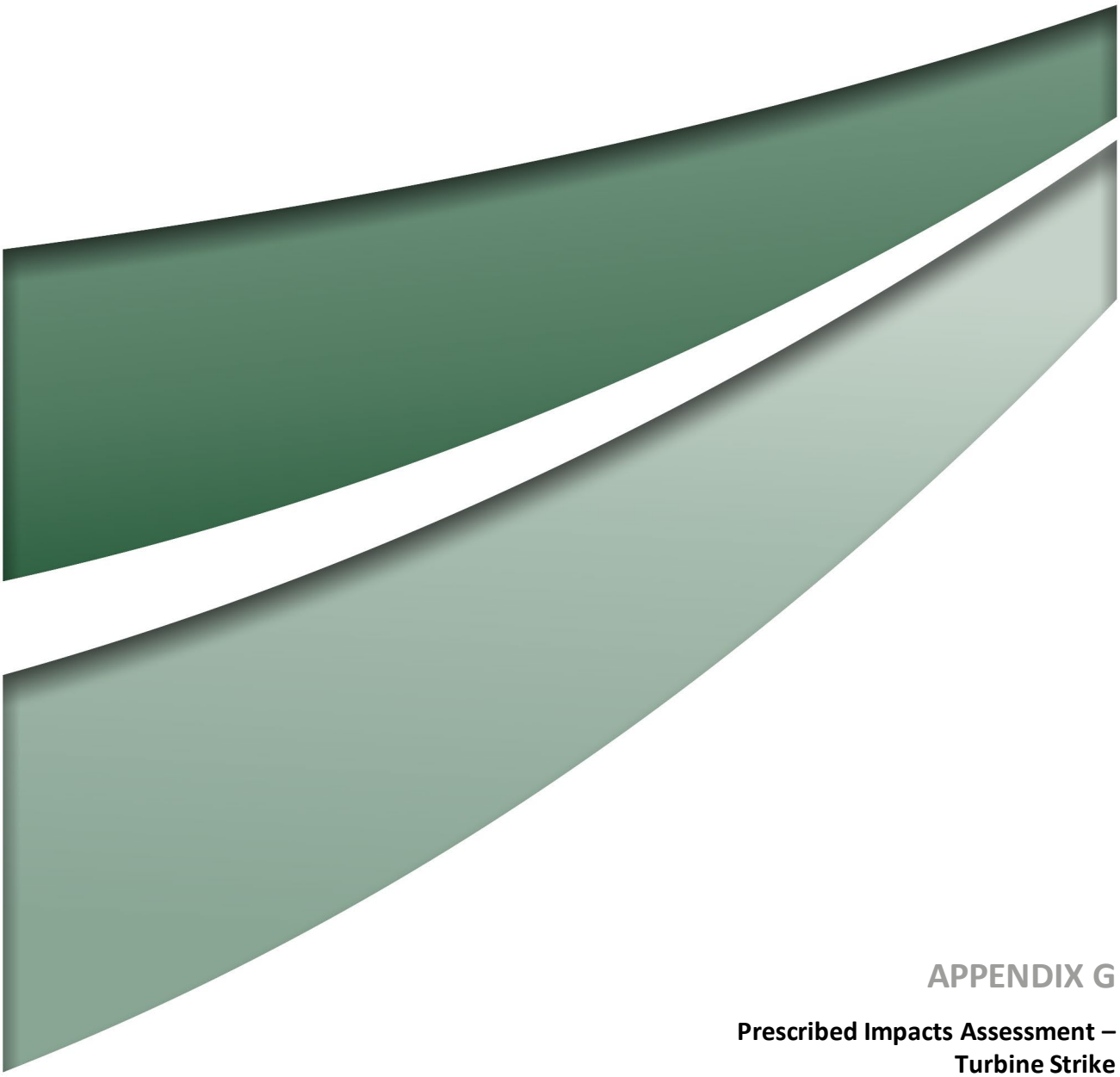

APPENDIX G

Prescribed Impacts Assessment –
Turbine Strike

umwelt
Environmental & Social Consultants

renewables

LIVERPOOL RANGE WIND FARM

Appendix G – Turbine Strike Prescribed Impact Assessment

FINAL

December 2021

LIVERPOOL RANGE WIND FARM

Appendix G – Turbine Strike Prescribed Impact Assessment

FINAL

Prepared by
Umwelt (Australia) Pty Limited
on behalf of
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Project Director: Allison Riley
Project Manager: Bill Wallach
Report No. 4859a/R03/Appendix G
Date: December 2021

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

Acknowledgement of Country

Umwelt would like to acknowledge the traditional custodians of the country on which we work and pay respect to their cultural heritage, beliefs, and continuing relationship with the land. We pay our respect to the Elders – past, present, and future.

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Document Status

Rev No.	Reviewer		Approved for Issue	
	Name	Date	Name	Date
Final	Allison Riley	14/12/2021	Allison Riley	14/12/2021

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1.0 Introduction

1.1 Background

This document has been prepared to address Section 8.3.5 criterion 1 (a)-(c) of the 'assess prescribed biodiversity impacts' section of the Biodiversity Assessment Method (BAM) (DPIE 2020a) for the proposed modification to Development Consent SSD 6696 that was granted for the Liverpool Range Wind Farm (LRWF) project.

Umwelt has prepared this Prescribed Impact Assessment in keeping with the approach used by Umwelt to assess the prescribed impacts of turbine strikes for the Rye Park Wind Farm project located north of Yass, New South Wales (NSW), granted approval to modify the Development Consent SSD 6693 in April 2021. The approach for assessment of prescribed impacts was designed in consultation with the Queanbeyan Biodiversity Conservation and Science (BCS) Directorate. The methodology for qualitative collision risk assessment, including an explanation of the likelihood and consequence scores and overall risk rating matrix, is set out in **Section 8.0** of this Prescribed Impact Assessment**.** Aerial species considered as part of this analysis were selected based on recorded flight data collected during bird and bat utilisation surveys during 2012-2015 (NGH Environmental) and during 2020 by Umwelt in the Project site. In keeping with the Prescribed Impact Assessment of turbine strike for the Rye Park Wind Farm, only those aerial fauna species with a distinct risk of being impacted by turbine strike from the Project were considered.

This assessment considers the utilisation of the 18 aerial fauna species across the broader Project site, which includes the extent of landholdings, as well as adjoining lands where vantage point surveys allowed for visual inspection beyond the Project site boundary. This is necessary to capture given the mobility of the species being assessed and the BAM criterion being considered (DPIE, 2020a).

In **Figure 1.1**, we present the Indicative Development Footprints which comprises the impact areas associated with the ground disturbances of Liverpool Range Wind Farm, assessed in accordance with the BAM (DPIE, 2020a). The Indicative Development Footprints includes a combination of the Indicative Development Footprint – Wind Farm, Indicative Development Footprint – External Transmission Line, and the Indicative Development Footprint – Public Road Upgrades. A detailed tiled map set is provided for **Figure 1.1** and all other figures in this report, in **Appendix 1**.

1.2 Indicative Turbine Specifications

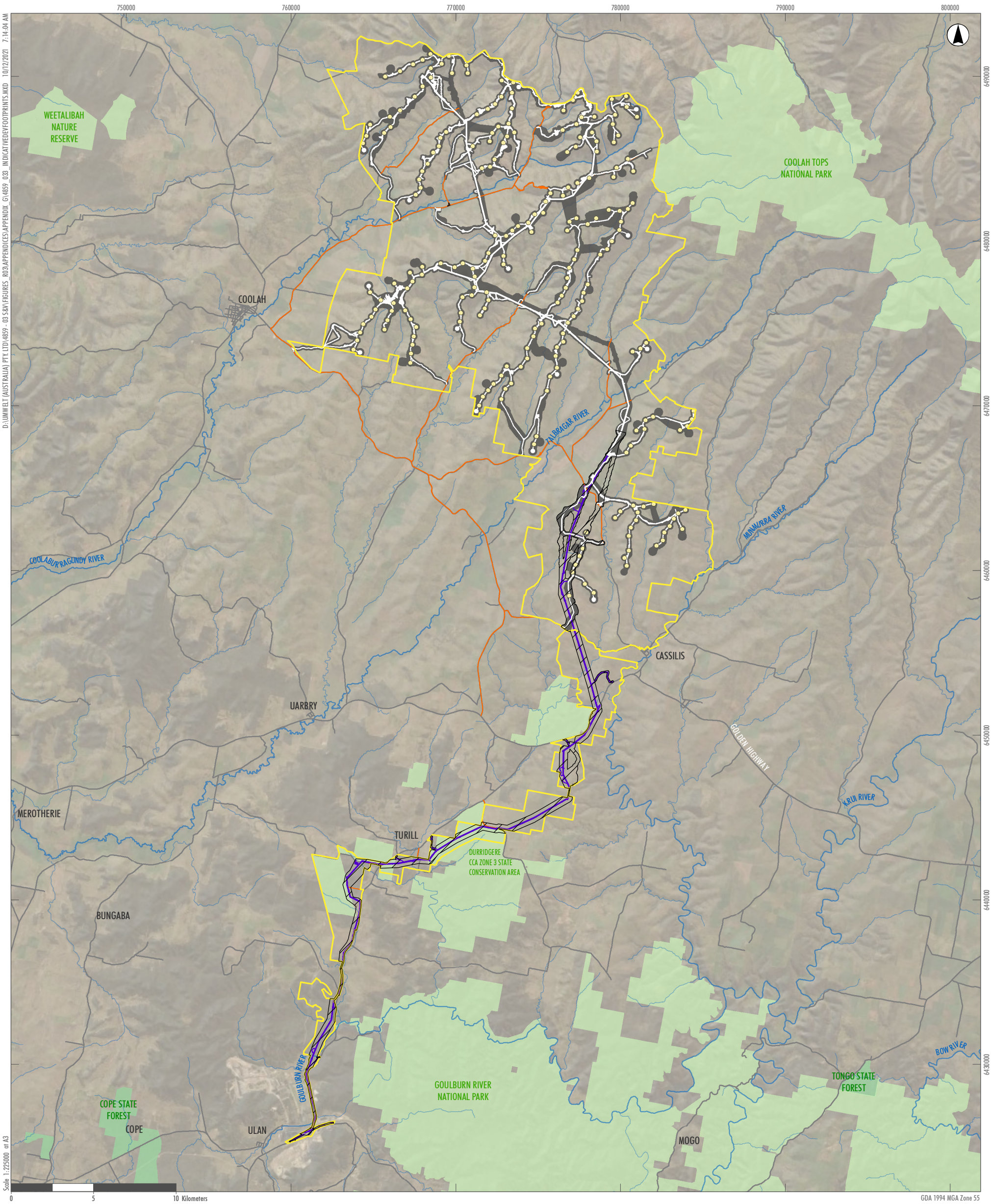
The assumed turbine measurements used for this assessment are indicative for the purpose of interpreting observations and species flight behaviour in relation to collision risk. The indicative measurements are as follows:

- hub height of 145 metres above ground level (AGL)
- blade length of 105 metres.

The rotor swept area (RSA) – the area swept by the rotating blades during turbine operation – is between 40 metres AGL (i.e., ground clearance) and 250 metres AGL (i.e., maximum blade tip height), equating to an area of 34,636 metres^2 (m^2) per turbine or approximately 772 hectares of total aerial space for the 223 proposed turbines.

The Approved Project (SSD 6696) identified a proposed wind turbine blade length of between 50 metres and 65 metres. Based on the higher of these lengths, this equates to an RSA of 13,273 m^2 per turbine, or approximately 354 hectares of total aerial space for the 267 approved wind turbines.

The increased indicative blade length proposed by the Modified Project equates to an increase of 21,363 m^2 of aerial habitat per turbine or an increase of 418 hectares of aerial habitat in total, compared to the Approved Project.



Legend

- Modified Site Boundary
- Modified Wind Turbines
- Indicative Development Footprint – Wind Farm
- Indicative Development Footprint – External Transmission Line
- Indicative Development Footprint – Public Road Upgrades

Modified Development Corridor

- Modified Development Corridor – Wind Farm
- Modified Development Corridor – External Transmission Line
- Road
- Drainage Line
- National Parks (NPWS Estate)
- State Forest

FIGURE 1.1

Liverpool Range Wind Farm
Modified Development Corridor
and Indicative Development Footprints

Image Source: ESRI Basemap (2021) Data source: NSW LPI (2021), NSW DSFI (2021); NPWS Estate (2019)

2.0 Bird and Bat Utilisation Surveys

2.1 Umwelt BBUS Surveys

The BAM identifies impacts associated with a wind farm to the flyways and migration routes of bird and bat species as 'prescribed impacts' that require specific assessment in accordance with Section 6 of the BAM (DPIE 2020a). The BDAR is required to have regard to the impacts to species that may use the Project site as a flyway or migration route, including:

(a) resident threatened aerial species,

(b) resident raptor species, and

(c) nomadic and migratory species that are likely to fly over the Project site.

To facilitate addressing the requirements of Section 6 of the BAM, Umwelt completed a single comprehensive BBUS program in May 2020 as well as an additional Bird Utilisation program in August 2020. This survey effort was undertaken to contribute to the previous extensive BBUS programs undertaken by NGH Environmental (2013a, 2013b and 2017) as part of the Approved Project (SSD6696), described below in **Section 2.2**.

Umwelt used vantage point surveys to assess bird and bat site utilisation and characterise flight behaviour of birds in the Project site, but the surveys were specifically undertaken within the Modified Development Corridor. Vantage points were selected to provide suitable spatial coverage, generally at elevated locations with high visibility over the surrounding area (including turbine locations).

The purpose of the BBUS was to:

- Identify 'At Risk' species, being those that are susceptible to collision-based impacts due to observed flight behaviours.
- Be undertaken in accordance with the Best Practice Guidelines for Implementation of Wind Energy projects in Australia (Clean Energy Council 2018).
- Align with industry guidelines for the assessment of impacts from wind farms on birds and bats (AusWEA, 2005).

2.1.1 Bird Utilisation

Bird utilisation was determined by recording all observed bird species and observed abundances at each vantage point. A total of seven bird utilisation sites were surveyed in May 2020, each site was surveyed over three survey periods (morning, noon and evening), twice. A total of 16 bird utilisation surveys were completed across the seven sites in May 2020. Two bird utilisation sites were surveys in August 2020, each site was surveyed twice, totalling four bird utilisation surveys. Bird utilisation surveys were completed over a one (1) hour period.

In addition to bird species and abundances being recorded, the following bird behaviour was also collected where applicable:

- observation type (visual or aural)

- the distance and direction of the bird from the observer (to the nearest 10 metres and 10 degrees respectively)
- estimated height of flight above ground level (AGL) (to the nearest 5 metres below 30 metres and to the nearest 10 metres at and above 30 metres)
- direction of travel (to the nearest 10 degrees)
- flight pattern (not flying, local movement, directional flight, circling, stooping, varied, other)
- for birds observed not in flight, behaviour would be noted (perched, foraging, aggressive behaviour, mating etc).

To record bird activity throughout the day, the replication of bird utilisation sites occurred at different times of the day, either:

- morning (6 am – 10 am)
- midday (10 am – 2 pm)
- afternoon (2 pm – 6 pm).

2.1.2 Bat Utilisation

During the May 2020 survey, six bat utilisation sites were surveyed. At each site, an Anabat microbat echolocation recorder was deployed for the duration of the field survey.

Four bat utilisation sites involved the Anabat recorder being installed at or near ground height.

The remaining two bat utilisation sites had the Anabat recorder deployed at height on existing meteorological masts for the duration of the field survey. Umwelt deployed these Anabat recorder as high as possible, with the meteorological masts used, this height was approximately 35 metres AGL.

All call data was downloaded and sent to an expert for identification. The results of the call analysis are provided in **Appendix 2** of this report.

2.2 NGH Environmental BBUS Surveys

Full detail on the extent and nature of BBUS surveys completed by NGH Environmental are provided in the Biodiversity Assessment (2013a and 2013b) and Biodiversity Assessment Addendum (2017). A brief summary is provided below:

- Between October 2012 and October 2013, 24 bird utilisation surveys were undertaken. Each survey was 30 minutes in length.
- In March 2015, four bird utilisation surveys were undertaken. Each survey was 30 minutes in length.

Bird species were recorded (by sight and vocalisations) within the search area, flying overhead and outside the search area. The following variables were also recorded:

- Number of individuals.
- Distance from observer.

- Flight height AGL (0-20 metres, 21-40 metres, 41-165 metres and >165 metres).
- Bird behaviour.

A total of 34 bat utilisation sites were surveyed by NGH Environmental (2017). Each site included the deployment of an Anabat recorder at or near ground level. Each site was surveyed overnight (NGH Environmental 2017).

3.0 Candidate List of Protected Animals Utilising the Development Site

The candidate list of protected animals that were considered as part of the prescribed impact assessment included:

- resident aerial species
- resident raptor species, and
- nomadic and migratory species that are likely to fly over the Modified Development Corridor.

Targeted surveys were undertaken to determine the list of species that could be adversely affected by the proposed development. The survey methodology and effort is described above in **Section 2.0**.

3.1 Species Recorded or Predicted to and Considered in the Assessment

Table 3.1 lists species that were either recorded or are predicted to occur in the vicinity of the Liverpool Range Wind Farm based on the presence of suitable habitat and the presence of nearby records. In summary, the assessment considered 27 species, comprising 17 threatened species (12 bird and five bat species) (refer to **Table 3.1**).

Of the 27 species, 18 species (13 birds and five bat species) were considered to have a moderate or above likelihood of being impacted by turbine strike (refer to **Table 3.1**). The likelihood and nature of impact of wind turbine strike on these species has been considered further in **Section 8.0.**

Table 3.1 Candidate Species List

Candidate Species	Recorded in Project site?	Considered Further Due to Likelihood of Impact being Moderate or Above
silvereye (*Zosterops lateralis*)	✓	×
Australian pelican (*Pelecanus conspicillatus*)	✓	×
swamp harrier (*Circus approximans*)	×	×
pied currawong (*Strepera graculina*)	✓	×
Australian magpie (*Gymnorhina tibicen*)	✓	×
white-throated needletail (*Hirundapus caudacutus*)	✓	✓
black-chinned honeyeater (*Melithreptus gularis*)	✓	✓
painted honeyeater (*Grantiella picta*)	×	✓

Candidate Species	Recorded in Project site?	Considered Further Due to Likelihood of Impact being Moderate or Above
superb parrot (*Polytelis swainsonii*)	×	✓
wedge-tailed eagle (*Aquila audax*)	✓	✓
little eagle (*Hieraaetus morphnoides*)	×	✓
brown falcon (*Falco berigora*)	✓	✓
spotted harrier (*Circus approximans*)	×	×
square-tailed kite (*Lophoictinia isura*)	✓	✓
white-striped freetail bat (*Austronomus australis*)	✓	×
Gould's wattled-bat (*Chalinolobus gouldii*)	✓	×
eastern cave bat (*Vespadelus troughtoni*)	✓	✓
Corben's long-eared bat (*Nyctophilus corbeni*)	✓	✓
large bent-winged bat (Miniopterus orianae oceanensis)	✓	✓
yellow-bellied sheath-tail bat (*Saccolaimus flaviventris*)	✓	✓
large-eared pied bat (*Chalinolobus dwyeri*)	✓	✓
barking owl (*Ninox connivens*)	✓	✓
powerful owl (*Ninox strenua*)	✓	✓
masked owl (*Tyto novaehollandiae*)	✓	×
regent honeyeater (*Anthochaera phrygia*)	×	✓
swift parrot (*Lathamus discolor*)	×	✓
dusky woodswallow (*Artamus cyanopterus*)	✓	✓

Highlighted rows identify those species listed as threatened under either the BC Act or EPBC Act

4.0 Wind Turbine Strike Impact Assessment

Criterion a (i): Predict the likelihood of impact on species living in, or likely to fly over, the proposed development site, including but not limited to bat or bird strike and barotrauma

To ascertain the likelihood and consequence of impacts on aerial species, a risk-based assessment approach has been applied. This assessment has been developed with consideration of a comprehensive report completed by the Arthur Riley Institute (Lumsden *et al.* 2019). The assessment considers the likelihood of blade strike based on recorded flight behaviours and assesses consequence using a range of measures associated with population ecology, abundance and conservation status.

Literature considering bird and bat strike with structures (including wind turbines and their associated infrastructure) largely focusses on the consequences of strike resulting in outputs such as species mortality rates, rather than examining the cause of strikes. Furthermore, studies are commonly focussed on a single piece of infrastructure or isolated site. Drewitt and Langston (2008) examined factors contributing to avian wind turbine strike such as geographic location, structural attributes and time of year, with a particular emphasis on morphology and behaviour. They noted that susceptibility to strike varies greatly between species and can be attributed to morphology and flight characteristics, vision, degree of flocking and provisioning of young. Attributes more likely to result in collision with wind turbines include:

- Migratory species that fly long distances at night, that will be disoriented by fog or flashing lights.
- Species that fly locally but further to forage, as short flights are more likely at lower altitudes.
- Species that soar, circle and thermal, such as raptors and swifts, as their vision is directed at the ground for navigation and they often do not see wind turbines in front of them.
- Species that make frequent foraging flights to feed young are believed to take greater risks to find sufficient food (Henderson et al 1996).

Causes of bat strikes with wind turbines are poorly understood, however in Europe and the United States patterns are emerging providing an indication of which species are more likely to be struck, with migratory, tree-roosting bats comprising the vast majority of mortalities. It is expected that migratory behaviour coupled with a propensity to fly at turbine rotor height results in the bulk of mortalities (Valdez and Cryan 2021).

The information described above is considered in the detailed process of assessment the likelihood of impact, consequence of impact and resulting overall risk rating for each species. These components are described in the following sections.

5.0 Rate of Impact

Criterion a (ii) Predict the rate and timing of impact per turbine per year for species likely to be affected

The rate of impact per turbine per year is not quantitatively estimated here given the lack of information on key relevant factors such as turbine avoidance. Rather, a risk-based assessment, similar to that developed by the Arthur Riley Institute (Lumsden *et al.* 2019) has been completed. The details of this assessment are included within the response to **Section 8.0**.

Where available, mortality estimates from other Australian wind farms has been considered for each aerial species within the responses below. Mortality estimates include data from two of 15 Victorian wind farms at which mortality monitoring has been undertaken and mortality rates for particular species determined (Moloney *et al.* 2019). However, it is emphasised that mortality rates are likely to vary considerably between wind farms, depending on a range of variables such as their proximity to key habitat features (e.g., important cave roosts), turbine size, landscape position and the inherent spatial variability in species abundance and utilisation of airspace (Richardson 2000, Drewitt and Langston 2006, Krijgsveld *et al.* 2009). For this reason, it is not advisable to extrapolate or predict mortality estimates provided in Moloney *et al.* (2019) for other wind farms such as the Project. However, the consideration of available mortality data is important when estimating relative risk for a species, such as in **Section 8.3**.

6.0 Consequences of Impacts

Criterion a (iii) Predict the consequences of impacts for the persistence of bioregional populations, with reference to relevant literature and other published sources of information

The consequences of impacts for the persistence of the assessed species in the bioregion depends on a range of poorly understood or unknown factors including the following:

- the relative importance of the Project site for the long-term persistence of the greater population in the bioregion
- the degree of connectivity in regard to the movement of individuals between the Project site and surrounding areas
- whether likely mortality rates from blade strike in the Project site would exceed the rate of replacement of individuals either in situ or through dispersal from elsewhere.

Given the lack of data with which to predict estimates and the inherent high uncertainty associated with predictions if attempted, the consequence of impacts for the persistence of bioregional populations is not predicted here.

7.0 Cumulative Impacts

Criterion a (iv) Predict the cumulative impacts of the proposed development alongside existing wind farms on species mortality, movement pattern and use of adjacent habitat

In order to adequately assess cumulative impacts of the Project together with other wind farms in the region, it is first necessary for the effects of all other relevant wind farms to be quantified to a consistent standard and to be available (Moloney et al. 2019). In the absence of this information, a summary including an examination of basic factors such as species distribution relative to nearby wind farms and the total number of turbines in the region is provided below.

Only two wind farms, one operational and one under construction, are located near to the Project (**Table 7.1**), and no other operational wind farms are located within 3,000 km^2 of the Project. There is one additional wind farm project located in proximity to the Project, Valley of the Winds. This project is not currently approved, with and Environmental Impact Statement and associated Biodiversity Assessment currently in preparation.

Table 7.1 Wind Farms in the vicinity of the Project

Name	Distance (km)	Direction	Turbines	Phase
Bodangora Wind Farm	71	WSW	33	Operation
Crudine Ridge Wind Farm	90	SSW	37	Construction
Uungula Wind Farm	96	SW	Up to 96	Approved
Valley of the Winds (proposed)	15 (nearest location)	SW	175	Assessment
Spicers Creek Wind Farm (proposed)	73	SW	Unknown	Assessment
Barney's Reef Wind Farm (proposed)	42	SW	Up to 65	Assessment
Burrendong Wind Farm (proposed)	102	SW	Up to 72	Assessment

Given the significant distance between the project and the nearest wind farms, it is considered highly unlikely that localised populations will undergo any cumulative impacts. Instead, cumulative impacts may only be felt by nomadic or migratory populations that happen to pass through each project's footprint, which is impractical to predict and manage given the large spatial range of some species (e.g., swift parrot and white-throated needletail).

While it is important to assess the potential cumulative impacts of the Project, it is equally important to identify the Project occurs within the Central – West Orana Renewable Energy Zone (REZ) identified by the NSW Government's Electricity Strategy and Electricity Infrastructure Roadmap. Specifically, the Project occurs in the north-eastern corner of the Central – West Orana REZ. REZs will be critical in delivering affordable and reliable energy production; helping to replace the State's existing power stations as they come to their scheduled end of operational life. The NSW Government describes the REZs as modern-day power stations, combining a range of renewable energy generation (including wind), storage (including battery) and high-voltage poles and wires to connect across NSW.

The initiative to establish REZs across particular regions of NSW will inevitably encourage a substantial increase to the pipeline of large-scale renewable energy and storage projects. In turn, cumulative impacts of all Projects within the REZs will be an important consideration for all Projects.

8.0 Likelihood and Nature of Impacts

Criterion a (v) likelihood and nature of impacts on aerial species living in, or likely to fly over, the proposed development site, including barriers to migratory pathways, and breeding, feeding and resting resources

8.1 Comparison to Operating Wind Farms

In the absence of multiple operating wind farms in the region of the Project, data has been sourced from wind farms in Victoria (Moloney *et al.* 2019) and south-east NSW (BCD unpublished data) where mortality monitoring has taken place. The following risk assessment considers species mortality from these sources, as well as ecological and biological factors, to assess turbine blade strike risk, risks relating to barotrauma, and the impact of the proposed development on migratory pathways.

8.1.1 Risk Assessment Method

The relative risk of blade strike for the 18 species assessed here was estimated using two criteria to ascribe likelihood of risk and four criteria to ascribe consequence of risk (**Table 8.1, Table 8.2**). These six criteria were employed in a study conducted with the aim of developing a science-based approach to aid decision-making regarding turbine collision risk for birds and bats in Victoria (Lumsden *et al.* 2019). The criteria used by Lumsden *et al.* (2019) to determine the relative risk for 'species of interest' were:

- Criterion A – Flight Height
- Criterion B – Habitat Preference
- Criterion C – Geographic Population Concentration
- Criterion D – Demographic Resilience
- Criterion E – Population Size, and
- Criterion F – Listed Conservation Status.

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

Table 8.1 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 Project site

Table 8.2 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 regional, 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 *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and/or the BC Act

Each of the 18 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 Project site. Descriptions for each ranking are outlined in **Table 8.3.**

Criterion A (flight height) was assessed by identifying the frequency of flights observed between 40 metres and 250 metres above ground level (AGL) in the Project site 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 Project site) was assessed by determining the status or estimating the frequency of occurrence in the Project site. This Criterion is included as it is an essential component for estimating overall blade strike risk. Data from field surveys conducted by NGH Environmental 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 Project site 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 and/or the BC 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 of importance 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 8.3 Descriptions of each score for Criterion A-F

Likelihood/ Consequence Score	Criterion A	Criterion B	Criterion C	Criterion D	Criterion E	Criterion F
Low	Species that do not or rarely fly at RSA height.	Species that rarely occur in the Project site.	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 and/or the BC 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 Project site.	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 and/or the BC Act

Likelihood/ Consequence Score	Criterion A	Criterion B	Criterion C	Criterion D	Criterion E	Criterion F
High	Species in which a high proportion of flight activity is at RSA height.	Species that regularly occur in, or regularly move through the Project site.	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 and/or the BC Act.

8.2 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 rating (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** scores were 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 extremely unlikely based on knowledge of the species' flight behaviour and/or observations from the Project site.

The following describes how the **consequence of collision** scores were determined:

- **High:** The majority of Criteria C, D, E and 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, D, E and F were Moderate.
- **Low:** The majority of Criteria C, D, E and F were Low.

Once the overall scores 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 overall risk rating and level of concern (refer to **Table 8.4**). Five overall risk ratings were used, namely Negligible, Minor, Moderate, High, and Severe, based on the combination of the scores for likelihood and consequence.

Table 8.4 Risk matrix

		Consequence of collisions		
		Low	Moderate	High
Likelihood of collisions	Low	Negligible	Minor	Moderate
	Moderate	Minor	Moderate	High
	High	Moderate	High	Severe

8.3 Assessment of Likelihood and Consequence of Impact

8.3.1 Barking owl

8.3.1.1 Information on barking owl from Australian wind farms

There are no published records of blade strike of barking owls in the available literature in Victoria (Moloney et al. 2019) or south-east New South Wales (BCD unpublished data).

8.3.1.2 Status and flight behaviour in the Project site

Barking owl were not recorded during field surveys, however the Project lies within the species' known range (BCD 2021b) and there are multiple sightings in surrounding areas in all directions, specifically Coolah Tops National Park and Durridgere State Conservation Area (ALA 2021a, Eldridge *et al*. 2020). One individual of the species was recorded during nocturnal surveys targeting the species in the north eastern portion of the Project, near the adjoining Coolah Tops National Park. **Figure 8.1** presents BioNet records of the species in the wider locality

8.3.1.3 Likelihood and Consequence of Impacts

The overall risk rating for barking owl is **High**, based on a High likelihood and Moderate consequence of collisions (**Table 8.5**). The rationale for responses to each criterion is as follows:

A) Barking owl are known to perch and hunt in large trees, as well as aerially above canopies, which may include flight within the RSA (Marchant, Higgins and Davies 1999).

B) Barking owl are likely to occur in the Project site for foraging activity due to its proximity to Coolah Tops National Park where breeding habitat is likely to occur (BCD 2021b, ALA 2021a).

C) Barking owl are widely distributed in NSW, but sparse in population due to habitat fragmentation (BCD 2021b).

D) The life-history characteristics of barking owl overlap with certain aspects of both the descriptions for a Low and High rating for Criterion D (Marchant, Higgins and Davies 1999).

E) The total population of barking owl is not quantified, however is thought to be above 10,000 individuals (Birdlife International 2021b).

F) Barking owl are not listed under the EPBC Act but are listed Vulnerable under the BC Act.

Table 8.5 Barking owl risk assessment

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

8.3.2 Large bent-winged bat

8.3.2.1 Information on large bent-winged bat from Australian wind farms

Large bent-winged bat mortality has been recorded in south-east New South Wales (BCD unpublished data) but not quantified. There are eight published records of blade strike of the closely related southern bent-winged bat in the available literature in Victoria (Moloney et al. 2019). A mortality model for southern bent-winged bat generated a mortality rate estimate of 0.1 individuals per turbine per year (95% CI 0-0.5) for one particular wind farm (Moloney et al. 2019).

8.3.2.2 Status and flight behaviour in the Project site

Large bent-winged bat were positively identified through call detection during the 2012 field surveys (NGH Environmental2013a, 2013b) and the 2015 surveys (NGH Environmental2015). Microbat call analysis from the 2020 bat utilisation survey conducted by Umwelt detected calls that could be from large bent-winged bat, however, were unable to confirm the species' presence from the data collected (Echo Ecology and Surveying 2021). **Figure 8.1** presents BioNet records of the species in Project site and the wider locality.

8.3.2.3 Likelihood and Consequence of Impacts

The overall risk rating for large bent-winged bat is **High**, based on a High likelihood and Moderate consequence of collisions **(Table 8.6).** The rationale for responses to each criterion is as follows:

A) Based on available data large bent-winged bats are likely to occasionally fly at RSA height in the Project site.

B) Large bent-winged were recorded in the Project site from multiple locations across multiple years.

C) Large bent-winged bats congregate in large numbers at caves with breeding taking place in sparse 'maternity caves' (Dwyer, Hamilton-Smith 1965). No breeding/maternity caves are known to occur in or near the Project site.

D) The life-history characteristics of the large bent-winged bat overlap with certain aspects of both the descriptions for a Low and High rating for Criterion D (Churchill 2009).

E) It is likely that the total population of large bent-winged bats is over 20,000 individuals (Churchill 1998, Pennay *et al.* 2011).

F) The large bent-winged bat is listed as vulnerable in NSW under the BC Act.

Table 8.6 Large bent-winged bat risk assessment

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

8.3.3 Powerful owl

8.3.3.1 Information on powerful owl from Australian wind farms

There are no published records of blade strike of powerful owl from Victoria, however there is a record of at least one strike on the species from south-east New South Wales (BCD unpublished data).

Lumsden *et al.* (2019) assesses a Likelihood and Consequences for turbine strike on the powerful owl as Moderate, with the Moderate Likelihood and High Consequence being the lowest probability (8.7%), while High Likelihood and Moderate Consequence had the highest probability (48.8%).

8.3.3.2 Status and flight behaviour in the Project site

Powerful owl was recorded during the 2013 nocturnal surveys (NGH Environmental 2013a). Two occurrences were recorded following playback of powerful owl call, however it was noted that the two responses may have been from the same individual. There are multiple sightings of powerful owl in surrounding areas in all directions, specifically Coolah Tops National Park and Durridgere State Conservation Area (ALA 2021b, Eldridge *et al*. 2020). **Figure 8.1** and detailed **Figure 8.1** set provided in **Appendix 1** presents BioNet records of the species in the wider locality.

8.3.3.3 Likelihood and Consequence of Impacts

The overall risk rating for powerful owl is **High**, based on a High likelihood and Moderate consequence of collisions (**Table 8.7**). The rationale for responses to each criterion is as follows:

A) Powerful owl are known to perch and hunt in the canopy of tall trees, as well as aerially, which may include flight within the RSA (Marchant, Higgins and Davies 1999).

B) Powerful owl are likely to occur in the Project site for foraging activity due to its proximity to Coolah Tops National Park where the species breeding habitat is likely to occur (BCD 2021b, ALA 2021b).

C) Powerful owl are widely distributed within suitable habitat which itself is widely distributed, with a large home range (Marchant, Higgins and Davies 1999).

D) The life-history characteristics of powerful owl overlap with certain aspects of both the descriptions for a Low and High rating for Criterion D (Marchant, Higgins and Davies 1999).

E) The total population of powerful owl is estimated at between 2,200 – 2,800 individuals, however this population is considered stable (Birdlife International 2021c).

F) Powerful owl are not listed under the EPBC Act, but are listed Vulnerable under the BC Act.

Table 8.7 Powerful owl risk assessment

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

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

8.3.4 Regent honeyeater

8.3.4.1 Information on regent honeyeater from Australian wind farms

There are no records of blade strike of regent honeyeater in available literature from Victoria (Moloney *et al* 2019) or south-east New South Wales (BCD unpublished data).

8.3.4.2 Status and flight behaviour in the Project site

No regent honeyeater were recorded during field, however the Project is within the species' range, results of the desktop assessment indicate the species, or its habitat are known to occur within the Project site (DoEE 2019), and there are multiple confirmed sightings within 5-10 km of the Project's north-eastern boundary (DPIE 2021b). Additionally, the Project site is located in the middle of three identified breeding locations for the regent honeyeater (DoE 2016). Additionally, the Project site is not identified within the Important Area mapping for the regent honeyeater (DPIE 2021). **Figure 8.1** presents BioNet records of the species in the wider locality.

8.3.4.3 Likelihood and Consequence of Impacts

The overall risk rating for regent honeyeater is **High**, based on a Moderate likelihood and High consequence of collisions **(Table 8.8)**. The rationale for responses to each criterion is as follows:

A) There is insufficient literature describing regent honeyeater flight height, however the species has the potential to fly at RSA height, especially during migration, hence Criterion A is assigned a Moderate classification.

B) Based on the lack of observations of this species in the Project site but known occurrence in the region, potential foraging and breeding habitat presence in the Project site and wider region, as well the Project site being located between breeding sites, Criterion B is Moderate because this species has the potential to seasonally visit the Project site in a given year.

C) Regent honeyeaters congregate in and are primarily observed in foraging habitat that is highly fragmented (DoE 2016).

D) Due to the low numbers of regent honeyeaters remaining (see point e) and fidelity to breeding sites (DoE 2016), Criterion D is considered High.

E) The total population of regent honeyeater remaining was estimated at 100 breeding pairs (Crates *et al*. 2018).

F) Regent honeyeater is listed as critically endangered under both the EPBC Act and BC Act.

Table 8.8 Regent honeyeater risk assessment

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

8.3.5 Swift parrot

8.3.5.1 Information on swift parrot from Australian wind farms

There are no records of blade strike of swift parrot in available literature from Victoria (Moloney *et al* 2019) or south-east New South Wales (BCD unpublished data).

8.3.5.2 Status and flight behaviour in the Project site

Swift parrot was not observed during field surveys, however given the size of the remaining population and seasonal migration of the species it is possible that the species could occur in the Project site in a particular year. The Project sits within 'predicted' habitat and is surrounded by 'known' habitat (BCD 2000b), however it is not identified within the Important Area mapping for the swift parrot (DPIE 2021b). **Figure 8.1** presents BioNet records of the species in the wider locality.

8.3.5.3 Likelihood and Consequence of Impacts

The overall risk rating for swift parrot is **High**, based on a Moderate likelihood and High consequence of collisions **(Table 8.9**). The rationale for responses to each criterion is as follows:

A) No data exists to accurately describe swift parrot flight heights, however in a 2005 report on swift parrot wind farm interactions, Smales assigned 25% of a swift parrot's flight to within 30 – 120 m, based on known flight behaviour of other similar parrots. This flight height is within the RSA and is likely during migration as the species transits between sites.

B) Based on the lack of observations of this species in the Project site but known occurrence in the region, potential foraging habitat presence in the Project site and wider region, Criterion B is Moderate because this species has the potential to be an occasional seasonal visitor in the Project site in a given year. Because a rating of Low for Criterion B is not considered, the overall likelihood of collision is automatically deemed High due to the High rating assigned for Criterion A.

C) Swift parrot are considered to be one migrating population, with a restricted range and a substantial proportion of the population may move through any given area, hence a rating of High for Criterion C is most accurate.

D) The life-history characteristics of the swift parrot overlap with certain aspects of both the descriptions for a Low and High rating for Criterion D (Higgins 1999)

E) The total population of swift parrot is estimated to be below 2,000 individuals (Garnett, Szabo & Dutson 2011) and as low as 500 (Olah *et al*. 2020).

F) Swift parrot are listed as critically endangered under the EPBC Act and endangered under the BC Act.

Table 8.9 Swift parrot 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	Moderate	**Consequence**	High	**Risk Rating**	High	

8.3.6 White-throated needletail

8.3.6.1 Information on white-throated needletail from Australian wind farms

The white-throated needletail 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 *et al.* 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 NSW, with much of the data collected in this region being not publicly available (BCD unpublished data). There are six records of deceased white-throated needletail at Capital Wind Farm from 2012/13 on the Atlas of Living Australia.

8.3.6.2 Status and flight behaviour in the Project site

White-throated needletail were not recorded during the field surveys, results from the desktop assessment indicate that the needletail or their habitat are known to occur in the Project site (DoEE 2019), and the Project sits within their known range (BCD 2019a). **Figure 8.1** and detailed **Figure 8.1** set provided in **Appendix 1** presents BioNet records of the species in the wider locality.

8.3.6.3 Likelihood and Consequence of Impacts

The overall risk rating for white-throated needletail is **High**, based on a High likelihood and Moderate consequence of collisions **(Table 8 10).** The rationale for responses to each criterion is as follows:

A) A high proportion of the white-throated needletail's flight activity is at RSA height.

B) Based on the lack of observations of this species in the Project site but known occurrence or foraging habitat presence reported in the database search, Criterion B is Moderate because this species is likely to be an occasional seasonal visitor in the Project site each year. The overall likelihood of collision is deemed High due to the High score assigned for Criterion A.

C) Although the white-throated needletail has a very large range it is noted that because a large proportion of this species' population may occur at specific preferred foraging areas or use particular migratory paths there is a high degree of variability in the likelihood of collisions between locations across its distribution in eastern Australia.

D) The life-history characteristics of the white-throated needletail overlap with certain aspects of both the descriptions for a Low and High score for Criterion D (Higgins 1999).

E) The total population of white-throated needletail has not been estimated (Birdlife International 2020). The population size of the nominate subspecies that migrates to Australia is likely to comprise approximately 10,000 individuals (DoE 2015).

F) The white-throated needletail is listed as vulnerable and migratory under the EPBC Act.

Table 8.10 White-throated needletail risk assessment

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

8.3.7 Black-chinned honeyeater

8.3.7.1 Information on black-chinned honeyeater from Australian wind farms

There are no published records of blade strike of black-chinned honeyeaters in the available literature in Victoria (Moloney et al. 2019) or south-east New South Wales (BCD unpublished data).

8.3.7.2 Status and flight behaviour in the Project site

Black-chinned honeyeater were recorded once in the Project site during the 2012 field surveys (NGH Environmental 2013), at which time one individual was observed and no behaviour, flight or height data was recorded. No black-chinned honeyeater were recorded during the 2020 bird utilisation surveys or 2021 general surveys conducted by Umwelt. **Figure 8.1** and detailed **Figure 8.1-G5** provided in **Appendix 1** presents project and BioNet records of the species in the Project site and wider locality.

8.3.7.3 Likelihood and Consequence of Impacts

The overall risk rating for black-chinned honeyeater is **Moderate**, based on a Moderate likelihood and Moderate consequence of collisions **(Table 8.11**). The rationale for responses to each criterion is as follows:

A) Based on knowledge of this species' flight behaviour from elsewhere, black-chinned honeyeaters are likely to regularly fly below and occasionally fly at RSA height in the Project site.

B) Black-chinned honeyeater have been recorded in the Project site, but not recently despite surveys. They are considered to be resident to a locale, with no nomadism (Higgins, Peter and Steele 2001).

C) Black-chinned honeyeater are widely distributed within areas of suitable habitat across its range and the habitat itself is relatively widely dispersed, despite the habitat being niched and fragmented (SWIFFT 2021).

D) There is insufficient literature on the life history of black-chinned honeyeater, so Criterion D is conservatively assigned a Moderate rank (Higgins, Peter and Steele 2001)

E) The total population of the black-chinned honeyeater is unknown (Birdlife International (a) 2021) though it is likely to exceed 10,000 individuals.

F) Black-chinned honeyeater are not listed as threatened under the EPBC Act, however are listed as Vulnerable under the BC Act.

Table 8.11 Black-chinned honeyeater risk assessment

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

8.3.8 Corben's long-eared bat

8.3.8.1 Information on Corben's long-eared bat from Australian wind farms

There are no published records of blade strike of Corben's long-eared bats in the available literature in Victoria (Moloney et al. 2019) or south-east New South Wales (BCD unpublished data). The majority of wind farms monitored to date in Victoria are located outside of this species' distribution. There are published records of blade strike of the closely related lesser long-eared bat (six strikes) and Gould's long-eared bat (one strike) in the available literature in Victoria (Moloney et al. 2019). A mortality model for the lesser long-eared bat generated a mortality rate estimate of 0.1 individuals per turbine per year (95% CI 0-0.5) for one particular wind farm (Moloney et al. 2019).

8.3.8.2 Status and flight behaviour in the Project site

Corben's long-eared bat were recorded from multiple locations during the 2012 field surveys conducted by NGH Environmental. Microbat call analysis from the 2020 bat utilisation survey conducted by Umwelt detected calls that could be from Corben's long-eared bat, however were unable to confirm the species' presence from the data collected (Echo Ecology and Surveying 2021). **Figure 8.1** and detailed **Figure 8.1** provided in **Appendix 1** presents records of the species in the Project site and wider locality.

8.3.8.3 Likelihood and Consequence of Impacts

The overall risk rating for Corben's long-eared bat is **Moderate**, based on a Moderate likelihood and Moderate consequence of collisions (**Table 8.12**). The rationale for responses to each criterion is as follows:

A) Based on available data, Corben's long-eared bat may occasionally fly at RSA height.

B) Corben's long-eared were positively identified during 2012 surveys of the Project site, but not again in 2015 and not confirmed in 2020.

C) Corben's long-eared bat have a wide but sparse distribution, and are highly concentrated where located (Law *et al.* 2016).

D) The life-history characteristics of the Corben's long-eared bat overlap with certain aspects of both the descriptions for a Low and High rating for Criterion D (Churchill 2009).

E) The population of Corben's long-eared bats is not fully quantified, but is likely to be between 5,000 and 20,000 individuals and therefore a Moderate score has been assigned for Criterion E (Pennay *et al.* 2011).

F) Corben's long-eared bat are listed as vulnerable under both the EPBC Act and BC Act.

Table 8.12 Corben's long-eared bat risk assessment

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

8.3.9 Dusky woodswallow

8.3.9.1 Information on dusky woodswallow from Australian wind farms

Moloney *et al.* (2019) reported one record of blade strike of dusky woodswallow at Victorian wind farms from post-construction mortality monitoring from 2003 to 2018. Smales (2014) also reported one record of blade strike from a total of eight wind farms in south-eastern Australia (i.e., Victoria and South Australia). It is likely that these reports are referring to the same record.

8.3.9.2 Status and flight behaviour in the Project site

Dusky woodswallow were recorded during the 2020 surveys conducted by Umwelt, with two observations comprising flocks of five and six birds. **Figure 8.1** and detailed **Figure 8.1** set provided in **Appendix 1** presents records of the species in the Project site and wider locality.

8.3.9.3 Likelihood and Consequence of Impacts

The overall risk rating for dusky woodswallow is **Moderate**, based on a High likelihood and Low consequence of collisions **(Table 8.13).** The rationale for responses to each criterion is as follows:

A) A high proportion of dusky woodswallow's flight activity is at RSA height.

B) Dusky woodswallow were observed during the 2020 surveys only.

C) Dusky woodswallow are widely distributed within areas of suitable habitat across its range and the habitat itself is relatively widely dispersed.

D) Dusky woodswallow are not long-lived, has relatively high fecundity and a high capacity to replace individuals lost (Higgins et al. 2006).

E) The total population of dusky woodswallow is unknown (Birdlife International 2020d) though it is likely to exceed 20,000 individuals.

F) Dusky woodswallow are not listed under the EPBC Act, but is listed as vulnerable under the BC Act.

Table 8.13 Dusky woodswallow 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	

8.3.10 Painted honeyeater

8.3.10.1 Information on painted honeyeater from Australian wind farms

There are no published records of blade strike of painted honeyeaters in the available literature in Victoria (Moloney *et al.* 2019) or south-east New South Wales (BCD unpublished data). The majority of wind farms monitored in Victoria are on the south-western edge or outside of this species' distribution.

8.3.10.2 Status and flight behaviour in the Project site

Painted honeyeater was recorded once in the Project site during field survey conducted during October 2012 (NGH Environmental 2013) (refer to **Figure 8.1-I2** and **Figure 8.1-K1** in **Appendix 1**), at which time one individual was observed foraging in mistletoe and no height or flight data was recorded. **Figure 8.1** and detailed **Figure 8.1** provided in **Appendix 1** presents project and BioNet records of the species in the Project site and wider locality.

8.3.10.3 Likelihood and Consequence of Impacts

The overall risk rating for painted honeyeater is **Moderate**, based on a Moderate likelihood and Moderate consequence of collisions **(Table 8.14).** The rationale for responses to each criterion is as follows:

A) Based on knowledge of this species' flight behaviour from elsewhere, painted honeyeaters are likely to regularly fly below and occasionally fly at RSA height in the Project site.

B) Painted honeyeater are an uncommon/rare visitor, most likely to occur during spring and summer when mistletoe is flowering in the Project site. Applicable to the Project, suitable habitat for painted honeyeater is largely restricted to the transmission line south of the wind turbine layout, specifically in Durridgere State Conservation Area and Goulburn River National Park.

C) Painted honeyeater are widely distributed within areas of suitable habitat across its range and the habitat itself is relatively widely dispersed.

D) Painted honeyeater are not long-lived, have relatively high fecundity and a high capacity to replace individuals lost (Higgins et al. 2001).

E) Garnett et al. (2011) estimated a declining population of between 2,500 and 10,000 mature individuals, roughly equivalent to 3,750 - 15,000 individuals in total. Taking a precautionary approach, the lower estimate has been accepted and Criterion E is assigned 'High'.

F) Painted honeyeater are listed as vulnerable under the EPBC Act and the BC Act.

Table 8.14 Painted honeyeater 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	

8.3.11 Superb parrot

8.3.11.1 Information on superb parrot from Australian wind farms

There are no records of blade strike of superb parrot in the available literature from Victoria (Moloney *et al.* 2019) which is unsurprising given the lack of wind farms in the superb parrot's range in north-eastern Victoria. Furthermore, there are no records of blade strike of superb parrot in the available data collected in south-eastern New South Wales to date (BCD unpublished data). In central-eastern NSW, there are two operational wind farms which may present a risk to superb parrot, namely Bodangora and Blayney. These wind farms are located at the current eastern edge of the superb parrot's range in the Southern Tablelands region.

Research to be conducted on the movement of superb parrots in New South Wales including at the under construction Bango Wind Farm is likely to improve understanding of the susceptibility of this species to blade strike and indirect impacts resulting from the operation of turbines (Rayner 2019).

8.3.11.2 Status and flight behaviour in the Project Area

The Project is located outside the routine habitat of superb parrot, however there have been sightings of superb parrot west of the Project in the nearby town of Coolah in 2015, and north in Tamworth in 2019 (SEED 2021). Superb parrot were not observed during the field surveys, and superb parrot foraging (black box) and nesting (river red gum) habitat was not identified on site (NGH 2013), however the species may transit through the Project site whilst migrating. It is noted however that superb parrot was recorded by Umwelt ecologists in the township of Coolah, while in the region for survey on the Project. **Figure 8.1** presents records of the species in the wider locality.

8.3.11.3 Likelihood and Consequence of Impacts

The overall risk rating for superb parrot is **Moderate**, based on a Moderate likelihood and Moderate consequence of collisions (**Table 8.15**)**.** Rationale for responses to each criterion is as follows:

A) Superb parrots regularly fly below RSA height and occasionally flies at RSA height.

B) Superb parrot have not been recorded in the Modified Development Corridor, but have the potential to occur given records in the township of Coolah.

C) Superb parrot's distribution is relatively restricted, and the extent of its habitat has been reduced substantially since European settlement.

D) The life-history characteristics of superb parrot overlap with certain aspects of both the descriptions for a Low and High rating for Criterion D (Higgins 1999).

E) There are several estimates of total superb parrot population size. Higgins (1999) estimated that there were less than 5,000 breeding pairs, Garnett and Crowley (2000) estimated a total of 5000 adult birds, Baker-Gabb (2011) estimated a total of 5,000 to 8,000 individuals and Garnett et al. 2011 estimated there to be well over 10,000 individuals. Based on these population estimates Criterion E was assigned 'Moderate'.

F) Superb parrot are listed as vulnerable under the EPBC Act and the BC Act.

Table 8.15 Superb parrot risk assessment

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

8.3.12 Wedge-tailed eagle

8.3.12.1 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 two Victorian wind farms.

At two wind farms in north-western Tasmania, a total of 18 wedge-tailed eagle carcasses were recorded during monitoring conducted for three and six 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).

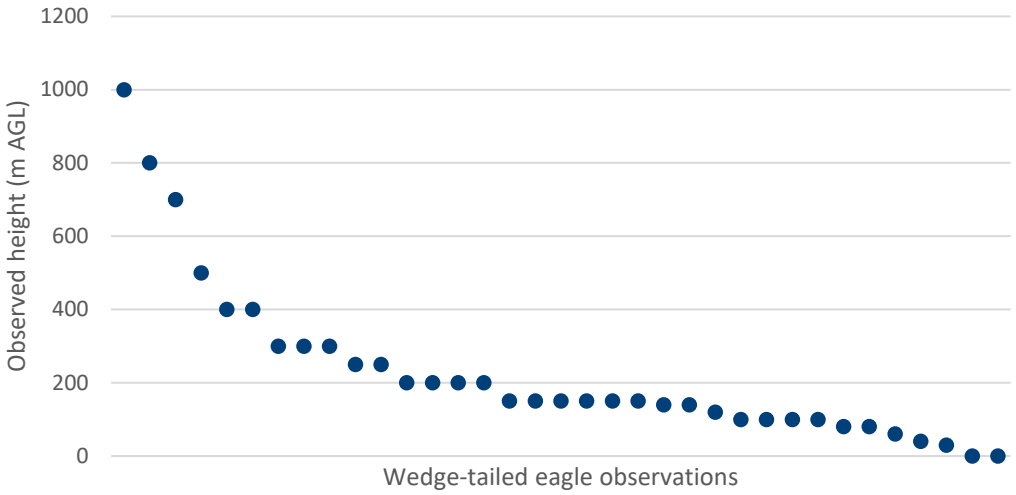
Wedge-tailed eagles are known to have collided with wind turbines in south-east NSW however the total number of fatalities detected in this region is not publicly available (BCD unpublished data). Six wedge-tailed eagle carcasses were recorded under turbines at Gullen Range Wind Farm during monthly monitoring of 30-32 turbines (out of a total of 73 turbines) conducted from January – June 2015 (BLA, 2016).

8.3.12.2 Status and flight behaviour in the Project Area

Wedge-tailed eagle were commonly observed throughout the Project site during both the 2012 surveys (27 observations) conducted by NGH and 2020 bird utilisation surveys (35 observations) conducted by Umwelt.

During the 2020 Umwelt surveys conducted by Umwelt, detailed flight and behaviour information was recorded. A summary of wedge-tailed eagle observations made during these surveys is summarised below and presented in **Graph 8.1**:

- 57% (20/35) of observations were of individuals, 37% (13/35) were of pairs, 3% (1/35) were of three birds and less than 2% (1/35) were of four birds.
- Wedge-tailed eagles were recorded in flight on 33 occasions:
    - 68% (24/35) of observed flights involved circling or soaring behaviour, while the remaining comprised directional flight



Graph 8.1 Observed heights of wedge-tailed eagle flights during the 2020 bird utilisation surveys

8.3.12.3 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 (**Table 8.16**). The rationale for responses to each criterion is as follows:

A) A high proportion of wedge-tailed eagle flight activity is at RSA height.

B) Wedge-tailed eagle are a common resident in the Project site.

C) Wedge-tailed eagle are w idely distributed within areas of suitable habitat across its range and the habitat itself is relatively widely dispersed.

D) 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, however overall, they average out between the two and hence Criterion D is assigned Moderate (Marchant and Higgins 1993).

E) The total population of wedge-tailed eagle is described as very large by Birdlife International (2020) and given this species very large distribution (c. 10.6 million km^2) the total population is likely to exceed 20,000 individuals.

F) The subspecies of wedge-tailed eagle that occurs in the Project Area is not listed as threatened under the EPBC Act or the BC Act.

The wedge-tailed eagle's risk rating of Moderate reflects the low level of impact that a potentially high frequency of blade strike in the Project Area is likely to have on this species' total population.

Table 8.16 Wedge-tailed eagle risk assessment

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

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

8.3.13 Little eagle

8.3.13.1 Information on little eagle from Australian wind farms

Moloney *et al.* (2019) reported one record of blade strike of little eagle from post-construction mortality monitoring of 15 wind farms in Victoria from 2003 to 2018. Smales (2014), reported two records of blade strike of little eagle from eight wind farms in south-eastern Australia (i.e., Victoria and South Australia). It is likely that these reports are referring to the same record of blade strike in Victoria.

8.3.13.2 Status and flight behaviour in the Project site

Little eagle was not recorded during surveys for the Project, despite extensive surveys since 2012. There are approximately 12 known records of the species within 10 km of the Modified Development Corridor (DPIE 2021). This includes in Coolah Tops National Park, in the township of Coolah and in proximity to the external transmission line south of the Golden Highway. **Figure 8.1** and detailed **Figure 8.1** set provided in **Appendix 1** presents BioNet records of the species in the wider locality.

Based on the broad habitat requirements, high mobility and wide-ranging distribution of this species, there is potential, albeit low, for this species to occur at any location within the Project site. As with other raptors, the little eagle is likely to spend a high proportion of time at RSA height whilst flying within the Project site.

8.3.13.3 Likelihood and Consequence of Impacts

The overall risk rating for little eagle is **Moderate,** based on a Moderate likelihood and Moderate consequence of collisions (**Table 8.17**). The rationale for responses to each criterion is as follows:

A) A high proportion of little eagle flight activity is likely to occur at RSA height.

B) Little eagle has not been recorded in the Project site despite extensive surveys since 2012, but the species does have the potential to occur.

C) The little eagle is widely distributed within areas of suitable habitat across its range and the habitat itself is relatively widely dispersed.

D) The life-history characteristics of the little eagle overlap with certain aspects of both the descriptions for a 'low' and 'high' rating for Criterion D (Marchant and Higgins 1993).

E) In 2009, the population of little eagle was estimated to number 10,000 to 100,000 individuals, based upon an estimate made by Ferguson and Christie (2001), although the data quality is listed as poor (Birdlife International 2020). Given the uncertainty of this estimate and the decline of little eagle in NSW (Barrett et al. 2007) and the ACT (Olsen and Fuentes 2005) Criterion E was assigned 'moderate' (based on the lower population estimate).

F) The little eagle is listed as vulnerable in NSW under the BC Act.

Table 8.17 Little eagle risk assessment

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

8.3.14 Brown falcon

8.3.14.1 Information on brown falcon from Australian wind farms

The brown falcon is commonly reported during mortality monitoring events at wind farms in Australia. Moloney *et al.* (2019) report brown falcon as the fourth most frequently recorded bird species found dead during monitoring from 2003 to 2018 across 15 wind farms in Victoria, with 48 carcasses detected and equating to 8% of all birds found. Using this data, Moloney *et al.* (2019) calculated mortality estimates of 0.4 (95% CI: 0.1 – 0.7) and 0.6 (95% CI: 0.2 – 1.0) individuals per turbine per year at two Victorian wind farms.

Brown falcon are also known to have collided with wind turbines in south-east NSW however the total number of fatalities detected in this region is not publicly available (BCD unpublished data).

8.3.14.2 Status and flight behaviour in the Project site

Brown falcon were commonly observed throughout the Project site during both the 2012 surveys (9 observations) conducted by NGH Environmental and 2020 bird utilisation surveys (1 observation) conducted by Umwelt. Of the 10 total records, seven were in flight, one was perched, and flight behaviour was not recorded on two records.

During the 2020 surveys conducted by Umwelt, detailed flight and behaviour information was recorded. Such information was not recorded during the NGH Environmental surveys (2013a, 2013b and 2017), instead only a flight range was recorded for just two of the nine records. All three records for which flight information is known are within RSA, with one at 100 metres and two with a 41-140 metre range.

With detailed flight information recorded by Umwelt at just a single record of the species, its flight behaviour has not been graphically presented.

A summary of brown falcon observations made during these surveys is presented below:

- 90% (9/10) of observations were of individuals, 10% (1/10) were of pairs.
- Brown falcon were recorded in flight on 7 occasions:
    - 43% (3/7) of observed flights involved circling or soaring behaviour
    - 57% (4/7) comprised directional flight

8.3.14.3 Likelihood and Consequence of Impacts

The overall risk rating for brown falcon is **Minor**, based on a High likelihood and Low consequence of collisions (**Table 8.18**). The rationale for responses to each criterion is as follows:

A) A high proportion of brown falcon flight activity was recorded at RSA height. However the species is known to more commonly fly or hover at heights between 10 – 50 metres, therefore just within RSA (Marchant and Higgins 1993). It is acknowledged however that literature also notes the species will soar to at least 200 metres (Marchant and Higgins 1993).

B) Brown falcon are a common resident in the Project site.

C) Brown flacon are widely distributed within areas of suitable habitat across its range and the habitat itself is relatively widely dispersed.

D) The life-history characteristics of the brown falcon have certain aspects of the descriptions for a Low score for Criterion D. They breed across their entire range; juveniles are known to disperse and local movements by adult birds between breeding territories is also known to occur (Marchant and Higgins 1993).

E) Total population for the brown falcon is believed to be more than 225,000 pairs, despite local declines in some agricultural areas. Based on this population estimate, the species has been assigned a score of Low for Criterion E.

F) The brown falcon is not listed as threatened under the EPBC Act or the BC Act.

Table 8.18 Brown falcon 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	

8.3.15 Eastern cave bat

8.3.15.1 Information on eastern cave bat from Australian wind farms

There are no records of blade strike of eastern cave bat in the available literature from post-construction monitoring conducted and made publicly available (BCD unpublished data, Moloney *et al.* 2019).

The TBDC profile for the species states that “very little is known about the biology of this uncommon species” and “little is understood of its feeding or breeding requirements or behaviour” (DPIE 2021). With this level of lack of information lacking on the species, the likelihood of its flying behaviour and interaction with wind turbines is substantially restricted.

8.3.15.2 Status and flight behaviour in the Project site

There are 14 known records of the species within 10 km of the external transmission line south of the Golden Highway (DPIE 2021). No records of the species are known in proximity to the Wind Farm component of the Modified Development Corridor.

NGH Environmental survey effort recorded this species at seven locations, spanning the north of the Project site to Durridgere State Conservation Area. It was recorded at one location. **Figure 8.1** and detailed **Figure 8.1** provided in **Appendix 1** presents BioNet records of the species in the Project site and wider locality.

8.3.15.3 Likelihood and Consequence of Impacts

The overall risk rating for eastern cave bat is **Moderate**, based on a Moderate likelihood and Moderate consequence of collisions **(Table 8.19**). The rationale for responses to each criterion is as follows:

A) Despite there being a substantial lack of information on the flying behaviour of this species, it is possible that the eastern cave bat will involve flying activity at RSA height. However, due to the lack of information it has been assigned a Moderate rating.

B) Eastern cave bat was recorded at multiple locations across the Project site.

C) Eastern cave bat is found in a broad band on both sides of the Great Dividing Range from Cape York (QLD) to Kempsey (NSW), with records from the New England Tablelands and the upper north coast of NSW. The western limit appears to be the Warrumbungle Range, approximately 80km to the northwest, and there is a single record from southern NSW, east of the ACT (DPIE 2021).

D) There is very little known about these traits of the eastern cave bat, therefore a conservation score of Moderate has been assigned.

E) There is no available literature or information on the population of this species.

F) The subspecies of eastern cave bat is listed as Vulnerable under the BC Act, but is not listed as threatened under the BC Act.

Table 8.19 Eastern cave bat risk assessment

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

8.3.16 Square-tailed kite

8.3.16.1 Information on square-tailed kite from Australian wind farms

The are no reports of square-tailed kite being recorded during mortality monitoring events at wind farms in Australia. Lumsden *et al.* (2019) identifies the square-tailed kite as a 'species of interest'. Further, Lumsden *et al.* (2019) assesses a Likelihood and Consequences for turbine strike on the species between Moderate and High, with the Moderate Likelihood and High Consequence being the lowest probability (8.7%), while High Likelihood and Moderate Consequence had the highest probability (48.8%).

Square-tailed kites are not known to have collided with wind turbines in south-east NSW (BCD unpublished data). The species was not recorded during monitoring from 2003 to 2018 across 15 wind farms in Victoria (Moloney *et al.* 2019).

8.3.16.2 Status and flight behaviour in the Project site

There are no known records of square-tailed kite within 10 km of the Modified Development Corridor for the wind farm (DPIE 2021). However, a breeding nest was recorded by NGH Environmental in proximity to the external transmission line easement and an associated access track. Umwelt did not record the species. **Figure 8.1** presents records of the species in the Project site and wider locality.

The species has not been recorded during any of the bird utilisation surveys, therefore no flight behaviour was observed, nor can it be analysed.

8.3.16.3 Likelihood and Consequence of Impacts

The overall risk rating for square-tailed kite is **Minor**, based on a Low likelihood and Moderate consequence of collisions (**Table 8.20**). The rationale for responses to each criterion is as follows:

A) No flight activity has been recorded for square-tailed kite in the Project site, however it likely that the species would fly at RSA height.

B) Square-tailed kite was only recorded in one location, along the transmission line. Despite extensive bird utilisation surveys since 2012, it was not recorded in the wind farm component of the Project site. It is not considered to be a resident in the Project site.

C) Square-tailed kite are widely distributed within areas of suitable habitat across its range and the habitat itself is relatively widely dispersed.

D) The life-history characteristics of the square-tailed kite is considered to align with aspects of the Low score for Criterion C. The species is highly mobile and dispersive and it not considered likely to be susceptible to population fragmentation (TTSC 2009). However, the species is known to have breeding pairs with great site-fidelity for more than 10 years (Marchant and Higgins 1993). The species is typically solitary outside of breeding season, with pairs hardly ever seen (Marchant and Higgins 1993).

E) There have been increased records or locations being recorded for the square-tailed kites in annual reports (TSSC 2009). However, it is recognised that the species is generally considered to be data deficient (TSSC 2009). It's extent of occurrence is generally believed to occur across the extent of NSW, with the exception of driest, highest and treeless parts of the state (TSSC 2009), approximately 700,000 km^2. Even if only 10% of the extent of occurrence is occupied, its area of occupancy would still span approximately 70,000 km^2. The square-tailed kite population in Australia is estimated to be roughly 10% of the global estimate, or between 100 and 1,000 mature birds.

F) The subspecies of square-tailed kite is listed as Vulnerable under the BC Act, but is not listed as threatened under the EPBC Act.

Table 8.20 Square-tailed kite risk assessment

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

8.3.17 Yellow-bellied sheathtail-bat

8.3.17.1 Information on yellow-bellied sheathtail bat from Australian wind farms

There are no published records of blade strike of yellow-bellied sheathtail bats in the available literature from post-construction monitoring conducted in its range in south-eastern Australia (BCD unpublished data, Moloney *et al.* 2019).

8.3.17.2 Status and flight behaviour in the Project site

The species was recorded twice as part of surveys for the Project. Neither record occur within the Modified Development Corridor, but occur in proximity to the external transmission line component of the Project, specifically within the Durridgere State Conservation Area and on private land on the west side of Ulan Road (**Figure 8.1** and detailed **Figure 8.1-G4** set provided in **Appendix 1**).

8.3.17.3 Likelihood and Consequence of Impacts

The overall risk rating for yellow-bellied sheathtail bat is **Moderate**, based on a Moderate likelihood and Moderate consequence of collisions (**Table 8.21**). The rationale for responses to each criterion is as follows:

A) The yellow-bellied sheathtail-bat is likely to regularly fly below RSA height and occasionally fly at RSA height.

B) The yellow-bellied sheathtail-bat is likely to occasionally occur in or move through the Project site, based on the survey data, the species is most likely to occur in the transmission line component of the Project site rather than the wind farm component.

C) The yellow-bellied sheathtail-bat is widely distributed within areas of suitable habitat across its range and the habitat itself is relatively widely dispersed.

D) The life-history characteristics of the yellow-bellied sheathtail-bat overlap with certain aspects of both the descriptions for a 'low' and 'high' rating for Criterion D.

E) Very little is known about the ecology of the yellow-bellied sheathtail-bat though given its very large distribution (Churchill 2008) its population is likely to exceed 5,000 individuals and may possibly be over 20,000. Given the migratory nature of individuals that occur in south-eastern Australia coupled with the lack of any population estimates Criterion E is conservatively assigned 'moderate'.

F) The yellow-bellied sheathtail-bat is listed as vulnerable in NSW under the BC Act.

The yellow-bellied sheathtail-bat's risk rating of Moderate reflects the moderate level of impact that a potentially Moderate frequency of blade strike in the Project site is likely to have on this species' total population.

Table 8.21 Yellow-bellied sheathtail-bat risk assessment

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

8.3.18 Large-eared pied bat

8.3.18.1 Information on large-eared pied bat from Australian wind farms

There are no records of blade strike of large-eared pied bat in the available literature from post-construction monitoring conducted and made publicly available (BCD unpublished data, Moloney *et al.* 2019).

8.3.18.2 Status and flight behaviour in the Project site

There are more than 20 known records of the species within 10 km of the external transmission line component of the Modified Development Corridor (DPIE 2021). NGH Environmental survey effort recorded the large-eared pied bat at five locations as part of the original assessment, primarily within and adjacent to the Durridgere State Conservation Area as well as one location in the wind farm component of the Project (NGH 2013a, 2013b and 2017). Umwelt survey effort did not record this species despite extensive surveys. **Figure 8.1** and detailed **Figure 8.1** set provided in **Appendix 1 presents** records of the species in the Project site and wider locality.

8.3.18.3 Likelihood and Consequence of Impacts

The overall risk rating for large-eared pied bat is **Moderate**, based on a Moderate likelihood and Moderate consequence of collisions (**Table 8.22**). The rationale for responses to each criterion is as follows:

A) Despite there being a substantial lack of information on the flying behaviour of this species, it is possible that the large-eared pied bat will involve flying activity at RSA height. However, due to the lack of information it has been assigned a Moderate rating.

B) Despite extensive bat utilisation surveys since 2012, large-eared pied bat was only recorded at one location in the wind farm component of the Project site, it is unlikely the species would be a in the Project site.

C) The distribution of the large-eared pied bat is discontinuous and ranges from Shoalwater Bay in Queensland through to Ulladulla in New South Wales (DERM 2011).

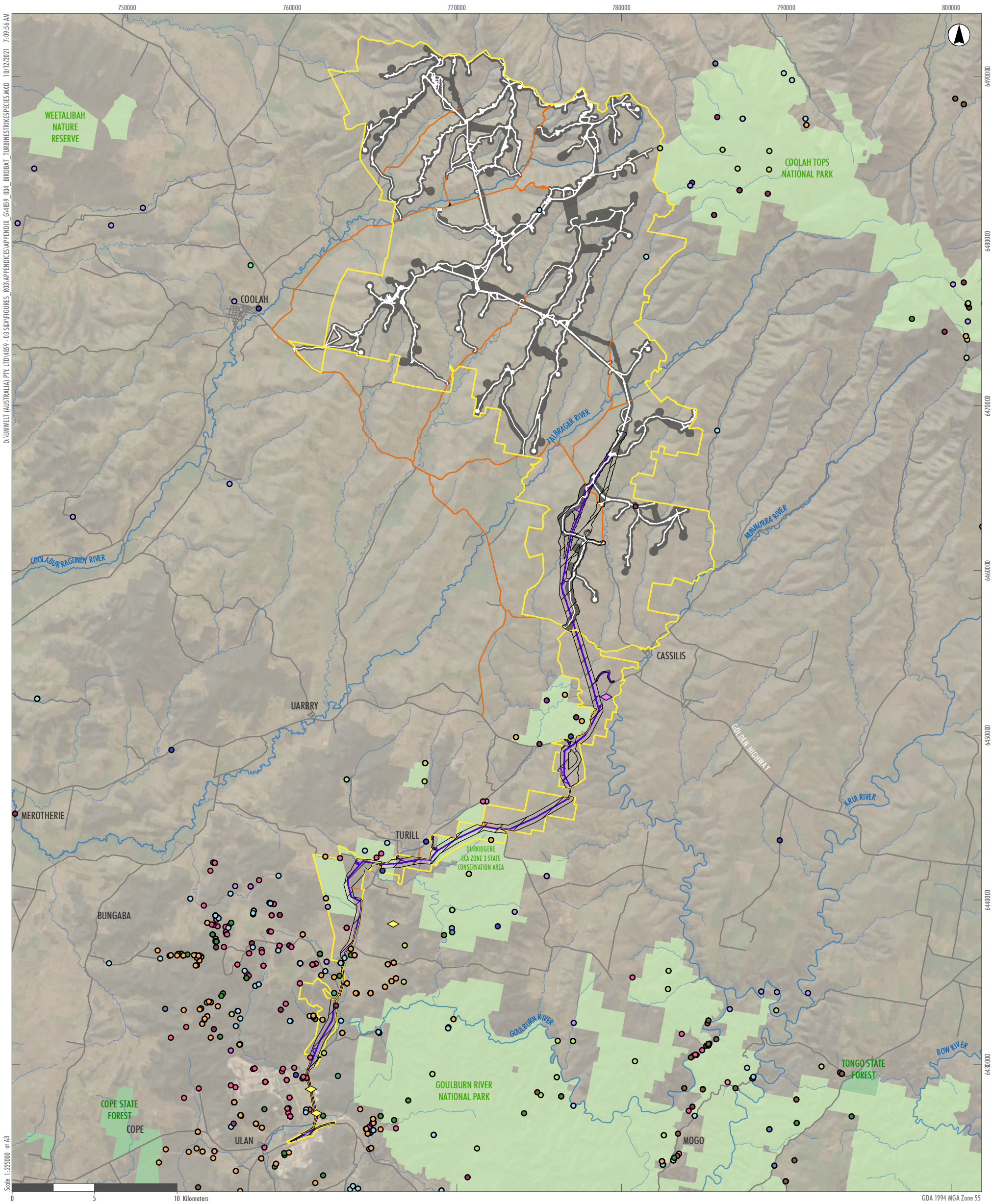
D) There is very little known about these traits of the large-eared pied bat, therefore a conservation score of Moderate has been assigned.

E) The EPBC Act listing advice for large-eared pied bat states that there is no definitive data on total population numbers (TSSC 2010). However, it is presumed to have undergone large declines in numbers due to removal of suitable habitat (TSSC 2010). Therefore, conservatively it has been assigned a score of High.

F) The large-eared pied bat is listed as Vulnerable under the EPBC Act or the BC Act.

Table 8.22 Large-eared pied bat risk assessment

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



Legend

- Modified Site Boundary
- Indicative Development Footprint – Wind Farm
- Indicative Development Footprint – External Transmission Line
- Indicative Development Footprint – Public Road Upgrades

Modified Development Corridor

- Modified Development Corridor – Wind Farm
- Modified Development Corridor – External Transmission Line

Umwelt and NGH TS Records

- Black-chinned honeyeater
- Painted Honeyeater

NSW Bionet Atlas Records

- Barking Owl
- Black-chinned Honeyeater (eastern subspecies)
- Dusky Woodswallow
- Eastern Cave Bat
- Large Bent-winged Bat
- Large-eared Pied Bat
- Little Eagle
- Painted Honeyeater
- Powerful Owl
- Regent Honeyeater
- Square-tailed Kite
- Superb Parrot
- Swift Parrot
- White-throated Needletail
- Yellow-bellied Sheathtail-bat

- Road
- Drainage Line
- National Parks (NPWS Estate)
- State Forest

FIGURE 8.1

Liverpool Range Wind Farm
Bird and Bat Turbine Strike Species

Image Source: ESRI Basemap (2021) Data source: NSW LPI (2021), NSW DSFI (2021); NPWS Estate (2019), NSW Bionet Atlas records (2021), (NGH Environmental 2013a, 2013b and 2017)

9.0 Impact of Avoidance Behaviour

Criterion a (vi) predict the impact of avoidance behaviour for migratory species relative to migration distances, and the availability of suitable habitat for breeding, feeding and resting over the migration route

Avoidance behaviour is considered as a behavioural change by a particular species whereby either specific habitat, locality or wider region is avoided. The potential indirect impacts associated with such avoidance behaviour may have on migratory or partly migratory species is difficult to predict given the lack of relevant information available. Assessment against such criterion will be only possible through the preparation (i.e., completion of baseline monitoring) and subsequent implementation (i.e., ongoing monitoring) of the Bird and Bat Adaptative Management Plan for the Project, as required under Development Consent SSD 6696.

Species for which a high proportion of their population exhibits migratory behaviour such as white-throated needletail, large bent-winged bat, superb parrot, regent honeyeater, swift parrot and dusky woodswallow, may be more likely to be affected by impacts (direct and indirect) than sedentary species though the magnitude and nature of such impacts on each is unknown. Mitigation measures prepared as part of the Bird and Bat Adaptative Management Plan will aim to consider potential impacts of avoidance behaviour.

10.0 Justification of Likelihood and Nature of Impact Predictions

Criterion b: Justify predictions of likelihood and nature of impact, with reference to relevant literature and other published sources of information

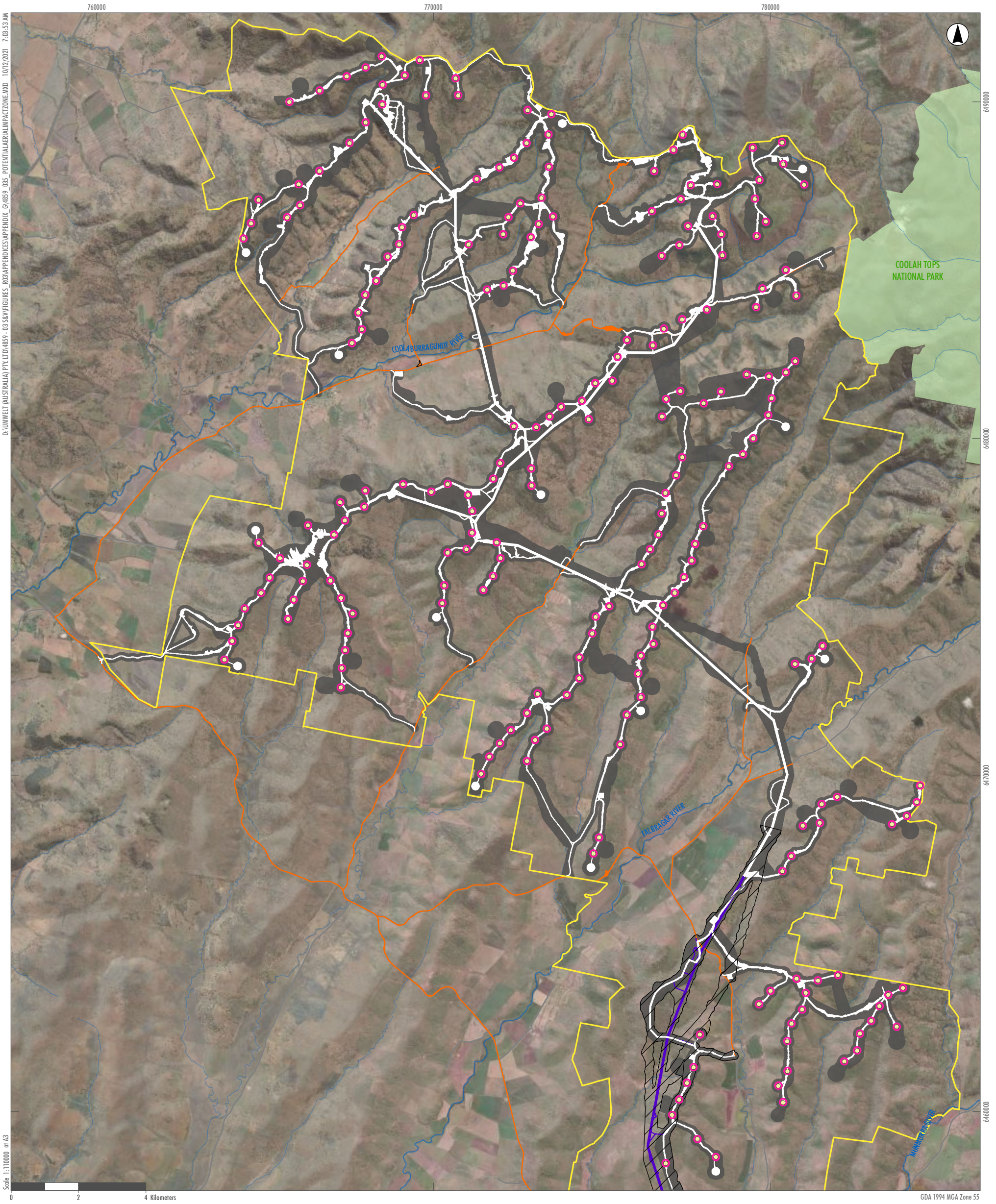
The nature of impacts associated to aerial fauna species from wind energy projects include direct turbine blade strike and barotrauma, the latter being injury caused by a sudden or substantial change in air pressure. While literature exists as to the nature of such impacts, the rate of occurrence and likelihood of impact is very difficult to accurately determine. A contributing factor to this difficulty is the range of environmental variables (including minimum, maximum and average wind speeds, drought conditions, frequency and intensity of storm cells, etc.) that interact with such impacts, variables which can differ within a single project at any given time as well as varying between different projects. Additionally, the wind farm industry is currently dealing with challenges relating to vast inconsistencies with the way in which baseline and ongoing monitoring surveys are being undertaken, including how and what data is being collected. Such inconsistencies either prevent or inhibit comparative analysis. State and Federal guidelines are currently being prepared to address these challenges.

The preparation (i.e., completion of baseline monitoring) and subsequent implementation (i.e., ongoing monitoring) of the Bird and Bat Adaptative Management Plan for the Project as required by Development Consent SSD 6696 will be essential in providing a framework to measure impacts on aerial fauna species by the Project. Furthermore, this plan will develop trigger levels and mitigation measures designed to manage such impacts through the operational phase of the Project.

11.0 Likely Zone of Disturbance

Criterion c: Map the disturbance zone around wind turbines, and the significant landscape and habitat features within that zone, for species likely to be affected, e.g. hollow bearing trees and important habitat for migratory species.

There is currently no information on the degree to which wind turbines disturb aerial species in Australia. For this reason, the likely zone of disturbance around wind turbines is unknown. In the absence of such information being published or formally recognised, Umwelt has buffered each of the proposed 223 wind turbines by 100 metres to indicate a potential likely zone of disturbance (**Figure 11.1** and detailed **Figure 11.1** set provided in **Appendix 1**). It is acknowledged that this represents a potential likely zone of disturbance in plain view, i.e. view of the impact area as projected on a horizontal plane. However, as described in **Section 1.2**, the RSA is between 40 metres AGL (i.e. ground clearance) and 250 metres AGL (i.e. maximum blade tip height), equating to an area of 34,636 m^2 per turbine or approximately 772 hectares of total aerial space for the 223 proposed turbines.



Legend

- Modified Site Boundary
- Modified Wind Turbines
- Potential Aerial Impact Zone (100m radius)
- Indicative Development Footprint – Wind Farm
- Indicative Development Footprint – External Transmission Line
- Indicative Development Footprint – Public Road Upgrades

Modified Development Corridor

- Modified Development Corridor – Wind Farm
- Modified Development Corridor – External Transmission Line
- Drainage Line
- National Parks (NPWS Estate)

FIGURE 11.1

Liverpool Range Wind Farm
Potential Aerial Impact Zone (100 metre turbine buffers)

Image Source: ESRI Basemap (2021) Data source: NSW LPI (2021), NSW DSFI (2021); NPWS Estate (2019)

12.0 Conclusion

Of the 18 species assessed six (6) are assigned a High risk rating, 10 are assigned a Moderate risk rating and two (2) are assigned a Minor risk rating of being impacted by the Project (**Table 12.1**). The resultant risk rating for these species is primarily due to their relative abundance in the Project site, their predicted or observed flight behaviour in the Project site and/or their known susceptibility to blade strike at wind farms in south-east Australia. For each of the six (6) species assigned an overall risk rating of High four (4) species were considered to have a High likelihood of collision. The two species that were considered to have a Moderate likelihood of collision were considered to have a High consequence from a potential collision.

The risk rating for powerful owl, barking owl and large bent-winged bat reflect the likelihood of those species occurring in the Project site, their population sizes and potential to fly within the RSA. The overall risk rating of High for swift parrot and regent honeyeater reflect the very small remaining population sizes, coupled with each species' migratory nature and habitat fragmentation.

The overall risk rating of High for white-throated needletail largely reflects the High likelihood of collision of birds in the Project site given their known susceptibility to blade strike at other wind farms in Australia.

The results of this assessment have informed the identification of prescribed impacts on protected species in the BDAR and will inform the Bird and Bat Adaptive Management Plan for the project.

Table 12.1 Risk Assessment Summary

Common Name	Latin Name	Likelihood	Consequence	Risk Rating
white-throated needletail	*Hirundapus caudacutus*	High	Moderate	High
barking owl	*Ninox connivens*	High	Moderate	High
large bent-winged bat	*Miniopterus orianae oceanensis*	High	Moderate	High
powerful owl	*Ninox stenua*	High	Moderate	High
regent honeyeater	*Anthochaera phrygia*	Moderate	High	High
swift parrot	*Lathamus discolor*	Moderate	High	High
large-eared pied bat	*Chalinolobus dwyeri*	Moderate	Moderate	Moderate
yellow-bellied sheath-tail bat	*Saccolaimus flaviventris*	Moderate	Moderate	Moderate
eastern cave bat	*Vespadelus troughtoni*	Moderate	Moderate	Moderate
Corben's long-eared bat	*Nyctophilus corbeni*	Moderate	Moderate	Moderate
dusky woodswallow	*Artamus cyanopterus*	High	Low	Moderate
wedge-tailed eagle	*Aquila audax*	High	Low	Moderate
black-chinned honeyeater	*Melithreptus gularis*	Moderate	Moderate	Moderate
painted honeyeater	*Grantiella picta*	Moderate	Moderate	Moderate

Common Name	Latin Name	Likelihood	Consequence	Risk Rating
superb parrot	*Polytelis swainsonii*	Moderate	Moderate	Moderate
little Eagle	*Hieraaetus morphnoides*	Moderate	Moderate	Moderate
brown falcon	*Falco berigora*	Moderate	Low	Minor
square-tailed kite	*Lophoictinia isura*	Low	Moderate	Minor

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