabilitation. The Disturbance Footprint has been used as the assessment unit when undertaking the impact assessment on ecological values. This area, along with the Project's Development Corridor and supporting infrastructure layout is provided in **Figure 5.1.**

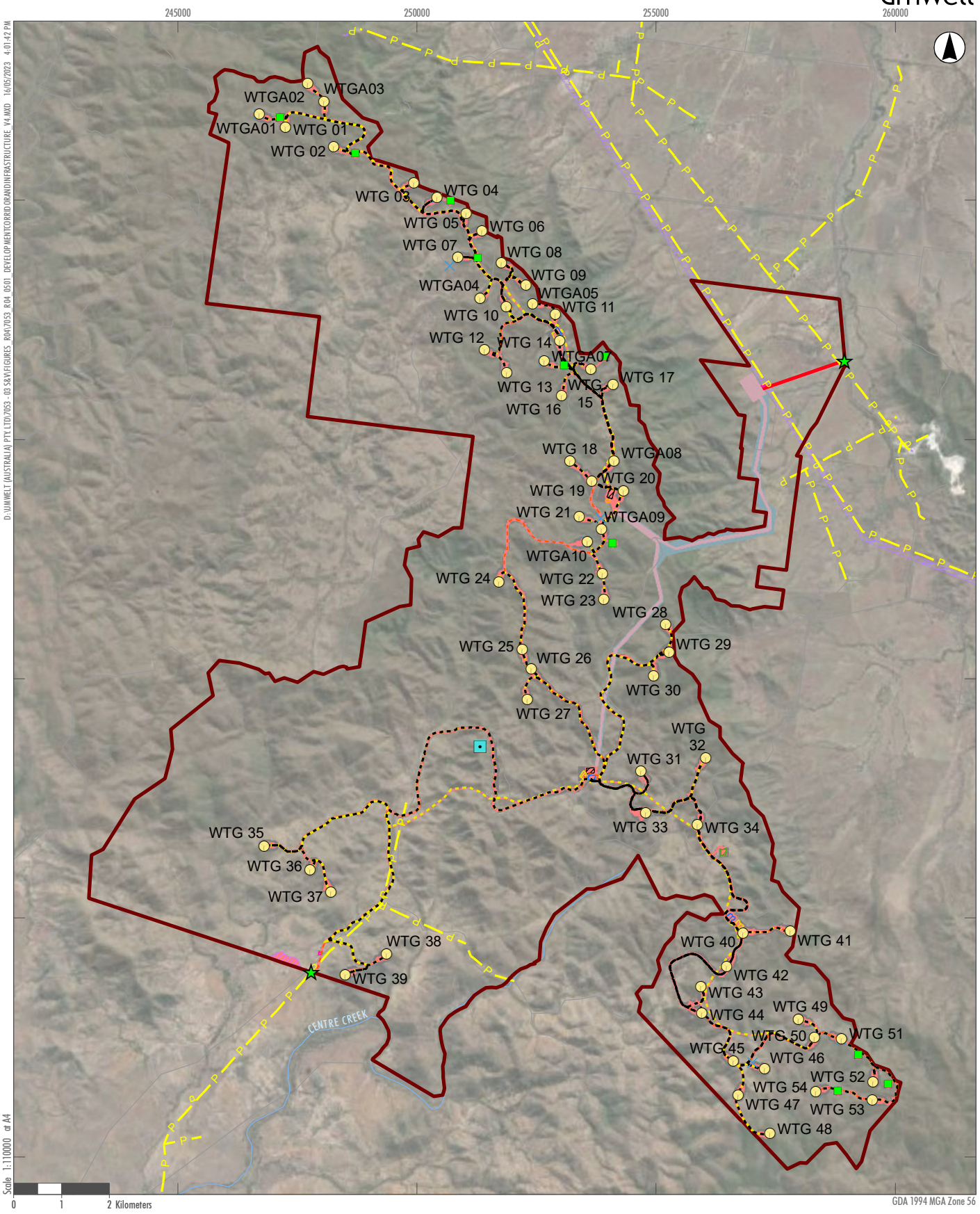
Potential impacts to fauna may occur during all phases of the Project. The potential impacts identified and assessed include:

- Construction impacts:
    - Habitat loss including threatened species habitat.
    - Fauna injury and mortality.
    - Loss of fauna movement opportunities.
    - Indirect impacts such as disturbance from noise, light and dust.
    - Habitat degradation and increased threats from the pests and weeds.
- Operational impacts:
    - Vehicle strikes.

Potential impacts relating to the birds and bats are specifically addressed in the Bird and Bat Utilisation Report (**Appendix D**), however information has also been provided in **Section 5.2.2** to **Section 5.2.4** on the following impacts:

- Collisions with turbine blades and other infrastructure (e.g. guy wires) including barotrauma.
- Barrier effects.

Avoidance, mitigation and management measures for the above potential impacts are presented in **Section 6.0.**



Legend

- Study Area (16,758 Ha)
- Project Site (Development Corridor - 1346 Ha)
- Disturbance Footprint
- HV Electricity Network
- Easements

Proposed Project Infrastructure

- Site Access
- Access Road
- Overhead Line
- Underground Line
- Compound
- Concrete Batching Plant
- Construction Camp
- Laydown
- Operation and Maintenance Area
- Site Entry
- Substation
- Transmission Infrastructure
- Grid Connection Easement
- Access
- Temporary Met Masts
- Permanent Met Masts
- Turbines

Existing Project Infrastructure

- Existing Met Mast

FIGURE 5.1

Development Corridor and Infrastructure Layout

Image Source: ESRI Basemap (2021) Data source: Queensland Spatial (2020)

5.1 Construction Impacts

The greatest risk of adverse impact to threatened fauna species will occur during the construction phase. The Disturbance Footprint, which occupies a subset of the Development Corridor, has been used as the assessment unit when undertaking the assessment of direct impacts. The extent of clearing represented by the Disturbance Footprint is considered to be a 'worst-case' scenario. When assessing potential indirect impacts resulting from the Project, the Disturbance Footprint and the wider surrounding area have been considered.

The construction activities to support the installation of turbines, associated electrical lines, ancillary infrastructure and access tracks will involve vegetation clearing and earth works including excavation and ground reinstatement. Potential direct and indirect impacts on threatened fauna species associated with these activities are described below.

5.1.1 Habitat Loss

The Disturbance Footprint encompasses a total of 877.5 ha. Vegetation clearing is a direct impact that results in the loss of vegetation and associated habitat values, including habitats that support threatened species. Potential impacts resulting from clearing native vegetation can include:

- Reduced patch size of vegetation communities potentially compromising the viability of the community and associated habitat.
- Loss of habitat causing a reduction of biological diversity or loss of local populations and genotypes.
- Loss of or disturbance to microhabitat features such as tree hollows, ground timber including hollow logs, surface rocks, leaf litter and boulder piles.
- Loss of floristic diversity and the food resources this provides such as foliage, flowers, nectar, fruit and seeds.
- Fragmentation of habitats resulting in reduced dispersal opportunities for fauna.
- Destruction of abiotic features necessary to support vegetation communities and habitat types.

Vegetation clearing and construction of the Project will be staged. Although the resulting impact from clearing will be largely permanent (noting some areas to be rehabilitated), staging will allow for impacts resulting from this activity to be limited to a relatively small area within the Disturbance Footprint and wider Study Area at any one time. For some mobile fauna species, this localised impact will allow time for individuals to temporarily relocate away from disturbance. However, for species with small home ranges or reduced dispersal abilities (i.e. skinks, frogs) this may cause localised population depletion.

While the clearance of vegetation for the Project is unavoidable, it will only be completed as strictly necessary. In addition, a range of measures will be implemented to minimise the overall level of impact from clearing. It is acknowledged however that where clearing and habitat loss cannot be avoided, particularly in high constraint areas (i.e. greater glider (breeding and denning habitat) and northern quoll (breeding and shelter habitat)), it is likely to result in permanent impacts to threatened biodiversity values.

5.1.1.1 Fauna Habitat Types

The Disturbance Footprint is primarily linear, distributed across the landscape in a predominately north south fashion. For these reasons, habitat loss is not anticipated to provide barriers to fauna movement, allowing existing populations to disperse and access resources within and beyond the Study Area.

The fauna habitat types and the associated potential impact areas (as well as mapped area within the Ground-truthed Mapping Extent) is provided in **Table 5.1** below.

Table 5.1 Potential Impact Areas to Fauna Habitat Types

Fauna Habitat Type	Ground-truthed Mapping Extent (ha)	Development Corridor (ha)	Disturbance Footprint (ha)
Mixed eucalypt woodland on steep slopes	7,264.3	651.4	420.4
Eucalyptus crebra woodland	2,575.5	209.2	144.3
Eucalyptus moluccana woodland	241.8	85.6	55.5
Semi-evergreen vine thicket	330.8	28.8	8.4
Riparian *Melaleuca* woodland	240.8	5.8	4.7
Alluvial eucalypt woodland	36.9	1.3	0.7
Non-remnant pasture	2,234.1	364.3	243.5
Total	12,924.1	1,346.5	877.3

5.1.1.2 Conservation Significant Fauna

The potential clearance of fauna habitat (**Table 5.1**) includes areas which may be utilised by fauna listed as threatened or Special Least Concern under the NC Act that are known to occur or are considered a moderate or high likelihood of occurring (**Section 4.3**). The potential impacts on conservation significant fauna have been quantified (**Table 5.2**) based on the fauna habitat types mapped within the Disturbance Footprint and modelled habitat areas presented in **Appendix E.** In some instances, a further breakdown in habitat areas has been provided due to the significance of specific habitat types (features that are limiting in the landscape and are essential for the survival of the species). For some species, the impact calculations presented in **Table 5.2** differ from those in the original Terrestrial Fauna Assessment submitted to support the Development Application. This change in numbers is due to footprint refinements as updated species habitat mapping undertaken to meet DCCEEWs requirements for the Preliminary Documentation. Mapped habitat for each species is described in **Appendix E.**

All species listed as migratory under the EPBC Act, have been impact assessed in line with the *Significant Impact Guidelines 1.1 – MNES* (DCCEEW) and are not considered further in this report. As per the *Significant Residual Impact Guideline* (DSDIP), Special Least Concern animals must be assessed. As per the Environmental Offsets Regulation 2014, there are only two Special Least Concern animals – short-beaked echidna and platypus. As such, potential impacts to short-beaked echidna are assessed within this report.

Further, impacts to the yellow-bellied glider (south-eastern) have not been considered in impact assessment as the species was listed under the NC Act after the Project's development application was properly made to the State Assessment and Referral Agency on 6 October 2021. However, this species will be assessed under the Commonwealth approval process.

Table 5.2 Potential Habitat Loss Impacts to Threatened Fauna

Common Name	Scientific Name	Survey Extent (ha)	Development Corridor (ha)	Disturbance Footprint (ha)
Threatened Species				
glossy black-cockatoo	*Calyptorhynchus lathami*	Breeding: 152.5	38.6	23.8
		Foraging: 2,600.1	372.7	242.5
greater glider	*Petauroides volans*	Breeding and Denning: 2,339.5	330.4	206.9
		Foraging and Dispersal: 7,560.9	500.4	331.5
squatter pigeon (southern)	*Geophaps scripta scripta*	Breeding: 184.0	4.5	3.6
		Foraging: 57.7	2.2	1.5
		Dispersal: 6,683.9	470.0	324.4
white-throated needletail	*Hirundapus caudacutus*	Roosting and Foraging: 2,866.1	427.9	365.9
		Foraging and Dispersal: 7,823.9	554.2	267.9
collared delma	*Delma torquata*	Breeding, foraging and dispersal: 249.8	6.1	5.0
koala	*Phascolarctos cinereus*	Breeding, Foraging and Dispersal: 11,128.2	1,111.3	721.1
		Climate Refugia: 277.7	7.1	5.3
Special Least Concern (Non-Migratory)				
short-beaked echidna	*Tachyglossus aculeatus*	Breeding, foraging and dispersal: 12,924.1	1,346.5	877.3

5.1.2 Habitat Fragmentation and Loss of Movement Opportunities

Clearing may result in reduced fauna movement opportunities, leading to reduced species recruitment, genetic flow and ultimately affect the long-term viability and persistence of fauna populations within the landscape.

Habitat within the Disturbance Footprint and the wider Study Area has been historically subjected to low level fragmentation impacts as a result of ongoing agricultural works, including the creation of farm dams and installation of tracks, firebreaks and fences. Further vegetation clearing will be required for the construction of the Project, which may exacerbate existing fragmentation impacts.

Threatened fauna species that are considered most susceptible to fragmentation impacts as a result of the construction of the Project include greater glider (southern and central) (*Petauroides volans*) and koala (*Phascolarctos cinereus*). Although the koala (*Phascolarctos cinereus*) is considered highly mobile and is known to disperse through cleared areas, it is while making these movements that they are most susceptible to vehicle collision and attack by dogs and other predators. In contrast, the greater glider (southern and central) (*Petauroides volans*) is known to have a low dispersal ability. Vegetation clearing may create gaps or expand existing gaps between areas of suitable habitat and potentially restrict the movement of individuals and access to required habitat resources.

The Project is situated on the Great Dividing Range and remnant vegetation within the Study Area provides connectivity through biodiversity corridors that facilitate north-south movement of fauna at a regional scale. Internal fauna movement is likely afforded by waterways, ridgelines and gullies. The clearance of habitat within the Disturbance Footprint may temporarily disrupt fauna movement internally, as well as to adjacent high-quality areas outside of the Study Area. Although the Project is primarily linear in nature and will have few hard dispersal barriers (i.e. fencing), clearing widths for up to 100 m for linear infrastructure (i.e. 275 Kv transmission lines) and up to 165 m for turbines will reduce functional connectivity for a number of species (i.e. greater glider (*Petauroides volans*)). Siting of the Development Corridor and Disturbance Footprint has considered the location of threatened fauna species habitat in the landscape and the use of existing disturbed or cleared areas has been maximised.

5.1.3 Fauna Injuries and Mortality

Physical trauma to fauna has the potential to occur during all phases of the Project, however the highest likelihood will be during construction activities that involve vegetation clearing, earthworks and trenching. Fauna may be injured or killed during construction principally through:

- Strike from moving vehicles/machinery – key issue for ground dwelling species, particularly those with poor mobility.
- Entrapment in habitat during removal – key issue during tree felling for species that use tree hollows or hollow logs for roosting and denning.
- Entrapment in trenches/holes – key issue for ground dwelling species (reptiles and small mammals), particularly those that are active at night and cannot detect trenches to avoid.

The species which are most at risk of injuries and mortality are those that are cryptic, difficult to detect (i.e. harder to be observed and moved by spotter-catchers) and/or have poorly developed dispersal mechanisms. Larger species with defined territories and movement patterns (i.e. koala) are less likely to be at risk of direct mortality where appropriate mitigation measures are applied (i.e. spotter-catchers undertaking pre-clearance surveys).

Some mobile species, such as birds, may move away from areas being disturbed and may not be adversely impacted in terms of direct physical trauma unless fauna are nesting or are killed by vehicle strike. However, other species that are less mobile (i.e. ground-dwelling reptile and mammal species, or those that are nocturnal and nest or roost in trees or tree hollows during the day (i.e. arboreal mammals such as gliders), may find it difficult to move away from roosts or active breeding places.

There is the potential for fauna injury or mortality during all phases of the Project through vehicle collision, but particularly when high volumes of vehicle activity occur during the construction phase of the Project. The construction of the Project infrastructure, as well as the general use of access tracks and roads across the Disturbance Footprint will result in increased vehicle movements that may cause injury or death to fauna by vehicle strike. During the operation and maintenance phase, vehicle movements will be dramatically reduced, however some risk of collision does remain. Mammals, reptiles, amphibians and birds are all at risk of vehicle strike, particularly common species (e.g. macropods) that are tolerant of disturbance and/or those species that can utilise roads for movement pathways or as foraging habitat.

In addition, entrapment of wildlife in trenches or other excavations associated with the Project may also cause physical trauma to fauna. For example, open trenches for underground utilities, or other pits are known to be effective at trapping a wide variety of wildlife and often result in mortality. Species most likely to become trapped in pits or other excavations during construction of the Project are ground dwelling species that are capable of moving across modified environments and arboreal species which ascend to the ground to disperse.

Threatened fauna species that are most susceptible to mortality as a result of construction of the Project include greater glider (*Petauroides volans*), koala (*Phascolarctos cinereus*), squatter pigeon (southern) (*Geophaps scripta scripta*) and collared delma (*Delma torquata*). As described above, clearing and construction will be staged so only a subset of the Disturbance Footprint and overall Study Area will be impacted at one time.

Mitigation measures for fauna injury and mortality are presented in **Section 6.3.**

5.1.4 Indirect Impacts

Indirect impacts from the Project construction phase such as noise, light and dust caused by heavy machinery, increased vehicle movement and wind farm construction may impact sensitive fauna species occupying the Study Area.

It is expected that noise from excavation, construction and earthmoving associated with the Project will potentially cause disturbance to all groups of fauna. This may result in the short-term avoidance of the area for the duration of these activities. As alternative habitats are available elsewhere, an overall loss of fauna diversity as a result of construction is considered low, with many, if not all species are likely to resume normal activities. The long-term impacts from construction noise or other indirect impacts are not anticipated to occur.

The loss of vegetation and habitat, as well as the construction activities required to be undertaken to clear vegetation or complete construction, can potentially result in indirect or secondary impacts to the associated fauna and flora values. This includes:

- Increased edge effects reducing the condition of quality of remaining vegetation communities and habitat types.
- The establishment and spread of exotic species that may displace native species, native habitat resources and alter fire regimes.
- Soil exposure resulting in an increased risk of erosion and sedimentation of water bodies, reducing water quality and degrading aquatic habitats.

- Increased risk of contamination associated with activities such as refueling or storage of chemicals.
- Temporary changes in hydrology from installation of infrastructure creating a barrier to surface flow and increasing stormwater run-off.
- Generation of dust emissions leading to excessive deposition of dust on leaves of plants suppressing photosynthesis and growth.
- Increased noise and light levels affecting foraging and breeding behaviour for some fauna species or resulting in complete avoidance and displacement from habitats.
- Periodic burst of elevated noise levels may startle and disorientate fauna species within proximity.
- Although unlikely, increased anthropogenic activity may lead to temporary increased pest levels.

It is important to note that during the construction phase these potential impacts are likely to be short-term and concentrated in specific areas before moving progressively through the Disturbance Footprint. However, it is acknowledged that some of these indirect impacts such as increased edge effects are longer term.

Further information about potential indirect impacts relating to weeds, edge effects, soil erosion and sedimentation and dust are provided in the subsequent sections.

5.1.5 Exacerbation of Pest Fauna and Weeds

The Study Area was found to support introduced fauna including, feral pig, (*Sus scrofa*), feral cat (*Felis catus*), cane toad (*Rhinella marina*), black rat (*Rattus rattus*) and feral horse (*Equus caballus*). These species, left unchecked, may flourish in newly disturbed areas, disperse into higher quality habitat areas and further contribute toward the degradation of fauna habitat within the Study Area. Given the prevalence of these species within the existing landscape, it is unlikely that the proposed works will result in further introductions of feral vertebrate species. However, habitat modification may facilitate larger populations of certain introduced species such as European rabbit (*Oryctolagus cuniculus*) and house mouse (*Mus musculus*) where some native species will not be able to persist as well as movement opportunities for exotic predators (i.e. wild dog (*Canis lupus*) and feral cat (*Felis catus*)). Weed and pest management measures are discussed in **Section 6.3.**

The introduction and/or spread of weeds is an indirect impact that can impact the integrity of remaining vegetation, increase the intensity and/or frequency of fires, as well as threaten the long-term survival of threatened fauna species. Within the Study Area weed species are common within cleared and regrowth vegetation, as well as sporadically throughout the remnant vegetation. The weed species that pose the biggest threat to fauna and associated habitat values are the Category 3 'restricted' species listed under the Biosecurity Act, Weeds of National Significance, as well as high-biomass grass species. High-biomass grass species can out-compete native vegetation as well as reduce the germination of native species. The high biomass of these species also increases the intensity and/or frequency of fires.

5.2 Operational and Maintenance Impacts

Potential impacts to fauna during the operation and maintenance phase include:

- Vehicle strike (Vehicle usage during the operational phase of the Project is expected to be significantly lower than during construction due to the decrease in site personnel).
- Mortality to birds and bats through collision with infrastructure.
- Barotrauma suffered by bats flying in close proximity to turbine blades.
- Barrier effects to avifauna from project infrastructure.

Vegetation clearing is unlikely to be required as part of the operation and maintenance of the Project. The exception to this is areas directly adjacent to certain infrastructure (i.e. substation) and in areas required for use throughout the life of the Project such as access tracks. In these locations, clearing works will predominantly comprise grass slashing and pruning and will be conducted as required for safe access and operation of infrastructure.

5.2.1 Vehicle Strikes

During operation, it is expected that temporary periods of increased vehicle activity, including light vehicles, large trucks and maintenance equipment will occur on the access tracks within the Disturbance Footprint. Although the frequency of vehicle movements during operations is expected to be minor, there is some risk of vehicle strike to fauna species including medium to large mammals, woodland birds which forage on the ground and reptiles. Of the known and potentially occurring species listed under the NC Act, two are considered vulnerable to vehicle strike: koala (*Phascolarctos cinereus*) and squatter pigeon (southern) (*Geophaps scripta scripta*).

5.2.2 Infrastructure Collisions

Certain bird and bat species are known to collide with wind turbine blades, towers, nacelles, guy cable, power lines and meteorological masts resulting in injury or death. The majority of fatalities appear to result from turbine collisions (Grodsky et al. 2011). Drewitt & Langston (2008) identify a range of factors that influence risk of collisions with such infrastructure, including:

- Physical attributes of a wind turbine generator (i.e. turbine dimensions, lighting).
- Species-specific variables (i.e. abundance, flight behaviour, turbine avoidance capacity).
- Biophysical attributes (i.e. landscape position, topography, vegetation type).

Factors falling under the latter two points are often interrelated and generally highly spatially and temporally variable. Proximity to roost locations, migratory flight pathways and wetlands appear to be particularly important factors that influence bird and bat utilisation.

Data from Australia, Europe and North America indicate that the risk of collision is likely to be highest in any given area or landscape where species most susceptible to collision (i.e. migratory species, raptors, swifts, waterbirds, high flying microbats) most frequently occur. The consequence of mortality resulting from collision for any given species is largely influenced by the species' population size and life history traits such as longevity and fecundity which combine to determine a species' capacity to replace individuals lost.

Of the known and potentially occurring threatened species, one species (the white-throated needletail) has been identified as being at very high overall risk of collision-based impacts from the Project due to a high likelihood and high consequence of collisions. Several non-listed microbat species are also at moderate to high overall risk of impacts from the Project due to the probability that they may fly at RSA height, noting the very high level of uncertainty inherently associated with any estimate relating to whether each species rarely, occasionally or regularly flies at RSA height.

A potential secondary impact associated with bird and bat collisions is the increased presence of both native and exotic ground-dwelling predators who may feed on carrion. The increased use of cleared areas by native predators to forage may result in greater levels of direct predation and competition with exotic predators including the feral cat (*Felis catus*) and fox (*Vulpes vulpes*).

5.2.3 Barotrauma

Barotrauma is a phenomenon in which rapid air pressure changes cause tissue damage to air-containing structures, most notably the lungs (Baerwald et al. 2008). Barotrauma can also result in non-lethal injuries such as hearing impairments and other internal injuries that may result in bats succumbing to their injuries at a later time.

There is currently no published information on barotrauma in Australia. One study undertaken in Canada found that 90% of bat fatalities involved internal haemorrhaging consistent with barotrauma, and that collision with turbine blades accounted for about 50% of the fatalities (Baerwald et al. 2008). However, another study found that only 6% of bats collected at a wind farm in Illinois had lesions possibly consistent with barotrauma, leading to the conclusion that traumatic injury (i.e. collisions) is the major cause of bat mortality at wind farms (Rollins et al. 2012).

Due to the difficulty in diagnosing barotrauma unless the carcass is examined immediately after death, it is possible that cases attributed to barotrauma have been confused with traumatic injury associated with direct collisions.

Of the microbat species detected during field surveys, it is considered probable that seven species may fly at RSA, none of which are listed under the NC Act. In the absence of data from RSA height in the Study Area a very high level of uncertainty is inherently associated with any estimate relating to whether each species rarely, occasionally or regularly flies at RSA. However, the risk of barotrauma is relevant to all microbat individuals when flying within RSA.

5.2.4 Barrier Effects

Barrier effects can be caused by wind turbines disrupting links between feeding, roosting and/or nesting areas, or diverting flights (including migratory flights) around a wind farm. Species that pass wind farms frequently on migration appear to be of higher concern than other species (Hötker, Thomsen & Köster 2006). However, these effects on birds, possibly resulting in higher energy consumption or injuries as a result of collision, are not yet well known (Schuster, Bulling & Köppel 2015). There is currently no published information on barrier effects from wind farms in Australia.

5.3 Decommissioning and Rehabilitation Phase

The Project will be decommissioned in accordance with the Decommissioning Management Plan and in compliance with any planning conditions at the time of the decision. This plan follows the current best practice approach for removal of infrastructure including the removal of all above ground structures; the removal of all underground structures to at least 1 m below ground level with structures beneath this level to remain in situ. This approach is considered less environmentally damaging than the complete removal of all above and below ground structures from the Disturbance Footprint. Areas of disturbed land will be reinstated to the original condition prior to the construction of the Project or to the condition just prior to the commencement of the decommissioning activities.

Overall, impacts on threatened fauna values associated with the decommissioning and rehabilitation phase are expected to be minor. However, there is some potential for impacts to occur on threatened fauna species and their habitat in both a direct and indirect capacity. Direct impacts may include:

- Slashing and pruning of recolonised vegetation in specific locations, that may support threatened species habitat.
- Vehicle and other operational equipment strike.

Indirect impacts associated with decommissioning and rehabilitation are expected to be similar (although less severe) to construction phase impacts including:

- Elevated noise and light.
- Soil erosion and sedimentation.
- Edge effects.
- Increased dust generation as a result of increased vehicles and machinery.

6.0 Avoidance, Mitigation and Management

Neoen is committed to ensuring the Project follows the principles of ecologically sustainable development. In planning for and developing the Project, Neoen have implemented the hierarchy of management principles. These principles and the order in which they have been applied is as follows.

1. Avoid: locating activities to avoid direct and indirect impacts on threatened fauna species.
2. Minimise: minimising direct and indirect impacts where they cannot be completely avoided.
3. Mitigate: implementing mitigation and management measures to reduce direct, indirect and cumulative impacts.
4. Remediate and rehabilitate: actively remediate and rehabilitate impacted areas to promote long-term recovery.
5. Offset (where necessary): provide suitable offsets for activities that result in significant residual impacts to MSES even with the implementation of the above principles.

6.1 Avoidance

The avoidance of threatened fauna values has been demonstrated through both selection of the Study Area and the design and siting of the Development Corridor. Revisions to both have occurred throughout the life of the Project as a result of community and landholder consultation, wind resource data, grid connectivity options and an understanding of on-ground constraints.

The Development Corridor size and configuration in particular has undergone several revisions and has been informed by an ecological constraints analysis, which is described in **Section 6.1.1** below.

6.1.1 Ecological Constraint Analysis

The Development Corridor shown within this report has been subject to an ecological constraint analysis. The purpose of the constraint analysis was to determine priority avoidance areas based on the presence (potential and known) of flora and fauna values with varying sensitivity levels and environmental significance. The analysis utilised habitat mapping informed by field validated data and incorporated a traffic light system with values ranging from a very high constraint value to a limited constraint value.

A key initial input in the constraints analysis was the delineation of remnant and regrowth habitat types from non-remnant cleared areas, as well as the identification of suitability for threatened fauna species including the presence of habitat features which may be limited in the environment. Two threatened species considered known or potentially occurring within the Study Area may inhabit select non-remnant areas: the squatter pigeon (southern) (*Geophaps scripta scripta*) and koala (*Phascolarctos cinereus*). However, both these species have broad habitat requirements and are not overly sensitive to disturbance. Non-remnant areas are unlikely to be relied upon for any stage of the species lifecycle. The majority of remaining known or potentially occurring threatened species are highly unlikely to inhabit these areas due to the absence of necessary habitat features and / or ecological functionality.

Siting Project infrastructure within areas that have already been previously cleared allows for threatened fauna values to be largely avoided in these areas. Unnecessary vegetation clearing for some Project elements such as access tracks and laydown areas is also avoided and as the areas affected are already impacted by historical clearing and edge effects, the severity of new habitat fragmentation impacts is minimised.

The main priority fauna value that was considered in the constraints analysis was habitat features considered unique or uncommon in the landscape (e.g. breeding and denning habitat for greater glider (*Petauroides volans*)). This process directed infrastructure towards pre-disturbed areas, avoiding fauna habitat areas to the greatest extent possible.

6.2 Minimise

Where impacts on threatened fauna cannot be avoided, all efforts will be made to minimise Project impacts. Vegetation clearing and the subsequent construction of the Project will occur progressively and in stages. By doing this, only a small subset of the Disturbance Footprint will be impacted at one time. Indirect impacts resulting from the construction of the Project will be localised, short-term, and actively managed as detailed below. Furthermore, clearing extents detailed in **Section 5.1** represent a worst-case scenario.

Since the original development application was submitted for the Project, predicted direct impacts to threatened fauna species across the Study Area have been minimised via a significant redesign of the Project, as described below in **Section 6.2.1**.

Micro-siting of Project infrastructure will also provide opportunities to further minimise direct impacts on fauna values (see **Section 6.2.2** below).

6.2.1 Design Changes

The Project originally proposed the construction, operation and decommissioning of 118 turbine generators and supporting ancillary infrastructure within a Development Corridor covering 1,973.3 ha. Influenced by a range of factors including MNES values, the Project scope and Development Corridor configuration were recently reassessed and adjusted by Neoen. This process resulted in significant changes to the Project including a decrease in the number of turbines (118 to 63) and the Development Corridor size (reduced by >400 ha). A primary benefit of these changes is the minimisation of impacts to threatened species habitat.

6.2.2 Micro-siting

Project infrastructure will be sited within the Development Corridor based on the location of on-ground constraints including habitat for threated fauna species. Additional field surveys specific to terrestrial ecology (as well as other types of constraints) will be conducted prior to construction, including pre-clearance surveys. This data will allow for increased accuracy and detail in mapped terrestrial ecological values within the Development Corridor including threatened fauna habitat values. Ground-truthed ecological field data will strongly influence the final design of the Project, with the avoidance hierarchy principles in place. Future refinement of the Project will seek to avoid threatened species individuals and habitat, particularly species where significant residual impacts may occur.

Infrastructure micro-siting will aim to avoid or further minimise disturbance to:

- Habitat features required by threatened fauna species including hollow bearing trees and stags, trees with diameter at breast height (DBH) >30 cm, large hollow logs and complex boulder piles.
- Breeding habitat for threatened and migratory fauna species.
- Vine thicket communities.
- Riparian zones, including avoiding placement of turbines within 50 m of waterways.

6.3 Mitigate and Manage

Throughout the life of the Project, potential impacts to threatened fauna species and associated habitats will be directly or indirectly managed via Project Management Plans. All mitigation and management measures relevant to threatened fauna species will be captured in one or multiple of the Project Management Plans, listed below:

- Preliminary Construction Environmental Management Plan (CEMP).
- Preliminary Bird and Bat Adaptive Management Plan (BBAMP).
- Preliminary *Cycas megacarpa* Translocation Management Plan (CTMP).
- Offset Area Management Plan (OAMP).
- Preliminary Vegetation Management Plan (VMP).
- Preliminary Fauna Management Plan (FMP).
- Preliminary Weed and Pest Management Plan.
- Preliminary Rehabilitation Management Plan.
- Preliminary Bushfire Management Plan.

Most of the Project Management Plans above are required to support Project approvals under both Commonwealth and State legislation. As such, it is noted that they may include requirements specific to either legislative framework.

6.3.1 General Management Measures

All measures captured in this section will be documented in an appropriate Project management plan, which will also include objectives relevant to the theme, timing details and specific metrics to measure progress relative to the objectives. Measures are listed under their associated themes below.

6.3.1.1 Fauna

Project mitigation and management measures related to fauna include:

- A qualified fauna spotter will be present at all times during clearing.
- A qualified fauna spotter will be present at all times during clearing and pre-clearance surveys. The fauna-spotter will inspect habitat features (including but not limited to: hollowing-bearing trees and stags, caves and rocky boulder piles) for MNES prior to felling, using work platforms, inspection cameras or other methods deemed safe and suitable. Fauna spotters will also be present during earthworks where exposed trenches and holes will be left for periods greater than 24 hours
- In areas of threatened fauna habitat planned to be cleared, qualified spotter-catchers will scout the area immediately prior to the commencement of disturbance for the presence of habitat trees and other features (i.e. coarse woody debris, hollow logs, large stones and boulder piles), as well as listed species. This will include an inspection of terrestrial habitat features (hollows, potential dens, surface rocks and fallen logs) prior to disturbance using work platforms, inspection cameras, or other methods deemed safe and suitable. Habitat features/trees will be marked using appropriate paint or flagging tape. Located fauna (excluding koalas, see **Section 6.3.2**) will be moved to a nearby and suitable undisturbed location by the spotter-catcher.
- Exclusion zones will be established around identified active and potentially active breeding places, such as nests, burrows, dens etc. Where there is the potential an active breeding place will be tampered with, this will only be done in accordance with an approved and appropriate (low or high risk) DES Species Management Program (SMP) as per the Nature Conservation (Animals) Regulation 2020.
- Micro-siting of Project infrastructure will aim to retain habitat trees (including hollow-bearing trees or stags, trees with DBH >30 cm, and trees containing potential animal breeding places) and terrestrial habitat features (including complex boulder piles, hollow logs). Habitat trees and features that can be avoided will be demarcated. If construction is planned to occur in proximity to a habitat tree/s to be retained, a tree protection zone (TPZ) may be established if deemed necessary by the spotter-catcher. The TPZ will be calculated using Australian Standard (AS) 4970-2009.
- Where they cannot be retained, hollow bearing trees and stags will be 'slow felled' to minimise the chances of injury or death and will be inspected after felling by a qualified fauna spotter to confirm no injured wildlife are present.
- Where they cannot be retained in situ, habitat features (i.e. ground timber including hollow logs, large stones and boulders) will be relocated to adjacent areas of suitable habitat if safe and practical (i.e. the relocation of habitat features must not cause unnecessary disturbance)
- Movement within the Study Area will be via approved access tracks only with speed limits enforced. The requirement to enter and traverse the Study Area will be minimised and limited to those required for essential Project activities.
- Night works within or adjacent to areas of threatened fauna habitat will be avoided where possible to reduce impacts from construction light and noise on threatened fauna species (i.e., by interrupting male koala mating calls during breeding season). Where night works are required, lights will be directed to minimise light spill into adjacent habitats and the use of alternative, low-noise construction equipment considered.

- Fauna exclusion fencing will be installed around infrastructure that may pose a hazard such as the substation and laydown areas. Elsewhere, fencing will only be installed as required and will be 'fauna-friendly' (i.e. not barbed wire).
- Any open excavations will be checked for trapped fauna in the morning and at the end of the day by a suitably qualified spotter-catcher. Trench ladders, ramps, sticks, ropes and moist hessian sacks at regular intervals (or similar) will be utilised where trenches or excavations are anticipated to remain open for extended periods. This will help trapped fauna escape and/or survive until removed by a fauna spotter-catcher.

6.3.1.2 Weeds and Pests

A number of mitigation and management measures have been developed to minimise the proliferation and/or introduction of introduced weeds and pests. These measures will be implemented via several Project management plans, but primarily the Weed and Pest Management Plan.

Measures outlined in the Weed and Pest Management Plan will be relevant to the Disturbance Footprint with a 5 m buffer either side to account for potential GPS inaccuracies. The following points outline the management objectives of the plan:

- Maintain (or improve) the condition of retained habitat compared against baseline condition in terms of disturbance from weeds and pests.
- No introduction or proliferation of invasive weed species or pest fauna species.
- Successful removal invasive weeds for all areas subject to disturbance.

Table 6.1 below outlines the overarching performance criteria and management actions which will be implemented to minimise the risk of introduction or proliferation of weeds/pests throughout the Project. The timing, monitoring and reporting requirements will be detailed in the final Weed and Pest Management Plan, which will be developed and approved prior to construction.

Table 6.1 Weed and Pest Management Measures for the Disturbance Footprint (plus a 5 m buffer)

Project Phase	Indicative Performance Criteria	Management Actions	Timing	Monitoring Activity
Pre-construction	Pest species presence and abundance identified within relevant Project areas	• Pre-clearance surveys will be undertaken within the applicable areas to record the presence and abundance of pest fauna. • Baseline conditions will need to be established prior to construction such that impacts from the Project can be monitored throughout the Project lifecycle.	0–6 months prior to site disturbance during suitable seasonal conditions	Pre-clearance survey report Baseline condition assessment
	Invasive weed species presence and abundance identified within relevant Project areas	• Pre-clearance surveys will be undertaken within the applicable areas to record the presence and abundance of introduced flora and those classified as Category 3 Restricted Matters and/or WoNS or species defined as weeds in the Preliminary Vegetation Management Plan. • Baseline conditions will need to be established prior to construction such that impacts from the Project can be monitored throughout the Project lifecycle.		Pre-clearance survey report Baseline condition assessment
	Successful removal of invasive weeds within all Project areas subject to disturbance	• Areas containing infestations will be treated prior to the commencement of site disturbance and any construction activities. Refer to Appendix A of the Vegetation Management Plan for species specific control methods. Chemical treatment adjacent to sensitive areas should be avoided, where possible. If chemical treatment is required, spot spraying methods will be undertaken.		Pre-clearance survey report
Construction, operation and maintenance, decommissioning and rehabilitation	No increase in pest fauna presence and abundance within the applicable areas	• Implement a species-specific control program for pest fauna in consultation with landowner(s). This is only to be implemented if incidence of any feral species has increased during construction or operation as reasonably attributable to the Project. The species-specific control program will be detailed in the Weed and Pest Management Plan.	Throughout construction, operation and maintenance, decommissioning and rehabilitation	Construction audits (monthly) Compliance audits (annually for life of the Project approval)

Project Phase	Indicative Performance Criteria	Management Actions	Timing	Monitoring Activity
		• Avoid inclusion of any water retaining voids or pits in the design where these are not otherwise required for the control of stormwater run-off erosion and sediment control measures or dams required to supply water for construction activities. Where pits and voids are required, include appropriate cover to prevent extended water retention and subsequent breeding opportunities for cane toads • For pits and voids where long-term presence of retained water is reasonably anticipated and covering is not practicable, fencing to exclude access by cane toads will be incorporated in the design. Sediment fencing, free standing or attached to the base of other fencing material has proven to be effective • Wash down and laydown areas will be designed to include cane toad traps where exclusion from areas of potential water retention is not practicable and where cane toad activity is locally detected • No alteration, or refuse left exposed, which will specifically assist breeding opportunities for cane toad, red fox, feral cat, dog, house mouse or rat on site • To reduce the presence of pest fauna on site, all food scaps must be placed into designated waste bins, and their lids securely closed • Train workforce in the identification of pest fauna species present in the area.		

6.3.2 Species Specific Measures

Mitigation and management measures specific to the known and potentially occurring threatened fauna species and the short-beaked echidna (*Tachyglossus aculeatus*) within the Study Area are detailed in **Table 6.2** below. Greater consideration has been given to threatened species that may be particularly sensitive to potential Project impacts including the endangered greater glider (*Petauroides volans*) and koala (*Phascolarctos cinereus*).

Sections 6.3.3 provides detail regarding the Preliminary BBAMP, which largely includes measures relevant to potential operational impacts on threatened birds and bats, as well as migratory birds.

Table 6.2 Threatened Species Specific Management Measures

Fauna Species	Measures
glossy black-cockatoo (*Calyptorhynchus lathami*)	• Any active breeding places will be managed under an approved DES High Risk SMP. • As detailed in the Preliminary BBAMP, a single glossy black-cockatoo (*Calyptorhynchus lathami*) death will be a reportable incident to DES/DCCEEW and trigger further investigation with regard to causation. Dependent on the outcome of the investigation, the overall collision risk determination for the species may be revised. • Other operational measures relevant to glossy black-cockatoo (*Calyptorhynchus lathami*) are detailed in the Preliminary BBAMP.
greater glider (southern and central)(*Petauroides volans*)	• Where clearing is proposed for areas of greater glider breeding and denning habitat, pre-clearance surveys must include canopy searches and inspections of suitably sized hollows (>8 cm diameter). • Every effort will be made to retain suitable hollow bearing trees (those containing hollows >8 cm diameter) within areas identified as breeding and denning habitat including *Eucalyptus moluccana* woodlands. The retention of trees >30 cm DBH on patch edges will be prioritised next in areas of potential greater glider habitat. Trees to be retained within the Disturbance Footprint must be clearly demarcated and avoided. If deemed necessary, a TPZ may be established. • Glider poles are proposed to be installed at 12 locations within the Disturbance Footprint to provide movement opportunities between areas of suitable habitat in the landscape. The proposed glider pole locations represent areas important for dispersal and where ongoing connectivity is required to avoid isolation of patches and retention of possible high use areas (i.e. riparian corridors). Glider pole locations will be finalised during the detailed design phase of the Project. • Five 'pinch points' are proposed within the Disturbance Footprint associated with areas of greater glider modelled habitat to maintain movement opportunities and minimise fragmentation impacts on the species. Pinch points describe locations of the Disturbance Footprint which are reduced in width to the extent that individuals can easily disperse across (i.e., based on usual volplane distances, the clearing will have a width no greater than 1.2 times the average canopy height at that location). Pinch points locations will be finalised during the detailed design phase of the Project. • In areas of habitat where greater gliders are known to occur (i.e. the far northern Study Area), cleared suitable hollows (>8 cm diameter) will be replaced at a 1:2 ratio with a suitable nest box, to be installed in adjacent suitable habitat (i.e. two nest boxes for every hollow removed). A nest box is considered suitable if it is a design known to be used by the greater glider. • In the unlikely event that a greater glider (southern and central) is killed as a result of Project activities, DES/DCCEEW will be notified within a maximum period of 2 business days.

Fauna Species	Measures
squatter pigeon (southern) (*Geophaps scripta scripta*)	• Where clearing is proposed for areas of squatter pigeon (southern) breeding, foraging or dispersal habitat, pre-clearance surveys must include flushing to encourage the movement of individuals out of the clearing area. • As squatter pigeon (southern) nests on the ground and is at high risk of direct mortality, nests should be identified and clearly demarcated by a spotter-catcher during pre-clearance surveys. If the spotter-catcher determines a nest to be active, it will be managed in accordance with an approved High-risk SMP. • To reduce vehicle or plant collision or crushing of nests, all vehicles and pedestrians will remain within designated access tracks in squatter pigeon breeding habitat. • To minimise the chances of a collision, in known squatter pigeon (southern) occurrence areas speed limits (in private areas) will be reduced to 40 km/hr or less and signage will be installed that indicates subspecies' presence. • The construction contractor will not conduct water extraction activities at any location that provide suitable resources for squatter pigeon (southern) (i.e. suitable watercourses and reservoirs) • As outlined in the Preliminary BBAMP, a single squatter pigeon (southern) death will be a reportable incident to DES/DCCEEW and trigger further investigation with regard to causation. Dependent on the outcome of the investigation, the overall collision risk determination for the species may be revised. • Other operational measures relevant to squatter pigeon (southern) are detailed in the Preliminary BBAMP.
white-throated needletail (*Hirundapus caudacutus*)	• As detailed in the Preliminary BBAMP the single death of a white-throated needletail will be a reportable incident to DES/DCCEEW and trigger further investigation with regard to causation. Dependent on the outcome of the investigation, the overall collision risk determination for the species may be revised. • Other operational measures relevant to this species are detailed in the Preliminary BBAMP.
collared delma (*Delma torquata*)	• Micro-siting of Project infrastructure will aim to retain terrestrial habitat features including large stones, boulders and coarse woody debris. Habitat features that can be avoided will be demarcated. Where they cannot be retained in situ, features will be relocated to adjacent areas of suitable habitat if safe and practical (i.e., the relocation of habitat features must not cause unnecessary disturbance). • Where clearing is proposed for areas of potential collared delma habitat, pre-clearance surveys must include active searches targeting areas with common surface rocks. Should an individual or eggs of the species be located, the pre-clearance survey constraints protocol (see **Section 6.3.4**) will be enacted to ensure any potential impacts on the species are avoided or managed appropriately. In the unlikely event that a collared delma is killed as a result of Project activities, DES/DCCEEW will be notified within a maximum period of 2 business days.

koala (*Phascolarctos cinereus*)	• Pre-clearance surveys will include canopy searches for koalas. If a koala is located during pre-clearance surveys or during clearing activities:
	  ○ the individual must not be forcibly relocated
	  ○ any tree which houses a koala as well as any tree with a crown that overlaps that tree will not be cleared until the koala vacates the tree on its own volition

Fauna Species	Measures
	○ allow a clearing buffer surrounding the tree, equal to the height of the tree or deemed suitable by the fauna spotter-catcher ○ any injured koala (and fauna in general) should be transported to a vet or recognised wildlife carer ○ requirements for koalas subject to handling to be examined and if suspected of Chlamydia infection will be taken to a predesignated veterinarian/wildlife care facility for treatment prior to release. • Clearing must be carried out in a way that ensures any koala present have time to move out of the clearing site without human intervention. • In the unlikely event that a koala is killed as a result of Project activities, DES/DCCEEW will be notified within a maximum period of 2 business days.
short-beaked echidna (*Tachyglossus aculeatus*)	• Pre-clearance surveys will include on-ground searches for short-beaked echidna. If an echidna is located during pre-clearance surveys or during clearing activities: ○ the individual will be relocated to a nearby area of suitable habitat ○ any injured echidna should be transported to a vet or recognised wildlife carer.

6.3.3 Bird and Bat Adaptive Management Plan

Monitoring and management actions relating to threatened birds and bats will be undertaken in accordance with a pre-approved BBAMP. The strategy of the BBAMP is to monitor and mitigate the potential impacts of turbine strike on birds and bats via trigger based, adaptive management.
The implementation of a trigger will be the primary mechanism for monitoring and managing impacts on the white-throated needletail.

Pre- and post-commissioning monitoring of bird and bat activity (including flight behaviours) is a key requirement of the plan. The monitoring will inform a risk profile for each turbine. This strategy leads to direct and tailored management actions, applied at the appropriate locations and times.

6.3.4 Pre-clearance Survey Constraint Protocol

This section defines an adaptive management response which is to be engaged if a collared delma (*Delma torquata*) is encountered during pre-clearance surveys or any other surveys undertaken prior to construction. Excluding potentially occurring threatened flora species, this species is the focus of the protocol as it is highly sensitive to disturbance, reported to potentially be sedentary and restricted to very small areas of suitable habitat (Department of the Environment, Water, Heritage and the Arts, 2008). Remaining conservation significant fauna species are generally highly mobile and therefore able to temporarily relocate, or have broad habitat preferences making them less sensitive to disturbance.

The trigger to undertake the pre-clearance surveys constraint protocol is the observation of one or more individual collared delma (*Delma torquata*) within the Disturbance Footprint during future surveys or construction. If either are to be found, the constraints protocol below will then be followed.

STEP 1: Halt construction/clearing activities in the area (i.e. adjacent areas within the Disturbance Footprint where suitable habitat is present – to be determined by a suitably qualified ecologist).

STEP 2: Undertake investigation into potential impacts on the species. This should include:

- Updating of habitat mapping.
- Updating of Significant Impact Assessment.
- Determination of avoidance and mitigation strategies.

STEP 3: Communicate outcomes with DCCEEW and DES as appropriate to determine next steps.

It is noted that the above process is focused towards Commonwealth requirements. This is due to the fact that Commonwealth offset requirements have stricter delivery requirements (i.e. must be land based) and require additional time to acquire and seek approval for. As the species is also protected under State legislation, any potential impacts on the species will also be communicated with DES.

6.4 Rehabilitate

The Disturbance Footprint includes a number of linear sections associated with access tracks and supporting ancillary infrastructure such as communication and power cable lines. Linear sections of the Disturbance Footprint vary in width but in some locations span approximately 100 m; these widths have been deemed necessary for the safe transport and installation of turbine infrastructure. Excluding established access tracks and fire safety Asset Protection Zones, which at all times will need to remain free of vegetation, previously cleared areas will be reclaimed and rehabilitated. Further to this, all areas of temporary ancillary infrastructure will also be subject to rehabilitation efforts including:

- Laydown areas.
- Concrete batching plants.
- Construction compound.
- Temporary workers accommodation camp.

With current design details, it is estimated approximately 20% of the total Disturbance Footprint (i.e. the area that will be cleared for the Project) may be able to be rehabilitated following construction. This equates to approximately 180 ha of native vegetation being rehabilitated.

Rehabilitation will include the planting of native species known to the region, consistent with the characteristics of surrounding retained vegetation. In locations where the integrity of infrastructure will not be compromised, opportunities to create supplementary habitat for threatened species such as the greater glider (*Petauroides volans*), koala (*Phascolarctos cinereus*) and squatter pigeon (southern) (*Geophaps scripta scripta*) will be investigated. For example, in addition to native grasses and shrubs which will provide ground cover for dispersing koalas and squatter pigeons (southern), trees likely to form hollows in the future will also be planted as appropriate (e.g. *Corymbia citriodora* or *Eucalyptus moluccana*).

7.0 Environmental Offset Requirements

Where a Project is deemed to have a significant residual impact (SRI) on a Matter of State Environmental Significance (MSES), an environmental offset is required in accordance with the *Environmental Offsets Act 2014*. Environmental offsets can take various forms, including financial settlement offsets, proponent driven offsets or a combination of the two.

MSES within the Disturbance Footprint relevant to fauna include:

- Protected wildlife habitat, comprising NC Act listed, threatened fauna and special least concern animals known to occur or deemed a high or moderate likelihood of occurrence.
- Connectivity areas.
- Waterways for waterway barrier works.

Potential impacts on the above MSES (excluding waterways for waterway barrier works) have been assessed against the SRI guidelines. Although potential direct impacts may occur to 'at risk' waterways for barrier works as a result of the Project, works will preferentially be designed and constructed in accordance with the relevant accepted development requirements and would therefore not require a development approval. As such, this MSES has not been further assessed. If necessary, a full SRI assessment for impacts to waterways for waterway barrier works may be completed during the detailed design of the Project.

Potential impacts on the relevant MSES above were assessed against SRI guidelines (**Appendix E**) and are discussed below.

7.1.1 Significant Residual Impact Assessment

The assessment of impacts on MSES concluded that the Project will result in an SRI on MSES, namely protected wildlife habitat for greater glider (southern and central).

Based on the findings above and under the provisions of the *Environmental Offsets Act 2014* an environmental offset will be required for the Project. The requirement for an offset, size (area) and offset pathway will be determined following the completion of final design and as part of further pre-clearance surveys for the Project.

8.0 Conclusion

This report has outlined the findings of the terrestrial fauna assessment for the Project. Terrestrial fauna values have been identified via desktop review and field assessments conducted across a three-year period. Key findings of the terrestrial fauna assessment include:

- A total of 211 fauna species from 156 genera were also identified during the field survey program, comprising 148 birds, 37 mammals, 19 reptiles and 7 amphibians. This includes:
    - Threatened fauna species listed under the NC Act confirmed during field surveys:
        - Glossy black-cockatoo (*Calyptorhynchus lathami*) (Vulnerable under NC Act).
        - Greater glider (southern and central) (*Petauroides volans*) (Endangered under EPBC Act and NC Act).
        - Yellow-bellied glider (south-eastern (*Petaurus australis australis*) (Vulnerable under EPBC Act and NC Act).
        - Squatter pigeon (southern) (*Geophaps scripta scripta*) (Vulnerable under EPBC Act and NC Act).
        - White-throated needletail (*Hirundapus caudacutus*) (Vulnerable under NC Act and Vulnerable/Migratory under EPBC Act).
    - Migratory fauna confirmed during the field survey included:
        - Rufous fantail (*Rhipidura rufifrons*) (Special Least Concern under the NC Act).
        - Spectacled monarch (*Symposiarchus trivirgatus*) (Special Least Concern under the NC Act).
- Six broad habitat types were defined, comprising habitat for threatened fauna species above.
- The bird and bat utilisation study concluded that the white-throated needletail has a Very High overall collision risk ranking, whereas all other identified, at-risk birds have a Moderate or Minor collision risk ranking. Microbat species vary in risk from Moderate to High.
- MSES include protected wildlife habitat and connectivity.

Having regard to the above, the potential impacts and mitigation measures associated with the Project were presented. The assessment identifies numerous sources of potential impact, with the greatest risk to terrestrial fauna occurring during the construction phase, due of habitat loss. Other potential impacts include wind turbine collision-based impacts, exacerbation of biosecurity risks and disturbance from indirect impacts such as noise, light and dust.

The Project has employed avoidance controls as part of the existing Development Corridor design and will continue to consider ecological constraints as the clearing footprint is further refined. Where avoidance is not possible, the Project will be governed by a CEMP, FMP and a BBAMP. These management plans will outline procedures to limit and reduce impacts on fauna, as well as define the operational response as it relates to bird and bat risk/mortality.

With consideration of Project mitigation measures and that the final clearing footprint will be considerably smaller than the Development Corridor, an SRI assessment was conducted for MSES (excluding the yellow-bellied glider (south-eastern) given its' listing date was after the development application was properly made to the State Assessment and Referral Agency on 6 October 2021). The assessment identified that the Project will have a SRI on greater glider (southern and central). This impact will require offsets under the *Environmental Offset Act 2014*. The requirement for an offset, size (area) and offset pathway will be determined following the completion of final design and as part of further pre-clearance surveys for the Project.

9.0 References

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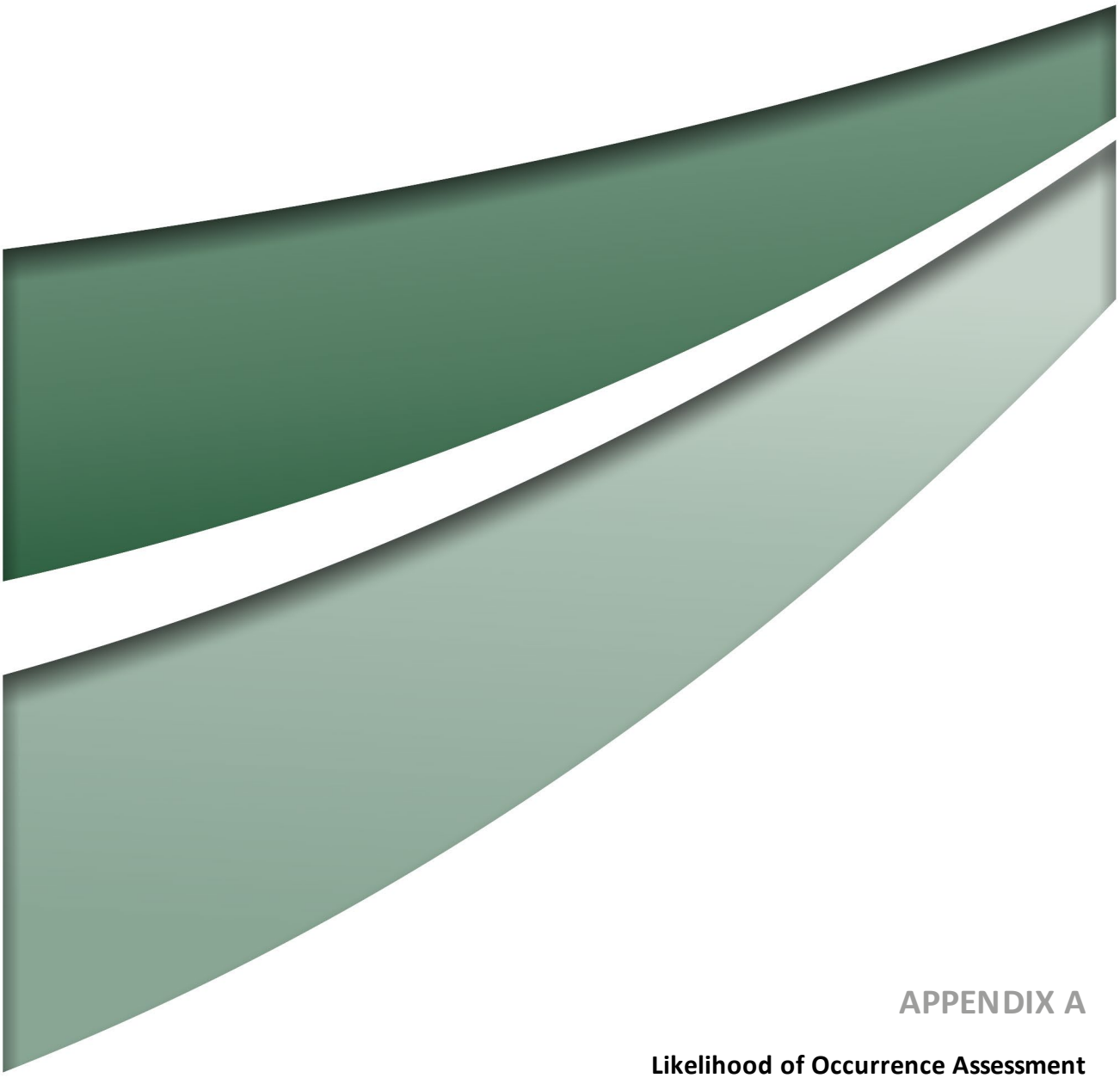


APPENDIX A

Likelihood of Occurrence Assessment

Table A1 Likelihood of Occurrence Assessment

Scientific Name	Common Name	EPBC Act Status	NC Act Status	Preferred Habitat	Likelihood of Occurrence
Threatened Species					
Birds					
Calidris ferruginea	curlew sandpiper	Critically Endangered, Migratory	Endangered	The species mainly occurs on intertidal mudflats in sheltered coastal areas such as estuaries, bays, inlets and lagoons, and around non-tidal swamps, lakes and lagoons near the coast, and ponds in saltworks and sewage farms. They are also recorded less often inland, including around ephemeral and permanent lakes, dams, waterholes and bore drains, usually with bare edges of mud or sand, occurring in both fresh and brackish waters.	**Unlikely** – No proximal records for this species exist, and the inland location of the Study Area is unlikely to provide suitable habitat.
Calyptorhynchus lathami	glossy black-cockatoo	-	Vulnerable	Prefers habitat dominated by *Allocasuarina*, or open sclerophyll forests and woodlands with a stratum of *Allocasuarina* beneath a canopy of myrtaceous species. They are known to feed in belah (*Casuarina cristata*) and bull oak (*Allocasuarina luehmannii*) forests. This species feeds almost exclusively on *Casuarina* and *Allocasuarina* seeds. Requires tree hollows, usually mature *Eucalyptus* for breeding.	**Known –** This species was recorded in *Allocasuarina torulosa* adjacent to the Study Area boundary in the north and observed once in-flight during vantage point surveys in the central east portion of the Study Area.
Charadrius leschenaultia	greater sand plover	Vulnerable, Migratory	Vulnerable	The species is almost entirely coastal, inhabiting littoral and estuarine habitats. They mainly occur on sheltered sandy, shelly or muddy beaches, large intertidal mudflats, sandbanks, salt-marshes, estuaries, coral reefs, rocky islands rock platforms, tidal lagoons and dunes near the coast.	**Low** – Suitable habitat does not occur within the Study Area. Records for this species occur within the wider Project region though are further east towards the coast.

Scientific Name	Common Name	EPBC Act Status	NC Act Status	Preferred Habitat	Likelihood of Occurrence
Cyclopsitta diophthalma coxeni	Coxen's fig-parrot	Endangered	Endangered	The species occurs in rainforest habitats including subtropical, dry, littoral and vine forest types. Within these habitats, the species is likely to favour alluvial areas that support figs and other trees with fleshy fruits. The species has also been recorded in sub-littoral mixed scrub; corridors of riparian vegetation in woodland, open woodland or other types of cleared habitat; and isolated stands of fig or other trees on urban, agricultural or cleared land.	**Low** – The Study Area is located north of the historic range of the species. The Study Area may provide suitable habitat within vine forest and riparian woodland habitats.
Epthianura crocea macgregor	yellow chat (Dawson)	Critically Endangered	Endangered	The species is restricted to coastal areas of central Queensland (Qld), known to occur in breeding populations on the Torilla Plain and Fitzroy River Delta. The species inhabits marine plain wetlands that are subject to extensive seasonal inundation and varying degrees of both fresh and saltwater (tidal) influence.	**Low** – Suitable marine plain and wetland habitat does not occur within the Study Area. Records for this species occur within the wider Project region though are further east towards the coast.
Erythrotriorchis radiatus	red goshawk	Vulnerable	Endangered	The species occurs in coastal and sub-coastal tall open forests and woodlands, preferring areas with a mosaic of vegetation types, permanent water and abundant small birds. Associated with gorge and escarpment country in partially cleared country in eastern Qld. In eastern Australia, populations seem to move from inland nest sites to coastal plains in winter, thus occupying home ranges of 50-220 km^2.	**Low** – No recent records for this species exist in the region and the species is thought to be locally extinct. The Study Area may provide habitat within remnant eucalypt woodland associated with permanent water sources.
Falco hypoleucos	grey falcon	Vulnerable	Vulnerable	Occupies woodlands, shrublands, and grasslands of arid to semi-arid landscapes often in association with watercourses. Occasionally found in coastal woodlands. Uses nests of other birds of prey usually in tall eucalypts near water.	**Low –** Records of this species are rare within the Project region as this species rarely occupies coastal woodland. Limited habitat for this species exists within the Study Area.

Scientific Name	Common Name	EPBC Act Status	NC Act Status	Preferred Habitat	Likelihood of Occurrence
Geophaps scripta scripta	squatter pigeon (southern)	Vulnerable	Vulnerable	The species occurs in open, dry woodland with a grassy understorey in proximity to permanent water. Prefers areas of sandy soil with sparser cover of low grasses; and less common on heavier soils with dense grass cover.	**Known** – This species was recorded frequently on site, commonly along tracks in proximity to water sources.
Grantiella picta	painted honeyeater	Vulnerable	Vulnerable	The species inhabits mistletoes in eucalypt forests/woodlands, riparian woodlands of black box (*Eucalyptus largiflorens*) and river red gum (*E. camaldulensis*), box-ironbark-yellow gum woodlands, *Acacia*-dominated woodlands, *Melaleuca*, *Casuarina* or *Callitris* woodlands, and trees on farmland or in gardens. The species prefers woodlands which contain a higher number of mature trees, as these host more mistletoes.	**Low** – Some suitable habitat for this species may exist within eucalypt woodland in the Study Area, however, there are no records proximal to the Project.
Hirundapus caudacutus	white-throated needletail	Vulnerable, Migratory	Vulnerable	The species is found across a range of habitats, more often over wooded areas, where it is almost exclusively aerial, though it roosts in tree hollows and the foliage canopy. It forages for insects aerially, flying anywhere between "cloud level" and "ground level", often forming mixed feeding flocks with other species. The species roosts in tall trees at night, mainly in forests.	**Known** – This species was recorded commonly during field surveys, often flocking in high numbers above ridges and peaks within the Study Area.
Neochmia ruficauda ruficauda	star finch (eastern, southern)	Endangered	Endangered	The species inhabits tall grass and reed beds associated with swamps and watercourses. It may also be found in grassy woodlands, open forests and mangroves. The condition of preferred habitat varies according to season, grazing pressure and fire.	**Unlikely** – No proximal records for this species exist, and the Study Area is unlikely to provide suitable habitat.

Scientific Name	Common Name	EPBC Act Status	NC Act Status	Preferred Habitat	Likelihood of Occurrence
Numenius madagascariensis	eastern curlew	Critically Endangered / MIgratory	Endangered	The species occurs in sheltered coasts, especially estuaries, bays, harbours, inlets and coastal lagoons, with large intertidal mudflats or sandflats, often with beds of seagrass. The species occurs on ocean beaches (often near estuaries), and coral reefs, rock platforms, or rocky islets. They are often recorded among saltmarsh and on mudflats fringed by mangroves, sometimes within the mangroves. They are also found in coastal saltworks and sewage farms.	**Unlikely** – No proximal records for this species exist, and the inland location of the Study Area is unlikely to provide suitable habitat.
Poephila cincta cincta	southern black-throated finch	Endangered	Endangered	The species inhabits grassy, open woodlands and forests, typically dominated by *Eucalyptus* spp. including narrow-leaved ironbark (*E. crebra*), river red gum (*E. camaldulensis*) and silver-leaved ironbark (*E. melanophloia*), *Corymbia* spp. and *Melaleuca* spp, and occasionally in tussock grasslands or other habitats often along or near watercourses, or in the vicinity of water.	**Low –** This location of the Study Area is outside of this species current known distribution. Some available tussock grasslands may be present but it is unlikely that they would exist in a large enough patch to support this species.
Rostratula australis	Australian painted-snipe	Endangered	Vulnerable	The species occurs in shallow freshwater wetlands or saltmarshes, including inundated grasslands, dams and bore drains, generally with good cover of grasses or low scrub.	**Low** – Suitable habitat for this species is unlikely to occur within the Study Area. Records for this species occur within the wider Project region but are found on low lying marsh and swamp land which is not present within the Study Area.

Scientific Name	Common Name	EPBC Act Status	NC Act Status	Preferred Habitat	Likelihood of Occurrence
Stagonopleura guttata	diamond firetail	Vulnerable	Vulnerable	This species is distributed from south-east Queensland to Eyre peninsula, South Australia and to approximately 300 km inland from coastal regions. The species utilizes eucalypt, acacia and casuarina woodlands, open forests and other lightly timbered environments. The species prefers habitat with a low tree density, few large logs, low litter cover and high grass cover for foraging, roosting and breeding.	**Low –** Some suitable habitat for this species may exist within eucalypt woodlands within the Study Area, however, there are no records proximal to the Project.
Turnix melanogaster	black-breasted button-quail	Vulnerable	Vulnerable	The species is restricted to rainforests and forests, mostly in areas with 770-1200 mm rainfall per annum. They prefer drier low closed forests, particularly semi-evergreen vine thicket, low microphyll vine forest, araucarian microphyll vine forest and araucarian notophyll vine forest. They may also be found in low, dense acacia thickets and, in littoral areas, in vegetation behind sand dunes.	**Low** – Some suitable habitat for this species may exist within vine forest in the Study Area, however, there are no records proximal to the Project.
Mammals					
Chalinolobus dwyer	large-eared pied bat	Vulnerable	Vulnerable	In south-east Qld, the species has primarily been recorded from higher altitude moist tall open forest adjacent to rainforest. Most records are from canopied habitat, although narrow connecting riparian strips in otherwise cleared habitat are sometimes quite heavily used. Rainforest and moist eucalypt forest habitats on rhyolite, trachyte and basalt at high elevation are important roosting habitat for the species.	**Low** – Some suitable habitat for this species may exist within vine forest in the Study Area, however, there are no records proximal to the Project.

Scientific Name	Common Name	EPBC Act Status	NC Act Status	Preferred Habitat	Likelihood of Occurrence
Dasyurus hallucatus	northern quoll	Endangered	-	The species occupies a diversity of habitats including rocky areas, eucalypt forest and woodlands, rainforests, sandy lowlands and beaches, shrubland, grasslands and desert. The species is also known to occupy non-rocky lowland habitats such as beach scrub communities in central Qld. The species generally encompasses some form of rocky area for denning purposes, with surrounding vegetated habitats used for foraging and dispersal. Rocky habitats are usually of high relief, often rugged and dissected.	**Known –** This species was recorded twice on camera traps in the central-east portion Study Area from riparian *Melaleuca* woodland adjacent to remnant eucalypt woodland.
Macroderma gigas	ghost bat	Vulnerable	Endangered	The species occurs throughout a wide range of habitats from rainforest, monsoon and vine scrub to open woodlands in arid areas. These habitats are used for foraging, while roost habitat is more specific. Ghost bats move between a number of roosts seasonally or as dictated by weather conditions and/or foraging opportunities, as such they require a range of roost sites. Roost sites can include caves, rock crevices and disused mine adits.	**Low** – The species is known historically from the wider region, however, fauna habitat surveys completed during the field survey did not identify any suitable caves for this species within the Study Area. Habitat assessments completed during the field survey program did not identify any suitable roosting habitat including caves or abandoned mines. However, habitat within the Study Area may be suitable for foraging and dispersal.

Scientific Name	Common Name	EPBC Act Status	NC Act Status	Preferred Habitat	Likelihood of Occurrence
Nyctophilus corbeni	Corben's long-eared bat	Vulnerable	Vulnerable	The species inhabits a range of inland dry forest habitats including river red gum (*Eucalyptus camaldulensis*), mallee, brigalow (*Acacia harpophylla*) and other arid and semi-arid habitats; in southern Qld it is more common in box, ironbark and cypress pine forests on sandy soils. The species is most abundant in vegetation with a distinct canopy and a dense, cluttered shrub layer, and in large, continuous remnants. Roosts solitarily in tree hollows, crevices, and under loose bark (particularly on dead bull oak (*Allocasuarina luehmannii*) or belah (*Casuarina cristata*).	**Unlikely** – Suitable habitat is not present within the Study Area, and the Study Area is located north of the known range of the species.
Petauroides volans	greater glider (southern and central)	Endangered	Endangered	The species is largely restricted to eucalypt forests and woodlands; it is typically found in highest abundance in taller, montane, moist eucalypt forests with relatively old trees and abundant hollows.	**Known –** This species was recorded within gum-topped box (*Eucalyptus moluccana*) woodland during spotlight surveys within the Study Area.
Petaurus australis australis	yellow-bellied glider (south-eastern)	Vulnerable	Vulnerable	The species occurs in eucalypt-dominated woodlands and forests, including both wet and dry sclerophyll forests. Abundance is highly dependent on habitat suitability, which is in turn determined by forest age and floristics. The subspecies shows a preference for large patches of mature old growth forest that provide suitable trees for foraging and shelter.	**Known** – Species was recorded on four occasions during the field survey program while completing spotlighting surveys in *Eucalyptus moluccana* woodlands in the north of the Study Area.

Scientific Name	Common Name	EPBC Act Status	NC Act Status	Preferred Habitat	Likelihood of Occurrence
Phascolarctos cinereus	koala (combined populations of Qld, NSW and the ACT)	Vulnerable	Vulnerable	The species inhabits a range of temperate, sub-tropical and tropical forest, woodland and semi-arid communities dominated by eucalypt species. The species is limited by habitat (restricted to below 800 m above sea level (asl)), temperature and, at the western and northern ends of the range, leaf moisture.	**Moderate** – The species is known from the wider region, albeit in low densities. The extensive eucalypt woodlands and forests within the Study Area may provide suitable habitat for the species.
Potorous tridactylus tridactylus	long-nosed potoroo (SE mainland)	Vulnerable	Vulnerable	The species is sparsely distributed along the coast and Great Dividing Range of south-east Qld. There is limited information about the species' habitat in Qld, it can be found in wet eucalypt forests to coastal heaths and scrubs. The main factors appear to be access to some form of dense vegetation for shelter and the presence of an abundant supply of fungi for food.	**Low** – Some suitable habitat for this species may exist within the Study Area, however, there are no records proximal to the Project.
Pteropus poliocephalus	grey-headed flying-fox	Vulnerable	-	The species occurs in rainforests, open forests, closed and open woodlands, *Melaleuca* swamps and *Banksia* woodlands. Roosting camps are usually in dense riparian vegetation.	**Low** – Some suitable foraging habitat for this species may exist within vine forest in the Study Area, however, there are no records proximal to the Project.
Reptiles					
Delma torquata	collared delma	Vulnerable	Vulnerable	The species normally inhabits eucalypt-dominated woodlands and open-forests in the following land zones: alluvium, undulating country on fine-grained sedimentary rocks, and sandstone ranges. The presence of rocks, logs, coarse woody debris and leaf litter are essential characteristics of the species' microhabitat.	**Moderate** – Suitable eucalypt habitat is present within the Study Area and two historic records exist within the search extent.

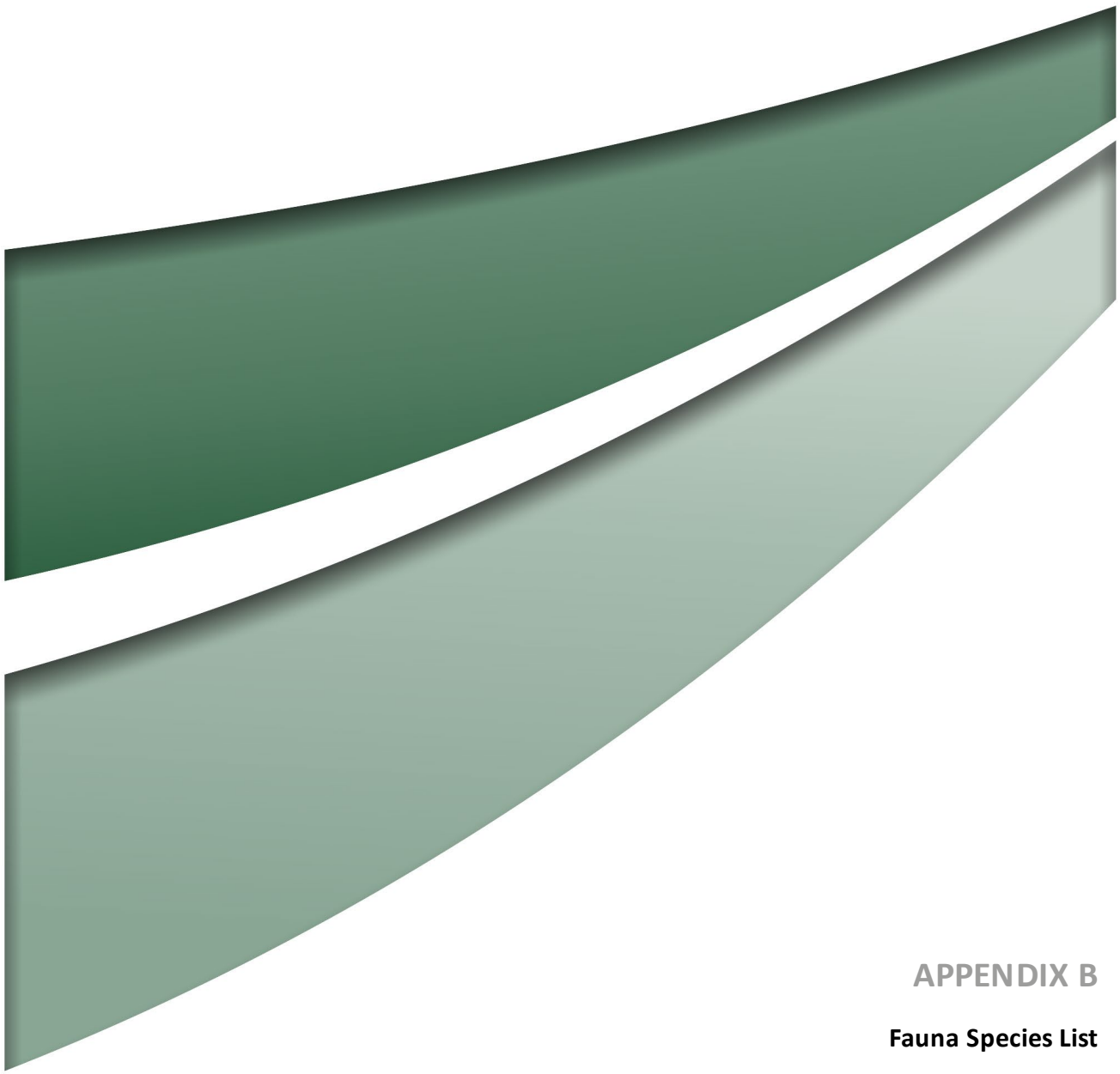
Scientific Name	Common Name	EPBC Act Status	NC Act Status	Preferred Habitat	Likelihood of Occurrence
Denisonia maculata	ornamental snake	Vulnerable	Vulnerable	The species inhabits lower-lying subtropical areas with deep-cracking clay soils and adjacent slightly elevated ground of clayey and sandy loams. The species is also found in vegetation of woodland and shrub land, including brigalow (*Acacia harpophylla*), riverside woodland and open forest, particularly on natural levees.	**Low** – This species has been historically recorded in the region, however, suitable habitat for this species does not exist within the Study Area.
Egernia rugosa	yakka skink	Vulnerable	Vulnerable	The species occurs in a variety of drier forests and woodlands, usually on well-drained, gritty soils, including poplar box (*Eucalyptus populnea*) on alluvial soils, white cyrpus pine (*Callitris glaucophylla*) on sands, bull oak (*Allocasuarina luehmannii*), brigalow (*Acacia harpophylla*), bendee (*A. catenulata*) and mulga (*A. aneura*). The species inhabits burrows, abandoned rabbit warrens, and hollow logs or in deep rock crevices.	**Low**– Suitable eucalypt woodland habitat is present within the Study Area; however, this species has not been recorded in the search extent.
Elseya albagula	southern snapping turtle	Critically endangered	Endangered	The species is only found in the Burnett, Fitzroy, Raglan and Mary river drainages of south-east Qld. It prefers permanent flowing water habitats where there are suitable shelters and refuges.	**Low** – This species has been recorded from creeks in the wider region. The Study Area lacks suitable watercourses to support this species.
Furina dunmalli	Dunmall's snake	Vulnerable	Vulnerable	The species has been found in a broad range of habitats, including forests and woodlands on black alluvial cracking clay/ clay loams dominated by including brigalow (*Acacia harpophylla*) and other *Acacia* spp., *Callitris* spp. or bull oak (*Allocasuarina luehmannii*), and various spotted gum (*Corymbia citriodora*), ironbark (*Eucalyptus crebra* and *E. melanophloia*) and white cyprus pine (*Callitris glaucophylla*) open forest and woodland associations on sandstone derived soils.	**Low** – The species is not known from the search extent. Eucalypt woodland and forest may provide suitable habitat for the species.

Scientific Name	Common Name	EPBC Act Status	NC Act Status	Preferred Habitat	Likelihood of Occurrence
Rheodytes leukops	Fitzroy river turtle	Vulnerable	Vulnerable	The species is a benthic feeder that occurs in flowing rivers with large deep pools with rocky, gravelly or sandy substrates, connected by shallow riffles. Preferred areas have high water clarity and are often associated with ribbonweed (*Vallisneria* sp.) beds. Commonly associated riparian vegetation includes forest red gum (*Eucalyptus tereticornis*), river she-oak (*Casuarina cunninghamiana*), weeping bottlebrush (*Melaleuca viminalis*) and snow-in summer (*M. linariifolia*).	**Unlikely** – No proximal records for this species exist, and the Study Area is unlikely to provide suitable habitat.
Migratory Species					
Marine Birds					
Apus pacificus	fork-tailed swift	Migratory	Special Least Concern	The species is almost exclusively aerial, flying from less than 1 m to at least 300 m above ground and probably much higher.	**High** -Likely to occur overhead throughout the Study Area, as this species frequently visits the region on migration and utilises updrafts from hills and ridges to maintain flight.
Marine Species					
Crocodylus porosus	salt-water crocodile	Migratory	Special Least Concern	The species mostly occurs in tidal rivers, coastal floodplains and channels, billabongs and swamps up to 150 km inland from the coast. It usually inhabits the estuarine reaches of rivers. In Qld, the species is usually restricted to coastal waterways and floodplain wetlands. Floating rafts of vegetation provide important nesting habitat.	**Unlikely** – No proximal records for this species exist, and the Study Area is unlikely to provide suitable habitat.

Scientific Name	Common Name	EPBC Act Status	NC Act Status	Preferred Habitat	Likelihood of Occurrence
Terrestrial Species					
Cuculus optatus	oriental cuckoo	Migratory	Special Least Concern	The species uses a range of vegetated habitats such as monsoon rainforest, wet sclerophyll forest, open woodlands and often along edges of forests, or ecotones between forest types.	**Moderate** – This species has been recorded within 25 km of the Study Area and some suitable habitat may exist on site, such as open eucalypt forest and woodland.
Monarcha melanopsis	black-faced monarch	Migratory	Special Least Concern	The species is a wet forest specialist, occurring mainly in rainforests and riparian vegetation. In wet sclerophyll forest, the species mostly frequents sheltered gullies and slopes with a dense understorey of ferns and/or shrubs. They forage from trees and shrubs or by taking insect prey from the air (sallying).	**Moderate** – This species has been recorded within 25 km of the Study Area and some suitable habitat, such as riparian woodland, exists on site.
Monarcha trivirgatus	spectacled monarch	Migratory	Special Least Concern	The species occurs in thick understorey in rainforests, wet gullies and waterside vegetation, as well as mangroves.	**Known** – This species was recorded twice within the Study Area, once from vine thicket and once from eucalypt woodland.
Motacilla flava	yellow wagtail	Migratory	Special Least Concern	Habitat requirements for the species are highly variable, but typically include open grassy flats near water. Habitats include open areas with low vegetation such as grasslands, airstrips, pastures, sports fields; damp open areas such as muddy or grassy edges of wetlands, rivers, irrigated farmland, dams, waterholes; sewage farms, sometimes utilise tidal mudflats and edges of mangroves.	**Unlikely** – Suitable habitat for this species does not exist within the Study Area. The closest record of this species to the Study Area has been identified over 70 km to the west.

Scientific Name	Common Name	EPBC Act Status	NC Act Status	Preferred Habitat	Likelihood of Occurrence
Myiagra cyanoleuca	satin flycatcher	Migratory	Special Least Concern	The species inhabits heavily vegetated gullies in eucalypt-dominated forests and taller woodlands, and on migration, occur in coastal forests, woodlands, mangroves and drier woodlands and open forests.	**Moderate** – This species has been historically recorded within 15 km of the Study Area. Suitable habitat for this species exists within the Study Area in the form of vegetated gullies.
Rhipidura rufifrons	rufous fantail	Migratory	Special Least Concern	In east and south-east Australia, the species mainly inhabits wet sclerophyll forests, often in gullies dominated by eucalypts; usually with a dense shrubby understorey often including ferns.	**Known** – This species was recorded three times within the Study Area, once from vine thicket and twice from eucalypt woodland.
Wetlands Species					
Actitis hypoleucos	common sandpiper	Migratory	Special Least Concern	The species utilises a wide range of coastal wetlands and some inland wetlands with varying levels of salinity. The species is mostly found around muddy margins or rocky shores and rarely on mudflats. It has been recorded in estuaries and deltas of streams, as well as on banks further upstream; around lakes, pools, billabongs, reservoirs, dams and claypans, and occasionally piers and jetties.	**Low** – Although freshwater systems exist within the Study Area, suitable wetland habitat is not present. Records from the region occur along the coast away from the site.
Calidris acuminata	sharp-tailed sandpiper	Migratory	Special Least Concern	The species prefers muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation. This includes lagoons, swamps, lakes and pools near the coast, and dams, waterholes, soaks, bore drains and bore swamps, saltpans and hypersaline salt lakes inland. They also occur in salt works and sewage farms.	**Low** – Although freshwater systems exist within the Study Area, suitable wetland habitat is not present. Records from the region occur along the coast away from the site.

Scientific Name	Common Name	EPBC Act Status	NC Act Status	Preferred Habitat	Likelihood of Occurrence
Calidris melanotos	pectoral sandpiper	Migratory	Special Least Concern	The species prefers shallow fresh to saline wetlands. It is found at coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands.	**Low** – Although freshwater systems exist within the Study Area, suitable wetland habitat is not present. Records from the region occur along the coast away from the site.
Gallinago hardwickii	Latham's snipe	Migratory	Special Least Concern	In Australia, the species occurs in permanent and ephemeral wetlands up to 2000 m asl. They usually inhabit open, freshwater wetlands with low, dense vegetation such as swamps, flooded grasslands or heathlands, around bogs and other water bodies.	**Low** – Although freshwater systems exist within the Study Area, suitable wetland habitat is not present.
Pandion haliaetus	osprey	Migratory	Special Least Concern	In east and south-east Australia, the species mainly inhabits wet sclerophyll forests, often in gullies dominated by eucalypts; usually with a dense shrubby understorey often including ferns.	**Unlikely** – No proximal records for this species exist, and the Study Area is unlikely to provide suitable habitat.



APPENDIX B

Fauna Species List

Table B1 Fauna Species List

Family	Common Name	Scientific Name	EPBC Status	NC Act Status
Fauna				
Amphibians				
Bufonidae	cane toad	*Bufo marinus**	-	-
Hylidae	common green treefrog	*Litoria caerulea*	-	Least Concern
Hylidae	broad palmed rocketfrog	*Litoria latopalmata*	-	Least Concern
Hylidae	striped rocketfrog	*Litoria nasuta*	-	Least Concern
Limnodynastidae	scarlet sided pobblebonk	*Limnodynastes terraereginae*	-	Least Concern
Limnodynastidae	ornate burrowing frog	*Platyplectrum ornatum*	-	Least Concern
Birds				
Acanthizidae	yellow-rumped thornbill	*Acanthiza chrysorrhoa*	-	Least Concern
Acanthizidae	white-throated gerygone	*Gerygone olivacea*	-	Least Concern
Acanthizidae	fairy gerygone	*Gerygone palpebrosa*	-	Least Concern
Acanthizidae	white-browed scrubwren	*Sericornis frontalis*	-	Least Concern
Acanthizidae	weebill	*Smicrornis brevirostris*	-	Least Concern
Accipitridae	collared sparrowhawk	*Accipiter cirrocephalus*	-	Least Concern
Accipitridae	brown goshawk	*Accipiter fasciatus*	-	Least Concern
Accipitridae	grey goshawk	*Accipiter novaehollandiae*	-	Least Concern
Accipitridae	wedge-tailed eagle	*Aquila audax*	-	Least Concern
Accipitridae	pacific baza	*Aviceda subcristata*	-	Least Concern
Accipitridae	whistling kite	*Haliastur sphenurus*	-	Least Concern
Accipitridae	black kite	*Milvus migrans*	-	Least Concern

Family	Common Name	Scientific Name	EPBC Status	NC Act Status
Aegothelidae	Australian owlet-nightjar	*Aegotheles cristatus*	-	Least Concern
Anatidae	pacific black duck	*Anas superciliosa*	-	Least Concern
Anatidae	Australian wood duck	*Chenonetta jubata*	-	Least Concern
Apodidae	white-throated needletail	*Hirundapus caudacutus*	Vulnerable, Migratory	Vulnerable
Ardeidae	white-necked heron	*Ardea pacifica*	-	Least Concern
Ardeidae	white-faced heron	*Egretta novaehollandiae*	-	Least Concern
Artamidae	black-faced woodswallow	*Artamus cinereus*	-	Least Concern
Artamidae	dusky woodswallow	*Artamus cyanopterus*	-	Least Concern
Artamidae	white-breasted woodswallow	*Artamus leucorynchus*	-	Least Concern
Artamidae	pied butcherbird	*Cracticus nigrogularis*	-	Least Concern
Artamidae	grey butcherbird	*Cracticus torquatus*	-	Least Concern
Artamidae	Australian magpie	*Gymnorhina tibicen*	-	Least Concern
Artamidae	pied currawong	*Strepera graculina*	-	Least Concern
Burhinidae	bush stone-curlew	*Burhinus grallarius*	-	Least Concern
Cacatuidae	sulphur-crested cockatoo	*Cacatua galerita*	-	Least Concern
Cacatuidae	little corella	*Cacatua sanguinea*	-	Least Concern
Cacatuidae	red-tailed black-cockatoo	*Calyptorhynchus banksii*	-	Least Concern
Cacatuidae	yellow-tailed black-cockatoo	*Calyptorhynchus funereus*	-	Least Concern
Cacatuidae	glossy black-cockatoo	*Calyptorhynchus lathami*	-	Vulnerable
Cacatuidae	galah	*Eolophus roseicapilla*	-	Least Concern
Cacatuidae	cockatiel	*Nymphicus hollandicus*	-	Least Concern
Campephagidae	ground cuckoo-shrike	*Coracina maxima*	-	Least Concern

Family	Common Name	Scientific Name	EPBC Status	NC Act Status
Campephagidae	black-faced cuckoo-shrike	*Coracina novaehollandiae*	-	Least Concern
Campephagidae	white-bellied cuckoo-shrike	*Coracina papuensis*	-	Least Concern
Campephagidae	cicadabird	*Coracina tenuirostris*	-	Least Concern
Campephagidae	varied triller	*Lalage leucomela*	-	Least Concern
Casuariidae	emu	*Dromaius novaehollandiae*	-	Least Concern
Charadriidae	masked lapwing	*Vanellus miles*	-	Least Concern
Climacteridae	white-browed treecreeper	*Climacteris affinis*	-	Least Concern
Climacteridae	white-throated treecreeper	*Cormobates leucophaea*	-	Least Concern
Columbidae	emerald dove	*Chalcophaps indica*	-	Least Concern
Columbidae	peaceful dove	*Geopelia striata*	-	Least Concern
Columbidae	squatter pigeon (southern)	*Geophaps scripta scripta*	Vulnerable	Vulnerable
Columbidae	wonga pigeon	*Leucosarcia melanoleuca*	-	Least Concern
Columbidae	topknot pigeon	*Lopholaimus antarcticus*	-	Least Concern
Columbidae	brown cuckoo-dove	*Macropygia amboinensis*	-	Least Concern
Columbidae	crested pigeon	*Ocyphaps lophotes*	-	Least Concern
Columbidae	common bronzewing	*Phaps chalcoptera*	-	Least Concern
Columbidae	rose-crowned fruit-dove	*Ptilinopus regina*	-	Least Concern
Coraciidae	dollarbird	*Eurystomus orientalis*	-	Least Concern
Corcoracidae	white-winged chough	*Corcorax melanorhamphos*	-	Least Concern
Corcoracidae	apostlebird	*Struthidea cinerea*	-	Least Concern
Corvidae	Torresian crow	*Corvus orru*	-	Least Concern
Cuculidae	fan-tailed cuckoo	*Cacomantis flabelliformis*	-	Least Concern

Family	Common Name	Scientific Name	EPBC Status	NC Act Status
Cuculidae	pallid cuckoo	*Cacomantis pallidus*	-	Least Concern
Cuculidae	pheasant coucal	*Centropus phasianinus*	-	Least Concern
Cuculidae	Horsfield's bronze-cuckoo	*Chalcites basalis*	-	Least Concern
Cuculidae	eastern koel	*Eudynamys orientalis*	-	Least Concern
Cuculidae	channel-billed cuckoo	*Scythrops novaehollandiae*	-	Least Concern
Dicruridae	spangled drongo	*Dicrurus bracteatus*	-	Least Concern
Dicruridae	willie wagtail	*Rhipidura leucophrys*	-	Least Concern
Estrildidae	plum-headed finch	*Neochmia modesta*	-	Least Concern
Estrildidae	red-browed finch	*Neochmia temporalis*	-	Least Concern
Estrildidae	double-barred finch	*Taeniopygia bichenovii*	-	Least Concern
Estrildidae	zebra finch	*Taeniopygia guttata*	-	Least Concern
Eurostopodidae	white-throated nightjar	*Eurostopodus mystacalis*	-	Least Concern
Falconidae	brown falcon	*Falco berigora*	-	Least Concern
Falconidae	nankeen kestrel	*Falco cenchroides*	-	Least Concern
Falconidae	peregrine falcon	*Falco peregrinus*	-	Least Concern
Gruidae	brolga	*Antigone rubicunda*	-	Least Concern
Halcyonidae	blue-winged kookaburra	*Dacelo leachii*	-	Least Concern
Halcyonidae	laughing kookaburra	*Dacelo novaeguineae*	-	Least Concern
Halcyonidae	forest kingfisher	*Todiramphus macleayii*	-	Least Concern
Hirundinidae	welcome swallow	*Hirundo neoxena*	-	Least Concern
Hirundinidae	tree martin	*Petrochelidon nigricans*	-	Least Concern
Maluridae	red-winged fairy-wren	*Malurus elegans*	-	Least Concern

Family	Common Name	Scientific Name	EPBC Status	NC Act Status
Maluridae	red-backed fairy-wren	*Malurus melanocephalus*	-	Least Concern
Megaluridae	brown songlark	*Cincloramphus cruralis*	-	Least Concern
Megaluridae	rufous songlark	*Cincloramphus mathewsi*	-	Least Concern
Megapodiidae	Australian brush-turkey	*Alectura lathami*	-	Least Concern
Meliphagidae	blue-faced honeyeater	*Entomyzon cyanotis*	-	Least Concern
Meliphagidae	brown honeyeater	*Lichmera indistincta*	-	Least Concern
Meliphagidae	noisy miner	*Manorina melanocephala*	-	Least Concern
Meliphagidae	Lewin's honeyeater	*Meliphaga lewinii*	-	Least Concern
Meliphagidae	white-throated honeyeater	*Melithreptus albogularis*	-	Least Concern
Meliphagidae	black-chinned honeyeater	*Melithreptus gularis*	-	Least Concern
Meliphagidae	scarlet honeyeater	*Myzomela sanguinolenta*	-	Least Concern
Meliphagidae	white-eared honeyeater	*Nesoptilotis leucotis*	-	Least Concern
Meliphagidae	little friarbird	*Philemon citreogularis*	-	Least Concern
Meliphagidae	noisy friarbird	*Philemon corniculatus*	-	Least Concern
Meropidae	rainbow bee-eater	*Merops ornatus*	-	Least Concern
Monarchidae	magpie-lark	*Grallina cyanoleuca*	-	Least Concern
Monarchidae	leaden flycatcher	*Myiagra rubecula*	-	Least Concern
Monarchidae	broad-billed flycatcher	*Myiagra ruficollis*	-	Least Concern
Monarchidae	spectacled monarch	*Symposiachrus trivirgatus*	Migratory	Special Least Concern
Motacillidae	Australasian pipit	*Anthus novaeseelandiae*	-	Least Concern
Nectariniidae	mistletoebird	*Dicaeum hirundinaceum*	-	Least Concern
Neosittidae	varied sittella	*Daphoenositta chrysoptera*	-	Least Concern

Family	Common Name	Scientific Name	EPBC Status	NC Act Status
Oriolidae	olive-backed oriole	*Oriolus sagittatus*	-	Least Concern
Oriolidae	Australasian figbird	*Sphecotheres vieilloti*	-	Least Concern
Otididae	Australian bustard	*Ardeotis australis*	-	Least Concern
Pachycephalidae	grey shrike-thrush	*Colluricincla harmonica*	-	Least Concern
Pachycephalidae	little shrike-thrush	*Colluricincla megarhyncha*	-	Least Concern
Pachycephalidae	golden whistler	*Pachycephala pectoralis*	-	Least Concern
Pachycephalidae	rufous whistler	*Pachycephala rufiventris*	-	Least Concern
Pardalotidae	striated pardalote	*Pardalotus striatus*	-	Least Concern
Pelecanidae	Australian pelican	*Pelecanus conspicillatus*	-	Least Concern
Petroicidae	eastern yellow robin	*Eopsaltria australis*	-	Least Concern
Petroicidae	red-capped robin	*Petroica goodenovii*	-	Least Concern
Petroicidae	rose robin	*Petroica rosea*	-	Least Concern
Phasianidae	brown quail	*Coturnix ypsilophora*	-	Least Concern
Podargidae	tawny frogmouth	*Podargus strigoides*	-	Least Concern
Podicipedidae	Australasian grebe	*Tachybaptus novaehollandiae*	-	Least Concern
Pomatostomidae	grey-crowned babbler	*Pomatostomus temporalis*	-	Least Concern
Psittacidae	Australian king-parrot	*Alisterus scapularis*	-	Least Concern
Psittacidae	red-winged parrot	*Aprosmictus erythropterus*	-	Least Concern
Psittacidae	budgerigar	*Melopsittacus undulatus*	-	Least Concern
Psittacidae	little lorikeet	*Parvipsitta pusilla*	-	Least Concern
Psittacidae	scaly-breasted lorikeet	*Trichoglossus chlorolepidotus*	-	Least Concern
Psittaculidae	pale-headed rosella	*Platycercus adscitus*	-	Least Concern

Family	Common Name	Scientific Name	EPBC Status	NC Act Status
Psittaculidae	rainbow lorikeet	*Trichoglossus moluccanus*	-	Least Concern
Psophodidae	spotted quail-thrush	*Cinclosoma punctatum*	-	Least Concern
Ptilonorhynchidae	green catbird	*Ailuroedus crassirostris*	-	Least Concern
Ptilonorhynchidae	spotted bowerbird	*Ptilonorhynchus maculatus*	-	Least Concern
Rhipiduridae	grey fantail	*Rhipidura albiscapa*	-	Least Concern
Rhipiduridae	rufous fantail	*Rhipidura rufifrons*	Migratory	Special Least Concern
Strigidae	southern boobook	*Ninox boobook*	-	Least Concern
Strigidae	barking owl	*Ninox connivens*	-	Least Concern
Threskiornithidae	straw-necked ibis	*Threskiornis spinicollis*	-	Least Concern
Turnicidae	painted button-quail	*Turnix varius*	-	Least Concern
Tytonidae	eastern barn owl	*Tyto delicatula*	-	Least Concern
Zosteropidae	silvereye	*Zosterops lateralis*	-	Least Concern
Mammals				
Canidae	dingo	*Canis familiaris dingo*	-	-
Dasyuridae	northern quoll	*Dasyurus hallucatus*	Endangered	Least Concern
Emballonuridae	yellow-bellied sheathtail bat	*Saccolaimus flaviventris*	-	Least Concern
Emballonuridae	Troughton's sheathtail bat	*Taphozous troughtoni*	-	Least Concern
Equidae	wild horse	*Equus caballus**	-	-
Felidae	cat	*Felis catus**	-	-
Leporidae	European brown hare	*Lepus europaeus**	-	-
Macropodidae	black-striped wallaby	*Macropus dorsalis*	-	Least Concern
Macropodidae	eastern grey kangaroo	*Macropus giganteus*	-	Least Concern

Family	Common Name	Scientific Name	EPBC Status	NC Act Status
Macropodidae	whiptail wallaby	*Macropus parryi*	-	Least Concern
Macropodidae	Herbert's rock-wallaby	*Petrogale herberti*	-	Least Concern
Macropodidae	unadorned rock-wallaby	*Petrogale inornata*	-	Least Concern
Macropodidae	swamp wallaby	*Wallabia bicolor*	-	Least Concern
Miniopteridae	little bent-wing bat	*Miniopterus australis*	-	Least Concern
Miniopteridae	eastern bent-wing bat	*Miniopterus orianae*	-	Least Concern
Molossidae	northern freetail bat	*Chaerephon jobensis*	-	Least Concern
Molossidae	northern free-tailed bat	*Ozimops lumsdenae*	-	Least Concern
Molossidae	eastern free-tailed bat	*Ozimops ridei*	-	Least Concern
Molossidae	bristle-faced free-tailed bat	*Setirostris eleryi*	-	Least Concern
Muridae	black rat	*Rattus rattus**	-	-
Petauridae	yellow-bellied glider (south-eastern)	*Petaurus australis australis*	Vulnerable	Vulnerable
Petauridae	sugar glider	*Petaurus breviceps*	-	Least Concern
Petauridae	squirrel glider	*Petaurus norfolcensis*	-	Least Concern
Phalangeridae	common brushtail possum	*Trichosurus vulpecula*	-	Least Concern
Potoroidae	rufous bettong	*Aepyprymnus rufescens*	-	Least Concern
Pseudocheiridae	greater glider (southern and central)	*Petauroides volans*	Vulnerable	Vulnerable
Pteropodidae	black flying-fox	*Pteropus alecto*	-	Least Concern
Pteropodidae	little red flying-fox	*Pteropus scapulatus*	-	-
Rhinolophidae	eastern horseshoe bat	*Rhinolophus megaphyllus*	-	Least Concern
Suidae	pig	*Sus scrofa**	-	-
Tachyglossidae	short-beaked echidna	*Tachyglossus aculeatus*	-	Special Least Concern

Family	Common Name	Scientific Name	EPBC Status	NC Act Status
Vespertilionidae	Gould's wattled bat	*Chalinolobus gouldii*	-	Least Concern
Vespertilionidae	chocolate wattled bat	*Chalinolobus morio*	-	Least Concern
Vespertilionidae	hoary wattled bat	*Chalinolobus nigrogriseus*	-	Least Concern
Vespertilionidae	little pied bat	*Chalinolobus picatus*	-	Least Concern
Vespertilionidae	inland broad-nosed bat	*Scotorepens balstoni*	-	Least Concern
Vespertilionidae	little broad-nosed bat	*Scotorepens greyii*	-	Least Concern
Vespertilionidae	south-eastern broad-nosed bat	*Scotorepens orion*		Least Concern
Vespertilionidae	northern broad-nosed bat	*Scotorepens sanborni*	-	Least Concern
Reptiles				
Agamidae	eastern bearded dragon	*Pogona barbata*	-	Least Concern
Colubridae	green tree snake	*Dendrelaphis punctulatus*	-	Least Concern
Diplodactylidae	wood gecko	*Diplodactylus vittatus*	-	Least Concern
Diplodactylidae	robust velvet gecko	*Nebulifera robusta*	-	Least Concern
Diplodactylidae	ocellated velvet gecko	*Oedura monilis*	-	Least Concern
Diplodactylidae	southern spotted velvet gecko	*Oedura tryoni*	-	Least Concern
Elapidae	eastern small-eyed snake	*Cryptophis nigrescens*	-	Least Concern
Gekkonidae	Bynoe's gecko	*Heteronotia binoei*	-	Least Concern
Pygopodidae	Burton's legless lizard	*Lialis burtonis*	-	Least Concern
Scincidae	open-litter rainbow skink	*Carlia pectoralis*	-	Least Concern
Scincidae	orange-flanked rainbow skink	*Carlia rubigo*	-	Least Concern
Scincidae	tree-base litter-skink	*Lygisaurus foliorum*	-	Least Concern
Scincidae	eastern blue-tongued lizard	*Tiliqua scincoides*	-	Least Concern

Family	Common Name	Scientific Name	EPBC Status	NC Act Status
Varanidae	sand monitor	*Varanus gouldii*	-	Least Concern
Varanidae	black-tailed monitor	*Varanus tristis*	-	Least Concern
Varanidae	lace monitor	*Varanus varius*	-	Least Concern

APPENDIX C

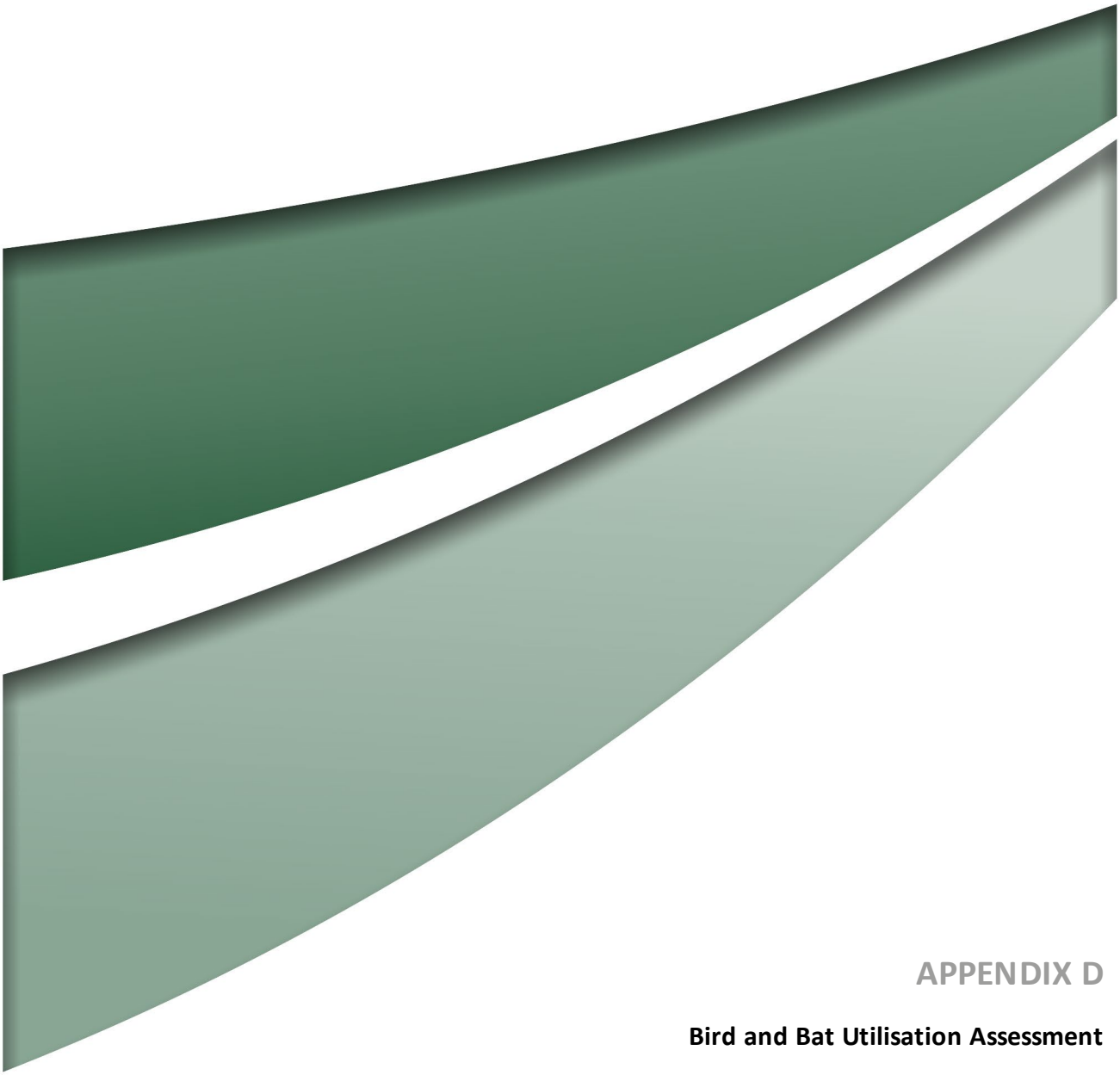
Fauna Habitat Types

Fauna Habitat Types	Mixed eucalypt woodland on steep slopes	*Eucalyptus crebra* woodland
Habitat Description	Mixed eucalypt woodland on steep slopes and ridges, commonly with *Corymbia citriodora* and/or *Eucalyptus crebra* +\- *E. acmenoides*, *E. tereticornis*	*Eucalyptus crebra* +\- *Corymbia erythrophloia*, *C. citriodora* woodland on slopes and ridges
Associated Regional Ecosystems	11.11.3, 11.11.4, 11.11.4a, 11.11.4b, 11.12.6	11.11.15, 11.12.1
Habitat Features	Commonly recorded habitat features include rocky outcrops and fallen logs of various sizes, while in some instances there is a denser cover of shrubs and grasses. Permanent water is rare in these areas, generally only existing in standing pools in creek beds or dams.	This habitat type generally has a grassier understorey with boulders and fallen logs occasionally present. Permanent water is rare in these areas, generally only existing in standing pools in creek beds or dams.
Disturbance Present	Grazing, erosion, weeds including common prickly pear (*Opuntia stricta*) and lantana (*Lantana camara*)	Grazing, erosion, weeds including velvet tree pear (*Opuntia tomentosa*) and lantana (*Lantana camara*)
Ground-truthed Mapping Extent (ha)	7,544.3	2,575.4
Representative Photograph		

Fauna Habitat Types	*Eucalyptus moluccana* woodland	Semi-evergreen vine thicket
Habitat Description	*Eucalyptus moluccana* woodland on slopes and ridges	Vine thicket on upper slopes and gullies with various floristics including *Euroschinus falcatus* var. *falcatus*, *Brachychiton australis*, *Flindersia* spp., *Ficus* sp., *Jasminum* sp., *Alyxia* sp., etc.
Associated Regional Ecosystems	11.11.3c, 11.11.4c	11.11.5a, 11.12.4
Habitat Features	This habitat type supports a variable assemblage of hollows suitable for nesting/roosting by arboreal mammals and birds. A sparse ground layer is often present with scattered fallen logs of various sizes.	The dense, complex structure of this habitat type make it suitable for smaller birds, reptiles and mammals which are capable of navigating the thick shrubs, vines and rocky outcrops.
Disturbance Present	Grazing, weeds including velvet tree pear (*Opuntia tomentosa*) and common prickly pear (*Opuntia stricta*)	Weeds including lantana (*Lantana camara*), velvet tree pear (*Opuntia tomentosa*) and common prickly pear (*Opuntia stricta*)
Ground-truthed Mapping Extent (ha)	241.7	50.7
Representative Photograph		

Fauna Habitat Types	Riparian *Melaleuca* woodland	Alluvial eucalypt woodland
Habitat Description	*Melaleuca fluviatilis* woodland +\- Eucalyptus tereticornis fringing a watercourse	*Eucalyptus tereticornis* +\- *Corymbia tessellaris* woodland on alluvial soils sometimes with *Casuarina cunninghamiana* as dominant.
Associated Regional Ecosystems	11.3.25b	11.3.4, 11.3.25
Habitat Features	This habitat type fringes rocky creek beds with an abundance of fine litter. Vegetation is often sparsely distributed and adjacent to non-remnant pasture, resulting in incursions from exotic species.	This habitat type generally has a grassy understorey with a sparse shrub layer. The large, older growth eucalypt species in the canopy supports a variable assemblage of hollows suitable for nesting/roosting by arboreal mammals and birds. Termitaria were also observed regularly within this habitat type.
Disturbance Present	Weeds including rubber vine (*Cryptostegia grandiflora*) and lantana (*Lantana camara*)	grazing, weeds including rubber vine (*Cryptostegia grandiflora*) and lantana (*Lantana camara*)
Ground-truthed Mapping Extent (ha)	240.8	36.8
Representative Photograph		

Fauna Habitat Types	Non-remnant pasture
Habitat Description	Non-remnant areas containing pasture comprising native and non-native grasses, scattered native trees and various infrastructure including tracks and dams.
Associated Regional Ecosystems	N/A
Habitat Features	This habitat type contains naturalised pasture grasses including buffel grass (*Cenchrus ciliaris*) and guinea grass (*Megathyrsus maximus*) providing little suitable habitat for native fauna species. Trees and shrubs are sparsely distributed.
Disturbance Present	Grazing, clearing, tracks, infrastructure, weeds including rubber vine (*Cryptostegia grandiflora*) and lantana (*Lantana camara*)
Ground-truthed Mapping Extent (ha))	2,234.3
Representative Photograph	



APPENDIX D

Bird and Bat Utilisation Assessment

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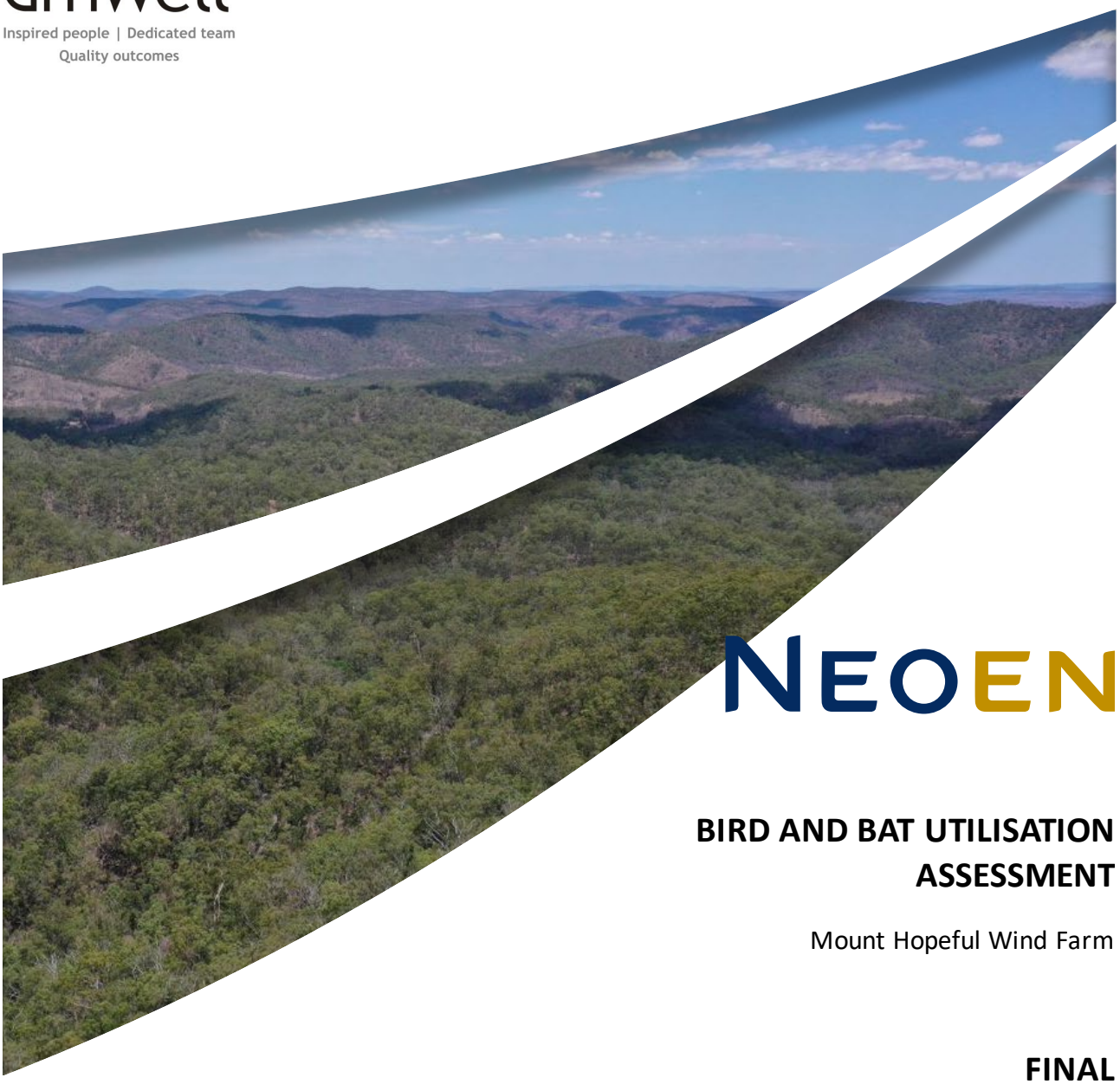
Inspired people | Dedicated team
Quality outcomes



NEOEN

BIRD AND BAT UTILISATION ASSESSMENT

Mount Hopeful Wind Farm

FINAL

May 2023

BIRD AND BAT UTILISATION ASSESSMENT

Mount Hopeful Wind Farm

FINAL

Prepared by
Umwelt (Australia) Pty Limited
on behalf of
Neoen Australia Pty Ltd

Report No. 22753/R07/Appendix A
Date: December 2022

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This report was prepared using Umwelt's ISO 9001 certified Quality Management System.

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Abbreviations and Glossary

Abbreviations

Abbreviation	Description
AHD	Australian height datum
AGL	above ground level
BACI	before-after control-impact
BBAMP	Bird and bat adaptive management plan
BBUS	Bird and bat utilisation survey
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cth)
ha	hectares
km	kilometres
LGA	Local government area
m	metres
NC Act	*Nature Conservation Act 1992* (QLD)
Neoen	Neoen Australia Pty Ltd
Qld	Queensland
RSA	rotor swept area
Umwelt	Umwelt (Australia) Pty Ltd
WTG	Wind turbine generator

Glossary

Term	Meaning
Barotrauma	A phenomenon in which rapid air pressure changes cause tissue damage to air-containing structures, most notably the lungs of bats (Baerwald et al. 2008)
Biophysical	The biotic and abiotic surrounding of an organism or population
Blade Strike	A collision between bird or bat and wind turbine blade
Fecundity	The ability to produce an abundance of offspring
Interrelated	Related or connected to one another
Riparian	Relating to wetlands adjacent to rivers and streams.
Plateau	An area of fairly level high ground
Volant	Able to fly

1.0 Introduction

Umwelt was engaged by Neoen Australia Pty Ltd (Neoen) to undertake ecological surveys to support a development application for the proposed Mount Hopeful Wind Farm (the Project). This bird and bat utilisation assessment presents the methods and results of six dedicated bird and bat utilisation surveys, as well as bird and bat observations made during other flora and fauna field surveys, and an analysis of the findings with respect to potential impacts from the Project.

1.1 Scope of Works

The aims of this assessment are to document the bird and bat species that are present or likely to occur in the Study Area, and to assess the risk of impacts for species flying at rotor swept area (RSA), particularly those that are of conservation concern.

Specific objectives for the scope of work include:

- Determining the status of bird and bat species in the Study Area through review of existing data and field survey.
- Identifying which bird and bat species are susceptible to blade strike from wind turbines in the Study Area through analysis of flight behaviour recorded on site and assessment of external information.
- Assessing potential impacts of the Project on bird and bat species and estimating the relative level of risk associated with potential impacts on species that are considered most at risk.
- Outlining available measures that have been employed at wind farms to avoid or mitigate impacts of blade strike on birds and bats.

1.2 Project Description

The Mount Hopeful Wind Farm is located on the Ulam Range approximately 45 km south of Rockhampton, Queensland (Qld) and 65 km west of Gladstone, Qld (**Figure 1.1**). The Project involves the development of a wind farm that contains 63 wind turbine generators (WTGs, referred to herein as turbines), ancillary infrastructure including up to ten temporary and ten permanent wind monitoring masts, six substations, battery energy storage systems (BESS), temporary construction compound/laydown areas, a concrete batching plant, high voltage (275 kV) overhead powerlines, as well as underground power and communication cables. The Project is expected to have a maximum generation capacity of approximately 400 megawatts (MW).

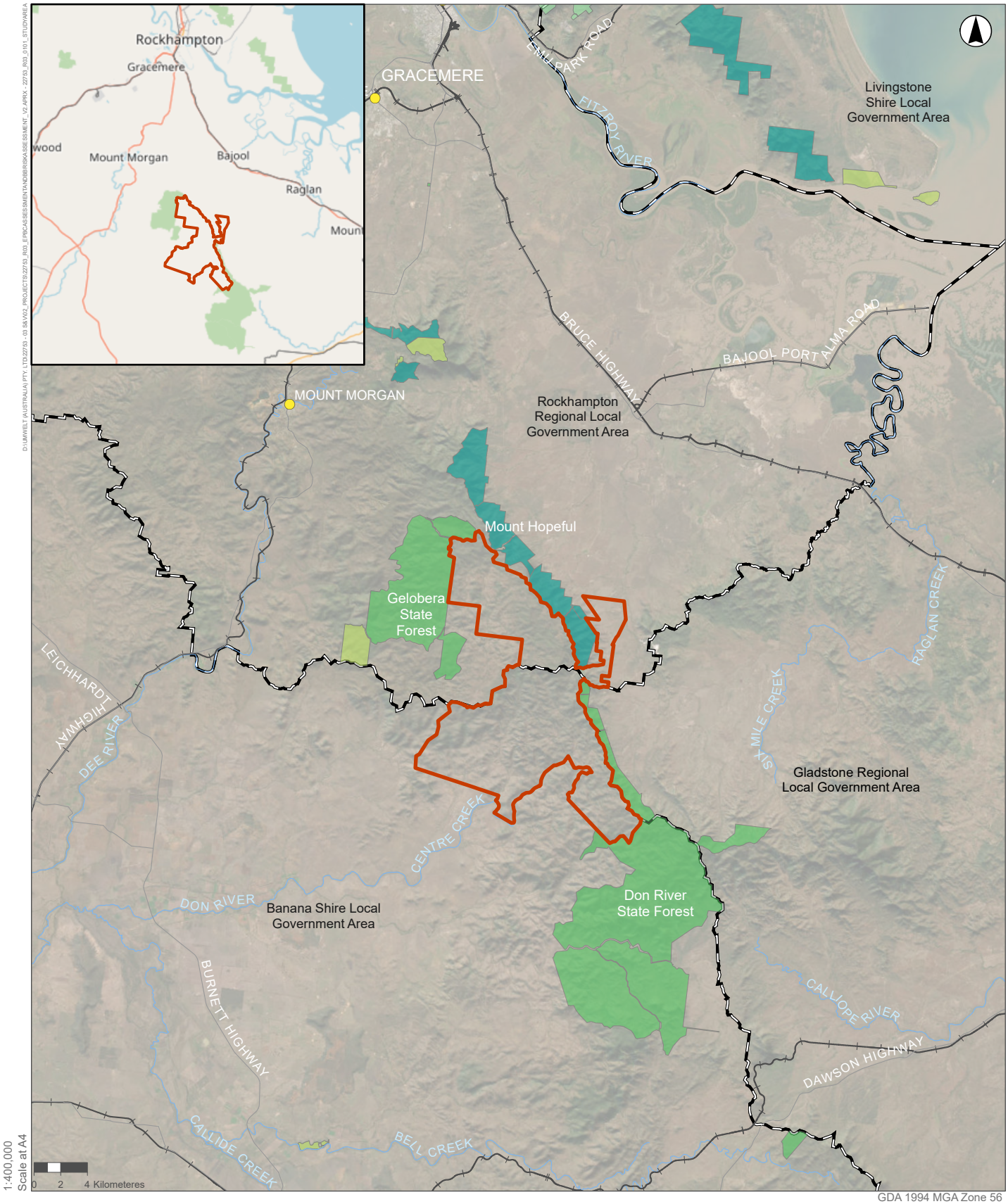
At this stage in the Project, turbine specifications have not been confirmed by Neoen.

1.2.1 Study Area

The Project is proposed over 18 land parcels and will utilise a number of local road reserves, which will be collectively referred to as the 'Study Area'. The Study Area is within the Rockhampton Regional Council and Banana Shire Council Local Government Areas (LGA) and covers approximately 16,976 ha of land.

Elevation within the Study Area ranges from approximately 500 m Australian Height Datum (AHD) to 120 m AHD, characterised by hilly terrain that comprises peaks and valleys, with areas of lower, generally flatter topography surrounding the Study Area to the east and west.

Major highways in proximity to the Study Area include the Bruce Highway to the east, Burnett Highway to the west, and the Dawson Highway to the south. These major transport corridors link to the cities of Rockhampton and Gladstone, as well as the Port of Gladstone from which the proposed turbine components will be transported.



Legend

- Town
- Roads
- Railway
- Watercourses
- Local Government Area (LGA)
- Study Area
- Conservation Park
- National Park
- Resources Reserve
- State Forest

FIGURE 1.1

Study Area Mount Hopeful Wind Farm

Image Source: ESRI Basemap (2022) **Data source:** Department of Resources (2022)

1.2.2 Wind Turbine Dimensions

The Project proposes up to 63 turbines, with a maximum overall height (tip height) of 260 m above ground level (AGL). The turbines will have a horizontal axis, with a rotor consisting of three blades with a maximum blade length of up to 90 m and a maximum hub height of up to 180 m. The selected blade length and wind turbine hub height will be configured so that the tip height does not exceed 260 m. These maximum specifications are summarised in **Table 1.1.**

Table 1.1 Turbine Specifications

Feature	Maximum Specification
Project generation capacity	Approximately 400 MW
Turbine electrical output	Approximately 6.5 MW
Maximum number of turbines	63
Tip height	Up to 260 m
Blade length	Up to 90 m

** The specifications listed in the table are considered to be an upper limit and are intended to provide flexibility for any innovation in turbine design between now and the time of detailed design and construction.*

The rotor swept area (RSA) refers to the physical area swept by the rotating blades during operation. For a hub height of 145 m and blade length of 90 m, the RSA would be located at a height of between 55 m to 235 m AGL (**Figure 1.2a**), and for a hub height of 170 m and blade length of 90 m, the RSA would be between 80 m to 260 m AGL (**Figure 1.2b**).

For the purposes of data analysis for this report, an inclusive RSA of 55 to 260 m was considered.

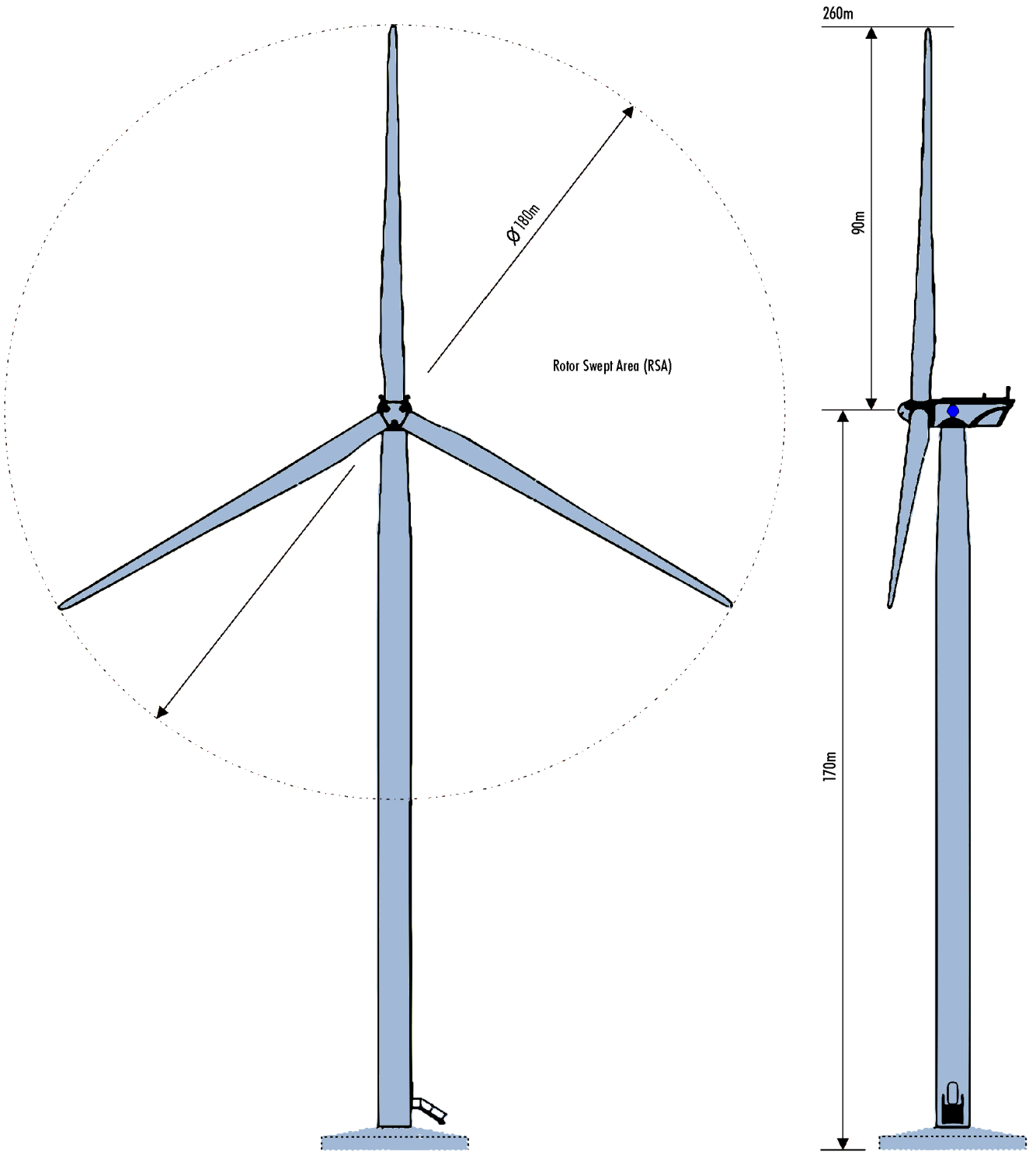


FIGURE 1.2A

Indicative Turbine Rotor Swept Area

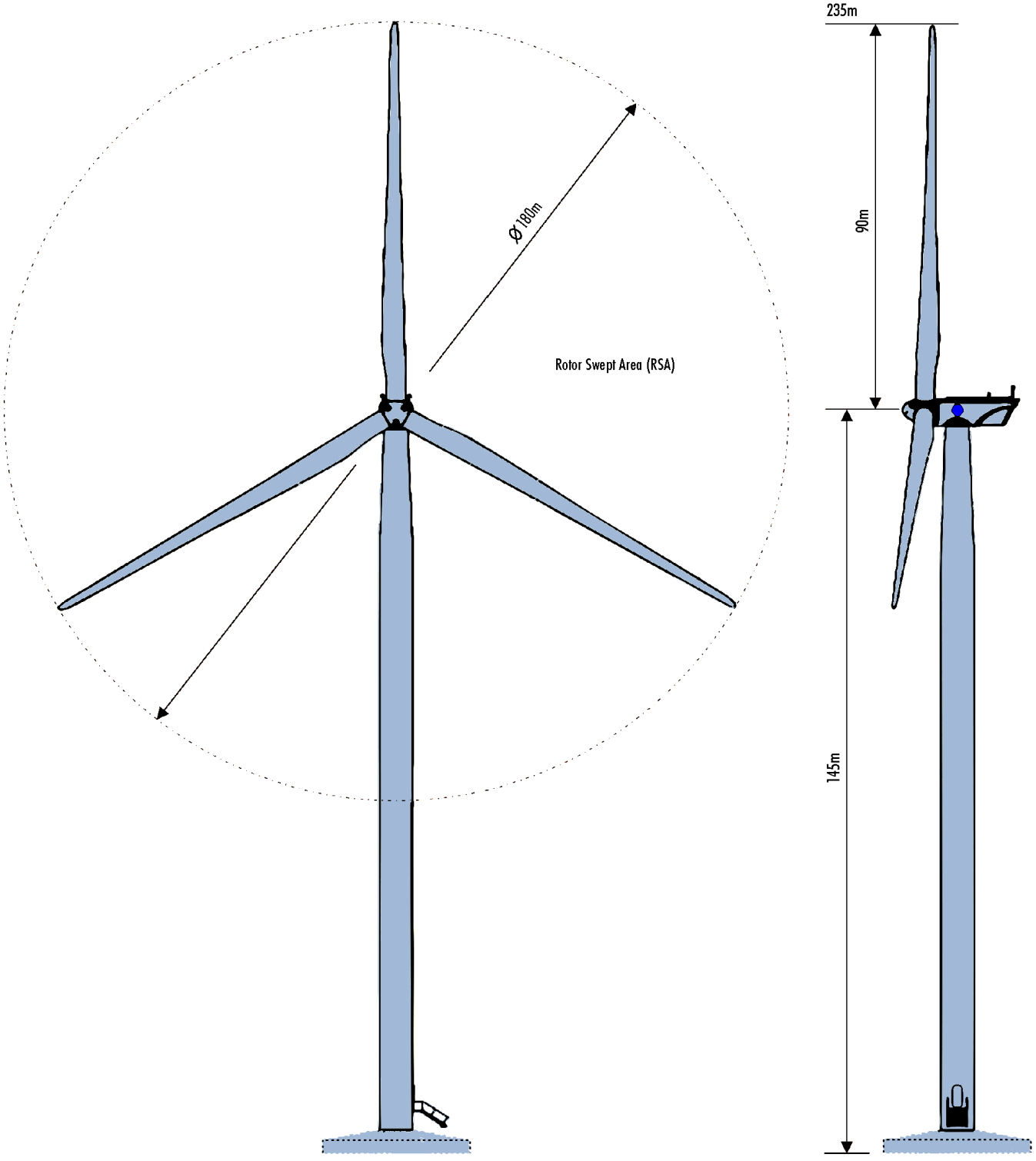


FIGURE 1.2A

Indicative Turbine Rotor Swept Area

Image Source: ESRI Basemap (2022) **Data source:** Department of Resources (2022)

2.0 Methods

2.1 Desktop Assessment

Tools used to investigate the potential occurrence of bird and bat species listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and/or the *Nature Conservation Act 1992* (NC Act) (using a 10 km buffer around the Project boundary) included:

- EPBC Act Protected Matters Search Tool (PMST) (Department of Climate Change, Energy, the Environment and Water (DCCEEW) 2022).
- Wildlife Online search tool (Department of Environment and Science (DES) 2022).
- Spatial Portal (Atlas of Living Australia (ALA) 2022).
- Atlas and Birdata (BirdLife Australia 2022).

2.2 Field Survey

2.2.1 Survey Timing

Umwelt ecologists initially conducted bird utilisation surveys in 2019 during Winter (9 to 12 July 2019 and 7 to 12 August 2019) to establish vantage point locations and begin collecting a baseline avifaunal data set. The next surveys were conducted during 2020 in Autumn (23 February to 5 March 2020) and late Spring (5 to 12 November 2020). The timing of these surveys coincided with the seasonal migration of EPBC Act listed birds, including white-throated needletail (*Hirundapus caudacutus*) and fork-tailed swift (*Apus pacificus*).

Ecologists conducted additional bird utilisation survey in 2021 during Spring (8 to 15 October 2021) and 2022 during Summer (14 to 21 February 2022) to capture seasonal variation in birds present within the Project site and airspace. Additional Project associated surveys have been undertaken throughout this period recording bird species incidentally to capture threatened species records and contribute towards the broader understanding of avifaunal biodiversity across the Study Area.

Bird and bat utilisation surveys occurred in various months and seasons to best record species presence within the Study Area. The survey timing is as follows:

- July 2019 (Winter)
- February to March 2020 (Autumn)
- November 2020 (Spring)
- October 2021 (Spring)
- February 2022 (Summer).

Vantage point surveys were not undertaken during the July 2019 (Winter) survey. Bird and bat data collected during this survey was limited to the use of bat call detectors and incidental observations (recording flight data). The vantage point methodology as described in **Section 2.2.2** and **Section 2.2.3** was undertaken during the remaining four surveys.

A summary of the survey effort and timing of surveys has been outlined in **Appendix B**.

2.2.2 Bird Utilisation Survey

2.2.2.1 Vantage Point Surveys

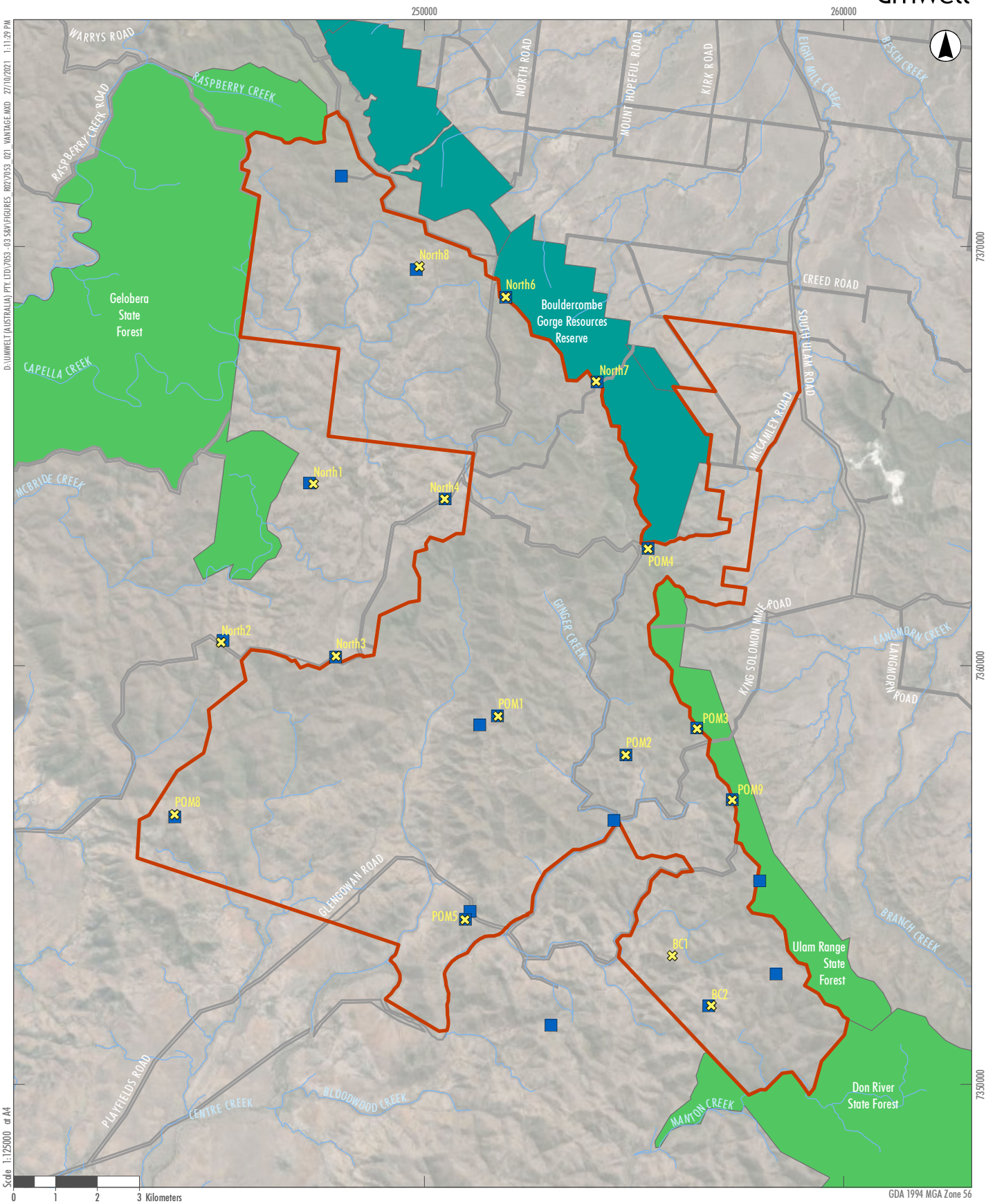
Sixteen vantage survey points were selected on the ridgelines and peaks of the Study Area based on the degree of visibility of surrounding areas. The vantage survey points were configured such that representativeness and coverage of the Study Area was maximised. Four control sites (North 1, North 2, North 3 and North 4) were selected outside of the Study Area to inform the before-after control-impact (BACI) model. A further 12 vantage point locations were selected throughout the Study Area. The position of each vantage survey point is depicted in **Figure 2.1**. Photographs taken from each vantage survey point are presented in **Appendix A**.

Vantage point surveys were conducted to assess site utilisation and flight behaviour of bird species in the Study Area. Each site was surveyed for one hour during three sampling windows per day to minimise sampling bias. On each field trip, vantage points were surveyed twice during each sampling window such that individual surveys were undertaken on six occasions at each vantage point. The sampling windows are outlined below and tables detailing survey effort at each vantage point are presented in **Appendix B**.

- Morning (between 6.00 am and 10.00 am).
- Midday (between 10.00 am and 2.00 pm).
- Afternoon (between 2.00 pm and 6.00 pm).

During each vantage point survey, a single observer recorded the following information for each observation:

- Species and abundance.
- Observation type (visual or aural).
- Distance and direction from the observer (to the nearest 10 m and 10° respectively).
- Approximate height AGL of the observed bird/s (to the nearest 10 m).
- Direction of flight (to the nearest 10°).
- Flight pattern (i.e. not flying, local movement, directional flight, circling, swooping, varied, other).
- Behaviour (i.e. flight, foraging, perching, mating, aggressive interactions, hollow inspection, nesting, on station).



Legend

- Study Area
- Anabat Location
- Vantage Survey
- Watercourse
- Roads
- Resources Reserve
- State Forest

FIGURE 2.1

Vantage Point Survey and Anabat Location Survey

Image Source: ESRI Basemap (2020) Data source: QLD Government (2020)

2.2.2.2 Incidental Observations

Incidental bird observations were recorded at various locations throughout the Study Area during travel between vantage point sites. For each record the following were noted; species, location of the observation recorded, abundance, flight behaviour, flight height and flight direction. Additional incidental observations were recorded during other ecology field surveys conducted in July 2019, May to June 2020, October to November 2020, January 2021, October 2021 and October 2022. Incidental records of threatened species within 1.5 km of the Study Area buffer have been included in this assessment given the aerial nature of some species and the ability to traverse habitat across the Study Area.

2.2.3 Bat Utilisation Survey

Microchiropteran (microbat) echolocation calls were sampled using Anabat Swift recording devices at each vantage point location (**Figure 2.1**). Devices were placed approximately two metres AGL facing a cleared area or flyway and left for between two to five nights, and one Anabat Swift device was deployed at approximately 50 m AGL for three nights. Call data collected from each device was sent to Balance! Environmental for identification. Across all surveys, the total number of detector nights was 104 The number of sampling nights for each detector location is provided in **Appendix C**.

The likelihood that bat species detected in the Study Area fly at RSA height was based on literature relevant to the flight behaviour of recorded species. Where possible height information was inferred from calls detected from the elevated Anabat Swift device (approximately 50 m AGL upon met mast).

2.2.4 Field Survey Limitations

Ecologists aimed to survey all sites twice during each survey window which was largely achieved except for periods when inclement weather disrupted surveys. Vehicle incidents during February 2022 BBUS meant two vantage point could only be surveyed five times at the northern half of the Study Area and survey effort was largely concentrated within the midday and afternoon survey windows. Efforts were made to randomise the order of surveys across the whole Study Area, however the restricted access between the northern and southern halves of the Study Area meant that field surveys comprised two sampling efforts (north and south). Double counting of birds was managed by avoiding surveying the nearest vantage survey points concurrently such that observers were approximately three kilometres apart.

Ecologists were unable to determine exact numbers of birds present for aural observations, so for the purposes of this report and data analyses all aural observations will be assigned a count of one individual.

2.3 Likelihood of Occurrence Assessment

Given the rarity and/or potentially infrequent habitation of the Study Area by threatened or migratory species, it was necessary to complete a likelihood of occurrence assessment. The likelihood of occurrence of bird and bat species listed under the EPBC Act and/or the NC Act was determined through review of existing records, assessment of the suitability of vegetation in the Study Area for species known from the region, and observations made during field surveys. Species were assigned to one of the following categories:

- **Known to Occur:** this category includes all species recorded in the Study Area in previous datasets or during Umwelt field survey.
- **High Potential to Occur:** This category includes species previously recorded in the immediate vicinity. The Study Area contains preferred habitat resources which may support a population of the species.
- **Moderate Potential to Occur:** The species is known from the broader area (desktop search extent) and some of the preferred habitat is present within the Study Area. Aerial foragers and other migratory birds that may overfly the Study Area are also included.
- **Low Potential to Occur:** The Study Area supports some suitable habitat, often marginal. The species may disperse through the Study Area infrequently and is unlikely to depend on the habitat for survival.
- **Unlikely to Occur:** This category includes those species for which the Study Area offers limited or no potential habitat, is outside their known range and/or is lacking broader habitat requirements.

Threatened bird and bat species listed under the EPBC Act which have a Moderate or High likelihood of occurrence within the Study Area were included in the risk assessment.

2.4 Risk Assessment

2.4.1 Approach

The risk assessment considered the likelihood of species presence and conservation status of species observed or indicated to be present in the Study Area, as well as risk to observed species based on flight characteristics. Species that met any of the following criteria were included in the risk assessment:

- Bird and bat species listed as threatened and/or migratory under the EPBC Act recorded in the Study Area or deemed to have a Moderate or High likelihood of occurrence in the Study Area.
- Bird and bat species listed as threatened under the NC Act recorded in the Study Area or deemed to have a Moderate or High likelihood of occurrence in the Study Area.
- Bird species recorded flying at RSA height in the Study Area.
- bat species recorded in the Study Area that have Moderate to High potential to occur at RSA height.

2.4.2 Criteria for Estimating the Relative Risk of Blade Strike

The relative risk for assessed species was estimated using two criteria to ascribe likelihood of risk, and four criteria to ascribe consequence of risk (**Table 2.1** and **Table 2.2**). This method was employed in a recent study that aimed to develop a science-based approach to aid decision-making regarding turbine collision risk for birds and bats in Victoria (Lumsden *et al.* 2019).

Each criterion was either adopted unchanged or adjusted for the purposes of this assessment to ensure each was relevant to specific aspects of the Project, for example geographic location. For the purposes of this assessment, Criteria A, C and F were slightly altered, Criterion B was substantially altered, and the thresholds and spatial scale for Criterion E were adjusted.

Each species was ranked either low, moderate or high for each criterion depending on which was most appropriate in consideration of the assessed species' ecology and observed or predicted utilisation of the Study Area. Descriptions for each ranking are outlined in **Table 2.1** and **Table 2.2**. The approach used to assess each species against each criterion is described in **Appendix D**.

Table 2.1 Criteria Used to Ascribe Likelihood of Risk

A	B
Known or likely frequency of flights within RSA height	Status or frequency of occurrence in the Study Area.

Table 2.2 Criteria Used to Ascribe Consequence of Risk

C	D	E	F
Highly localised or concentrated population (for whole or part of lifecycle), such that siting of wind farm could have significant consequence to Queensland, national or international population	Impact on population relative to demographic capacity to replace fatalities (i.e., generalised combination of dispersal capacity of potential replacements, fecundity and generation time)	Known or estimated size of national or global population	Listed conservation status under the EPBC Act and/or the NC Act.

Each species was ranked either Low, Moderate or High for each criterion depending on which is most appropriate in consideration of the assessed species' ecology and observed or predicted utilisation of the Study Area. Descriptions for each ranking are outlined in (**Table 2.3**).

Criterion A (flight height) was assessed by identifying the frequency of flights observed between 55 m and 260 m in the Study Area and assessing this with consideration of observed and reported flight behaviour from elsewhere in Australia. Given that flight height data for bird and bat species in Australia is scant and observation data from pre-construction surveys at wind farms sites is largely unavailable, estimates of flight height require an adequate number of observations from the assessed site coupled with consideration of expert opinion on known flight behaviour for each species assessed. This Criterion is important as flight height is the primary variable through which a relative estimate of collision risk can be reached.

Criterion B (status in Study Area) was assessed by determining the status or estimating the frequency of occurrence in the Study Area. This Criterion is included as it is an essential component for estimating overall blade strike risk. Data from field surveys conducted by NGH in 2012, 2013, 2015 and 2016, and by Umwelt in 2020 were primarily used to establish the ranking for this criterion. In the absence of species observations, likelihood of occurrence was predicted based on historical and local observations, known ranges and/or presence of suitable foraging or nesting habitat.

Criterion C (geographic population concentration) was assessed by estimating the degree to which a species' population may be concentrated due to site related factors such as geographic location, habitat type, proximity to important habitat or roost locations (i.e., significant wetlands, roost caves) and how this relates to the specific landscape in which the Study Area is located. Lumsden *et al.* (2019) noted that this criterion is intended to account for situations where the degree to which a taxon is geographically concentrated may influence the risk posed by the particular location of a wind farm. Where large flocks or aggregations are involved the concentration of individuals may be for short seasonal periods but may nonetheless substantially heighten risk to a large portion of a species' total population. This is particularly important if a large proportion of a species' population passes through a localised area, such as a migratory corridor, over the course of each seasonal passage.

Criterion D (demographic resilience) was assessed through consideration of known aspects of each assessed species breeding biology and, most specifically, the nature of species' life-history traits. This criterion is included in the risk assessment as it is necessary to estimate the capacity to which a species may replace individuals lost to mortality resulting from blade strike.

Criterion E (population size) is included to account for the variation in the significance of mortality of a given number of individuals between species as a result of the large variation in assessed species' national or global populations. This, when assessed in combination with Criterion D provides a measure through which the relative vulnerability of a species to loss of individuals can be estimated.

Criterion F (listed conservation status) refers to the status of bird and bat species listed under the EPBC Act or the NC Act. In instances where a species listing differs between Acts, for example one that is listed vulnerable under the EPBC Act and endangered under the BC Act the most threatened listing category is selected for the purposes of this assessment. The order being critically endangered, endangered and vulnerable. Species listed as migratory and/or marine under the EPBC Act are not assigned a rank for this criterion.

Table 2.3 Descriptions of Each Ranking for Criterion A-F

Rank	Criterion A	Criterion B	Criterion C	Criterion D	Criterion E	Criterion F
	Likelihood of Risk		Consequence of Risk			
Low	Species that do not or rarely fly at RSA height	Species that rarely occur in the Study Area	Species that are widely distributed within areas of suitable habitat and the habitat itself is relatively widely dispersed	Species that form breeding territories and that have a reasonable proportion of the population as nonbreeding 'floaters' that can rapidly replace breeding territorial adults if lost; species that may or may not form breeding territories and that are short-lived and have high fecundity; species that have capacity for long range or widespread juvenile or sub-adult dispersal	Total population (i.e. whether that corresponds to the national population of Australian endemics or a migrant's global population) is estimated to number more than 20,000 individuals	Species not listed or listed as near threatened or data deficient under the EPBC Act or the NC Act
Moderate	Species which regularly fly below RSA height and occasionally fly at RSA height	Species that occasionally occur in, or occasionally move through the Study Area	Species that may be more widespread or have greater flexibility in the range of suitable habitat availability, but where a high proportion of their population is likely to be concentrated at sites where they do occur	Species with life-history characteristics that sit between the low and high descriptions here	Total population is estimated to number between 5,000 and 20,000 individuals	Species listed as vulnerable under the EPBC Act or the NC Act
High	Species in which a high proportion of flight activity is at RSA height	Species that regularly occur in, or regularly move through the Study Area	Bat species that have major aggregations at a few caves, or bird or bat species that have either very restricted distributions or those where a substantial proportion of a population may move through certain areas (i.e. migratory pathways)	Species that form breeding territories but where there is limited capacity for a lost breeding adult to be readily replaced; species that do not form breeding territories and that are long-lived and/or have low fecundity; species that may have short-distance juvenile or sub-adult dispersal capacity only	Total population is estimated to number less than 5,000 individuals	Species listed as endangered or critically endangered under the EPBC Act or the NC Act

2.4.3 Estimating Overall Risk

Estimates of overall risk for each assessed species were determined by following an approach similar to that employed by Lumsden *et al*. (2019) with the most notable exception being the difference in spatial scale for which resulting estimates of risk are intended to be relevant to (i.e. state-wide vs site-specific). Elements of the likelihood and consequence of collision were combined to form an overall qualitative risk category (Low/Moderate/High) specific to the Project for the likelihood of collision and the consequence of collision. Likelihood of collision questions (Criterion A and B) and consequence of collision questions (Criterion C to F) were combined in a generally additive process to determine whether the overall likelihood and consequence of collisions was Low, Moderate or High. The following describes how the **likelihood of collision** was determined:

- **High**: Either criteria A or B is High and neither can be Low.
- **Moderate**: All other combinations not described in High or Low.
- **Low**: Both criteria A and B are Low, or:
    - In cases where criterion A is Low because the likelihood of flight at RSA is deemed highly unlikely based on knowledge of the species' flight behaviour and/or observations from the Study Area.
    - In cases where criterion B is Low because the likelihood of occurrence is deemed very unlikely based on the distribution of the species, expert advice and / or supported by literature or records.

The following describes how the **consequence of collision** was determined:

- **High:** The majority of criteria C through F are High, or the risk associated with criterion C for localised concentration is High. It was considered that the consequences of high mortality due to wind turbine collisions for species that have a limited distribution and/or have the capacity to be highly concentrated is sufficiently large such that, if a species' risk associated with this element was High, the consequences of collision should also be set to High, irrespective of the risks of the other criteria.
- **Moderate**: The majority of criteria C through F were Moderate.
- **Low:** The majority of criteria C through F were Low.

In cases where risk achieved two of two criteria, the higher risk rating was designated, e.g., two Moderate and two High criteria would result in a High rating.

Once the overall risk levels for the likelihood and consequence of collision specific to the Project had been assigned for a species, the results were then placed into a risk matrix to determine the level of concern (**Table 2.4**). Five categories of risk were used, namely Negligible, Low, Moderate, High, and Very High, based on the combination of the scores for likelihood and consequence.

Table 2.4 Risk matrix

		Consequence of Collisions		
		Low	Moderate	High
Likelihood of Collisions	Low	Negligible	Minor	Moderate
	Moderate	Minor	Moderate	High
	High	Moderate	High	Very High

2.4.4 Collision Risk Modelling for White-throated Needletail

Collision risk modelling for white-throated needletail was assessed by Biosis Pty Ltd (Biosis) using their Deterministic Collision Risk Model (refer to Appendix B of Attachment G (Bird and Bat Adaptive Management Plan) of the Preliminary Documentation). The collision risk model accounts for the bird flight data that occurs within the heigh area occupied by wind turbines. Flight data collected during BBUS (**Section 2.2.2**) was used as an empirical sample for the model to extrapolate the number of flights that may occur over a 12-month period.

2.4.4.1 Overview of the Model

As per the collision risk modelling (Appendix B of Attachment G (Bird and Bat Adaptive Management Plan) of the Preliminary Documentation) the model categorises turbines into a static and dynamic components. The entire turbine (including the tower, nacelle and the rotor when stationary) represents the static component. The dynamic component is the volume swept by the leading edge of the rotor blades in the time it takes the species of interest to pass through the airspace in which the rotor sweeps.

Since the turbine tower below rotor swept height is always a static component and poses minimal collision risk, the model takes this into account by dividing flights into those below turbine rotor height, and those within the height zone swept by turbine rotors and allocates different risk rates to these height zones.

The risk assessment accounts for a combination of variables that are specific to the proposed wind farm and to data for birds from the site. They include the following:

- The numbers of flights of the species below rotor height, and for which just the lower portion of turbine towers may present a collision risk.
- The numbers of flights at heights within the zone swept by turbine rotors, and for which the upper portion of towers, nacelles and rotors present a collision risk.
- The numbers of bird movements-at-risk, as recorded during timed point counts, extrapolated to determine an estimated number of movements-at-risk the species makes in an entire year. Account is taken of the portion of the year that birds may be present in Australia, and they may thus be at risk. The mean area (m^2 per turbine), of tower, nacelle and stationary rotor blades of a wind generator that present a risk to birds. Thus, the mean area presented by a turbine is between the maximum (where the direction of the bird is perpendicular to the plane of the rotor sweep) and the minimum (where the direction of the bird is parallel to the plane of the rotor sweep). The mean presented area is determined from turbine specifications supplied to Biosis for the specific make and model of turbine. It represents the average area presented to an incoming flight from any direction.

- The additional area (m^2 per turbine) presented by the movement of rotors during the potential flight of a bird through a turbine. This information is determined via a calculation involving species-specific, independent parameters of flight speed and body length and supplied turbine specifications.
- The model assumes that all turbines at the site represent equal risk.
- A calculation of the average number of turbines a bird is likely to encounter in a given flight through the site. This is based on the scattered configuration of turbines in the landscape and the total number of turbines proposed for the project.

2.4.4.2 Avoidance Rate

Results are provided based on various avoidance rates for white-throated needletail. The avoidance rate is the capacity for a bird to avoid a collision, whether that occurs due to a cognitive response on the part of a bird or not. An avoidance rate of 0.95 would equate to one flight in 20 in which a bird takes no action to avoid a turbine and a 0.999 avoidance rate equates to one flight in 1000 in which it would not avoid a turbine.

It should be noted that internationally there is very little empirical evidence for the actual avoidance rate for any bird species and for this reason it is prudent to provide a range of estimates that are considered to be reasonable. The evidence that is available suggests that avoidance capacity is species-specific, and that the great majority of birds have avoidance capability that is higher than 0.98. Overseas avoidance rates of greater than 0.99 have been demonstrated to be applicable to a variety of seabirds (Cook et al. 2014).

Based on experience with a wide range of bird species, it is certain that virtually all species have high capacity to avoid collision with the static components of turbines. White-throated needletails are highly agile, aerial birds and it is not considered likely that they would collide with stationary turbines. For this reason, an avoidance rate of 0.999 has been applied to static turbine components in the modelling regardless of the different dynamic avoidance rates applied. Various avoidance rates are modelled for the dynamic turbine components because, while it is reasonable to assume that White-throated Needletails can avoid a moving rotor most of the time, the actual rate at which they can do so is not certain. For this reason, results are provided for 0.990, 0.995 and 0.999 avoidance rates for the dynamic components (moving rotor) of turbines.

2.4.4.3 Result Metrics

Bird movement data was measured by the number of flights recorded at the site. Only when a reasonable estimate can be made for the number of individuals that might occur at the site can the model incorporate that to provide results expressed as an annual estimate of the number of individuals that might collide (otherwise the results remain expressed as the simple number of flights at risk). In order to provide results in terms of an annual estimate of bird collisions, a site-population estimate for white-throated needletails has been applied for the present modelling.

The model cannot forecast the frequency of collisions around the predicted annual average, and it is important to recognise that the number of any actual collisions that might occur can be expected to vary from year to year in a distribution around the average.

All results are provided to three significant figures simply to permit differences between them to be apparent. This should not be taken to indicate a measure of precision in result values. Output values represent annual 'average' results and, of course actual bird fatalities will always be measured in numbers of individuals and that may vary from year-to-year in a distribution around the mean.

3.0 Results

3.1 Desktop Assessment

Review of database searches identified 30 threatened and/or migratory bird species and 4 threatened bat species that have the potential to occur within the Study Area. These results were combined with field observations to develop the Likelihood of Occurrence Assessment (**Section 3.3**) and Risk Assessment (**Section 3.4**).

3.2 Field Survey

3.2.1 Site Conditions

Weather conditions recorded at the nearest weather station (Rockhampton Aero (039083)) during the surveys are presented in **Appendix E**.

3.2.2 Bird Utilisation Survey

3.2.2.1 Species Diversity

A total of 137 bird species were recorded within the Study Area during the BBUS field program. A further 18 bird species have been recorded within the Study Area during other Project associated fauna surveys. A list of all species recorded at each location is presented in **Appendix F**.

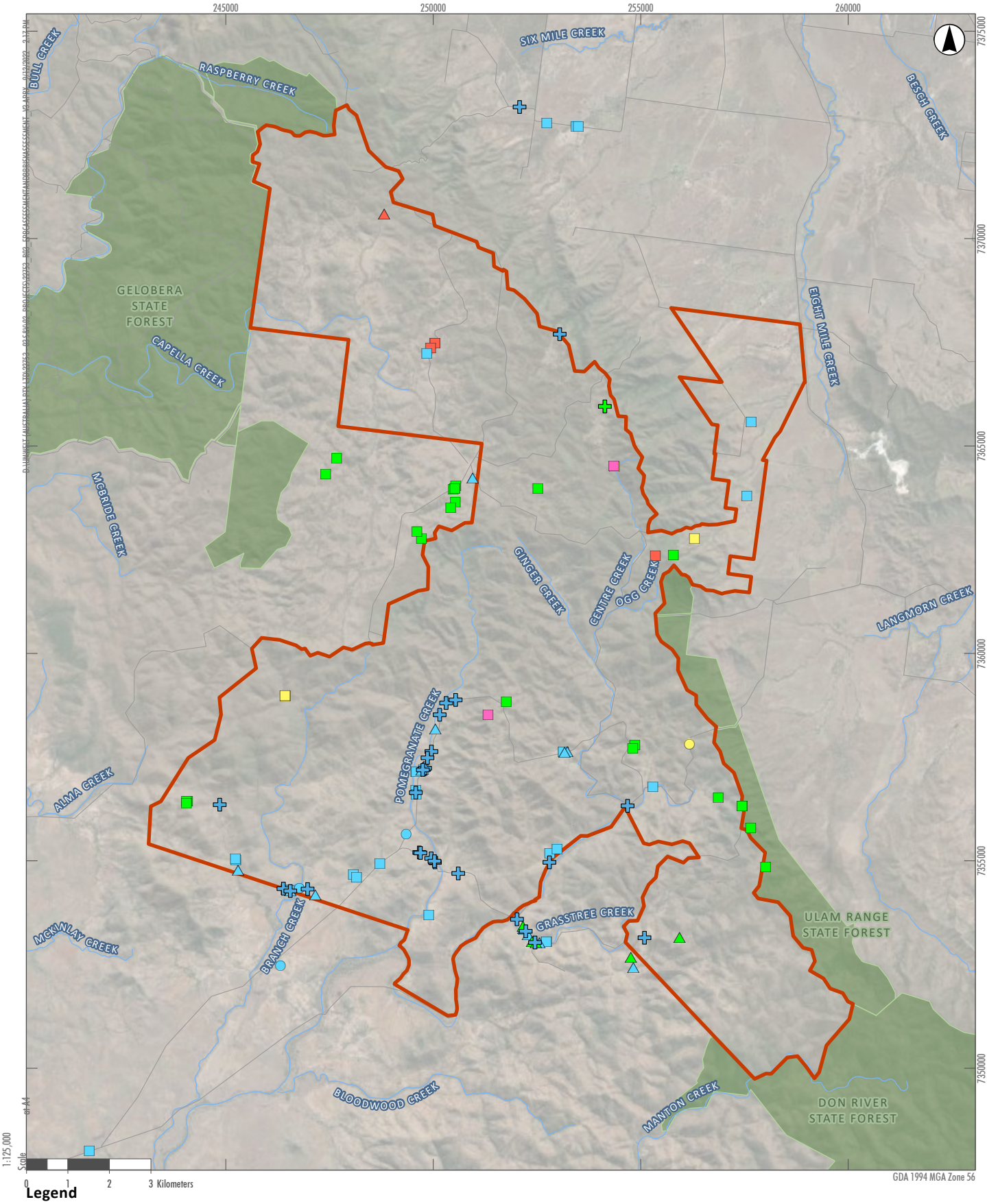
Of the bird and bat species identified within the Study Area, five are listed as threatened or migratory under the NC Act and/or the EPBC Act. These are detailed in **Table 3.1** and illustrated in **Figure 3.1**.

Table 3.1 Listed Threatened and Migratory Species Recorded During All Surveys

Common Name	Scientific Name	NC Act Listing	EPBC Act Listing
glossy black-cockatoo	*Calyptorhynchus lathami*	Vulnerable	-
rufous fantail	*Rhipidura rufifrons*	Special Least Concern	Migratory
spectacled monarch	*Symposiachrus trivirgatus*	Special Least Concern	Migratory
squatter pigeon (southern)	*Geophaps scripta scripta*	Vulnerable	Vulnerable
white-throated needletail	*Hirundapus caudacutus*	Vulnerable	Vulnerable; Migratory

Glossy Black-cockatoo

Glossy black-cockatoo was recorded on five occasions, once during the bird utilisation survey where a flock of 22 were observed transiting south from the POM4 vantage point along the eastern ridge of the Study Area between 60 to 90 m AGL. The remaining four observations were of small flocks (two–three individuals), with one group foraging within a stand of *Allocasuarina torulosa*.



Legend

- Watercourse
- Roads
- Study Area
- State Forest

Threatened Bird Species

2019

- Squatter pigeon (southern) (*Geophaps scripta scripta*)
- Rufous fantail (*Rhipidura rufifrons*)

2020

- Glossy black-cockatoo (*Calyptorhynchus lathami*)
- Squatter pigeon (southern) (*Geophaps scripta scripta*)
- White-throated Needletail (*Hirundapus caudacutus*)
- Spectacled monarch (*Symposiachrus trivirgatus*)
- Rufous fantail (*Rhipidura rufifrons*)

2021

- Glossy black-cockatoo (*Calyptorhynchus lathami*)
- Squatter pigeon (southern) (*Geophaps scripta scripta*)
- White-throated Needletail (*Hirundapus caudacutus*)

2022

- Squatter pigeon (southern) (*Geophaps scripta scripta*)
- White-throated Needletail (*Hirundapus caudacutus*)

FIGURE 3.1

Location of Records of Bird Species Listed under the EPBC Act and/or the NC Act in the Study Area

Image Source: ESRI Basemap (2020) Data source: QLD Government (2020)

Rufous Fantail

Rufous fantail was only recorded incidentally and not during vantage point surveys, as such no flight data were recorded. Of four observations, three were made on the western edge of the Study Area, while the remaining observations occurred along the eastern boundary of the Study Area.

- One individual observed actively foraging within a narrow gully, comprising a structurally complex lower tree and shrub layer. The gully was situated adjacent to steep sloping Eucalypt woodland.
- One individual observed within vine thicket vegetation, comprising structurally complex shrub layer over ground microhabitat of fallen logs and course litter.
- Two individuals were recorded on separate occasions on steep slopes, dispersing through eucalypt woodland in close proximity to vine thicket vegetation and in areas invaded by *Lantana camara*.

On all occasions, the rufous fantail was using lower portions of habitat, occupying the ground and mid-stratum vegetation layers (i.e., below RSA).

Spectacled Monarch

Spectacled monarch was observed only twice incidentally during June 2020 in other ecological surveys, however the observations were made over 6 km apart, once in the central portion and once in the north-eastern portion of the Study Area. On both occasions the species was observed in the mid-statum vegetation layers.

Habitat suitable for foraging and dispersal was present within the Study Area and included the following:

- semi-evergreen vine thicket
- gullies in eucalypt woodlands where dense vegetation occurs.

The species utilises this region on its' migration and does not reside or breed in the region. As such habitat within the Study Area has been identified as foraging and dispersal only (i.e., below RSA).

Squatter Pigeon (Southern)

Squatter pigeon was observed on 78 occasions, throughout the field survey program, although this is likely to include multiple observations of the same individuals. It was commonly recorded along access tracks in non-remnant areas of the Study Area and was observed using a range of habitat types. All observations were made incidentally with 55.1% of observations based on one individual, however groups of up to 11 individuals were observed, often within close proximity to water sources.

Water sources suitable for the foraging of the squatter pigeon (southern) do not occur commonly within the Study Area. Stream order 1 and 2 watercourses occur extensively, however are associated with rugged and steep terrain areas generally at elevation. Farm dams identified using the Department of Resources (DoR) Reservoirs dataset were all considered suitable and are likely to be the primary resource utilised by the species due to their permanency.

On all occasions the species was observed on the ground or perched upon infrastructure (farm gates). When flushed, squatter pigeon was infrequently observed flying onto a nearby tree perch, no taller than 6 m (below RSA).

White-throated Needletail

White-throated needletail were observed on 30 occasions, 21 of which were incidental. Observations were variable in abundance and behaviour, with some individuals transiting through the airspace, however the majority of observations were of larger flocks (1 to 180) circling between 5 to 400 m AGL. White-throated needletail are further discussed in **Section 3.2.2.3**.

3.2.2.2 Species by Record and Count

Fifty-four species were recorded frequently (i.e., >10 times) throughout all field surveys, both during vantage point surveys and incidentally. **Table 3.2** outlines the 10 most recorded (visually and aurally) bird species. Pied currawong, rainbow lorikeet and Torresian crow were all recorded at every vantage point and incidentally, often observed in-flight or heard calling from a distance.

Table 3.2 Top 10 Species by Record

Rank	Common Name	Scientific Name	Total Observations
1	pied currawong	*Strepera graculina*	228
2	rainbow lorikeet	*Trichoglossus moluccanus*	161
3	Torresian crow	*Corvus orru*	161
4	white-throated honeyeater	*Melithreptus albogularis*	128
5	wedge-tailed eagle	*Aquila audax*	125
6	Australian magpie	*Gymnorhina tibicen*	109
7	noisy friarbird	*Philemon corniculatus*	108
8	laughing kookaburra	*Dacelo novaeguineae*	107
9	striated pardalote	*Pardalotus striatus*	91
10	squatter pigeon (southern)	*Geophaps scripta scripta*	78

Table 3.3 outlines the top 10 species by count, calculated using visual observations made both during vantage point surveys and incidentally. White-throated needletail was commonly observed in large flocks of up to 180, topknot pigeon was observed on only three occasions in flocks of 60 to 100, while rainbow lorikeet was observed frequently as individuals or pairs, with occasional observations of flocks (up to 39 individuals).

Table 3.3 Top 12 Species Observed Visually by Count

Rank	Common Name	Scientific Name	Total Count (Visual)
1	Torresian crow	*Corvus orru*	864
2	white-throated needletail	*Hirundapus caudacutus*	698
3	rainbow lorikeet	*Trichoglossus moluccanus*	337
4	pied currawong	*Strepera graculina*	261
5	topknot pigeon	*Lopholaimus antarcticus*	222
6	wedge-tailed eagle	*Aquila audax*	170
7	white-throated honeyeater	*Merops ornatus*	164

Rank	Common Name	Scientific Name	Total Count (Visual)
8	rainbow bee-eater	*Trichoglossus moluccanus*	163
9	noisy friarbird	*Philemon corniculatus*	160
10	squatter pigeon	*Geophaps scripta scripta*	143

3.2.2.3 At-risk Species

Twenty-four bird species were observed flying within the RSA, placing them at risk of turbine blade strike. A summary of these species and their minimum and maximum flight heights are presented in **Table 3.4**.

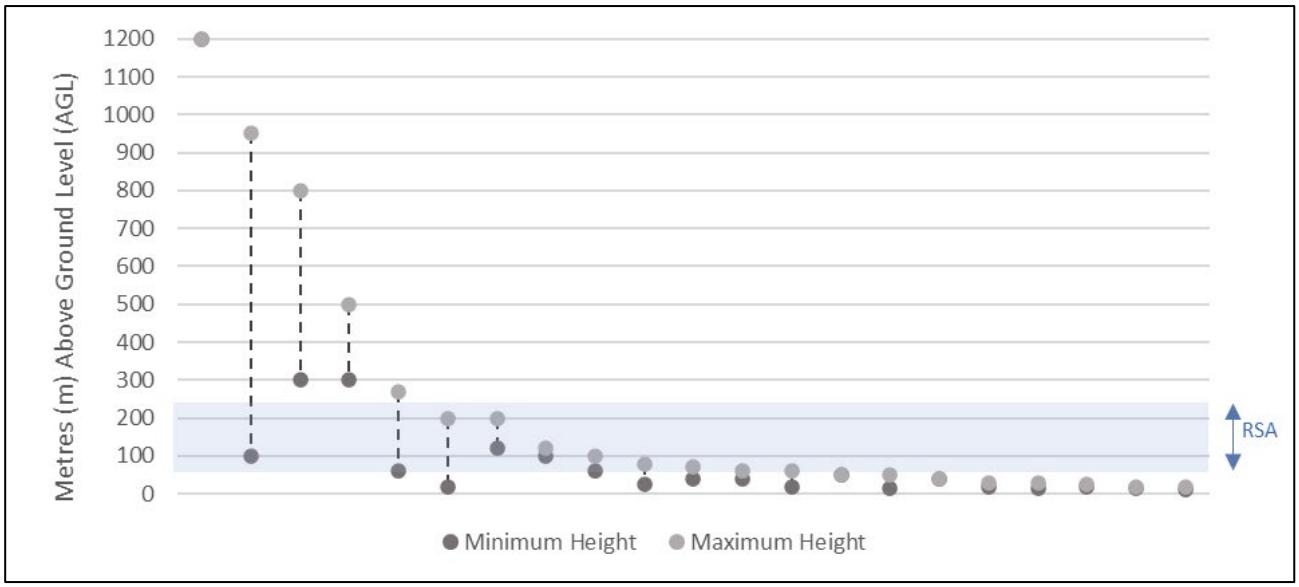
Table 3.4 At-risk Species

Common Name	Scientific Name	Observed Flight Height	
		Minimum	Maximum
Australian magpie	*Gymnorhina tibicen*	0	700
black kite	*Milvus migrans*	200	300
blue-faced honeyeater	*Entomyzon cyanotis*	10	120
brown falcon	*Falco berigora*	10	1200
brown goshawk	*Accipiter fasciatus*	14	200
channel-billed cuckoo	*Scythrops novaehollandiae*	6	1000
galah	*Eolophus roseicapilla*	80	80
glossy black-cockatoo	*Calyptorhynchus lathami*	20	90
nankeen kestrel	*Falco cenchroides*	0	300
noisy friarbird	*Philemon corniculatus*	0	80
pacific baza	*Aviceda subcristata*	10	190
peregrine falcon	*Falco peregrinus*	10	700
pied currawong	*Strepera graculina*	0	130
rainbow bee-eater	*Merops ornatus*	5	120
rainbow lorikeet	*Trichoglossus moluccanus*	1	300
red-tailed black-cockatoo	*Calyptorhynchus banksii*	20	100
scaly-breasted lorikeet	*Trichoglossus chlorolepidotus*	30	60
sulphur-crested cockatoo	*Cacatua galerita*	10	1200
topknot pigeon	*Lopholaimus antarcticus*	80	500
Torresian crow	*Corvus orru*	0	800
tree martin	*Petrochelidon nigricans*	10	250
wedge-tailed eagle	*Aquila audax*	10	1500
whistling kite	*Haliastur sphenurus*	200	300
white-throated needletail	*Hirundapus caudacutus*	1	1100

Six at-risk species are highlighted due to the frequency of observed flights within the RSA, total count, and/or their status as a listed threatened or migratory species, including brown falcon, rainbow lorikeet, sulphur-crested cockatoo, Torresian crow, wedge-tailed eagle and white-throated needletail. A summary of observations for these species are discussed below.

Brown Falcon

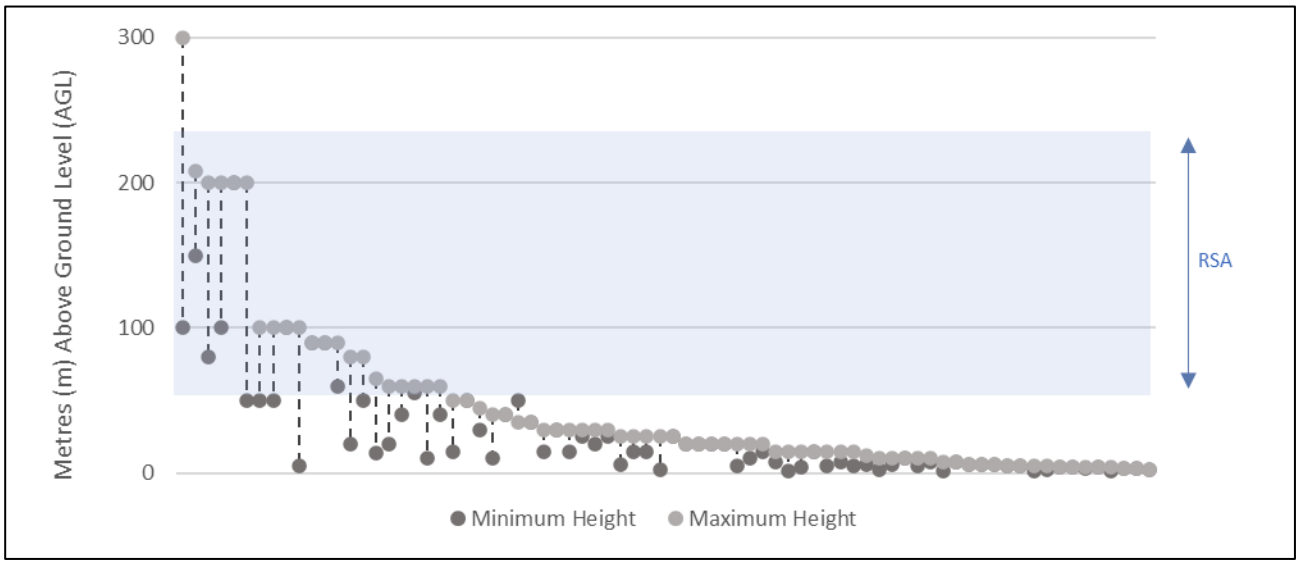
Brown falcon were recorded on 34 occasions (most commonly solitarily) of which 21 records were made across all surveys where flight data was recorded (**Graph 3.1**). 42.9% of flights observed were within the RSA.



Graph 3.1 Brown Falcon minimum and maximum heights recorded during the BBUS program

Rainbow Lorikeet

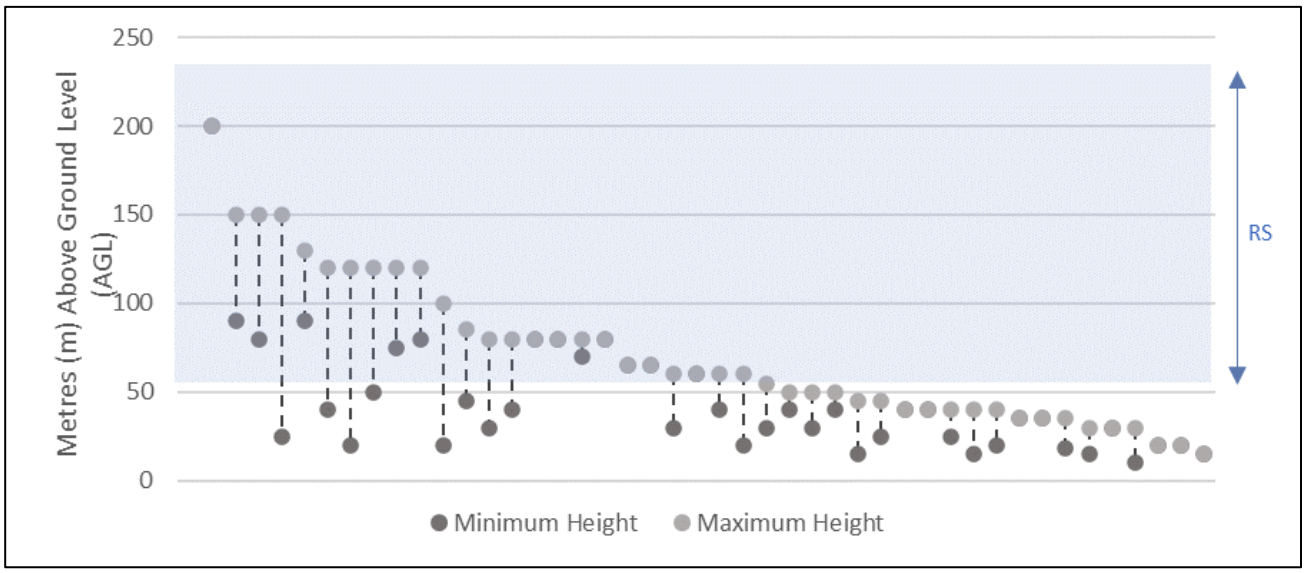
Rainbow lorikeet were recorded on 161 occasions; 76 instances during all surveys of which 47.2% were visual observation of rainbow lorikeets transiting through the Study Area airspace; 27.6% of these observed flights were within the RSA (**Graph 3.2**). Most observations were of indivuals, pairs and small flocks (up to seven lorikeets), though one flock of 39 was recorded.



Graph 3.2 Rainbow Lorikeet minimum and maximum heights recorded during the BBUS program

Sulphur-crested Cockatoo

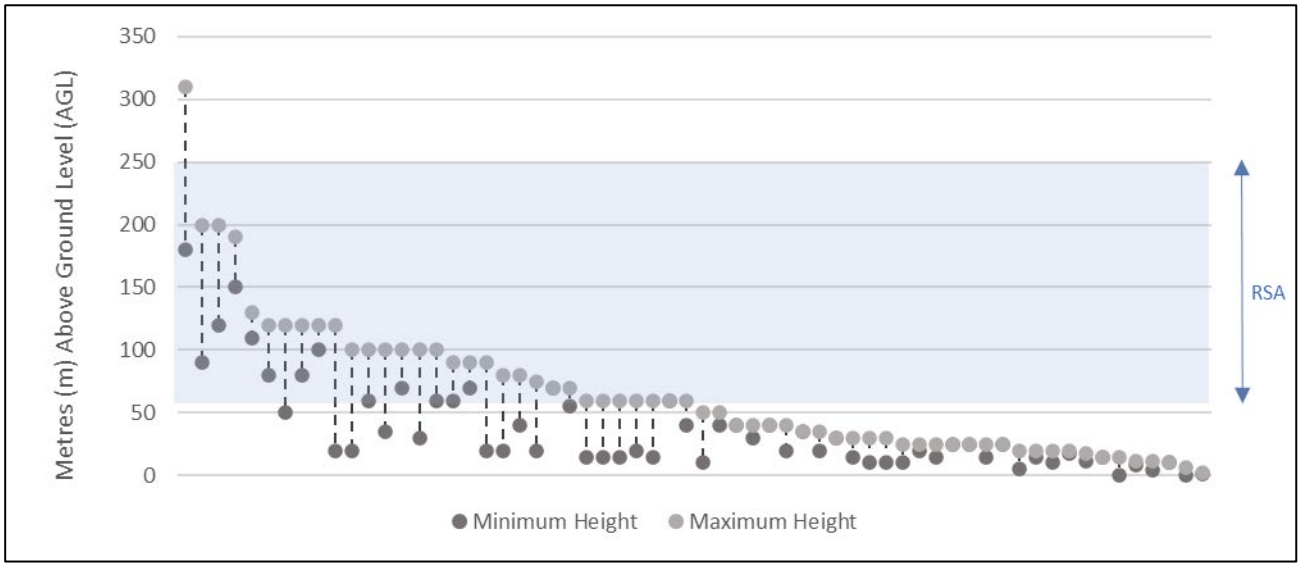
Sulphur-crested cockatoo were recorded on 78 occasions, 45 instances during all surveys of which 57.7% were visual records across all surveys where birds were observed transiting through the Study Area airspace; 55.6% of those flights were in the RSA (**Graph 3.3**). Most records were of individuals, though pairs and flocks of up to eight cockatoos were recorded. Sulphur-crested cockatoo were recorded at a height of 600 m to 1200 m, this flight height is not included in **Graph 3.3** to better display flight heights within the RSA.



Graph 3.3 Sulphur-crested cockatoo minimum and maximum heights recorded during the BBUS program

Torresian Crow

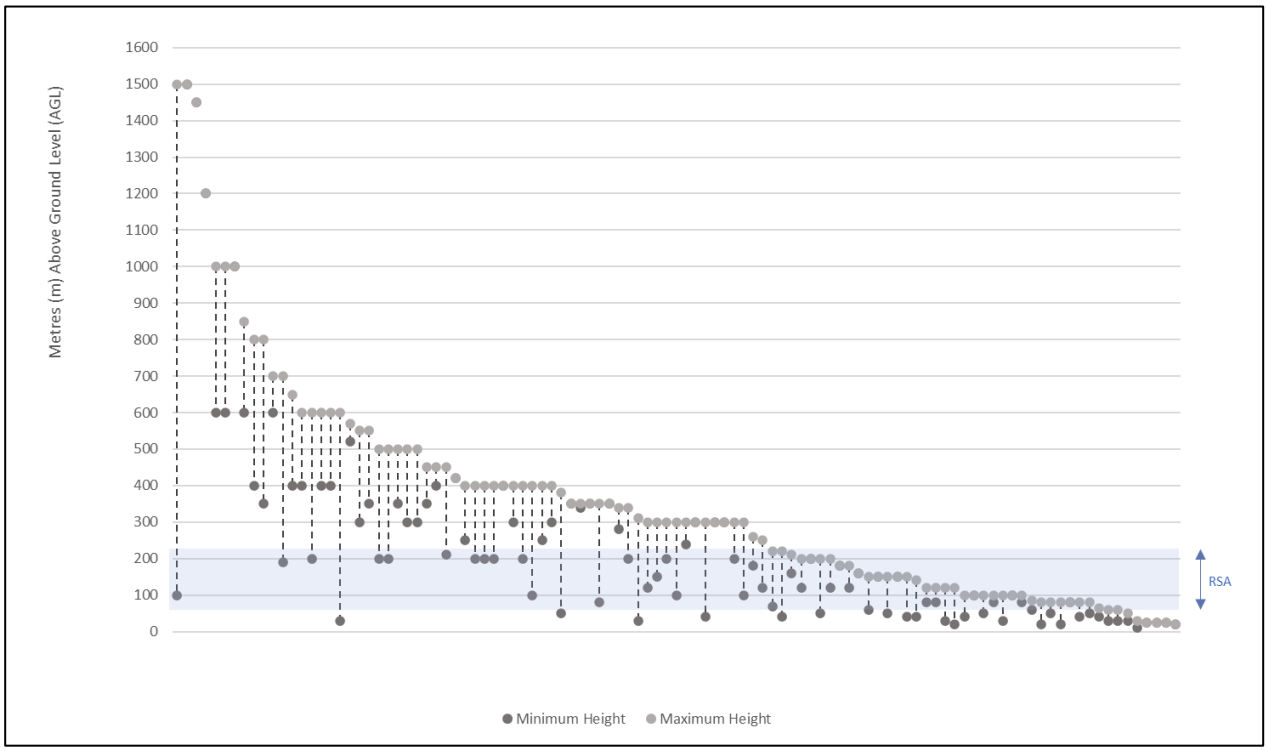
Torresian crow were observed on 161 occasions, 63 instances during all surveys of which 31.9% were visual records across all surveys where most commonly as individuals with some observations of pairs and small flocks (up to 16 individuals). 49.2% of visual observations made during all surveys were of crows transiting the Study Area air space through the RSA (**Graph 3.4**). Torresian crow were recorded at a height of 800 m, this flight height is not included in **Graph 3.4** to better display flight heights within the RSA.



Graph 3.4 Torresian crow minimum and maximum heights recorded during the BBUS program

Wedge-tailed Eagle

Wedge-tailed eagle were observed on 125 occasions across all surveys, usually solitarily or in pairs, with two observations of small flocks (three and four eagles). 64.5% of wedge-tailed eagles of observations involved birds circling through the Study Area air space, with the remaining 35.5% transiting overhead. 63% of these observations involved flight within the RSA (**Graph 3.5**).



Graph 3.5 Wedge-tailed eagle minimum and maximum heights recorded during the BBUS program

White-throated Needletail

White-throated needletail was recorded on 30 occasions flying over a diversity of habitat types, both incidentally and during BBUS. A total of 698 individuals have been recorded during surveys with a total of 324 individuals recorded at vantage points during BBUS and a total of 374 individuals recorded incidentally across all survey events. The number of individuals observed in aggregations ranged from one to 180. During the morning BBUS survey period (6 am to 10 am) a total of 413 individuals were recorded. During the midday BBUS survey period (10 am to 2 pm) a total of 236 individuals were recorded. During the afternoon BBUS survey period (2 pm to 6 pm) a total of 49 individuals were recorded.

A summary of the white-throated needletail records made throughout the field survey program is provided in **Table 3.5.**

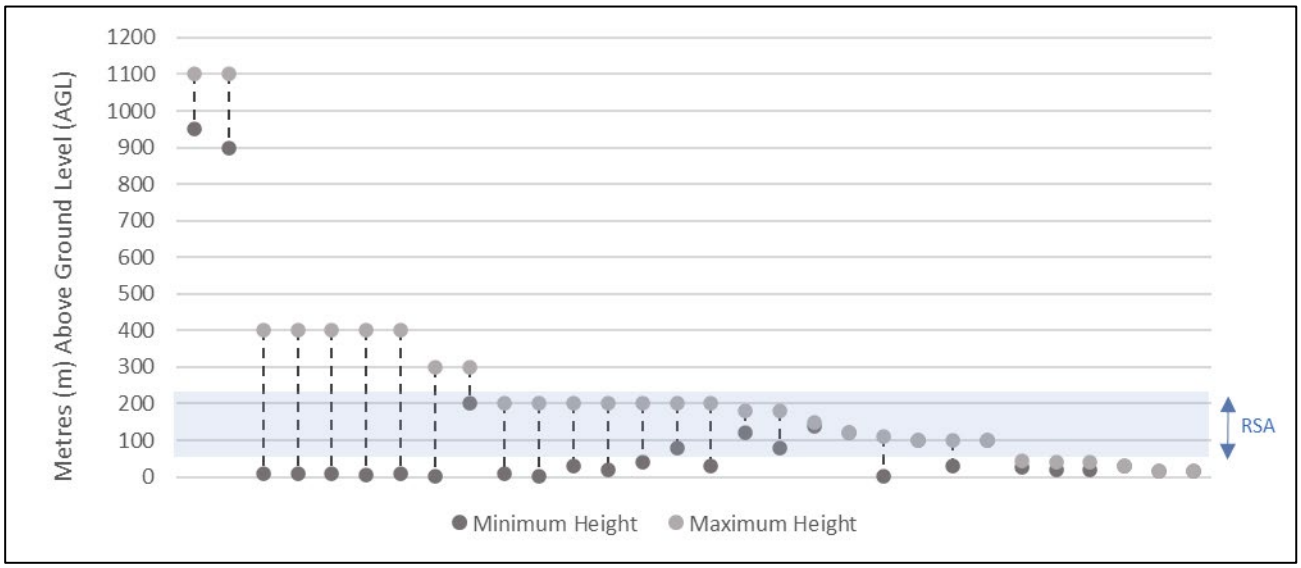
Table 3.5 White-throated Needletail Records

Date	Survey Period	Latitude (GDA94)	Longitude (GDA 94)	Count
28/02/2020	Morning (6 am–10 am)	-23.883207	150.486404	70
29/02/2020	Morning (6 am–10 am)	-23.88362202	150.4866362	29
29/02/2020	Morning (6 am–10 am)	-23.88349405	150.4865347	1
29/02/2020	Morning (6 am–10 am)	-23.827547	150.59845	6
3/03/2020	Morning (6 am–10 am)	-23.81588274	150.5512635	10
3/03/2020	Morning (6 am–10 am)	-23.816328	150.550781	25
3/03/2020	Morning (6 am–10 am)	-23.81638452	150.550749	2

Date	Survey Period	Latitude (GDA94)	Longitude (GDA 94)	Count
3/03/2020	Morning (6 am–10 am)	-23.81248477	150.5196786	1
4/03/2020	Morning (6 am–10 am)	-23.816097	150.551132	16
4/03/2020	Morning (6 am–10 am)	-23.826971	150.543045	10
4/03/2020	Morning (6 am–10 am)	-23.811903	150.519531	7
4/03/2020	Morning (6 am–10 am)	-23.816105	150.551132	1
4/03/2020	Morning (6 am–10 am)	-23.816105	150.551147	6
4/03/2020	Morning (6 am–10 am)	-23.821007	150.549469	4
12/11/2020	Midday (6 am–10 am)	-27.7006771	152.9148582	4
23/01/2021	Morning (6 am–10 am)	-23.91164328	150.5654752	180
23/01/2021	Morning (6 am–10 am)	-23.91502085	150.567564	45
29/02/2020	Midday (10 am–2 pm	-23.866512	150.6091	15
4/03/2020	Midday (10 am–2 pm	-23.886278	150.617828	25
4/03/2020	Midday (10 am–2 pm	-23.886259	150.617813	25
4/03/2020	Midday (10 am–2 pm	-23.899616	150.623108	4
4/03/2020	Midday (10 am–2 pm	-23.891569	150.618912	5
8/11/2020	Midday (10 am–2 pm	-23.8726454	150.5926574	5
23/01/2021	Midday (10 am–2 pm	-23.91468987	150.6024838	120
11/11/2020	Midday (10 am–2 pm	-23.82534656	150.5420071	10
22/1/2021	Midday (10 am–2 pm	-23.91879832	150.5908907	20
22/1/2021	Midday (10 am–2 pm	-23.9152745	150.5684851	3
14/02/2020	Afternoon (2 pm–6 pm)	-23.79161437	150.5870644	5
25/02/2020	Afternoon (2 pm–6 pm)	-23.862768	150.562439	43
8/11/2020	Afternoon (2 pm–6 pm)	-23.873354	150.5921572	1

While only nine of these records were made during the bird utilisation survey, minimum and maximum flight height was often recorded during other ecological surveys, allowing for analysis of 76.7% of all records (**Graph 3.6**). Needletails were observed transiting through and foraging in circular movements through the Study Area airspace. Approximately 50% of observations involved flocks of 10 or more individuals, with two large flocks of 120 and 180 needletails recorded during an ecological survey in January 2021. A total of 73.3% of observations involved flight within the RSA.

Records throughout a migration event generally began during spring when the species arrives in Australia and ended in autumn when the species is leaving Australia. Data has been collected across two migration events recording 310 individuals during the 2019-2020 migration and 384 individuals during the 2020–2021 migration.



Graph 3.6 White-throated needletail minimum and maximum heights

3.2.3 Bat Utilisation Survey

Call data from the anabat swift units from all bat utilisation surveys found 18 microbats to be present in the Study Area, nine of which were found during every season surveyed (**Table 3.6**). None of the microbat species identified are listed under the EPBC Act or NC Act. Total calls from each species and mixed groups are presented in **Appendix C**.

Table 3.6 Microbat species detected during all call detection nights

Common Name	Scientific Name	Jul 2019	Feb-Mar 2020	Nov 2020	Jan 2021	Feb 2022
bristle-faced free-tailed bat	*Setirostris eleryi*		X			
chocolate wattled bat	*Chalinolobus morio*	X	X	X	X	X
eastern bent-winged bat	*Miniopterus orianae*	X	X	X	X	
eastern free-tailed bat	*Ozimops ridei*	X	X	X	X	X
eastern horseshoe-bat	*Rhinolophus megaphyllus*	X	X		X	X
Gould's wattled bat	*Chalinolobus gouldii*	X	X	X	X	X
hoary wattled bat	*Chalinolobus nigrogriseus*		X	X	X	X
inland broad-nosed bat	*Scotorepens balstoni*		X			X
lesser long-eared bat or Gould's long-eared bat	*Nyctophilus sp* (*N. geoffroyi* or *N. gouldi*)		X			X
little bent-wing bat	*Miniopterus australis*	X	X	X	X	X
little broad-nosed bat	*Scotorepens greyii*	X	X	X	X	X
little pied bat	*Chalinolobus picatus*		X			X
northern broad-nosed bat	*Scotorepens sanborni*	X	X	X	X	X
northern freetail bat	*Chaerephon jobensis*	X	X	X	X	X
northern free-tailed bat	*Ozimops lumsdenae*	X	X	X	X	X
south-eastern broad-nosed bat	*Scotorepens orion*				X	X

Common Name	Scientific Name	Jul 2019	Feb-Mar 2020	Nov 2020	Jan 2021	Feb 2022
Troughton's sheathtail bat	*Taphozous troughtoni*		X			X
yellow-bellied sheathtail bat	*Saccolaimus flaviventris*	X	X		X	X

3.3 Likelihood of Occurrence

The likelihood of occurrence assessment includes the five recorded listed species, and an additional five species with a High or Moderate potential of occurring in the Study Area (**Table 3.7**).

Table 3.7 Likelihood of Occurrence

Common Name	Scientific Name	NC Act Status	EPBC Act Status
Known			
glossy black-cockatoo	*Calyptorhynchus lathami erebus*	Vulnerable	-
rufous fantail	*Rhipidura rufifrons*	Special Least Concern	Migratory
spectacled monarch	*Monarcha trivirgatus*	Special Least Concern	Migratory
squatter pigeon (southern)	*Geophaps scripta scripta*	Vulnerable	Vulnerable
white-throated needletail	*Hirundapus caudacutus*	Vulnerable	Vulnerable; Migratory
High			
black-faced monarch	*Monarcha melanopsis*	Special Least Concern	Migratory
oriental cuckoo	*Cuculus optatus*	Special Least Concern	Migratory
fork-tailed swift	*Apus pacificus*	Special Least Concern	Migratory
satin flycatcher	*Myiagra cyanoleuca*	Special Least Concern	Migratory
Moderate			
Latham's snipe	*Gallinago hardwickii*	Special Least Concern	Migratory

3.4 Risk Assessment

Based on the risk rating criteria outlined in **Section 2.4.2** and **2.4.3**, 35 bird species and 21 bat species were included in the risk assessment. The risk rating for each bird and bat species considered in the risk assessment is presented in **Table 3.8**.

An additional three species have been assessed despite their low likelihood of occurrence within the Study Area including red goshawk, ghost bat and grey-headed flying fox. The inclusion of these species in the risk assessment is resultant of the Project's Request for Information (RFI) as requested by DCCEEW. These species have been addressed in **Section 3.4.1**, **Section 3.4.2** and **Section 3.4.3**.

The rationale for species ranked Very High and Moderate-High is also listed in this section, and the remaining species' risks are discussed in **Appendix D**.

Table 3.8 Risk Assessment Ratings

Common Name	Scientific Name	Likelihood	Consequence	Risk Rating
white-throated needletail	*Hirundapus caudacutus*	High	High	Very High
microbat species	microchiroptera	High	Low - Moderate	Moderate-High
red goshawk	*Erythrotriorchis radiatus*	Low	High	Moderate
ghost bat	*Macroderma gigas*	Low	High	Moderate
grey-headed flying-fox	*Pteropus poliocephalus*	Moderate	Moderate	Moderate
Australian magpie	*Gymnorhina tibicen*	High	Low	Moderate
black flying fox	*Pteropus alecto*	High	Low	Moderate
black kite	*Milvus migrans*	High	Low	Moderate
brown falcon	*Falco berigora*	High	Low	Moderate
brown goshawk	*Accipiter fasciatus*	High	Low	Moderate
channel-billed cuckoo	*Scythrops novaehollandiae*	High	Low	Moderate
collared sparrowhawk	*Accipiter cirrocephalus*	Moderate	Moderate	Moderate
glossy black-cockatoo	*Calyptorhynchus lathami*	Moderate	Moderate	Moderate
grey goshawk	*Accipiter novaehollandiae*	Moderate	Moderate	Moderate
nankeen kestrel	*Falco cenchroides*	High	Low	Moderate
noisy friarbird	*Philemon corniculatus*	High	Low	Moderate
peregrine falcon	*Falco peregrinus*	High	Low	Moderate
pacific baza	*Aviceda subcristata*	High	Low	Moderate
fork-tailed swift	*Apus pacificus*	High	Low	Moderate
pied currawong	*Strepera graculina*	High	Low	Moderate
rainbow bee-eater	*Merops ornatus*	High	Low	Moderate
squatter pigeon	*Geophaps scripta scripta*	Moderate	Moderate	Moderate
topknot pigeon	*Lopholaimus antarcticus*	High	Low	Moderate
Torresian crow	*Corvus orru*	High	Low	Moderate
tree martin	*Petrochelidon nigricans*	High	Low	Moderate
wedge-tailed eagle	*Aquila audax*	High	Low	Moderate
whistling kite	*Haliastur sphenurus*	High	Low	Moderate
black-faced monarch	*Monarcha melanopsis*	Moderate	Low	Minor
blue-faced honeyeater	*Entomyzon cyanotis*	Moderate	Low	Minor
galah	*Eolophus roseicapilla*	Moderate	Low	Minor
Latham's snipe	*Gallinago hardwickii*	Moderate	Low	Minor
oriental cuckoo	*Cuculus optatus*	Moderate	Low	Minor
rainbow lorikeet	*Trichoglossus moluccanus*	Moderate	Low	Minor
red-tailed black-cockatoo	*Calyptorhynchus banksii*	Moderate	Low	Minor
rufous fantail	*Rhipidura rufifrons*	Moderate	Low	Minor

Common Name	Scientific Name	Likelihood	Consequence	Risk Rating
satin flycatcher	*Myiagra cyanoleuca*	Moderate	Low	Minor
spectacled monarch	*Symposiachrus trivirgatus*	Moderate	Low	Minor
scaly-breasted lorikeet	*Trichoglossus chlorolepidotus*	Moderate	Low	Minor
sulphur-crested cockatoo	*Cacatua galerita*	Moderate	Low	Minor

3.4.1 Red Goshawk

3.4.1.1 Information on red goshawk from Australian wind farms

There is no publicly available information on blade strike from wind farms located within this species' Australian range. Raptors and other large birds of prey are particularly susceptible to collision risk at wind farms. The placement of wind turbines coincides with areas where raptors soar on ridge-lift (Debus 2019).

3.4.1.2 Likelihood and Consequence of Impacts

The overall risk rating for red goshawk is Moderate, based on a Low likelihood and High consequence of collisions. The rationale for responses to each criterion is as follows:

- Red goshawk was not recorded during Project associated surveys as such, it is difficult to determine whether red goshawk flight activity occurs at RSA height. One study indicated the species is capable of flying up to 150 m AGL (Hertog 1986). Another study describing behaviour of what was potentially a pair of red goshawks described the species flying approximately 25-30 m above tree height (Smith 1991). Given the lack of flight data and observations of the species during Project associated surveys it can be assumed based on the above information that a portion of red goshawk flight activity could occur at RSA height.
- Despite extensive survey through bird utilisation surveys over four seasons and diurnal bird survey throughout the field survey program, red goshawk was not recorded within the Study Area. The species is considered to be extinct in the Rockhampton region (Noske 2021).
- Red goshawk is sparsely disbursed across coastal and sub-coastal regions of northern and eastern Australia from the Kimberley Division to north-eastern New South Wales (Marchant & Higgins 1993). The species and its habitat are widely distributed.
- The life-history characteristic of red goshawk overlap with certain aspects of both the descriptions for a 'low' and 'high' rating for Criterion D (Marchant & Higgins 1993).
- The total red goshawk Australian population is estimated to be 900 to 1400 mature individuals (BirdLife International 2022).
- The listing status of red goshawk is Vulnerable under the EPBC Act and Endangered under the NC Act.

The red goshawk's risk rating of Moderate reflects the low likelihood of collision in the Study Area if the species were to occur and the potentially high consequence. This assessment has been made based on assumptions relevant to red goshawk flight heights and the associated risk of collision if the species were to occur within the Study Area. The likelihood of occurrence assessment has identified red goshawk as having a low likelihood of occurring within the Study Area.

Table 3.9 Red goshawk risk assessment

	Criterion A	Criterion B	Criterion C	Criterion D	Criterion E	Criterion F
Low		X	X			
Moderate				X		
High	X				X	X
Risk Rating						
Likelihood	Low	**Consequence**	High	**Risk Rating**	**Moderate**	

3.4.2 Ghost Bat

3.4.2.1 Information on ghost bat from Australian wind farms

There is no publicly available information on blade strike from the majority of wind farms located in this species' Australian range.

3.4.2.2 Likelihood and Consequence of Impacts

The overall risk rating for ghost bat is Moderate, based on a Low likelihood and High consequence of collisions. The rationale for responses to each criterion is as follows:

- Ghost bat was not recorded during Project associated surveys however, it is unlikely to regularly fly at RSA height.
- Ghost bat was not recorded during project associated surveys. Database records (ALA 2022b) indicate the species has the potential to occur within the general location of the Study Area indicating a moderate likelihood of occurrence based on an anticipated low presence within the Study Area.
- Ghost bat distribution is largely discontinuous, and species aggregate and rely on caves (Threatened Species Scientific Committee (TSSC) 2016).
- The life-history characteristic of ghost bat overlap with certain aspects of both the descriptions for a 'low' and 'high' rating for Criterion D (TSSC 2016).
- The total population of ghost bat is estimated at between 4,000 and 6,000 individuals (Armstrong *et al.* 2021).
- The listing status of ghost bat is listed as Vulnerable under the EPBC Act and Endangered under the NC Act.

Ghost bat's Moderate risk rating largely reflects the high consequence of blade strike and low likelihood of collision in the Study Area is likely to have on this species overall.

Table 3.10 Ghost Bat Risk Assessment

	Criterion A	Criterion B	Criterion C	Criterion D	Criterion E	Criterion F
Low	X	X				
Moderate				X	X	
High			X			X
Risk Rating						
Likelihood	Low	**Consequence**	High	**Risk Rating**	**Moderate**	

3.4.3 Grey-headed Flying-Fox

3.4.3.1 Information on ghost bat from Australian wind farms

There is no publicly available information on blade strike from the majority of wind farms located in this species' Australian range.

3.4.3.2 Likelihood and Consequence of Impacts

The overall risk rating for grey-headed flying-fox is Moderate, based on a Moderate likelihood of collision and Moderate consequence of collisions. The rationale for responses to each criterion is as follows:

- Grey-headed flying-fox was not recorded during Project associated surveys. They regularly fly below RSA height and are capable of flying at RSA height.
- Grey-headed flying-fox was not recorded during project associated surveys. Database records indicate the species irregularly occurs in low numbers in the region and the nearest camps where occupation has been observed are at the maximum nightly foraging extent of the species. As such this species has been assessed as having a low likelihood of occurrence.
- Grey-headed flying-fox is nomadic and widely dispersed within areas of suitable habitat, and the habitat itself is widely dispersed.
- The life-history characteristic of grey-headed flying fox overlap with certain aspects of both the descriptions for a 'low' and 'high' rating for Criterion D.
- The total population of grey-headed flying-fox is estimated at 25,000 individuals.
- The listing status of grey-headed flying-fox is Vulnerable under the EPBC Act and the NC Act.

Table 3.11 Grey-headed Flying-fox Risk Assessment

	Criterion A	Criterion B	Criterion C	Criterion D	Criterion E	Criterion F
Low		X			X	
Moderate	X		X	X		X
High						
Risk Rating						
Likelihood	Moderate	**Consequence**	Moderate	**Risk Rating**	**Moderate**	

3.4.4 White-throated Needletail

3.4.4.1 Information on white-throated needletail from Australian wind farms

White-throated needletail has been assigned an overall risk rating of Very High. This species is particularly vulnerable to blade strike (Hull *et al.* 2013). Five birds have been found during post-construction mortality monitoring conducted at 15 wind farms in Victoria from 2003 to 2018 (Moloney, Lumsden & Smales 2019). There are 11 records of blade strike of white-throated needletail at both Bluff Point Wind Farm and at Studland Bay Wind Farm in north-west Tasmania (Hull *et al.* 2013). White-throated needletail are known to have collided with wind turbines in south-east New South Wales, with much of the data collected in this region being not publicly available (BCD unpublished data). Despite this, there are six records of deceased white-throated needletail at Capital Wind Farm from 2012/13 on the Atlas of Living Australia.

3.4.4.2 Likelihood and Consequence of Impacts

The overall risk rating for white-throated needletail is Very High, based on a High likelihood and High consequence of collisions. The rationale for responses to each criterion is as follows:

- A high proportion of the white-throated needletail's flight activity is at RSA height.
- White-throated needletail regularly occurs in or moves through the Study Area between October and April.
- An ecologically significant proportion of the white-throated needletail's population is likely to occur in and migrate through the Study Area each year due to the Study Area's location and position in the landscape spanning the forested eastern escarpment of the Great Dividing Range. Observations from the Study Area indicate that an internationally significant proportion of its population occurs in the Study Area annually (Department of the Environment 2015). The Study Area spans the main north – south corridor of forested mountainous habitat in the greater region and is hence likely to comprise important foraging and roosting habitat and constitute the most frequently used migratory pathway in the region. Hence, criterion C is assigned 'high'.
- The life-history characteristics of the white-throated needletail overlap with certain aspects of both the descriptions for a 'low' and 'high' rating for Criterion D (Higgins 1999).
- The total population for the species is estimated to be approximately 41,000 birds (Garnett and Baker 2021) and has undergone a 30 to 50% decline in recent decades (Tarburton 2014; TSSC 2019).
- White-throated needletail is listed as Vulnerable and migratory under the EPBC Act.

The white-throated needletail's risk rating of Very High reflects the high likelihood of collision in the Study Area and the potentially high consequence of such given a substantial proportion of the white-throated needletail's declining population is likely to occur in and move through the Study Area each year.

Table 3.12 White-throated Needletail Risk Assessment

	Criterion A	Criterion B	Criterion C	Criterion D	Criterion E	Criterion F
Low						
Moderate				X	X	X
High	X	X	X			
Risk Rating						
Likelihood	High	**Consequence**	High	**Risk Rating**	**Very High**	

3.4.4.3 Collision Risk Modelling

Species that received a Very High overall risk rating from the risk assessment in **Section 3.4** were subject to collision risk modelling to determine the actual predicted impacts to the species from the Project.

Collision risk modelling was provided by Biosis for white-throated needletail for the Mount Hopeful Wind Farm based on the BBUS data that has been collected for the Project (**Section 2.4;** Appendix B of Attachment G (Bird and Bat Adaptive Management Plan) of the Preliminary Documentation). The assessment was based on the two different turbine dimensions outlined in **Section 1.2.2**. The results are presented as the projected annual number of potential collisions and are presented in **Table 3.13**.

Table 3.13 Annual Collision Risk Model Results for White-throated Needletail

Turbine Option	Estimated Annual Number of Collisions for Three Dynamic Avoidance Rate Scenarios		
	0.990	0.995	0.999
Vestas V162	0.172	0.089	0.022
General Electric GE 164	0.166	0.083	0.017

At the time of writing this report no empirical data was available to determine the avoidance capacity of white-throated needletails at wind energy facilities. Given the agility of the species it is probable that their capacity to avoid collisions is within the range of modelled avoidance rates set out in **Table 3.13**. At a lower, conservative extreme, the results at 0.99 dynamic avoidance rate are about 0.17 collisions per annum for white-throated needletails for either of the two turbine specifications modelled. This would equate to an approximate average of one white-throated needletail collision in 5.9 years. Results for the highest avoidance rate of 0.999 (estimated annual collision of approximately 0.02) would equate to an approximate average of one white-throated needletail collision in 50 years.

Results of the collision risk modelling undertaken by Biosis (Appendix B of Attachment G of the Preliminary Documentation) indicate little difference in risk to white-throated needletails between the two turbine options. As noted above, the differences in flight heights below and within RSA as they relate to the two turbine specifications are due to a single observation of 29 birds recorded at 70 metres height. Thus, the small difference between modelled results cannot be considered to be a reliable indicator of different risks due to the different rotor heights of the two turbines.

Rather than rotor-height, the primary factor influencing the slightly different results for the two turbines is the higher rotor speed of the Vestas turbine, with an average of 12.1 revolutions per minute, compared to an average rotor speed of 9.7 revolutions per minute for the General Electric turbine. As the average flight speed of the species is held as a constant in the risk model, greater rotor speed exposes a bird interacting with a turbine to a heightened level of collision risk.

3.4.5 Non-listed Microbats

A total of 18 non-listed microbats were detected in the Study Area during bat call detection nights, with four species recorded from the Anabat Swift device placed at 50 m AGL (Gould's wattled bat, little bent-wing bat, northern freetail bat, yellow-bellied sheathtail bat), noting that calls may be detected from approximately 20 m below the device.

Of the species detected in the Study Area it is considered probable that seven species may fly above 55 to 80 m AGL, namely Gould's wattled bat, large bent-winged bat, northern freetail bat, northern free-tailed bat, eastern free-tailed bat, yellow-bellied sheathtail bat, Troughton's sheathtail bat. In the absence of data from RSA height in the Study Area a very high level of uncertainty is inherently associated with any estimate relating to whether each species rarely, occasionally or regularly flies at RSA height (a crucial component of the risk assessment method followed in this report).

Given the height of the RSA proposed to be installed in the Study Area it is unlikely that any of these species match a High rating for Criterion A, that is a species in which a high proportion of flight activity is at RSA height. Rather a Moderate rating is most accurate for the seven aforementioned species identified as being most likely to fly at RSA height. Thus, either an overall risk rating of Moderate may be most accurate for those of the aforementioned seven species that are assigned an overall Low rating for consequence and an overall risk rating of High for species assigned an overall Moderate rating for consequence.

Table 3.14 Microbat Risk Assessment

	Criterion A	Criterion B	Criterion C	Criterion D	Criterion E	Criterion F
Low			X		X	X
Moderate	X			X	X	
High		X				
Risk Rating						
Likelihood	High	**Consequence**	Low - Moderate	**Risk Rating**	**Moderate - High**	

4.0 Potential Impacts

This section provides a high-level overview of common impacts to volant wildlife from wind turbine projects. A final BBAMP that addresses these impacts along with site-specific and regional considerations of wind farm-species interactions will be prepared prior to the operation of the wind farm.

Additionally, Appendix E of Attachment B (Assessment of Matters of National Environmental Significance) of the Preliminary Documentation includes a significant impact assessment, which considers impacts to threatened species based on the area of relevant habitat to be impacted by the Project.

4.1 Collisions

Mortality at wind farms can result from birds or bats colliding with wind turbine blades, towers, nacelles, guy cable, power lines and meteorological masts. There are a range of factors that influence risk of collisions with such infrastructure including (Drewitt & Langston 2008):

- Physical attributes of a wind turbine generator (i.e., turbine dimensions, lighting).
- Species-specific variables (i.e., abundance, flight behaviour, turbine avoidance capacity).
- Biophysical attributes (i.e., landscape position, topography, vegetation type).

Factors falling under the latter two points are often interrelated and generally highly spatially and temporally variable by nature. Proximity to roost locations, migratory flight pathways and wetlands appear to be particularly important factors that influence bird and bat utilisation. A range of other factors not necessarily related to a site's biophysical state such as weather conditions (inc. wind speed, temperature and relative humidity) can also affect utilisation and therefore collision risk (e.g., Amorim 2012).

Data from Australia, Europe and North America indicate that the risk of collision is likely to be highest in any given area or landscape where species most susceptible to collision (i.e., migratory species, raptors, swifts, waterbirds, high flying microbats) most frequently occur and lowest in areas where activity of such species is comparatively low. The consequence of mortality resulting from collision for any given species is largely influenced by the species' population size and life history traits such as longevity and fecundity which combine to determine a species' capacity to replace individuals lost.

4.2 Barotrauma

Barotrauma is a phenomenon in which rapid air pressure changes cause tissue damage to air-containing structures, most notably the lungs (Baerwald *et al.* 2009). It is thought that barotrauma can also result in non-lethal injuries, such as hearing impairments and other internal injuries that may result in bats succumbing to their injuries away from turbines (US Fish and Wildlife Service 2012).

Research conducted in North America on the relative risk of barotrauma compared with direct collisions has resulted in mixed findings regarding the proportion of deaths that have been attributed to each factor (Ellison 2012) though it appears the majority of fatalities are due to collisions (Grodsky *et al.* 2011; Rollins *et al.* 2012).Baerwald *et al.* (2009) found that barotrauma to the lungs and possibly other organs accounted for 46% of bats killed at turbines with 92% of bats having haemorrhaging in the thoracic and/or abdominal cavities. Rollins *et al.* (2012) found that only 6% (5/81) of bats collected at a wind farm in Illinois had lesions possibly consistent with barotrauma etiology leading the authors to conclude that 'traumatic injury is the major cause of bat mortality at wind farms, and, at best, barotrauma is a minor etiology'.

Due to the difficulty in diagnosing barotrauma unless the carcass is examined immediately after death, it is possible that cases attributed to barotrauma have been confused with traumatic injury associated with direct collisions.

There is currently no published information on barotrauma in Australia.

4.3 Barrier Effects

Barrier effects can be caused by wind turbines disrupting links between feeding, roosting and/or nesting areas, or diverting flights, including migratory flights, around a wind farm (Hötker, Thomsen & Köster 2006; Schuster, Bulling & Köppel 2015). Migrating species that pass wind farms frequently such as swifts appear to be of higher concern than other species (Hötker, Thomsen & Köster 2006). However, these effects on birds, possibly resulting in higher energy consumption or injuries as a result of collision, are not yet well known (Schuster, Bulling & Köppel 2015).

There is currently no published information on barrier effects from wind farms in Australia.

5.0 Management Actions

Neoen propose an adaptive management approach to turbine strike impacts, informed by seasonal surveys. This section outlines the adaptive management approach and presents mitigation measures which are considered in the Preliminary Bird and Bat Adaptive Management Plan (BBAMP) (Attachment G of the Preliminary Documentation).

5.1 Adaptive Management Plan

Neoen will undertake monitoring and management actions in accordance with the BBAMP for the Project (Attachment G of the Preliminary Documentation). The strategy of the management plan is to monitor and mitigate the potential impacts of turbine strike on birds and bats via trigger based, adaptive management. Pre and post commissioning monitoring of bird and bat activity (including flight behaviours) is a key requirement of the plan. The monitoring will inform a risk profile of each turbine to direct tailored management actions as when, and where required.

The specific objectives of the BBAMP include:

- Provide an overview of pre-commissioning survey results for the Project.
- Present the outcomes of the collision risk assessment, focussing on species which were deemed a high or very high risk of collision impacts.
- Present an overview of post-commissioning survey requirements including further bird and bat utilisation survey, as well as a carcass detection program.
- Provide proposed impact trigger thresholds for EPBC Act listed threatened and migratory species.
- Present the adaptive management framework to be initiated in the event that a trigger threshold is reached or exceeded.
- Outline ongoing and preventative mitigation and management measures, as well as reporting requirements.

5.2 Mitigation Measures

There are a range of mitigation measures employed at wind farms globally to reduce the impact of operating turbines on birds and bats. These include measures designed to deter birds and bats from turbines, measures employed to minimise the attractiveness of turbines and measures used to lure birds and bats away from turbines. Other measures include altering the operation of turbines such that the risk of birds and/or bats that do fly through a turbine's RSA may be at lower risk of impact. Despite the widespread implementation of several mitigation measures there has been relatively little empirical research conducted on the efficacy of the majority of those that have been employed (Gartman *et al.* 2016). Only a few mitigation measures specifically employed to reduce bird and bat collision risk overseas are regularly implemented in Australia and to date there has been no empirical research published on the effectiveness of mitigation measures employed here.

This section outlines the main mitigation measures that have been employed in Australia and/or overseas with a focus on cases where measures appear to be effective in reducing direct impacts, noting that the aforementioned BBAMP will provide a more detailed plan for adaptive management actions to reduce impacts.

5.2.1 Carrion Removal

Removal of carrion from near turbines is undertaken at wind farms (particularly in Australia) to mitigate the risk of carrion feeders such as raptors and other scavengers colliding with turbines. Carrion removal programs typically involve regular searches of target areas for any animal. Regular searches and removal limit the amount of time carcasses are present to attract scavengers and can be complemented by opportunistic identification by personnel undertaking unrelated work at a given wind farm.

Despite carrion removal programs being a key component of most bird and bat adaptive management plans prepared for wind farms in Australia, there is currently no publicly available information based on empirical research on their effectiveness. However, regular carrion removal is an established technique to reduce the presence of aerial scavengers employed in aviation to reduce the risk of aircraft bird strike (Australian Airports Association 2016).

5.2.2 Lighting

There is inconsistency amongst recommended use of (or avoidance of) lighting on wind turbines to specifically reduce impacts on birds and bats. This is probably partly due to variability in the way in which different species appear to respond (or not) to different lighting arrangements or configurations (i.e., according to colour, constant vs flashing etc) and the overall poor understanding of bird and bat interactions with turbines at night.

In instances where lighting is required on wind turbines it appears that the use of synchronised, flashing red lights is the best option for mitigating bird and bat collisions at night. There are evidence that steady-burning lights on communication towers increase the risk of collision for nocturnal migrants (Longcore, Rich & Gauthreaux 2008). Gehring, Kerlinger & Manville (2009) found that communication towers with red strobe, red flashing, and white strobe lights result in less mortality than towers with steady-burning lights. The use of synchronised, flashing red aviation lights on wind turbines was recommended by Kerlinger *et al.* (2010) to mitigate risk of blade strike for birds as it was found that their use does not attract birds. A study conducted by Bennett & Hale (2014) found that use of flashing red aviation lights does not appear to be one of the potential causes of bat fatalities at wind farms leading the authors to recommend red aviation lights on turbines over other options to manage impacts on bats.

There is currently no information on the influence of lighting on wind turbines on bird and bat collision risk in Australia.

5.2.3 Painting Turbines

May *et al.* (2020) demonstrated that painting one wind turbine blade black reduced the annual bird fatalities across a range of bird species by 70%, compared to a non-painted turbine. Painting a turbine blade increased rotor visibility by reducing 'motion smear', the phenomenon where fast-moving objects appear to blend together.

It is noted that painting turbine blades would conflict with standard conditions of wind farm project approval, and this measure would require additional authorisation from regulators and special consideration from all stakeholders.

5.2.4 Temporary Shutdown Periods

Employing temporary shutdown of turbines has been shown to be an effective measure for reducing fatalities of certain birds and bats (de Lucas et al. 2012; Gartman et al. 2016; Smallwood & Bell 2020). For example, de Lucas et al. (2012) investigated mortality rates for Griffon vulture (*Gyps fulvus*) at 10 out of 13 wind facilities in Spain by conducting turbine shutdown programs from 2008 to 2009 and compared rates from a non-stop program in 2006 to 2007. The researchers found that selectively stopping a few turbines during a few months of the year can significantly reduce mortality rates by more than 50% (de Lucas *et al.* 2012; Gallego *et al.* 2011). This mortality reduction was achieved through short shutdown periods between the first two hours after sunrise until the last two hours before sunset, resulting in only a negligible reduction (0.07%) in energy production (de Lucas et al. 2012). In another study, Smallwood & Bell (2020) found that employing turbine shutdown periods significantly reduced fatalities of bats but not of birds in the United States.

Temporary turbine shutdowns specifically designed to reduce the risk of strike of a threatened bird species (Tasmanian wedge-tailed eagle (*Aquila audax fleayi*)) are employed at the Cattle Hill Wind Farm in Tasmania, however the effectiveness of this measure on reducing collision risk has not been reported.

5.2.5 Altering Cut-In Speed of Turbines (Curtailment)

Increasing the cut-in speed of wind turbines (the velocity at which turbines start producing electricity) appears to be the most effective mitigation measure for reducing microbat mortality partly because bat mortality rates are generally higher during nights with low wind speeds (Kerns, Erickson & Arnett 2005; Rydell et al. 2010; Amorim, Rebelo & Rodrigues 2012). Investigations conducted in North America indicate that bat mortality can be reduced by increasing the cut-in speed with reductions from 30% to 90% being reported (Arnett et al. 2008; Baerwald et al. 2009; Arnett et al. 2010). Similarly, Wellig *et al.* (2018) found that collision risk could be drastically reduced if nocturnal operation of wind turbines would be restricted to wind speeds above 5 ms^{-1} at a site in Switzerland.

A curtailment study was undertaken at the Cape Nelson North wind farm in southwest Victoria which reported similar results to international studies showing a significant decrease in bat mortality of 54% when curtailment measures were applied to the site (Bennett *et al.* 2022). This mitigation measure appears to be most effective at locations where there is a high frequency of flights undertaken at RSA such as in migratory pathways.

6.0 Significant Impact Assessment

The potential for residual impacts on birds and bats as a result of wind turbine collisions, barotrauma and barrier effects was considered for significance against the Commonwealth Significant Impact Assessment (SIA) guidelines. Given the Project may also result in other impacts on fauna, such as habitat loss, SIAs were addressed in Attachment B of the Preliminary Documentation. A summary of this assessment, as it relates to this report are presented below.

The SIA assessment considered the potential impacts on threatened and migratory fauna, including threatened birds and bats identified as having a Moderate to Very High collision risk profile (**Section 3.4**). Disregarding habitat clearance impacts, the assessment identified no SIA to birds or bats as a result of turbine collision, barotrauma or barrier effects, noting the following reasons:

- Collision Risk Modelling:
    - Modelling for the white-throated needletail determined at a lower, conservative extreme, the results at 0.99 dynamic avoidance rate are 0.17 collisions per annum for white-throated needletails for either of the two turbine specifications modelled.
- Adaptive management:
    - The Project will be governed by a BBAMP, which identifies the operational response to bird and bat collisions in the event that mortalities are recorded and exceed trigger thresholds (the Preliminary BBAMP is provided as Attachment G of the Preliminary Documentation).
    - The BBAMP outlines a dynamic monitoring approach, with individual turbine risk profiles informing the frequency and timing of monitoring events, including carcass searches.
- Flight behaviours/infrequent visitation:
    - As documented in this report, numerous threatened and migratory species present a moderate collision due to the infrequency of flights at RSA or the infrequency of occurrence with the Study Area.
    - The predicted size of migratory bird populations, coupled with operational response measures as governed by the BBAMP reduce the likelihood of significant impacts on populations as a result of mortality from wind turbine collisions.
- Habitat availability/fauna movement corridors:
    - The Project is situated within and adjacent to a large, vegetated corridor associated with Ulam Range.
    - The Study Area does not support regionally unique habitat features (i.e., wetlands or other important foraging/roosting locations) that the Project would be otherwise restricting access to (e.g., flight barriers).
    - The Study Area does not support habitat features such as wetlands that may attract large groups of threatened or migratory water birds.
    - The Study Area does not support any known flying fox camps and is not positioned near mapped nationally important camp locations.

7.0 Conclusion

A total of 137 bird species were recorded within the Study Area during the field surveys; five of which are threatened and listed under state and/or federal legislation:

- Glossy black cockatoo.
- Rufous fantail.
- Spectacled monarch.
- Squatter pigeon (southern).
- White-throated needletail.

An additional four species were found to have a High likelihood of occurring in the Study Area, and one species with a Moderate likelihood of occurring.

The risk assessment found white-throated needletail to have a Very High risk of impact by the Project and for seven identified microbat species to have a Moderate to High-risk potential. An additional three species were included in the assessment based on the Project's RFI including red goshawk, grey-headed flying-fox and ghost bat. Despite these species Low likelihood of occurrence within the Study Area, they each received a Moderate overall risk rating. These species, along with other species with a Moderate and Minor risk potential, have been considered in the preliminary BBAMP.

In conjunction with the collision risk modelling undertaken by Biosis, the findings of this document have been used to develop the preliminary BBAMP which uses an adaptive management process to mitigate the risk of turbine strike and barotrauma on threatened and migratory bird and bat species listed under the EPBC Act. A Project BBAMP will be developed based on conditions of the Project approval which will seek to mitigate and manage Project risks on both EPBC Act and NC Act listed threatened species and non-threatened species. The preliminary BBAMP details mitigation and management procedures to be undertaken during the operational phase of the Project including:

- A carcass detection program as well as a detailed carcass persistence trial.
- A carrion removal program.
- The use of lighting and deterrents.
- Shutdown or curtailment processes based on unacceptable risks to white-throated needletail.
- Pre-clearance nest surveys for red goshawk.
- An adaptive management process based on the identification of unacceptable risks (trigger levels) to all threatened and migratory species.

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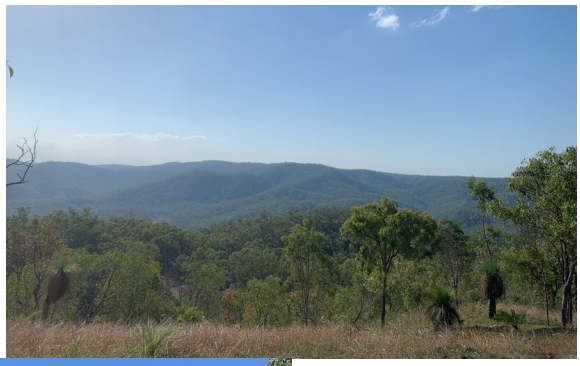
APPENDIX A

Vantage Point Photos

POM1



POM2

POM3


POM4

POM5


POM8

POM9

No photographs available

NORTH1

No photographs available

NORTH2

NORTH3

NORTH4

NORTH6


NORTH7



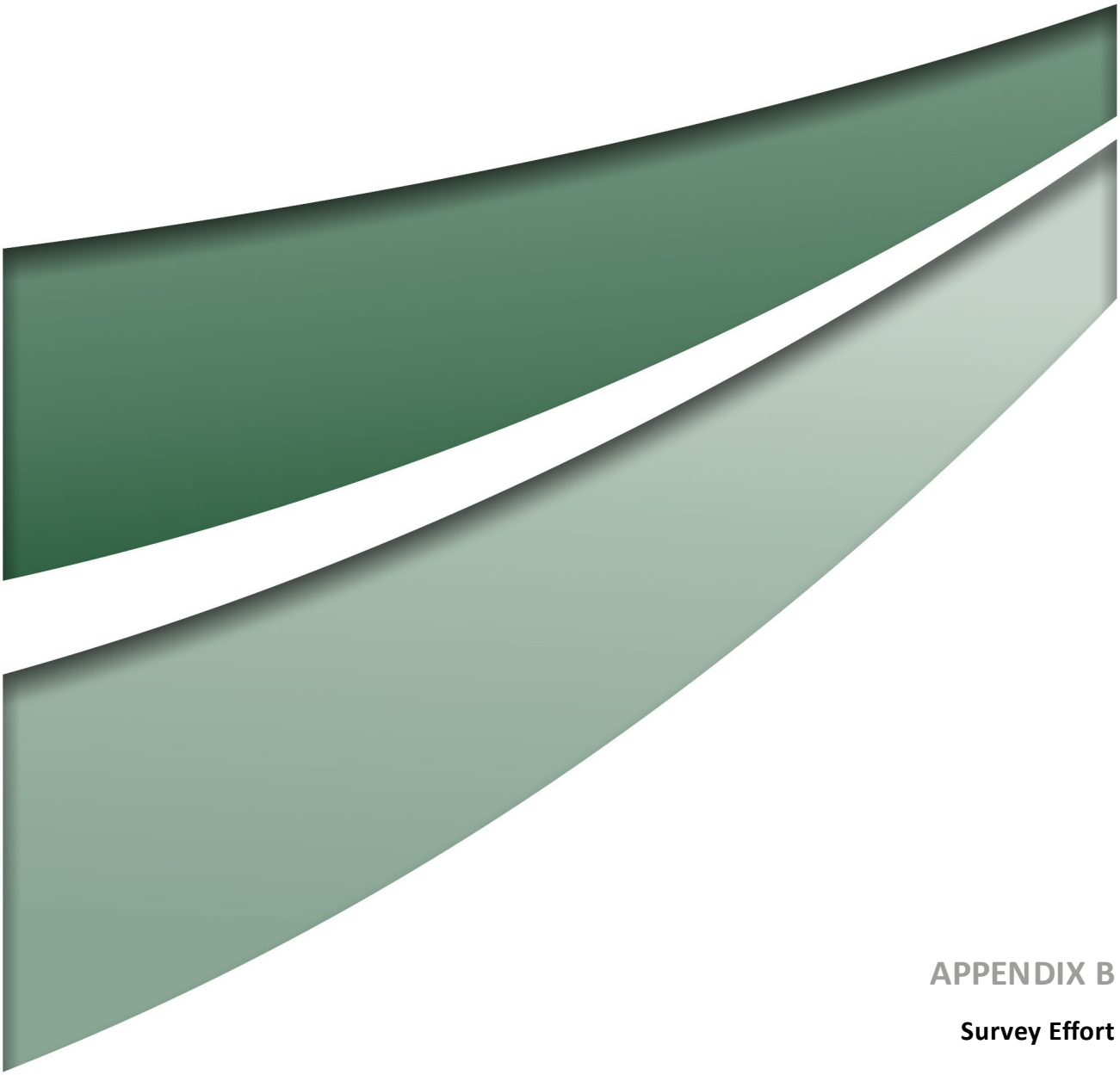


BC1




BC2



APPENDIX B

Survey Effort

Bird Utilisation Surveys

February – March 2020Vantage Point Survey Schedule (Autumn)

Survey Period	26 Feb	28 Feb	29 Feb	1 Mar	2 Mar	3 Mar	4 Mar
Morning (6:00 – 10:00)		POM2 POM3 POM9	POM3 POM5 POM8	POM3 POM4 POM9		NORTH1 NORTH4	NORTH2 NORTH3
Midday (10:00 -14:00)	POM9	POM4	POM1 POM8	POM2 POM3	NORTH2 NORTH3	NORTH1 NORTH4	
Afternoon (14:00 – 18:00)	POM2	POM3	POM1 POM5	POM4 POM9	NORTH2 NORTH3	NORTH1 NORTH4	

November 2020 Vantage Point Survey Schedule (Spring)

Survey Period	5 Nov	6 Nov	7 Nov	8 Nov	9 NOV	10 Nov	11 Nov
Morning (6:00 – 10:00)	NORTH1 NORTH2 NORTH6 NORTH7	POM2 POM3 POM4 POM5	POM1 POM2 POM3 POM8	POM1 POM4 POM5 POM8	NORTH3 NORTH4	NORTH1 NORTH3 NORTH4 NORTH6	NORTH2 NORTH7
Midday (10:00 -14:00)	NORTH1 NORTH3 NORTH4 NORTH6	POM1 POM3 POM4 POM8	POM2 POM4 POM5 POM8	POM1 POM2 POM3 POM5	NORTH2 NORTH6 NORTH7 POM1	NORTH2 NORTH3 NORTH4 NORTH7	
Afternoon (14:00 – 18:00)	NORTH2 NORTH3 NORTH4 NORTH7	POM1 POM3 POM4 POM5	POM1 POM3 POM4 POM5	POM2 POM3 POM8	NORTH1 NORTH3 NORTH4 NORTH6	NORTH2 NORTH6 NORTH7	

October 2021 Vantage Point Survey Schedule (Spring)

Survey Period	8 Oct	9 Oct	10 Oct	11 Oct	12 Oct	13 Oct	14 Oct	15 Oct
Morning (6:00 – 10:00)	NORTH7 NORTH8 NORTH6 NORTH4		NORTH6 NORTH4 NORTH7 NORTH8	POM1	POM4 POM8 POM3 POM1	POM5 POM4	BC1 BC2	POM3 POM8
Midday (10:00 -14:00)	NORTH4 NORTH6 NORTH8 NORTH7	NORTH7 NORTH4 NORTH6 NORHT8		POM4 POM8 POM5 POM4	POM1 POM4 POM8 POM3	POM8 POM3 POM1 POM5	BC1 BC2	
Afternoon (14:00 – 18:00)	NORTH6 NORTH4 NORTH7 NORTH8	NORTH8 NORTH7 NORTH4 NORTH8		POM8 POM3	POM1 POM4	POM4 POM8 POM3 POM1	BC1 BC2	

February 2022 Vantage Point Survey Schedule (Summer)

Survey Period	14 Feb	15 Feb	16 Feb	17 Feb	18 Feb	19 Feb	20 Feb	21 Feb
Morning (6:00 – 10:00)		NORTH4 NORTH6			POM4 POM8	POM1 POM3 POM4 POM5	POM1 POM3 POM5 POM8	BC1 BC2 BC1 BC2
Midday (10:00 -14:00)		NORTH4 NORTH6 NORTH7 NORTH8	NORTH4 NORTH6 NORTH7 NORTH8	NORTH4 NORTH7 NORTH8	POM1 POM3 POM4 POM5	POM3 POM4 POM5 POM8	POM1 POM3 POM4 POM8	BC1 BC2 BC1 BC2
Afternoon (14:00 – 18:00)	NORTH7 NORTH8	NORTH4 NORTH6 NORTH7 NORTH8	NORTH4 NORTH6	NORTH7	POM1 POM3 POM5 POM8	POM1 POM8	POM1 POM5	BC1 BC2

Bat Utilisation Surveys

July 2019 Survey Bat Call Detection Nights (Winter)

Site ID	Deployment Date	Retrieval Date	Total Nights
POM4	9/07/2019	11/07/2019	2
N/A (-23.8861, 150.5892)	9/07/2019	11/07/2019	2

February – March 2020 Survey Bat Call Detection Nights (Autumn)

Site ID	Deployment Date	Retrieval Date	Total Nights
North1	2/03/2020	4/03/2020	2
North2	2/03/2020	4/03/2020	2
North3	2/03/2020	4/03/2020	2
North4	2/03/2020	4/03/2020	2
POM1	25/02/2020	1/03/2020	5
POM2	25/02/2020	1/03/2020	5
POM3	29/02/2020	4/03/2020	4
POM4	26/02/2020	1/03/2020	4
POM5	26/02/2020	2/03/2020	5
POM8	1/03/2020	4/03/2020	3
POM9	26/02/2020	1/03/2020	4
Other (-23.92998, 150.57360)	26/02/2020	2/03/2020	5
Other (-23.89965, 150.62312	1/03/2020	4/03/2020	3

November 2020 Survey Bat Call Detection Nights (Spring)

Site ID	Deployment Date	Retrieval Date	Total Nights
North1	9/11/2020	11/11/2020	2
North2	9/11/2020	11/11/2020	2
North3	10/11/2020	12/11/2020	2
North4	9/11/2020	11/11/2020	2
North6	9/11/2020	11/11/2020	2
North7	9/11/2020	11/11/2020	2
Pom1	6/11/2020	7/11/2020	1
Pom2	6/11/2020	12/11/2020	6
Pom3	6/11/2020	9/11/2020	3
Pom4	6/11/2020	8/11/2020	2
Pom5	6/11/2020	8/11/2020	2
Pom8	6/11/2020	8/11/2020	2

January 2021 Survey Bat Call Detection Nights (Summer)

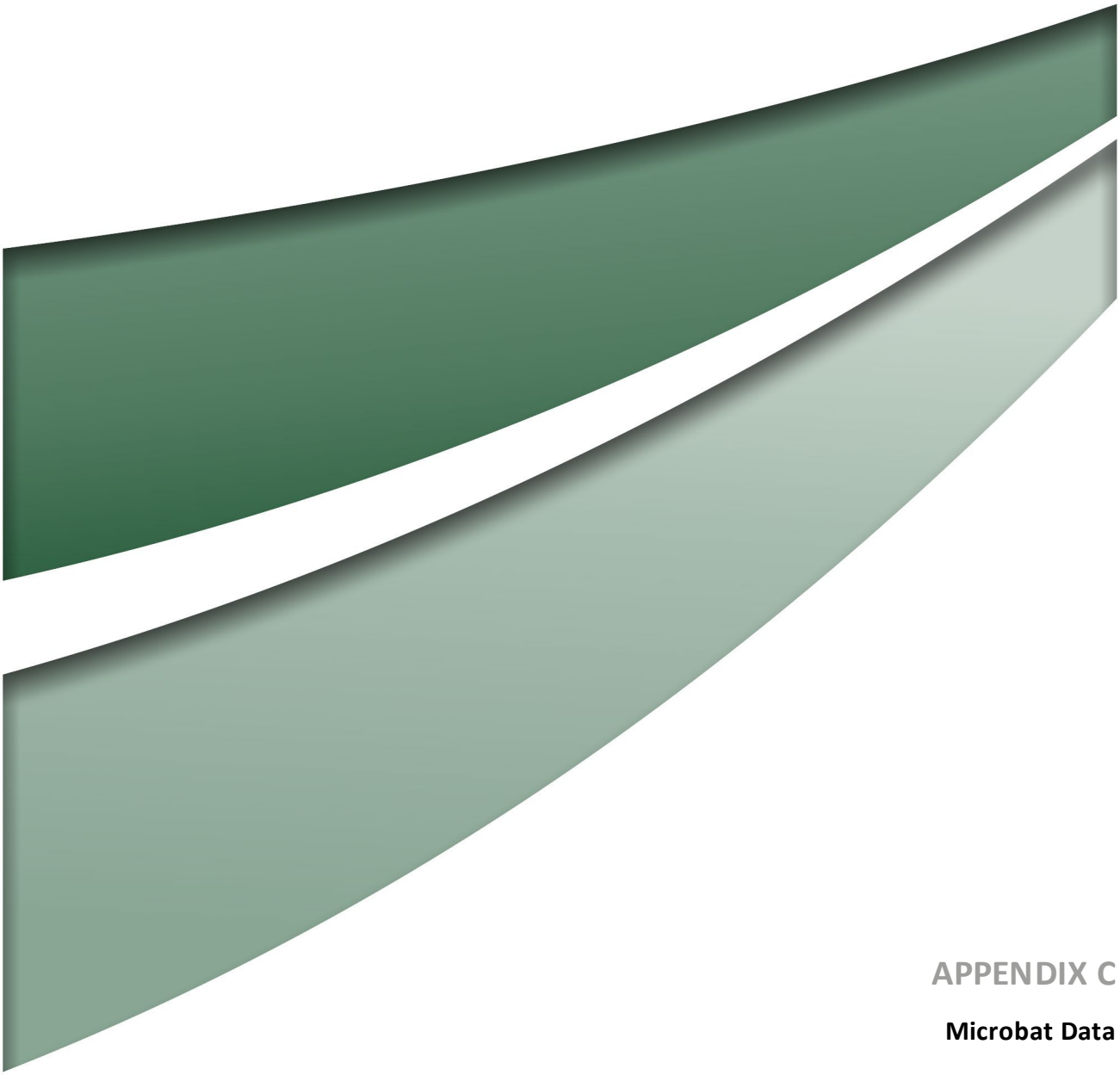
Site ID	Deployment Date	Retrieval Date	Total Nights
Other (-23.92635, 150.61061)	22/01/21	24/01/21	2
Other (-23.91968, 150.62659)	22/01/21	24/01/21	2

October 2021 Survey Bat Call Detection Nights (Spring)

Site ID	Deployment Date	Retrieval Date	Total Nights
North4	08/10/2021	10/10/2021	2
North6	08/10/2021	10/10/2021	2
North7	08/10/2021	10/10/2021	2
North8	08/10/2021	10/10/2021	2
POM1	11/10/2021	13/10/2021	2
POM3	11/10/2021	13/10/2021	2
POM4	11/10/2021	13/10/2021	2
POM5	11/10/2021	13/10/2021	2
POM8	11/10/2021	13/10/2021	2
Other (-23.7463,150.5279)	08/10/2021	10/10/2021	2
Other (-23.8649, 150.5582)	11/10/2021	13/10/2021	2

February 2022 Survey Bat Call Detection Nights (Summer)

Site ID	Deployment Date	Retrieval Date	Total Nights
North4	15/02/2022	17/02/2022	2
North6	15/02/2022	17/02/2022	2
North7	14/02/2022	17/02/2022	3
North8	14/02/2022	17/02/2022	3
POM1	18/02/2022	20/02/2022	2
POM3	18/02/2022	20/02/2022	2
POM4	18/02/2022	20/02/2022	2
POM5	18/02/2022	20/02/2022	2
POM8	18/02/2022	20/02/2022	2
Other (-23.8648, 150.5577)	18/02/2022	20/02/2022	2



APPENDIX C

Microbat Data

Microbat species and calls detected July 2019 (Winter)

Common Name	Scientific Name	Calls Detected
Individual Species		
eastern horseshoe-bat	*Rhinolophus megaphyllus*	188
northern freetail bat	*Chaerephon jobensis*	107
little bent-wing bat	*Miniopterus australis*	84
hoary wattled bat	*Chalinolobus nigrogriseus*	71
eastern free-tailed bat	*Ozimops ridei*	42
eastern bent-winged bat	*Miniopterus orianae*	5
northern free-tailed bat	*Ozimops lumsdenae*	4
northern broad-nosed bat	*Scotorepens sanborni*	3
chocolate wattled bat	*Chalinolobus morio*	2
Gould's wattled bat	*Chalinolobus gouldii*	2
little broad-nosed bat	*Scotorepens greyii*	1
Mixed Species Groups		
S. greyii / C. nigrogriseus		8

Microbat species and calls detected February – March 2020 (Autumn)

Common Name	Scientific Name	Calls Detected
Individual Species		
Gould's wattled bat	*Chalinolobus gouldii*	949
northern freetail bat	*Chaerephon jobensis*	844
northern free-tailed bat	*Ozimops lumsdenae*	327
northern broad-nosed bat	*Scotorepens sanborni*	298
yellow-bellied sheathtail bat	*Saccolaimus flaviventris*	264
little bent-wing bat	*Miniopterus australis*	209
eastern free-tailed bat	*Ozimops ridei*	187
large bent-winged bat	*Miniopterus orianae oceanensis*	160
chocolate wattled bat	*Chalinolobus morio*	62
long eared bat sp.	*Nyctophilus sp.*(*N. geoffroyi* or *N. gouldi*)	45
little broad-nosed bat	*Scotorepens greyii*	30
hoary wattled bat	*Chalinolobus nigrogriseus*	20
inland broad-nosed bat	*Scotorepens balstoni*	19
eastern horseshoe-bat	*Rhinolophus megaphyllus*	15
Troughton's sheathtail bat	*Taphozous troughtoni*	3
bristle-faced free-tailed bat	*Setirostris eleryi*	1

Common Name	Scientific Name	Calls Detected
Mixed Species Groups		
C. gouldii / S. balstoni / O. ridei		6051
C. jobensis / O. lumsdenae / S. flaviventris		1190
C. nigrogriseus / Scotorepens sp.		842
S. greyii / S. sanborni		653
S. greyii / S. sanborni / Chalinolobus picatus		63
M. o. oceanensis / S. sanborni		21
S. eleryi / S. greyii		6

Microbat species and calls detected November 2020 (Spring)

Common Name	Scientific Name	Calls Detected
Individual Species		
northern freetail bat	*Chaerephon jobensis*	2987
Gould's wattled bat	*Chalinolobus gouldii*	1661
eastern free-tailed bat	*Ozimops ridei*	397
northern broad-nosed bat	*Scotorepens sanborni*	382
little bent-wing bat	*Miniopterus australis*	355
little broad-nosed bat	*Scotorepens greyii*	65
hoary wattled bat	*Chalinolobus nigrogriseus*	21
yellow-bellied sheathtail bat	*Saccolaimus flaviventris*	20
eastern bent-wing bat	*Miniopterus orianae*	13
northern free-tailed bat	*Ozimops lumsdenae*	11
chocolate wattled bat	*Chalinolobus morio*	8
eastern horseshoe-bat	*Rhinolophus megaphyllus*	2
south-eastern broad-nosed bat	*Scotorepens orion*	1
Mixed Species Groups		
C. gouldii / O. ridei		1196
S. greyii / C. nigrogriseus		95
S. sanborni / C. picatus		74
S. flaviventris / C. jobensis		3

Microbat species and calls detected January 2021 (Summer)

Common Name	Scientific Name	Calls Detected
Individual Species		
Gould's wattled bat	*Chalinolobus gouldii*	80
little broad-nosed bat	*Scotorepens greyii*	63
northern freetail bat	*Chaerephon jobensis*	20
northern broad-nosed bat	*Scotorepens sanborni*	11
eastern horseshoe-bat	*Rhinolophus megaphyllus*	8
yellow-bellied sheathtail bat	*Saccolaimus flaviventris*	6
eastern free-tailed bat	*Ozimops ridei*	4
little bent-wing bat	*Miniopterus australis*	2
eastern bent-wing bat	*Miniopterus orianae*	2
northern free-tailed bat	*Ozimops lumsdenae*	1
chocolate wattled bat	*Chalinolobus morio*	1
Mixed Species Groups		
S. sanborni / C. picatus		17
C. gouldii / O. ridei		10
S. greyii / C. nigrogriseus		2

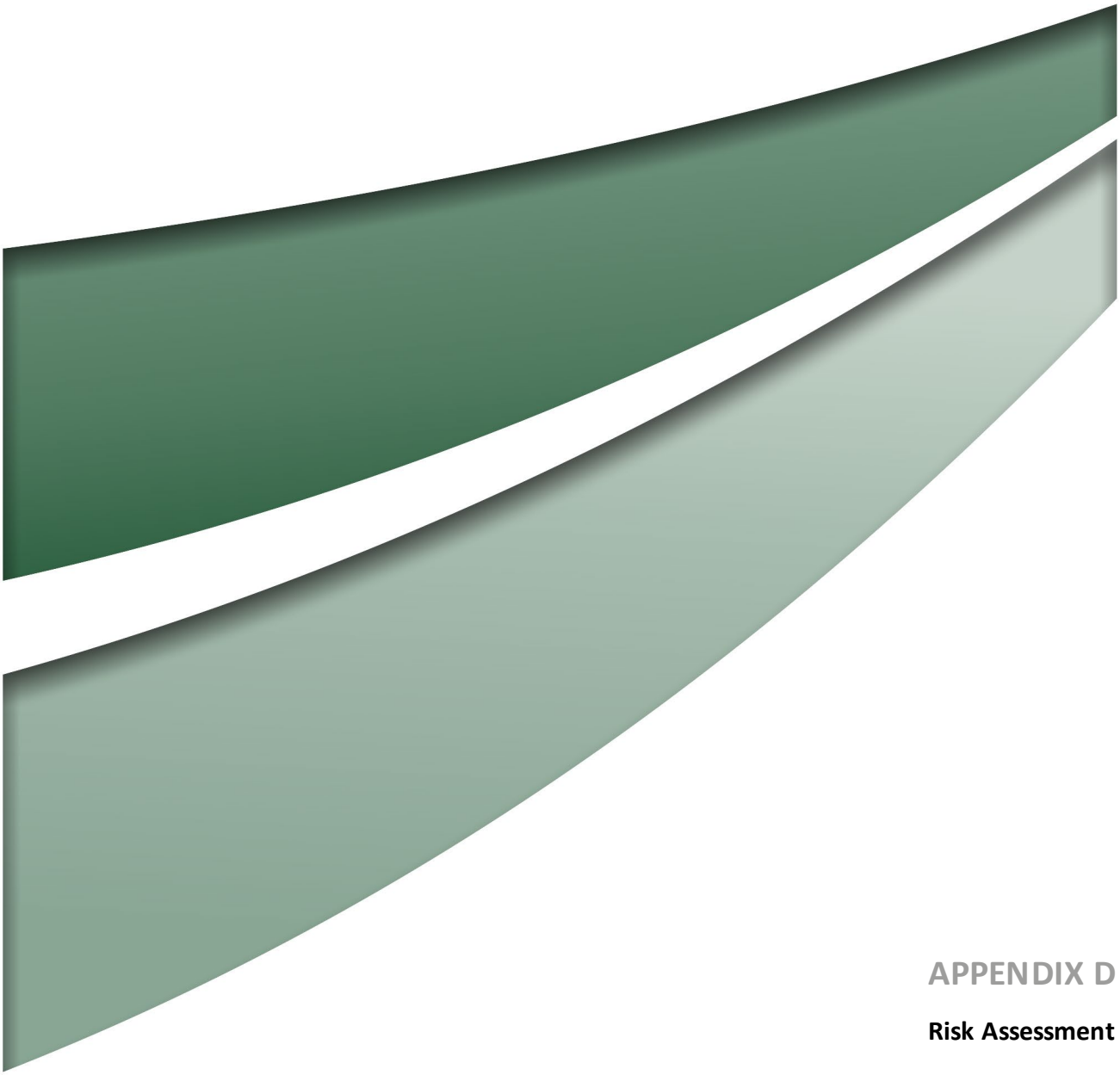
Microbat species and calls detected October 2021 (Spring)

Common Name	Scientific Name	Calls Detected
Individual Species		
Gould's wattled bat	*Chalinolobus gouldii*	1272
hoary wattled bat	*Chalinolobus nigrogriseus*	146
little broad-nosed bat	*Scotorepens greyii*	976
northern freetail bat	*Chaerephon jobensis*	365
northern broad-nosed bat	*Scotorepens sanborni*	248
eastern horseshoe-bat	*Rhinolophus megaphyllus*	4
yellow-bellied sheathtail bat	*Saccolaimus flaviventris*	164
eastern free-tailed bat	*Ozimops ridei*	4
little bent-wing bat	*Miniopterus australis*	308
eastern bent-wing bat	*Miniopterus orianae*	96
northern free-tailed bat	*Ozimops lumsdenae*	76
chocolate wattled bat	*Chalinolobus morio*	2
Mixed Species Groups		
C. gouldii / O. ridei		1882
C. nigrogriseus / S. greyii		765

Common Name	Scientific Name	Calls Detected
S. greyii / S. sanborni		123
S. sanborni / Chalinolobus picatus		11

Microbat species and calls detected February 2022 (Summer)

Common Name	Scientific Name	Calls Detected
Individual Species		
Gould's wattled bat	*Chalinolobus gouldii*	212
northern freetail bat	*Chaerephon jobensis*	380
northern free-tailed bat	*Ozimops lumsdenae*	37
northern broad-nosed bat	*Scotorepens sanborni*	39
yellow-bellied sheathtail bat	*Saccolaimus flaviventris*	46
little bent-wing bat	*Miniopterus australis*	79
eastern free-tailed bat	*Ozimops ridei*	15
chocolate wattled bat	*Chalinolobus morio*	1
long eared bat sp.	*Nyctophilus sp.*(*N. geoffroyi* or *N. gouldi*)	1
little broad-nosed bat	*Scotorepens greyii*	9
hoary wattled bat	*Chalinolobus nigrogriseus*	8
inland broad-nosed bat	*Scotorepens balstoni*	4
eastern broad-nosed bat	*Scotorepens orion*	2
eastern horseshoe-bat	*Rhinolophus megaphyllus*	4
Troughton's sheathtail bat	*Taphozous troughtoni*	1
little pied bat	*Chalinolobus picatus*	38
Mixed Species Groups		
C. gouldii / O. ridei		22
C. nigrogriseus / S. greyii		4
C. pictatus / S. sanborni		96



APPENDIX D

Risk Assessment

Risk Assessment

A total of 23 bird and eight bat species that met the criteria for inclusion in the risk assessment were assessed.

Non-listed bird and bat species (barring wedge-tailed eagle) were subject to a briefer risk assessment than species listed under the EPBC Act and/or the NC Act.

D1 Threatened Birds

D1.1 Squatter pigeon

Information on squatter pigeon from Australian wind farms

There is no publicly available literature on blade strike at wind farms in the squatter pigeon's range.

Likelihood and Consequence of Impacts

The overall risk rating for squatter pigeon is Moderate, based on Moderate likelihood and Moderate consequence of collisions. The rationale for responses to each criterion is as follows:

- As the squatter pigeon is highly unlikely to fly at RSA height in the Study Area the overall rating for the likelihood of collision is deemed Low regardless of the response to criterion B.
- The squatter pigeon is a common resident in the Study Area.
- The southern subspecies of squatter pigeon (*Geophaps scripta scripta*) is widely dispersed within areas of suitable habitat and its habitat is relatively scattered.
- The life-history characteristics of the squatter pigeon match the description for a 'low' rating for Criterion D (Higgins and Davies 1996)
- Garnett & Crowley (2000) estimated the number of mature individuals to be approximately 40,000, although this estimate was considered to be of low reliability. The total squatter pigeon population is likely to exceed 20,000 however the southern subspecies' population may number between 5,000 – 20,000 individuals. Hence, criterion E is conservatively assigned Moderate.
- The southern subspecies of squatter pigeon is listed as vulnerable under the EPBC Act and the NC Act.

Squatter pigeon's Moderate ranking reflects the species' vulnerable listing and frequency of occurrence within the Study Area, despite the Low ranking for Criteria A, C and D.

Squatter Pigeon Risk Assessment

	Criterion A	Criterion B	Criterion C	Criterion D	Criterion E	Criterion F
Low	X		X	X		
Moderate					X	X
High		X				
Risk Rating						
Likelihood	Moderate	**Consequence**	Moderate	**Risk Rating**	**Moderate**	

D1.2 Glossy black-cockatoo

Information on glossy black-cockatoo from Australian wind farms

There are no publicly available information on blade strike from wind farms in the glossy black-cockatoo's range.

Likelihood and Consequence of Impacts

The overall risk rating for glossy black-cockatoo is Moderate, based on a Moderate likelihood and Moderate consequence of collisions. The rationale for responses to each criterion is as follows:

- Glossy black-cockatoo is an uncommon resident or visitor in the Study Area.
- Glossy black-cockatoo 's habitat is widely dispersed, and individuals do not typically congregate in large numbers in particular areas.
- The life-history characteristics of the glossy black-cockatoo overlap with certain aspects of both the descriptions for a 'low' and 'high' rating for Criterion D (Higgins 1999).
- Garnett and Crowley (2000) estimated the total population size of glossy black-cockatoo to comprise 17,140 individuals and the population occurring in the Study Area to comprise 5,000 individuals. Hence, criterion E is assigned 'moderate' based on total population size though it is noted that the population size may be less than 5,000.
- Glossy black-cockatoo is listed as vulnerable under the NC Act.

The glossy black-cockatoo's Moderate risk rating reflects the risk of collisions based on their presence in the Study Area and potential to fly at RSA height and the Moderate rating for consequence based on population size, their low reproduction rate and their status under the EPBC Act and the NC Act.

Glossy black-cockatoo risk assessment

	Criterion A	Criterion B	Criterion C	Criterion D	Criterion E	Criterion F
Low	X		X			
Moderate		X		X	X	X
High						
Risk Rating						
Likelihood	Moderate	**Consequence**	Moderate	**Risk Rating**	**Moderate**	

D2 Migratory Listed Birds

D2.1 Latham's snipe

Information on Latham's snipe from Australian wind farms

There are no records of blade strike of Latham's snipe in the available literature from Victoria (Moloney *et al.* 2019) or Tasmania (Hull *et al.* 2013). Latham's snipe was identified by Smales (2006) as being one of three of the highest priority species (in regard to collision risk) in the Gippsland region of Victoria based on risk posed by species' flight behaviour and conservations status.

Likelihood and Consequence of Impacts

The overall risk rating for Latham's snipe is Minor, based on a Moderate likelihood and Low consequence of collisions. The rationale for responses to each criterion is as follows:

- Latham's snipe regularly flies below RSA height and occasionally flies at RSA height though the height at which Latham's snipe tend to fly during migration is unknown.
- Latham's snipe is likely to be an infrequent visitor in the Study Area particularly during southward (July-September) and northward passage (February to April).
- Latham's snipe can congregate in relatively large numbers at certain wetland sites. Sites considered to support important habitat for Latham's snipe are those that regularly support at least 18 individuals (Department of the Environment 2015a). As no such sites are present in or near the Study Area, Criterion C is assigned 'low'.
- The life-history characteristics of the Latham's snipe overlap with certain aspects of both the descriptions for a 'low' and 'high' rating for Criterion D (Higgins and Davies 1996).
- Hansen *et al.* (2016) estimated that the total population of Latham's snipe which visits Australia is 30,000 individuals. Hence, criterion E is assigned 'low' though it is noted that recent population monitoring conducted in Hokkaido, Japan indicated a steep decline between 2018 (35,000 birds) to 2020 (20,000) (Wild Bird Society of Japan 2020).
- Latham's snipe is listed as migratory under the EPBC Act.

Latham's snipe was not recorded in the Study Area during the bird utilisation survey or incidentally during 2019/20. Latham's snipe may occasionally migrate through the Study Area during southward (July-September) or northward passage (February to April) (Higgins and Davies 1996). Dams in the Study Area comprise suitable stopover habitat though due to their limited habitat value (i.e., small size and lack of suitable vegetation cover) occurrences would be infrequent. No waterbodies in the Study Area constitute important habitat for Latham's snipe as per the important habitat guidelines for this species (Department of the Environment 2015a).

The Latham's snipe's Minor risk rating reflects the risk of blade strike of individuals migrating through the Study Area coupled with the minor consequence that the potential collision rate may have on their population.

Latham's snipe risk assessment

	Criterion A	Criterion B	Criterion C	Criterion D	Criterion E	Criterion F
Low			X		X	X
Moderate	X	X		X		
High						
Risk Rating						
Likelihood	Moderate	**Consequence**	Low	**Risk Rating**	**Minor**	

D2.2 Oriental cuckoo

Information on oriental cuckoo from Australian wind farms

There is no publicly available information on blade strike at wind farms within the oriental cuckoo's range in Australia.

Likelihood and Consequence of Impacts

The overall risk rating for oriental cuckoo is Minor, based on a Moderate likelihood and Low consequence of collisions. The rationale for responses to each criterion is as follows:

- Little is known about the height range in which oriental cuckoo fly whilst migrating, though the majority of movements are likely to occur below 55 m AGL.
- Oriental cuckoo is likely to regularly occur in or move through the Study Area between November – March.
- Though oriental cuckoo does not congregate in high numbers, a large proportion of the population that migrates south of the Study Area annually is likely to migrate through a relatively restricted area along the coast and eastern escarpment of the Great Dividing Range where the majority of suitable habitat is present. Hence, Criterion C is assigned Moderate.
- The life-history characteristics of oriental cuckoo matches the description for a Low rating for-Criterion D (Higgins 1999).
- The total population size has not been quantified though it is estimated to exceed 1 million (BirdLife International 2015).
- Oriental cuckoo is listed as migratory under the EPBC Act.

Oriental cuckoo are likely to regularly occur in or move through the Study Area between November to March but may be present as early as August (Higgins 1999). Oriental cuckoo typically arrive in Qld from their breeding grounds in the Northern Hemisphere during November/December and return north during February/March (Higgins 1999).

Oriental cuckoo's Minor overall risk rating reflects the anticipated regular occurrence within the Study Area, predicted low flight behaviour (below RSA) and minor rating for consequence based on their very large population size, capability to replace lost individuals and non-threatened status at the state and national scale.

Oriental cuckoo risk assessment

	Criterion A	Criterion B	Criterion C	Criterion D	Criterion E	Criterion F
Low	X			X	X	X
Moderate			X			
High		X				
Risk Rating						
Likelihood	Moderate	**Consequence**	Low	**Risk Rating**	**Minor**	

D2.3 Fork-tailed swift

Information on fork-tailed swift from Australian wind farms

There is one record of blade strike of fork-tailed swift in the available literature from Victoria (Moloney *et al.* 2019). There is no publicly available information on blade strike from the majority of wind farms located in this species' Australian range.

Likelihood and Consequence of Impacts

The overall risk rating for fork-tailed swift is Moderate, based on a High likelihood and Low consequence of collisions. The rationale for responses to each criterion is as follows:

- A high proportion of the fork-tailed swift's flight activity is at RSA height.
- Fork-tailed swift regularly occurs in or moves through the Study Area between October to April.
- Fork-tailed swift is widely dispersed throughout Australia and although it occasionally congregates in very high numbers it may do so anywhere in its range over a vast range of landforms and vegetation types.
- The life-history characteristics of fork-tailed swift overlap with certain aspects of both the descriptions for a 'low' and 'high' rating for Criterion D (Higgins 1999).
- The global population size has not been quantified, but the species is reported to be generally common throughout most of its breeding range (del Hoyo *et al.* 1999) and it is highly likely to exceed 20,000 individuals given national population estimates for China, Japan, Taiwan, South Korea and Russia (Birdlife Australia 2022).
- Fork-tailed swift is listed as migratory under the EPBC Act.

Fork-tailed swift are likely to regularly occur in or move through the Study Area between October to April in small to very large flocks (Higgins 1999).

Fork-tailed swift's Moderate risk rating largely reflects the relatively low consequence that blade strike in the Study Area is likely to have on this species overall.

Fork-tailed swift risk assessment

	Criterion A	Criterion B	Criterion C	Criterion D	Criterion E	Criterion F
Low			X		X	X
Moderate				X		
High	X	X				
Risk Rating						
Likelihood	High	**Consequence**	Low	**Risk Rating**	**Moderate**	

D2.4 Rufous fantail

Information on rufous fantail from Australian wind farms

There are no records of blade strike of rufous fantail in the available literature from Victoria (Moloney *et al.* 2019) though there are only few records of rufous fantail in parts of western Victoria where post-construction monitoring has been conducted.

Likelihood and Consequence of Impacts

The overall risk rating for rufous fantail is Minor, based on a Moderate likelihood and Minor consequence of collisions. The rationale for responses to each criterion is as follows:

- Little is known about the height range in which rufous fantail fly whilst migrating though the majority of movements are likely to occur below 55 m AGL.
- Rufous fantail regularly occurs in or moves through the Study Area.
- Though the rufous fantail does not congregate in high numbers a large proportion of the population that migrates south of the Study Area annually is likely to migrate through a relatively restricted area along the coast and eastern escarpment of the Great Dividing Range where the majority of suitable habitat is present. Hence, Criterion C is assigned 'moderate'.
- The life-history characteristics of rufous fantail matches the description for a Low rating for Criterion D (Higgins et al. 2006).
- The total population of rufous fantail is estimated to exceed 20,000 individuals (Department of the Environment 2015b).
- Rufous fantail is listed as Migratory under the EPBC Act.

Rufous fantail are likely to regularly occur in or move through the Study Area. The number of birds migrating through the Study Area is likely to peak during southward passage which usually occurs in QLD from October to November (Higgins *et al.* 2006). Rufous fantail movement patterns are poorly understood in Central QLD though this species has been recorded during each month of the year in the Rockhampton region.

Rufous fantail's Minor overall risk rating reflects the anticipated regular occurrence within the Study Area, predicted low flight behaviour (below RSA) and minor rating for consequence based on their very large population size, capability to replace lost individuals and non-threatened status at the state and national scale.

Rufous fantail risk assessment

	Criterion A	Criterion B	Criterion C	Criterion D	Criterion E	Criterion F
Low	X			X	X	X
Moderate			X			
High		X				
Risk Rating						
Likelihood	Moderate	**Consequence**	Low	**Risk Rating**	**Minor**	

D2.5 Satin flycatcher

Information on satin flycatcher from Australian wind farms

There are no records of blade strike of satin flycatcher in the available literature from Victoria (Moloney *et al.* 2019) or Tasmania (Hull *et al.* 2013).

Likelihood and Consequence of Impacts

The overall risk rating for satin flycatcher is Minor, based on a Moderate likelihood and Minor consequence of collisions. The rationale for responses to each criterion is as follows:

- Little is known about the height range in which satin flycatcher fly whilst migrating, though the majority of movements are likely to occur below 55 m AGL.
- Satin flycatcher is likely to regularly occur in or move through the Study Area particularly between August to November and February to May.
- Though the satin flycatcher does not congregate in high numbers a large proportion of the population that migrates south of the Study Area annually is likely to migrate through a relatively restricted area along the coast and eastern escarpment of the Great Dividing Range where the majority of suitable habitat is present. Hence, Criterion C is assigned 'moderate'.
- The life-history characteristics of satin flycatcher matches the description for a Low rating for Criterion D (Higgins et al. 2006).
- The total population of satin flycatcher is estimated to exceed 20,000 individuals (Department of the Environment 2015b).
- Satin flycatcher is listed as migratory under the EPBC Act.

Satin flycatcher are likely to regularly occur in or move through the Study Area during their migration south through Queensland between August to November and during northward passage between February to early May (Higgins *et al.* 2006). Satin flycatcher have been recorded in the Rockhampton region during all months though the majority of records are between August to November.

Satin flycatcher's Minor overall risk rating reflects the anticipated regular occurrence within the Study Area, predicted low flight behaviour (below RSA) and minor rating for consequence based on their large population size, capability to replace lost individuals and non-threatened status at the state and national scale.

Satin flycatcher risk assessment

	Criterion A	Criterion B	Criterion C	Criterion D	Criterion E	Criterion F
Low	X			X	X	X
Moderate			X			
High		X				
Risk Rating						
Likelihood	Moderate	**Consequence**	Low	**Risk Rating**	**Minor**	

D2.6 Black-faced monarch

Information on black-faced monarch from Australian wind farms

There is no publicly available information on blade strike at wind farms within the black-faced monarch's range in Australia.

Likelihood and Consequence of Impacts

The overall risk rating for black-faced monarch is Minor, based on a Moderate likelihood and Minor consequence of collisions. The rationale for responses to each criterion is as follows:

- Little is known about the height range in which black-faced monarch fly whilst migrating though the majority of movements are likely to occur below 55 m AGL.
- The black-faced monarch is likely to regularly occur in or move through the Study Area particularly between September to November and February to April.
- Though the black-faced monarch does not congregate in high numbers a large proportion of the population that migrates south of the Study Area annually is likely to migrate through a relatively restricted area along the coast and eastern escarpment of the Great Dividing Range where the majority of suitable habitat is present. Hence, Criterion C is assigned 'moderate'.
- The life-history characteristics of the black-faced monarch matches the description for a 'low' rating for Criterion D (Higgins *et al.* 2006).
- The total population of black-faced monarch is estimated to exceed 20,000 individuals (Department of the Environment 2015b).
- Black-faced monarch is listed as migratory under the EPBC Act.

Black-faced monarch are likely to regularly occur in or move through the Study Area particularly during southward passage from September to November and northward passage between February to April (Higgins *et al.* 2006). Black -faced monarch have been recorded during all months in the Rockhampton region barring June and July. The majority of records in the region fall within migratory periods during September to October and March to April.

The black-faced monarch's Minor overall risk rating reflects the anticipated regular occurrence within the Study Area, predicted low flight behaviour (below RSA) and minor rating for consequence based on their large population size, capability to replace lost individuals and non-threatened status at the state and national scale.

Black-faced monarch risk assessment

	Criterion A	Criterion B	Criterion C	Criterion D	Criterion E	Criterion F
Low	X			X	X	X
Moderate			X			
High		X				
Risk Rating						
Likelihood	Moderate	**Consequence**	Low	**Risk Rating**	**Minor**	

D2.7 Spectacled monarch

Information on spectacled monarch from Australian wind farms

There is no publicly available information on blade strike at wind farms within the spectacled monarch's range in Australia.

Status in the Study Area

Likelihood and Consequence of Impacts

The overall risk rating for spectacled monarch is Minor, based on a Moderate likelihood and Minor consequence of collisions. The rationale for responses to each criterion is as follows:

- Little is known about the height range in which spectacled monarch fly whilst migrating though the majority of movements are likely to occur below 55 m AGL.
- Spectacled monarch is likely to regularly occur in or move through the Study Area.
- Though the spectacled monarch does not congregate in high numbers a large proportion of the population that migrates south of the Study Area annually is likely to migrate through a relatively restricted area along the coast and eastern escarpment of the Great Dividing Range where the majority of suitable habitat is present. Hence, Criterion C is assigned Moderate.
- The life-history characteristics of spectacled monarch matches the description for a Low rating for-Criterion D (Higgins et al. 2006).
- The total population of spectacled monarch is estimated to exceed 20,000 individuals (Department of the Environment 2015).
- Spectacled monarch is listed as migratory under the EPBC Act.

Spectacled monarch movement patterns are not well known though observations in eastern Australia indicate that a proportion of their population undertakes migratory movements (Higgins *et al.* 2006). Birds on southward passage are likely to pass through the Study Area during September to October and those migrating north are likely to move through the Study Area during March to April (Higgins *et al.* 2006).

Individuals that are largely sedentary or those that do not migrate further south or north than Central QLD may be present in the Study Area at any time of year. Spectacled monarch have been recorded during all months in the Rockhampton/Gladstone region.

Spectacled monarch's Minor overall risk rating reflects the anticipated regular occurrence within the Study Area, predicted low flight behaviour (below RSA) and minor rating for consequence based on their large population size, capability to replace lost individuals and non-threatened status at the state and national scale.

Spectacled monarch risk assessment

	Criterion A	Criterion B	Criterion C	Criterion D	Criterion E	Criterion F
Low	X			X	X	X
Moderate			X			
High		X				
Risk Rating						
Likelihood	Moderate	**Consequence**	Low	**Risk Rating**	**Minor**	

D3 Non-listed Birds

Non-listed birds were included in the risk assessment due to observed flights within the RSA.

D3.1 Wedge-tailed eagle

Information on wedge-tailed eagle from Australian wind farms

The wedge-tailed eagle is commonly reported during mortality monitoring events at wind farms in Australia. Moloney *et al.* (2019) report wedge-tailed eagle as the second most frequently recorded bird species found dead during monitoring from 2003 to 2018 across 15 wind farms in Victoria, with 58 carcasses detected and equating to 10% of all birds found. Using this data, Moloney *et al.* (2019) calculated mortality estimates of 0.06 (95% CI: 0.02 – 0.41) and 0.1 (95% CI: 0 - 0.2) individuals per turbine per year at 2 Victorian wind farms.

At 2 wind farms in north-western Tasmania, 18 wedge-tailed eagle carcasses were recorded during monitoring conducted for 3 and 6 years at Bluff Point Wind Farm and Studland Bay Wind Farm respectively (Hull *et al.* 2013). This particular monitoring program modelled a mortality estimate of 1.5 and 1.1 collisions per annum at Bluff Point (37 turbines) and Studland Bay (25 turbines). A 95% turbine avoidance rate closely approximated the observed mean annual mortality rate of 1.6 and 1.1 individuals per annum at each wind farm respectively (Smales *et al.* 2013).

Wedge-tailed eagle occur at the majority of wind farms in Australia however publicly available information on blade strike is restricted to that collected from select Victoria and Tasmania wind farms discussed above.

Likelihood and Consequence of Impacts

The overall risk rating for wedge-tailed eagle is Moderate, based on a High likelihood and Low consequence of collisions. The rationale for responses to each criterion is as follows:

- A high proportion of the wedge-tailed eagle's flight activity is at RSA height.
- Wedge-tailed eagle is a common resident in the Study Area.
- Wedge-tailed eagle is largely sedentary, is widely dispersed within areas of suitable habitat and the habitat itself is widely dispersed.
- The life-history characteristics of the wedge-tailed eagle overlap with certain aspects of both the descriptions for a 'low' and 'high' rating for criterion D (Marchant and Higgins 1993).
- The total population of wedge-tailed eagle is described as very large by Birdlife International (2020) and given its very large distribution (c. 10.6 Mkm^2) its total population is very likely to exceed 20,000 individuals.
- The subspecies of wedge-tailed eagle that occurs in the Study Area is not listed as threatened under the EPBC Act or the NC Act.

Wedge-tailed eagle's Moderate risk rating largely reflects the relatively low consequence that a potentially high frequency of blade strike in the Study Area is likely to have on this species overall.

Wedge-tailed eagle risk assessment

	Criterion A	Criterion B	Criterion C	Criterion D	Criterion E	Criterion F
Low			X		X	X
Moderate				X		
High	X	X				
Risk Rating						
Likelihood	High	**Consequence**	Low	**Risk Rating**	**Moderate**	

D3.2 Other diurnal raptors

Black kite, brown falcon, brown goshawk, nankeen kestrel, pacific baza, peregrine falcon and whistling kite have been recorded flying at RSA height in the Study Area. Grey goshawk and collared sparrowhawk have been recorded in the Study Area below RSA height though each species is likely to occur at RSA height.

Other raptor species that have not been recorded in the Study Area but may occasionally move through the area such as white-bellied sea-eagle, little eagle, square-tailed kite, swamp harrier, spotted harrier, black falcon and Australian hobby are not included in this assessment though are noted to be at risk of blade strike wherever they occur given their flight behaviour.

The Moderate risk rating for these eight raptors reflects the relatively low consequence that blade strike in the Study Area is likely to have on these species overall given their large populations and secure status at State and National level. Variability between species in terms of the potential impact of a set number of collisions on local populations is likely (for example the loss of five grey goshawk would have a greater impact than the loss of five black kite on both species' respective local populations) though overall a low rating for consequence is appropriate for all eight species at the broader scale.

Diurnal raptor risk assessment

	Criterion A	Criterion B	Criterion C	Criterion D	Criterion E	Criterion F
Low			All		All barring GG	All
Moderate	GG, CS	BG, CS, PB, PF, GG, WK		All	GG	
High	BF, BG, BK, NK, PB, PF, WK	BF, BK, NK				

Risk Rating						
BF, BG, BK PB, PF, NK, WK	**Likelihood**	High	**Consequence**	Low	**Risk Rating**	**Moderate**
CS, GG	**Likelihood**	Moderate	**Consequence**	Moderate	**Risk Rating**	**Moderate**

LEGEND: PB: Pacific baza, BK: black kite, BG: brown goshawk, GG: grey goshawk, CS: collared sparrowhawk, BF: brown falcon, PF: peregrine falcon, NK: nankeen kestrel, WK: whistling kite.

D3.3 Rainbow bee-eater

There is no publicly available information on blade strike at wind farms within the rainbow bee-eater's range in Australia.

The overall risk rank for rainbow bee-eater is Moderate, based on a Moderate likelihood and a Low consequence of collisions. The rationale for responses to each criterion is as follows:

Rainbow bee-eater risk assessment

	Criterion A	Criterion B	Criterion C	Criterion D	Criterion E	Criterion F
Low			X	X	X	X
Moderate	X					
High		X				

Risk Rating					
Likelihood	High	**Consequence**	Low	**Risk Rating**	**Moderate**

D3.4 Channel-billed Cuckoo

Channel-billed cuckoo are included in the risk assessment as they were observed flying within the RSA. The overall risk rating for channel-billed cuckoo is moderate, based on a high likelihood and low consequence collisions.

Channel-billed cuckoo risk assessment

	Criterion A	Criterion B	Criterion C	Criterion D	Criterion E	Criterion F
Low			X		X	X
Moderate		X		X		
High	X					
Risk Rating						
Likelihood	High	**Consequence**	Low	**Risk Rating**	**Moderate**	

D3.5 Topknot pigeon

Topknot pigeon are included in the risk assessment as they were observed flying within the RSA. The overall risk rating for topknot pigeon is moderate, based on a high likelihood and low consequence of collisions.

Topknot pigeon risk assessment

	Criterion A	Criterion B	Criterion C	Criterion D	Criterion E	Criterion F
Low			X		X	X
Moderate		X		X		
High	X					
Risk Rating						
Likelihood	High	**Consequence**	Low	**Risk Rating**	**Moderate**	

D3.6 Other Parrots

Rainbow lorikeet, red-tailed black cockatoo, galah and sulphur-crested cockatoo are common residents in the Study Area which were occasionally recorded flying at RSA height during the bird utilisation survey. Additionally, scaly-breasted lorikeet was observed flying through the RSA.

The overall risk rating for these four species is Minor, based on a Moderate likelihood and Low consequence of collisions.

Parrots risk assessment (rainbow lorikeet, galah, red-tailed black-cockatoo, scaly-breasted lorikeet and sulphur-crested cockatoo)

	Criterion A	Criterion B	Criterion C	Criterion D	Criterion E	Criterion F
Low			X		X	X
Moderate	X	X		X		
High						
Risk Rating						
Likelihood	Moderate	**Consequence**	Low	**Risk Rating**	**Minor**	

D3.7 Common passerines

These five common passerines were regularly recorded in the Study Area during the bird utilisation survey and are included in the risk assessment as they were observed flying at RSA height on at least one occasion.

The overall risk rating for blue-faced honeyeater is Minor, based on a Moderate likelihood and Low consequence of collisions. The overall risk rating for Australian magpie, noisy friarbird, pied currawong, Torresian crow and tree martin is Moderate, based on a High likelihood and Low consequence of collisions.

Common resident passerine risk assessment (blue-faced honeyeater, striated pardalote, pied currawong, Torresian crow, tree martin)

	Criterion A	Criterion B	Criterion C	Criterion D	Criterion E	Criterion F
Low	BFH		All	All	All	All
Moderate	AM, NF, PC, TC, TM					
High		All				
Risk Rating						

BFH	**Likelihood**	Moderate	**Consequence**	Low	**Risk Rating**	**Minor**
AM, NF, PC, TC, TM	**Likelihood**	High	**Consequence**	Low	**Risk Rating**	**Moderate**

AM: Australian Magpie, BFH: blue-faced honeyeater, NF: Noisy Friarbird, PC: pied currawong, TC: Torresian Crow, TM: tree martin

D4 Bats

No bats listed under the EPBC Act and/or the NC Act were detected in the Study Area during bird and bat utilisation surveys or other Project associated surveys and none are considered likely to occur in the Study Area. An additional two species, grey-headed flying fox and ghost bat have been included in the risk assessment (**Section 3.4**) despite their Low likelihood of occurrence within the Study Area.

D4.1 Black flying-fox

Black flying-fox were recorded on two occasions in the Study Area. One was observed on 25 May 2020 flying along a creek line at a height of 25 m AGL after foraging in a fig tree. The second observation was of an individual flying at 50 m AGL on 31 May 2020.

The overall risk rating for black flying-fox is Moderate, based on a High likelihood and Low consequence of collisions.

Black flying-fox risk assessment

	Criterion A	Criterion B	Criterion C	Criterion D	Criterion E	Criterion F
Low			X		X	X
Moderate		X		X		
High	X					
Risk Rating						
Likelihood	High	**Consequence**	Low	**Risk Rating**	**Moderate**	

D5 References

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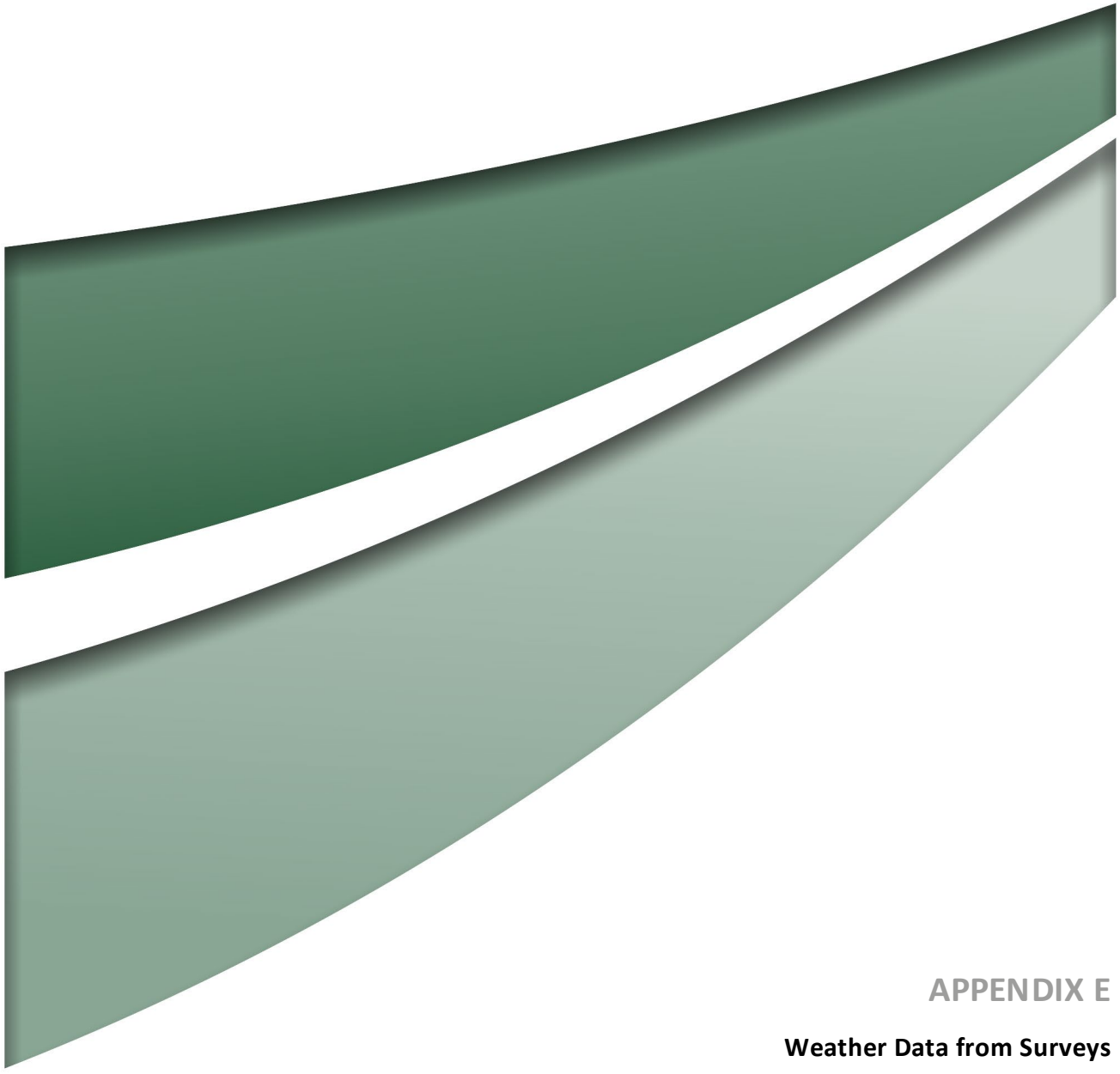


APPENDIX E

Weather Data from Surveys

Table E.1 Weather Conditions at Rockhampton Aero Weather Station (039083) during the summer survey (BoM (a) 2021; BoM (b) 2021).

Date	Temperature (°C)		Wind Direction		Wind Speed (km/h)	
	Minimum	Maximum	9 am	3 pm	9 am	3 pm
26/2/20	24.0	32.8	ESE	E	11	11
27/2/20	24.8	33.7	N	NNE	9	15
28/2/20	23.6	33.7	SE	E	7	11
29/2/20	24.3	32.3	ESE	E	13	20
1/3/20	23.0	32.3	ESE	ESE	20	15
2/3/20	23.2	33.5	SE	E	13	15
3/3/20	23.8	32.4	SE	ENE	11	17
4/3/20	24.8	30.4	SE	ESE	19	13

Table E.2 Weather Conditions at Rockhampton Aero Weather Station (039083) during the spring survey (BoM (c) 2021).

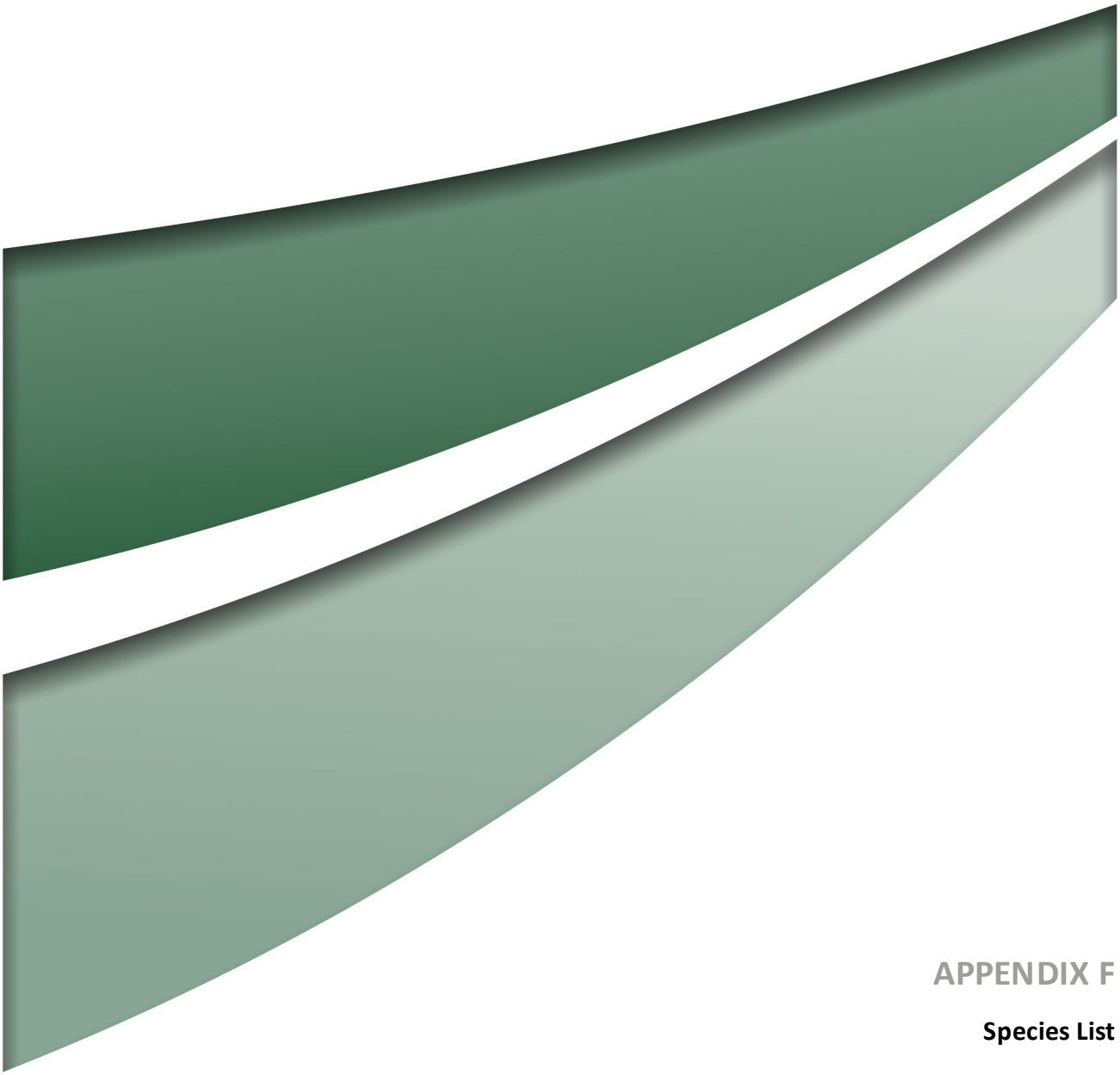
Date	Temperature (°C)		Wind Direction		Wind Speed (km/h)	
	Minimum	Maximum	9 am	3 pm	9 am	3 pm
5/11/20	18.2	34.0	N	N	19	20
6/11/20	19.8	35.2	SSE	NNW	11	11
7/11/20	20.3	30.6	E	ENE	19	17
8/11/20	23.6	28.8	E	ENE	26	20
9/11/20	19.6	27.9	ESE	ENE	24	22
10/11/20	17.9	28.8	ESE	E	17	22
11/11/20	17.7	29.1	E	E	11	17

Table E.3 Weather Conditions at Rockhampton Aero Weather Station (039083) during the spring survey (BoM (c) 2021).

Date	Temperature (°C)		Wind Direction		Wind Speed (km/h)	
	Minimum	Maximum	9 am	3 pm	9 am	3 pm
8/10/21	17.7	32.4	NE	SE	9	13
9/10/21	19.2	30.8	E	NE	11	15
10/10/21	17.5	31.4	NNE	NNE	13	20
11/10/21	15.4	32.9	N	NNE	11	24
12/10/21	21.4	33.2	E	NNE	2	20
13/10/21	20.9	32.4	NNE	ENE	7	17
14/10/21	22.5	33.4	NNE	ENE	19	20
15/10/21	20.8	35.1	NNW	W	20	26

Table E.4 Weather Conditions at Rockhampton Aero Weather Station (039083) during the summer survey (BoM (c) 2022).

Date	Temperature (°C)		Wind Direction		Wind Speed (km/h)	
	Minimum	Maximum	9 am	3 pm	9 am	3 pm
14/02/22	20.8	31.5	ESE	E	24	26
15/02/22	21.5	31.3	ESE	ESE	26	22
16/02/22	21.7	31.2	ESE	ENE	20	19
17/02/22	22.1	32.6	E	NE	19	17
18/02/22	22.3	33.8	ESE	ENE	11	11
19/02/22	22.4	32.7	ESE	ENE	13	20
20/02/22	22.0	32.4	ESE	ENE	17	19
21/02/22	21.9	33.8	E	ENE	13	13



APPENDIX F

Species List

Common Name	Scientific Name	NC Act Status	EPBC Act Status	Observation Location																
				NORTH							POM							BC		Incidental/ Other
				1	2	3	4	6	7	8	1	2	3	4	5	8	9	1	2	
Birds																				
apostlebird	*Struthidea cinerea*	Least Concern	-												X					X
Australasian figbird	*Sphecotheres vieilloti*	Least Concern	-			X	X													X
Australasian grebe	*Tachybaptus novaehollandiae*	Least Concern	-																	X
Australasian pipit	*Anthus novaeseelandiae*	Least Concern	-	X		X	X													X
Australian brush-turkey	*Alectura lathami*	Least Concern	-											X						X
Australian bustard	*Ardeotis australis*	Least Concern	-																	X
Australian king-parrot	*Alisterus scapularis*	Least Concern	-					X			X	X	X	X						X
Australian magpie	*Gymnorhina tibicen*	Least Concern	-	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X
Australian owlet-nightjar	*Aegotheles cristatus*	Least Concern	-																	X
Australian wood duck	*Chenonetta jubata*	Least Concern	-																	X
barking owl	*Ninox connivens*	Least Concern	-																	X
bar-shouldered dove	*Geopelia humeralis*	Least Concern	-								X			X						
black kite	*Milvus migrans*	Least Concern	-														X			X
black-chinned honeyeater	*Melithreptus gularis*	Least Concern	-																	X
black-faced cuckoo-shrike	*Coracina novaehollandiae*	Least Concern	-	X		X		X	X		X		X	X	X	X		X	X	X
black-faced woodswallow	*Artamus cinereus*	Least Concern	-																	X
blue-faced honeyeater	*Entomyzon cyanotis*	Least Concern	-				X		X		X			X	X	X			X	X
blue-winged kookaburra	*Dacelo leachii*	Least Concern	-										X		X					X

Common Name	Scientific Name	NC Act Status	EPBC Act Status	Observation Location																
				NORTH							POM							BC		Incidental/ Other
				1	2	3	4	6	7	8	1	2	3	4	5	8	9	1	2	
brolga	*Antigone rubicunda*	Least Concern	-																	X
brown cuckoo-dove	*Macropygia phasianella*	Least Concern	-											X						X
brown falcon	*Falco berigora*	Least Concern	-		X		X	X	X			X			X		X		X	X
brown goshawk	*Accipiter fasciatus*	Least Concern	-									X	X							X
brown honeyeater	*Lichmera indistincta*	Least Concern	-				X		X											X
brown quail	*Coturnix ypsilophora*	Least Concern	-			X							X		X					X
brown songlark	*Cincloramphus cruralis*	Least Concern	-				X													
brown treecreeper	*Climacteris picumnus*	Least Concern	-											X						
budgerigar	*Melopsittacus undulatus*	Least Concern	-																	X
buff-rumped thornbill	*Acanthiza reguloides*	Least Concern	-																X	
bush stone-curlew	*Burhinus grallarius*	Least Concern	-																	X
cattle egret	*Bubulcus ibis*	Least Concern	-																	X
channel-billed cuckoo	*Scythrops novaehollandiae*	Least Concern	-	X	X		X		X		X		X	X	X	X				X
cicadabird	*Coracina tenuirostris*	Least Concern	-		X		X	X	X		X		X	X			X		X	X
collared sparrowhawk	*Accipiter cirrocephalus*	Least Concern	-								X				X					X
common bronzewing	*Phaps chalcoptera*	Least Concern	-											X						X
crested pigeon	*Ocyphaps lophotes*	Least Concern	-	X																X
dollarbird	*Eurystomus orientalis*	Least Concern	-	X				X						X	X					X
double-barred finch	*Taeniopygia bichenovii*	Least Concern	-												X					X
dusky woodswallow	*Artamus cyanopterus*	Least Concern	-																	X
eastern barn owl	*Tyto delicatula*	Least Concern	-																	X

Common Name	Scientific Name	NC Act Status	EPBC Act Status	Observation Location																
				NORTH							POM							BC		Incidental/ Other
				1	2	3	4	6	7	8	1	2	3	4	5	8	9	1	2	
eastern koel	*Eudynamys orientalis*	Least Concern	-	X	X	X	X				X	X	X	X	X		X			X
eastern yellow robin	*Eopsaltria australis*	Least Concern	-																	X
emerald dove	*Chalcophaps indica*	Least Concern	-																	X
emu	*Dromaius novaehollandiae*	Least Concern	-		X															X
fairy gerygone	*Gerygone palpebrosa*	Least Concern	-																	X
fan-tailed cuckoo	*Cacomantis flabelliformis*	Least Concern	-	X			X	X	X		X		X	X	X	X	X	X	X	X
forest kingfisher	*Todiramphus macleayii*	Least Concern	-	X			X	X	X		X		X	X	X	X		X	X	X
galah	*Eolophus roseicapilla*	Least Concern	-										X		X	X				X
glossy black-cockatoo	*Calyptorhynchus lathami erebus*	Vulnerable	-											X						X
golden whistler	*Pachycephala pectoralis*	Least Concern	-																	X
green catbird	*Ailuroedus crassirostris*	Least Concern	-																	X
grey butcherbird	*Cracticus torquatus*	Least Concern	-												X					X
grey fantail	*Rhipidura albiscapa*	Least Concern	-																	X
grey goshawk	*Accipiter novaehollandiae*	Least Concern	-					X												X
grey shrike-thrush	*Colluricincla harmonica*	Least Concern	-				X		X		X		X	X						X
grey-crowned babbler	*Pomatostomus temporalis*	Least Concern	-	X																
ground cuckoo-shrike	*Coracina maxima*	Least Concern	-			X													X	
Horsfield's bronze-cuckoo	*Chalcites basalis*	Least Concern	-																	X
laughing kookaburra	*Dacelo novaeguineae*	Least Concern	-	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X
leaden flycatcher	*Myiagra rubecula*	Least Concern	-	X				X	X			X	X	X		X				X

Common Name	Scientific Name	NC Act Status	EPBC Act Status	Observation Location																
				NORTH							POM							BC		Incidental/ Other
				1	2	3	4	6	7	8	1	2	3	4	5	8	9	1	2	
Lewin's honeyeater	*Meliphaga lewinii*	Least Concern	-				X	X	X		X	X	X	X	X		X			X
little corella	*Cacatua sanguinea*	Least Concern	-																	X
little friarbird	*Philemon citreogularis*	Least Concern	-								X									X
little lorikeet	*Glossopsitta pusilla*	Least Concern	-																	X
little shrike-thrush	*Colluricincla megarhyncha*	Least Concern	-										X	X						X
magpie-lark	*Grallina cyanoleuca*	Least Concern	-												X					X
masked lapwing	*Vanellus miles*	Least Concern	-												X					X
masked woodswallow	*Artamus personatus*	Least Concern	-																	X
mistletoebird	*Dicaeum hirundinaceum*	Least Concern	-	X	X	X	X	X	X		X	X		X	X	X		X	X	X
nankeen kestrel	*Falco cenchroides*	Least Concern	-	X		X	X				X		X		X	X		X	X	X
noisy friarbird	*Philemon corniculatus*	Least Concern	-	X	X		X				X	X	X	X	X	X	X		X	X
noisy miner	*Manorina melanocephala*	Least Concern	-	X	X	X	X				X	X	X		X	X		X	X	X
olive-backed oriole	*Oriolus sagittatus*	Least Concern	-																	X
Pacific baza	*Aviceda subcristata*	Least Concern	-				X	X												X
Pacific black duck	*Anas superciliosa*	Least Concern	-																	X
painted button-quail	*Turnix varius*	Least Concern	-		X															X
pale-headed rosella	*Platycercus adscitus*	Least Concern	-			X		X			X	X	X	X	X			X	X	X
pallid cuckoo	*Cacomantis pallidus*	Least Concern	-																	X
peaceful dove	*Geopelia striata*	Least Concern	-		X	X					X			X						X
peregrine falcon	*Falco peregrinus*	Least Concern	-								X		X	X						X

Common Name	Scientific Name	NC Act Status	EPBC Act Status	Observation Location																
				NORTH							POM							BC		Incidental/ Other
				1	2	3	4	6	7	8	1	2	3	4	5	8	9	1	2	
pheasant coucal	*Centropus phasianinus*	Least Concern	-	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X
pied butcherbird	*Cracticus nigrogularis*	Least Concern	-	X	X	X	X	X			X		X	X	X	X	X	X	X	X
pied currawong	*Strepera graculina*	Least Concern	-	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X
plumed whistling-duck	*Dendrocygna eytoni*	Least Concern	-																	X
plum-headed finch	*Neochmia modesta*	Least Concern	-																	X
rainbow bee-eater	*Merops ornatus*	Least Concern	-			X			X		X		X	X	X	X		X		X
rainbow lorikeet	*Trichoglossus moluccanus*	Least Concern	-	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X
red-backed fairy-wren	*Malurus melanocephalus*	Least Concern	-				X	X	X				X	X	X			X	X	X
red-browed finch	*Neochmia temporalis*	Least Concern	-					X					X							X
red-capped robin	*Petroica goodenovii*	Least Concern	-																	X
red-tailed black-cockatoo	*Calyptorhynchus banksii*	Least Concern	-						X					X		X		X		X
red-winged parrot	*Aprosmictus erythropterus*	Least Concern	-													X				
restless flycatcher	*Myiagra inquieta*	Least Concern	-								X		X							
rose robin	*Petroica rosea*	Least Concern	-											X						X
rose-crowned fruit-dove	*Ptilinopus regina*	Least Concern	-																	X
rufous fantail	*Rhipidura rufifrons*	Special Least Concern	Migratory																	X
rufous songlark	*Cincloramphus mathewsi*	Least Concern	-																	X
rufous whistler	*Pachycephala rufiventris*	Least Concern	-						X		X			X						X
scaly-breasted lorikeet	*Trichoglossus chlorolepidotus*	Least Concern	-				X													X

Common Name	Scientific Name	NC Act Status	EPBC Act Status	Observation Location																
				NORTH							POM							BC		Incidental/ Other
				1	2	3	4	6	7	8	1	2	3	4	5	8	9	1	2	
scarlet honeyeater	*Myzomela sanguinolenta*	Least Concern	-						X				X	X						X
silvereye	*Zosterops lateralis*	Least Concern	-					X												X
southern boobook	*Ninox boobook*	Least Concern	-																	X
spangled drongo	*Dicrurus bracteatus*	Least Concern	-			X		X	X		X	X	X	X	X	X		X		X
spectacled monarch	*Symposiachrus trivirgatus*	Special Least Concern	Migratory																	X
spotted bowerbird	*Ptilonorhynchus maculatus*	Least Concern	-																	X
spotted quail-thrush	*Cinclosoma punctatum*	Least Concern	-																	X
squatter pigeon	*Geophaps scripta scripta*	Vulnerable	Vulnerable																	X
straw-necked ibis	*Threskiornis spinicollis*	Least Concern	-																	X
striated pardalote	*Pardalotus striatus*	Least Concern	-	X	X	X	X	X			X	X	X	X	X	X	X	X	X	X
sulphur-crested cockatoo	*Cacatua galerita*	Least Concern	-	X		X	X	X			X	X	X	X	X	X				X
tawny frogmouth	*Podargus strigoides*	Least Concern	-									X				X	X			X
topknot pigeon	*Lopholaimus antarcticus*	Least Concern	-											X						X
Torresian crow	*Corvus orru*	Least Concern	-	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X
tree martin	*Petrochelidon nigricans*	Least Concern	-						X											X
varied sittella	*Daphoenositta chrysoptera*	Least Concern	-					X					X		X	X				X
varied triller	*Lalage leucomela*	Least Concern	-				X							X						
wedge-tailed eagle	*Aquila audax*	Least Concern	-	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X
weebill	*Smicrornis brevirostris*	Least Concern	-						X						X	X				
welcome swallow	*Hirundo neoxena*	Least Concern	-																	X

Common Name	Scientific Name	NC Act Status	EPBC Act Status	Observation Location																
				NORTH							POM							BC		Incidental/ Other
				1	2	3	4	6	7	8	1	2	3	4	5	8	9	1	2	
whistling kite	*Haliastur sphenurus*	Least Concern	-												X		X			X
white-bellied cuckoo-shrike	*Coracina papuensis*	Least Concern	-																	X
white-breasted woodswallow	*Artamus leucorynchus*	Least Concern	-																	X
white-browed scrubwren	*Sericornis frontalis*	Least Concern	-					X						X						X
white-browed treecreeper	*Climacteris affinis*	Least Concern	-											X						
white-cheeked honeyeater	*Phylidonyris niger*	Least Concern	-								X		X		X				X	
white-eared honeyeater	*Nesoptilotis leucotis*	Least Concern	-								X		X	X	X				X	X
white-faced heron	*Egretta novaehollandiae*	Least Concern	-																	X
white-throated gerygone	*Gerygone olivacea*	Least Concern	-													X				X
white-throated honeyeater	*Melithreptus albogularis*	Least Concern	-	X	X		X	X	X		X	X	X	X	X	X		X	X	X
white-throated needletail	*Hirundapus caudacutus*	Vulnerable	Vulnerable, Migratory	X			X		X			X				X				X
white-throated nightjar	*Eurostopodus mystacalis*	Least Concern	-																	X
white-throated treecreeper	*Cormobates leucophaea*	Least Concern	-				X	X	X		X		X	X	X	X		X	X	X
white-winged chough	*Corcorax melanorhamphos*	Least Concern	-																	X
willie wagtail	*Rhipidura leucophrys*	Least Concern	-																	X
wonga pigeon	*Leucosarcia melanoleuca*	Least Concern	-											X						X

Common Name	Scientific Name	NC Act Status	EPBC Act Status	Observation Location																
				NORTH							POM							BC		Incidental/ Other
				1	2	3	4	6	7	8	1	2	3	4	5	8	9	1	2	
yellow-rumped thornbill	*Acanthiza chrysorrhoa*	Least Concern	-																	X
yellow-tailed black-cockatoo	*Calyptorhynchus funereus*	Least Concern	-																	X
zebra finch	*Taeniopygia guttata*	Least Concern	-																	X
Microbats																				
bristle-faced free-tailed bat	*Mormopterus eleryi*	Least Concern	-								X	X				X				X
chocolate wattled bat	*Chalinolobus morio*	Least Concern	-		X	X			X			X	X	X	X	X	X			X
eastern bent-wing bat	*Miniopterus orianae*	Least Concern	-		X	X		X	X			X	X	X	X	X	X			X
eastern cave bat	*Vespadelus troughtoni*							X	X				X		X					
eastern free-tailed bat	*Mormopterus ridei*	Least Concern	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X
eastern horseshoe-bat	*Rhinolophus megaphyllus*	Least Concern	-						X		X	X	X	X			X			X
Gould's wattled bat	*Chalinolobus gouldii*	Least Concern	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X
hoary wattled bat	*Chalinolobus nigrogriseus*	Least Concern	-	X	X	X	X	X	X		X	X	X	X	X	X	X			X
inland broad-nosed bat	*Scotorepens balstoni*	Least Concern	-			X		X	X		X	X	X	X	X	X	X			X
little bent-wing bat	*Miniopterus australis*	Least Concern	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X
little broad-nosed bat	*Scotorepens greyii*	Least Concern	-	X	X	X	X	X	X		X	X	X	X	X	X	X			X
little pied bat	*Chalinolobus picatus*	Least Concern	-		X			X	X		X	X	X	X	X	X	X			X
northern broad-nosed bat	*Scotorepens sanborni*	Least Concern	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X
northern freetail bat	*Chaerephon jobensis*	Least Concern	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X
northern free-tailed bat	*Mormopterus lumsdenae*	Least Concern	-	X	X	X	X				X	X	X	X	X	X	X			X

Common Name	Scientific Name	NC Act Status	EPBC Act Status	Observation Location															
				NORTH							POM							BC		Incidental/ Other
				1	2	3	4	6	7	8	1	2	3	4	5	8	9	1	2	
-	*Nyctophilus sp. (N. geoffroyi* or *N. gouldi*)	Least Concern	-		X	X					X	X	X	X	X	X	X			X
south-eastern broad-nosed bat	*Scotorepens orion*	Least Concern	-					X	X		X		X		X					
southern horseshoe bat	*Rhinolophus megaphyllus megaphyllus*	Least Concern	-											X						
Troughton's sheathtail bat	*Taphozous troughtoni*	Least Concern	-									X			X					
yellow-bellied sheathtail bat	*Saccolaimus flaviventris*	Least Concern	-	X	X	X			X		X	X	X	X	X	X	X			X

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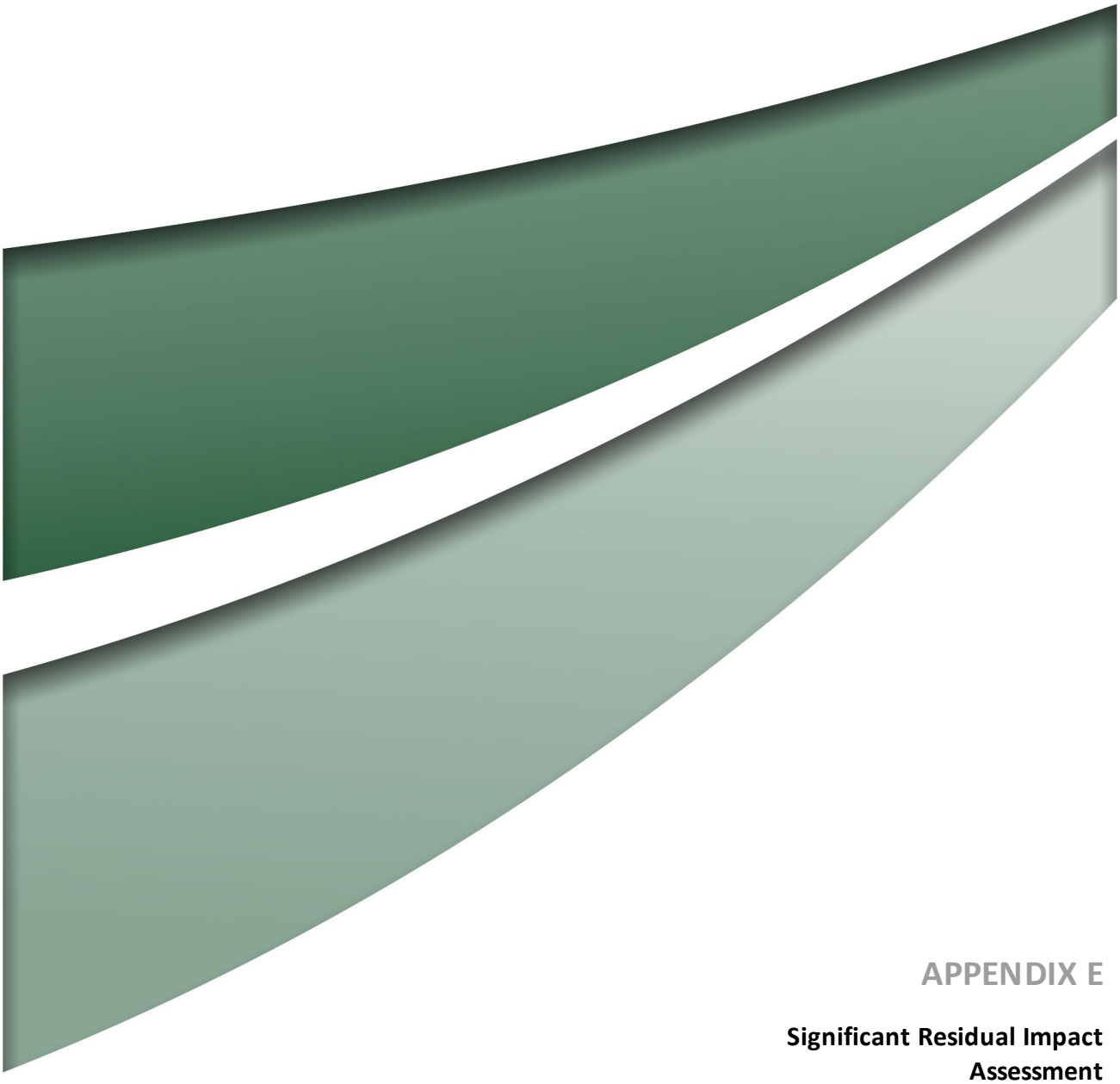

APPENDIX E

Significant Residual Impact Assessment

umwelt
Environmental & Social Consultants

NEOEN

SIGNIFICANT RESIDUAL IMPACT ASSESSMENT

Mount Hopeful Wind Farm

FINAL

May 2023

SIGNIFICANT RESIDUAL IMPACT ASSESSMENT

Mount Hopeful Wind Farm

FINAL

Prepared by
Umwelt (Australia) Pty Ltd
on behalf of
Neoen Australia Pty Ltd

Report No. 7053/R04 Appendix F
Date: June 2021

Brisbane

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This report was prepared using Umwelt's ISO 9001 certified Quality Management System.

1.0 Protected Wildlife Habitat

With regards to fauna, protected wildlife habitat prescribed in the *Environmental Offsets Regulation 2014* includes:

- An area of essential habitat on the essential habitat map for an animal that is endangered or vulnerable wildlife.
- An area of habitat (e.g. foraging, roosting, nesting or breeding habitat) for an animal that is a critically endangered, endangered, vulnerable or a special least concern animal.

With regards to the Study Area, the following Matter of State Environmental Significance (MSES) pertaining to the terrestrial fauna assessment include:

- Protected wildlife habitat (fauna).
- Connectivity.

A significant residual impact test was performed for each species, as detailed in **Section 1.1** and **Section 1.2** and for connectivity in **Section 2.0** below.

1.1 Threatened Species

1.1.1 Collared Delma (*Delma torquata*)

The collared delma is endemic to Queensland and inhabits open-forest and woodlands that are typically adjacent to rocky terrain. The species distribution extends from the western edges of Brisbane in southeast Queensland, northwest to the Blackdown Tablelands and west to the Roma region of inland Queensland (Steve K Wilson 2015). The population is heavily fragmented with records occurring at the Bunya Mountains, Blackdown Tablelands National Park (NP), Bullyard Conservation Park, D'Aguilar Range NP Expedition NP, Naumgna and Lockyer Forest Reserves, Western Creek near Millmerran and the Toowoomba Range (Davidson 1993; Ryan 2006).

Potential habitat across the Ground-truthed Mapping Extent was generally found to have low levels of required microhabitat. Eucalypt woodlands associated with REs 11.3.25b and 11.3.4 generally occur adjacent to steep hillslopes with exposed rocky boulders and other microhabitat features. In select patches of these communities, ground timber and woody debris was recorded as being common to abundant across a range of sizes from less than 10 cm to greater than 30 cm. Leaf litter was also abundant in places but generally comprised a single thin layer and did not form 'mats'. Outcrops of stones consisted of sizes that were generally less than 20 cm in diameter. Rocky outcrop areas were typically associated with ephemeral creek lines and banks. Native grass cover was largely absent in these areas. Whilst some habitat features may provide micro habitat for collared delma, the absence of key ground cover species limits the suitability of the habitat overall.

The collared delma was not recorded during the field survey program but is conservatively considered to have a moderate likelihood of occurrence. Within the Study Area, collared delma may be found in alluvial eucalypt woodland where some suitable microhabitat (exposed rocky outcrops) is present (**Table 1.1** and **Figure 1.1**).

The SRI assessment for the species is presented in **Table 1.2.** In summary, an SRI was **not triggered** for this species.

Table 1.1 Potential Area of Impact to Habitat: Collared Delma

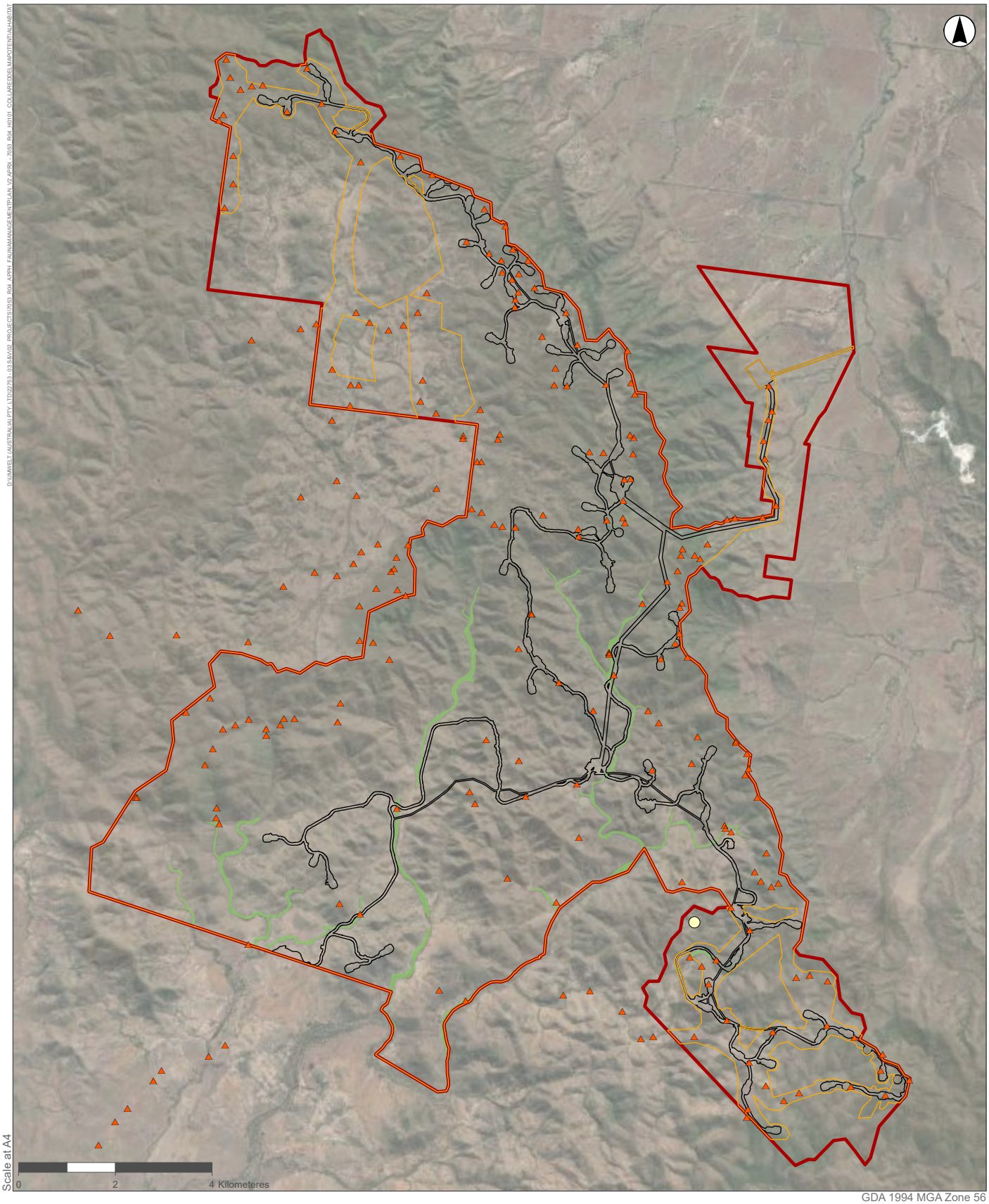
Fauna Habitat Type	Area (ha)	
	Ground-truthed Mapping Extent	Disturbance Footprint
Breeding and Foraging	249.8	5.0
Total	**249.8**	**5.0**

Table 1.2 Significant Residual Impact Assessment: Collared Delma

Evaluation Criteria	Response
Lead to a long-term decrease in the size of local population	**No**. The species was not detected during field survey. Potentially suitable habitat is present within the Study Area although is restricted to alluvial eucalypt woodlands. Potential impacts of the Project on the species includes habitat loss and degradation. Under worst-case scenario, a maximum of 5.0 ha of potential habitat will be cleared for construction of the Project. Potential habitat is considered to be of low to moderate quality due to the presence of cattle, weeds and pests. Nonetheless, direct impacts to potential habitat will be minimised via micro-siting wherever possible including at watercourse crossings. As the species is sedentary, there is a risk of mortality during clearing works. To manage this risk, pre-clearance surveys will include targeted searches for the species in areas of potential habitat to be cleared. Although it is considered unlikely, should the species be encountered during pre-clearance surveys, work will stop and the pre-clearance survey protocol will be enacted (see **Section 6.3.4** of the body of this report). Potential indirect impacts on the species include habitat degradation via weed incursion and altered fire regimes; all of which will be actively managed via the Project management plans. For these reasons, a long-term decrease in the size of a local population of the species is unlikely to result from the Project.
Reduce the extent of occurrence of the species	**No**. The extent of occurrence of the species has not been estimated. However, the species has previously been reported to be relatively common in occupied areas. The species is known from a small number of localities across south-eastern Queensland and northern NSW, across an area that extends from Middlemount in the north to Deepwater in NSW. The Study Area does not occur near the limit of the species range nor does it occur near a known location of the species. Modelled potential habitat for the species is limited, generally of low to moderate condition and unlikely to be important for connectivity in the wider local area. Although a maximum of 5.0 ha may be cleared for construction of the Project, large areas of potential habitat will remain which should be of sufficient size to support any population that may occur.

Evaluation Criteria	Response
	Refinement of the Project's design may further reduce the area of impact from what is currently represented within the Disturbance Footprint. Impacts to modelled habitat may be further minimised and potentially avoidable as a result of the micro-siting process. Project works are therefore unlikely to lead to a material change to the availability or quality of habitat for the species to the point where the species' extent of occurrence would be reduced.
Fragment an existing population	**No**. No populations of the species are known to occur within the Study Area. Little is known about the movement patterns of the species, though it is thought to be relatively sedentary; one study by Porter (1998) found that individuals occupy a small (<20 m) home range. As populations are likely to be contained within a small geographical area, they may be susceptible to fragmentation. Although some direct impacts to potential habitat are anticipated, remaining habitat would be sufficiently connected/functional for the species, given its' low dispersal capacity. However, potential habitat is largely associated with a riparian vegetation community (RE 11.3.25b) and clearing within these areas will be minimised as a priority due to the association with watercourses and other habitat features limited in the landscape (i.e. hollow bearing trees). The potential impact to modelled habitat within the Study Area is low and may be reduced following the ongoing refinement of the Project's design and micrositing. Based on the extent of modelled habitat , the Project is unlikely to present a significant barrier to the species or fragment an existing population.
Result in genetically distinct populations forming as a result of habitat isolation	**No**. No populations of the species are known to occur within the Study Area. The sedentary nature of the species means populations are susceptible to isolation as a result of habitat fragmentation. The potential impact to modelled habitat within the Study Area is low and may be reduced following the ongoing refinement of the Project's design. Based on the extent of modelled habitat the Project is unlikely to isolate habitat to the extent where genetically distinct populations would form.
Result in invasive species that are harmful to an endangered or vulnerable species becoming established in the endangered or vulnerable species' habitat	**No**. Invasive species, particularly weeds including lantana (*Lantana camara**) were recorded throughout the field survey program. The feral cat, a recognised threat to the species, was also recorded multiple times. The Project will employ best practice control methods for weeds and pests and is unlikely to introduce or exacerbate weeds or pests beyond existing levels.
Introduce disease that may cause the population to decline	**No**. There are no known diseases affecting the species. Nonetheless, the Project will employ best practice biosecurity protocols; therefore, introduction of a disease that may cause the species to decline is unlikely.
Interfere with the recovery of the species	**No**. A recovery plan for the Queensland Brigalow Belt Reptiles including the collared delma has been drafted by WWF-Australia in 2006 (Richardson 2006). Several recovery objectives are outlined in the plan and on the species SPRAT profile and broadly cover a range of topics including identification of threats and key habitat, research priorities, conservation and the establishment of reserves, monitoring programs and the development of management guidelines. The Project is unlikely to hinder the success of any of the recovery actions. Furthermore, the Project will not exacerbate any known threats to the species including cattle grazing, weed and pest levels and altered fire regimes. Potential indirect impacts on the species as a result of the Project will be actively managed via one or multiple Management Plans. Given the above and that the species was not recorded during the field survey program, the Project is unlikely to interfere with the recovery of the species.

Evaluation Criteria	Response
Cause disruption to ecologically significant locations (breeding, feeding, nesting, migration or resting sites) of a species	**No**. No populations of the species are known to occur within the Study Area. The Project may involve the loss of modelled habitat, however the impact to habitat is low and may be reduced from what is currently represented within the Development Corridor or avoided entirely. Given the above and that the species was not recorded from the Study Area, the Project is unlikely to cause disruption to ecologically significant locations for the species.



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Scale at A4

GDA 1994 MGA Zone 56

Legend

- Active Diurnal Search Sites
- Collared Delma Record (ALA)
- Ground-truthed Mapping Extent
- Disturbance Footprint
- Study Area

Potential Collared Delma Habitat

- Breeding and Foraging

FIGURE 1.1

COLLARED DELMA POTENTIAL HABITAT

Image Source: ESRI Basemap (2022) **Data source:** Department of Resources (2022)

1.1.2 Glossy Black-cockatoo (*Calyptorhynchus lathami*)

The glossy black-cockatoo prefers woodland areas dominated by she-oak (*Allocasuarina*), or open sclerophyll forests (i.e. *Eucalyptus, Corymbia* or *Angophora*) and woodlands with a stratum of *Allocasuarina* beneath.

Glossy black-cockatoos were recorded during the field survey program on three occasions. One observation was made during the bird utilisation survey, where a flock of 22 individuals were observed transiting south from the POM4 vantage point along the eastern ridge of the Study Area between 60 – 90 m above ground level (AGL). The remaining two observations were of small flocks (three individuals), with one group foraging within a stand of forest she-oak (*Allocasuarina torulosa*), and the other group transiting north at 40 m AGL. The location of these records are shown on Figure 4.2 of the Mount Hopeful Fauna Assessment (Umwelt 2023).

Within the Study Area, glossy black-cockatoos may be found in eucalypt woodlands on alluvium and steep slopes, as well as in riparian *Melaleuca* woodlands (**Table 1.3** and **Figure 1.2**). The predicted habitat areas are considered an over-representation of potential foraging habitat within the Study Area, with the primary food source, *Allocasuarina torulosa*, distributed unevenly throughout. Potential breeding habitat within the Study Area is uncommon, limited to a single vegetation community (RE 11.11.3c). This community was the only that was found during the field survey program to support occasional large, hollow bearing trees. It should be noted that no evidence of nesting glossy black-cockatoos was recorded during the field survey program.

The SRI assessment for the species is presented in **Table 1.4**. In summary, an SRI was **not triggered** for this species.

Table 1.3 Potential Area of Impact to Habitat: Glossy Black-Cockatoo

Fauna Habitat Type	Area (ha)	
	Ground-truthed Mapping Extent	Disturbance Footprint
Breeding	152.1	23.8
Foraging and dispersal	2,600.1	242.5
Total	**2,752.2**	**266.2**

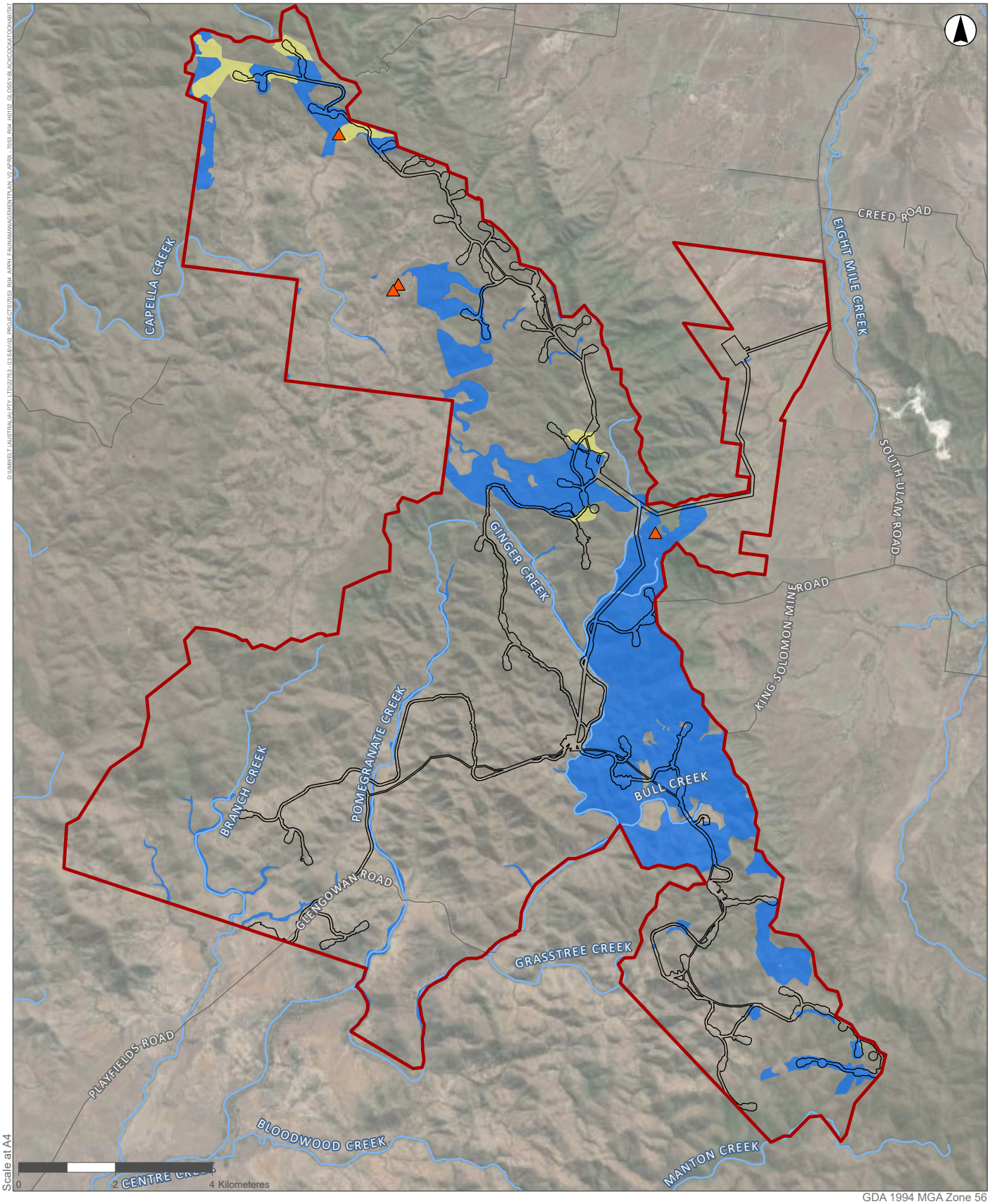
Table 1.4 Significant Residual Impact Assessment: Glossy Black-Cockatoo

Evaluation Criteria	Response
Lead to a long-term decrease in the size of local population	**No**. The collision risk assessment conducted for the species resulted in a moderate risk ranking (Umwelt 2021). Based on this assessment, potential exists for infrequent, individual mortality at turbines near/or between potential habitat areas. The Project will operate under a BBAMP which will govern operational requirements to further minimise impacts on this species, as impacts or potential impacts are detected. Given the infrequency of visits to the Study Area and low numbers recorded, coupled with an adaptive management approach, it is unlikely that the Project will lead to a long-term decrease in the size of a local population as a result of collision with turbine blades or other infrastructure (e.g. masts and guy wires).

Evaluation Criteria	Response
	The majority of habitat predicted for direct impact from the Project is suitable only for foraging and the occurrence of foraging opportunities within areas mapped as foraging habitat is rare. Given the infrequent / transient use of the Study Area by the species, and the availability of similar foraging habitat beyond the Disturbance Footprint, it is unlikely that the Project will lead to a long-term decrease in the size of a local population. The refinement of the Project's design has further reduced the area of impact from what was previously represented within the Development Corridor.
Reduce the extent of occurrence of the species	**No**. The glossy black-cockatoo has a large distribution extending across a significant portion of the Queensland coast. The distribution ranges from the Dawson-Mackenzie-Isaac Rivers basin, north to the Connors-Clarke Ranges south to Dawes and Many Peaks Ranges, and inland to the Expedition, Peak and Denham Ranges, including the Blackdown Tableland. The Study Area is not located near the limit of the species range. Micro-siting efforts will aim to retain hollow-bearing trees and large trees on patch edges, avoiding potential nesting sites. Species-specific management includes the halting of vegetation clearing in areas where active nesting hollows are located. Active animal breeding places may only be tampered with under an approved high-risk SMP. Suitable habitat supported within the Study Area includes habitat types which are dominant in the broader landscape, covering large areas of land. Given the linear nature of the Project and high mobility of the species, vegetation clearing required for the construction of the Project is unlikely to materially reduce the extent of occurrence for this species. The Project is unlikely to create significant barriers to movement or alienate large portions of habitat.
Fragment an existing population	**No**. Given the linear nature of the Disturbance Footprint and high mobility of the species, habitat clearance associated with the Project is unlikely to present significant barriers to any existing population to the extent where it would become fragmented. The presence of wind turbine generators may act as a barrier to movement, although little is understood regarding the avoidance strategies employed by the species on wind farms. Given the high mobility of the species, it is unlikely the Project will fragment an existing population.
Result in genetically distinct populations forming as a result of habitat isolation	**No**. Given the linear nature of the Project and high mobility of the species, vegetation clearance or built infrastructure associated with the Project is unlikely to isolate habitat to the extent where genetically distinct populations would form.
Result in invasive species that are harmful to an endangered or vulnerable species becoming established in the endangered or vulnerable species' habitat	**No.** No invasive species are considered a recognised threat to the species, however, the Conservation Advice for *Calyptorhynchus lathami lathami* (south-eastern glossy black cockatoo), a subspecies of the glossy black cockatoo (*Calyptorhynchus lathami*), documents that invasive weeds are currently a minor threat to this species habitat. Feral cats were recorded within the Study Area and may be harmful to this species. Although potential habitat is generally moderately to highly connected, existing conduits for movement do occur comprising cleared areas for tracks, fence lines and cattle grazing areas. Based on this, it is considered unlikely that clearing required for construction of the Project will significantly exacerbate the movement of exotic predators, including feral cats. Regardless, baseline weed and pest surveys will be undertaken prior to construction with monitoring undertaken to determine if any increase occurs as a result of the Project. If the presence or abundance of weeds and/or pests increases, this will be addressed via corrective actions stipulated in the Weed and Pest Management Plan.

Evaluation Criteria	Response
	It is unlikely the Project will result in harmful invasive species becoming established in glossy-black cockatoo habitat. Nonetheless, the Project will employ best practice control methods for weeds and pests.
Introduce disease that may cause the population to decline	**No**. There are no known diseases affecting the species. The Project follows best practice construction and operational methods; therefore, introduction of a disease is unlikely.
Interfere with the recovery of the species	**No**. There is no recovery plan in place for the species. A key threat to the recovery of the species is the loss of habitat, particularly the loss of feeding trees, nesting sites and roosting areas. The majority of habitat predicted for direct impact from the Project is suitable only for foraging and the occurrence of foraging opportunities within areas mapped as foraging habitat is rare. The refinement of the Project's design has further reduced the area of impact from what was previously represented within the Development Corridor. Given the infrequent use of the Study Area and the area of habitat disturbance comparative to the amount of habitat in the broader region, vegetation clearance associated with the Project is unlikely to interfere with the recovery of the species.
Cause disruption to ecologically significant locations (breeding, feeding, nesting, migration or resting sites) of a species	**No**. A maximum of 266.2 ha of habitat including 23.8 ha of potential breeding habitat and 242.5 ha of potential foraging habitat has been identified within the Disturbance Footprint. Glossy black-cockatoo is an obligate nester, relying on large trees (live or dead), usually eucalypts for breeding. Most nest hollows have an entrance diameter of 20 to 25cm and are in vertical or near vertical spouts, or trunk cavities exposed by the loss of a large branch (Glossy Black Conservancy, n.d.). Presence of hollows of 20 cm or greater has been used as an microhabitat parameter when assigning suitable breeding habitat to mapped fauna habitat within the Disturbance Footprint. Within areas mapped as potential breeding habitat, the occurrence of hollows of suitable diameter for this species is rare to occasional and mapping is considered to be conservative. The Project may disrupt foraging habitat, although the foraging potential (based on the occurrence and density of *Casuarina* and *Allocasuarina* species) varies within the mapped foraging habitat area. Three foraging tree species including black sheoak (*Allocasuarina littoralis*), forest sheoak (*Allocasuarina torulosa*) and river oak (*Casuarina cunninghamiana* subsp. *cunninghamiana*) occur within the Disturbance Footprint. *Casuarina cunninghamiana subsp. cunninghamiana* is recognised as being used as a foraging resource to a lesser extent than *Allocasuarina torulosa* and *Allocasuarina littoralis* for the south-eastern subspecies (*Calyptorhynchus lathami lathami*) (DAWE 2021). The occurrence of *Allocasuarina torulosa* and *Allocasuarina littoralis* as a potential foraging resource within the Disturbance Footprint is not likely to be heavily relied upon given the low density of occurrence of these species and their availability in the wider landscape. The majority of habitat predicted for direct impact from the Project is suitable only for foraging and the occurrence of foraging opportunities within areas mapped as foraging habitat is rare.

Evaluation Criteria	Response
	Micro-siting efforts will aim to retain hollow-bearing trees and large trees on patch edges, avoiding potential nesting sites. Active animal breeding places will not be tampered with without an approved DES High Risk SMP. Species specific management includes the halting of vegetation clearing in areas where active nesting hollows are located. In addition, clearing will not be permitted to resume until the nesting cockatoos leave the area on their own accord. As detailed in the Preliminary BBAMP, a single glossy black-cockatoo death will be a reportable incident to DES and trigger further investigation with regard to causation. Dependent on the outcome of the investigation, the overall collision risk determination for the species may be revised. Based on the low density of breeding and foraging opportunities within mapped habitat in the Disturbance Footprint, and the species-specific management applied to the Project, it is considered unlikely that the Project would cause disruption to ecologically significant locations (breeding, feeding, nesting, migration or resting sites) for the species.



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Scale at A4

GDA 1994 MGA Zone 56

Legend

- Glossy black-cockatoo (*Calyptorhynchus lathami*)
- Roads
- Watercourse
- Study Area
- Disturbance Footprint

Glossy-black Cockatoo Habitat

- Foraging and Dispersal
- Nesting

FIGURE 1.2

GLOSSY BLACK-COCKATOO HABITAT

Image Source: ESRI Basemap (2022) **Data source:** Department of Resources (2022)

1.1.3 Greater Glider (Southern and Central) (*Petauroides volans*)

Greater gliders are typically found in highest abundance in taller, montane, moist eucalypt forests with relatively old trees and abundant hollows. During the day, this species spends most of its time denning in hollowed trees, with each animal inhabiting up to twenty different dens within its home range. Hollows are therefore an important and limiting habitat resource. As described in the species' Conservation Advice (DCCEEW 2022b), the species' probability of occurrence is positively correlated with the availability of tree hollows.

The greater glider is known to occur within the Study Area, recorded three times during spotlighting surveys. In June 2020, one individual was recorded in a *Eucalyptus moluccana* tree 18 m above ground level (AGL) within RE 11.3.26 in an area directly adjacent to the Study Area. In November 2020, another individual was recorded near the June 2020 record within the same patch of *Eucalyptus moluccana* woodland. Targeted nocturnal surveys undertaken in October 2021 resulted in the identification of one further individual within *Eucalyptus moluccana* woodland (RE 11.11.3c) in the north-western portion of the Study Area. The location of these records are provided in Figure 4.2 of the Mount Hopeful Fauna Assessment (Umwelt 2023).

Eucalypt woodlands and forests dominate the Ground-truthed Mapping Extent and comprise a number of REs identified as 'habitat' or 'potential habitat' consistent with DES (2022). The relevant REs and their habitat categorisation as per the guidelines are:

- 11.3.4 (Habitat)
- 11.3.25 (Habitat)
- 11.11.3 (Habitat)
- 11.11.3c (Habitat)
- 11.11.4 (Habitat)
- 11.11.4a (Potential habitat)
- 11.11.4b (Potential habitat)
- 11.11.4c (Habitat)
- 11.12.6 (Habitat)
- 11.11.15 (Habitat)
- 11.12.1 (Habitat).

Hollow-bearing trees and stags however did not occur consistently across these communities. Based on the findings of the field survey program, the greatest abundance of hollows and occurrence of medium or large sized hollows was limited to select patches of REs 11.3.4, 11.3.25b, 11.12.6, 11.11.3, 11.11.3c, 11.11.4a and 11.11.4b. It is these areas exclusively that are considered suitable for breeding and denning, with remaining areas of connected eucalypt forest and woodland considered suitable for foraging and dispersal. However, excluding the *Eucalyptus moluccana* woodland communities, hollows were generally uncommon reflecting the steep terrain, shallow soils and low water availability in the area. Although not included in DES, 2022, select areas of RE 11.3.25b have also been mapped as greater glider (southern and central) habitat based on the presence of habitat resources, confirmed during the field survey program.

The extent of greater glider (southern and central) habitat within the Ground-truthed Mapping Extent and Disturbance Footprint is provided in **Table 1.5** and **Figure 1.3**.

The SRI assessment for the species is presented in **Table 1.6**. In summary, an SRI was **triggered** for this species.

Table 1.5 Potential Area of Impact to Habitat: Greater Glider

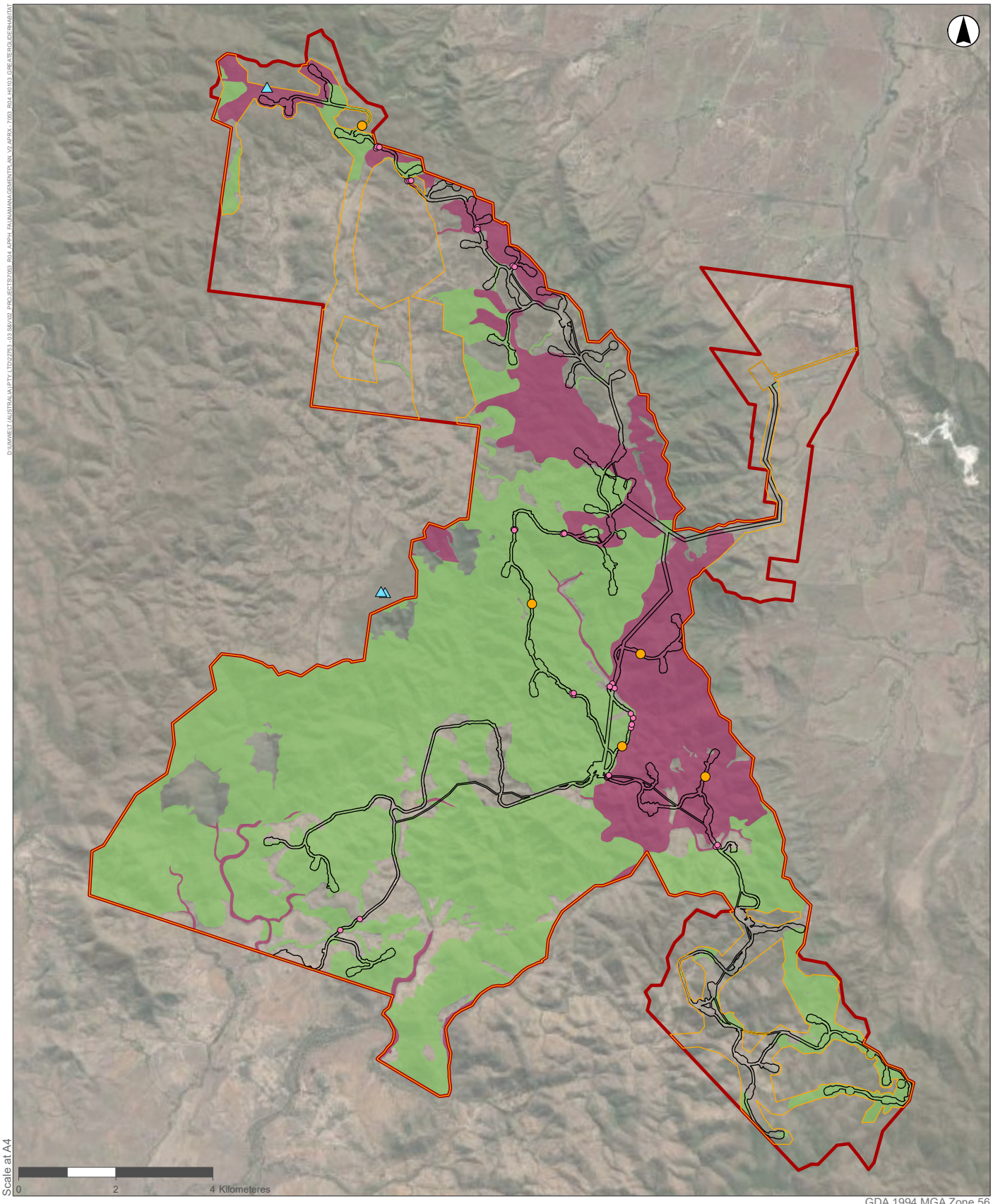
Fauna Habitat Type	Area (ha)	
	Ground-truthed Mapping Extent	Disturbance Footprint
Breeding and Denning	2,339.5	206.9
Foraging and Dispersal	7,560.9	331.5
Total	9,900.5	538.4

Table 1.6 Significant Residual Impact Assessment: Greater Glider (Southern and Central)

Evaluation Criteria	Response
Lead to a long-term decrease in the size of local population	**No.** Greater glider (southern and central) was recorded twice during the field survey program; once in the far north adjacent to the Disturbance Footprint and twice at a location immediately west of the Study Area. Several REs identified to comprise greater glider 'habitat' or 'potential habitat' as per DES (2022) occur within the Disturbance Footprint and wider Ground-truthed Mapping Extent. Apart from the *Eucalyptus moluccana* woodland community however, findings from the field surveys determined that suitable hollow-bearing trees are generally absent or in low abundance. Where hollows occur, potential habitat is considered suitable for breeding and denning. However, the low abundance of this habitat feature indicates the modelled extent of breeding and denning habitat may be overstated. Potential habitat for the greater glider dominates the Ground-truthed Mapping Extent and is not considered unique or high quality due to the rocky substrate and low water availability (resulting in stunted tree growth and low hollow abundance), historical clearing for agricultural works and ongoing disturbance from weeds and pests. Habitat fragmentation impacts have been considered in the design and siting of the Disturbance Footprint. Through the use of pinch points (5) and the installation of glider poles (13) at select locations, movement opportunities for the species will be provided within the Disturbance Footprint. Furthermore, habitat availability is expected to be high in the wider local area. There are several protected areas adjacent to the Study Area including Gelobera State Forest and Don River State Forest which are likely to provide a greater abundance of important habitat resources including hollow bearing trees or stags. Modelled habitat has a relatively high degree of connectivity both internally and to external areas including the State Forests, and this connectivity will be largely maintained following the construction of the Project. The refinement of the Project's design has further reduced the area of impact from what was previously represented within the Development Corridor. Potential indirect impacts on the species as a result of the Project are expected to be limited but will be actively managed via the Project management plans which will include specific measures for the greater glider including pre-clearance survey requirements. Based on the above, a long-term decrease in the size of a local population is unlikely to result from the Project.

Evaluation Criteria	Response
Reduce the extent of occurrence of the species	**No.** The greater glider has a large distribution extending across the majority of the east coast of Australia. The species area of occupancy is estimated at 15,316 km^2, however this may be overstated given the low resolution in the mapping methodology used by the Commonwealth (2km x 2km grid). Micro-siting efforts will aim to retain hollow-bearing trees and large trees on patch edges. Through the installation of glider poles and the inclusion of pinch points within the Disturbance Footprint, movement within and to adjacent areas will be facilitated. Large tracts of connected habitat will remain following the construction of the Project and no significant patch isolation will occur. Furthermore, the Study Area does not occur near the limit of the species distribution. Based on this, Project works are considered unlikely to materially reduce the availability or quality of habitat for the species to the point where the occurrence of a population of this species would be reduced.
Fragment an existing population	**No.** The species is known to have limited dispersal abilities and is sensitive to habitat fragmentation. Modelled habitat within the Disturbance Footprint (and wider Ground-truthed Mapping Extent) generally has moderate levels of existing fragmentation as a result of historical clearing and ongoing agricultural practices. Nonetheless, connectivity to adjacent protected areas is high. Through considered design and siting of the Disturbance Footprint, internal connectivity within and to adjacent protected areas will be largely maintained. The use of existing cleared areas has been maximised and no significant patch isolation will occur. Five pinch points will also be maintained within the Disturbance Footprint to facilitate ongoing movement. To ensure suitability for the dispersal of the greater glider, the clearing width at pinch points will be determined based on the canopy height at those locations and the usual greater glider volplane distances. As a priority, clearing will be minimised at watercourse crossings noting that riparian vegetation may be an important movement corridor for the species. This includes design measures which have sought to cross watercourses at as close as possible to 90 degrees. Micro-siting efforts will aim to retain hollow-bearing trees and large trees on patch edges. Once constructed, the Project itself will only create localised barriers to movement, however these barriers will not to be of the extent that they would fragment an existing population into two or more populations.
Result in genetically distinct populations forming as a result of habitat isolation	**No.** Through considered design and siting of the Disturbance Footprint, internal connectivity within and to adjacent protected areas will be largely maintained. The use of existing cleared areas has been maximised and no significant patch isolation will occur. As a priority, clearing will be minimised at watercourse crossings noting that riparian vegetation may be an important movement corridor for the species. This includes design measures which have sought to cross watercourses at as close as possible to 90 degrees. Micro-siting efforts will aim to retain hollow-bearing trees and large trees on patch edges. The Project will create localised barriers to movement, however these barriers will not to be of the extent they could result in genetically distinct populations forming as a result of habitat isolation.
Result in invasive species that are harmful to an endangered or vulnerable species becoming established in the endangered or vulnerable species' habitat	**No.** European red fox and feral cats are invasive species that are known to predate upon the greater glider (southern and central). While feral cat was recorded during the field survey program, European red fox was not, however, this species is likely to occur within the Study Area and wider region. It is unlikely the Project will result in invasive species that are harmful to an endangered or vulnerable species becoming established in the species' habitat. Nonetheless, the Project will employ best practice control methods for weeds and pests.

Evaluation Criteria	Response
Introduce disease that may cause the population to decline	**No.** The species is not known to be vulnerable to disease directly. Phytophthora root fungus (*Phytophthora cinnamomic*) has the potential to indirectly impact the species via the infection of eucalyptus trees. The Project will implement best practice biosecurity protocols therefore, introduction of a disease that may cause the species to decline is unlikely.
Interfere with the recovery of the species	**Likely.** There is no recognised recovery plan for the species, however one is required to stop decline and abate threats. The recently published Conservation Advice (DCCEEW, 2022) includes conservation and management priorities which are grouped into four key themes including habitat loss, disturbance and modification (including fire), climate change, invasive species (including threats from predation, grazing, trampling) and ex-situ recovery actions. Habitat loss, disturbance and modification is a recognised threat to the species. Whilst the final impact area to suitable habitat will be smaller than the area currently represented in the Disturbance Footprint, the loss of hollow-bearing trees will still occur and the Project will impact known habitat types where the species was recorded during field surveys (i.e. *Eucalyptus moluccana* woodland). Modelled habitat may also be of regional significance to the species due to its role in providing connectivity and dispersal opportunities for the species along the Ulam Range. The Project may interfere with the recovery of the species by reducing the availability of habitat in the regional context, albeit to a limited extent.
Cause disruption to ecologically significant locations (breeding, feeding, nesting, migration or resting sites) of a species	**Likely.** The species is reliant on hollow-bearing trees for breeding and has a low reproductive rate. Females give birth to a single young between March – June (McKay 2008). Clearing may occur within areas of potential breeding and denning habitat during the species' breeding season. Pre-clearance surveys will be conducted in areas of habitat to be cleared and include searches for denning individuals. Active animal breeding places will not be tampered with without an approved DES High Risk SMP. Micro-siting will aim to retain hollow-bearing trees where possible. However as stated above, it is anticipated that some suitable hollow-bearing trees will require removal. In areas of known greater glider habitat (i.e. the far northern Study Area), for every suitable hollow that is removed two suitable nest boxes will be installed. While this measure is anticipated to limit the chances of a net loss of suitable hollows, it is noted that this habitat resource is already limited in the landscape and individuals may not inhabit nest boxes for unknown reasons. Based on this, it is considered likely the Project may cause disruption to ecologically significant locations (breeding, feeding, nesting, migration or resting sites) for the species.



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GDA 1994 MGA Zone 56

Legend

- Towns
- Greater Glider (Southern and Central) Record (ALA)
- Greater Glider (Southern and Central) Record (Umwelt)
- Proposed Glider Poles
- Pinch Points
- Ground-truthed Mapping Extent
- Disturbance Footprint
- Study Area

Greater Glider (Southern and Central) Habitat

- Foraging and Dispersal
- Breeding and Denning

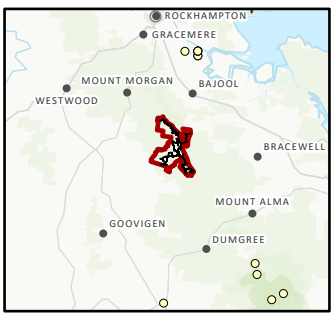


FIGURE 1.3

GREATER GLIDER (CENTRAL AND SOUTHERN) HABITAT

Image Source: ESRI Basemap (2022) **Data source:** Department of Resources (2022)

1.1.4 Koala (*Phascolarctos cinereus*)

The koala is an arboreal, folivorous mammal found across eastern Australia, including Queensland, New South Wales, the Australian Capital Territory, Victoria and South Australia. The koala inhabits a range of temperate, sub-tropical and tropical forest, woodland and semi-arid communities dominated by *Eucalyptus* species. Along the Great Dividing Range, they inhabit moist forests and woodlands mostly dominated by *Eucalyptus* species. They are also known to occur in modified or regenerating native vegetation communities.

Habitat for the koala within the Study Area comprises eucalypt woodlands (**Table 1.7** and **Figure 1.4**). Habitat searches, incidental observations, spotlighting and SAT sites did not identify the presence of koala within the Study Area. A total of 20 koala SAT searches were completed in May-June 2020 and November 2020 within five vegetation communities containing koala food trees. The results of the assessment are provided in **Table 1.8**. The SAT methodology (Phillips & Callaghan 2011) uses activity levels to quantify the use of an area by koalas by calculating the percentage of scat trees relative to the total number of trees searched per site. Due to the absence of any scat trees, activity levels for all sites in the assessment was 0%.

The koala is considered to have a moderate likelihood of occurrence based on the presence of suitable eucalypt woodland and forest habitat and scattered desktop records from the wider region. The closest desktop records are both from 1940 and occur east of the Study Area within 14 km. Undated desktop records also occur west (approximately 28 km away) near Wowan, and south (approximately 21 km away) near Round Mountain.

Historical accounts indicate that in the early 1900s, widespread pelt hunting practices within the Rockhampton electorate severely reduced and fragmented the regional koala population. Since then, there have been very few sightings in the area suggesting population numbers are likely low and still recovering. Based on the lack of evidence of koala in the Study Area and recent activity in the surrounding region, the likelihood of occurrence assessment is considered conservative as the koala is likely to occur in very low densities, if at all.

Despite this, suitable habitat for the species is widely available across the Ground-truthed Mapping Extent. The Ground-truthed Mapping Extent is dominated by large tracts of Eucalyptus and/or Corymbia forest, which are functionally connected to tracts of suitably habitat outside of the Study Area at a landscape scale. This habitat is suitable to support the ecological requirements of the species including breeding, foraging and dispersal. Riparian forests and woodlands are also present in low-lying, alluvial areas and may provide climate refugia during extreme weather conditions. However, it is noted that water availability within the Ground-truthed Mapping Extent and wider Study Area is generally limited due to the absence of perennial watercourses and large watercourses (i.e. stream order 4 or higher). Based on this, more valuable areas of refugia are likely to occur outside of the Study Area associated with riverine and floodplain communities to the east. The SRI assessment for the species is presented in **Table 1.9**. In summary, an SRI was **not triggered** for this species.

It should be noted that the Commonwealth Significant Impact Assessment undertaken in line with *Significant Impact Guidelines 1.1 – MNES* (Department of the Environment, 2013), concluded a significant outcome. This is due to the specific requirements of assessment against Habitat Critical to the Survival of the Species. As per the *Conservation Advice for Phascolarctos cinereus (koala)* (Department of Agriculture, Water and the Environment, 2022) habitat critical to the survival of the species includes habitat occupied and habitat currently unoccupied by the species, and as such this part of the test was triggered and a significant result determined. The concept of habitat critical to the survival of the species is not relevant to the SRI process.

Table 1.7 Potential Area of Impact to Habitat: Koala

Fauna Habitat Type	Area (ha)	
	Ground-truthed Mapping Extent	Disturbance Footprint
Breeding, Foraging and Dispersal	11,128.2	721.1
Climate Refugia	277.7	5.3
Total	**11,405.9**	**726.5**

Table 1.8 Koala SAT Results

RE ID	Short Description	Sites	Scat Trees
11.3.25b	*Melaleuca leucadendra* and/or *M. fluviatilis*, *Nauclea orientalis* open forest	1	0
11.3.26	*Eucalyptus moluccana* or *E. microcarpa* woodland to open forest on margins of alluvial plains	1	0
11.11.3	*Corymbia citriodora*, *Eucalyptus crebra*, *E. acmenoides* open forest on old sedimentary rocks with varying degrees of metamorphism and folding. Coastal ranges	3	0
11.11.4b	*Corymbia trachyphloia* or *Eucalyptus acmenoides*, *E. crebra* woodland +/- *Acacia leiocalyx*	2	0
11.12.1	*Eucalyptus crebra* woodland on igneous rocks	1	0
11.12.6	*Corymbia citriodora* open forest on igneous rocks (granite)	12	0
	Total	**20**	**0**

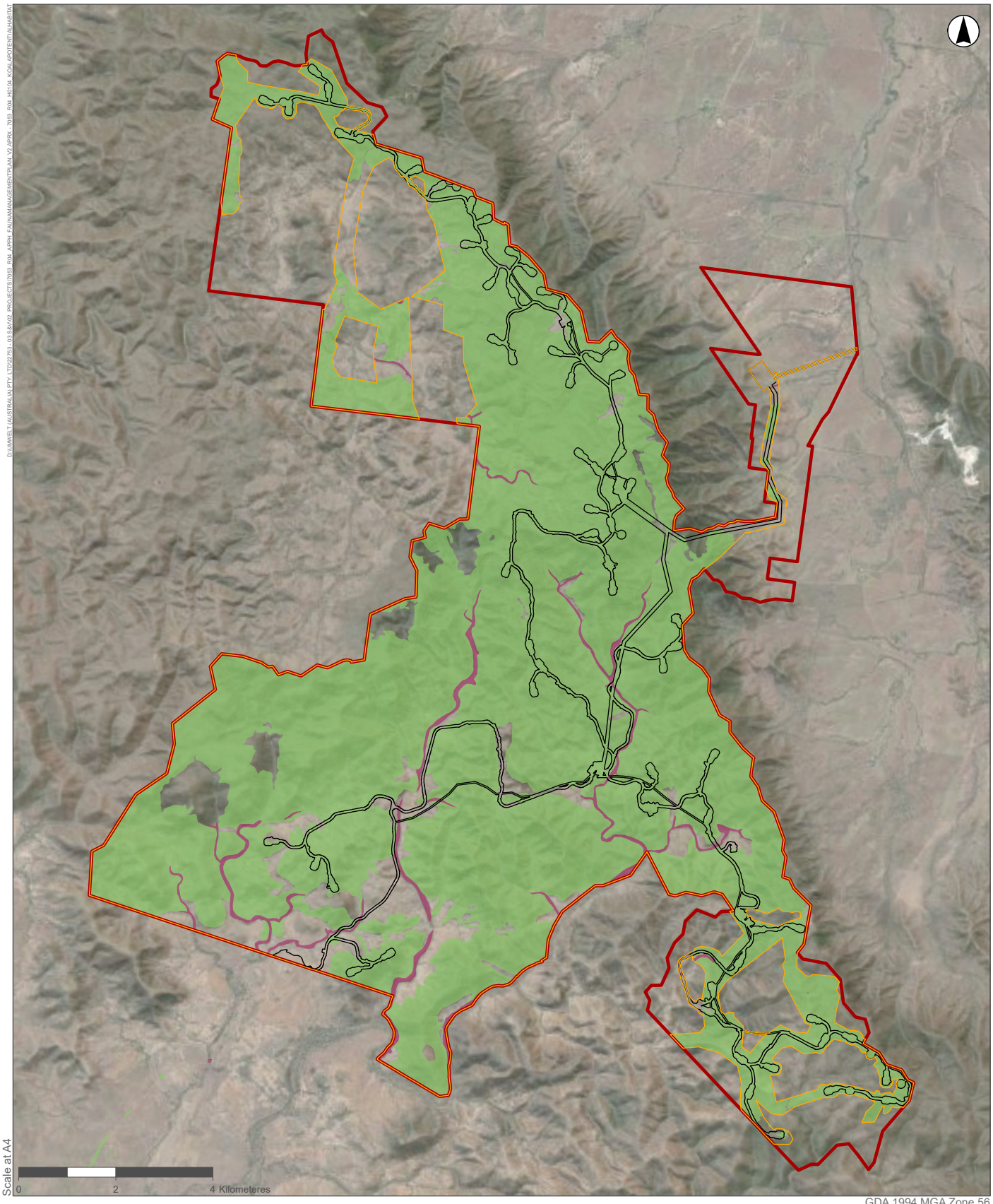
Table 1.9 Significant Residual Impact Assessment: Koala

Evaluation Criteria	Response
Lead to a long-term decrease in the size of local population	**No.** This species was not recorded during the field survey program despite the use of recommended survey methods and extensive field effort. Desktop records in the region are scarce and generally >50 years old. Hunting practices within and surrounding Rockhampton in the early 1900s are known to have severely reduced the regional population and recovery has been very slow. Only a small number of transient individuals are likely to utilise the Ground-truthed Mapping Extent and wider Study Area at one time. A maximum of 726.45 ha of potential koala habitat will be directly impacted for construction of the Project, including 721.14 ha suitable for breeding, foraging and dispersal and 5.31 of potential climate refugia. Potential habitat for koala dominates the Ground-truthed Mapping Extent and is not considered unique or high quality due to the ongoing disturbance from cattle grazing, weeds and pests.

Evaluation Criteria	Response
	Potential habitat associated with the non-remnant vegetation communities especially is highly disturbed and in places contains a low abundance of koala food trees. Within the wider region potential habitat is likely to occur extensively and include areas of higher quality particularly in protected areas such as the adjacent State Forests. The extent of habitat that will remain following the construction of the Project is of the magnitude and quality to support a much larger population than is currently expected to occur. Noting this, any important population present is expected to continue to persist within the region regardless of the Project. Indirect impacts on the species as a result of the Project are expected to be limited, as the Project is highly unlikely to increase pests or vehicle strikes with the suite of general mitigation measures proposed including speed limits and pest monitoring. Nonetheless, koala specific measures including pre-clearance survey requirements are also proposed and will be captured in the Fauna Management Plan. Given the potential absence or infrequent use of the modelled habitat by this species as well as the implementation of Project management plans, a long-term decrease in the size of a population is unlikely to result from the Project.
Reduce the extent of occurrence of the species	**No.** As stated in the species' Conservation Advice, the area of occupancy for the koala is estimated at 19,428 km^2 and is contracting. It is noted that the area of occupancy may be potentially overstated given the low resolution in the mapping methodology used by the Commonwealth (2 km x 2 km grid). The koala is widespread across Queensland and the Study Area is not located near the limit of the species distribution. Although the Project will result in the removal of up to 726.5 ha of potential habitat, only a very small number of individuals are expected to be utilising such habitat. The quantum of potential habitat that will remain is sufficient to continue to maintain any potentially occurring population. Furthermore, habitat of similar and better quality is widely available in the local area and connectivity to these areas will be maintained. Based on this, Project works are considered unlikely to materially reduce the availability or quality of habitat for the species to the extent that the area of occurrence of a population would be reduced.
Fragment an existing population	**No.** The species is considered highly mobile and known to readily disperse large distances including across cleared areas. Modelled potential habitat generally has low to moderate levels of fragmentation as a result of historical clearing and ongoing agricultural practices. Where potential habitat is associated with non-remnant vegetation, existing fragmentation impacts are more pronounced, and the canopy cover overall is notably lower. Modelled habitat does however have a relatively high degree of connectivity to adjacent protected areas. Through considered design and siting of the Development Corridor and Disturbance Footprint, connectivity within and to adjacent protected areas will be largely maintained. The use of existing cleared areas has been maximised and five pinch points will be maintained.

Evaluation Criteria	Response
	During construction, increased vehicle activity and ground excavations may become temporary barriers to dispersing individuals. However, the risk of mortality as a result of entrapment and collision will be actively managed via Project management plans. Vehicle traffic will be localised to the construction site and speed limits will be enforced. Any open excavations will contain materials to aid evacuation (i.e. ramps, sticks, hessian sacks) and be checked at set times by a spotter catcher. Once constructed, the Project itself will not create a barrier to movement as ground surfaces will be reinstated and turbines will occur in discrete locations. Furthermore, it is expected 20% of the Disturbance Footprint will be revegetated post construction with native species including eucalypt trees where practical. Based on the above, the Project is considered unlikely to present significant barriers to the species local movement to the extent that it fragments a population into two or more populations.
Result in genetically distinct populations forming as a result of habitat isolation	**No.** The species is considered highly mobile and known to readily disperse large distances including across cleared areas. Modelled potential habitat generally has low to moderate levels of fragmentation as a result of historical clearing and ongoing agricultural practices. Where potential habitat is associated with non-remnant vegetation, existing fragmentation impacts are more pronounced, and the canopy cover overall is notably lower. Modelled habitat does however have a relatively high degree of connectivity to adjacent protected areas. Through considered design and siting of the Development Corridor and Disturbance Footprint, connectivity within and to adjacent protected areas will be largely maintained. The use of existing cleared areas has been maximised and five pinch points will be maintained. During construction, increased vehicle activity and ground excavations may become temporary barriers to dispersing individuals. However, the risk of mortality as a result of entrapment and collision will be actively managed via Project management plans. Vehicle traffic will be localised to the construction site and speed limits will be enforced. Any open excavations will contain materials to aid evacuation (i.e. ramps, sticks, hessian sacks) and be checked at set times by a spotter catcher. Once constructed, the Project itself will not create a barrier to movement as ground surfaces will be reinstated and turbines will occur in discrete locations. Furthermore, it is expected 20% of the Disturbance Footprint will be revegetated post construction with native species including eucalypt trees where practical. Based on the above, the Project is considered unlikely result in genetically distinct populations forming as a result of habitat isolation.
Result in invasive species that are harmful to an endangered or vulnerable species becoming established in the endangered or vulnerable species' habitat	**No.** Several exotic fauna species were identified during the field survey program. Wild dogs were recorded commonly and are expected to occur throughout the wider Study Area and surrounding region. Although potential habitat is generally moderately to highly connected, existing conduits for movement do occur comprising cleared areas for tracks, fence lines and cattle grazing areas. Based on this, it is considered unlikely that clearing required for construction of the Project will significantly exacerbate the movement of exotic predators. Regardless, baseline pest surveys (including wild dogs) will be undertaken prior to construction with monitoring undertaken to determine if any increase occurs as a result of the Project. If the presence or abundance of pests increases, a species-specific control program with be designed and implemented. The Project will employ best practice control methods for weeds and pests and is unlikely to introduce or exacerbate weeds or pests beyond existing levels.

Evaluation Criteria	Response
Introduce disease that may cause the population to decline	**No.** Chlamydia and Koala Retrovirus (KoRV) are known threats to the species. Project works are unlikely to spread disease; nonetheless, best practice biosecurity measures will be implemented through the Project management plans. Should an unwell koala be identified during clearing works, it will be handled appropriately by a qualified spotter catcher and taken to a predesignated veterinarian/wildlife care facility for treatment prior to release. Based on the above, it is unlikely the Project will introduce disease that may cause the species to decline.
Interfere with the recovery of the species	**No.**. There is limited information available about the koala population viability and trend within the Rockhampton region. However, historical hunting practices are known to have reduced numbers severely in the 1900s. Despite the availability of suitable habitat, there is no evidence to suggest that koalas are currently occupying the modelled habitat within the Study Area. Given the low density of the population in the region, if koalas were to utilise the area, only a small number of transient individuals are likely to be present within the Ground-truthed Mapping Extent and wider Study Area at one time. Potential habitat for koala dominates the Ground-truthed Mapping Extent and is not considered unique or high quality due to the ongoing disturbance from cattle grazing, weeds and pests. Potential habitat associated with the non-remnant vegetation communities especially is highly disturbed and in places contains a low abundance of koala food trees. Within the wider region potential habitat is likely to occur extensively and include areas of higher quality particularly in protected areas such as the adjacent State Forests. The extent of habitat that would remain following the construction of the Project is of the magnitude and quality to support a much larger population than is currently expected to occur. Noting this, any population present in the region is expected to continue to persist and the quantum and quality of habitat which would be removed as a result of the Project would not be sufficient to interfere with the species' recovery.
Cause disruption to ecologically significant locations (breeding, feeding, nesting, migration or resting sites) of a species	**No.** As described above, a small number of individuals may utilise modelled habitat and comprise a population. Male koalas are known to disperse large distances during the breeding season in search of a mate, and dispersal will not be hindered by the Project, as described earlier. Koalas are nocturnal and mating calls generally occur at night when Project-related noise will be minimal. As the species does not have specific breeding requirements, all potential habitat may be suitable for breeding and large areas will be retained following construction of the Project. Potential habitat degradation will be actively managed through the Project management plans. Given the potential absence or infrequent use of the modelled habitat by this species, the Project is unlikely to cause disruption to ecologically significant locations (breeding, feeding, nesting, migration or resting sites) of the species.



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Scale at A4

GDA 1994 MGA Zone 56

Legend

- Towns
- Koala Record (ALA)
- Ground-truthed Mapping Extent
- Disturbance Footprint
- Study Area

Potential Koala Habitat

- Breeding, Foraging and Dispersal
- Climate Refugia

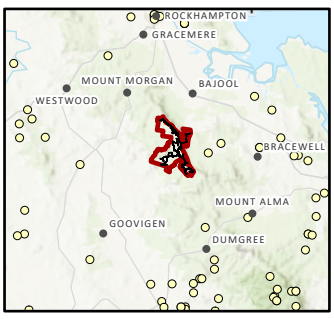


FIGURE 1.4

KOALA POTENTIAL HABITAT

Image Source: ESRI Basemap (2022) **Data source:** Department of Resources (2022)

1.1.5 Squatter Pigeon (Southern) (*Geophaps scripta scripta*)

The squatter pigeon occurs in open-forests to sparse, open-woodlands and scrub. Foraging habitat comprises remnant or regrowth open-forest to sparse, open-woodland or scrub dominated by *Eucalyptus, Corymbia*, *Acacia* or *Callitris* species, on sandy or gravelly soils, within 3 km of a suitable, permanent or seasonal waterbody. Breeding habitat occurs on stony rises occurring on sandy or gravelly soils, within 1 km of a suitable, permanent waterbody.

The subspecies is known to access suitable waterbodies to drink on a daily basis, including permanent or seasonal rivers, creeks, lakes, ponds and waterholes, and artificial dams. The subspecies prefers to drink where there is gently sloping, bare ground on which to approach and stand at the water's edge.

Although breeding can occur throughout the year if conditions are suitable, breeding generally coincides with the dry season (April to October) when their primary food source (grass seed) is most abundant. The nest is a depression scraped into the ground beneath a tussock of grass, bush, fallen tree or log and is sparsely lined with grass.

The squatter pigeon (southern) is known to occur within the Study Area, recorded on 78 occasions throughout the field survey program, although this is likely to include multiple observations of the same individuals. It was commonly recorded along access tracks in non-remnant areas of the Study Area. The location of these records are provided in Figure 4.2 of the Mount Hopeful Fauna Assessment (Umwelt 2023).

Suitable habitat within the Ground-truthed Mapping Extent includes areas that may provide breeding, foraging and dispersal opportunities. Breeding and foraging habitat is generally limited, reflecting the dominant surface geology types (metamorphic and igneous rocks) and steep terrain associated with mapped watercourses. Breeding, foraging and suitable water sources within the Study Area and adjacent were found to all largely occur within 1 km of each other. The local movements of the subspecies will largely be driven by the presence of these resources, and given their tendency to utilise cleared, low-lying areas it is considered likely that the shortest and most direct route to adjacent habitat will be utilised. Based on this, the extent of dispersal habitat was limited to a 1 km distance from breeding and foraging habitat.

Modelled habitat for the species within the Ground-truthed Survey Extent and the Disturbance Footprint is provided in **Table 1.10** and **Figure 1.5**.

The SRI assessment for the species is presented in **Table 1.11**. In summary, an SRI was **not triggered** for this species.

Table 1.10 Potential Area of Impact to Habitat: Squatter Pigeon

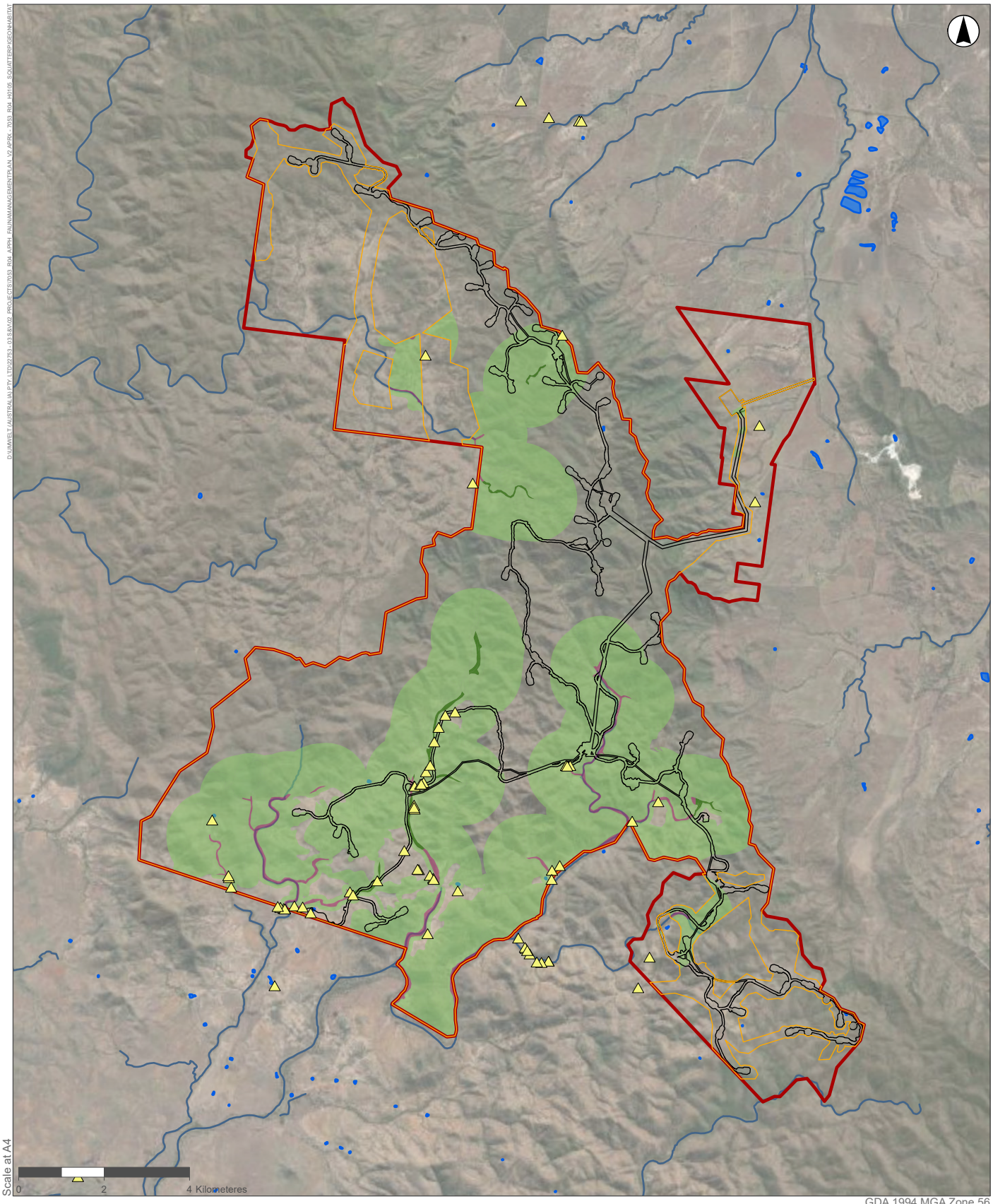
Fauna Habitat Type	Area (ha)	
	Ground-truthed Mapping Extent	Disturbance Footprint
Breeding	184.0	3.6
Foraging	57.7	1.5
Dispersal	6,683.9	324.2
Total	**6,925.7**	**329.2**

Table 1.11 Significant Residual Impact Assessment: Squatter Pigeon

Evaluation Criteria	Response
Lead to a long-term decrease in the size of local population	**No.** The squatter pigeon (southern) is known from the Study Area and surrounds, primarily recorded in cleared non-remnant vegetation. Under worst-case scenario, a maximum of 329.23 ha of suitable habitat including 3.59 ha of breeding habitat, 1.47 ha of foraging habitat and 324.17 ha of dispersal habitat will be directly impacted via vegetation clearing required for construction of the Project. Habitat is considered to be of moderate quality due to the presence of cattle, weeds and pests including feral cat which was recorded during the field survey program. Nonetheless, direct impacts to habitat will be minimised wherever possible via micro-siting and the final clearing areas are expected to be lower. Farm dams will be maintained to ensure the availability of suitable water sources required by the species is not affected. The quantum of habitat that will remain following construction of the Project, particularly breeding and foraging habitat, will be sufficient to maintain the population present. As the subspecies is predominantly ground-dwelling and known to frequent tracks, there is a risk of mortality during construction as a result of vehicle/plant strike. To manage this risk, speed limits will be strictly enforced and pre-clearance surveys will include flushing for the subspecies in areas of habitat to be cleared. Potential indirect impacts on the species including habitat degradation via weed and pest incursion will be actively managed via the Project management plans. The turbine collision risk assessment identified the species as being of Moderate risk for impacts from the Project, reflecting the species' vulnerable listing and frequency of occurrence within the Study Area. However it is noted that the species is highly unlikely to fly at RSA height. Any potential operational impacts on this subspecies will be managed by the Project BBAMP. Given the implementation of the Project management plans including the BBAMP, it is considered unlikely that the Project will lead to a long-term decrease in the size of a local population.
Reduce the extent of occurrence of the species	**No.** The squatter pigeon (southern) occurs across a large portion of eastern Queensland. It's area of occupancy was estimated to be 10,000 km^2 (1,000,000 ha) in 2000. However, it is noted that this estimate may be potentially overstated given the low resolution in the mapping methodology used by the Commonwealth (2 km x 2 km grid).

Evaluation Criteria	Response
	During the field survey program the subspecies was commonly recorded in low-lying land both within the Study Area and in areas adjacent. These areas were generally highly disturbed from historical clearing and ongoing cattle grazing activities. The Project is linear in nature and infrastructure has been sited to maximise wind patterns in the landscape i.e. along ridgelines and hill tops. As a result, direct impacts to breeding and foraging habitat are particularly limited and clearing in these areas will be further minimised via micro-siting. Therefore, the Project is unlikely to reduce the area of occurrence of a population.
Fragment an existing population	**No.** The squatter pigeon (southern) is considered highly mobile and was frequently recorded in highly disturbed and cleared areas, highlighting the subspecies' ability to utilise fragmented landscapes. The Project has been strategically sited to maximise the use of cleared areas, minimising additional habitat fragmentation including within breeding and foraging habitat, which are likely important for the population's persistence in the area. Clearing will be completed only as strictly necessary and final impact areas are likely to be lower. The turbine collision risk assessment identified the species as being of Moderate risk for impacts from the Project. However, the species is highly unlikely to fly at RSA height and as such it is unlikely the wind turbines will create a barrier to movement. Potential operational impacts on squatter pigeon (southern) will be managed by the Project BBAMP. As such, it is unlikely the Project will fragment an existing.
Result in genetically distinct populations forming as a result of habitat isolation	**No.** The squatter pigeon (southern) is considered highly mobile and was frequently recorded in highly disturbed and cleared areas, highlighting the subspecies' ability to utilise fragmented landscapes. The Project has been strategically sited to maximise the use of cleared areas, minimising additional habitat fragmentation including within breeding and foraging habitat, which are likely important for the population's persistence in the area. Clearing will be completed only as strictly necessary and final impact areas are likely to be lower. As such, it is unlikely the Project will result in genetically distinct populations forming as a result of habitat isolation.
Result in invasive species that are harmful to an endangered or vulnerable species becoming established in the endangered or vulnerable species' habitat	**No.** Invasive species including weeds and predators such as the feral cat were recorded throughout the field survey program. Historical clearing has occurred in discrete locations across the Study Area primarily for cattle grazing purposes. It is considered likely that these areas already act as conduits for pest movement in the landscape. Regardless, baseline weed and pest surveys will be undertaken prior to construction with monitoring undertaken to determine if any increase occurs as a result of the Project. If the presence or abundance of weeds and/or pests increases, a species-specific control program with be designed and implemented. The Project will employ a range of best practice control methods for weeds and pests. Based on this, it is unlikely the Project will result in invasive species that are harmful to the squatter pigeon (southern) becoming established.
Introduce disease that may cause the population to decline	**No.** There are no known diseases affecting the subspecies. Nonetheless, the Project will follow best practice biosecurity protocols during both construction and operation; therefore, introduction of a disease is unlikely.

Evaluation Criteria	Response
Interfere with the recovery of the species	**No.** There is no recovery plan currently in place for the subspecies nor is one considered required. As per SPRAT, the following recovery actions have been recommended (EPA 2006; Garnett & Crowley 2000): • Determine the population size and distribution of the Squatter Pigeon (southern) in southern Queensland and New South Wales, and assess the pigeon's conservation status and requirements. • Undertake studies in North and Central Queensland to determine the relationship between pigeon abundance, tree density and stocking rates. • Establish sites for sub-population monitoring. If possible, these sites should be established with the cooperation of local land-owners and/or conservation organisations. • Develop and implement public education programs and community based tree planting schemes to revegetate favoured habitat types. • Establish control measures for predators (especially cats and foxes) at important sites. • Establish conservation measures to protect grassy woodlands and forests. The Project is highly unlikely to impede any of the above actions and populations within central Queensland are likely to be stable. Although clearing will occur within areas of suitable habitat, the majority of the area to be impacted comprises habitat suitable for dispersal only. Construction of the Project is unlikely to change the subspecies utilisation of the Study Area or limit its success in the region. Implementation of the Project's BBAMP will assist in minimising potential impacts to the subspecies during operation. Therefore, the Project is unlikely to interfere with the recovery of the subspecies.
Cause disruption to ecologically significant locations (breeding, feeding, nesting, migration or resting sites) of a species	**No.** Squatter pigeon (southern) may breed throughout the year if conditions are suitable. Within the Ground-truthed Mapping Extent, breeding habitat for the subspecies is of average quality and limited. Although under worst case scenario a maximum of 3.6 ha of breeding habitat will be impacted via vegetation clearing, micro-siting efforts are anticipated to reduce this extent significantly as many areas will also be associated with watercourse crossings. Specific mitigation measures are also proposed to ensure no squatter pigeon (southern) nests are impacted during construction, including nest searches during pre-clearance surveys and demarcating any located. Active animal breeding places will only be tampered with under an approved DES High Risk SMP. Additionally, to reduce vehicle or plant collision or crushing of nests, all vehicles and pedestrians will remain within designated access tracks. The Project is therefore unlikely to disrupt the breeding cycle of a population.



1:125,000
Scale at A4

GDA 1994 MGA Zone 56

Legend

- Squatter Pigeon (Southern) Record (ALA)
- Squatter Pigeon (Southern) Record (Umwelt)
- Suitable Watercourses
- Ground-truthed Mapping Extent
- Disturbance Footprint
- Study Area
- Reservoirs (DoR)

Squatter Pigeon (Southern) Habitat

- Breeding
- Dispersal
- Foraging

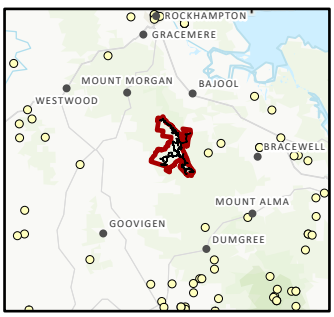


FIGURE 1.5

SQUATTER PIGEON (SOUTHERN) HABITAT

Image Source: ESRI Basemap (2022) **Data source:** Department of Resources (2022)

1.1.6 White-throated Needletail (*Hirundapus caudacutus*)

White-throated needletails are an almost exclusively aerial, large-bodied swift that are insectivorous feeding on a variety of insect prey items during their migration in Australia across a range of habitat types and landscapes. Whilst in Australia the species is gregarious observed flying in flocks of hundreds and even thousands of birds.

They are regularly recorded above wooded areas including open forest and rainforest, though may also fly below the canopy between trees or in clearings. When flying above farmland, they are more often recorded above partly cleared pasture, plantations, or remnant vegetation at the edge of paddocks.

During non-breeding migrations to Australia the white-throated needletail feeds on a variety of insects including beetles, cicadas, flying ants, bees, wasps, flies, termites, moths, locusts and grasshoppers. The species feeds up to the height of clouds over a variety of foraging habitats including heavily treed forests. Open foraging habitats include farmland, heathland or mudflats, although the species has been observed feeding at lower altitudes closer to the ground as low as 15 cm at a coastal saltworks.

White-throated needletail was recorded on 30 occasions flying over a diversity of habitat types, both incidentally and during the BBUS. Six hundred and ninety-eight individuals have been recorded during surveys with a total of 320 individuals recorded at vantage points during BBUS and a total of 378 individuals recorded incidentally across all survey events. The number of individuals observed in aggregations ranged from 1 to 180. During the morning BBUS survey period (6 am to 10 am) a total of 318 individuals were recorded. During the midday BBUS survey period (10 am to 2 pm) a total of 236 individuals were recorded. During the afternoon BBUS survey period (2 pm to 6 pm) a total of 144 individuals were recorded. The location of these records are provided in Figure 4.2 of the Mount Hopeful Fauna Assessment (Umwelt 2023).

Potential habitat for white-throated needletail within the Study Area consists of roosting, foraging and dispersal habitat. Given the species is a non-breeding migrant to Australia, no breeding habitat exists and will not be considered further. The Study Area is dominated by woodland communities dominated by *Eucalyptus* species, semi-evergreen vine thicket and non-remnant pasture which provide foraging habitat for the species. The Project is located at the Ulam Range, which forms a part of the Great Dividing Range. South-easterly trade winds generated by warm Pacific and Tasman maritime air create the potential for convection along the Great Dividing Range which is aided by orographic lift, the movement of air masses from lower to higher elevations over rising terrain (Spassiani 2020). During the summer months, easterly troughs along the inland side of the Great Dividing Range form a boundary between moist coastal air and the drier air that occurs inland producing a ridge of high pressure along the coast (Bureau of Meteorology 2010). The combination of montane topography and pressure systems along the Great Dividing Range produce updrafts and with it, foraging opportunities for white-throated needletail.
Given the preference for roosting on tall and /or hollow bearing trees at the top of ridges, as well as vertical tree trunks, rock faces and dense canopy foliage, white-throated needletail roosting habitat is limited to remnant vegetation with mature stands of trees confined to ridgelines and mountains throughout the Study Area. As per the Queensland DoR Mountain peaks and capes dataset, the North Pimple is the landscape feature with the lowest elevation (454 m) in the local area. To ensure a conservative approach, all areas with an elevation of 400 m or higher were therefore considered the limit of potential roosting and foraging habitat. Due to the species broad habitat requirements and aerial nature, all remaining areas of regrowth and remnant vegetation are considered potential foraging and dispersal habitat. Habitat for the white-throated needletail is quantified in **Table 1.12** and shown on **Figure 1.6.**

The SRI assessment for the species is presented in **Table 1.13**. In summary, an SRI was **not triggered** for this species.

Table 1.12 Potential Area of Impact to Habitat: White-throated Needletail

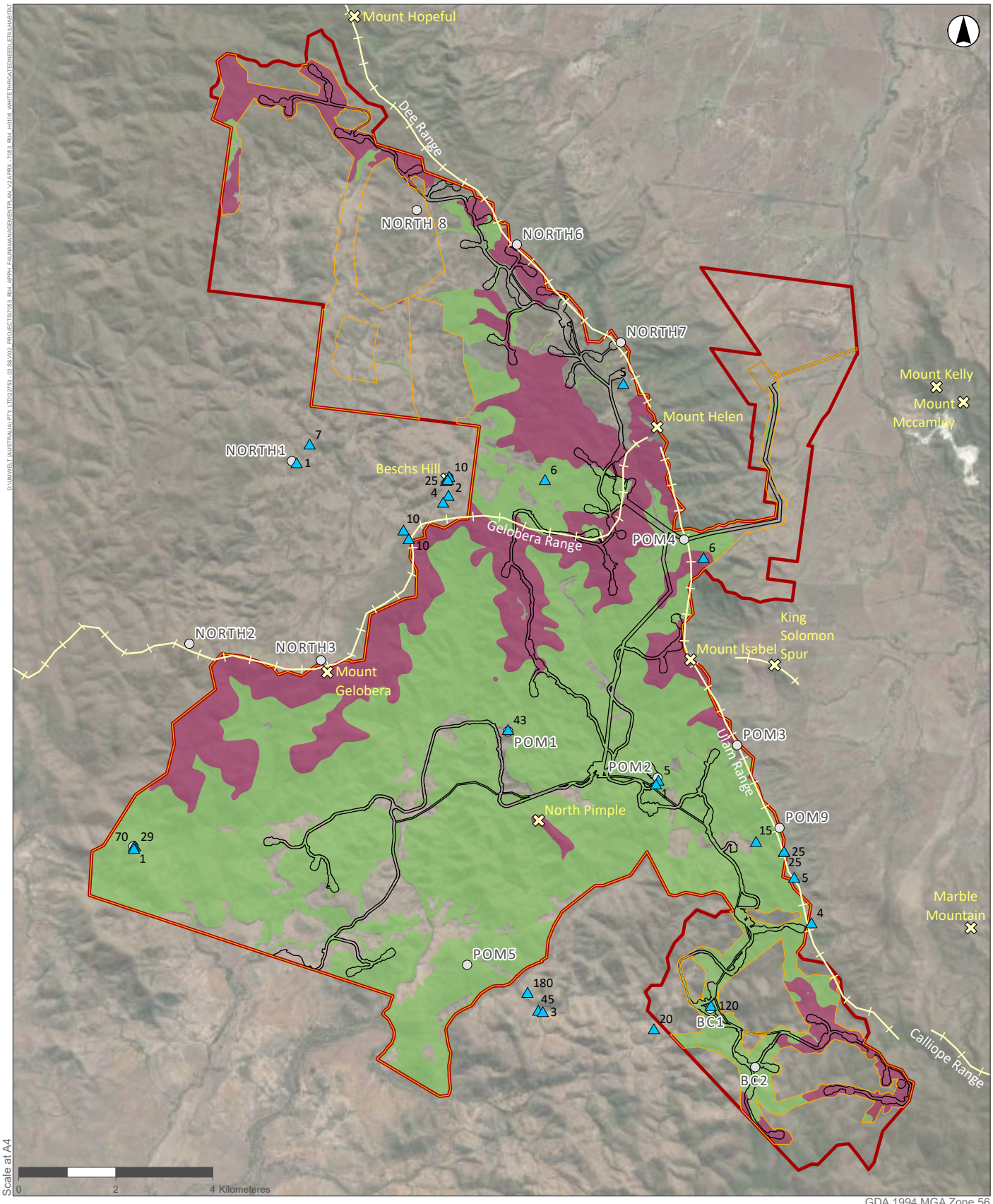
Fauna Habitat Type	Area (ha)	
	Ground-truthed Mapping Extent	Disturbance Footprint
Roosting and Foraging	7,823.9	267.9
Foraging and Dispersal	2,866.1	365.9
Total	**10,690.0**	**633.8**

Table 1.13 Significant Residual Impact Assessment: White-throated Needletail

Evaluation Criteria	Response
Lead to a long-term decrease in the size of local population	**No.** The white-throated needletail is known to the Study Area, recorded on 30 occasions during the field survey program, totalling 698 individuals. It is a non-breeding migrant to eastern Australia where it occurs as transient populations, often influenced by prevailing weather conditions. The species generally arrives in Australia during spring and migrates along both sides of the Great Diving Range in Queensland and NSW to the southern parts of their range. The journey is reversed as the species leaves Australia in autumn. While migrating, it is likely the species will inhabit the airspace above all remnant and regrowth habitat types within the Study Area. Under worst-case scenario, up to 267.9 ha of roosting and foraging habitat and 365.9 ha of foraging and dispersal habitat will be directly impacted via vegetation clearing for construction of the Project. Relative to the area that will be cleared, large areas of suitable habitat will remain. Given the species aerial nature and broad requirements for roosting and foraging, it is unlikely this loss of habitat will result in a material change to the species' utilisation of the area. The turbine collision risk assessment identified the species as being of Very High risk for impacts from the Project, reflecting the Vulnerable status of the species and the frequency at which the species occurs at RSA. Given the flight behaviours of the species and known occurrence within the Study Area, the mortality of individual birds may occur during the lifetime of the Project, particularly whilst the species is present in Australia (October - March). However, collision risk modelling completed for the Project indicates overall mortality numbers will be very low (i.e. 1 individual every 5.9 years). The potential impact on this species would be managed by the Project BBAMP, which governs the operational and compliance reporting response following any confirmed mortality event. As the plan is adaptive, the death of a single white-throated needletail would result in notification to DCCEEW, an investigation and additional monitoring. Given the implementation of a BBAMP, it is considered unlikely that the Project will lead to a long-term decrease in the size of a population.
Reduce the extent of occurrence of the species	**No.** While in Australia the species has a large distribution that extends across eastern Australia. As per the species' Conservation Advice, the estimated area of occupancy within Australia is >18,000 km^2 however this may be overstated given the mapping methodology used by the Commonwealth (2 km x 2 km grid).

Evaluation Criteria	Response
	Although the Project will result in a maximum loss of up to 267.9 ha of roosting and foraging habitat and 365.9 ha of foraging and dispersal habitat, habitat is likely to only be utilised temporarily while on migration. The quantum of habitat that will remain is likely to be sufficient to support the ecological requirements of populations of the size observed during field surveys. Furthermore, areas of suitable habitat are likely to occur extensively within the wider region. Given the aerial nature and high mobility of the species, as well as the broad habitat requirements and habitat availability in the broader region, the Project is unlikely to reduce the area of occurrence of a population.
Fragment an existing population	**No.** The species is highly mobile, flying for thousands of kilometres during migration. It is known to occur within fragmented landscapes as well as over a range of habitat types. The Project has been strategically sited to maximise the use of cleared areas, minimising additional habitat fragmentation including within roosting and foraging habitat, which may be preferred habitat while a population is present in the area. Given the aerial nature of the species, vegetation clearance associated with the Project is unlikely to reduce the mobility of the species and will not result in the fragmentation of a population. Once operational, wind turbines may present a barrier to movement. The turbine collision risk assessment identified the species as being of Very High risk for impacts. Predicted mortality rates determined through Collision Risk Modelling based on existing BBUS data and turbine specifications indicates collision events will be rare (i.e. 1 mortality every 5.9 years). The potential impact on this species would be managed by the Project BBAMP, which governs the operational and compliance reporting response following any confirmed mortality event. As such, it is unlikely the Project will fragment an existing population into two or more populations.
Result in genetically distinct populations forming as a result of habitat isolation	**No.** The species is highly mobile, flying for thousands of kilometres during migration. It is known to occur within fragmented landscapes as well as over a range of habitat types. The Project has been strategically sited to maximise the use of cleared areas, minimising additional habitat fragmentation including within roosting and foraging habitat, which may be preferred habitat while a population is present in the area. Given the aerial nature of the species, vegetation clearance associated with the Project is unlikely to reduce the mobility of the species and is unlikely to separate a population into genetically distinct populations as a result of habitat isolation. Once operational, wind turbines may present a barrier to movement. The turbine collision risk assessment identified the species as being of Very High risk for impacts. Predicted mortality rates determined through Collision Risk Modelling based on existing BBUS data and turbine specifications indicates collision events will be rare (i.e. 1 mortality every 5.9 years). The potential impact on this species would be managed by the Project BBAMP, which governs the operational and compliance reporting response following any confirmed mortality event. As such, it is unlikely the Project will result in genetically distinct populations forming as a result of habitat isolation.
Result in invasive species that are harmful to an endangered or vulnerable species becoming established in the endangered or vulnerable species' habitat	**No.** Invasive species are not known to be a threat to the white-throated needletail. Nonetheless, the Project will employ best practice control methods for weeds and pests and is unlikely to introduce or exacerbate weeds or pests beyond existing levels.

Evaluation Criteria	Response
Introduce disease that may cause the population to decline	**No.** There are no known diseases affecting the species. The Project will employ best practice biosecurity protocols during construction and operation; therefore, introduction of a disease that may cause the species to decline is unlikely.
Interfere with the recovery of the species	**No.** As identified on SPRAT, a recovery plan for the white-throated needletail is not required as the necessary information is provided in the species' Conservation Advice. This document identifies the primary conservation actions for the species as the protection of breeding habitat in East Asia and the protection of important habitat in Australia. There is currently no evidence to suggest that the species relies on the habitat of the Ground-truthed Mapping Extent or wider Study Area while in Australia or on migration. No roosting locations were identified during the field survey program, however potential roosting habitat has been identified based on the topography of the site and presence of hollow-bearing trees. Following construction of the Project, large and extensive areas of potential roosting and foraging habitat will remain which are of sufficient scale to support any individuals that may occur. Infrastructure including wind turbines are recognised as potential collision threats to the species, and the improvement of knowledge surrounding the species and wind farms is identified as an information and research priority. Monitoring will be completed as part of the BBAMP as required and allow additional data on the white-throated needletail to be collected. Given the above, it is unlikely that Project will interfere with recovery of the species.
Cause disruption to ecologically significant locations (breeding, feeding, nesting, migration or resting sites) of a species	**No.** The species is a non-breeding migrant to Australia. The species uses the aerial space above vegetated habitat and forages predominantly on insects. Foraging resources are widely available and are not a limitation to building sufficient energy reserves required for their return migration to breeding grounds. Once operational, wind turbines may present a barrier to movement. The turbine collision risk assessment identified the species as being of Very High risk for impacts. Predicted mortality rates determined through Collision Risk Modelling based on existing BBUS data and turbine specifications indicates collision events will be rare (i.e. 1 mortality every 5.9 years). The potential impact on this species would be managed by the Project BBAMP, which governs the operational and compliance reporting response following any confirmed mortality event. Therefore, the Project is unlikely to cause disruption to ecologically significant locations (breeding, feeding, nesting, migration or resting sites) of a species.



Legend

- Towns
- White-throated Needletail Record (ALA)
- White-throated Needletail Record (Umwelt)
- Mountains, Peaks and Capes (DoR)
- Vantage Point Sites
- Mountain Range (DoR)
- Ground-truthed Mapping Extent
- Disturbance Footprint
- Study Area

White-throated Needletail Habitat

- Foraging and dispersal
- Roosting and foraging

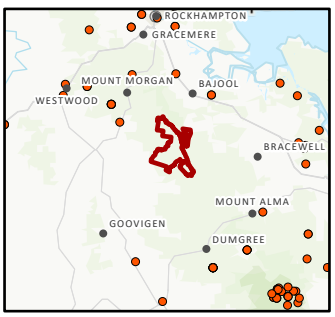


FIGURE 1.6

WHITE-THROATED NEEDLETAIL HABITAT

Image Source: ESRI Basemap (2022) **Data source:** Department of Resources (2022)

1.2 Special Least Concern (Non-Migratory) Species

1.2.1 Short-beaked Echidna (*Tachyglossus aculeatus*)

The short-beaked echidna is found in almost all terrestrial habitats in Australia. This species relies on a substrate of leaf litter and course woody debris for foraging. It shelters in fallen logs, rock crevices, dense leaf litter and abandoned burrows.

The short-beaked echidna was recorded twice on camera traps within the Study Area, one from vine forest in the southwest corner and the other from eucalypt woodland in the central-east portion. The location of these records are provided in Figure 4.2 of the Mount Hopeful Fauna Assessment (Umwelt 2023). The generalist nature of the species is reflected by its potential to occur within all habitat types in the Study Area (**Table 1.14** and **Figure 1.7**).

The SRI assessment for the species is presented in **Table 1.15**. In summary, an SRI was **not triggered** for this species.

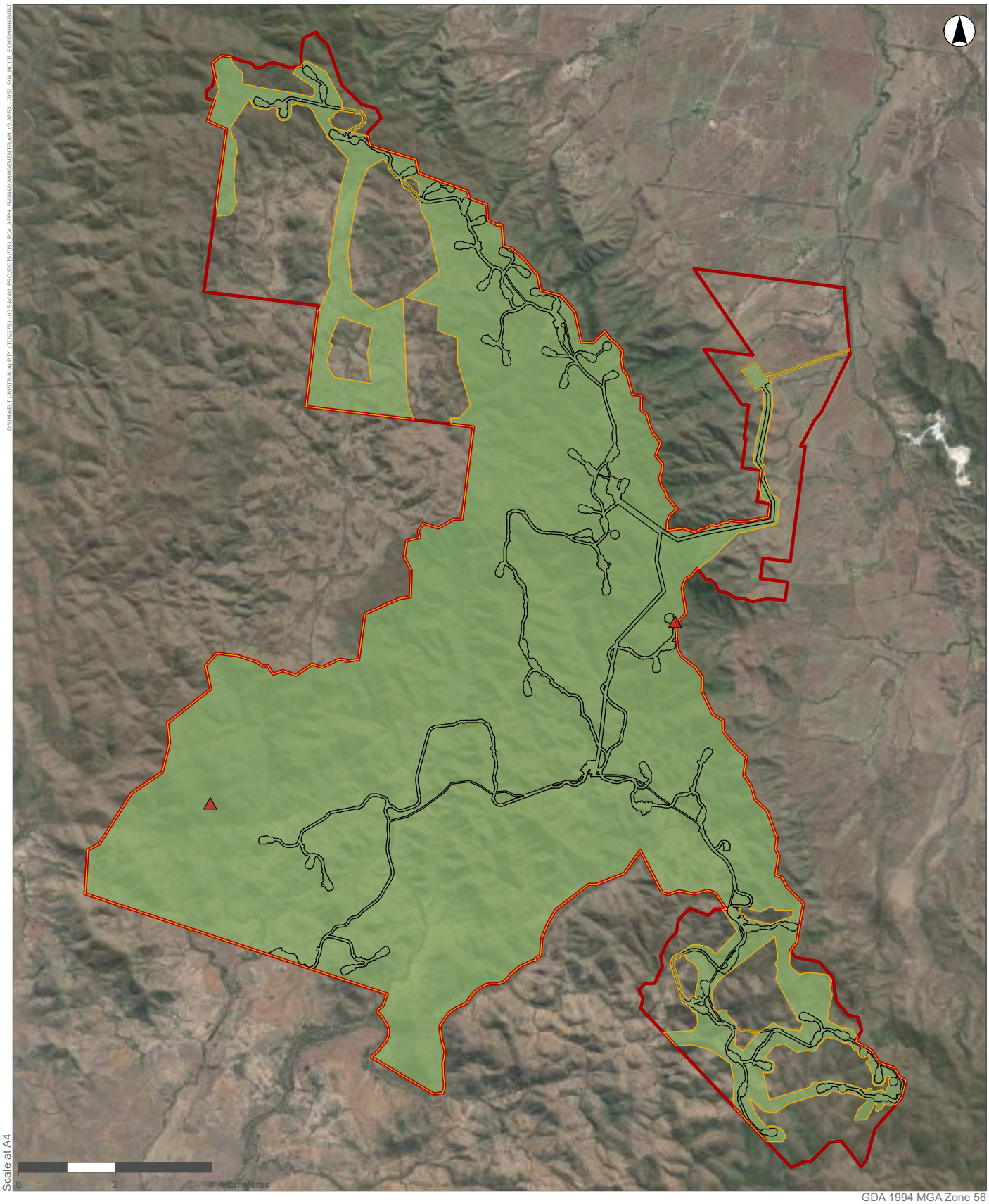
Table 1.14 Potential Area of Impact to Habitat: Short-beaked Echidna

Fauna Habitat Type	Area (ha)	
	Ground-truthed Mapping Extent	Disturbance Footprint
Foraging, Breeding and Dispersal	12,924.1	877.3
Total	**12,924.1**	**877.3**

Table 1.15 Significant Residual Impact Assessment: Short-beaked Echidna

Evaluation Criteria	Response
Lead to a long-term decrease in the size of a local population	**No.** Extensive survey effort recorded the species only twice in the Study Area. Due to the broad habitat requirements of the species, there are large areas of potential habitat for the species in the Study Area and wider region. The refinement of the Project's design has further reduced the area of impact from what was previously represented within the Development Corridor. Given the linear nature of the Project, ability of the species to disperse between habitat patches and area of habitat disturbance comparative to habitat in the broader region, a long-term decrease in the size of a local population of this species is unlikely to result from the Project.
Reduce the extent of occurrence of the species	**No.** Due to the broad habitat requirements of the species, there are large areas of potential habitat for the species in the Study Area and region. The linear nature of the Project and the ability for the species to disperse between habitat patches means the Project is unlikely to reduce the species' extent of occurrence.
Fragment an existing population	**No.** Given the linear nature of the Project and the ability for the species to disperse between vegetated patches, the potential habitat loss associated with the Project is unlikely to present significant barriers to any existing population to the extent where it would become fragmented.
Reduce gene flow among populations	**No.** Given the linear nature of the Project and the ability for the species to disperse between vegetated patches, the potential habitat loss associated with the Project is unlikely to isolate habitat to the extent where genetically distinct populations would form.

Evaluation Criteria	Response
Disrupt ecologically significant locations (breeding, feeding or nesting sites)	**No.** The generalist nature of the species means it has broad habitat requirements and a lack of limiting habitat features (such as hollow-bearing trees or rocky relief) needed for its survival. Additionally, there are large areas of potential habitat for the species in the Study Area and region. Therefore, habitat within the Disturbance Footprint is not regarded as ecologically significant.



Legend

- short-beaked echidna(*Tachyglossus aculeatus*)
- Ground-truthed Mapping Extent
- Disturbance Footprint
- Study Area
- Short-beakd Echidna Habitat

FIGURE 1.7

SHORT-BEAKED ECHIDNA HABITAT

Image Source: ESRI Basemap (2022) **Data source:** Department of Resources (2022)

2.0 Connectivity

Connectivity areas are areas of remnant vegetation outside urban areas that are required for ecosystem functioning (including facilitating fauna movement). In deciding if a significant residual impact is likely to occur on a connectivity area, an administering agency (that is the State) must consider the significance of the vegetation in the context of the local and the regional landscape. As described in the Queensland Environmental Offsets Policy (version 1.13) (Department of Environment and Science, 2022), the local and regional fragmentation needs to be quantified.

DES have developed the Landscape Fragmentation and Connectivity (LFC) tool to be used as a decision support tool to quantify any significant impact on connectivity. Consistent with the original Development Application material, the LFC tool has been employed as the primary method in assessing whether or not the Project may have an SRI on connectivity areas. However, habitat and landscape connectivity more broadly, as well as the fauna values that are known or likely to occur on site have also been considered in the context of the Project impacts. This reflects recent advice from the Department of Resources (DoR).

2.1 LFC Tool

The LFC tool determines the significance of a proposed impact on connectivity areas by assessing:

1. Whether the change in the core ecosystem extent at the local scale (post impacts) is greater than a threshold determined by the level of fragmentation at the regional scale; OR

2. If any core area (greater than or equal to one hectare) is lost or reduced to patch fragments (core to non-core).

The LFC tool was run using default values for test parameters and the most recently published version of the DoR Regulated Vegetation Management map (version 6.06).

As per the LFC tool output log file, the Project will result in direct impacts to 323.67 ha of vegetation within a Category B area on the Regulated Vegetation Management map (i.e. connectivity areas). The specific results as they pertain to each of the above tests is provided in Table 2.1 below. In summary, the analysis determined any impact on connectivity areas is not significant.

Table 2.1 Significant Residual Impact Assessment Criteria for Connectivity Areas

Impact Criteria	SRI Outcome
An action is likely to have a significant residual impact on connectivity areas if the action will result in:	
1. The change in the core remnant ecosystem extent at the local scale (post impact) is greater than a threshold determined by the level of fragmentation at the regional scale	**No**. The tool determined that the regional extent of core remnant is 87,990.46 ha or 32.80%. Based on this, the fragmentation local impact threshold of 10% applies. Clearing required for the Project will result in a 2.88% reduction of core areas at the local scale. As this is below 10%, test one does not indicate a significant impact on connectivity.
2. Any core area that is greater than or equal to 1 ha is lost or reduced to patch fragments (core to not-core)	**No.** The tool determined that there is one core remnant area occurring on site (i.e. intersecting the Disturbance Footprint). This core area is predicted to remain on site post impact. Therefore, test two does not indicate a significant impact on connectivity.

2.2 Other Considerations

The Study Area comprises relatively large areas of both cleared non-remnant vegetation (Category X) and intact remnant vegetation (Category B) as shown on the DoR Regulated Vegetation Management map. Category B areas are common within the central Study Area (occurring across the entire width), in the far north and in the far south-east. Remnant vegetation is generally well connected, predominantly occurring as a continuous patch that extends beyond the Study Area largely in a north-west to south-east direction. Remnant vegetation directly adjacent to the Study Area includes several parks or protected areas including Bouldercombe Gorge Resources Reserve, Ulam Range State Forest, Gelobera State Forest, Don River State Forest and Mount Hopeful Conservation Park. This potential north-west/south-east biodiversity corridor is recognised as a State significant biodiversity corridor as per the DES Biodiversity Planning Assessment (BPA) corridor mapping.

As described in Section 6.1.1, the Project design has been subject to an ecological constraint analysis and as a result has undergone several revisions since initial concept designs in 2021. A key initial input in the constraints analysis was the delineation of remnant and regrowth habitat types from non-remnant cleared areas, as well as the identification of suitability for threatened fauna species. This process directed infrastructure towards pre-disturbed areas, avoiding fauna habitat and connectivity areas to the greatest extent possible.

Since the original Development Application, the Project size and scope has been significantly reduced. Initially comprising 116 turbines and covering the majority of the Study Area, the Project now involves up to 63 turbines and will be contained in a smaller and more compact footprint that avoids areas of intact remnant vegetation in the south west as well as portions of the Ulam Range ridgeline in the east. Despite these positive changes, it is acknowledged that the Project will still result in the loss of approximately 324 ha of State-mapped remnant vegetation, which also provides habitat for several threatened species. Habitat within the Disturbance Footprint and the wider Study Area has been historically subjected to low level fragmentation impacts as a result of ongoing agricultural works, including the creation of farm dams, tracks, firebreaks and installation of fences. Vegetation clearing required for the construction of the Project may exacerbate existing fragmentation impacts.

Threatened fauna species relevant to the Study Area that are considered most susceptible to fragmentation impacts include koala (*Phascolarctos cinereus*) and greater glider (*Petauroides volans*). To ensure fauna movement opportunities are maintained for these species, the Project has committed to the installation of glider poles at a thirteen key locations as well as five 'pinch points'. Pinch points describe locations of the Disturbance Footprint which are reduced in width to the extent that individuals can easily disperse across (i.e. based on usual volplane distances, the clearing will have a width no greater than 1.2 times the average canopy height at that location). For more detail on these measures see Section 6.3.2 of the main body of this report.

The Disturbance Footprint (i.e. maximum clearing extent for the Project) is primarily linear and narrow. Notwithstanding the above, the threatened species known or considered likely to occur within the Study Area are highly mobile and/or are known to utilise cleared areas to disperse. Project infrastructure is not anticipated to create barriers to fauna movement within the Study Area or to adjacent areas as cleared areas will be reinstated to a safe and stable surface, and in select locations, rehabilitated. Based on this, and the large availability of remnant vegetation in the immediate surrounding area that will be retained, it is considered likely that existing populations will continue to disperse and access resources within and beyond the Study Area following the Project. The north-west/south-east biodiversity corridor will be maintained. Based on the above considerations, it is considered unlikely that the Project would result in a significant residual impact to connectivity.

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