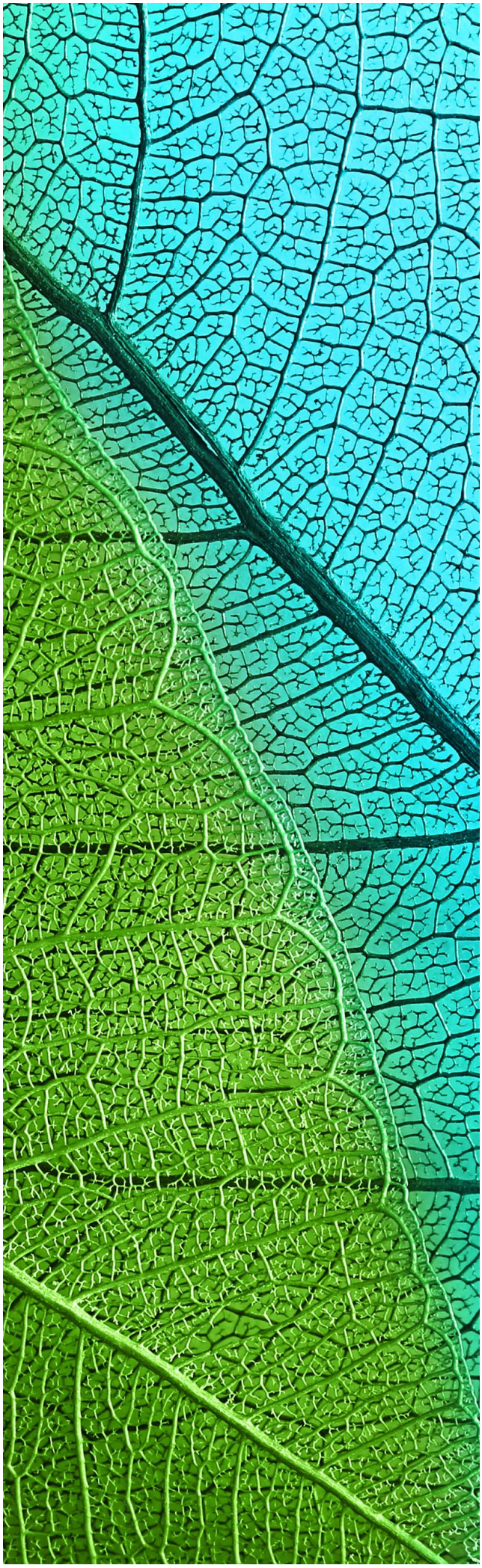

Clarke Creek Wind Farm
PHASE 1
Queensland

Bird and Bat Management Plan
(EPBC 2018/8141)

Prepared for
Clarke Creek Energy Pty Ltd
ABN 34 614 169 096

August 2024
Report No. 17047 (4.16)

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SQUADRON ENERGY

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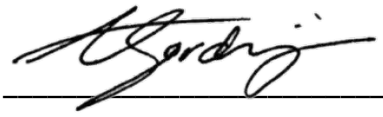
Declaration of Accuracy

In making this declaration, I am aware that Section 491 of the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) makes it an offence in certain circumstances to knowingly provide false or misleading information or documents to specified persons who are known to be performing a duty or carrying out a function under the EPBC Act or the *Environment Protection and Biodiversity Conservation Regulations 2000* (Cth). The offence is punishable on conviction by imprisonment or a fine, or both. I am authorised to bind the approval holder to this declaration and that I have no knowledge of that authorisation being revoked at the time of making this declaration.

Signed 

Full name (please print) Alana Gordijn

Organisation (please print) Squadron Energy

Date 28/08/2024

Glossary of Terms

AEMO	Australian Energy Market Operator
Approval holder	Clarke Creek Energy Pty Ltd (ACN: 614 169 096) and Isaac Wind & Solar Energy Pty Ltd (ACN: 615 593 078)
BBMP	Bird and Bat Management Plan
BUS	Bird utilisation survey
CCWF	Clarke Creek Wind Farm
Collector Group	A group of turbines that are connected to a substation via a common electrical reticulation network, which transfers electrical energy from that collector group to the substation.
Commissioning	All activities, including turning of turbines, after the components of the wind turbines are installed. For a collector group of turbines commissioning commences when all turbines in a collector group are installed, inclusive of the completion of pre-commissioning checks, and energised to produce electricity for commercial purposes.
Construction	Then period between commencement of works on site and the commissioning of the last wind turbine and the commencement of full operation (see below) of the wind farm.
CCEPL	Clarke Creek Energy Pty Ltd
CRM	Collision Risk Model
DCCEEW	Commonwealth Department of Climate Change, Energy, the Environment and Water
DEHP	(Qld) Department of Environment and Heritage Protection (now DESI)
DESI	(Qld) Department of Environment, Science and Innovation (formerly DES)
DoEE	(Cth) Department of the Environment and Energy
DSDI	Department of State Development and Infrastructure (formerly DSDILGP and DSDMIP)
DSITI	Department of Science, Information Technology and Innovation
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EPBC Act approval	EPBC Act approval 2018/8141, dated 9/11/2018.
Full operation	Once all wind turbines have been commissioned and are able to operate simultaneously after the final Hold Point test has been passed.
Minister	The Australian Government Minister administering the EPBC Act including any delegate thereof

MNES	Matters of national environmental significance under the EPBC Act
NC Act	*Nature Conservation Act 1992*
Phase 1	Stages 1 and 2 (of 3) of the approved Project, comprising 100 wind turbines with a tip height of 210m and a hub height of 130m.
Phase 2	Stage 3 (of 3) of the approved project, which is currently in development and will include up to 95 turbines.
Pre-commissioning	The construction period before the commissioning, including the installation of components and functionality checked, with the turbines remaining unconnected to the grid
Pre-construction	Period before start of the action
The Project	Clarke Creek Wind Farm (the Project)
RSA	Rotor swept area (58m-210m)
Section	Phase 1 will comprise 13 Sections, with 7 or 8 turbines per section. Turbines will be allocated to particular Sections generally depending on their completion status. A Section may be comprised of turbines from different Collector Groups.
Stage	Refers to Stages 1, 2 and 3 of the Project, as approved under the Queensland Planning Act 2016 approval (Original Ref. 2011-19748 SPD)
WTG	Wind turbine generator

Document Version Control

Version	Date of Issue	Description of Key Changes	Reason for Changes	Issued by
17047(4.10)	November 2023	Updated turbine shutdown triggers, amended objectives, responded to DCCEEW comments	Comments from DCCEEW	Inga Kulik
17047(4.11)	December 2023	Updated according to DCCEEW comments	Comments from DCCEEW	Inga Kulik
17047(4.12)	April 2024	Updated according to DCCEEW comments and Clarke Creek Wind Farm Project –EPBC2018/8141 – Notification of Proposed Project Variation (02 Feb 2024)	Comments from DCCEEW	Inga Kulik
17047(4.13)	May 2024	Updated to address SQE comments	Comments from SQE	Inga Kulik
17047(4.14)	June 2024	Addition of Appendix 5	Addition of Appendix 5	Inga Kulik
17047(4.15)	August 2024	Updated to address DCCEEW comments. Statistical Advice updated.	Comments from DCCEW	Inga Kulik
17047(4.16)	27 August 2024	Updated to address DCCEEW comments received 26/08/2024	Comments from DCCEEW	Alana Gordijn

1. Introduction

1.1. Background, project description & location

The Clarke Creek Wind Farm (the Project) is located approximately 190 kilometres north-west of Rockhampton, between Marlborough and Middlemount on the Marlborough-Sarina Highway (Figure 1). The project approval allows a maximum of 195 wind turbines with a tip height of 210m. The project is being implemented in different timelines, with Phase 1 (Stages 1 and 2) comprising 100 wind turbines with a tip height of 210m and a hub height of 130m (Figure 2). Phase 2 (Stage 3) of the project is currently in development and will include up to 95 turbines.

Approval was granted to Clarke Creek Energy Pty Ltd (CCEPL) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) on 9th November 2018: EPBC 2018/8141 (the EPBC Act approval).

The project has also been approved under Section 76(2) of the Queensland *Planning Act 2016* on 10th August 2018, with minor changes to the layout approved on 4th June 2019, 23rd December 2020, 25th March 2022 and 10th July 2024.

Both approvals include conditions that require a Bird and Bat Management Plan (BBMP) to be prepared. In accordance with the EPBC Act Approval, the approval holder must not begin operation of the wind farm unless the Minister has approved the Bird and Bat Management Plan in writing. In accordance with the Queensland Planning Act approval conditions, the BBMP will be submitted to the Department of State Development and Infrastructure (DSDI; formerly DSDILGP and DSDMIP) prior to the commencement of operations at each phase. Section 1.2 describes the relevant conditions which this plan has been prepared to address.

This BBMP was prepared in line with the Environmental Management Plan Guidelines (DCCEEW 2024) by a team of suitably qualified ecologists from Nature Advisory Pty Ltd (formerly Brett Lane & Associates Pty Ltd) including Peter Lansley (Zoologist, B Zoo (Hons)), Curtis Doughty (Senior Zoologist, B Zoo (Hons)), Inga Kulik (Senior Ecologist and Project Manager, PhD) and Brett Lane (Principal Consultant, BA [Zool]).

1.2. Relevant conditions of project approvals

The relevant conditions of the EPBC Act approval and Queensland Planning Act approval are presented in Table 1.

1.3. Scope of this BBMP

The scope of this BBMP currently covers the Clarke Creek Wind Farm Phase 1, to satisfy the conditions of the EPBC Act approval and Queensland Planning Act approval, as detailed in Section 1.2.

In accordance with Conditions 10, 10A, 11 and 11A of the EPBC Act approval, a separate BBMP will be prepared for Clarke Creek Wind Farm Phase 2.

Table 1: Commonwealth and State approval conditions and BBMP section reference

Condition number	Permit condition requirements	BBMP Sections
EPBC Act approval conditions		
9	To avoid and mitigate impacts to EPBC Act listed bird and bat species from turbine collision and barotrauma in Phase 1, the approval holder must implement the Phase 1 Bird and Bat Management Plan until the completion of the action.	Section 1.1
10	To avoid and mitigate impacts to EPBC Act listed bird and bat species from turbine collision and barotrauma in Phase 2, the approval holder must submit a Bird and Bat Management Plan (BBMP) for Phase 2 (Phase 2 BBMP) to the department for the Minister's approval.	Section 1.3
10A	The approval holder must not commence commissioning in Phase 2 unless the Minister has approved the Phase 2 BBMP in writing.	Section 1.3
11	The Phase 2 BBMP submitted for the Minister's approval must meet the requirements specified in Attachment N.	Section 1.3
11A	The approval holder must implement the Phase 2 BBMP approved by the Minister from commencement of commissioning in Phase 2 until the completion of the action.	Section 1.3
11B	At the same time that the approval holder submits the Phase 2 BBMP to the department, the approval holder must also submit to the department for the Minister's approval, a revised version of the Phase 1 Bird and Bat Management Plan that meets the requirements of condition 11C of this approval.	Section 9.4

Condition number	Permit condition requirements	BBMP Sections
11C	The revised Phase 1 Bird and Bat Management Plan submitted for the Minister's approval in accordance with condition 11B of this approval, must: a. align the post-commissioning fatality monitoring and adaptive management in Phase 1 with that set out in the BBMP for Phase 2; b. specify and statistically justify the site-specific survey effort at temporal and spatial resolutions (study duration, turbine sample, search interval, search plot, transect width), that will be implemented post-commissioning in the project area, for EPBC Act listed bird and bat species; c. specify and statistically justify the effort required to undertake site-specific carcass detectability trials, including the timing and frequency of searcher efficiency and carcass persistence trials, as well as corrections of unsearched areas (i.e. density weighted proportion analysis) to accurately correct for bias in calculating annual mortality estimates; d. include details of requirements for DNA testing of carcasses that cannot be otherwise identified by a suitably qualified bird and bat ecologist as not being an EPBC Act listed bird and bat species; e. provide details of the methodology, data input/output and results of all statistical analyses underlying the monitoring program, including the statistically justified survey effort required across Phase 1 and species-specific annual mortality estimates; f. include a peer-review of the statistical analyses and results of the post-commissioning fatality monitoring program by an independent suitably qualified statistician; and g. include an adaptive management framework that: i. incorporates site-specific data collected through the post-commissioning fatality monitoring program; ii. details adaptive avoidance and mitigation measures; iii. includes a table of species-specific trigger levels and corrective actions that will be implemented if those triggers are exceeded, including but not limited to providing environmental offsets in accordance with the Environmental Offsets Policy; and iv. detail a process for the periodic review of the post-commissioning fatality monitoring, impact avoidance and mitigation measures, and corrective actions.	Section 9.4
11D	Following submission of the revised Phase 1 Bird and Bat Management Plan in accordance with condition 11B of this approval, if the Minister makes a written request to the approval holder to make specified revisions to the Phase 1 Bird and Bat Management Plan, the approval holder must revise the Phase 1 Bird and Bat Management Plan and submit the revised Phase 1 Bird and Bat Management Plan to the department in accordance with any such request.	Section 9.4

Condition number	Permit condition requirements	BBMP Sections
12A	In the event any EPBC Act listed threatened bird or bat species-specific trigger level specified in the Phase 1 Bird and Bat Management Plan or any BBMP approved by the Minister, is exceeded, the approval holder must: a. notify the department of the exceedance as an incident in accordance with condition 26 of this approval; and b. publish on the website and submit to the department, a report that details the findings of a review of the following by an independent suitably qualified expert over the 12 month period commencing no later than 1 month after the detection of the exceedance: i. the utilisation of the project area by the EPBC Act listed threatened bird and bat species relevant to the exceeded trigger level; and ii. the efficacy and implementation of impact avoidance, mitigation and management measures, and the adaptive management frameworks detailed in all BBMPs approved by the Minister.	Section 5.3.2
12B	Each report required under condition 12A of this approval must: a. be prepared by an independent suitably qualified expert; b. be published on the website and submitted to the department within 15 months of notifying the department of the relevant species-specific trigger level exceedance; c. remain published on the website until the expiry of this approval; d. include a summary of the review findings; e. list the key recommendations (if any) made by the independent suitably qualified expert to reduce the likelihood of future trigger level exceedance; and f. include a statement made by the approval holder as to which of the recommendations it will accept, and how and by when the approval holder will act on each of the accepted recommendations.	Section 5.3.2 Section 9.1.5
14(d)	The Offset Strategy must: Determine and justify trigger levels for the requirement to provide and offset for a significant residual impact on EPBC Act listed threatened bird and bat species	Section 5.6
17A	Within 18 months following commissioning of Phase 1, the approval holder must submit a Bird and Bat Offset Strategy (BBOS) for all Phases to the department for the Minister's approval.	Section 5.8

Condition number	Permit condition requirements	BBMP Sections
17B	The BBOS submitted for the Minister's approval must: a. propose environmental offsets that will be delivered in the event a species-specific trigger level specified in a BBMP approved by the Minister is reached or exceeded; b. specify the mechanism and responsible parties for the delivery of each of the proposed environmental offsets; c. demonstrate how each of the proposed environmental offsets are consistent with the Environmental Offsets Policy; d. specify what the outcome of each environmental offset is and the timeframe in which each outcome will be delivered; e. propose feasible and effective contingencies, to be implemented in the event any outcome of an environmental offset is not achieved within the specified timeframe; f. detail the benefit of each proposed environmental offset and its outcome to the conservation of each EPBC Act listed threatened bird and bat species; and g. detail a program to periodically publish on the website and report to the department, information regarding the implementation of each proposed environmental offset.	Section 5.8
17C	Following submission of the BBOS, if the Minister makes a written request to the approval holder to make specified revisions to the BBOS, the approval holder must revise the BBOS and submit the revised BBOS to the department in accordance with any such request.	Section 5.8
17D	The approval holder must implement the BBOS approved by the Minister, from within 20 business days of the Minister's approval of the BBOS and until the expiry of this approval.	Section 5.8
23	The approval holder must: a. submit plans electronically to the Department for approval by the Minister; b. publish each plan on the website within 20 business days of the date the plan is approved by the Minister or, as relevant to the biodiversity management plan, within 20 business days of the date a revised biodiversity management plan is submitted to the Minister, unless otherwise agreed to in writing by the Minister; c. exclude or redact sensitive ecological data from plans published on the website or provided to a member of the public; and d. keep plans published on the website until the end date of this approval.	Section 1.6
24	The approval holder must ensure that any monitoring data (including sensitive ecological data), surveys, maps, and other spatial and metadata required under a plan or conditions of this approval, is prepared in accordance with the Department's *Guidelines for biological survey and mapped data* (2018) and submitted electronically to the Department in accordance with the requirements of the plan.	Section 9.2

Condition number	Permit condition requirements	BBMP Sections
25A	The approval holder must include the following information in all compliance reports prepared for each ACR period following commissioning: a. a count of all turbine strikes detected for EPBC Act listed bird and bat species in the project area and in each Phase, during the ACR period, and a compilation and analyses of information in relation to each turbine strike regarding: i. the method of detection; ii. the species detected; iii. prevailing environmental/meteorological conditions at the estimated time of the collision; and iv. likely factors in the presence of the EPBC Act listed bird and bat species and EPBC Act listed migratory bird or bat species leading to the collision; b. estimations of annual mortality and injury rates for each EPBC Act listed threatened bird and bat species, calculated in accordance with the BBMP(s) for each Phase approved by the Minister; c. species occurrence records in accordance with the *Guidelines for biological survey and mapped data,* Commonwealth of Australia 2018, or as otherwise specified by the Minister in writing; and d. an evaluation of effectiveness of the measures implemented during the reporting period to avoid and mitigate mortality and/or injury to EPBC Act listed threatened bird and bat species	Section 9.1.2
26	The approval holder must notify the department electronically, within 2 business days of becoming aware of any incident, or potential or actual non-compliance with these conditions or commitments made a plan. The approval holder must specify in each notification: a. any condition or commitment made in a plan which has not been or may have been not complied with; b. a short description of the incident or non-compliance; and c. the location (if applicable, including co-ordinates), date and time of the incident or non-compliance.	Section 9.1.3
27	The approval holder must provide to the department in writing, within 12 business days of becoming aware of an incident, or potential or actual non-compliance with these conditions or commitments made in a plan, the details of that incident or non-compliance. The approval holder must specify: a. all corrective measures and investigations which the approval holder has already taken in respect of the incident or non-compliance; b. the potential impacts of the incident or non-compliance; c. the method and timing of any corrective measures that the approval holder proposes to undertake to address the incident or non-compliance; and d. any variation of these conditions or revision of a plan that will be required to prevent recurrence of the incident or non-compliance, and/or to address its consequences.	Section 9.1.3

Condition number	Permit condition requirements	BBMP Sections
31	The approval holder may, at any time, apply to the Minister for a variation to a plan by the Minister as subsequently revised in accordance with these conditions, by submitting an application in accordance with the requirements of section 143A of the EPBC Act.	Section 9.3
Queensland Planning Act approval conditions		
9(a)	Prepare a Bird and Bat Management Plan (BBMP) certified by a suitably qualified ecologist. The BBMP must include:	Section 1.1
(i)	Identification of 'at risk' bird and bat groups (i.e. all threatened and common species), seasons, and areas within the project site which may attract high levels of mortality	Section 2.2
(ii)	incorporate baseline data, including additional pre-operational surveys;	Section 2
(iii)	the identification of threshold (trigger) levels for species	Section 5.1, 5.2
(iv)	identification of mitigation measures and implementation strategies in order to reduce impacts on bird and bat groups	Section 3, 5
(v)	monitoring requirements	Section 4
(vi)	a decision-making framework, including the trigger for operational shut-down	Section 5
9(b)	Submit the BBMP to Department of State Development, Manufacturing, Infrastructure and Planning (windfarms@dsdmip.qld.gov.au).	Section 1.1
9(c)	Operate the development in accordance with the BBMP	n/a

1.4. BBMP objectives and commitments

The primary objective of this BBMP (as per conditions of approval) is to ensure the protection of EPBC Act listed threatened bird and bat species.

The EPBC Act approval (definitions) define EPBC Act listed threatened bird and bat species as:

- White-throated Needletail (*Hirundapus caudacutus*);
- Rainbow Bee-eater (*Merops ornatus*);
- Rufous Fantail (*Rhipidura rufifrons*);
- Fork-tailed Swift (*Apus pacificus*);
- Satin Flycatcher (*Myiagra cyanoleuca*);
- Red Goshawk (*Erythrotriorchis radiates*); and
- Corben's Long-eared Bat (*Nyctophilus corbeni*).

It is noted that Rainbow Bee-eater is not listed as threatened anymore but listed as a marine species under the EPBC Act.

The implementation of this plan will identify impacts of the operation of wind farm on bird and bat species of concern, including common species potentially vulnerable to collision or disturbance impacts based on experience at other wind farms in Australia (e.g., raptors), as well as key listed threatened and migratory species.

This will be achieved through the following actions:

- monitor and mitigate the wind farm's impacts on bird and bat species;
- identify if significant impacts are happening to the seven EPBC Act listed bird and bat species listed in Part C of the EPBC Act approval; and
- outline a strategy for managing and mitigating any significant impacts on these species during the operation of the Project.

This BBMP will be implemented when Phase 1 of the wind farm commences commissioning.

The aim of this BBMP will be achieved by establishing monitoring and management procedures consistent with the methods outlined by the Australian Wind Energy Association (AusWEA 2005) and endorsed in the Clean Energy Council's Best Practice Guidelines for Implementation of Wind Energy Projects in Australia (CEC 2018). The Queensland State Code 23 – Wind Farm Development (Department of State Development, Infrastructure, Local Government and Planning 2022), has also been considered in development of this Plan.

The specific objectives of this BBMP, derived from the conditions of approval, are set out in the following Table 2.

Table 2: Objectives of BBMP and commitments to achieve objectives

Objective	Commitment to achieve objective	BBMP reference
Ensure the protection of EPBC Act listed threatened bird and bat species.	This will be achieved through the actions listed below in this table.	Sections 2.2 (p.13), 3 (p.17), 5 (p.35) and 7 (p.50)
To implement a monitoring program to estimate the impact of the Project on the seven at-risk birds and/or bats that can reasonably be attributed to the operation of the Project	Carcass monitoring will be implemented in accordance with the carcass monitoring program outlined in this plan.	Section 4 (p.19)
To directly record impacts on birds and bats through a statistically-based program of carcass searches	The carcass monitoring program has been designed to be used in accordance with the statistical analysis outlined in Appendix 2 to estimate annual mortality rates for birds and bats of this wind farm.	Section 4.3 (p.19), Appendix 2 (p.66)
To document a decision-making framework that identifies *impact triggers* requiring a management response	Impact triggers have been defined for both threatened and non-threatened species, along with a decision-making framework.	Section 5 (p.35)

Objective	Commitment to achieve objective	BBMP reference
To detail mitigation measures and related management strategies to be implemented in response to impact triggers occurring	Mitigation and management measures have been defined as ongoing management actions and in response to impact triggers.	Section 3 (p.17), 5 (p.35)
To identify matters to be addressed in periodic reports on the outcomes of monitoring, the application of the decision-making framework, mitigation measures implemented and their success	Annual reports will be prepared and provided to DESI and DCCEEW. In case of incidents, an incident notification and a report of corrective actions and mitigation measures will be prepared.	Section 9 (p.57)

This plan adopts an adaptive management approach. Therefore, management measures set out in this BBMP will be amended with the approval of the Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW) to ensure effective mitigation is implemented in response to the findings of monitoring, new information, and/or the latest best practices. A suitably qualified ecologist will design any amended monitoring, as well as train personnel undertaking the monitoring program, analyse and interpret data, formulate adaptive management measures, and prepare reports.

1.5. Consultation during preparation of this BBMP

Extensive consultation with DCCEEW (formerly DoEE) has been undertaken during the preparation of this BBMP including a face-to-face workshop in Canberra in November 2019 and a meeting held in December 2023 and follow up discussions with key personnel of the Department. This version of the BBMP is based on detailed feedback from DCCEEW that has been addressed in this report including separate discussions and response tables prepared between 2019 and 2024.

1.6. Approval and publication of this BBMP

Condition 23 of the EPBC Act approval requires this plan to be submitted electronically to the Department for approval by the Minister.

Within 20 business days of this plan being approved by the Minister, this BBMP will be published on the approval holder's website.

As required, sensitive ecological data will be excluded or redacted from the BBMP published on the website, as well as from any plan that is provided to any member of the public. The BBMP will remain published on the website until the end date of the EPBC Act approval.

2. Existing environment

2.1. Site description

The project is located approximately 80 kilometres west of Marlborough, 76 kilometres east of Middlemount, 150 kilometres south-west of Mackay and 150 kilometres north-west of Rockhampton. It falls within the Isaac Regional Council and Livingstone Council areas in Queensland (Figure 1). The Project site covers approximately 76,300 hectares, consisting of eleven rural land tenures (predominantly used for cattle grazing bordered by the Marlborough-Sarina Highway to the west. Phase 1 includes two stages in the southern part of the project comprising 100 turbines and phase two includes a third stage to the north with 95 turbines. Figure 2 provides an overview of Project Area, Phases, and location of turbines within Phase 1.

The Project site lies within the Great Dividing Range in the Eastern Darling Downs province of the Brigalow Belt Bioregion, dominated by eucalypt woodlands and *Acacia* forest. Much of the low-lying areas within the Project site have been cleared for low to moderate intensity grazing which now occurs over mixed native and exotic pastures. Several ridgelines occur in the Project site, running in a northwest to northerly direction, ranging in height from 200m AHD to 550m AHD. Remnant vegetation and regrowth also occurs over the Project site, predominantly along upper hills and ridges, as well as along some drainage systems.

Fauna habitat has been identified across the Project site as five broad types: fringing riparian woodland, vine thickets, eucalypt woodland/open forest, non-eucalypt open forest and non-remnant open grassland pasture. These range in quality from poor to very good/excellent (NGH Environmental 2017) and support typical avifauna for this part of Queensland, potentially along with several threatened species. Some of these areas provided tree hollows, dense canopy and dense undergrowth. Habitat quality for birds and bats is poor in the largely cleared parts of the Project site, and fair to excellent in the areas of remnant native vegetation on the Project site (NGH Environmental 2017).

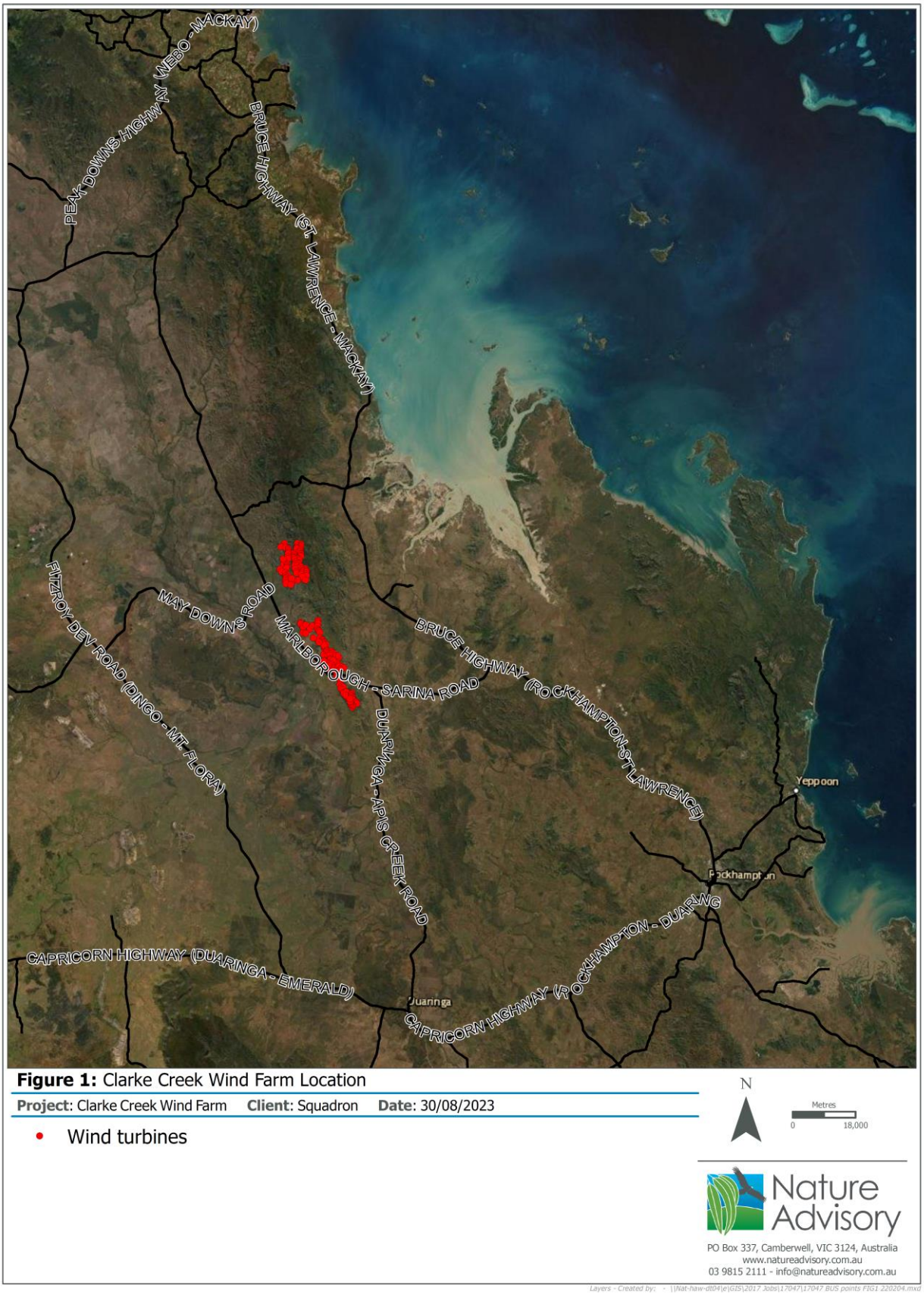


Figure 1: Regional Location of Clarke Creek Wind Farm

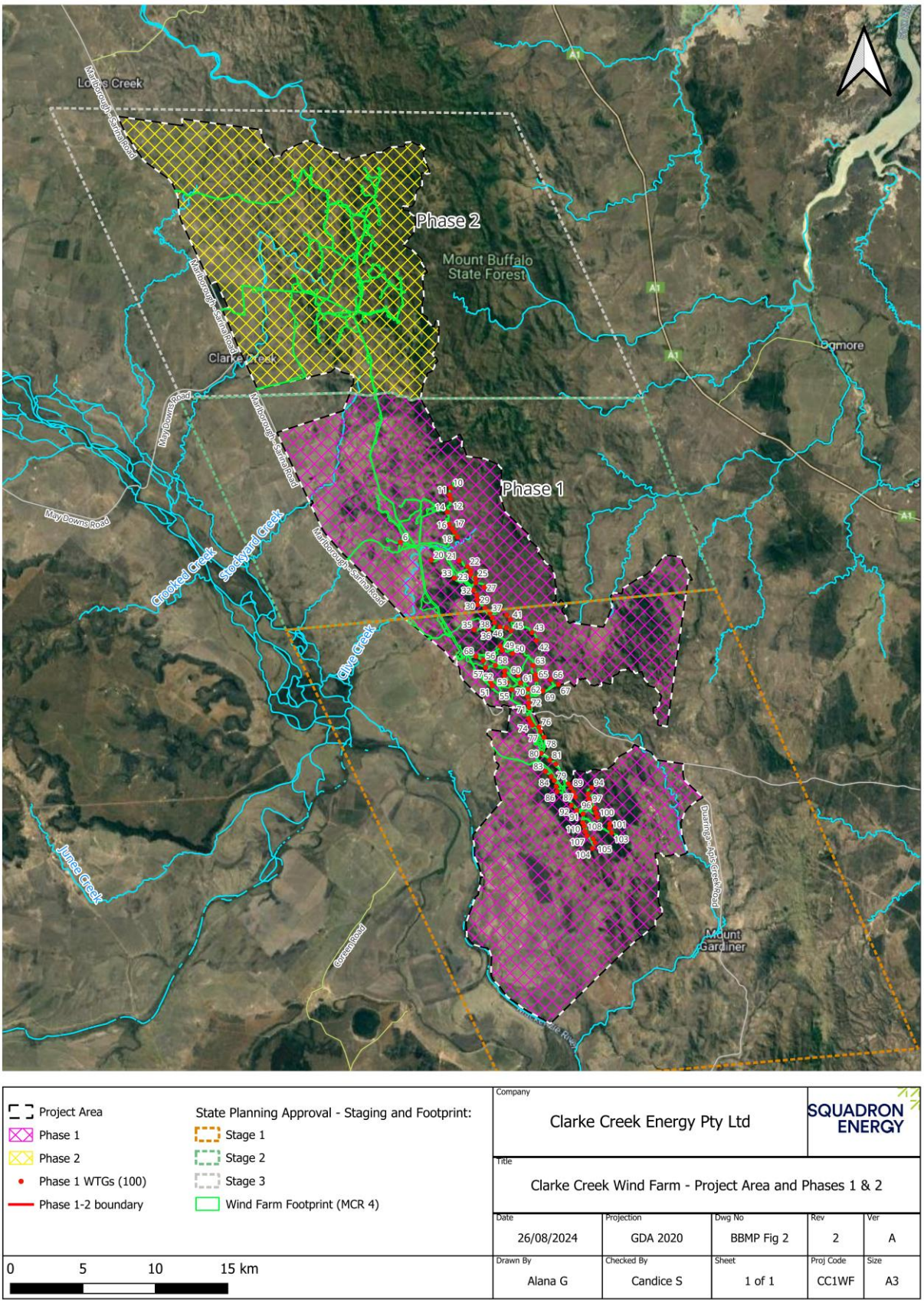


Figure 2: Layout of Clarke Creek Wind Farm showing the different stages and phases

2.2. Status of relevant EPBC Act listed threatened bird and bat species on the site

Pre-construction Bird Utilisation Surveys (BUS) were undertaken in March and September 2017 and in April and October 2020 (Nature Advisory 2021). Bat surveys were also carried out in 2017 (NGH Environmental 2017).

This section summarises the surveys results for the seven EPBC Act listed bird and bat species listed in the EPBC Act approval for this project that have the potential to occur and could be at risk from the project to be addressed in this BBMP:

- White-throated Needletail (*Hirundapus caudacutus*) – Vulnerable and Migratory
- Rainbow Bee-eater (*Merops ornatus*) – Marine (previously Migratory)
- Rufous Fantail (*Rhipidura rufifrons*) - Migratory
- Fork-tailed Swift (*Apus pacificus*) - Migratory
- Satin Flycatcher (*Myiagra cynoleuca*) - Migratory
- Red Goshawk (*Erythrotriorchis radiatus*) - Vulnerable
- Corben's Long-eared Bat (*Nyctophilus corbeni*) – Vulnerable

More detail is provided below but to summarise, the two years of BUS undertaken in 2017 and 2020 covered the periods during which these species move through or use the region and provide therefore a valid understanding of occurrence and baseline for future monitoring. Findings on their occurrence on the site from these surveys are provided below.

The feasibility of collision risk modelling (CRM) for each species is also considered. Given the following consideration of the regularity of occurrence of EPBC Act listed threatened and migratory bird and bat species on the project site, the requirements of DCCEEW for a CRM are likely to be feasible in part only for the White-throated Needletail and Rainbow Bee-eater, the listed species that have been recorded on the site and its surrounds and are at risk of collision.

2.2.1. White-throated Needletail (Hirundapus caudacutus)

The White-throated Needletail is listed as "Special Least Concern" under Queensland's *Nature Conservation Act 1992* (NC Act), and Vulnerable (Migratory) under the EPBC Act. Its global population size is estimated at 41,000 mature individuals (Garnett and Baker 2021). Individuals migrating during the non-breeding season and wintering in eastern Australia from August through April are known to breed from Siberia and Mongolia down to Japan (Chantler and Kirwan 2020). The species arrives to northern Australia during September to October (sometimes as late as December), with a mean date of the first sighting on 22nd of October (±27.62 days) (Higgins 1999). In Queensland and New South Wales, arrivals occur from October to November, with more frequent sightings from December to March (and some in April) as they return to their northern breeding grounds (SPRAT 2024).

No White-throated Needletails were recorded during the formal BUS in March and September 2017 and April 2020. In October 2020, 121 individuals were observed with 66 individuals flying at or above Rotor swept area (52m-210m) (RSA) height. Incidental sightings totalling over 50 individuals were recorded at or above RSA height across the Project site during the surveys.

The White-throated Needletail is unique in being an almost exclusively aerial forager, flying at a range of heights up to a kilometre or more in search of airborne insects. Flocks often dwell in the wind shear zone ahead of storms where airborne insects are concentrated.

Their occurrence is sporadic and numbers vary greatly, with flocks ranging from several birds to several hundred birds. White-throated Needletail is distributed widely over Eastern and Northern Australia between late Spring and early Autumn. Mapping flight paths of this species do not provide reliable information on the location of flyways. As they are very fast flyers and cover a lot of ground in a short time, they are equally likely to fly over any part of the landscape when in the area.

It is recommended that targeted surveys be undertaken between November and April when the species is most likely to be detected in larger numbers, as most birds are expected to have already arrived in Queensland and moving around. After completion of these surveys, CRM for the White-throated Needletail will be completed. The result of the CRM will be used to update the risk rating of turbines where the species has been observed. The BBMP is adaptive for the life of Phase 1, and as such if utilisation rates increase and/or carcasses are found during the operational period of Phase 1, turbine risk ratings will be reviewed and updated accordingly.

2.2.2. Rainbow Bee-eater (Merops ornatus)

The Rainbow Bee-eater was previously considered Migratory under the EPBC Act and is widespread in open woodland areas across Australia. This species forages on flying insects, typically flying to RSA heights to catch prey (Menkhorst *et al*. 2017). Rainbow Bee-eater was recorded regularly at RSA height during BUS at Clarke Creek and is considered at risk of collision with turbines. Due to the widespread distribution of the species, and as its population is considered secure within its range, it is considered unlikely that Rainbow Bee-eater populations are at significant risk from the Project.

It is noted that this species is no longer listed as Migratory under the EPBC Act but is still listed as Marine. As this species was included in the EPBC Act approval, it is included in this plan.

Targeted surveys for White-throated Needletail undertaken between November and April will also inform the presence and utilisation rate for Rainbow Bee-eater. After completion of these surveys, CRM for the Rainbow Bee-eater will be completed and the result used to update the risk rating of turbines where the species is at highest risk.

2.2.3. Rufous Fantail (Rhipidura rufifrons)

Rufous Fantail is listed as Migratory under the EPBC Act and typically inhabits low- to mid-storey dense vegetation in forests and vine thickets in Eastern Australia. This species is strongly migratory, overwintering in the north of Australia and New Guinea, and is largely absent from sub-tropical/temperate regions between May and September (Menkhorst *et al*. 2017).

This species migrates through Queensland to south-east Australia mainly from October to November and leaves in March/April (Species Profile, DCCEEW) so the BUS were undertaken at the appropriate time for detecting it. Rufous Fantail was observed during formal BUS in October 2020 with four individuals below RSA height due to its understory habitat preference. Given suitable habitat occurs mostly in gullies on the site and the species is unlikely to flight at RSA heights, no turbines in the project are considered to be high risk for this species and a CRM would not be required.

2.2.4. Fork-tailed Swift (Apus pacificus)

Fork-tailed Swift is listed as Migratory under the EPBC Act and mainly prefers open forest or plains. It is almost exclusively aerial and feeds up to hundreds of metres above the ground but can feed among open forest canopies. The species breeds internationally and seldom roosts in trees (Higgins *et al* 2006). This species arrives in Australia around October and leaves in April (Species Profile, DCCEEW) so the BUS occurred when it is present in the area. It has not been observed during any BUS in 2017 or 2020 and also not incidentally at the Project site but could be at risk colliding with turbines due to its aerial behaviour when it occasionally appears in the area.

As they are very fast flyers and cover a lot of ground in a short time, they are equally likely to fly over any part of the landscape when in the area. Targeted surveys for White-throated Needletail undertaken between November and April will also inform the presence and utilisation rate for Fork-tailed Swift. Since the species has not been observed at the site during two years of BUS surveys, it is considered unlikely that it occurs at the site in sufficient numbers to justify the preparation of a collision risk model for this species. In the case it is observed on site in sufficient numbers, a CRM will be prepared and the risk rating of turbines updated.

2.2.5. Satin Flycatcher (Myiagra cynoleuca)

The Satin Flycatcher occurs over wide areas of forests in Eastern Australia. This species is listed as Migratory under the EPBC Act. It migrates across cleared ground between remnant treed vegetation and tends to move within treed habitats below the RSA. This species moves through Queensland south from late August to November and then north again between February and April (Species Profile, DCCEEW). Some winter in northern Queensland. The BUS were timed appropriately for this species. Two individuals of this species were observed during the BUS in April 2020 and six in October 2020, all below RSA height. Small numbers of individuals may migrate through the site and only a small proportion of these have the potential to collide with turbines if they were to fly occasionally above tree height within RSA height where a turbine is operating. For these reasons, the preparation of a CRM will not be required for this species.

2.2.6. Red Goshawk (Erythrotriorchis radiatus)

The Red Goshawk is listed as Vulnerable under the EPBC Act. Its range covers a large area, from the central coast of New South Wales to the northern coast of Australia (DoEE 2019). The Red Goshawk occurs in coastal and sub-coastal areas in wooded and forested lands of tropical and warm-temperate Australia. It prefers forest and woodland with a mosaic of vegetation types, large prey populations (birds), and permanent water. The vegetation types include eucalypt woodland, open forest, tall open forest, gallery rainforest, swamp sclerophyll forest, and rainforest margins. (Marchant & Higgins 1993). The EPBC survey guidelines do not recommend specific timing for surveys of the Red Goshawk (Survey Guidelines for Australia's threatened birds, DEWHA 2010). Breeding season in northern Australia is from July to December and thus the surveys in April and October would have covered breeding and non-breeding season.

No Red Goshawk were observed during the BUS in 2017 and 2020 at the Project site or incidentally. Given the lack of permanent water and suitable areas for nesting, it is unlikely that the species occurs within the habitat in the wind farm site. Because of the extremely low density of the regional population, and lack of confirmed records in or close to the wind farm, Red Goshawk is considered at minimal risk from the Project. Given this, it is highly unlikely that data could be collected from the site that would inform a collision risk model and this is considered neither feasible nor warranted.

2.2.7. Corben's Long-eared Bat (*Nyctophilus corbeni*)

Corben's Long-eared Bat is listed as vulnerable under the EPBC Act. In Queensland, the preferred habitat of Corben's Long-eared Bat is eucalypt woodland, although it has also been recorded from rainforest with hoop pines in the Bunya Mountains, and in semi evergreen vine thickets on the banks of the Dawson River. It is most abundant in vegetation with a distinct canopy and a dense cluttered shrub layer. Corben's Long-eared Bat is thought to roost solitarily under the loose bark, and in the crevices and hollows of trees (DEHP 2017). It has been possibly detected during surveys by NGH Environmental in 2017. This species was recorded only as *Nyctophillus* spp. as the calls are difficult to distinguish accurately from other (least concern) *Nyctophillus* species but has been included as *Nyctophilus corbeni* as a precautionary measure. *Nyctophilus* bats have broad and rounded wings adapted for low-level foraging within vegetation —below the canopy— using slow, manoeuvrable flight (Churchill 2008, Baker & Gynther 2023). Considering their widespread but low-density distribution and their behaviour not to fly at rotor swept area height, wind farm operations are likely to pose a low risk to *Nyctophilus corbeni*. Therefore, the preparation of a CRM will not be required for this species.

3. Environmental management & mitigation measures

Mitigation involves the prevention, avoidance and/or reduction of the risk of an *impact trigger* occurring or continuing to occur. An *impact trigger* is defined in Section 4.3 as a threshold of impact on birds or bats that triggers an investigation and mitigation measures. This Section outlines such measures.

The overall objective of mitigation measures is to minimise impacts on EPBC Act listed threatened bird and bat species and to ensure that the operation of the Project does not lead to significant impacts on threatened or protected birds and bats. Any future novel or new mitigation measures that are identified to be of potential benefit for birds and bats at the Project site subsequent to trigger event investigations will be incorporated into the BBMP as part of an adaptive management approach. Major revisions to the BBMP will be communicated to DSDI and any variation to the BBMP will be applied for to the Minister in accordance with Section 143A of the EPBC Act.

3.1. Carrion removal program and stock forage control

Land-use and stock management below and around turbines can influence the presence and behaviour of native birds on site. Examples that could elevate bird collision rates include:

- Carrion can attract raptors; and
- Grain feeding of stock can attract parrots and cockatoos.

Mitigation measures to address these matters are proposed below.

Raptors forage for carrion (the fresh or decaying flesh of a dead animal) and also on small mammals and rabbits. To reduce the risk of raptors colliding with turbine blades, a carrion removal protocol will be implemented monthly from the start of the commissioning process, to reduce the attractiveness of the Project site to raptors and therefore reduce the potential for fatal collisions by this group of birds. This protocol will focus on areas within 200m around turbines.

The procedures below will be adopted for the Project.

- A designated suitable person will be appointed (such as the site manager) to perform the function of Carrion Removal Coordinator, who will ensure the activities described below:
    - Educate project staff and landowners to report any stock, introduced or native mammal within 200m of any turbine that may attract raptors;
    - Any carcasses and/or remains found that are within 200m of turbines, will be collected and disposed or relocated as soon as practicable, in a manner that will avoid attracting raptors close to turbines in consultation with the landowner;
    - Construction and Operations personnel will be required to notify the Carrion Removal Coordinator immediately following identification of carrion on site; and
    - Carcasses will be recorded in a dedicated carrion removal register maintained by the Carrion Removal Coordinator.
- Feral animal control on the Project site will involve removal or relocation of resulting carcasses located within 200m of a turbine as soon as practicable.

- An annual summary of carcass removal based on the Project's 'dedicated carcass removal register' will be provided in the annual reports.

3.2. Bat deterrents

Ultrasonic acoustic deterrents alone are to date generally a relatively poorly effective mitigation measure to reduce bat collisions (Arnett *et al.* 2013, Romano *et al*. 2019, Cooper *et al*. 2020), compared to others (e.g., curtailment). This is based on the fact that sources emitting ultrasonic sounds to deter bats or insects are limited to reach beyond the length of turbine blades if installed at the turbine tower.

More intensive research and advances in technology will be required to make this methodology an effective mitigation measure to deter bats from approaching wind turbines. So far, effectiveness can be increased by extending the ultrasonic coverage to the entire swept area of the turbine blades or applied acoustic deterrents in combination with other mitigation measures (Good *et al.* 2022).

3.3. Low wind speed cut-in

Low wind-speed curtailment is a well-known effective approach to mitigate bat mortality at wind farms around the world (Arnett *et al*. 2016, Wellig *et al.* 2018, Whitby *et al.* 2021, Lloyd *et al*. 2023), including Australia (Bennett *et al*. 2022). This method involves modifying nighttime turbine operations during periods of elevated bat risk (Arnett *et al*. 2011), and increasing turbine cut-in speed is known to reduce bat fatalities as bats tend to be less active at higher wind speeds (Baerwald *et al*. 2009, Arnett *et al*. 2011).

Given that the one threatened bat species at risk from CCWF, Corben's Long-eared Bat, has only been recorded as part of a call complex once in 2017 and is unlikely to fly at RSA height due to its typical behaviour, a general low wind speed cut-in will not be required at CCWF. This method is however considered as a trigger response should a threatened bat species be found underneath a turbine.

3.4. Lighting on turbines and buildings

Clarke Creek Wind Farm will have the following lighting:

- 70% of Turbines require steady red low intensity (minimum 100 candela) aviation lighting (required by the Civil Aviation Safety Authority in accordance with a Lighting Plan) with the remaining turbines being unlit.
- The electrical substations and buildings, such as the site office and maintenance sheds (see Figure 2) will have low level security lighting, which will be activated by light sensors and motion detectors.

Building lighting will be baffled and directed to avoid excessive light spillage and security lighting will be baffled to direct it towards the area requiring lighting and not skyward or laterally beyond the area required to be lit.

3.5. Pest animal control

The Project Biodiversity Management Plan includes pest animal monitoring and control.

4. Adaptive management and monitoring program

4.1. Operational Bird Utilisation Surveys

The pre-construction BUS will be replicated for a minimum of two years once Phase 1 of the wind farm is fully commissioned, with seasonal monitoring during the wet and dry season to replicate the initial (pre-construction) surveys of Phase 1. These surveys will seek to demonstrate whether the site continues to be utilised by the range of species identified in the pre-construction surveys and whether any turbines pose a particular risk to threatened species. Data from the BUS during the operational period of the wind farm will be used to identify potentially higher risk turbines or groups of turbines at Phase 1 where threatened species show risk behaviour (see Section 4.6).

4.2. Targeted surveys for White-throated Needletail and other migratory species

The White-throated Needletail nominal subspecies (*Hirundapus c. caudacutus*) is widespread throughout eastern and south-eastern Australia during the Australian summer months. It is a trans-equatorial migrant that breeds in the Northern Hemisphere summer and migrates south to the Southern Hemisphere during the non-breeding season, typically found in eastern Australia during the Southern Hemisphere summer and a few months in advance and after.

Targeted surveys will be undertaken during the first year of full operation of the wind farm to monitor for the presence of the White-throated Needletail and other migratory species of concern (i.e., Fork-tailed Swift, Rainbow Bee-eater) within the area of Clarke Creek Wind Farm. A fixed-point count method will be used, which requires an observer to be stationed at 10 fixed-point locations within the study area for a period of 45 minutes. During this period all White-throated Needletails and other migratory species observed will be recorded. If White-throated Needletails or other migratory birds are observed, the number, the approximate height when first sighted, flight height range and direction of flights will be documented.

Six monthly targeted surveys will be undertaken during a period between November and April of the first year of full operation. 40-minutes fixed-point counts will be used to collect spatial utilisation data and each of the points will be surveyed four times at different times of day (e.g., early morning, late morning, early afternoon, and late afternoon).

The data obtained from these surveys will be used to run a CRM on these species in order to ascertain any turbines that are high risk for these species. However, it is expected that data collected on some other migratory species may not be sufficient as these are rarely observed.

If the first year of observations does not provide sufficient information for the White-throated Needletail to run the CRM, then a second year of targeted surveys will be required. If after two years observations of are too low to run a CRM that will inform identifying high-risk turbines, targeted surveys for CRM may be discontinued. However, insufficient data within this timeframe does not necessarily mean that the site poses no risk to the species. Thus, injured or dead individuals will always be reported for the life of the approval and mitigation actions will be put in place as required.

4.3. Carcass monitoring

4.3.1. Purpose of carcass monitoring

Ongoing monitoring of mortality from blade strike at operating wind farms typically serves to (i) provide data that can inform adaptive management of the collision risk (i.e., patterns of mortality related to

seasonal changes or local conditions), and (ii) detect and estimate general mortality of threatened and non-threatened bird and bat species for the wind farm site, which can be used to understand actual bird and bat impacts. Recorded mortality during carcass searches of a threatened listed species indicates a higher risk of the turbines where the carcass has been found. These turbines will be included in future carcass searches (see Section 4.6).

Implementation of bird and bat monitoring programs in Australia is still developing (since 1998), and the techniques described here are based on lessons from several such programs already implemented (e.g., Hull *et al*. 2013), knowledge of experimental design and statistical analysis, and recent feedback from the regulatory authorities.

4.3.2. Description of 'mortality'

Mortality is defined as any dead bird or bat detected within the specified search radius. Detection can be either during the formal carcass searches (designed to generate an estimate in accordance with a statistically rigorous sampling design) or at other times (incidental observation, often by Operational staff). A protocol is triggered whenever a carcass is found, either within the formal searches or incidentally to collect consistent and useful data on the fatality event (see below).

It will be conservatively assumed that any dead bird or bat, or bird feather spot (defined as a clump of five feathers or more), detected beneath an operating turbine has died because of collision with turbine blades, unless there are obvious signs of another cause of death. Feather spots will be assumed to be remains of a bird carcass after scavenging and the scavenger correction factor will not be applied to them (see Section 4.4.9).

4.4. Carcass monitoring program – CCWF Phase 1

4.4.1. Overview of approach

The carcass monitoring program for CCWF Phase 1 will be implemented in a progressive manner. Phase 1 will comprise 13 Sections, with 7 or 8 turbines per section. Turbines will be allocated to particular Sections generally depending on their completion status. A Section may be comprised of turbines from different Collector Groups. The phases are summarised as follows:

1. **Incidental carcass detection program** (refer to Section 4.4.2);
2. **Interim carcass search program** – to be implemented progressively across the Wind Farm Sections (refer to Section 4.4.3);
3. **Full carcass search program** – to be implemented after all turbines across Wind Farm Sections in phase 1 are able to operate and export electricity simultaneously (full operation). This program will run for a period of at least two years (refer to Section 4.4.4 for more details); and
4. **Long-term carcass detection/search program** – to be implemented after the full carcass search program (refer to Section 4.4.5).

The progressive approach has been developed with consideration to:

- The inherently high-risk construction activities that will be taking place during turbine installation and commissioning activities, and requirements to maintain safe work areas and exclusion zones;
- The need for a practical monitoring program that provides clear and well-defined milestones for progressive implementation of carcass search program across the various Wind Turbine Sections of CCWF Phase 1; and

- The need to ensure that statistically robust results are generated from the full carcass search program, which will run once the unrestricted full operation of all turbines of Phase 1 at CCWF has commenced.

  After the first two years of full monitoring, a data-driven request regarding incidental carcass and long-term monitoring for the life of the wind farm operations will be submitted in a revised monitoring plan for approval by the Minister for Climate Change and Energy (see Section 4.4.5 for details).

4.4.2. Incidental carcass detection program

It is acknowledged that during the construction period of the CCWF Phase 1, once turbine components are installed but not operating, a risk to avifauna exists. While the chances of collision with stationary structures are minimal in comparison to wind turbines that are operating and generating electricity, we still consider it a risk that should not be ignored. During this time:

- There will be increased worker activity on and around turbine hardstands and surrounding areas as construction and commissioning activities are occurring.
- Incidental carcass detection will be conducted by CCEPL's personnel and contractors who are approved to work within the construction exclusion zones that will exist around the hardstands.
- Any carcasses detected during this period will be recorded in accordance with the incidental finds protocol at Section 4.5. Awareness training will be provided to the CCEPL and contractor teams to ensure that protocol can be implemented effectively.
- The incidental carcass detection will continue as the primary carcass detection method, until interim carcass search program is progressively rolled-out across the 13 Wind Farm Sections, as described in Section 4.4.3.
- The incidental carcass detection is a core element of the BBMP to ensure impacted birds and bats can be recorded prior to progressive implementation of the interim carcass search program, despite the site still being limited by construction activities and exclusion zones.

Note: Incidental carcass detection will remain a key element of bird and bat monitoring throughout the construction, commissioning, operation, and full operation of turbines at CCWF Phase 1.

4.4.3. Interim carcass search program

It is acknowledged that there is an elevated risk of bird and bat strikes once turbine components have been completely installed, and once the turbines are generating electricity during their regular operation. Since not all the Phase 1 wind turbines will commence operation simultaneously, but rather

this will occur progressively[1] across wind farm Sections[2], an interim carcass search program will be implemented, as follows:

- Once all turbines in any two wind farm Sections have passed their reliability test[3], the interim carcass search program will be implemented at turbines within those wind farm Sections.
- The interim searches will be conducted at turbines which have passed the reliability test, and which have been randomly selected in accordance with the strata selection (i.e., the 25% component, per Section 4.4.8).
- If the randomly selected turbine has not operated in the previous month since the previous search, the interim carcass search will not be undertaken at that turbine.
- To ensure an adequate level of searcher safety, interim searches will only be undertaken at turbines where there is no safety exclusion zone in place.
- The interim carcass search program will be progressively extended to the remaining 11 wind farm Sections, after all turbines in each Section have completed their reliability test.

While these interim searches are not part of the full carcass search program, it is a core element of the BBMP to ensure impacted birds and bats can be recorded prior to commencement of the full carcass search program.

4.4.4. Full carcass search program

The full carcass search program will commence within one month of the commencement of full operation (i.e. once all wind turbines have been commissioned and are able to operate simultaneously after the final Hold Point test has been passed).

The full carcass search program will run for a minimum period of two years after which the possibility of changes to the intensity and protocols for further long-term carcass search monitoring will be evaluated. This will ensure statistically useable and robust results are generated from the carcass monitoring program that include an estimate of both bird and bat mortality rates, together with an estimate of sampling precision. A statistical review of this monitoring program is provided in Appendix 2.

Several factors, such as carcass scavenging and carcass detectability, can affect mortality rate estimates and must be measured and included in any estimate of overall mortality rates. Scavenger

[1] Energization and operation of wind turbines will be undertaken in a progressive manner, consistent with 'hold point testing' requirements agreed with AEMO. During turbine commissioning, there are restrictions on the number of turbines that may be operated simultaneously and exporting electricity to the grid. That number is gradually increased after each hold point test is passed, until the final hold point test has been passed and all turbines are able to operate and export electricity simultaneously (full operation). It is noted that due to the nature of 'hold point testing', some turbines may be periodically turned off for undefined periods of time to ensure compliance with testing restrictions whilst testing of other turbines takes place.

[2] Turbines across the CCWF Phase 1 will be completed and handed over in 'Sections' (these are yet to be defined). Phase 1 will comprise 13 Sections, with 7 or 8 turbines per section. Turbines will be allocated to particular Sections generally depending on their completion status. A Section may be comprised of turbines from different Collector Groups.

[3] Each individual turbine must undergo and pass a 'reliability test', which takes an average of 168 hours per turbine and requires the completed turbine to operate consistently for the defined period of time, without interruption or error. Only after the reliability test is passed, can the completed turbine be allowed to operate in any regular ongoing manner.

trials will be conducted in accordance with Section 4.4.9, and detectability trials will be conducted in accordance with Section 4.4.10.

Human (or canine) detectability of carcasses is also a potential confounding variable and protocols have been developed to control this factor in the final mortality estimates. Section 4.4.6 provides more detail on this issue.

The practical considerations that have informed the design of the full carcass search program and associated trials are listed below.

- Carcasses of a suitable range of sizes for scavenger and detectability trials are difficult to source and usually involve a combination of carcasses found under operating turbines and those found along roads and other legal sources. Note that it is illegal to source un-cleaned carcasses from poultry producers.
- Annual scavenger and detectability correction factors will be generated and applied to estimate mortality rates (see Appendix 2), as there is no evidence in the literature for significant (or detectable) seasonal differences in scavenger activity for Australian wind farm sites (Symbolix 2020). However, scavenger and detectability trials will be undertaken in each season (dry and wet season). This precautionary sampling design is intended to capture seasonal variability, ensuring accurate and more truly reflective annual mortality estimates.
- It is probable that detectability will be higher in short grass at the dry time of the year compared with in longer grass at the wet time of the year, and detectability trials will be scheduled accordingly to capture this variability.

After two years of implementing the full carcass search program, a detailed report will be prepared reviewing the mortality detection program and providing recommendations for the future in response to any confirmed issues – see Section 9 for reporting requirements.

This review will inform if further and/or more targeted monitoring of demonstrated threatened species impacts is required. It will also be used to guide the remainder of the bird and bat surveys in the years following commencement of implementation of the BBMP. Any changes to the monitoring effort will be requested under a revised monitoring plan for approval by the Minister for Climate Change and Energy.

4.4.5. Long-term carcass detection/search program

Threatened birds and bats can collide at any time during the life of the wind farm operations. This is a risk that should not be ignored, and therefore, incidental carcass detection will remain in place for the life of the wind farm operations, along with the management actions in response to impact triggers (Section 5).

In addition, after two years of the full carcass search program period, the possibility of changes to the intensity and protocols for further long-term carcass search monitoring will be evaluated and informed by the outcomes of mortality rate estimates. This information will be used to objectively determine whether the wind farm imposes a low, moderate, or high impact risk for any threatened bird or bat species to provide justification for any proposed changes to the monitoring program. A simulation study will also be undertaken as part of the statistical review of the program to form an evidence base decision for changes in sampling effort and protocols. A proposal for further monitoring will be submitted in a revised plan for approval by the Minister, which will be supported by the analysis of the

mortality data from the two-year full monitoring program. Regardless, the full carcass monitoring program will continue until the revised plan is approved by the Minister.

4.4.6. Carcass search protocol

All carcass searches (interim and full search programs) will be undertaken by qualified ecologists or personnel trained in carcass searches and regularly assessed by the supervising ecologist.

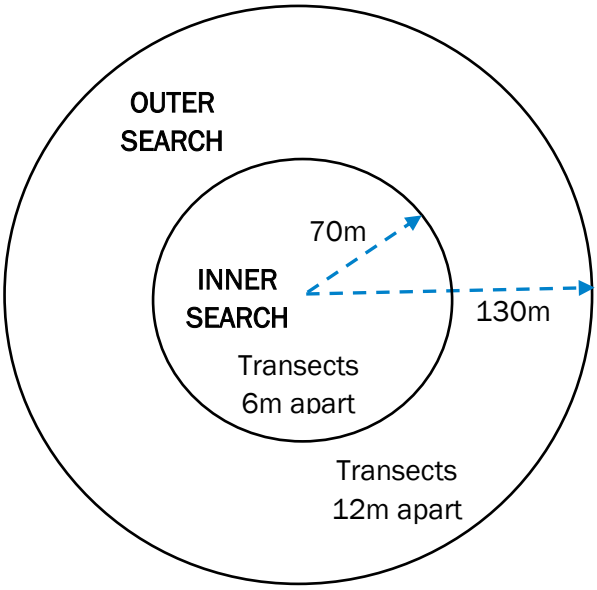
The search area beneath each turbine has been determined as the area to find bat and bird carcasses with turbines of this size (Hull & Muir 2010). Based on applying the Hull and Muir model to the Clarke Creek Wind Farm turbine model, 88% of bat carcasses are expected to be found within 70m of the turbine and 100% within a 130m circular search zone. 99% of medium bird carcasses are expected to be found within the 130m search zone (see Appendix 2). Carcasses of very large birds (Wedge-tailed Eagle) may be found a little further out, but 86% are expected to be within 130m of the turbine.

Given this evidence, inner and outer circular search zones have been designated. The inner zone targets the detection of carcasses of bats and small to medium and large sized birds. In the inner zone, a circle is formed with a 70m radius from the turbine and transects are spaced concentrically every 6m (Figure 3). The outer zone will comprise the zone between the 70m and 130m radius circles. Although they may be recorded in the inner zone, the outer zone will ensure the adequate detection of carcasses of medium to larger sized birds, which can fall further away from turbines. Search transects in the outer zone are spaced at 12m and carried out concentrically from the edge of the inner zone out to the edge of the outer zone.

The defined transect spacing and total search area are considered adequate to detect carcasses of bird and bat species at Clarke Creek Wind Farm (Appendix 2).

All selected turbines once operational will be searched once per month. A second follow-up search, a ‘pulse search’ will be undertaken to 70m once a month within several days of the first search to detect additional mortality of small to medium sized bats and birds. As bat and small bird carcasses persist for a shorter time than larger carcasses, the pulse search ensures the rate at which carcasses strike turbines are more accurately determined. The order of turbines searched will be randomized between searches. Each search and carcasses found will be documented in the form provided at Appendix 1

Figure 3: Inner and outer carcass search zones underneath the turbines



Searching with dogs

Trained dogs could also be used to undertake the carcass searches. However, this will depend upon the availability of trained dogs and dog handlers familiar with the territory and with the appropriate skills to undertake the searches. The suitability of using trained dogs will be determined by the suitably qualified ecologist responsible for overseeing the implementation of this BBMP. A decision on the use of dogs for carcass searches will be informed by the pre-operational monitoring required under the EPBC Act approval. The decision will primarily be based on the availability of trained dogs for the full 24 months of contiguous turbine strike monitoring required. Once a human or canine option is chosen, the method selected will be retained for the duration of the monitoring period.

Although trained dogs can have a better rate of detection, this factor can be corrected for in the searcher efficiency trials outlined below (Section 4.4.10). The landowners may also prefer that dogs not be used at certain times of the year, depending on land use.

If dogs are used for the searches, this will generally involve the dogs working on a transect line from downwind to upwind. The methodology will be detailed in an updated BBMP, should dogs be proposed for use. The method will be based on that described below, adapted as required in response to landholder requirements.

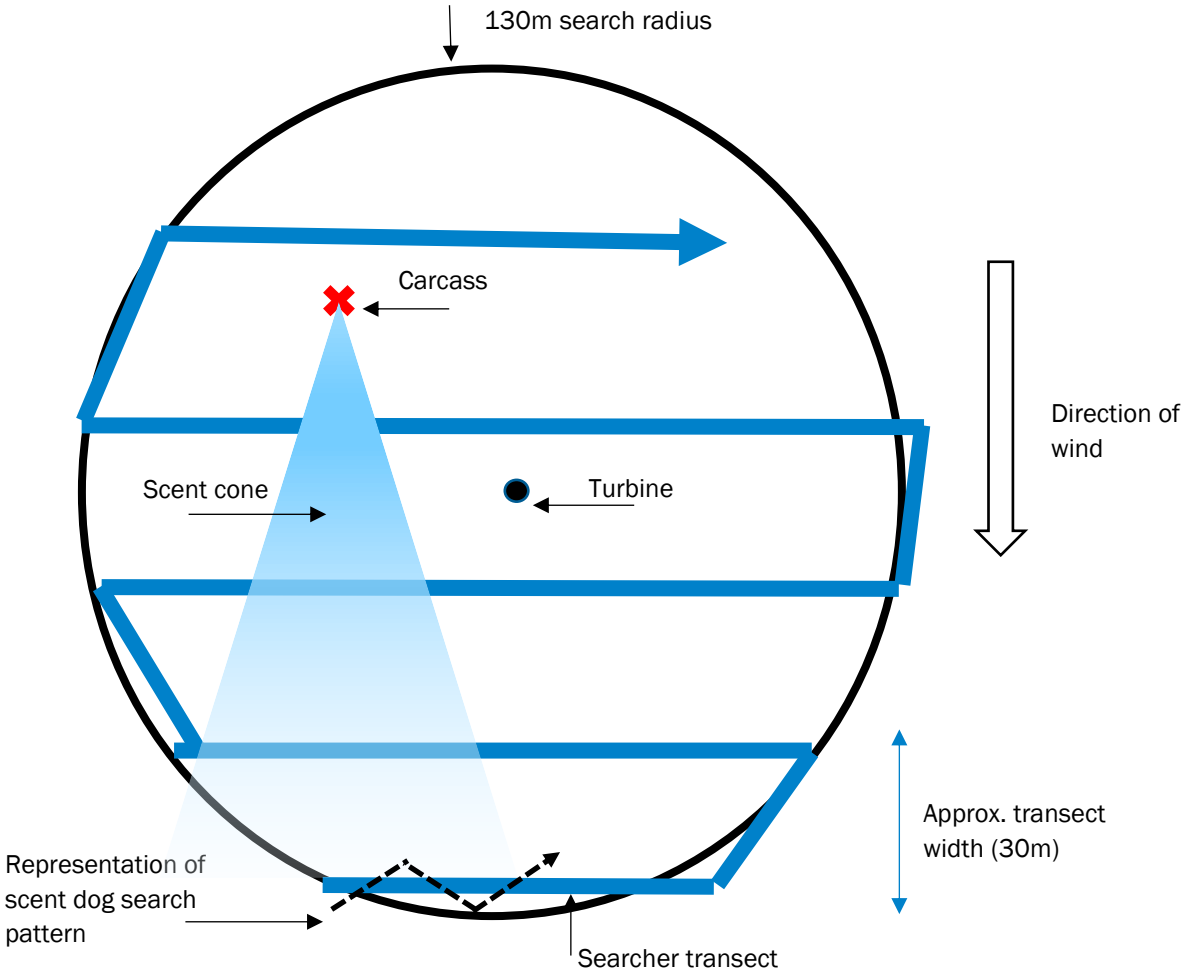
Scent dogs can be trained to locate a variety of targets. The same search area will be targeted out to 130 metres. The dog does not 'look' for carcasses but finds them via scent. Therefore, it does not need to cover as much ground as if it were looking with its eyes. It only needs to cover enough ground to encounter all possible 'scent cones' within the search radius.

The scent cone is the area downwind of the target, in this case a carcass, in which the scent will drift with the wind. So, if the wind is strong; the scent will drift further but in a narrower scent cone, and if the wind is light, the scent cone will be wider but will not drift as far. In the case of strong wind, then transects will need to be narrow to ensure scent cone areas are encountered. Whereas transects of

approximately 30 metres wide will be adequate to cover an area in moderate wind conditions, this will be reduced to 10 or 20 metres in conditions with no wind or strong wind.

The handler will start down wind of the turbine and walk across the direction of the wind allowing the dog to freely zig zag across the searcher's transects, using whistle commands to control how far the dog moves to each side of the transect (i.e., 30 metres). This will ensure all scent cone areas will be encountered (Figure 4). As represented in the Figure 4 the search pattern walking across the wind any carcasses scent cone will be encountered several times, or for a long duration, allowing the dog to easily detect and track down the carcass.

Figure 4: Search pattern for scent dog – across the wind turbine search radius



A GPS collar will be fitted to the dog which will allow the handler to track movements in real time and allow the handler to ensure the entire search area has been effectively covered by the dog. Search areas will be loaded onto GPS prior to commencing searches to allow the handler to see the exact borders of the area and the dog's movements within it. GPS data will be made available to regulators on request.

4.4.7. Carcass find protocol

If a carcass is detected (a 'find') the following variables will be recorded in the Carcass Search Data Sheet (see Appendix 1):

- Position of carcass in relation to the turbine i.e. distance in metres and compass bearing of the carcass from the base of the turbine;
- Substrate and vegetation;
- Species, age, number, sex (if possible), signs of injury and estimated date of strike;
- Weather (including recent extreme weather events, if any), visibility, maintenance of the turbine and any other factors that may affect carcass discovery; and
- If the species is not able to be immediately identified (e.g., an incidental find, and there is not an ecologist on site), photographs must be provided to the qualified ecologist immediately for identification purposes. The ecologist must reply within 2 business days, for the possible reporting of an impact trigger. If carcass identification is not possible, samples will be sent for DNA Analysis.

The carcass will be handled according to standard procedures, as follows:

- The carcass will be removed from the turbine site to avoid re-counting;
- The carcass will be handled by personnel wearing rubber gloves, packed into a plastic bag, wrapped in a sheet of newspaper then placed in a second plastic bag;
- The carcass will be clearly labelled by including a copy of its completed Carcass Search Data Sheet in the second plastic bag to ensure that its origin can be traced later, if required; and
- The double-bagged and wrapped carcass will be transferred to an on-site freezer (at the Project site office) for storage. The carcass will be available for a second opinion on the species identity, if necessary, and for use in scavenger and detectability trials (Sections 4.4.9 and 4.4.10). The freezer will only be used for holding carcasses and not for other uses.

The monitoring program will need to occur under a NC Act authority (Scientific Purposes Permit) and this permit will be obtained before the implementation of this BBMP starts.

4.4.8. Turbine selection

The EPBC Act approval allows a maximum of 195 wind turbines and associated infrastructure on the wind farm site. The development of the project is initiating with Phase 1 comprising 100 wind turbines with a tip height of 210m and a hub height of 130m. These turbines will be progressively constructed over a 6 to 12-month period.

It is proposed that a minimum of 30% (30) of the Phase 1 operating turbines will be searched monthly, comprising a fixed component of 25% (25 turbines searched each month) and a random component of 5% (5 turbines searched irregularly across the wind farm site). The selection of 25 fixed turbines to be included in the Phase 1 search will be made prior to the commencement of the first interim carcass search and they will remain the same for the duration of the two-year full monitoring period to reduce sampling error, enabling a more accurate estimate of bird and bat mortality rates. The additional five turbines will be randomly selected for Phase 1 on a rolling basis for each survey round as a strategy to maximize the chances of identifying threatened species fatalities and high-risk turbines.

Turbine selection for carcass searches does not require stratification from a statistical standpoint because choosing both fixed and unfixed turbines ensures capturing variability and a proportional distribution of samples. Further, the landscape around proposed turbines' locations is largely characterised by treed habitats, vastly dominated by Narrow-leaved Ironbark (*Eucalyptus crebra*) along with other eucalypt species. To a lesser extend it is dominated by Lemon-scented Gum (*Corymbia citriodora*) and Brigalow (*Acacia harpophylla*) (Cumberland Ecology 2017). Given that the habitat structure throughout the turbine layout is identified as woodland or open forest (Cumberland Ecology 2017, Nature Advisory 2021) with cattle grazing as the dominant land use, carcass detectability is not anticipated to vary significantly across the turbine layout and stratification regarding different habitat will not be required.

4.4.9. Scavenger rates and trials

It will be important to ascertain the rate at which carcasses are removed by scavengers. This can be used to develop a 'correction factor' that informs the estimate of the Project's impacts on birds and bats (mortality rate). Scavengers can include ground-based animals, such as foxes and rats (more likely to detect carcasses by scent), as well as aerial scavengers such as birds of prey and ravens (more likely to detect them visually). The scavenger trials described below are designed to ascertain the scavenging rate, usually expressed as the average carcass duration in the field.

An intact carcass will be defined as a carcass that does not appear to have been scavenged by a vertebrate scavenger. A partially eaten carcass will be any skeletal or flesh remains found. Feather and fur spots will be defined by their presence and the absence of any other remains (a feather spot being a cluster of five or more feathers). Intact or partial carcasses and feather/fur spots will be recorded as a 'find'. However, the scavenger correction factor will not be applied to fur and feather spots as these most likely represent the remains of carcasses after they have been scavenged and not to do so would significantly bias mortality estimates upwards.

Scavenger trials will be undertaken twice per year during the first year of full carcass search program implementation. The objective of having two trials is to account for different vegetation conditions, so one will be held when the grass is long and one when the grass is short. The two periods for scavenger trials are shown in Table 3. As explained later, raptor scavenger trials will be undertaken once per year in the dry season due to the likely low availability of carcasses. Should more be available then a second trial will be added.

Each scavenger trial will be undertaken by a trained person as detailed in Section 4.4.9 to determine the rate of loss by scavengers. The search area for scavenger trials will be limited to 70m from the base of the turbine (the inner search zone) and will be located at the previously randomly selected operating turbines that are searched on a regular basis.

Table 3: Timing for scavenger trials

Vegetation condition	Time period
Short grass (raptors only)	Dry season (September/October)
Long grass (no raptors, unless carcasses available)	Wet season (March/April)

To identify potentially different scavenging rates, three categories of carcass will be used (Table 4). Based on current mortality estimation requirements, every endeavour will be made to find all carcasses of each category. Improvements on this method would require an impractical and unlikely

availability of required carcass numbers, and do not lead to a commensurate improvement in the statistical power of estimates (see Appendix 2).

Table 4: Number of replicates for each scavenger trial

Micro-bat or bat proxies (e.g. mice)	Medium sized birds	Large birds (large raptor size)
10	10	10

For each scavenger trial, thirty carcasses in total will be randomly placed under different turbines. This will represent a minimum of 10 carcasses in each size class per trial (two trials per year). The carcasses will be checked daily for the first five days, then every two days for the following four days and then every three days until day 18, followed by every four days until they disappear or at the end of thirty days (see Table 5). On-site personnel will be trained by qualified ecologists and continue this trial beyond the first five to seven days.

Table 5: Scavenger trials search timetable

Day
Day 1
Day 2
Day 3
Day 4
Day 5
Day 7
Day 9
Day 12
Day 15
Day 18
Day 22
Day 26
Day 30

In addition, a second methodology will be trialled at Clarke Creek Wind Farm. This will involve the installation of infrared motion detector cameras within 1-2 metres of the trial carcass. The infrared camera will remain in the field for 5 days when it will be first checked. Then it will be retrieved by day 30 if the carcass still remains. The images will be downloaded and analysed. A potential limitation of this method includes disturbance associated with installation of the camera and creation of perches for birds from the poles holding the camera in place. Thus, this will be a trial and results will be included in the annual reports.

Additional information on scavenger trials is provided below.

- The timing of searches is based on experience and regulatory approval at several other wind farms where scavenger trials have been undertaken that show almost all carcasses have been scavenged within ten days. More frequent monitoring than that proposed herein will not significantly affect the estimated scavenging rate or impact on mortality estimates.

- A mix of carcass sizes (if available) will be obtained for use in the scavenger trials. Where carcasses of a species of concern cannot be found, a similar-sized and coloured substitute (i.e., other carcass type) will be used to reduce bias by visual predators. A list of suitable substitutes is provided in Appendix 4.
- Latex gloves will always be worn while handling carcasses to minimise contact with human scent, which may alter predator responses around carrion and to minimise disease risk to the handler.
- At each trial site, one carcass (or more) will be placed randomly within the 70m search area. Carcasses will be thrown in the air and allowed to land on the ground to simulate at least some of the fall and allow for ruffling of fur or feathers.
- Carcasses used in the trials will have their coordinates recorded to ensure that they are not confused with an actual fatality found under a turbine during the trial searches.
- Notes will be taken on evidence remaining at sites where carcasses have been scavenged (e.g. scavenger scats, bones, feathers, animal parts and type of scavenging if visible, such as tearing, pecking, complete removal of carcass, partial removal of carcass, bird or mammal predator evidence).
- Notes will be taken on the state of remaining carcasses in each search.

Conducting two scavenger trials at seasonally different times is designed to account for occasional seasonal changes in carrion use by some scavenger species. Previous studies have found that Red Foxes are reliant on rabbits and carrion in agricultural and forested areas (e.g., Brunner *et al*. 1975, Catling 1988, Molsher *et al.* 2000). Feral cats show uniform use of carrion throughout the year, whereas fox prey type is dependent on availability (Catling 1988). Catling (1988) found that foxes ate more carrion in winter/spring compared with summer/autumn, when they fed on adult rabbits. However, Molsher *et al*. (2000) found that there was no overall significant difference between seasons for carrion use by foxes. Seasonal differences only occurred in other prey types (not carrion), such as lambs, invertebrates and reptiles, as these are only available at certain times of the year. Given these uncertainties, conducting two scavenger trials at seasonally different times is considered appropriate.

Scavenger trials for large raptors will only be conducted once per year (at different season for each year) due to lack of availability of suitable carcasses for a technically sound trial. Experience from other wind farms indicates a low level of scavenging of these carcases and a high level of detectability that is consistent across the year during all seasons as larger carcasses are easier to find in long vegetation.

The scavenger trial design is a necessary compromise between high numbers of trials and practicality whilst ensuring a statistically valid trial design without altering either the behaviour of scavengers or the number of birds that may collide with turbines. The statistical issues associated with this trial are discussed further in Appendix 2. The second-year report will provide the first estimate based on real, site-specific data, of the precision of the estimates of the various parameters required to estimate mortality rate, including scavenging rate and searcher efficiency (see below).

4.4.10. Detectability (searcher efficiency) trials

The best use of available carcasses is to conduct the detectability trials concurrently with the scavenger trials during the first year of full carcass search program implementation. As humans are reliant on visual cues to determine carcass location, the two seasonal visibility categories of low and high grass cover (dry and wet season) will be compared.

To account for searcher variability in detecting carcasses, only personnel who have carried out monthly searches at the Project site will be involved in the detectability (searcher efficiency) trials. Detection efficiency (percentage of carcasses detected by each searcher) will then be incorporated into later analyses that derive mortality estimates. The number of carcasses to be employed in each trial is detailed in Table 6 and explained below. The carcass controller (a person not involved in monthly carcass searches) will throw each carcass into the air and allow it to land on the ground to simulate at least some of the fall and the potential ruffling of fur and feathers. The carcass controller will note the placement of carcasses (via GPS) and uses a randomiser tool to decide where and how many are deployed under each turbine, within the inner 70m search zone. This protocol aims to avoid bias by preventing the searcher from becoming aware of the trial. However, even if searchers behaviour is affected by an increased number of carcasses during trials, this would not impact mortality rate estimates because searcher efficiency trials and monitoring will be undertaken in the same manner and timeframes.

Table 6: Number of replicates per season for detectability trials

Season	Micro-bat	Medium sized birds	Large birds (large raptor size)
Wet season - Long grass / vegetated	10	10	10
Dry season - Short grass	10	10	10

Analysis of past trials from other wind farms across Victoria (see Appendix 2: Clarke Creek Farm Mortality Monitoring Program - Statistical Design; Section 3.2.4) indicates that there are large confidence intervals on the estimates of searcher efficiency, even for a high number of trials (e.g., ~20% percent of uncertainty in probability of carcass detection around the mean, even with 50 replicates). This means that only relatively large seasonal changes in detection (~20-30% or more) will be resolvable from normal background variation. Sampling will be undertaken during the two periods that represent the greatest change in vegetation cover (therefore visibility). Statistical confidence analysis indicates that this will result in a consistently precise detectability estimate after one year. Statistical issues arising from the practical limitations to which the trial design has responded are discussed in detail in the Appendix 2 abovementioned.

Any substitute carcasses for these trials will be of both similar size, colour and form to the species being represented or species of concern (e.g., brown mice rather than birds should be substituted for bats as birds do not have the same body shape, colour and appearance).

After two seasons of detectability trials the need and frequency of further detectability trials will be reviewed by the suitably qualified ecologist in the second annual report. If deemed necessary because scavenger and detectability trials were unsatisfactory, for example, through low detectability rates, the BBMP will be amended to require the continuation of these trials for the approval of DCCEEW. The ecological expert will provide a report in support of the submission of a revised plan for approval by the Minister after the 2-year period.

4.5. Incidental carcass protocol

Personnel working at the Project site may from time to time find carcasses within the Project site during construction, commissioning, day-to-day operations, and maintenance activities. In this case, the carcass will be handled according to the Carcass Detection Protocol outlined in Section 4.4.7. All Construction and Operation personnel will be made aware of this carcass handling protocol as part of their Site training and induction.

A Carcass Search Data Sheet (Appendix 1) will be completed for each incidental carcass found (whether removed or not).

This Incidental Carcass Protocol is valid for the life of the Project and upon an impact trigger being detected, the adaptive management requirements of this plan will be implemented.

4.6. Risk rating of turbines

Should carcass monitoring, targeted surveys or the results of BUS or carcass searching (see Sections 4.1, 4.2 and 4.3) provide new information on the occurrence of EPBC Act listed threatened and migratory bird and bat species on the site and on the impacts on them of the wind farm, then species-specific approaches to monitoring will be developed within the adaptive management framework described in Section 5. In addition, the risk rating of a turbine will be amended to high-risk if the following applies:

- A threatened bird or bat species carcass was found under or adjacent to this turbine; or
- BUS or targeted surveys revealed an increased activity at or adjacent to this turbine (i.e., more than 10 individuals of a threatened bird species flying at RSA height on more than one occasion indicating a pattern of behaviour).

The high-risk rating of a wind turbine will lead for this turbine to be added to the carcass search effort. A turbine rated as high-risk and that was not previously included in the monthly carcass searches will be initially searched for a period of three consecutive months. If after this investigation, no further fatality events of threatened species occur at that turbine, and the conclusion reached is that a previously fatality was an independent one-off occurrence or that the turbine does not impose a high-risk for threatened species, no future searches will be conducted. Otherwise, this turbine will be searched for the two-year full monitoring period or be incorporated into the long-term monitoring program. Mitigation measures, including shutdowns, if necessary, will be implemented to prevent reaching the threshold of a significant impact on the species population (refer to Table 10). For EPBC Act listed migratory bird species this high-risk rating of turbines only applies during the season, when these species are present in Queensland.

4.7. Estimating total mortality due to collision

The results of the full carcass search program, together with incidental carcass finds, will be detailed in the first annual report. The second annual report will detail the cumulative carcass find results from years 1 and 2 and will include an analysis of search results to provide information on:

- The species, number, age and sex (if possible) of birds and bats being struck by the turbine blades;
- Results of scavenger and detectability trials;
- Separate estimated annual mortality rates for all birds and all bats (and for threatened species with available data), including an estimate of the number of carcasses per turbine per year;

- Any detected spatial or temporal variation in the number of bird and bat strikes; and
- Whether further investigations or mitigations are required.

The statistical design and analytical models proposed to be used are described and discussed in in Appendix 2 and summarised below.

Mortalities are estimated with a Horvitz-Thompson style estimator (M. M. Huso 2011, see Appendix 2 (Symbolix), extract from which is provided below.

$$\hat{M}_{ij} \cong \frac{C_{ij}}{(\hat{g}_{ij})} \quad (1)$$

where

- $\hat{M}_{ij}$ is the estimated mortalities at turbine i during search j
- C_{ij} is the number of carcasses found
- $\hat{g}_{ij}$ is the estimate of the detection probability for that search and turbine

For a given turbine, $\hat{g}_{ij}$ is a function of

$$\hat{g}_{ij} \cong a_i r_{ij} p_{ij} \quad (2)$$

- a_i is the fraction of total carcasses within the searched area (note this is *not* the same as the fraction of area searched)
- r_{ij} is the fraction of the carcasses that arrived at turbine i but have not been lost to scavenge or decay before search j
- p_{ij} is the probability that an existing carcass will be detected by the searcher

Therefore, a robust mortality program requires the following components:

- a formal mortality monitoring survey where found carcasses are recorded, to determine C_{ij}
- an estimate of the fall zone of carcasses to determine a_i (this also accounts for potentially only searching a subset of all turbines)
- scavenger trials to estimate r_{ij}
- searcher efficiency trials to estimate p_{ij}

4.8. Coverage factor – search area

This is the ratio of the area searched to the (modelled) density of carcass. The density of carcasses as a function of distance will be estimated from methods in Hull & Muir 2010 which uses a Monte-Carlo simulation to generate the distribution of landing positions (the 'fall zone'), using a physics-based ballistics equation (see Appendix 2).

It has been calculated that the 70m circular search zone covers approximately:

- 88% of the bat fall zone
- 55% of the medium bird fall zone
- 41% of the Wedge-tailed Eagle fall zone

and the 130m circular search zone covers approximately:

- 100% of the bat fall zone
- 99% of the medium bird fall zone
- 86% of the Wedge-tailed Eagle fall zone

Further to this, the entire circular zone may not be surveyable, due to the difficult terrain at Clarke Creek. In the most extreme case, only the access roads and hardstands would be searchable. To model this, the density-weighted proportion (DWP) (M. M. P. Huso, Dalthorp, and Korner-Nievergelt 2015) of the fall zone covered by the access roads and hardstands has been calculated.

In this case, the DWP of every turbine is different. The mean value for a search is:

- 40% for bats
- 25% for birds
- 18% for WTEs

The area searched is appropriate to estimate mortality, especially considering the steep surrounding terrain which poses practical and safety challenges to expanding the search area further. Despite the low proportion of area searched, this is fully accounted for during the mortality estimation process (see Appendix 2).

The on-ground situation may be somewhere in between the extreme scenario (hardstand/road only) and the optimal scenario (130m and 70m search radii). Depending on the accessible area, the sampling fraction may be increased to account for a lower search area.

4.9. Carcass register

A carcass register will be prepared and updated with each carcass find and include the following details (see also Appendix 1):

- Location and distance from closes turbine tower
- Bearing of carcass from closest turbine tower (in degree)
- Preliminary species identification
- Photo number
- Details on signs of injury
- Estimated age of carcass (<24 hours; 1-3 days; > 3 days; other)
- Other notes (i.e. sex/age of birds)

5. Impact triggers and mitigation measures

This section establishes 'impact triggers'; namely, impact events that trigger a requirement to investigate, define and implement mitigation actions.

5.1. Impact trigger for EPBC Act and NC Act listed threatened species

An *Impact Trigger* for Threatened Species occurs if a carcass or recognisable parts of a bird or bat species listed as threatened or migratory under the EPBC Act (as defined within the EPBC Act approval) or NC Act is found within the specified search radius during any mortality search or incidentally during commissioning or operation.

5.2. Impact trigger for non-threatened species

An *Impact Trigger* for non-threatened species occurs if a carcass or recognisable parts of a non-threatened bird or bat species is found within the specified search radius during any mortality search or incidentally during commissioning or operation more than four times under the same or adjacent turbine during two successive searches.

Where population numbers are known and reported by DESI or where habitat extent is known, the definition of a significant impact on non-threatened species is any impact that is likely to reduce the viability of the population of the affected species in the bioregion. The assessment of the population will be determined by a suitably qualified ecologist.

5.3. Impact trigger response and investigation

If an *impact trigger* occurs, an adaptive management framework will be immediately triggered and the decision-making framework outlined in Section 5.3.1 will be followed.

Additionally, for any impact trigger involving an EPBC Act listed species, review and reporting by a suitably qualified independent expert will be initiated within one month of the trigger level exceedance, as detailed in Section 5.3.2.

5.3.1. Reporting, investigation and application of decision-making framework

- The occurrence of an impact trigger will be reported immediately to the Site Manager, who will report it to the relevant statutory planner at DESI and DCCEEW within two business days of the impact trigger being detected.
- Immediate initial investigation will occur (to be completed within ten business days) by an ecologist to determine, if possible, the circumstances that led to the impact trigger, including confirming if the death is due to turbine blade collision and, if so, what risk behaviours and environmental conditions led to the collision and whether they are continuing.
- The occurrence of an impact trigger involving a wind turbine that was not part of the full carcass monitoring program (i.e., an incidental detection of an injured or dead EPBC or NC Act listed bird or bat), will automatically require to include this turbine as part of the carcass search monitoring for at least three consecutive months. This further investigation will determine if the incident is a one-off occurrence or if the turbine is likely to be an actual high-risk turbine. The monitoring at this turbine will be extended for the whole period of the full carcass search program if another listed species is found injured or dead under the turbine within the three-month period of investigations. Any turbine that will be added into the full carcass monitoring program through this process will be included into the mortality rate estimation analysis.

- This investigation will aim to provide a clear understanding of the cause of the impact, informed by on-site investigations of the occurrence of the species on the Project site leading to a recommendation where possible of effective mitigation actions.
- Following this investigation, further action is not considered necessary if the species is no longer in the area or is not displaying species-specific risk behaviour[4].
- If the cause of the impact trigger is not clear from the initial investigation and the species is found still to be in the area and displaying risk behaviour findings will be used to select the most likely effective mitigation measure from those indicated in Table 7 and in Section 5.
- The Project is required (EPBC Act approval condition 14d) to determine and justify trigger levels which will require an offset for residual impacts on EPBC Act listed threatened bird and bat species. Trigger levels for offsets will differ depending on the species. If the trigger level for a significant residual impact for a species has been met, an offset will be provided in accordance with the Offset Strategy and as outlined in Section 5.6.

Any evaluation of impacts and decisions regarding mitigation measures and further investigations required will be undertaken in consultation with DESI and DCCEEW. Any required investigation, and recommended mitigation measures and their effectiveness, will be detailed in the annual reports.

The effectiveness of mitigation measures will be evaluated in all cases through continued carcass searches at wind turbine(s) where the impact trigger occurred.

[4] The definition of "Risk Behaviour" for the purpose of the BBMP is detections of a certain number of individuals of listed species specified in Table 9 (triggers), or a greater number, flying adjacent to (within 400m) or between turbines at RSA height.

Figure 5: Decision making framework for identifying and mitigating impact triggers for threatened species

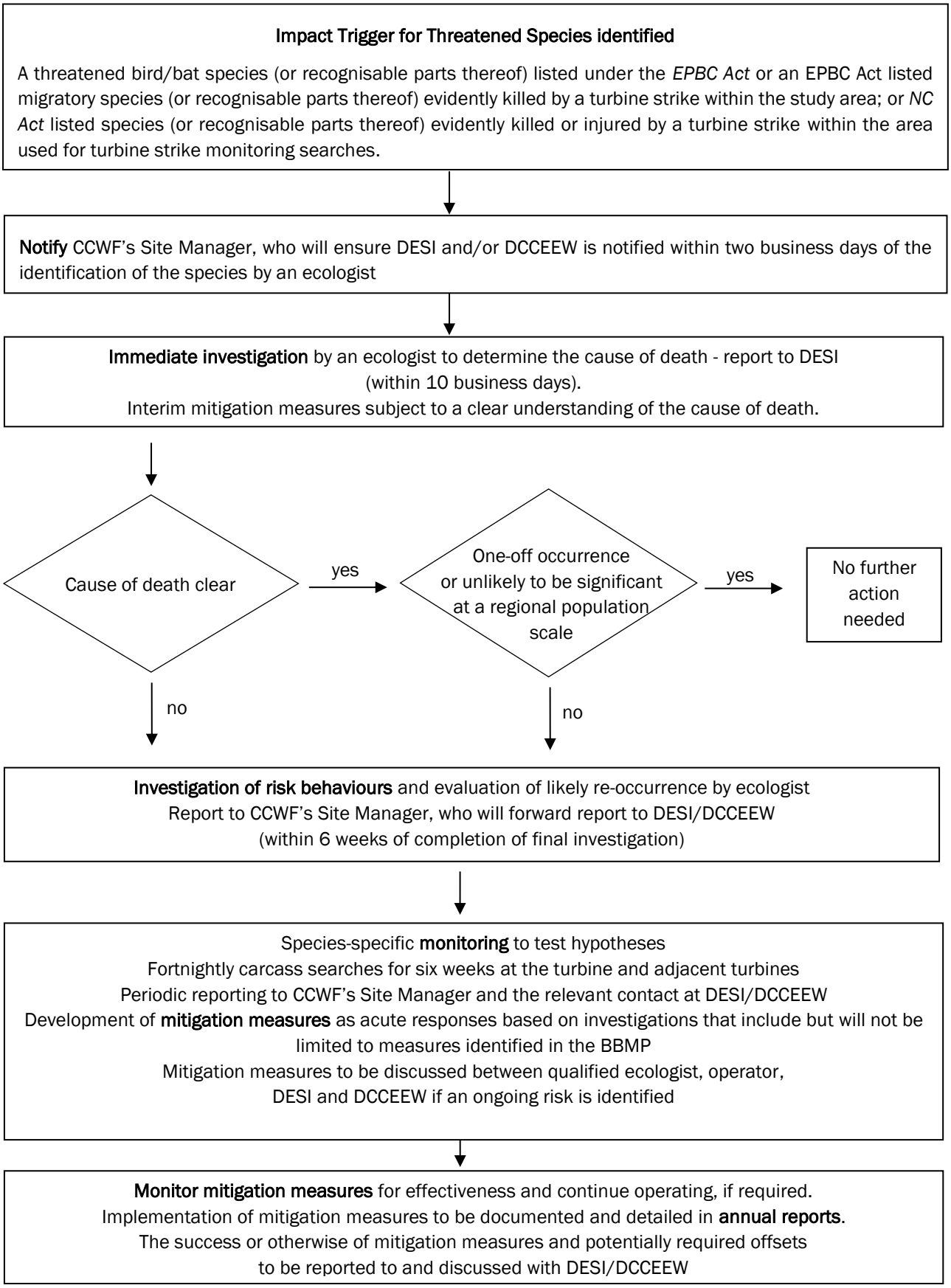


Table 7: Impact avoidance, trigger values, possible causes of impact, planned and *ad hoc* corrective actions.

Species	Impact Trigger (mortality)	Possible cause of impact	Corrective action / mitigation measures
White-throated Needletail	1 bird	Fly at RSA height – turbine collision possible	▪ Immediate investigation of location, extent numbers and timing of needletail activity (to be completed within ten days) by a suitably qualified ecologist to understand the factors which led to the collision and whether they are still occurring (e.g., individuals flying at RSA between or close to turbines, weather pattern, location, timing). ▪ If following this investigation by the suitably qualified ecologist, the fatality is deemed to be a one-off occurrence, an ongoing impact is unlikely to be significant at a population scale (i.e., less than 0.1% of the population estimate, or less than 41 birds), or the species is not exhibiting risk behaviour as defined in footnote 4, further action is not considered necessary. The number of fatalities will be estimated using on-site data for mortality rates. If this data is lacking or absent, estimates will be derived from searcher efficiency and scavenger loss rates collected from wind farm data across Victoria. The outcomes of the investigation will be shared with DESI and DCCEEW. ▪ Where an impact is considered not likely to be a one-off occurrence then targeted monitoring will be undertaken within one month to increase understanding of species movements/patterns proximate to the wind turbines and carcass searching effort will be increased for six weeks to fortnightly frequency at the turbine where the collision occurred and adjacent turbines to increase the likelihood of detection of any additional bird strikes. If the incident involves a turbine that was not initially included in the full carcass monitoring program, that turbine will undergo a three-month carcass search period to determine whether the incident is likely to be a one-off occurrence. If another carcass or injured animal of this species is found during this three-month period, the turbine will be included in the full carcass monitoring program and the same surveying protocols and corrective measures will apply. ▪ Determine if any turbines warrant the implementation of specific mitigation measures and under what conditions (e.g., consistent 'at risk' behaviour is observed at a particular location, or multiple strike events occur at a turbine). Implement mitigation/s where justified within 4 weeks of the recommendation (or as soon as feasible depending on procurement and installation timeframes). Mitigations include but are not limited to the installation of bird deterrent devices and / or targeted turbine curtailment or shutdown (refer to Section 5.5). Monitor and review effectiveness of mitigation/s. ▪ Review requirement for an offset and implement accordingly.

Species	Impact Trigger (mortality)	Possible cause of impact	Corrective action / mitigation measures
Fork-tailed Swift	1 bird	Fly at RSA height – turbine collision possible	▪ Immediate investigation of location, extent numbers and timing of species activity (to be completed within ten days) by a suitably qualified ecologist to understand the factors which led to the collision and whether they are still occurring (e.g., individuals flying at RSA between or close to turbines, weather pattern, location, timing). ▪ If following this investigation by the suitably qualified ecologist, the fatality is deemed to be a one-off occurrence, an ongoing impact is unlikely to be significant at a population scale (i.e., less than 0.1% of the population estimate), or the species is not exhibiting risk behaviour as defined in footnote 4, further action is not considered necessary. The number of fatalities will be estimated using on-site data for mortality rates. If this data is lacking or absent, estimates will be derived from searcher efficiency and scavenger loss rates collected from wind farm data across Victoria. The outcomes of the investigation will be shared with DESI and DCCEEW. ▪ Where an impact is considered not likely to be a one-off occurrence then targeted monitoring will be undertaken within one month to increase understanding of species movements/patterns proximate to the wind turbines and carcass searching effort will be increased for six weeks to fortnightly frequency at the turbine where the collision occurred and adjacent turbines to increase the likelihood of detection of any additional bird strikes. If the incident involves a turbine that was not initially included in the full carcass monitoring program, that turbine will undergo a three-month carcass search period to determine whether the incident is likely to be a one-off occurrence. If another carcass or injured animal of this species is found during this three-month period, the turbine will be included in the full carcass monitoring program and the same surveying protocols and corrective measures will apply. ▪ Determine if any turbines pose a high risk and warrant the implementation of specific mitigation measures and under what conditions (e.g., consistent 'at risk' behaviour is observed at a particular location, or multiple strike events occur at a turbine). Implement mitigation/s where justified within 4 weeks of the recommendation (or as soon as feasible depending on procurement and installation timeframes). Mitigations include but are not limited to the installation of bird deterrent devices and / or targeted turbine shutdown (refer to Section 5.5). Monitor and review effectiveness of mitigation/s. ▪ Review requirement for an offset and implement accordingly.
Rainbow Bee-eater	1 bird	Fly at RSA height – turbine collision possible	
Rufous Fantail	1 bird	Collision unlikely due to behaviour (restricted to undergrowth)	
Satin Flycatcher	1 bird	Collision unlikely due to behaviour (restricted to tree canopy)	
Other EPBC Act listed bird species	1 bird	Collision unlikely, as no other EPBC Act listed bird species were considered to have potential to occur	

Red Goshawk	1 bird	Nest site close to turbine (unlikely as habitat unsuitable) Foraging activity near turbines	▪ Immediate investigation of location, extent numbers and timing of Red Goshawk activity (to be completed within ten days) by a suitably qualified ecologist to understand the factors which led to the collision and whether they are still occurring (e.g., individuals flying at RSA between or close to turbines, weather pattern, location, timing). ▪ If following this investigation by the suitably qualified ecologist, the fatality is deemed to be a one-off occurrence, an ongoing impact is unlikely to be significant at a population scale (i.e., less than 0.1% of the population estimate), or the species is not exhibiting risk behaviour as defined in footnote 4, further action is not considered necessary. The number of fatalities will be estimated using on-site data for mortality rates. If this data is lacking or absent, estimates will be derived from searcher efficiency and scavenger loss rates collected from wind farm data across Victoria. The outcomes of the investigation will be shared with DESI and DCCEEW. ▪ Where an impact is considered not likely to be a one-off occurrence then targeted monitoring will be undertaken within one month to increase understanding of species movements/patterns proximate to the wind turbines and carcass searching effort will be increased for six weeks to fortnightly frequency at the turbine where the collision occurred and adjacent turbines to increase the likelihood of detection of any additional bird strikes. If the incident involves a turbine that was not initially included in the full carcass monitoring program, that turbine will undergo a three-month carcass search period to determine whether the incident is likely to be a one-off occurrence. If another carcass or injured animal of this species is found during this three-month period, the turbine will be included in the full carcass monitoring program and the same surveying protocols and corrective measures will apply. ▪ Determine if any turbines pose a high risk and warrant the implementation of specific mitigation measures and under what conditions (e.g., consistent 'at risk' behaviour is observed at a particular location, or multiple strike events occur at a turbine). Implement mitigation/s where justified within 4 weeks of the recommendation (or as soon as feasible depending on procurement and installation timeframes). Mitigations include but are not limited to the installation of bird deterrent devices and / or targeted turbine shutdown (refer to Section 5.5 and 5.6). Monitor and review effectiveness of mitigation/s. ▪ If a nest has been observed within 1000m of a turbine refer to Section 5.5 regarding turbine shutdown triggers. ▪ Discourage nesting close to turbines through removing nesting opportunities prior to next breeding season (but after the young have fledged in the previous season). ▪ Minimise perching opportunities within 1000m of turbines by removing suitable dead branches, etc. from trees found to be used by the species. ▪ Review requirement for an offset and implement accordingly

Species	Impact Trigger (mortality)	Possible cause of impact	Corrective action / mitigation measures
Corben's Long-eared Bat or other EPBC Act listed bat species	1 bat	Possible collision with turbines / barotrauma	▪ Avoid high intensity lighting within the Project site and use baffled lighting; avoid or minimise lighting within 500m of turbines. ▪ Immediate investigation of location, ongoing presence and timing of bat activity (within ten days) to understand the factors which led to the collision and whether they are still occurring (e.g., weather pattern, location, timing). ▪ If following this investigation by the suitably qualified ecologist, the fatality is deemed to be a one-off occurrence, or an ongoing impact is unlikely to be significant at a population scale (i.e., less than 0.1% of the population estimate), further action is not considered necessary. The number of fatalities will be estimated using on-site data for mortality rates. If this data is lacking or absent, estimates will be derived from searcher efficiency and scavenger loss rates collected from wind farm data across Victoria. The outcomes of the investigation will be shared with DESI and DCCEEW. If the incident involves a turbine that was not initially included in the full carcass monitoring program, that turbine will undergo a three-month carcass search period to determine whether the incident is likely to be a one-off occurrence. If another carcass or injured animal of this species is found during this three-month period, the turbine will be included in the full carcass monitoring program and the same surveying protocols and corrective measures will apply. ▪ Where an impact is considered not likely to be a one-off occurrence then targeting monitoring will be undertaken (within 1 month) to increase understanding of species movements/patterns at targeted locations. ▪ Determine if any turbines warrant the implementation of specific mitigation measures and under what conditions (e.g., consistent 'at risk' presence is observed at a particular location, or multiple collision events occur at a turbine). Implement mitigation/s where justified within 4 weeks of the recommendation (or as soon as reasonably possible depending on equipment procurement and installation timeframes). Mitigations include but are not limited to the installation of bat and insect deterrent devices, modifications to surrounding land use or land management practices, adjusting turbine cut-in speed to 3m/s and/or targeted turbine curtailment or shutdown (refer to Section 5.5) ▪ Monitor and review effectiveness of mitigation/s.

5.3.2. Detailed review of an EPBC Act listed species trigger level exceedance

In accordance with Condition 12A of the EPBC Act approval, in the event any EPBC Act listed bird or bat species-specific trigger level is exceeded, the following actions will be initiated:

- notify the department of the trigger level exceedance as an incident in accordance with the requirements set out in Section 9.2; and
- no later than one month after the detection of the trigger level exceedance, engage an independent suitably qualified expert to commence a review of the following factors over the 12-month period following detection of the exceedance:
    - the utilisation of the project area by the EPBC Act listed threatened bird and bat species relevant to the exceeded trigger level; and
    - the efficacy and implementation of impact avoidance, mitigation and management measures, and the adaptive management frameworks detailed in all BBMPs approved by the Minister.

Reporting of the above must be completed in accordance with the requirements set out in Section 9.1.5 of this BBMP.

5.4. Mortality thresholds (found mortalities) that will prompt mortality estimation

Table 8 provides indicative thresholds for found threatened species mortalities, which if reached or exceeded within a year, will prompt a mortality estimation to be undertaken which will be based on actual survey effort. The outcomes of that mortality estimation will be used to determine whether a Turbine Shutdown Trigger (Section 5.5) or Offset Trigger (Section 5.6) has been reached or exceeded.

The outcomes of the mortality estimation will be provided to DCCEEW within three months of the indicative threshold being reached or exceeded.

Table 8: Indicative thresholds (found mortalities) that will prompt mortality estimation to be completed

Species	Indicative threshold (found mortalities) that will prompt mortality estimation
White-throated Needletail	5*
Rainbow Bee-eater	117*
Rufous Fantail	176*
Fork-tailed Swift	12*
Satin Flycatcher	200*
Red Goshawk	1**
Corben's Long-eared Bat	1**

* Indicative threshold is based on base-level regular carcass searches by humans, excluding additional searches after impact trigger level events

** Due to smaller population sizes of Red Goshawk and Corben's Long-eared Bat, any observed mortality will prompt a mortality estimation to determine whether an offset trigger has been reached or exceeded.

5.5. Trigger levels to shutdown turbines

The following turbine shutdown trigger levels will apply to the operation of Phase 1:

1. **White-throated Needletail, Fork-tailed Swift, Rainbow Bee-eater, Rufus Fantail** or **Satin Flycatcher** found dead or injured under turbines and their annual estimated mortalities are in numbers equal to or larger than 0.1% of the estimated population size for each species (Table 9) per year.
2. One **Red Goshawk** is found dead or injured under a turbine and subsequent searches by qualified ecologists find an active nest is located within 1000 metres of that turbine. Turbines within 1000 metres of the nest site will be shut down for the remainder of the nesting cycle during daylight hours (up to 13 weeks from incubation to fledging; Debus 2020).
3. Ten **Corben's Long-eared Bat** found dead or injured under turbines per year will result in adjusting the turbine cut-in speed to 3 m/s or turbine shutdown of turbines where collision occurred during the at-risk periods when Corben's Long-eared Bats are present (to be determined from the investigation). Increasing cut-in speed is known to significantly reduce the overlap time between bat activity and turbine operations resulting in reduced bat mortality (e.g., Bennett *et al*. 2022).
4. The conclusion is that the risk behaviour of a threatened species is likely to result in collisions reaching or surpassing the threshold for the abovementioned triggers. This outcome triggers shutdowns as an acute response, aligning with the hierarchical structure in the decision-making framework depicted in Figure 5.
5. Other (non-threatened) listed species: where repeated ongoing mortalities occur at a turbine presenting a significant risk to the species at a bioregional level and the only mitigation option available for implementation at the location is turbine shutdown during the at-risk periods (to be determined from the foregoing investigation and considering any migratory species significant impact thresholds published by DCCEEW).

Table 9: Turbine Shutdown Triggers by species based on estimated annual mortalities

Species	Turbine Shutdown Trigger (Annual Estimated Mortalities)
White-throated Needletail	41*
Rainbow Bee-eater	1,000
Rufous Fantail	1,500
Fork-tailed Swift	100
Satin Flycatcher	1,700

* 0.1% of recently revised population estimate of 41,000 mature individuals (Garnett and Baker 2021)

If the approval holder detects that a turbine shutdown trigger has been reached or exceeded, the approval holder must cease operation of all turbines in the project site identified as contributing to the impact trigger. Any turbine shutdowns that are implemented will be regularly reviewed in accordance with the prepared incident investigation report to determine recommencement requirements and timing. This may vary depending on when the incident occurred relative to seasonal or migratory behaviour changes that reduce collision risk.

5.6. Trigger levels for offsets

Offset triggers have been defined in the Offset Strategy (NGH Environmental 2020) for vulnerable threatened species and provided for migratory species based on the 0.1% population threshold at a national level (Commonwealth of Australia 2017) and as guided by DCCEEW (see Table 10). Although these are different species than the ones detailed in the Commonwealth guidelines, it provides a benchmark for trigger thresholds, i.e. number of estimated strikes within a 12-month period.

If any mortality estimation indicates that an Offset Trigger in Table 10 has been reached or exceeded, then offset will be implemented in accordance with an approved Bird and Bat Offset Strategy (BBOS) (as detailed in Section 5.8). If the Offset Trigger occurs prior to approval of the BBOS, then the offset will be delivered in accordance with the EPBC Act Environmental Offset Policy.

Table 10: Offset triggers by species based on estimated annual mortalities

Species	Offset Trigger (Annual Estimated Mortalities)
White-throated Needletail	41*
Rainbow Bee-eater	1,000
Rufous Fantail	1,500
Fork-tailed Swift	100
Satin Flycatcher	1,700
Red Goshawk	1
Corben's Long-eared Bat	10†

* 0.1% of recently revised population estimate of 41,000 mature individuals (Garnett and Baker 2021)

† A conservative estimate of 0.1%, equal to 10 individuals, was set due to unknown national population size (TSSC 2015).

5.7. Specific management objectives, activities, timing and performance criteria

Table 11 summarises specific management objectives, activities, timing and performance criteria for the implementation of this BBMP. It can be used for monitoring and reporting. It includes commitments to specific objectives, management activities and controls, as well as performance

criteria for measures that are known to have worked in Australia on other wind farm projects. Being specific about *all* possible mitigation measures is not possible given they are not reasonably predictable for CCWF until investigation of an impact trigger gets underway. Australian experience is limited and any requirement will be triggered by circumstances unique to this wind farm site and species concerned. The adaptive management framework approach of this BBMP allows for the development and implementation of a particular set of measures that are relevant, effective and warranted given the reasons for and scale of the impact, and the species concerned.

Table 11: Specific management objectives, activities, timing and performance criteria

Management objectives	Management activities and controls	Timing	Performance criteria for measuring success of methods	Responsibility
Full operation BUS survey	Obtain operational bird utilisation data with a focus on species at risk	Full operation Year 1 and year 2	▪ Bird utilisation surveys (point count) undertaken as prescribed in section 4.1	Ecologist
Mortality monitoring	Incidental carcass searches and records	Commissioning and full operation periods – ongoing	▪ All incidental carcass finds of birds and bats recorded (section 4.5)	Wind farm personnel and ecologist
	30% of the operating turbines (30 turbines of Phase 1) to be surveyed each month to 130m radius, in accordance with the inner and outer zone search protocol. 25 turbines will be regularly searched each month and 5 randomly selected for a minimum period of two years. A pulse search will also be completed of each turbine.	Full operation period (once commissioning completed) monthly until at least the end of two years	▪ Phase 1 operational period mortality surveys undertaken monthly at 30 turbines, for at least two years, with a review after the first year to determine if a change in methodology is required	Ecologist
	Calculating annual mortality of birds and bats per turbine, based on monitoring activities. Mortality estimates should include correction factors from scavenger and detector efficiency trials. The need for further surveys will be reviewed based on the results of the first two years of monitoring	Commissioning and full operation periods, at the end of each year of mortality monitoring	▪ Scavenger and detector efficiency trials (2 of each) undertaken within the first year of full carcass search program implementation.	Ecologist

Management objectives	Management activities and controls	Timing	Performance criteria for measuring success of methods	Responsibility
Annual Reports	Preparation of Annual BBMP Reports	Full operation period – within three months of the completion of full carcass search program in years one and two, and each following year of operations	▪ Annual reports delivered within three months of completion of yearly monitoring, in compliance with Condition 12 of the EPBC Act approval ▪ Annual reports to include (but not be limited to) results of monitoring surveys for that year, any *impact triggers* or significant impacts identified, mitigation measures implemented, application of the decision-making framework and recommendations for the following year ▪ Estimates of annual mortality for birds and bats presented in the annual reports (See section 4.7)	Approval Holder
Mitigation measures to reduce risk	Carrion removal program – carcasses and/or remains to be removed from within 200m of turbines within 24 hours and disposed of appropriately	During commissioning and full operation periods (permanent)	▪ Carcasses removed ▪ Activity recorded in dedicated register	Site Manager
	Pest control program as detailed in Biodiversity Management Plan (NGH 2020)		▪ Monitor effectiveness of rabbit or other pest control, and where bird mortality is clearly related to their numbers, increase the effectiveness of control	
	Baffle and direct external lighting to avoid excessive light spillage and visibility from above.		▪ If mortality at turbines near light sources significantly exceeds that of activity at unlit turbines, type and duration of lighting will need to be reviewed, subject to security and OH&S limitations	

5.8. Bird and Bat Offset Strategy

Conditions 17A – 17D of the EPBC Act approval require the development and approval of a Bird and Bat Offset Strategy. The Condition requirements are:

Condition 17A: Within 18 months following commissioning of Phase 1, the approval holder must submit a Bird and Bat Offset Strategy (BBOS) for all Phases to the department for the Minister's approval.

Condition 17B: The BBOS submitted for the Minister's approval must:

a. propose environmental offsets that will be delivered in the event a species-specific trigger level specified in a BBMP approved by the Minister is reached or exceeded;
b. specify the mechanism and responsible parties for the delivery of each of the proposed environmental offsets;
c. demonstrate how each of the proposed environmental offsets are consistent with the Environmental Offsets Policy;
d. specify what the outcome of each environmental offset is and the timeframe in which each outcome will be delivered;
e. propose feasible and effective contingencies, to be implemented in the event any outcome of an environmental offset is not achieved within the specified timeframe;
f. detail the benefit of each proposed environmental offset and its outcome to the conservation of each EPBC Act listed threatened bird and bat species; and
g. detail a program to periodically publish on the website and report to the department, information regarding the implementation of each proposed environmental offset.

Condition 17C: Following submission of the BBOS, if the Minister makes a written request to the approval holder to make specified revisions to the BBOS, the approval holder must revise the BBOS and submit the revised BBOS to the department in accordance with any such request.

Condition 17D: The approval holder must implement the BBOS approved by the Minister, from within 20 business days of the Minister's approval of the BBOS and until the expiry of this approval.

6. Injured bird and bat handling protocol

All on-site staff and monitoring personnel will be advised of the correct procedure for assisting injured wildlife. Construction and Operations personnel who find injured wildlife will be required to report the find to the Site Manager, who will organise recovery of, and treatment for the animal. When safe to do so, place the animal immediately into a dark place e.g. box or cloth bag for transfer to the nearest wildlife carer or veterinarian.

All persons who handle injured or dead animals must wear gloves and understand the applicable OH&S requirements. Special care[5] will be taken to avoid bat borne viruses (i.e. Australian Bat Lyssavirus and Hendra Virus), including that only people with appropriate vaccinations will handle bats (living or deceased).

Contact details of local veterinary staff and wildlife carers are provided in Table 12 to ensure that if injured wildlife is found and cannot readily be released back to the wild, they are treated accordingly and in a timely manner.

Table 12: Vet and wildlife carer details for the local region

Name	Phone	Location/Address	Bats (Y/N?)
Wildlife Rockhampton	0429 GO WILD (0429 469 453)	PO Box 2066 Wandal QLD 4700	Yes
RSPCA	1300 ANIMAL (1300 264 625)	391 Yaamba Rd, North Rockhampton QLD 4701	Yes
Rockhampton Vet Clinic QLD	(07) 4928 4266	Dean St, Frenchville QLD 4701	No
Rockhampton Wildlife Rescue Association Inc	0437 556 744	North Rockhampton QLD 4701	Yes
Alma Street Veterinary Hospital	(07) 4922 8138	67 Alma St, Rockhampton QLD 4700	No

This Injured Bird and Bat Protocol is valid for two years after completion of commissioning and will be reviewed after this time frame. If it requires change this will be included in an amended BBMP for approval by DCCEEW, otherwise it will continue to apply.

[5] Queensland Government (2017) Bats and Human Health http://conditions.health.qld.gov.au/HealthCondition/condition/14/217/14/Bats-human-health, accessed 28/06/18

7. Roles and Responsibilities

7.1. Project Owner

The approval holder/project owner's representative will be responsible for implementation of this BBMP and the decision-making that goes with it, with technical support provided by the Ecological Advisor.

7.2. Site Manager

The site manager is responsible to report incidental carcass finds to the Ecological Advisor and to facilitate the implementation of the BBMP on site (from wind farm operations perspective), including non-compliances if these occur.

The site manager is responsible for operational staff to be trained in the incidental carcass protocol and carcass/carrion detection protocol.

7.3. Ecological Advisor

The ecological advisor is a degree-qualified and suitably experienced ecologist with knowledge of the impact of wind turbines on birds and will provide technical advice for the comprehensive implementation of the BBMP, and accurate and timely reporting as required in this plan.

8. Risk assessment

The aim of this risk assessment is to analyse the risks to achieving the BBMP's environmental objectives and provide risk management strategies should a risk arise to fulfill the objectives.

Risks to the implementation of this BBMP and achieving its objectives can arise from the following potential causes:

- Natural disaster such as flooding, bushfires, heatwaves, thunderstorms, etc;
- Technical difficulties subject to equipment failure (e.g., songmeters, vehicles);
- Human or canine failure to fulfill obligations; and
- Ineffectiveness of implemented corrective action or mitigation measures.

The assessment has been undertaken as follows:

- BBMP implementation activities have been listed as defined in this BBMP;
- Five potential impact causes have been assessed;
- Impact likelihood criteria have been developed and applied to each impact cause for specific implementation activities or tasks;
- Impact consequence criteria have been developed and applied to each potential cause for each implementation activity; and
- The risk level for implementation activity from the possible potential causes has been determined where relevant consistent with a risk matrix

8.1. Methodology

The risk assessment process was based on the Risk Evaluation Matrix Model used to measure the overall risk of a potential cause, such as natural disasters or technical or human failure. The assessment is based on the *likelihood* of that event and should it occur, its *consequences*. This model is currently used across a wide range of industry sectors, in particular for assessing environmental risk.

The Risk Evaluation Matrix Model also complies with the ISO31000 Risk Assessment Standard.

The assessment requires criteria to be developed for likelihood and consequence. These criteria are provided respectively in Table 13 and Table 14. Table 15 shows the risk levels used and how they are determined from the assessed likelihood and consequence levels.

Table 13: Qualitative measure of likelihood

Likelihood	Description (How likely is it that this event/circumstance will occur after management activities are implemented?)
Highly Likely	Is expected to occur in most circumstances
Likely	Will probably occur during the life of the project
Possible	Might occur during the life of the project
Unlikely	Could occur but considered unlikely or doubtful
Rare	May occur in exceptional circumstances

Table 14: Qualitative measure of consequences

What will be the consequence/result if the issue does occur?				
Minor	Moderate	High	Major	Severe
Minor risk of failure to achieve the BBMP's objectives. Short term delays of implementation at low costs with well characterised corrective actions.	Moderate risk of failure to achieve the BBMP's objectives. Short term delays of implementation at moderate cost and effort, but through well-defined corrective actions.	High risk of failure to achieve the BBMP's objectives. Medium to long-term delays of implementation at high costs and effort through uncertain corrective actions.	The BBMP's objectives are unable to be achieved, with significant barriers and no evidenced mitigation strategies.	The BBMP's objectives are unable to be achieved, may include widespread and severe environmental harm, with no evidenced mitigation strategies.

Table 15: Risk matrix defining risk level based on likelihood and consequence

		Consequence				
		Minor	*Moderate*	*High*	*Major*	*Severe*
Likelihood	*Highly likely*	*Medium*	*High*	*High*	*Severe*	*Severe*
	Likely	*Low*	*Medium*	*High*	*High*	*Severe*
	Possible	*Low*	*Medium*	*Medium*	*High*	*Severe*
	Unlikely	*Low*	*Low*	*Medium*	*High*	*High*
	Rare	*Low*	*Low*	*Low*	*Medium*	*High*

8.2. Results of risk assessment and risk management strategies

BBMP Objective(s)	BBMP Implementation activities	Hazard or potential cause of impact	Likeli-hood	Conse-quence	Risk Rating	Management actions	Likeli-hood	Conse-quence	Residual risk
Ensure the protection of EPBC Act listed threatened bird species	Carrion removal program and stock forage control	Natural disaster such as flooding, heatwaves, bushfire, etc preventing program implementation	Possible	Moderate	Low	• Continue carrion removal and stock forage control after event	Possible	Minor	Low
Ensure the protection of EPBC Act listed threatened bird and bat species	Reduce lighting on turbines and buildings	Technical difficulties / equipment failure lights could stay on, when supposed to turn off	Possible	Moderate	Low	• Electrician to repair automatic sensors and electrical circuits	Possible	Minor	Low
Ensure the protection of EPBC Act listed threatened bird and bat species	Bird and Insect deterrents (if deployed)	Technical difficulties / equipment failure deterrents could fail to turn on	Unlikely	Moderate	Low	• Technician to repair deterrents	Unlikely	Minor	Low
Ensure the protection of EPBC Act listed threatened bat species	Low speed wind curtailments (if deployed)	Technical difficulties / equipment failure inhibiting implementation	Unlikely	Moderate	Low	• Turbine engineer to repair curtailment technology. SCADA data to be reviewed to confirm low wind speed curtailment is functioning.	Unlikely	Minor	Low
Ensure the protection of EPBC Act listed threatened bird species	Pest Control	Natural disaster such as flooding, heatwaves, bushfire, etc	Unlikely	Moderate	Low	• Continue pest control after event	Unlikely	Minor	Low

BBMP Objective(s)	BBMP Implementation activities	Hazard or potential cause of impact	Likeli-hood	Conse-quence	Risk Rating	Management actions	Likeli-hood	Conse-quence	Residual risk
Implement a monitoring program to estimate the impact of the Project on the seven at-risk birds and/or bats that can reasonably be attributed to the operation of the Project Directly record impacts on birds and bats through a statistically-based program of carcass searches Detect impact and turbine shutdown triggers that require management actions and inform risk ratings of turbines	Carcass Searches	Difficult terrain, such as steep slopes and dense vegetation preventing search of entire search area	Likely	Moderate	Low	• Only search hardstands and tracks of affected turbines • Search more turbines • Adjust mortality estimate to account for reduced area searched	Likely	Minor	Low
		Natural disaster such as flooding, heatwaves, bushfire, etc preventing search from occurring	Possible	Moderate	Medium	• Cease carcass searches and continue the following month • Mortality estimate to account for missing data • Extend carcass searches by one month	Possible	Minor	Low
		Human or scent dog failure to fulfill obligations due to injury or sickness	Possible	Moderate	Low	• Replace searcher by another searcher who meets the searcher prerequisites • If not possible at short notice, skip survey and extend carcass searches by one month. • Or statistical analysis to account for missing data.	Possible	Minor	Low

BBMP Objective(s)	BBMP Implementation activities	Hazard or potential cause of impact	Likeli-hood	Conse-quence	Risk Rating	Management actions	Likeli-hood	Conse-quence	Residual risk
Implement a monitoring program to estimate the impact of the Project on the seven at-risk birds and/or bats that can reasonably be attributed to the operation of the Project	Scavenger and detectability trials	Human failure to fulfill obligations due to injury or sickness Nor enough bird and bat carcasses available	Possible	Moderate	Low	• Re-schedule trials when staff is well again • Source carcasses well in advance through alternative sources (e.g., mice or alternative bird carcasses, such as Noisy Minor and Myna)	Possible	Minor	Low
Understand the overall impact of the wind farm on birds and bats and identify high risk turbines	Mortality estimation	Technical difficulties Insufficient data	Unlikely	Moderate	Low	• Re-run statistical simulation on adequate equipment/software • State limitations, continue carcass searches until sufficient data available	Unlikely	Minor	Low
Ensure the protection of EPBC Act listed threatened bird and bat species	Corrective Actions	Ineffectiveness of corrective action	Unlikely	Moderate	Low	• Monitor effectiveness of corrective action and prepare report to DCCEEW and DES • Adjust corrective action or mitigation measure or provide alternative/additional corrective action to improve efficacy	Unlikely	Minor	Low

9. Reporting, data management and BBMP review

9.1. Reporting requirements

Reporting requirements under the BBMP are described in Sections 9.1.1 to 9.1.5.

The Site Manager, working with the Ecological Advisor is responsible for ensuring all reporting is prepared in a timely manner as outlined in this section and, where required, forwarded to required external parties.

9.1.1. BBMP annual monitoring reports

Reports will be completed on an annual basis with monthly summary reports of carcass searches to be provided to the Project Owner. The annual report will be provided to DESI and DCCEEW.

The first BBMP annual monitoring report will be prepared and submitted to DESI and DCCEEW within three months of the completion of the first year of full carcass search program implementation after Phase 1 of the wind farm becomes fully operational.

Annual reports will have, as a minimum the content described below. Annual strike reports, raw strike data and strike notifications.

- Confirmation of field research methodologies (as per this BBMP) and any difference and explanations for this.
- Results of carcass searches, and detection and persistence trials.
- Any other mortality recorded on site but not during designated carcass searches i.e. incidental records by site personnel;
- Environment/meteorological conditions (monthly average temperature and rainfall for the monitoring period).
- A summary of stock, feral and native animal carcass removal for the purposes of predator reduction.
- Details of any landowner feral animal control programs and their timing.
- The occurrence of any impact triggers and the resulting mitigation responses and corrective actions.
- Effectiveness of mitigation measures implemented in response to impact triggers and adaptive changes to these measures in response to evaluation of their effectiveness (if applicable).
- Detailed statistical analysis, including mortality estimates.

The second annual report will be prepared and submitted to DESI and DCCEEW within three months of the completion of the second year of full carcass search program implementation.

Matters to be addressed in the second annual report include those in the first year report plus the matters listed below.

- Updated estimates of bird and bat mortality rates (per turbine per year) based on statistical analysis.
- Seasonal and annual variation in the number and composition of bird and bat strikes, where detectable.
- A discussion of the results, including:
    - Bird risk reduction measures;

- Any further recommendations for reducing mortality, if necessary;
- Whether the level of mortality was unacceptable for affected listed species of birds or bats of concern;
- Usage of the Project site by species of concern based on BUS and targeted survey results and factors influencing this (climatic, geographical and infrastructure);
- Analysis of the effectiveness of the decision-making framework and mitigation measures based on observed mortality rates;
- Risk rating of turbines based on survey results;
- Results of Collision Risk Modelling for species of concern; and
- Recommendations about further monitoring and mitigation measures.

The content of the second-year report will be used to inform a revised BBMP about any proposed changes related to monitoring responsibilities, protocols, frequency and intensity in the following years. The revised BBMP will be submitted for approval by DCCEEW.

9.1.2. EPBC Annual Compliance Reporting

In accordance with Condition 25 of the EPBC Act approval, Annual Compliance Reports will be prepared for each Annual Compliance Report period, being the 12-month period from7 March to 6 March the following year (unless otherwise specified in writing by the Minister).

In accordance with Condition 25A of the EPBC Act approval, the following information must be included in all Annual Compliance Reports following Commissioning:

a. a count of all turbine strikes detected for EPBC Act listed bird and bat species in the project area and in each Phase, during the ACR period, and a compilation and analyses of information in relation to each turbine strike regarding:
   i. the method of detection;
   ii. the species detected;
   iii. prevailing environmental/meteorological conditions at the estimated time of the collision; and
   iv. likely factors in the presence of the EPBC Act listed bird and bat species and EPBC Act listed migratory bird or bat species leading to the collision;
b. estimations of annual mortality and injury rates for each EPBC Act listed threatened bird and bat species, calculated in accordance with the BBMP(s) for each Phase approved by the Minister;
c. species occurrence records in accordance with the *Guidelines for biological survey and mapped data,* Commonwealth of Australia 2018, or as otherwise specified by the Minister in writing; and
d. an evaluation of effectiveness of the measures implemented during the reporting period to avoid and mitigate mortality and/or injury to EPBC Act listed threatened bird and bat species

In accordance with Condition 25B of the EPBC Act approval, the Annual Compliance Reports will also provide accurate and complete details of how the BBMP was implemented during the ACR period.

9.1.3. Incident and non-compliance notification and reporting

In accordance with EPBC Act approval, an Incident means any event which has the potential to, or does, impact on protected matter(s).

In accordance with Condition 12A of the EPBC Act approval, should any EPBC Act listed bird or bat species-specific trigger level specified in the Phase 1 Bird and Bat Management Plan (or any BBMP approved by the Minister) be exceeded, the exceedance will be treated as an incident and Conditions 26 and 27 of the approval will be implemented as set out below.

Condition 26: the approval holder must notify the department electronically, within 2 business days of becoming aware of any incident, or potential or actual non-compliance with these conditions or commitments made a plan.

The approval holder will specify in each notification:

a. any condition or commitment made in a plan which has not been or may have been not complied with;

b. a short description of the incident or non-compliance; and

c. the location (if applicable, including co-ordinates), date and time of the incident or non-compliance.

Condition 27: The approval holder will provide to the department in writing, within 12 business days of becoming aware of an incident, or potential or actual non-compliance with these conditions or commitments made a plan, the following details of that incident or non-compliance:

a. all corrective measures and investigations which the approval holder has already taken in respect of the incident or non-compliance;

b. the potential impacts of the incident or non-compliance;

c. the method and timing of any corrective measures that the approval holder proposes to undertake to address the incident or non-compliance; and

d. any variation of these conditions or revision of a plan that will be required to prevent recurrence of the incident or non-compliance, and/or to address its consequences.

An incident notification will be prepared when an EPBC Act listed threatened bird or bat species is struck and provided to the Site Manager and DCCEEW and DESI within two business days.

9.1.4. Investigation reports

An investigation report will be prepared detailing further investigations undertaken and documenting the results of investigations to design mitigation measures if an impact trigger has occurred. This report will be provided to the Site Manager and DCCEEW within six weeks of investigation.

9.1.5. Review and reporting of EPBC Act listed species trigger exceedance (Cond. 12A)

Section 5.3.2 of this BBMP sets out the details of a review that must commence within one month of the detection of an EPBC Act listed species trigger level exceedance, by an independent suitably qualified expert. The outcomes of that review must be documented in a report, which must:

- be prepared by an independent suitably qualified expert;

- be published on the website and submitted to the department within 15 months of notifying the department of the relevant species-specific trigger level exceedance;
- remain published on the website until the expiry of this approval;
- include a summary of the review findings;
- list the key recommendations (if any) made by the independent suitably qualified expert to reduce the likelihood of future trigger level exceedance; and
- include a statement made by the approval holder as to which of the recommendations it will accept, and how and by when the approval holder will act on each of the accepted recommendations.

9.2. Management and preparation of monitoring data

In accordance with Condition 24 of the EPBC Act approval, any monitoring data (including sensitive ecological data), surveys, maps, and other spatial and metadata required by this BBMP must be prepared in accordance with the Department's *Guidelines for biological survey and mapped data* (2018) and submitted electronically to the Department in accordance with the requirements of this plan.

9.3. Review of this BBMP

This plan uses an adaptive management approach, whereby management measures set out in this BBMP may be amended in accordance with EPBC Act approval conditions to ensure effective management and mitigation are implemented. To ensure the effectiveness of this BBMP, all activities are subject to regular review and reporting. BBMP reviews will be undertaken as a minimum every two years as part of a continual improvement process. Triggers for a BBMP review also include (but are not be limited to) the occurrence of an impact trigger after operational carcass searches have ceased.

If a review results in a need to revise the BBMP, in accordance with Condition 31 of the EPBC Act approval, the approval holder will apply to the Minister for a variation to a plan by the Minister as subsequently revised in accordance with these conditions, by submitting an application in accordance with the requirements of section 143A of the EPBC Act.

9.4. Revision of this Phase 1 BBMP when submitting the Phase 2 BBMP

In accordance with 11B of the EPBC Act approval, at the same time that the approval holder submits the Phase 2 BBMP to the department, the approval holder must also submit to the department for the Minister's approval, a revised version of the Phase 1 Bird and Bat Management Plan that meets the requirements of condition 11C of the approval, as well as Condition 11D as required.

The requirements of Conditions 11C and 11D of the approval have been included in Table 1.

10. Training

This Section outlines the personnel involved in implementing the BBMP and any training required for the field work and report writing. All personnel working on the requirements of the BBMP will be familiar with the Plan (including technical context and field methods), and site policies and procedures (e.g., EH&S). The approval holder(s)/project owner(s) will ensure that suitably qualified and trained people are engaged to supervise and implement the monitoring program.

Any person undertaking searches will be trained and supervised by a qualified ecologist. The searcher will receive training from the supervising ecologist in the following areas:

- Turbine searches, including transect spacing in inner and outer zones, number and location of turbines to search and transect search methods;
- Equipment usage, such as GPS;
- Data recording;
- Carcass storage; and
- Species identification.

Each searcher will undertake a minimum of three searcher efficiency trials, where possible.

Where a scent-dog is used to search for carcasses, this will be undertaken by a single dog and their handler fully trained in this method. The same dog and handler will be reasonably required to undertake all carcass searches for the duration of this program.

The qualified ecologist will supervise the initial carcass search to ensure that field methods are being undertaken correctly and undertake an audit after the first three months to ensure that methods are being implemented correctly. The qualified ecologist will also be responsible for identifying any recorded carcasses from photographs or from specimens transferred to the on-site freezer after searches.

The first searcher efficiency trial will be initiated and set up by the supervising ecologist, who will, if required, train a separate person (the 'carcass controller') to run follow-up searcher efficiency trials. This training will include:

- Correct preparation and handling of trial carcasses;
- Correct methods for the random placement of trial carcasses within a randomly selected sub-set of the search areas; and
- The need to place trial carcasses without the searcher knowing they are being placed.

If a searcher is unable to undertake the monthly searches as planned (due to illness etc.) a back-up person will be identified in advance. If a back-up person is required to undertake searches, they will also be trained and supervised and will participate in searcher efficiency trials.

The scavenger trials will be set up by the supervising ecologist, with searches being undertaken by a trained searcher.

Analysis of mortality data will be undertaken by the supervising ecologist with support from a statistician.

Annual reports and all investigations resulting from an impact trigger (see Section 4.3) will be prepared by the supervising ecologist.

11. Emergency contacts and procedures

The Project requires a Safety and Emergency Management Plan (SEMP) under condition 11 of the State Development Approval addressing construction and operations. All environmental incidents shall be managed in accordance with the SEMP and key details and up to date contacts will be provided during the staff project induction.

All incidents are to be reported to the site manager within 24 hours.

All pollution incidents or any incident where serious or material harm to the environment is caused or threatened shall be reported immediately (and without delay) to the Owner's Representative and the relevant authorities in accordance with the *Environmental Protection Act 1994* and the *Nature Conservation Act 1992*. Key agency contacts are provided in Table 16.

Table 16: Key Agency contacts

Agency	Responsibility	Contact details
Department of Climate Change, Energy, the Environment and Water (DCCEEW)	MNES	**1800 803 772**
Department of Environment and Science (DES)	Pollution Hotline	**1300 130 372**
Queensland Fire and Emergency Service	Fire and Rescue	**000**
Ambulance	Accident and emergency	**000**
Police	Emergency	**000**
Rural Fire Service	Fire and Rescue	**000**
Rockhampton Hospital	Medical Assistance	**07 4920 6211**
Mackay Hospital	Medical Assistance	**07 4885 6000**
Poisons information	Medical Assistance	**13 11 26**
Department of Transport and Main Roads	Medical Assistance	**07 4931 1500**
Isaac Regional Council	Local Government	**1300 472 227**
Livingstone Shire Council	Local Government	**1300 790 919**

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13. Appendices

Appendix 1: Carcass Search Data Sheet

CLARKE CREEK WIND FARM - BIRD AND BAT MORTALITY MONITORING PROGRAM CARCASS SEARCH DATA-SHEET*				
Please fill out all details above the heavy line for each site searched All details below the line are required if a carcass is found Refer to Section 4.4 Carcass Find Protocol **Do not move a carcass until the details below have been completed**				
CCWF				
Date:				
Start Time:				
Finish Time:				
Turbine Number:				
Wind direction and strength in preceding 24 hours:				
Any unusual weather conditions in last 48 hours?				
Distance of Carcass from Tower (m):				
Bearing of Carcass from Tower (magnetic deg):				
Preliminary Species Identification:				
Photo Taken**	Yes / No			
Signs of injury:				
How old is carcass estimated to be (tick category):	<24 hrs	1-3 days	> 3 days	Other
Other Notes (i.e. sex/age of bird) and substrate:				
Post Find Actions: 1. Place carcass in sealable plastic bag then wrap it in newspaper and into another plastic bag (with copy of this sheet within) and take to freezer at site office. 2. Contact project ecologist to confirm identification of carcass				
* One form should be completed for each carcass found				
** Please attach photo to this form				

Appendix 2: Statistical Appendix

symbolix

Clarke Creek Farm Mortality Monitoring Program - Statistical Design

Prepared for Nature Advisory, 9 Aug 2024, Ver. 1.2

1 About this document

As part of the preparation and review of this Bird and Bat Adaptive Management Plan (BBAMP) (Nature Advisory 2021), a peer review highlighted concerns regarding the design and communication of the carcass search program (including estimation of mortality due to turbines).

This document provides a renewed design and statistical recommendations for both the main mortality survey component, as well as adjunct survey components (scavenger trials and searcher efficiency), of the BBAMP. This detail underpins the field instructions in the main body of the BBAMP.

The analysis has been updated as the survey design was refined and through a number of reviews. As such this memo contains general advice, an analysis of the proposed survey design's ability to inform shutdown triggers and a final recommendation that the proposed design and adaptive management stages are appropriate.

2 Design considerations

2.1 Site specifics

There are six listed species of concern which require an offset trigger (see BBAMP Section 3.4), as documented in the conditions of approval. These are the:

- White-throated Needletail
- Rainbow Bee-eater
- Rufous Fantail
- Fork-tailed Swift
- Satin Flycatcher

Out of these, the White-throated Needletail is the only species which has been observed on-site, and is expected to have a realistic risk of collision (Nature Advisory 2021).

There is also a requirement to monitor and report on the mortality of birds and bats more generally.

The turbine layout is shown in Figure 7 in the Appendix.

2.2 Mortality program objectives

The **primary** objective of a wind farm post-construction mortality program is to generate a statistical estimate of the number of bird and bat fatalities due to turbine collision over a period of time (typically annually). We will need to estimate total mortalities for groups of species and individual estimates for species of concern.

At Clarke Creek, **secondary** consideration is to inform the application of triggers for adaptive management. These triggers are based on the likely (i.e. estimated) range of true species mortality (not raw carcass counts).

The primary objective requires a statistical design so that the carcass counts can be expanded to estimate total mortality.

2.3 Components of the study

Mortalities are estimated with a Horvitz-Thompson style estimator of the of the form (Manuela M. Huso 2011):

$$\hat{M}_{ij} \cong \frac{C_{ij}}{(\hat{g}_{ij})} \tag{1}$$

where

- $\hat{M}_{ij}$ is the estimated mortalities at turbine i during search j
- C_{ij} is the number of carcasses found
- $\hat{g}_{ij}$ is the estimate of the detection probability for that search and turbine

For a given turbine, $\hat{g}_{ij}$ is a function of

$$\hat{g}_{ij} \cong a_i r_{ij} p_{ij} \tag{2}$$

- a_i is the fraction of total carcasses within the searched area (note this is *not* the same as the fraction of area searched)
- r_{ij} is the fraction of the carcasses that arrived at turbine i but have not been lost to scavenge or decay before search j
- p_{ij} is the probability that an existing carcass will be detected by the searcher

Therefore, a robust mortality program requires the following components:

- a formal mortality monitoring survey where found carcasses are recorded, to determine C_{ij}
- an estimate of the fall zone of carcasses to determine a_i (this also accounts for potentially only searching a subset of all turbines)
- scavenger trials to estimate r_{ij}

- searcher efficiency trials to estimate p_{ij}

This document outlines best practices for estimation of all components of the above equation.

We outline the field protocol in the remainder of this report, making reference to best practice guidelines.

2.4 Estimation technique

Specifically, in this document we use our custom software (Stark and Muir 2020) to generate estimates of total mortality.

We provide statistical details about the expected efficacy of the carcass search program by estimating the performance under different survey options. To do this we use our mortality estimation software (Stark and Muir 2020) which uses a Monte Carlo simulation to estimate mortality (more details of the method and general analysis approach are provided in the body of this memo).

We consider the:

- Overall probability of detection of a carcass (Section 3.6.2) (the likelihood of the survey program to detect a single carcass). This is equivalent to the 'Evidence of Absence' analysis provided by software like GenEst (Dalthorp et al. 2018) and discussed in papers like Manuela MP Huso and Dalthorp (2014).
- The ability of the survey program to inform impact triggers and the performance in low-find scenarios (Section 3.6.3).

3 Field design

3.1 Scavenger trials

Scavenger trials involve leaving carcasses out in field, monitoring their time until removal.

3.1.1 Aim

The purpose of scavenger (or carcass persistence) trials is to quantify the mean and confidence interval of the time to removal of carcasses from the study area.

This is needed as an input into the mortality estimate.

To derive an annual mortality estimate, we require an annual value for scavenge. We suggest surveying in more than one season to capture some of the seasonal variability, but we do not need multiple scavenge rates at different times of year.

3.1.2 Metric studied

The metric studied is the *survival function* $S(t)$, which determines the probability that a carcass will "survive" in-field past time t. When this is estimated, the mean and confidence interval on time to scavenge can be found.

3.1.3 Field methodology

Scavenger trials are proposed in two seasons of the year (wet and dry) - see BBAMP Section 3.3.5. The wet season survey will be in March/April, and is expected to have long grass cover. The dry season survey will be in September/October, and is expected to have short grass cover. The search area will be limited to 70m from the base of the turbines, and will use the same randomly selected set of turbines that are searched regularly.

In each season, the survey will consist of

- 10 microbats or bat proxies (e.g. mice)
- 10 medium sized birds
- 10 large birds (raptor sized)

for a total of 30 carcasses per season, or 60 per year.

We note that sourcing carcasses, particularly for larger birds can be difficult to do humanely and reliably. If sufficient large bird carcasses cannot be procured, it may be necessary to use a nominal value from data from other sites, or published nominal values (e.g. Stark and Muir (2020)). Any material deviation from the standard approach would be confirmed as acceptable by DEECCW.

The carcasses will be distributed among different turbines. Human observers will check the carcasses:

- daily for the first five days

- every two days for the following four days
- every three days until day 18
- every four days until the carcasses disappear, or the end of the trial (30 days)

Additionally, infrared motion detector cameras will be trialled at Clarke Creek, to provide temporally finer-grained resolution than human observers.

3.1.4 Sample size

How precisely can we measure time to (scavenger) loss?

If we assume an exponential loss function for carcasses (the simplest of the standard choices), the relative standard error is a simple function of the number of carcasses lost: RSE $= 1/\sqrt{n}$. As Figure 1 shows, the precision is not vastly improved by increasing the numbers of trials beyond 15-20 replicates.

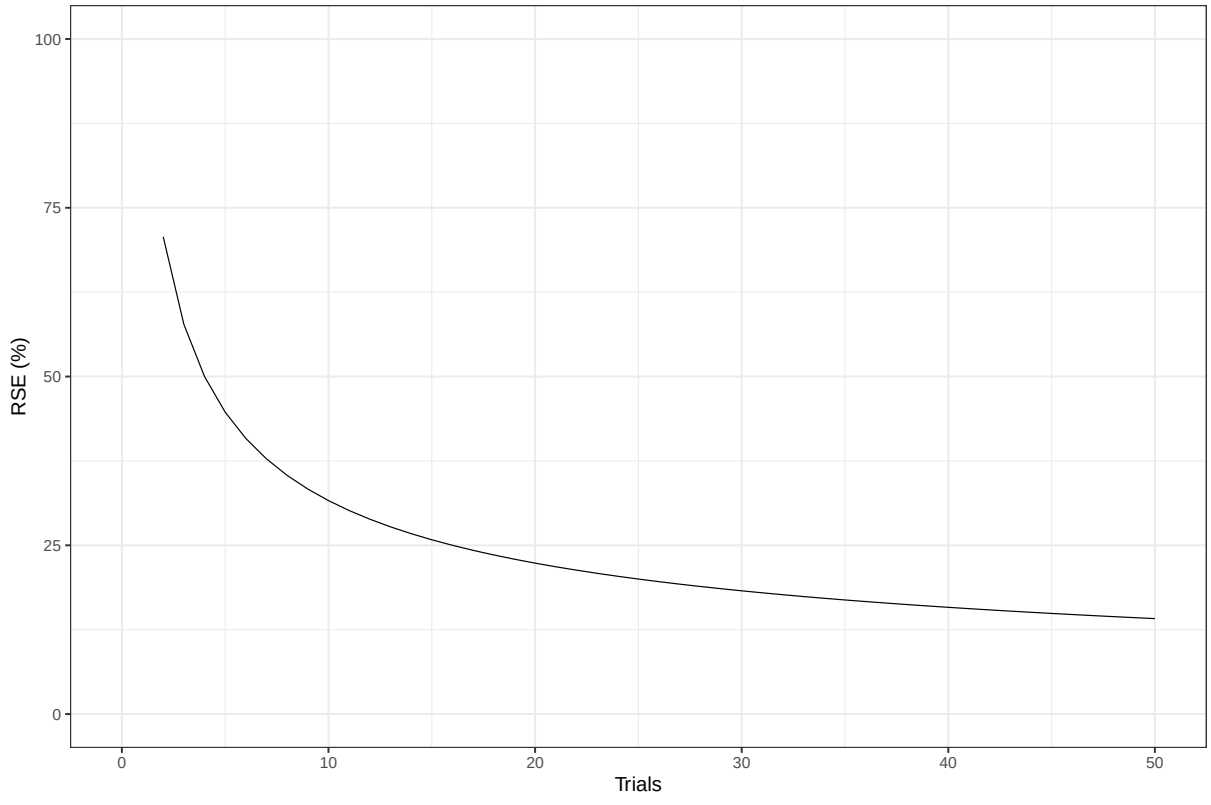

Figure 1: Relative standard error of scavenger rate as a function of carcasses lost

The design uses 20 microbat carcasses and 40 bird carcasses (20 medium, 20 large) per annum. This balances the precision requirements with the operational difficulty of sourcing carcasses.

3.1.5 Analysis methodology

Although motion-capture cameras record the exact time to removal, it is our experience that sometimes the event is only known to within an interval (e.g. the instrument misses the moment of removal).

Therefore, data is likely to be *censored*. There are two forms of censoring encountered in scavenger trials:

- Interval censoring: this means that we know an interval in which the scavenge event happened (e.g. we checked after 1 hour and the carcass was there, then checked after 2 hours and the carcass was gone), but we don't know the exact time of the event.
- Right censoring: the scavenge event happened after completion of the trial (e.g the trial ran for 30 days, and a carcass persisted until the end of the trial). This can also be conceptualised as an interval with the right side being infinity.

Simple methods (such as the mean time to scavenge) fail to account for censoring, and also fail to account for any time-dependence in the carcass loss function. To properly account for this, we use survival analysis (Kaplan and Meier (1958), Therneau and Grambsch (2000)).

Survival regression properly accounts for interval censoring, and allows variously shaped loss functions to be fit to the scavenger trial data.

The calculation can be carried out in statistical software. We recommend the `R` packages `survival` or `GenEst` (which provides a helpful wrapper for the `survival::survreg` function specifically for carcass persistence). Analysis should:

- Fit a range of carcass persistence distributions (at least exponential, Weibull and log-normal) to determine the best fit.
- Test for the significance of the covariates for carcass size.
- Generate an estimate (mean and confidence interval) for each significant covariate group. Covariate groups may be combined if no significant difference is found.

The report should identify

- The software/methods used
- The distribution chosen
- Time to scavenge (mean and confidence interval) for each covariate (e.g. bats in open woodland or bats - total)

3.2 Searcher efficiency trials

Searcher efficiency trials involve the surveyors going out into field with identical survey technique to the main mortality program, and looking for prior (manually) placed carcasses.

3.2.1 Aim

The aim of searcher efficiency trials is the quantify the probability (and confidence interval on that probability) that the searcher will find a carcass, under the planned survey protocol.

This is needed as an input into the mortality estimate.

To derive an annual mortality estimate, we require one, annual value for searcher efficiency. We suggest surveying in more than one season to capture some of the seasonal variability, but we do not need multiple searcher efficiency rates at different times of year.

3.2.2 Metric estimated

We are specifically interested in the Bernoulli parameter p, which is the probability that a searcher finds a carcass, given it is within their search area. We treat each carcass placed as a Bernoulli random variable with probability p of success where success = finding the carcass.

3.2.3 Field methodology

As the BBMP states, the carcasses, placements, and timings used for the scavenger trials will be used for the searcher efficiency trials. This is an efficient use of carcasses, and should not impact the efficacy of either survey.

Therefore, in each season, the survey will consist of

- 10 microbats or bat proxies (e.g. mice)
- 10 medium sized birds
- 10 large birds (raptor sized)

which is 60 total per year.

Transect spacing (or scent detection method, if dogs are used) in the searcher efficiency trials will be identical to those used in the main mortality survey program.

Carcasses should be placed randomly throughout the search area. As this is held concurrently with the scavenger trials, refer to Section 3.1.3 for details of carcass placement.

Carcasses do not need to be the same species as expected in the carcass searches but should have similar detection profiles. For example brown mice might suit as a proxy for bats, but white lab mice would not.

The same type of observer (human or canine) used in the carcass searches should be tested in this survey.

Blind trials are not feasible. Reasons for this include:

- The searcher efficiency trial requires a higher density of carcasses than by chance due to turbine fatalities, making it difficult not to alert the surveyors
- Carcasses can't be always procured that match the species profile of the site, which would also alert surveyors.

3.2.4 Sample size

Figure 2 shows the trade-off between sample size and the size of the confidence interval.

We take the expected mean searcher efficiencies from the values reported in Stark and Muir (2020). This report shows that human observers have an expected searcher efficiency of approximately 50% for bats. Dogs (for bats or birds), and humans searching for birds, have an expected searcher efficiency of approximately 85%.

The coarse black line shows us the estimated efficiency, given a field trial of known sample size, and some number of detections. The 95% confidence window is shown by the grey shaded area. The jaggedness of all curves is a known effect, due to the nature of a dichotomous variable (i.e. "I found it/I did not find it").

There is little precision gain for adding more than 15-20 replicates for a given species class.

The BBAMP suggests 60 trials in the first year with a review of results. As the same carcasses as in the scavenger trial are used, this results in 20 bat (proxy) trials and 40 bird trials (or 20 for each of the two bird size classes). This is reasonable and leaves scope to revise the approach based on the mortality estimates from year 1.

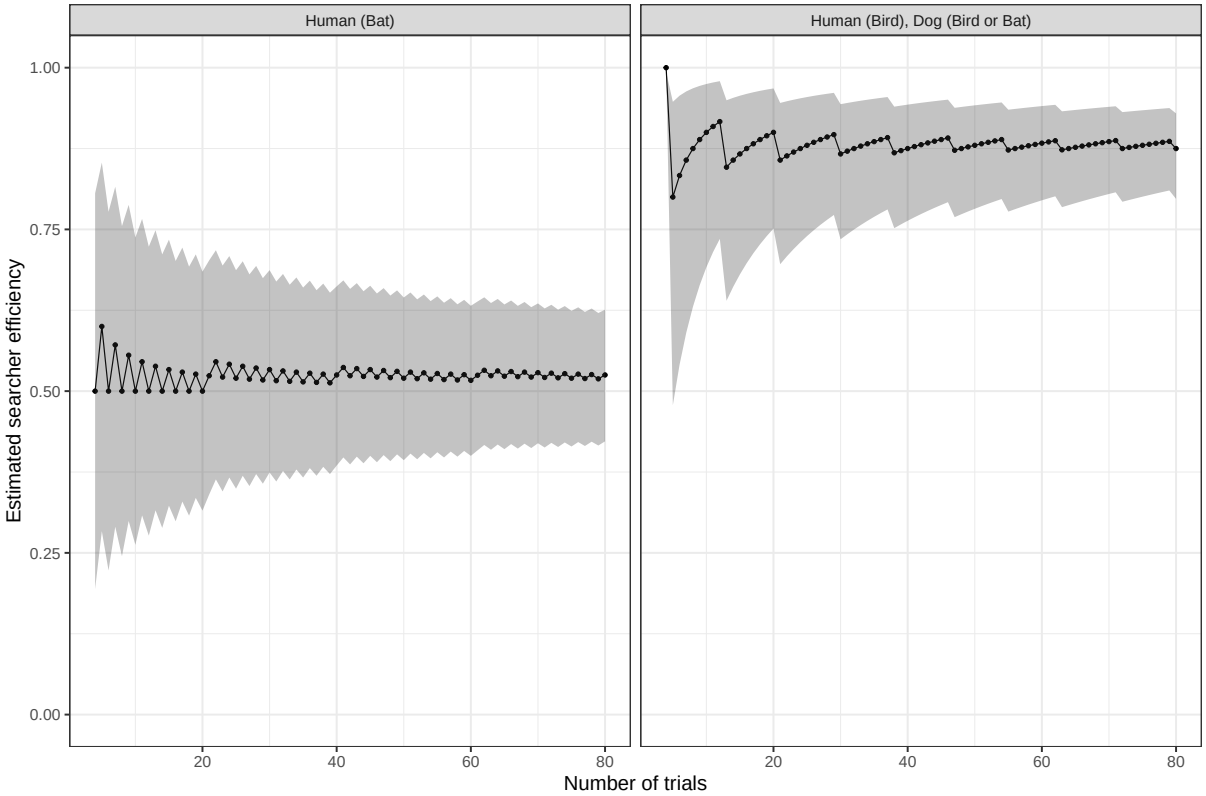

Figure 2: Mean and confidence intervals for varying numbers of searcher efficiency trials.

3.2.5 Analysis methodology

Binomial generalised linear modelling (otherwise known as logistic regression) is used to analyse this type of data. For more details see McCullagh (1989).

Analysis should:

- Test for the significance of the covariates for carcass size.
- Generate an estimate (mean and confidence interval) for each significant covariate group. Covariate groups may be combined if no significant difference is found.

The report should identify

- The software/methods used
- A summary of the covariates tested and the results
- Probability of detection (mean and confidence interval) for each covariate (e.g. bats in open woodland or bats - total)

3.3 Conclusions - adjunct surveys

The techniques for the adjunct surveys presented in the BBAMP:

- provide good statistical robustness
- are balanced with logistical requirements (e.g. sourcing carcasses)
- align with industry standards implemented across Victoria and New South Wales.

3.4 Proportion of area searched

3.4.1 Aim

Quantify an expansion factor to account for carcasses that fall outside the searched area of a turbine.

3.4.2 Metric estimated

The landing position of a struck carcass forms a radial distribution from the base of the turbine, and is dependant on the mass, size, and shape of the animal, as well as the size and height of the turbine (Hull and Muir 2010).

We need to estimate the proportion of this distribution covered by the proposed survey protocol.

3.4.3 Analysis method

Hull and Muir (2010) uses a Monte-Carlo simulation to generate the distribution of landing positions (the 'fall zone'), using a physics-based ballistics equation.

We have used that same software to generate fall zone distributions for Clarke Creek Wind Farm, with hub height 130m and tip height 208m. We calculated fall zones for each of:

- Bat (minimum area 0.0028m^2, maximum area 0.014m^2)
- Medium birds (minimum area 0.045m^2, maximum area 0.1m^2)
- Wedge-tailed Eagle (minimum area 0.07m^2, maximum area 0.6m^2).

The results are shown in Figure 3.

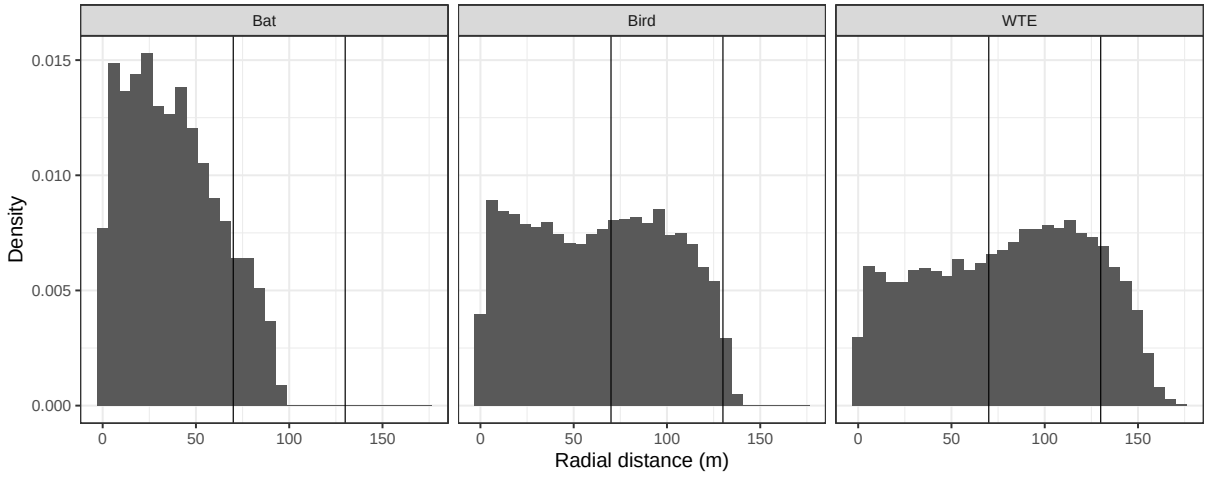

Figure 3: Fall zone distributions for bats, medium birds, and Wedge-tailed Eagles. The vertical lines represent the 70m and 130m search radii.

3.4.4 Results

From this distribution, we see that

- the 70m circular search zone covers approximately:
  - 88% of the bat fall zone
  - 55% of the medium bird fall zone
  - 41% of the Wedge-tailed Eagle fall zone
- and the 130m circular search zone covers approximately:
  - 100% of the bat fall zone
  - 99% of the medium bird fall zone
  - 86% of the Wedge-tailed Eagle fall zone

Further to this, we understand that the entire circular zone may not be surveyable, due to the difficult terrain at Clarke Creek. In the most extreme case, only the access roads and hardstands would be searchable. To model this, we calculate the density-weighted proportion (DWP) (M. Huso and Dalthorp 2015) of the fall zone covered by the access roads and hardstands[1]. We ignore the circular zone in this case as the shape of the hardstand and road is the limiting factor, rather than the search radius.

In this case, the DWP of every turbine is different. The mean value for a search is:

[1]We used the provided shapefiles from Goldwind Australia Pty Ltd, to define the hardstand and access road shapes for each turbine, `100WTG Layout with Roads and hardstands.kmz`.

- 40% for bats
- 25% for birds
- 18% for WTEs

The area searched is appropriate to estimate mortality, especially considering the steep surrounding terrain which poses practical and safety challenges to expanding the search area further. Despite the low proportion of area searched, this is fully accounted for during the mortality estimation process.

The on-ground situation may be somewhere in between the extreme scenario (hardstand/road only) and the optimal scenario (130m and 70m search radii). Depending on the accessible area, the sampling fraction may be increased to account for a lower search area.

3.5 Carcass searches and mortality estimation

3.5.1 Aim

The carcass searches sample the actual turbine collision mortalities, as the final input to estimate the total mortality.

Mortality estimation aims to quantify the total collision mortality of a species or species cohort. It provides a comparison metric between sites, and adds to cumulative modelling.

Additionally it can be used for compliance with trigger values. At Clarke Creek Wind Farm, there are six species with turbine shut-down trigger values (Table 1).

Note that these shutdown triggers are invoked as a second stage of management. For all the species listed in Table 1 an initial action is invoked when a single carcass of that species is found. At the first trigger, additional carcasses searches are conducted for a period at adjacent turbines.

After this, if the estimated number of mortalities meets or exceeds these trigger values within a year shutdowns can be invoked.

In the following examples we assess the survey design as stated in the BAM plan against the trigger values. We note that in practice the mortalities should be estimated according to the actual conducted survey design (incorporating additional surveys, etc.) before any trigger is invoked.

Table 1: Turbine shutdown trigger values at Clarke Creek.

Species	Trigger
White-throated Needletail	41
Rainbow Bee-eater	1000
Rufous Fantail	1500
Fork-tailed Swift	100
Satin Flycatcher	1700

3.5.2 Metric studied

The metric estimated is the total mortality of a species (cohort) of interest due to wind turbine operation.

For trigger species, we are also interested in the probability that a trigger is met or exceeded, given a number of carcasses found on the ground. Expressed mathematically, that is

$$\Pr(M \geq t|x)$$

where M is the true (and unknown) number of mortalities, t is the trigger and x is the number of carcasses found in the surveys.

3.5.3 Field methodology

The overall percentage of turbines surveyed is 30%, of 100 in Phase 1. The overall percentage is split into a "fixed" component (25%, which are turbines that are searched regularly), and a "random" component (5, which are searched irregularly).

Note that as turbines are commissioned, the sampling fraction remains constant, but the overall number increases.

The fixed component is searched at regular intervals, comprises the bulk of the search effort, and minimises the variance of the overall mortality due to the consistent nature of its design. It will comprise of 25 turbines total at Phase 1 commissioning, boosted to 49 turbines at Phase 2.

The random component is an additional set of turbines which are searched on a rolling basis every survey round (5 at Phase 1, and 10 at Phase 2). As they are searched inconsistently, there is more uncertainty associated with their finds, but they give coverage over the whole farm. The random component turbines can be selected by randomly ordering list of remaining (non-fixed) turbines, and adding them to each month's surveys. This will result in full farm coverage over the monitoring period.

For example, the set of fixed turbines could be those found in Table 2, and every month, one Group from the random turbines would also be sampled (Table 3).

Table 2: Fixed turbines (Phase 1)

Turbines
90, 91, 96, 97, 103, 107, 56, 57, 62, 74, 76, 77, 78, 82, 24, 29, 30, 47, 52, 53, 12, 33, 38, 42

Table 3: Random turbines (Phase 1) per survey round.

Group	Turbines
1	6, 66, 70, 80, 100
2	16, 44, 64, 93, 105
3	22, 35, 41, 50, 99
4	17, 19, 23, 31, 84
5	72, 85, 87, 92, 108
6	11, 27, 32, 37, 101
7	18, 20, 45, 51, 111
8	21, 59, 69, 94, 102
9	39, 63, 73, 83, 110
10	10, 58, 67, 81, 98
11	14, 26, 54, 61, 106
12	40, 60, 65, 75, 95
13	25, 28, 43, 46, 89
14	36, 49, 79, 104, 109
15	48, 55, 68, 71, 86, 88

3.5.4 Timing

The proposed survey timing is

- survey to a radius of 130m once a month
- survey to a radius of 70m a few days later (all year round)

The second survey is also known as a “pulse”.

3.6 Carcass survey - statistical review

There is no ‘golden rule’ governing the optimal frequency of searches. For example, we are not trying to determine the difference between classes, so a power analysis is not applicable.

We can use simulation methods[2] to estimate the proportion of carcasses that will be found given this survey design. The same method can help us understand the likelihood of a true absence by simulating the frequency of the search protocol missing all mortalities.

We will consider two related points:

1. **What is the overall probability of detection of the survey?**
2. **Given we detect evidence of mortality, what is the likely range of mortalities that occur?**

[2]For full details on the algorithm used see Stark and Muir (2020) or the analysis methodology section later in this document - Section 3.6.1.

We simulate the survey protocol as outlined above in Section 3.5.4.

In all cases we have assumed human searchers. We use the nominal values for general bird searcher efficiency and scavenger loss rates from Stark and Muir (2020), and assume the same searcher and scavenger efficiency for all scenarios.

It's worth remembering that the mortality estimate itself does **not** require coverage of all turbines and dates - only that the sample is chosen in a way that does not fail the assumptions of the Horvitz-Thompson estimator.

In the following sections, we concentrate on how the survey performs in detecting White-throated Needletails (WTNT). The results are however similar for birds generally, and bats. White-throated Needletails have the potential to be on-site at Clarke Creek from October to April inclusive (Nature Advisory 2021) so our analysis is limited to this time period.

Note: for each survey design we refer to in this section, the results are based off $n = 100000$ simulations.

3.6.1 Analysis methodology

There are a number of current analytical and numerical methods suitable for estimating total mortality from carcass counts. Analytical methods include Manuela M. Huso (2011) and Korner-Nievergelt et al. (2011), while Dalthorp et al. (2018) presents an numerical package that extends the analytics estimates.

A number of earlier mortality estimators exist (e.g. Erikson, M. D., and K. (2000), Smallwood (2007)), but these are rarely used today because they produce biased results or exclude some inputs. Bernardino et al. (2013) provides a good overview of these limitations.

One limitation of analytical methods is estimating r_{ij} when the time between surveys is not constant. In Australia, it is common for the time between searches to vary due to seasonal changes in effort or the use of a pulsed design in which the turbine is searched monthly with a return visit a few days later.

To allow for survey protocols with non-standard interval, we developed a Monte-Carlo simulation method (Stark and Muir 2020).

Monte-Carlo methods (Sawilowsky (2003), Ripley (1987)) simulate a large set of possible survey results, by simulating the actual sampling protocol and sampling from the empirical distributions for scavenge loss and searcher efficiency. In this way, we can directly sample the probability a carcass was lost before the survey, negating the need to calculate r_{ij} analytically each time.

The Monte-Carlo simulation generates a representative coverage of the phase space influencing the probability of detection. To generate an estimate of mortality, we extract all simulations with the same number of discovered carcasses as the 'real' survey data under consideration (Figure 4).

The distribution of simulated carcass arrivals is a direct estimate of the mortality estimate. From it, we extract the median and confidence intervals.

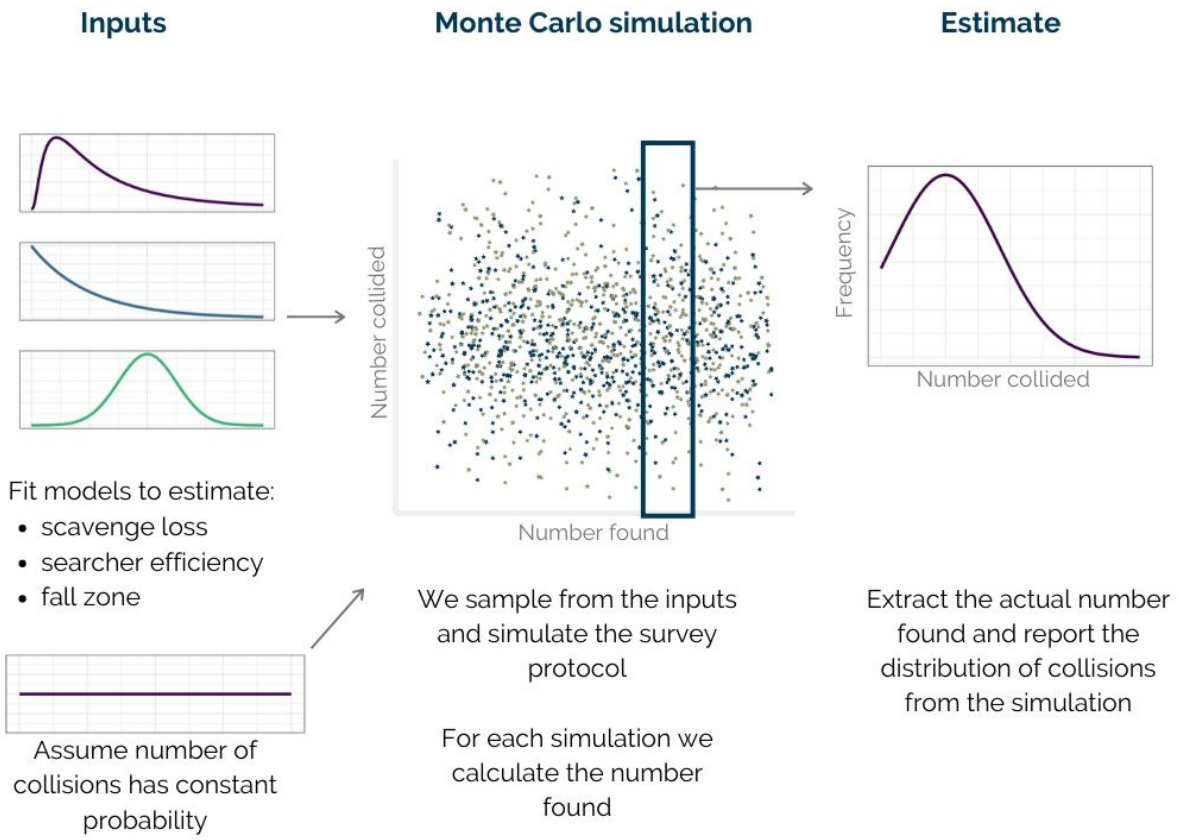

Figure 4: Schematic showing the application of the Monte-Carlo method to simulate the phase space of possible collisions and subsequent carcass finds. The inputs are based on empirical distributions estimated from field trials.

The Monte-Carlo simulator is an algorithmic / numerical approach to solving equations (1) and (2).

3.6.2 Overall probability of detection

Figure 5 shows the overall probability of detection for the WTNT given the survey design. The overall probability of detection is roughly 12% (5% if searching hardstand / road only), and is represented by the horizontal thick black line. We also recalculate it for each potential number of mortalities - the jagged lines. We can see that (as expected) it is centred around the overall probability of detection line, with lower M values having inherently more uncertainty, so more wobble.

These results are presented for Phase 1 (first 100 turbines), noting that results are similar

between Phase 1 and Phase 2.

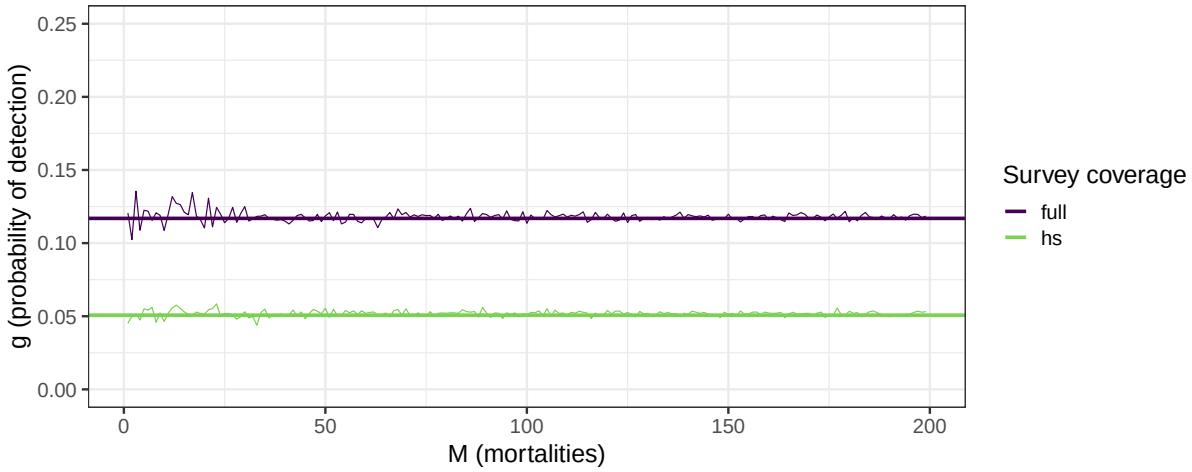

Figure 5: Overall probability of detection under proposed survey design.

From this, we can see the overall probability of detection of a single carcass is low. This however does not mean the survey is poorly designed - it still gives an unbiased estimate of overall mortality. However, as with most sample design the survey is unlikely to find threatened species if a small number of WTNT collide and won't trigger management actions for the WTNT if no carcasses are found.

As the number of mortalities increase the overall probability of detection for any one value approaches the central value, which is the overall g value refered to in equation (1)

- For the full survey g is 0.117
- For the hard-stand only survey g is 0.051.

We note that this estimate reflects the proposed survey design, using humans and for a WTNT species.

This can be used as a rough estimate of the expansion factor applied to translate similar species carcasses found into actual mortalities. For example 1000 mortalities is roughly equivalent to $1000 * g$ or 117 found carcasses in Phase 1 using the full survey design.

This is a useful 'rule of thumb' to ensure trigger values won't be met and undetected under a proposed survey design. However, we strongly recommend that a mortality estimate be carried out on actual data (including site- or region-specific scavenger and detection rates) to confirm the results before offsets or shut-downs are invoked. This ensures that any survey changes (including additional survey) is taken into account for actual management.

3.6.3 Likely ranges of mortalities

In this exercise, we are evaluating the ability of the survey design to inform impact trigger management. In particular, we focus on the White-throated Needletail trigger, which has been

deemed to be the species most practically at risk.

Figure 6 shows the likely range of WTNT mortalities from the simulations (M - y axis) for each number of finds (x - x axis). It displays the data in a box plot. A box plot has the middle 50% of data between the upper and lower edges of the box, with the middle line being the median. The tails and outliers are the vertical lines and dots respectively.

Again, results are presented for Phase 1 (100 turbines) and assume human searchers (which generally represent lower detection efficiency than dogs).

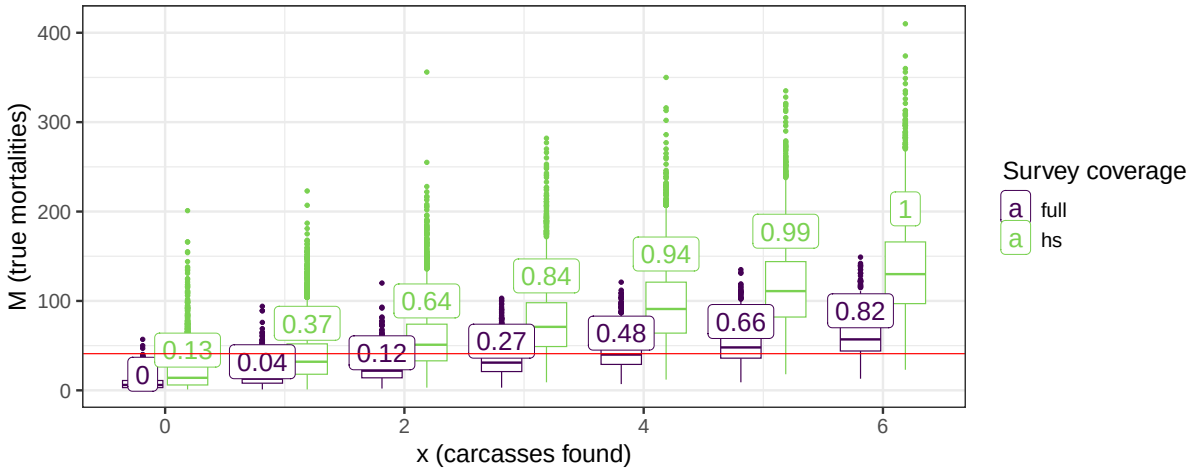

Figure 6: Likely range of mortalities, given number of carcasses found. The horizontal red line is the trigger, while the boxed numbers give the probability the trigger is exceeded.

For assessing trigger exceedance we advise the median **M** estimated from the simulation as the most appropriate 'average' to use. In Figure 6 the median scenario is indicated by the horizontal line in the middle of the box plot, and a `0.5` in the accompanying text box. Under the proposed design the trigger (41 WTNT carcasses in a 12 month period) is considered exceeded when five carcasses are found. Should access be so poor that every turbine can only have a hard-stand and road survey (an unlikely scenario) the trigger would be three carcasses.

Please note this number of carcasses should not blindly be applied as a trigger as on-ground circumstances can impact the actual survey design, and by extension the expansion factors applied to the carcasses. Figure 6 should only be used as an indication of the trigger, to be confirmed as part of the adaptive management.

Based on these results there is no need to increase the survey effort beyond that proposed, but we present alternative designs as an appendix, for completeness.

3.6.4 Conclusions and recommendations

Based on the analysis above, the proposed survey design and adaptive management process will work together to monitor risk of collision for threatened species, as well as provide summary

statistics on the number of bird and bat mortalities.

We note again that Figure 6 shows a potential relationship between found carcasses and actual mortalities if the proposed survey is unchanged. It demonstrates that finding none or one carcass on the ground does not indicate a shutdown trigger is breached for WTNT (or any of the other species of interest).

However there is an adaptive management trigger that will be invoked after only one threatened species carcass is found. That procedure will increase survey effort at nearby turbines for a period of time after the carcass is detected. This additional survey will *increase* the overall probablility of detection and consequently *decrease* the number of actual mortalities associated with a detected carcass.

We suggest in this case, a mortality estimate is conducted after the period of increased survey is completed. That mortality estimate will be based on the total found carcasses and consider the exact survey protocol used.

Should the median mortality/year estimated from that process exceed a shutdown trigger, the next stage of the adaptive management plan will be invoked.

A Mapping

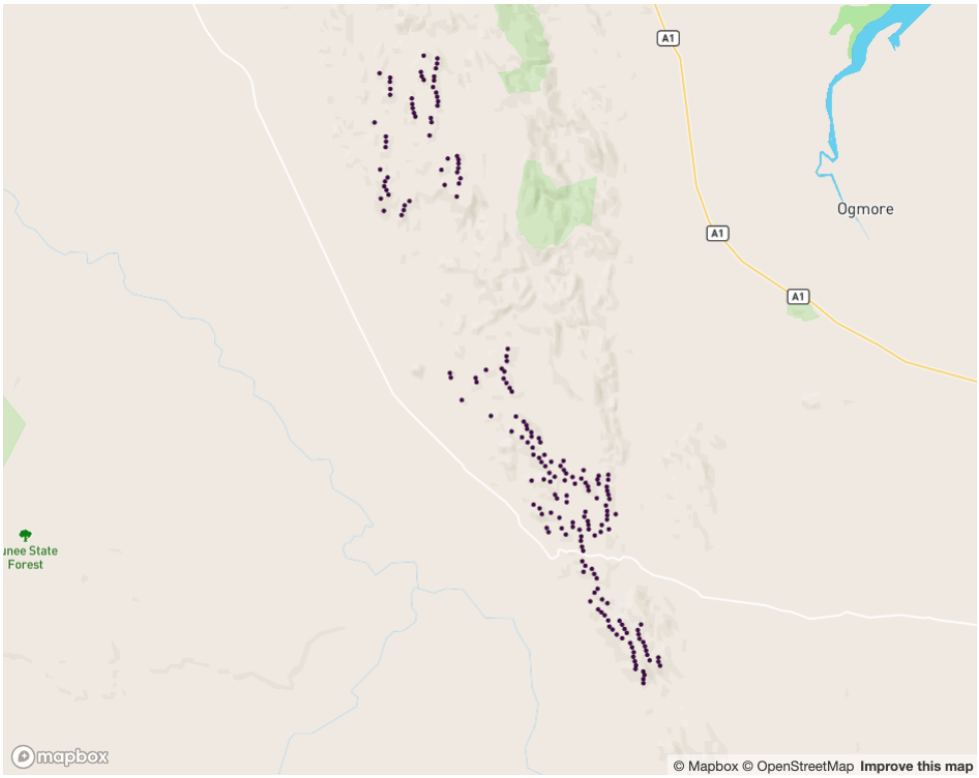

Figure 7: Site layout of turbines

B Competing designs

We are looking at detecting WTNT between October and April only (inclusive).

These are four alternative, competing survey designs, based on the full Phase 1 and 2 build. These scenarios were considered when optimising and finalising the design, and are presented here for completeness.

- Scenario 1: 35% of all turbines ($n = 195$ total turbines) searched Oct - Apr. Standard (130m radius) followed by Pulse (70m radius) three days later, once per month. An additional 5% of turbines are searched on a rolling basis.
- Scenario 2: 45% of all turbines searched Oct - Apr. Half of these have a Standard (130m radius) followed by a Pulse (70m radius) three days later, once per month. The other half just have a Standard but no Pulse. An additional 5% of turbines are searched on a rolling basis.
- Scenario 3: 45% of all turbines searched Oct - Apr. Standard (130m radius) followed by Pulse (70m radius) three days later, once per month. An additional 5% of turbines are searched on a rolling basis.
- Scenario 4: 56% of all turbines searched Oct - Apr. Standard (130m radius) followed by Pulse (70m radius) three days later, once per month. An additional 5% of turbines are searched on a rolling basis.

Scenario 0 is the baseline scenario.

We also present results if only the hardstand / road can be searched.

We then reproduce the overall probability of detection in Figure 8 and the likely range of mortalities in Figure 9.

Figure 8 shows that with the updated scenarios (under the full coverage), the overall probability of detection now sits in the range of 15-22% (as opposed to the original design's value of 12%).

Figure 9 shows that for scenario 1, finding six carcasses on the ground means a greater than 50% chance the trigger has been exceeded. Scenario 3 and 4 require more carcasses found to exceed the trigger, but represent a considerable increase in search effort.

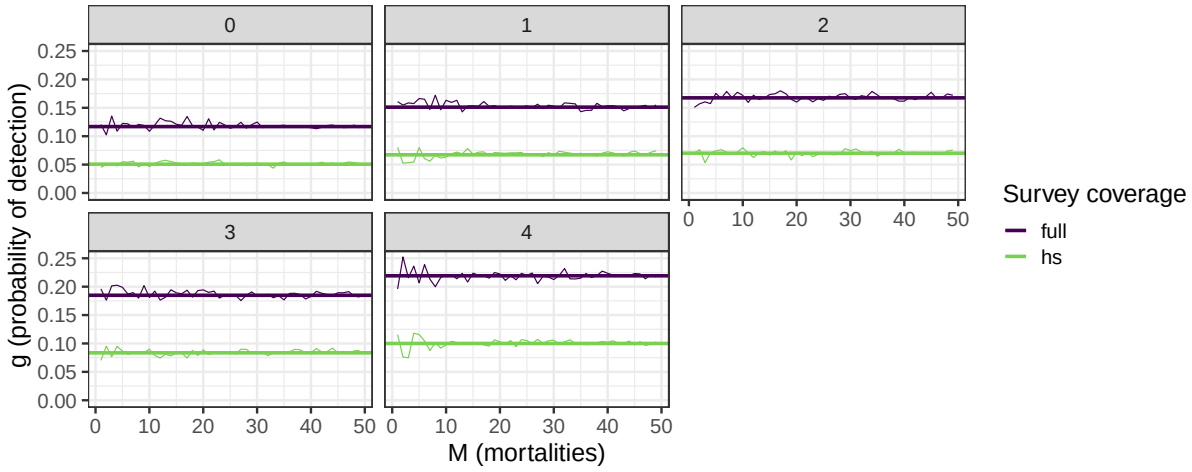

Figure 8: Overall probability of detection for various scenarios.

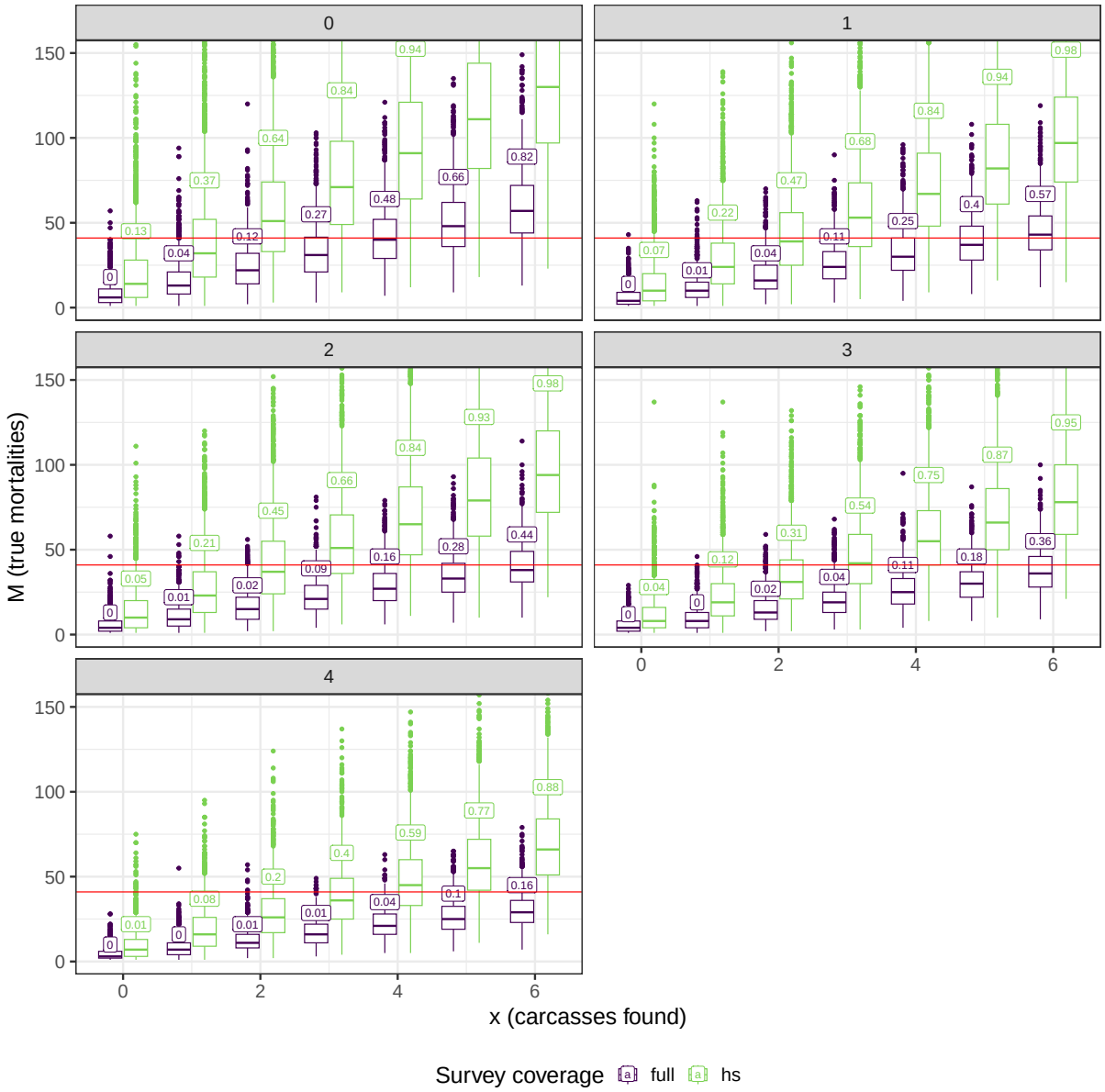

Figure 9: Likely range of mortalities versus count of carcasses found for various scenarios.

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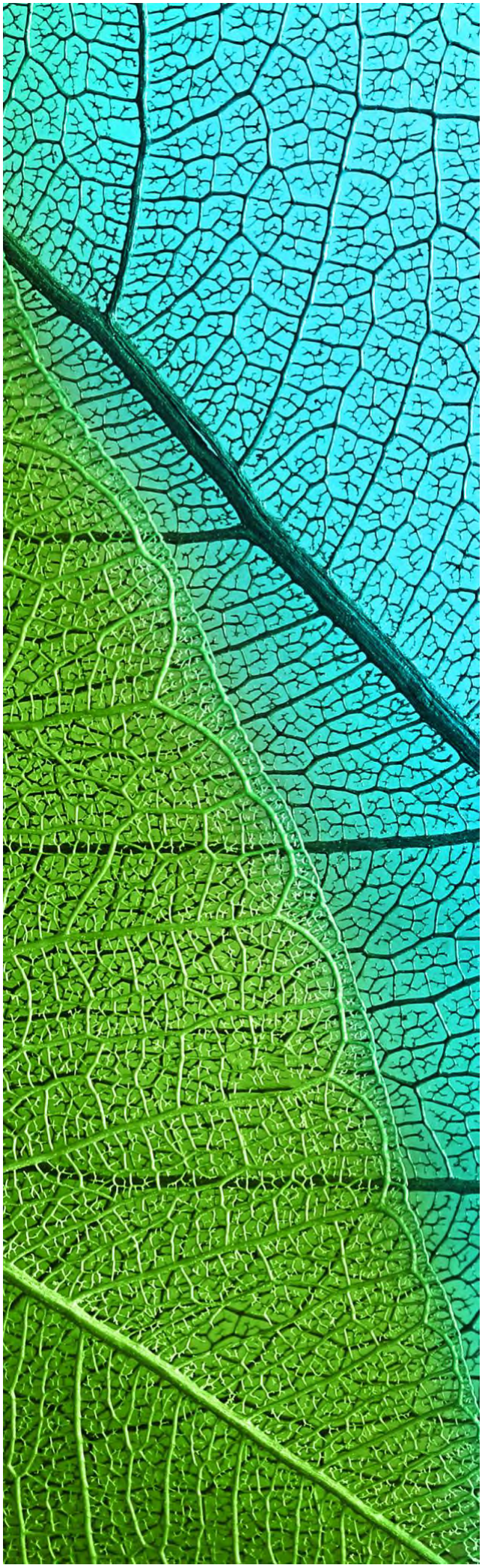
Appendix 3: BUS Report (2017/2020)



Clarke Creek Wind Farm

Bird Utilisation Survey Report

Prepared for Clarke Creek Wind Farm Pty Ltd
C/- NGH Pty Ltd

February 2021
Report 17047 (5.1)

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1. INTRODUCTION

Clarke Creek Energy Pty Ltd has commissioned Nature Advisory Pty Ltd together with NGH Pty Ltd and Green Tape Solutions Pty Ltd to undertake a bird utilisation survey (BUS) for the Clarke Creek Wind Farm (the Project) in Autumn and Spring 2020. The Project is located in the Isaac Regional Council and the Livingstone Shire Council Local Government Areas, approximately 150 km north-west of Rockhampton and 45 km south-west of the township of St Lawrence, Central Queensland. The Project is located over 11 freehold rural properties with an estimated area of 76,300 hectares (ha), known collectively as the 'Project Area'.

The Project received an approved Development Permit under the Queensland Planning Act 2016 from the Department of State Development, Manufacturing, Infrastructure and Planning (DSDMIP) in August 2018 (1711-2680 SDA). The Project was approved under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) by the then Department of Environment and Energy (now Department of Agriculture, Water and the Environment (DAWE)) in November 2018 (EPBC 2018/8141). The Project is planned to commence construction late 2020 / early 2021.

Two periods of BUS were completed in 2017 and reported on within the ecological assessment report which was submitted as part of the relevant assessment required under State Code 23 (DILGP 2017b) of the State Development Assessment Provisions (SDAP) (DILGP 2017a) to support lodgement of a Development Application for the wind farm to the State Assessment Referral Agency (SARA). The 2017 BUS were also reported on in the Preliminary Documentation submitted to DAWE under the EPBC Act.

1.1. Purpose

The purpose of the 2020 BUS is to further increase knowledge about the diversity of bird species and their utilisation of height strata to further inform the risk of collision with proposed turbines.

The 2020 BUS address the DSDMIP condition of approval that:

> *No. 9(a) Prepare a Bird and Bat Management Plan (BBMP)... The BBMP must include:*
>
> *(ii) incorporate baseline data, including additional pre-operational surveys.*

Whilst the EPBC approval does not prescribe additional pre-operational surveys, the results of the Autumn and Spring 2020 BUS will positively contribute to the Threatened BBMP which will be submitted to the DAWE for approval in accordance with EPBC condition of approval:

> *No. 9 The approval holder must submit a Threatened Bird and Bat Management Plan for the Minister's approval that ensures the protection of EPBC Act listed threatened bird and bat species.*

1.2. Scope

This report summarises the results of BUS undertaken at the Project Area. Specifically, the scope of the investigation included:

- Four seasonal surveys (Autumn and Spring 2017, and Autumn and Spring 2020) covering representative parts of the properties where turbines are proposed to be located, involving:
  - A statistically viable number of replicate surveys at each site, recording the numbers and heights at which each bird species was observed flying, covering the maximum area where turbines may be located and maximising the coverage of areas which birds may utilise.

- Incidental observations throughout the wind farm site, to elucidate the overall bird diversity of the site and to check whether threatened species are likely to be present.
- Compilation of bird species lists for the site.

This report is divided into the following sections:

Section 2 describes the sources of information, including the methods used for the field survey and limitations.

Section 3 provides an overview of the characteristics of the project area.

Section 4 presents the investigation results, describing the flora and fauna of the project area.

Section 5 discusses the conclusions and recommendations to inform the design process and assist the development of a minimum impact proposal.

BUS surveys and reporting from 2017-2020 have been undertaken by a team comprising Jason Searle (Senior Ecologist: NGH), Jasmine Vink (Ecologist: Green Tape Solutions), Andrew Rogers (Ecologist: Green Tape Solutions), Natalie Sheppard (Ecologist: NGH), Silverio Oliviera (Zoologist: NGH), Eamon O'Meara (Zoologist: Nature Advisory), Tom Cotter (Zoologist: Nature Advisory), Peter Lansley (Zoologist: Nature Advisory), Inga Kulik (Senior Ecologist and Project Manager: Nature Advisory), Beth Kramer (Senior Ecologist and Project Manager: NGH) and Brett Lane (Principal Ecologist: Nature Advisory).

2. SOURCES OF INFORMATION

2.1. Existing information

Existing information regarding the bird utilisation survey is described below. The Project Area refers to private properties located approximately 45 km south-west of St Lawrence and 150 km north-west of Rockhampton, Central Queensland. Specifically, the area where turbines are proposed to be located comprises part of the southern Conners Range, to altitudes of 400 to 600 metres AHD, aligned primarily north-south, to the west of the Bruce Highway and east of the Marlborough-Sarina Road.

Threatened species information was obtained from a wider area, termed the 'search region' defined for this assessment as an area of 20 km radius from the approximate centre point of the project area; coordinates: latitude 22°41'20.5"S and longitude 149°27'46.8"E.

2.1.1. Fauna

A representative list of the bird species recorded in the search region was obtained from the Atlas of Australian Birds (Birdata), a database administered by BirdLife Australia (2020), and from *Wildlife Online*, the Queensland State Government (2020) wildlife database. Fauna taxonomy used throughout this report follows the BirdLife nomenclature.

The presence or likelihood of occurrence in the project area of nationally threatened fauna species was obtained through the EPBC Act Protected Matters Search Tool (DAWE 2020a) based on a search region of 20 km from the boundary of the project area.

2.2. Field methodology

The surveys were consistent with the requirements for a "Level One" bird risk assessment in accordance with 'Wind Farms and Birds - Interim Standards for Risk Assessment' issued by the Australian Wind Energy Association (AusWEA 2005). This approach has been endorsed in the latest Best Practice Guidelines (Clean Energy Australia 2018). The methodology conforms with Queensland State Code 23 (Appendix 3), relating to wind farm development (DILGP 2017b).

Three field assessments were conducted namely:

- 13th to 16th October 2020 (Spring/pre wet season survey),
- 18th to 21st April 2020 (Autumn/post wet season survey),
- 12th to 19th September 2017 (Spring/pre wet season survey), and
- 22nd to 26th March 2017 (Autumn/post wet season survey).

Surveys were completed by Senior Zoologist Eamon O'Meara (E) (2017 dry and wet seasons), Senior Zoologist Peter Lansley (P) (2017 wet season), NGH ecologists Natalie Sheppard (N) (2020 wet season), Jason Searle (JS) (2020 dry and wet season), Andrew Rogers (AR) (2020 dry and wet season) as well as Silverio Oliviera (2020 dry season) and Green Tape Solutions ecologist Jasmine Vink (JV) (2020 wet season). During these assessments, the project area was accessed by vehicle and foot, and birds were recorded using binoculars.

Survey points in the project area were selected according to whether they were located on a ridge top or spur and offered a minimum 270-degree viewing, out to 80 m. In some cases, the terrain made this impossible so a more restricted viewing arc was accepted. Habitats covered some

reasonably intact grassy woodland and some mostly cleared sites on ridges and spurs. Habitat data was recorded for each site. Each of the survey points was at least 500 m apart.

2.2.1. Bird Utilisation Survey

The following techniques were used to document bird species at the survey points:

- The fixed-point bird count method involved an observer stationed at a survey point for 20 minutes. The adequacy of using 20 minutes as an interval to record the presence of birds during bird utilisation surveys was investigated in an earlier study at another wind farm site (Nature Advisory Pty Ltd, unpublished data), and falls within the "*Survey guidelines for Australia's threatened birds*" (DAWE 2017). This showed that 82 to 100 percent (average 88 percent) of species actually seen in one hour of surveying were seen in the initial 20 minutes of observation. Based on this result, the period of 20 minutes used in the formal bird utilisation surveys was considered adequate to generate representative data on the bird species in the area during the survey.
- All observers were qualified ecologists and zoologists with experience in bird searching and identification. There were slight differences in the locations of survey points between observers and between the four seasonal surveys. These are not considered to compromise the validity of the data as points were representative of the habitats in which they were located. All field work was overseen by a consistent point of contact and all survey design, data entry and data analysis were completed by a single qualified Zoologist from Nature Advisory.
- During this period, all bird species and numbers of individual birds observed within 80 m were recorded. The species, the number of birds and the height of the birds when first observed were documented. For species of concern (threatened species, waterbirds and raptors), the minimum and maximum heights were recorded (see also Section 2.2.2).
- Flight height is presented as below, at or above rotor swept area height (RSA height):
    - A = Below RSA (< 40 metres above ground)
    - B = At RSA (40 – 220 metres above ground)
    - C = Above RSA (> 220 metres above ground).

Each of the points was surveyed eight times (8 replicates), twice each at each of four different times of day: early morning (6 to 9am), late morning (9am to 12 noon), early afternoon (12 noon to 3pm) and late afternoon (3 to 6pm). This ensured even coverage of bird activity at each site throughout the day, over the duration of the survey. Twelve (12) sites were surveyed in the 2017 Autumn season, 24 sites in the 2017 Spring season, 32 sites in the 2020 Autumn season and 28 sites in the 2020 Spring season.

The daily schedule of survey points visited is set out below. The dry season survey included four additional points to reflect a minor change to the turbine layout.

Table 1: Daily BUS schedules Autumn 2017

Date and Replicate										
Time	22/03/2017		23/03/2017		24/03/2017		25/03/2017		26/03/2017	
8:00-10:00	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10
10:00-12:00	E2	E1	E3	E4	E5	E6	E7	E8	E9	E10
12:00-14:00	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10
14:00-16:00	E2	E1	E3	E4	E5	E6	E7	E8	E9	E10

Table 2: Daily BUS schedules Spring 2017

	Date and Replicate													
Time	12/09/2017		13/09/2017		14/09/2017		15/09/2017		16/09/2017		17/09/2017		19/09/2017	
8:00-10:00	E1	E2	E3, E4	E3, E4	E5, E6	E5, E6	E7, E8	E7, E8	E9, E10	E9, E10	E11, E12	E11, E12	E1, E2	E1, E2
	P1	P2	P3, P4	P3, P4	P5, P6	P5, P6	P7, P8	P7, P8	P9, P10	P9, P10	P11, P12	P11, P12	P1, P2	P1, P2
10:00-12:00	E1	E2	E3, E4	E3, E4	E5, E6	E5, E6	E7, E8	E7, E8	E9, E10	E9, E10	E11, E12	E11, E12		
	P1	P2	P3, P4	P3, P4	P5, P6	P5, P6	P7, P8	P7, P8	P9, P10	P9, P10	P11, P12	P11, P12		
12:00-14:00	E2	E1	E3, E4	E3, E4	E5, E6	E5, E6	E7, E8	E7, E8	E9, E10	E9, E10	E11, E12	E11, E12		
	P1	P2	P3, P4	P3, P4	P5, P6	P5, P6	P7, P8	P7, P8	P9, P10	P9, P10	P11, P12	P11, P12		
14:00-16:00	E1, E2	E1, E2	E3, E4	E3, E4	E5, E6	E5, E6	E7, E8	E7, E8	E9, E10	E9, E10	E11, E12	E11, E12		
	P1, P2	P1, P2	P3, P4	P3, P4	P5, P6	P5, P6	P7, P8	P7, P8	P9, P10	P9, P10	P11, P12	P11, P12		

Table 3: Daily BUS schedules Autumn 2020

Date and Replicate										
Time	18/04/2020		19/04/2020		20/04/2020		21/04/2020		22/04/2020	
7:00-9:30		P6, P5, P6	E3, E4, E3, E4	E9, E10, E9, E10	South Ridge 3, South Ridge 4, South Ridge 3, South Ridge 4,	E1, E2, E1, E2	E5, E5, E5, E5	N5, N5, N5		
	Green3, Green 4, Green 3, Green 4		P3, P4, P3, P4,		P1, P2, P1, P2	N4, N3, N4, N3, N4	E6, E6, E6, E6, E6		North Ridge 3, North Ridge 4	N7, N7
9:30-12:00	N1, N2, N1, N2	P5, P6, P5, P6	E3, E4, E3, E4	E9, E10, E9, E10	South Ridge 3, South Ridge 4, South Ridge 3, South Ridge 4,	E1, E2, E1, E2	E5, E5, E5, E5			
	Green3, Green 4, Green 3, Green 4		P3, P4, P3, P4,		P1, P2, P1, P2	N4, N3, N4	E6, E6, E6			
12:00-14:30	N2, N2, N2	P5, P6, P5, P6	E3, E4, E3, E4	E9, E10, E9, E10	South Ridge 3, South Ridge 4, South Ridge 3, South Ridge 4,	E1, E2, E1, E2				
	Green3, Green 4, Green 3, Green 4		P3, P4, P3, P4,	N3, N3, N4	P1, P2, P1, P2	N5, N5	North Ridge 3, North Ridge 4	N7, N8, N7, N8		
14:30-17:00	N1, N2, N1, N2	P5, P6, P5, P6, P5	E3, E4, E3, E4	E9, E10, E9, E10	South Ridge 3, South Ridge 4, South Ridge 3, South Ridge 4,	E1, E2, E1, E2		TP1, TP1, TP1, TP1, TP1, TP1		
	Green3, Green 4, Green 3, Green 4		P3, P4, P3, P4,	N3, N4, N3, N4	P1, P2, P1, P2	N6, N6, N5, N6, N5, N6	North Ridge 3, North Ridge 4, North Ridge 3, North Ridge 4	N7, N7, N7, N7		

Table 4: Daily BUS schedules Spring 2020

Date and Replicate										
Time	13/10/2020		14/10/2020			15/10/2020			16/10/2020	
7:00-9:30			E2, E1, E2, E1,	P1, P2, P1, P2	N1, N2, N1, N2	P3, P4, P3, P4	Green 3, Green 4, Green 3, Green 4		North Ridge 3, North Ridge 4, North Ridge 3, North Ridge 4	P5, P6, P5, P6
	E9, E10	N3, N4	E9, E10	N3, N4		E3, E4, E3, E4	South Ridge 3, South Ridge 4, South Ridge 3, South Ridge 4	N5, N6, N5, N6	E5, E6, E5, E6	N7, N8, N7, N8
9:30-12:00	E1, E2, E1	P1, P2	E2	P3, P4	N1, N2, N1, N2	P3, P4	N5, N6, N5, N6		North Ridge 3, North Ridge 4, North Ridge 3, North Ridge 4	P5, P6
	E9, E10, E9, E10	N3, N4, N3, N4	E4, E3, E4	Green 3, Green 4, Green 3, Green 4	P1, P2	E3	South Ridge 3, South Ridge 4, South Ridge 3, South Ridge 4	P5, P6	E5, E6, E5, E6	N7, N8, N7, N8
12:00-14:30	E1, E2, E1, E2	P1, P2, P1, P2	P3, P4, P3, P4	Green 3, Green 4, Green 3, Green 4		P5, P6, P5, P6	N5, N6, N5, N6		North Ridge 3, North Ridge 4, North Ridge 3, North Ridge 4	N7, N8, N7, N8
	E9, E10, E9, E10	N3, N4, N3, N4	E3, E4, E3, E4	N1, N2, N1, N2		E5, E6, E5, E6	South Ridge 3, South Ridge 4, South Ridge 3, South Ridge 4			
14:30-17:00	E1, E2, E1, E2	P1, P2, P1, P2	P3, P4, P3, P4	Green 3, Green 4, Green 3, Green 4		P5, P6, P5, P6	N5, N6, N5, N6		North Ridge 3, North Ridge 4, North Ridge 3, North Ridge 4	N7, N8, N7, N8
	E9, E10, E9, E10	N3, N4, N3, N4	E3, E4, E3, E4	N1, N2, N1, N2		E5, E6, E5, E6	South Ridge 3, South Ridge 4, South Ridge 3, South Ridge 4			

* Survey points are shown in Figure 1 and 2 and described in Appendix 7. The point numbers are preceded by the initial of the first name of the observer who conducted the survey that season, or that individual's designation of the site. Where possible, original site designations were retained.

Nocturnal bird surveys as part of BUS were considered unlikely to supply useful information in that it is difficult to record heights of any species heard or seen, particularly if they are flying at considerable height above ground. Incidental sightings and calls of nocturnal bird species were recorded, and members of the fauna survey team surveyed for nocturnal bird species using separate methodology (NGH 2017).

The level of BUS in the four seasonal surveys is considered sufficient to assess the risk to birds from the proposed wind farm, combined with the more general ecological survey data generated by other habitat and fauna investigations of the site (NGH 2017).

2.2.2. Incidental observations

In addition to the observations during formalised, fixed-point counts, incidental observations of birds of concern (threatened species, raptors, waterbirds) were made whilst travelling throughout the proposed wind farm site. Emphasis was placed on observing birds that were moving through the site at RSA height, threatened species, and species of concern including raptors and waterbirds.

2.2.3. Collision risk modelling

The Queensland Wind Farm State Code Planning Guideline (2017b) requires collision risk modelling (CRM) for birds to be part of the fauna impact assessment for wind farms. Currently, the code indicates a preference for collision risk modelling to be done for listed threatened species. Elsewhere in Australia, CRM has been used to model the number of individuals of listed threatened species affected over the life of a wind farm project, or annually, expressed as the likely number of individuals affected.

An important input to CRM is an estimate of the number of flights at risk across a wind farm site, a proportion of which can be assumed to be at turbine height (based on recorded flight heights) and estimated density. These data are generated through formal BUS, the method used in the current field investigation.

At Clarke Creek Wind Farm, five EPBC Act listed species were recorded during the surveys: Rainbow Bee-eater (Marine), Rufous Fantail (Marine: Migratory) Squatter Pigeon (Vulnerable), Satin Flycatcher (Migratory) and the White-throated Needletail (Vulnerable, Migratory), with Squatter Pigeon also considered to be Vulnerable under the Queensland Nature Conservation Act 1992 (NC Act). Of these the White-throated Needle-tail and Rainbow Bee-eater were considered at greatest risk due to flights recorded regularly at RSA height. Overall risk of collision for Rufous Fantail, Squatter Pigeon and Satin Flycatcher was considered low due to their propensity to remain close to the ground and canopy in open and woodland habitats.

The White-throated Needletail is unique in being an almost exclusively aerial forager, flying at a range of heights up to a kilometre or more in search of airborne insects. Flocks often dwell in the wind shear zone ahead of storms where airborne insects are concentrated.

Their occurrence is sporadic and numbers vary greatly, with flocks ranging from several birds to several hundred birds. White-throated Needletail is distributed widely over Eastern and Northern Australia between late Spring and early Autumn. Mapping flight paths of this species does not provide reliable information on the location of flyways as they are just as likely to fly over any part of the landscape when in the area. The great spatial and temporal variability in their occurrence make it very difficult to develop meaningful CRM inputs, in particular, generating a valid estimate of the number of birds passing through a wind farm in a year (i.e. during the seasons they are in Australia) is challenging. For this reason, CRM was not applied to this species even though it was recorded several times, both during formal BUS and incidentally.

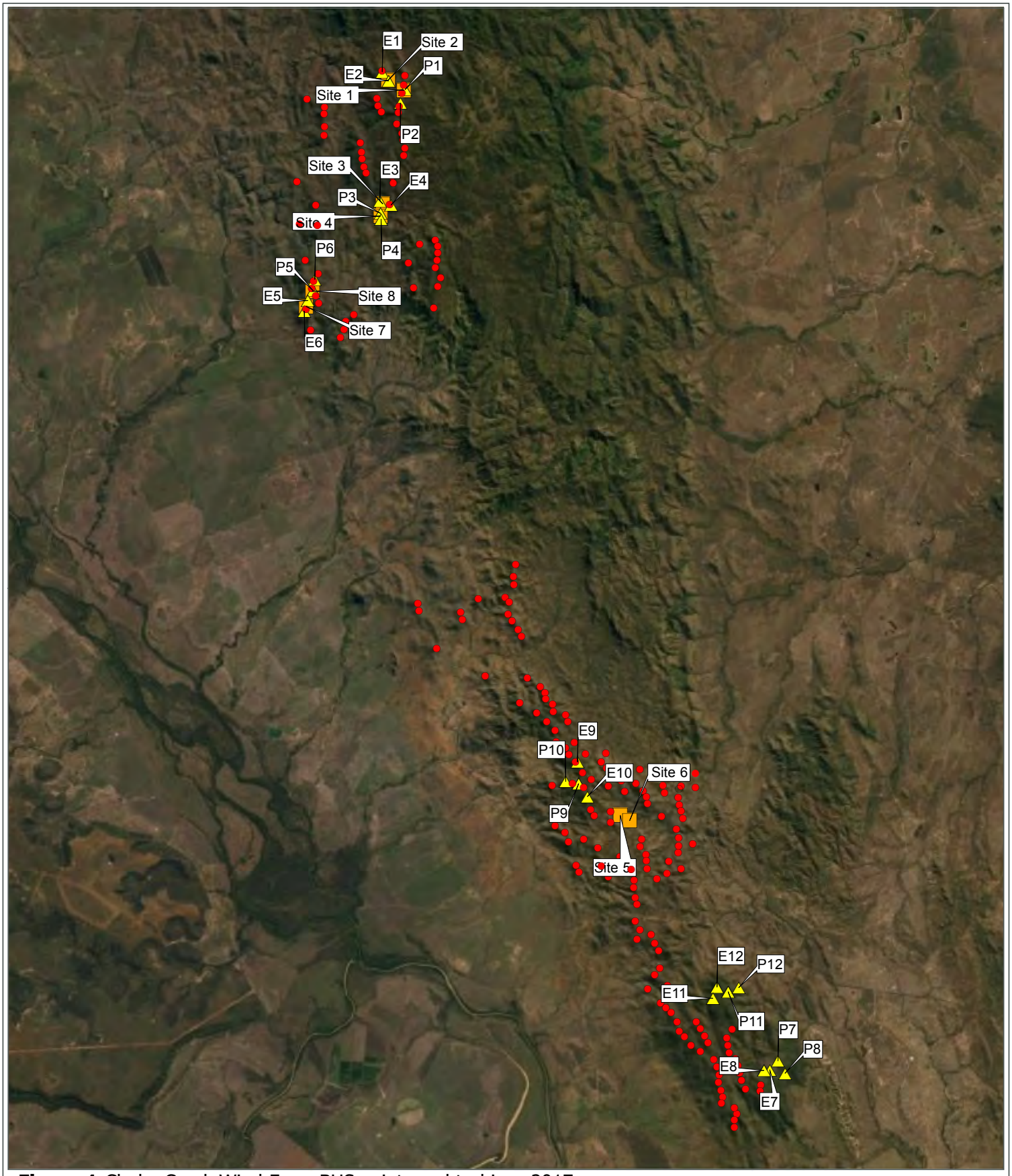

Figure 1: Clarke Creek Wind Farm BUS points and turbines 2017

Project: Clarke Creek Wind Farm **Client**: NGH Environmental Pty Ltd **Date**: 18/11/2019

N

Metres
0 3,600

Legend

- Clarke Creek Wind Farm turbines
- BUS points - September 2017
- BUS points - March 2017

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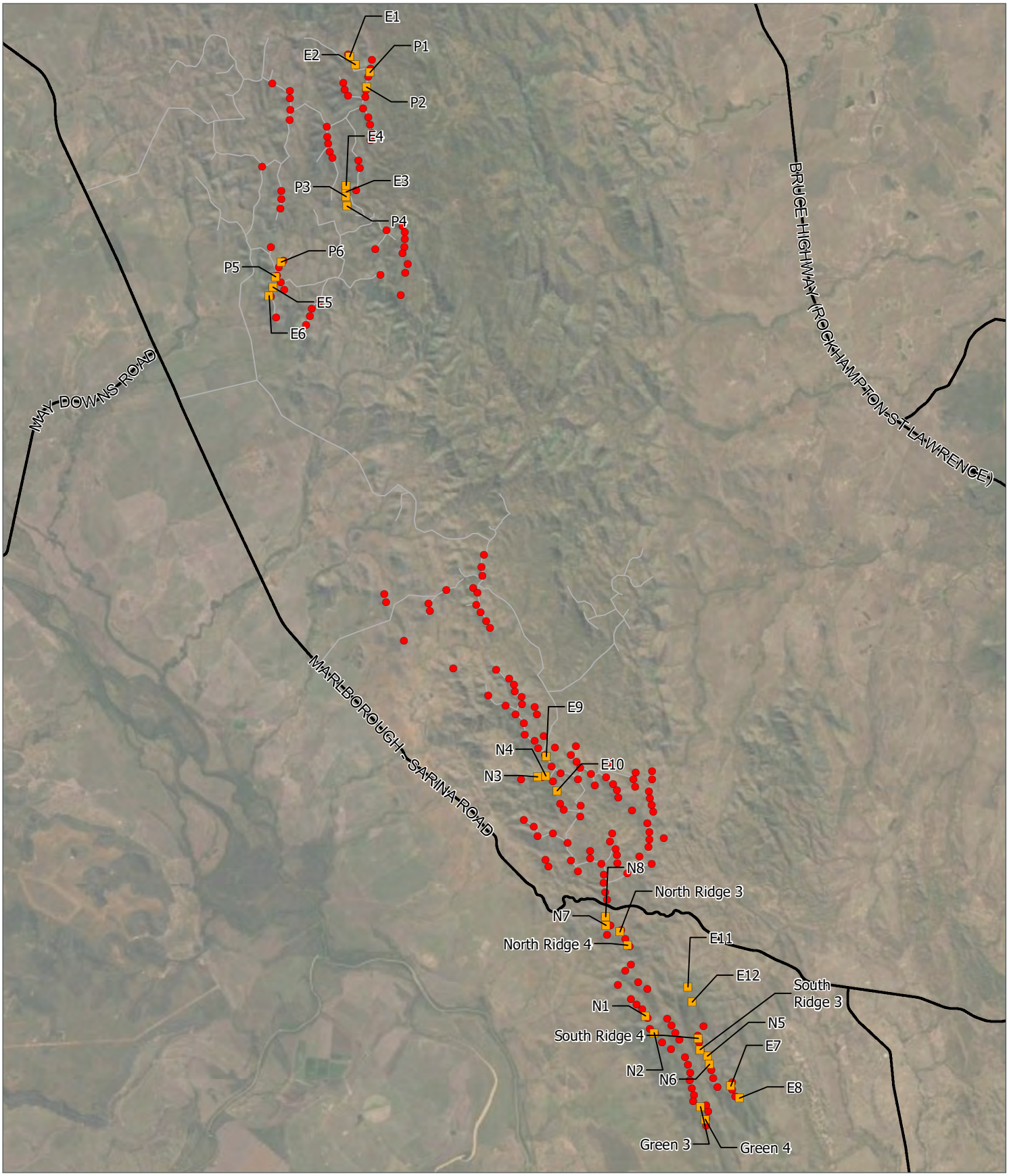

Figure 2: Clarke Creek Wind Farm BUS points and turbines 2020

Project: Clarke Creek Wind Farm **Client**: NGH Environmental Pty Ltd **Date**: 25/06/2020

N

Metres
0 3,600

Legend

- BUS sites - Spring and Autumn 2020
- Clarke Creek Wind Farm turbines

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2.3. Limitations

2017: An extended period of drought was prevalent in the region prior to the first survey effort. Weather conditions were mostly fine, warm and sunny throughout, with daily temperature range of around 18 to 32°C during both March and September 2017. East to south-easterly winds prevailed throughout the March 2017 surveys, varying from almost calm to a fresh breeze. Rain and drizzle were experienced towards the end of the March 2017 survey, which was the build-up to Cyclone Debbie, with low level cloud cover obscuring the wider view, which limited bird viewing, but no surveys were conducted in this time, and no further rain events were experienced prior to conclusion of survey efforts.

Easterly winds prevailed throughout the September 2017 surveys, varying from almost calm to a fresh breeze. No significant limitations were experienced during the data collection phase of this work.

2020: The daily temperatures for the Autumn period ranged around 17°C to 34°C in autumn 2020 with mostly fine, warm and sunny. Prevailing winds tended north east to north west, varying from calm to a moderate breeze. A storm developed on the afternoon of Sunday the 19th April, during which high winds and heavy rain occurred. Surveys were halted during the storm. Heavy rain fell in the early hours of Monday 20th April, clearing soon after commencement of that day's surveys. The remainder of the survey period was clear and sunny.

Conditions throughout the Spring 2020 survey period were fine and dry, with the most recent rainfall occurring sixteen days prior. Wind direction was predominantly from the E in the mornings and SE in the afternoons, with wind speed generally between 13 km per hour and 26 km per hour. Minimum temperatures ranged from 13.5°C – 19.6°C during the survey period. The average minimum temperature was 17.2°C. Maximum temperatures ranged from 27.9°C – 29.9°C, with an average maximum of 29°C (Bureau of Meteorology 2020 – St Lawrence Observations).

Time limitations occurred due to restrictions on driving after dark (travelling from survey points to camping sites). To account for this limitation, several surveys were slightly condensed to ensure that all sites were covered. This was done by reducing the time-gap between 20 min surveys. No other significant limitations were experienced during the data collection phase of this work.

The BUS points were adjusted between the first survey and the third survey. This included additional BUS points to cover additional turbine locations in the south of the project area reflecting a minor change to the turbine layout.

3. SITE DESCRIPTION

The Project Area supported a number of habitat types. The dominant vegetation type was tropical open Narrow-leaved Ironbark Eucalyptus crebra woodland. Some areas of Spotted Gum Corymbia maculata and Lemon-scented Gum Corymbia citriodora were present throughout the project area. The understorey and ground layer were dominated by a mosaic of native and introduced grasses including Buffel Grass Cenchrus ciliaris and regenerating Wattle Acacia spp. Occasional dry rainforests or semi-evergreen vine thickets (SEVTs) and stands of Paperbark Melaleuca sp. occurred in more sheltered areas such as gullies and sandy soil area, and on some southern aspect hills.

Several creeks and waterways crossed the project area, most of which had water flowing during the wet season survey. Many of these were found to be dry during the Spring (dry season) survey. Farm dams were also present throughout the study area.

The dominant land use is for cattle grazing. Surrounding land is a mixture of mostly cleared land for raising cattle, and state forests supporting intact native vegetation to the south-east and north-east of the project area.

The project area lies within the Brigalow Belt bioregion and falls within the Fitzroy River and MacKenzie River catchments, in Isaac Shire, Central Queensland.

3.1. Locations and descriptions of survey points

Over the 2017 survey period, 20 fixed survey points were established: eight in the wet (Autumn) season and 12 in the dry (Spring) season (Figure 1). A further 12 fixed survey points were established in Autumn 2020 (Figure 2), due to the extension of the wind farm footprint to the south along with improved access in that area. Survey points were located near proposed turbine locations. There were slight differences in survey point locations between surveys but these were not considered significant (see also Section 2.2.1).

The survey points were distributed as evenly as possible (subject to access constraints) across the wind farm to maximise coverage in areas where wind turbines are likely to be sited. Survey points were positioned on elevated ground, allowing, as much as terrain and vegetation permitted, a clear view in all directions.

Between the four seasonal surveys, the wind farm turbine layout was amended slightly and the southernmost points added in the 2020 survey as part of the revised wind farm layout. This difference is shown when comparing Figure 1 and Figure 2, which plot the location of survey points.

Table 5 provides a brief broad habitat type description, and the sites associated with these habitat types. Appendix 5 provides a description of the Regional Ecosystem (RE) types associated with each survey area point (based on Department of Natural Resources, Mining and Energy vegetation mapping).

Photographs of representative habitats on the site are shown in Figure 3 and Figure 4.

Table 5: Habitat types and associated BUS sites

Habitat Type	*Eucalyptus crebra* open savanah woodland	*Corymbia citriodora* open forest	Semi-evergreen vine thicket and microphyll vine forest	*Acacia* sp. thicket
Associated BUS sites	E5, E6, E7, E8, E9, N1, N2, N3, N4, N5, N6, N7, N8, Green 3, Green 4, North Ridge 3, North Ridge 4, South Ridge 3, P3, P4, P5, P6	E1, E2, E3, E4, E10, P1, P2	E5, E12, N2, South Ridge 4	E11, E12

Figure 3: Clarke Creek Wind Farm representative BUS site in forested habitat

Figure 4: Clarke Creek Wind Farm representative BUS site on mountain ridge

4. ASSESSMENT RESULTS

4.1. Cumulative counts of bird species

The cumulative number of species observed from the consecutive fixed-point bird counts conducted at the survey points during the survey period is shown in Figure 5, 6 and 7. Lower numbers were observed in Autumn 2017 (Figure 5) possibly due to the anomalous weather conditions, namely drought conditions leading to Tropical Cyclone Debbie (see also Section 2.3).

In Autumn 2020, the higher number of bird species observed relates to the increase in survey points due to an expansion of the windfarm footprint, and improved access to the south of the project area, where increased diversity of habitat has been surveyed. In addition, the increase in personnel conducting surveys allowed more surveys to be completed over a shorter period (Figure 7). This indicates that the number of species likely to be found within the Project Area footprint is most abundant during the Autumn or post-wet season period.

Figure 5: Cumulative number of bird species recorded during consecutive surveys in Autumn 2017

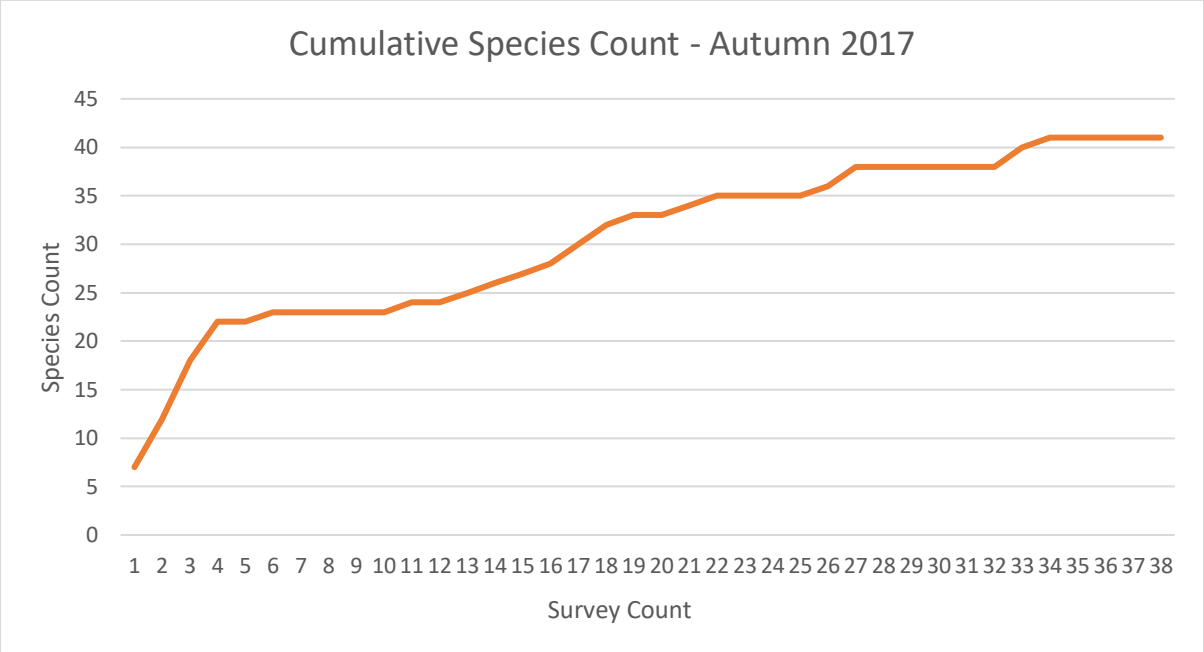


Figure 6: Cumulative number of bird species recorded during consecutive surveys in Spring 2017

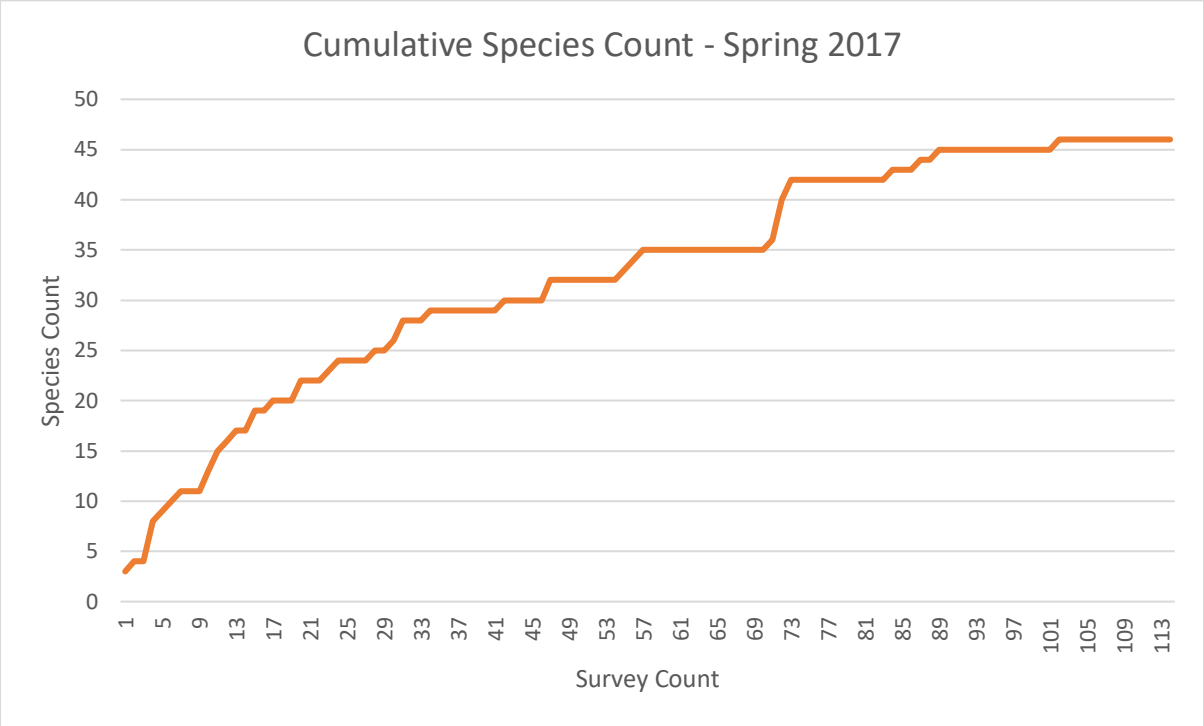


Figure 7: Cumulative number of bird species recorded during consecutive surveys in Autumn 2020

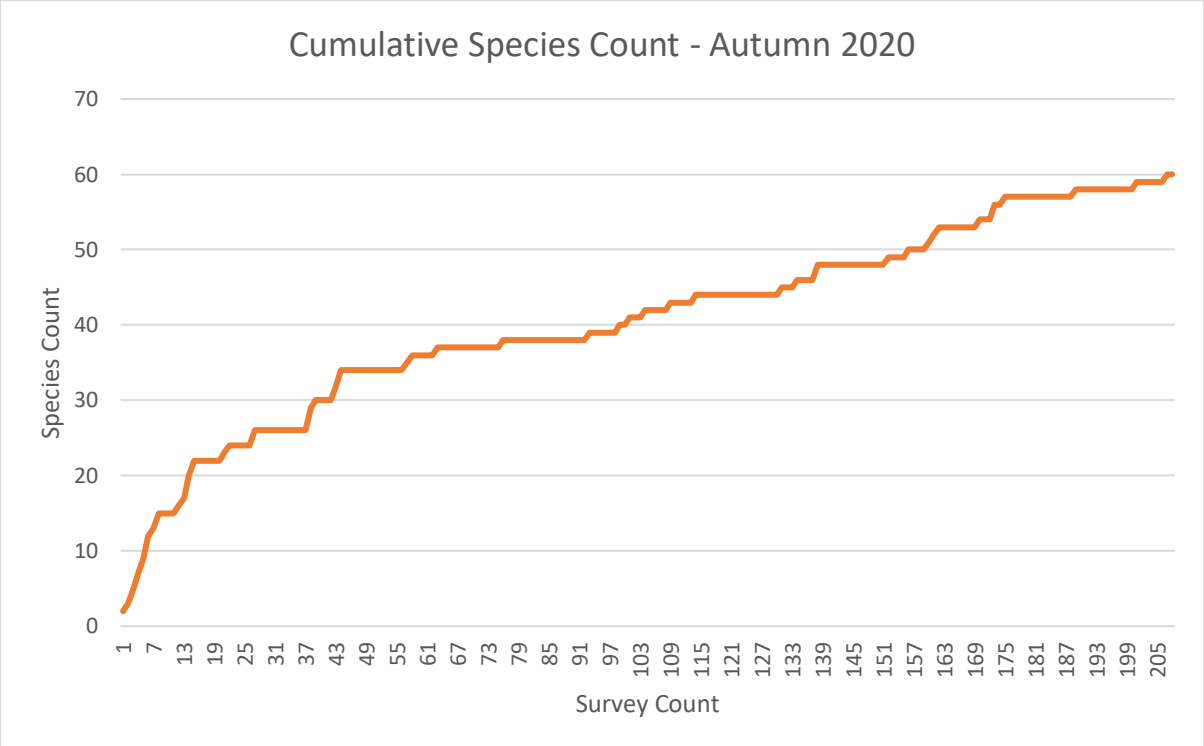
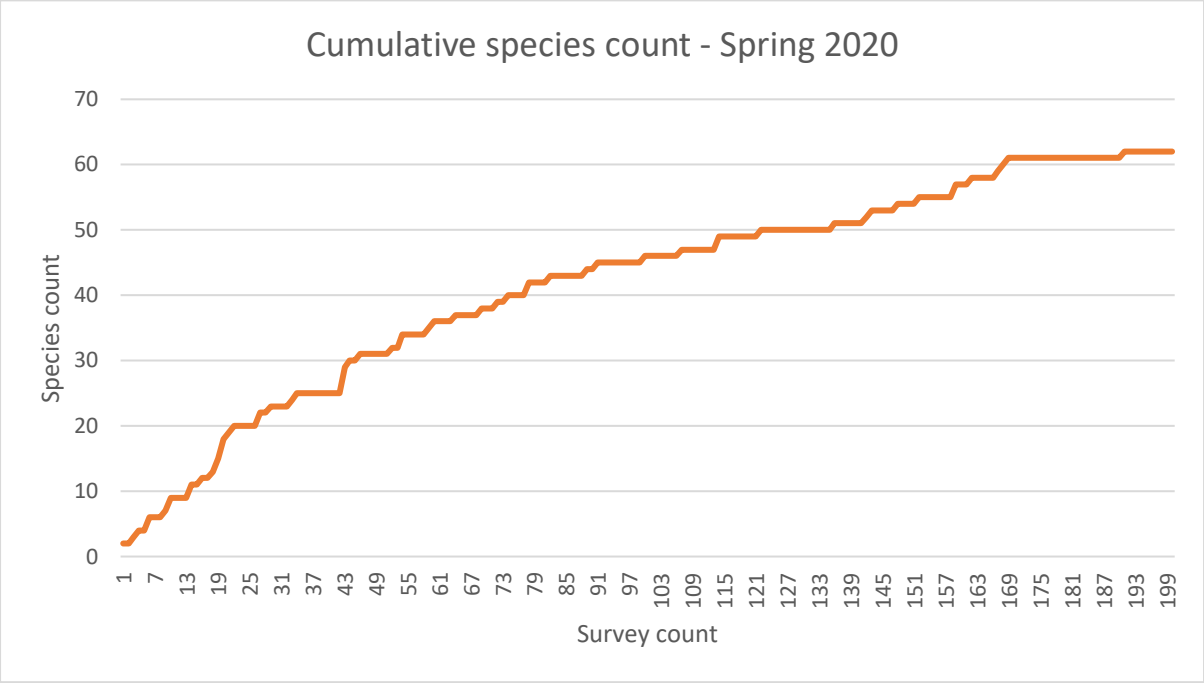


Figure 8: Cumulative number of bird species recorded during consecutive surveys in Spring 2020



4.2. Species Composition

A total of 153 bird species were observed within the project area over four surveys (Spring and Autumn of 2017 and 2020) including incidental observations, with 93 species recorded during the four BUS (Appendix 1: List of birds recorded during BUS at Clarke Creek Wind Farm, 2017 and 2020 combined). Species recorded were predominantly native farmland and bushland species with some records of raptors. The raw BUS data is presented in Appendices 3, 4, 5 and 6.

Species composition (diversity) can differ between months due to seasonal changes in presence and abundance, activity, changes in foraging behaviour and seasonal distribution of birds among various habitats.

During the BUS, a total of 62 species were seen in Spring 2020, 61 species in Autumn 2020, 47 species in Spring 2017 and 41 species in Autumn 2017. The diversity of birds during the two surveys in 2017 was similar with a small degree of seasonal variation. In 2020 a higher number of species was observed likely due to an extended project area and increased survey points. The most frequently observed species during BUS are listed below (Table 6).

Table 6: The five most common species at the survey points

Most Common Species		
Species	**Total # Obs**	**% Total Obs**
Autumn 2017		
Rainbow Lorikeet	286	27.06
Rainbow Bee-eater	225	21.29
Torresian Crow	123	11.64
Australian Magpie	73	6.91
Pied Currawong	57	5.39
Total	**764**	**72.29**

Most Common Species		
Species	**Total # Obs**	**% Total Obs**
Spring 2017		
Rainbow Lorikeet	136	12.51
Rainbow Bee-eater	136	12.51
Pied Currawong	130	11.96
Red-backed Fairywren	99	9.11
Australian Magpie	78	7.18
Total	**579**	**53.27**
Autumn 2020		
Rainbow Lorikeet	207	16.15
Pied Currawong	152	11.86
White-throated Honeyeater	75	5.85
Rainbow Bee-eater	70	5.46
Black-faced Cuckoo-shrike	61	4.76
Total	**565**	**44.08**
Spring 2020		
Pied Currawong	161	12.45
White-throated Needletail	121	9.36
Rainbow Bee-eater	118	9.13
Torresian Crow	106	8.20
Rainbow Lorikeet	83	6.42
Total	**589**	**45.55**
All Surveys Combined		
Rainbow Lorikeet	712	15.09
Rainbow Bee-eater	549	11.63
Pied Currawong	500	10.60
Torresian Crow	335	7.10
Australian Magpie	273	5.79
Total	**2369**	**50.21**

Overall, the most abundant species across the combined seasonal counts in order of cumulative frequencies were:

- Rainbow Lorikeet
- Rainbow Bee-eater
- Pied Currawong
- Torresian Crow
- Australian Magpie.

The five most abundant species comprised 50.21% of all birds at the impact survey points. The total number of birds observed over all surveys varied between 414 observations at survey point E10, to 14 observations at survey point P8. Most species recorded during the BUS surveys were common and widespread native species of agricultural and open woodland habitats of eastern Australia.

Densities of birds were relatively low across the entire survey area, recording a maximum of 1.5 birds/ha/hr at site E8 in the Autumn 2017 (post wet season) surveys, and a maximum of 0.68 birds/ha/hr at site E10 in the Spring (dry season) surveys.

Seasonal differences are evident when density is analysed for each survey. Density is much higher in the 2017 Autumn survey (Figure 9, Figure 10,

Figure 11 and Figure 12), which is most likely due to the persistent drought throughout the region, and the impending Tropical Cyclone Debbie at that time, possibly creating an area of greater abundance in resources such as food and water, and potentially shelter during this anomalous weather event.

Figure 9: Density of bird species at survey points in March 2017 (mean ± S.E.)

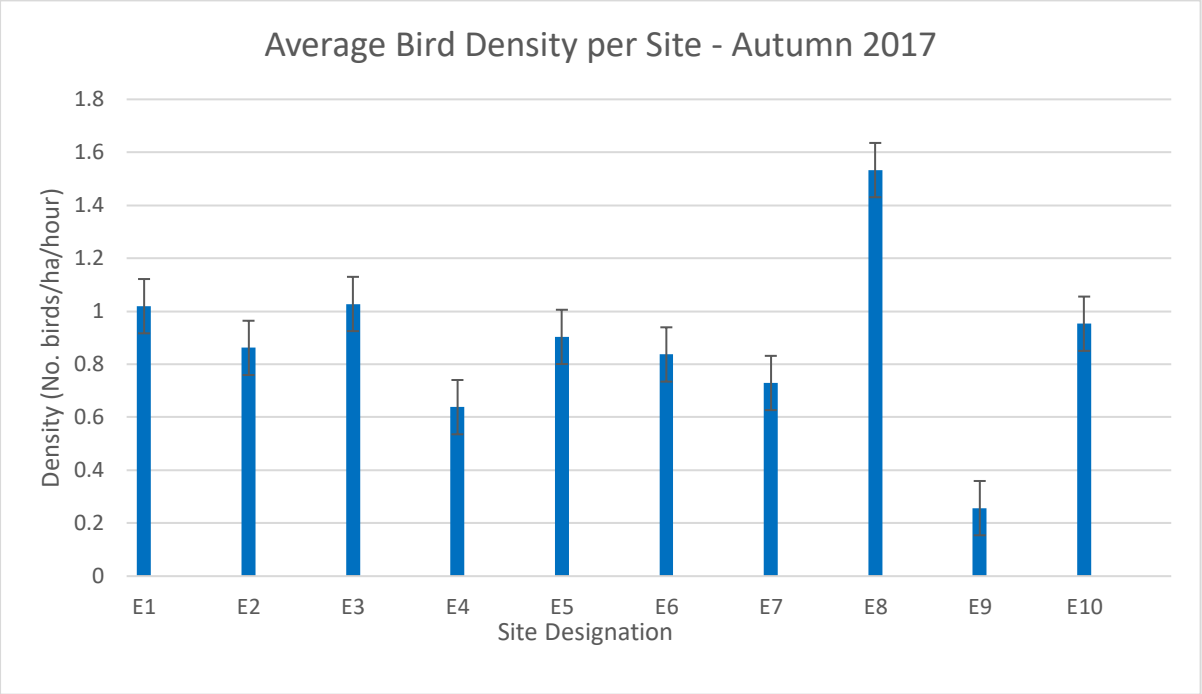


Figure 10: Density of bird species at survey points in September 2017 (mean ± S.E.)

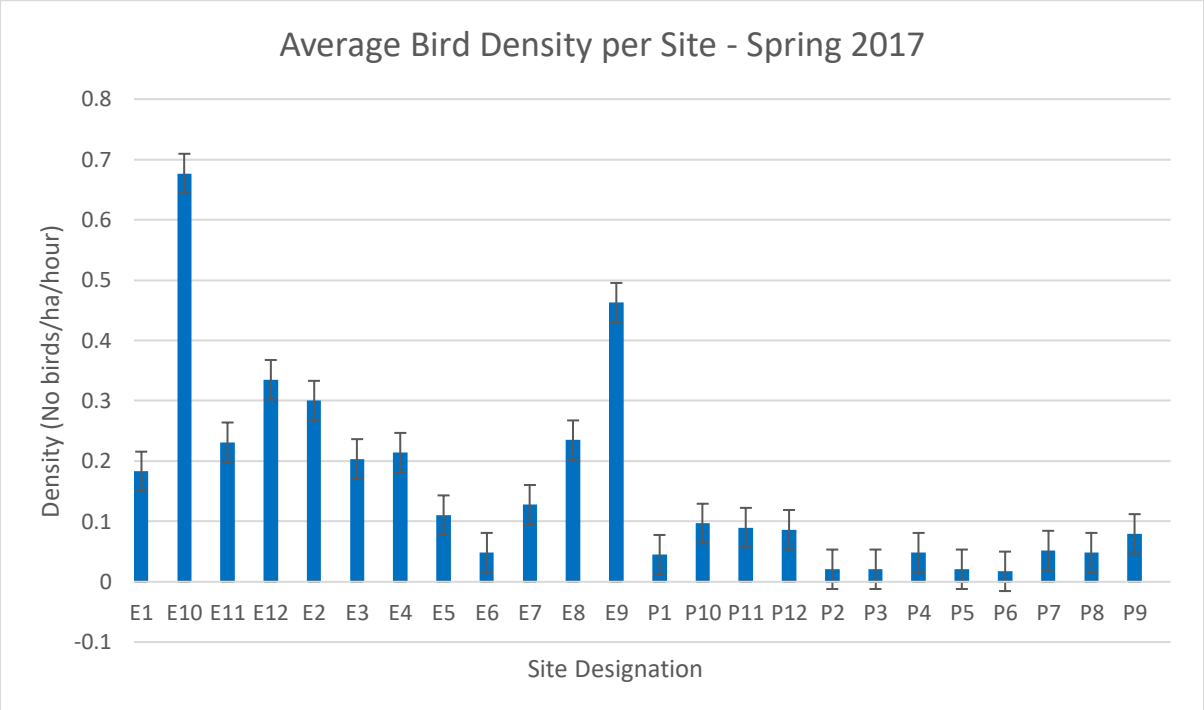


Figure 11: Density of bird species at survey points in April 2020 (mean ± S.E.)

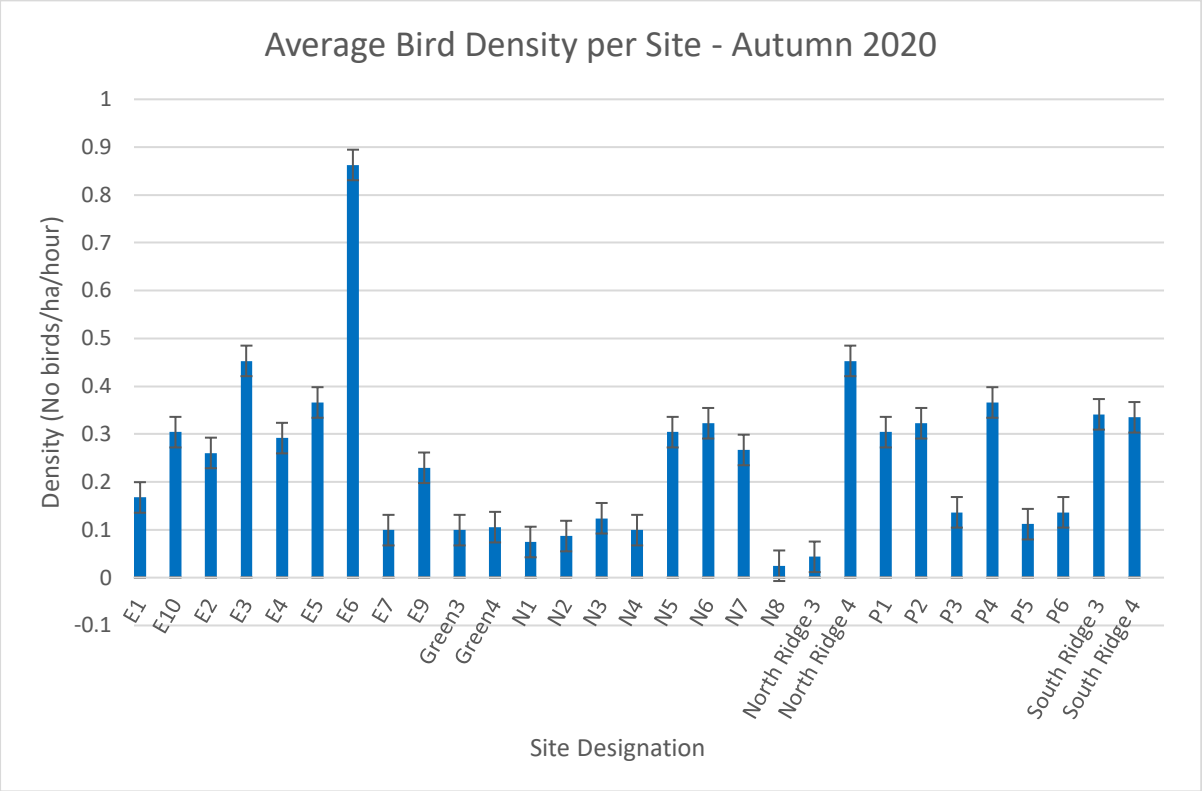
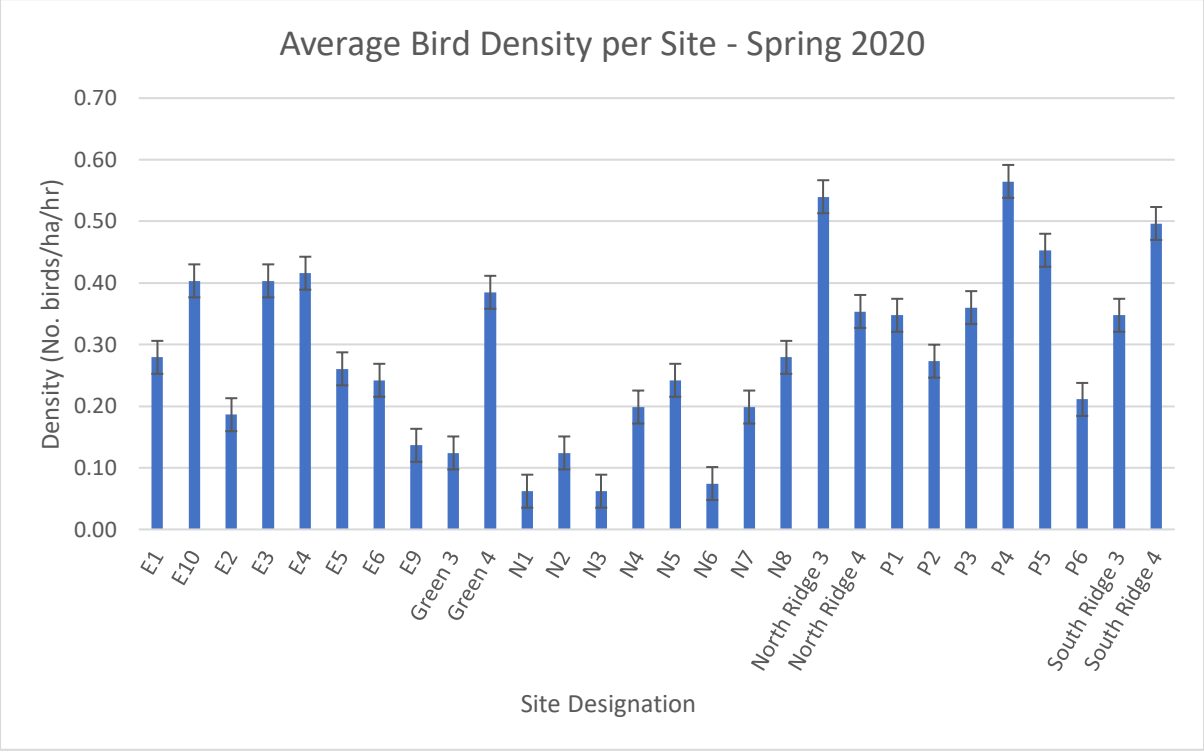


Figure 12: Density of bird species at survey points in October 2020 (mean ± S.E.)



The full bird list recorded within the Project Area during BUS and incidentally by the BUS team is provided in Appendix 1. The list follows the International Ornithological Congress nomenclature (Gill and Donsker, 2018).

4.3. Bird Flight Heights

Analysis of the field data shows that most birds are active between zero and 30 m above the ground (Figure 13, Figure 14, Figure 15 and

Figure 16). A small proportion of birds observed within the Project Area flew above 40 m within or above the RSA, particularly White-throated Needletail, Australian Pelican (anomalous numbers due to Tropical Cyclone Debbie), Wedge-tailed Eagle, Rainbow Lorikeet, Rainbow Bee-eater, Torresian Crow and Sulphur-crested Cockatoo.

There was minor variation in flight heights across the two seasons and potentially some evidence of migration, i.e. birds that were present in Autumn might be indicative of movements of these species within or beyond the tropics (e.g. Grey Fantail and Rufous Whistler; likely have arrived from further south, but also have resident populations in central Queensland) whereas in Spring 2017 and Spring 2020 the White-throated Needletail had already arrived to the region from the northern hemisphere on its southward migration.

Figure 13: Number and height distribution of bird species at survey points in Autumn 2017

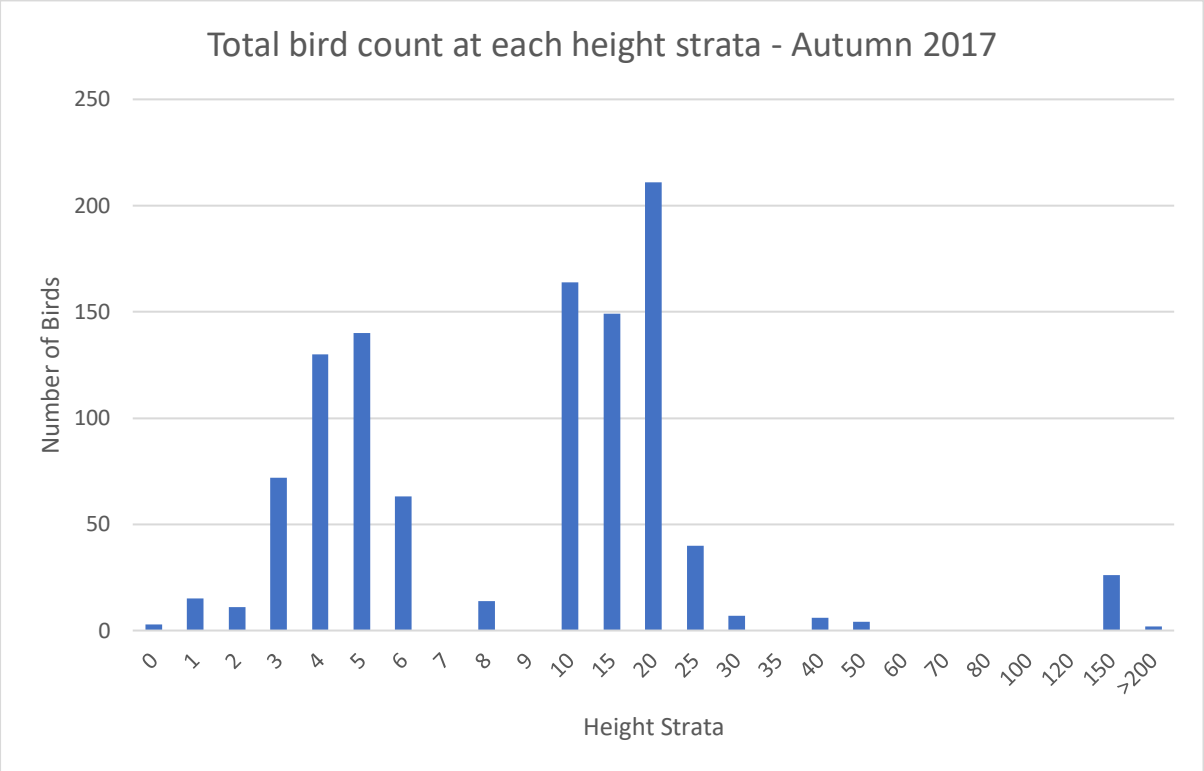


Figure 14: Number and height distribution of bird species at survey points in Spring 2017

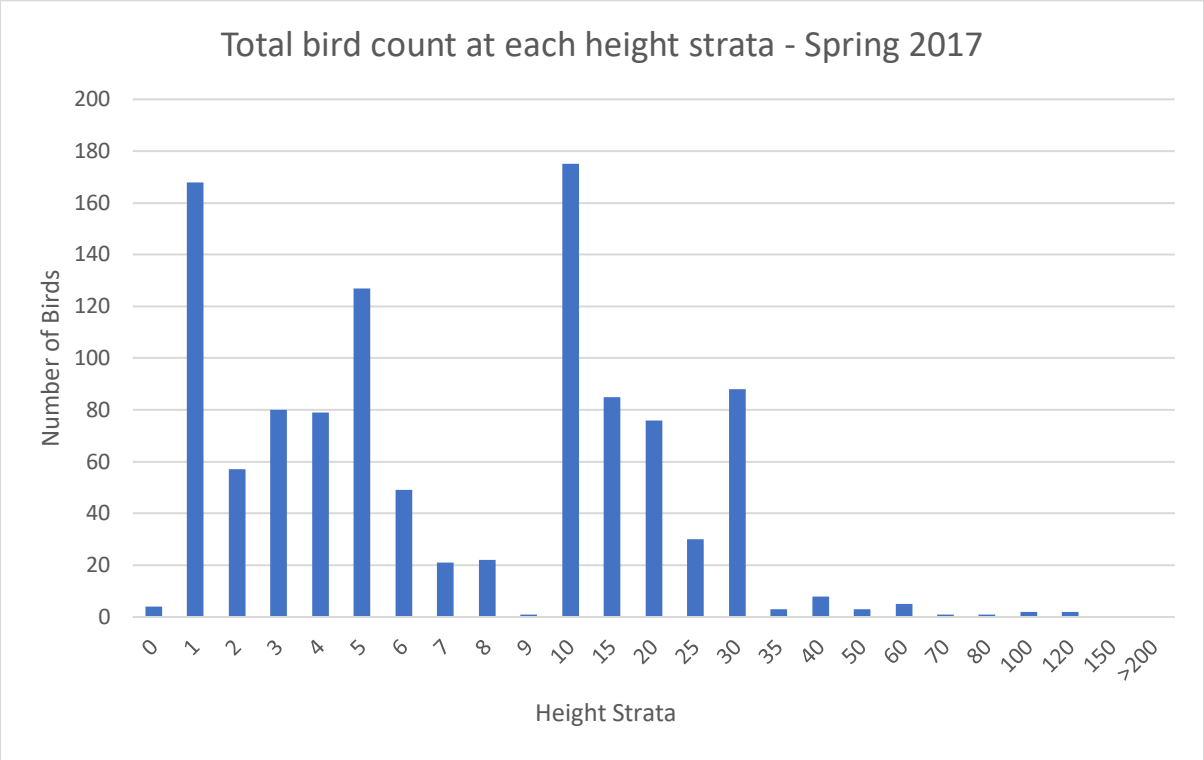


Figure 15: Number and height distribution of bird species at survey points in Autumn 2020

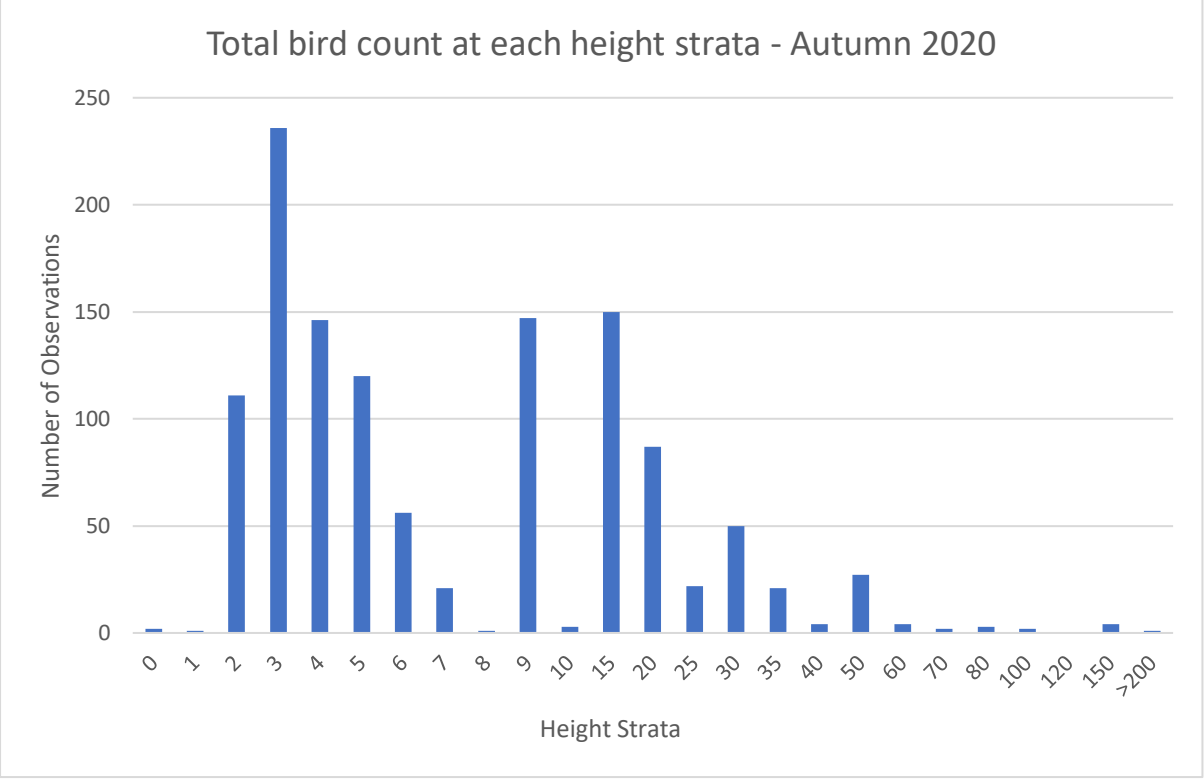
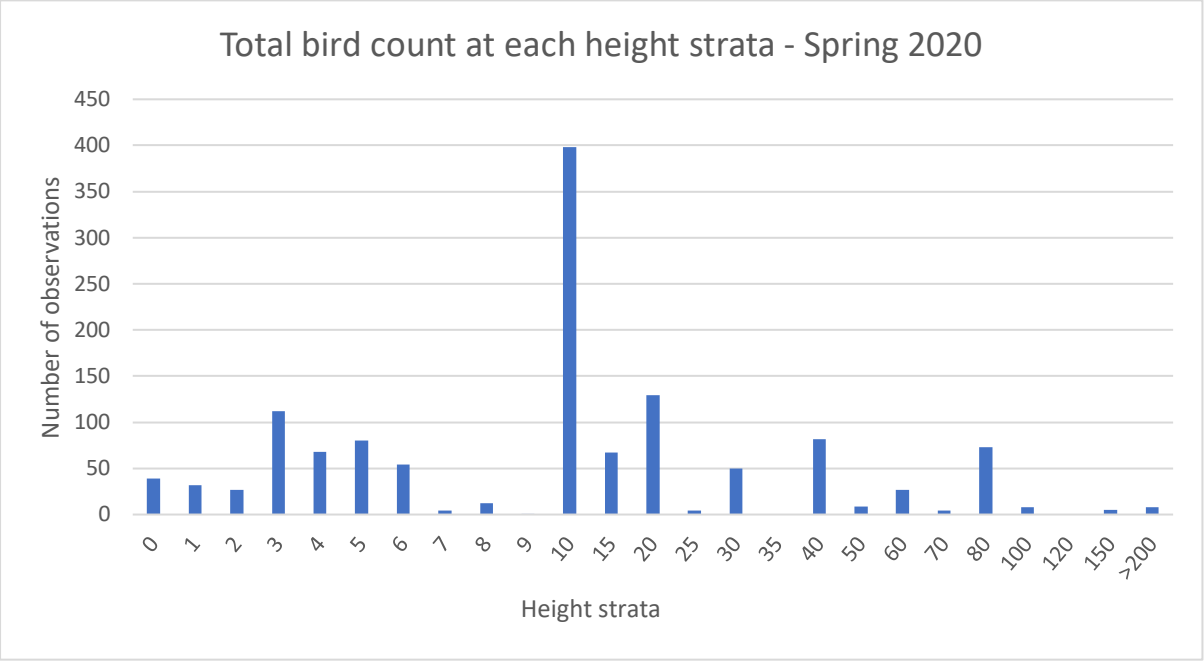


Figure 16: Number and height distribution of bird species at survey points in Spring 2020



Bird heights were classified as below (< 40 m), at (40–220 m), and above (> 220 m) RSA height. Detailed results of the number of birds recorded at the different flight heights are presented in Table 7. The raw data are presented in Appendices 3, 4, 5 and 6.

Thirty-eight (38) birds were recorded flying within the RSA height in the Autumn 2017 BUS (3.6% of 1,057 total observations), 45 in the Autumn 2020 BUS (3.51% of 1,282 observations), 23 in the Spring 2017 BUS (2.12% of 1087 observations), compared with 208 observations in the Spring 2020 BUS (16.09% of 1293 observations). Over the combined surveys the percentage of birds flying at RSA was 6.69% of all observations during formal BUS surveys (Table 7).

Table 7: Summary of birds recorded at the three flight heights

Flight Height	Impact survey points	
	Number of birds	Percentage of all birds
A (below RSA, <40m)	4373	93.18%
B (within RSA, 40 – 220m)	314	6.69%
C (above RSA, >220m)	6	0.13%
Total birds recorded	**4693**	**100**

Table 8: The five most common species observed within RSA height (40-220m)

RSA Flight Observations (>40m - <220m)			
Species	**Total Flights at RSA**	**% all Obs**	**% RSA Obs**
Autumn 2017			
Australian Pelican	24	2.27	63.16
Wedge-tailed Eagle	6	0.57	15.79
Pied Currawong	4	0.38	10.53
Nankeen Kestrel	2	0.19	5.26
Peregrine Falcon	2	0.19	5.26
Total	**38**	**3.60**	**100.00**
Spring 2017			
Wedge-tailed Eagle	8	0.74	34.78
Brown Falcon	5	0.46	21.74
Sulphur-crested Cockatoo	4	0.37	17.39
Rainbow Bee-eater	2	0.18	8.70
Pied Currawong	2	0.18	8.70
Torresian Crow	2	0.18	8.70
Total	**23**	**2.12**	**100.00**
Autumn 2020			
Wedge-tailed Eagle	10	0.78	22.22
Rainbow Lorikeet	9	0.70	20.00
Rainbow Bee-eater	9	0.70	20.00
Sulphur-crested Cockatoo	7	0.55	15.56
Red-tailed Black Cockatoo	3	0.23	6.67
Total	**38**	**2.96**	**84.44**
Spring 2020			
White-throated Needletail	66	5.10	31.28
Rainbow Bee-eater	62	4.80	29.38
Buff-rumped Thornbill	24	1.86	11.37
Torresian Crow	24	1.86	11.37
Rainbow Lorikeet	13	1.01	6.16
Total	**189**	**14.62**	**89.57**
All Surveys Combined			
Rainbow Bee-eater	73	1.55	23.03
White-throated Needletail	66	1.40	20.82
Wedge-tailed Eagle	32	0.68	10.09
Torresian Crow	27	0.57	8.52
Australian Pelican	25	0.53	7.89
Total Combined	**223**	**4.73**	**70.35**

The five most abundant species observed flying at RSA height over all surveys are:

- Rainbow Bee-eater (Marine EPBC Act)
- White-throated Needletail (Vulnerable (EPBC Act and NC Act)

- Wedge-tailed Eagle
- Torresian Crow
- Australian Pelican

These accounted for 4.73% of the total birds observed at impact survey points.

4.4. Threatened Species

The majority of birds found to utilise the proposed wind farm site were common, widespread birds. Of the species recorded during the BUS the following species were listed under the EPBC Act (Commonwealth).

- White-throated Needletail (Vulnerable EPBC Act and NC Act and Migratory).
- Satin Flycatcher (Migratory)
- Squatter Pigeon (southern) (Vulnerable EPBC Act and NC Act)
- Rainbow Bee-eater (Marine EPBC Act)
- Rufous Fantail (Marine: Migratory EPBC Act, SL: NC Act)

No other EPBC Act listed threatened bird species were recorded during the BUS. Grey Falcon (Vulnerable NC Act) was observed during Autumn 2017 (see Section 4.4.6).

4.4.1. White-throated Needletail

The White-throated Needletail breeds in Siberia and Japan and migrates to Australia in its non-breeding season. It usually arrives in Queensland moving southward in October and northward in March or April (Higgins 1999; Menkhorst et al. 2017). The species is listed as "Special Least Concern" under Queensland's NC Act, and Vulnerable (Migratory) under the EPBC Act.

No White-throated Needletails were recorded during the formal BUS in 2017 and April 2020. In October 2020, 121 individuals were observed with 66 individuals flying at or above RSA height. Incidental sightings totalling over 50 individuals were recorded at or above RSA height across the Project Area during the surveys.

Section 2.2.3 provides a discussion of the difficulties of generating information on the location, numbers and timing of Needletails generally and, therefore, the problems in developing accurate and precise predictions of the likely impacts of wind farms on this species through, for example, CRM. That said, observations elsewhere in Australia indicate that this species occasionally collides with wind farms, having been recorded once or twice at about half the 18 wind farms monitored for bird impacts (for at least a year and up to three years) by Nature Advisory in the last decade (Nature Advisory, unpubl. data).

It is not expected that numbers of Needletails passing through Clarke Creek Wind Farm would be large enough nor the rate of collision high enough (based on observations elsewhere in Australia) to place the overall population at risk in light of the large area of Great Dividing Range that this species would move through during its stay in Australia and no distinct flyways over this range. Collision with wind turbines is not considered to affect a large number of birds (Hull 2013).

The impacts of the Project on the White-throated Needletail are therefore not likely to lead to a significant impact on the state or national population of the species.

4.4.2. Satin Flycatcher

The Satin Flycatcher occurs over wide areas of forests in Eastern Australia. This species is listed as Migratory under the EPBC Act. It migrates across cleared ground between remnant treed vegetation and tends to move within treed habitats below the wind turbine RSA. Small numbers of individuals may migrate through the site and only a small proportion of these have the potential to collide with turbines if they were to occasionally fly above tree height within RSA height where a turbine is operating. Small numbers that may be affected do not represent a significant proportion of the total population which occupies a large proportion of the forested country in south-eastern Australia (Birdlife Australia 2020) and likely numbers in the thousands.

4.4.3. Squatter Pigeon

Squatter Pigeon is a primarily ground dwelling species (Higgins 1999; Menkhorst et al. 2017), and is not known to fly at RSA height. It is listed as Vulnerable under the EPBC Act and NC Act. This species was detected incidentally within the wind farm footprint in all survey periods but not near any proposed turbine locations, suggesting that where present on the wind farm site, it occupies areas away from sites of proposed turbine placement. In any event, in view of the terrestrial habits of the species it would be very unlikely to be flying at RSA height so is unlikely to be affected by the Project.

4.4.4. Rainbow Bee-eater

Rainbow Bee-eater is widespread in open woodland areas across Australia. This species forages on flying insects, typically flying to RSA heights to catch prey (Menkhorst et al. 2017). Rainbow Bee-eater was recorded regularly at RSA height during BUS at Clarke Creek, and is considered at risk of collision with turbines, however due to the widespread distribution of the species, and as its population is considered secure within its range, it is considered unlikely that Rainbow Bee-eater populations are at significant risk from the Project.

4.4.5. Rufous Fantail

Rufous Fantail typically inhabits low- to mid-storey dense vegetation in forests and vine thickets in Eastern Australia. This species is strongly migratory, overwintering in the north of Australia and New Guinea, and is largely absent from sub-tropical/temperate regions between May and September (Menkhorst et al. 2017). Rufous Fantail was observed during formal BUS, however it is not considered at significant risk of collision with turbines due to its understory habitat preference.

4.4.6. Raptors

Eleven raptor species were recorded over the four survey periods, with seven raptor species recorded during the BUS, comprising 74 individuals in total (Table 9). Generally, raptors were recorded in low numbers. The raw BUS data are presented in Appendices 3, 4, 5 and 6.

Grey Falcon was recorded during the Autumn 2017 BUS. Grey Falcon is listed as Vulnerable under the NC Act. It was not observed at RSA height. Previous records of this species are found in the region (Wildlife Online 2020; Birdata 2020), however this species is sparsely distributed, predominantly in arid inland open plains with treed watercourses (Menkhorst et al. 2017). It is suggested that this individual was driven to the Clarke Creek area by more abundant resources during the prevailing drought in the lead up to the Autumn 2017 surveys.

Wedge-tailed Eagle was the most abundant raptor species observed at the Project Area over both seasons. It was observed a total of 44 times throughout the project area across all surveys. Wedge-tailed Eagles will often fly at RSA heights and 72.73% of Wedge-tailed Eagle flights observed in the Project Area were at RSA height.

Wedge-tailed Eagles are vulnerable to collision with operating turbines because of their soaring habits while foraging. Wedge-tailed Eagles are regularly recorded colliding with wind turbines elsewhere in Australia. Most of the affected individuals are sub-adult birds between one and two years old. Once sub-adult Wedge-tailed Eagles leave their natal territory (usually expelled by their parents before the next breeding season commences), they wander long distances, up to one to two thousand kilometres based on banding records and recent satellite-tracking results (Cherriman 2019). This indicates that the population operates at a continental scale and numbers at least tens of thousands, given observed breeding densities (Merchant and Higgins 1993) likely over 100,000. The Project may affect several eagles per year, on average. Observations elsewhere (Nature Advisory, unpubl. data) indicate that numbers of Wedge-tailed Eagle strikes vary from year to year depending on how much breeding occurs, with mortality higher if there are heavy rains inland that support successful breeding producing larger numbers of dispersing sub-adults.

In summary, it is considered that the Project will not lead to a significant impact on the eagle's population.

Raptors formed approximately 14.4% of birds recorded at RSA height (Table 9). Based on the utilisation rate by other raptors at the survey points, the likely collision rate for these would be moderate (Brown Falcon) to low (Nankeen Kestrel, Peregrine Falcon and Pacific Baza). It is not expected however that larger regional and wider populations of these common raptor species would be affected significantly by the Project.

Table 9: Raptor species recorded at survey points during surveys

Species	A	B	C	Grand Total	Total at RSA	Total Raptor Flights (%)	Flights at RSA (%)	Flights recorded at RSA compared with all bird flights at RSA (%)	Flights recorded at RSA compared to all flights observed (%)
Wedge-tailed Eagle	6	32	6	44	32	59.5	77.4	10.1	0.7
Brown Falcon	7	9	0	16	9	21.6	56.3	2.8	0.2
Nankeen Kestrel	6	2	0	8	2	10.8	25.0	0.6	0.04
Peregrine Falcon	1	2	0	3	2	4.1	66.6	0.6	0.04
Pacific Baza	0	1	0	1	1	1.4	100	0.3	0.02
Grey Falcon	1	0	0	1	0	1.4	0	0	0
Whistling Kite	1	0	0	1	0	1.4	0	0	0
Total	22	46	6	74	46	100		14.4	1.0

A=below rotor swept area (RSA) height (<40 m); **B=** at RSA height (40-220 m);
C= above RSA height (>220 m).

4.4.7. Waterbirds

Australian Pelican was the only waterbird observed during the formal BUS. The large number of Australian Pelican observed during the Autumn 2017 survey is believed to be anomalous due to the impending Tropical Cyclone Debbie event. Incidental observations at farm dams and waterways comprised the majority of waterbird observations over the duration of the BUS. Turbines are to be located on elevated ridgelines away from large waterbodies. This will minimise the potential impact on waterbirds by the development of the Project.

31 species of waterbird were observed incidentally during the survey periods:

- Australasian Darter
- Australasian Grebe
- Australian Pelican
- Australian White Ibis
- Australian Wood Duck
- Black Bittern
- Black Swan
- Black-fronted Dotterel
- Black-necked Stork
- Black-winged Stilt
- Brolga
- Cattle Egret
- Cotton Pygmy-goose
- Eastern Great Egret
- Eurasian Coot
- Great Crested Grebe
- Green Pygmy Goose
- Grey Teal
- Gull-billed Tern
- Hardhead
- Intermediate Egret
- Little Black Cormorant
- Little Egret
- Little Pied Cormorant
- Masked Lapwing
- Nankeen Night-heron
- Pacific Black Duck
- Plumed Whistling-duck
- Straw-necked Ibis
- White-faced Heron
- White-necked Heron

All waterbird species were observed near standing water, farm dams, or creeks.

The Brolga and Black-necked Stork would be typical of an occasional movement by large waterbirds in Australia, where large distances are covered in response to seasonal drying or flooding of wetlands across the landscape.

Given the paucity of waterbird records at the BUS survey points of the Project Area, and the lack of extensive habitat in the immediate vicinity, it is not expected there would be significant risk to any waterbird populations arising from construction and operation of the wind farm.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions

A total of 153 bird species were recorded within the project area by the BUS team, 93 of these during the formal BUS. White-throated Needletail (Vulnerable EPBC Act and NC Act), Grey Falcon (Vulnerable NC Act), Rufous Fantail (Migratory EPBC Act), Rainbow Bee-eater (Marine EPBC Act) and Satin Flycatcher (Migratory EPBC Act) were the five threatened species recorded during the formal BUS, and one further threatened species observed incidentally; Squatter Pigeon (southern) (Vulnerable EPBC Act and NC Act).

Impacts on Wedge-tailed Eagle and other common raptors are expected to occur, with experience at other wind farms indicating that small numbers of these species will collide with turbines each year (Nature Advisory, unpubl. data). Their large, widespread populations and wide-ranging movements make it highly unlikely that the population effects will be of conservation concern.

Notwithstanding the difficulties of predicting the impact of the wind farm on the White-throated Needletail, small numbers of the species have been known to be affected by wind farms elsewhere and it is possible that there may be an occasional mortality at the Clarke Creek Wind Farm. The impact of a small number of casualties on the species' population over the life of the project is not considered to be significant.

5.2. Recommendations

It is recommended that the established survey points be used as impact and reference points in a BACI (Before-After-Control-Impact) monitoring program, developed as part of the BBMP for the project. The use of control and survey points was not differentiated during this BUS, however these may be defined for the purposes of BACI when the final turbine layout is confirmed, with control points being those outside the zone of influence of the turbines (i.e. >500 m).

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Appendix 1: List of birds recorded during BUS at Clarke Creek Wind Farm, 2017 and 2020 combined

Common Name	Scientific Name	EPBC Act	NC Act	BUS obs	Incidental
Apostlebird	*Struthidea cinerea*				X
Australasian Darter	*Anhinga novaehollandiae*				X
Australasian Figbird	*Sphecotheres vieilloti*			X	
Australasian Grebe	*Tachybaptus novaehollandiae*				X
Australasian Pipit	*Anthus novaeseelandiae*			X	
Australian Brush-turkey	*Alectura lathami*				X
Australian Bustard	*Ardeotis australis*				X
Australian Magpie	*Gymnorhina tibicen*			X	
Australian Pelican	*Pelecanus conspicillatus*			X	
Australian Raven	*Corvus coronoides*				X
Australian White Ibis	*Threskiornis molucca*				X
Australian Wood Duck	*Chenonetta jubata*				X
Azure Kingfisher	*Ceyx azureus*				X
Barking Owl	*Ninox connivens*				X
Black Bittern	*Ixobrychus flavicollis*				X
Black Kite	*Milvus migrans*				X
Black Swan	*Cygnus atratus*				X
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*			X	
Black-faced Woodswallow	*Artamus cinereus*			X	
Black-fronted Dotterel	*Elseyornis melanops*				X
Black-necked Stork	*Ephippiorhynchus asiaticus*				X
Black-winged Stilt	*Himantopus himantopus*				X
Blue-faced Honeyeater	*Entomyzon cyanotis*			X	
Blue-winged Kookaburra	*Dacelo leachii*				X
Brolga	*Grus rubicunda*				X
Brown Falcon	*Falco berigora*			X	
Brown Gerygone	*Gerygone mouki*			X	
Brown Goshawk	*Accipiter fasciatus*			X	
Brown Honeyeater	*Lichmera indistincta*			X	
Brown Quail	*Coturnix ypsilophora*			X	
Brown Thornbill	*Acanthiza pusilla*			X	
Brown Treecreeper	*Climacteris picumnus*			X	
Brush Cuckoo	*Cacomantis variolosus*			X	
Buff-rumped Thornbill	*Acanthiza reguloides*			X	
Cattle Egret	*Bubulcus ibis*	Marine			X
Channel-Billed Cuckoo	*Scythrops novaehollandiae*				X
Cockatiel	*Nymphicus hollandicus*			X	
Common Cicadabird	*Edolisoma tenuirostre*			X	
Common Pheasant	*Phasianus colchicus*				X
Cotton Pygmy-goose	*Nettapus coromandelianus*				X
Crested Pigeon	*Ocyphaps lophotes*				X

Common Name	Scientific Name	EPBC Act	NC Act	BUS obs	Incidental
Crested Shrike-tit	*Falcunculus frontatus*			X	
Dollarbird	*Eurystomus orientalis*			X	
Double-barred Finch	*Taeniopygia bichenovii*			X	
Dusky Honeyeater	*Myzomela obscura*				X
Dusky Woodswallow	*Artamus cyanopterus*				X
Eastern Barn Owl	*Tyto javanica*				X
Eastern Great Egret	*Ardea alba*	Marine			X
Eastern Yellow Robin	*Eopsaltria australis*			X	
Emu	*Dromaius novaehollandiae*				X
Eurasian Coot	*Fulica atra*				X
Fairy Gerygone	*Gerygone palpebrosa*			X	
Fan-tailed Cuckoo	*Cacomantis flabelliformis*			X	
Forest Kingfisher	*Todiramphus macleayii*			X	
Galah	*Eolophus roseicapilla*				X
Golden Whistler	*Pachycephala pectoralis*			X	
Golden-headed Cisticola	*Cisticola exilis*			X	
Great Bowerbird	*Chlamydera nuchalis*			X	
Great Crested Grebe	*Podiceps cristatus*				X
Green Pygmy-goose	*Nettapus pulchellus*				X
Grey Butcherbird	*Cracticus torquatus*			X	
Grey Falcon	*Falco hypoleucos*		V	X	
Grey Fantail	*Rhipidura albiscapa*			X	
Grey Shrike-thrush	*Colluricincla harmonica*			X	
Grey Teal	*Anas gracilis*				X
Grey-crowned Babbler	*Pomatostomus temporalis*			X	
Gull-billed Tern	*Gelochelidon nilotica*				X
Hardhead	*Aythya australis*				X
Intermediate Egret	*Ardea intermedia*	Marine			X
Large-tailed Nightjar	*Caprimulgus macrurus*				X
Laughing Kookaburra	*Dacelo novaeguineae*			X	
Leaden Flycatcher	*Myiagra rubecula*			X	
Lewin's Honeyeater	*Meliphaga lewinii*			X	
Little Black Cormorant	*Phalacrocorax sulcirostris*				X
Little Corella	*Cacatua sanguinea*			X	
Little Egret	*Egretta garzetta*	Marine			X
Little Friarbird	*Philemon citreogularis*			X	
Little Grassbird	*Poodytes gramineus*				X
Little Pied Cormorant	*Microcarbo melanoleucos*				X
Little Shrike-thrush	*Colluricincla megarhyncha*			X	
Magpie-Lark	*Grallina cyanoleuca*				X
Masked Lapwing	*Vanellus miles*				X
Mistletoebird	*Dicaeum hirundinaceum*			X	
Nankeen Kestrel	*Falco cenchroides*			X	

Common Name	Scientific Name	EPBC Act	NC Act	BUS obs	Incidental
Nankeen Night-heron	*Nycticorax caledonicus*				X
Noisy Friarbird	*Philemon corniculatus*			X	
Noisy Miner	*Manorina melanocephala*			X	
Olive-backed Oriole	*Oriolus sagittatus*			X	
Owlet Nightjar	*Aegotheles cristatus*				X
Pacific Baza	*Aviceda subcristata*			X	
Pacific Black Duck	*Anas superciliosa*				X
Pale-headed Rosella	*Platycercus adscitus*			X	
Pallid Cuckoo	*Cacomantis pallidus*			X	
Peaceful Dove	*Geopelia placida*			X	
Peregrine Falcon	*Falco peregrinus*			X	
Pheasant Coucal	*Centropus phasianinus*			X	
Pied Butcherbird	*Cracticus nigrogularis*			X	
Pied Currawong	*Strepera graculina*			X	
Plumed Whistling-duck	*Dendrocygna eytoni*				X
Rainbow Bee-eater	*Merops ornatus*			X	
Rainbow Lorikeet	*Trichoglossus moluccanus*			X	
Red-backed Button-quail	*Turnix maculosus*			X	
Red-backed Fairywren	*Malurus melanocephalus*			X	
Red-Backed Kingfisher	*Todiramphus pyrrhopygius*				X
Red-browed Finch	*Neochmia temporalis*			X	
Red-tailed Black Cockatoo	*Calyptorhynchus banksii*			X	
Red-winged Parrot	*Aprosmictus erythropterus*			X	
Restless flycatcher	*Myiagra inquieta*			X	
Rufous Fantail	*Rhipidura rufifrons*			X	
Rufous Songlark	*Cincloramphus mathewsi*				X
Rufous Whistler	*Pachycephala rufiventris*			X	
Sacred Kingfisher	*Todiramphus sanctus*			X	
Satin Flycatcher	*Myiagra cyanoleuca*			X	
Scaly-breasted lorikeet	*Trichoglossus chlorolepidotus*			X	
Scarlet Honeyeater	*Myzomela sanguinolenta*			X	
Shining Bronze-cuckoo	*Chrysococcyx lucidus*			X	
Silvereye	*Zosterops lateralis*			X	
Singing Honeyeater	*Gavicalis virescens*				X
Spangled Drongo	*Dicrurus bracteatus*			X	
Spotted Bowerbird	*Chlamydera maculata*				X
Spotted Pardalote	*Pardalotus punctatus*			X	
Squatter Pigeon (southern)	*Geophaphs scripta scripta*	V	V		X
Straw-Necked Ibis	*Threskiornis spinicollis*				X
Striated Pardalote	*Pardalotus striatus*			X	
Stubble Quail	*Coturnix pectoralis*			X	
Sulphur-crested Cockatoo	*Cacatua galerita*			X	
Superb Fairywren	*Malurus cyaneus*			X	

Common Name	Scientific Name	EPBC Act	NC Act	BUS obs	Incidental
Tawny Frogmouth	*Podargus strigoides*			X	
Torresian Crow	*Corvus orru*			X	
Tree Martin	*Petrochelidon nigricans*			X	
Varied Sittella	*Daphoenositta chrysoptera*			X	
Varied Triller	*Lalage leucomela*			X	
Wedge-tailed Eagle	*Aquila audax*			X	
Weebill	*Smicrornis brevirostris*			X	
Welcome Swallow	*Hirundo neoxena*				X
Whistling Kite	*Haliastur sphenurus*			X	
White-bellied Cuckoo-shrike	*Coracina papuensis*			X	
White-breasted Woodswallow	*Artamus leucorynchus*			X	
White-browed Scrubwren	*Sericornis frontalis*			X	
White-browed Treecreeper	*Climacteris affinis*			X	
White-Faced Heron	*Egretta novaehollandiae*				X
White-naped Honeyeater	*Melithreptus lunatus*			X	
White-Necked Heron	*Ardea pacifica*				X
White-throated Honeyeater	*Melithreptus albogularis*			X	
White-throated Needletail	*Hirundapus caudacutus*	V	V	X	
White-throated Treecreeper	*Cormobates leucophaea*			X	
White-winged Triller	*Lalage tricolor*			X	
Willie Wagtail	*Rhipidura leucophrys*				X
Yellow Thornbill	*Acanthiza nana*			X	
Yellow-faced Honeyeater	*Caligavis chrysops*			X	
Yellow-Rumped Thornbill	*Acanthiza chrysorrhoa*				X
Yellow-throated Miner	*Manorina flavigula*			X	
Zebra Finch	*Taeniopygia guttata*				X

Appendix 2: List of bird species recorded in an approximate 20 km radius of the central point of the project area (source: BirdLife Australia 2020)

Common Name	Scientific Name
Pacific Black Duck	*Anas superciliosa*
Australian Wood Duck	*Chenonetta jubata*
Brown Quail	*Synoicus ypsilophora*
Squatter Pigeon	*Geophaps scripta*
Crested Pigeon	*Ocyphaps lophotes*
Peaceful Dove	*Geopelia placida*
Brown-capped Emerald-Dove	*Chalcophaps longirostris*
Pheasant Coucal	*Centropus phasianinus*
Shining Bronze-Cuckoo	*Chalcites lucidus*
Little Bronze-Cuckoo	*Chalcites minutillus*
Fan-tailed Cuckoo	*Cacomantis flabelliformis*
Masked Lapwing	*Vanellus miles*
Straw-necked Ibis	*Threskiornis spinicollis*
Pacific Baza	*Aviceda subcristata*
Brown Goshawk	*Accipiter fasciatus*
Southern Boobook	*Ninox boobook*
Rainbow Bee-eater	*Merops ornatus*
Forest Kingfisher	*Todiramphus macleayii*
Laughing Kookaburra	*Dacelo novaeguineae*
Blue-winged Kookaburra	*Dacelo leachii*
Red-tailed Black-Cockatoo	*Calyptorhynchus banksii*
Glossy Black-Cockatoo	*Calyptorhynchus lathami*
Sulphur-crested Cockatoo	*Cacatua galerita*
Australian King-Parrot	*Alisterus scapularis*
Pale-headed Rosella	*Platycercus adscitus*
Little Lorikeet	*Glossopsitta pusilla*
Rainbow Lorikeet	*Trichoglossus moluccanus*
Scaly-breasted Lorikeet	*Trichoglossus chlorolepidotus*
White-throated Treecreeper	*Cormobates leucophaea*
Red-backed Fairy-wren	*Malurus melanocephalus*
Scarlet Honeyeater	*Myzomela sanguinolenta*
Noisy Friarbird	*Philemon corniculatus*
Little Friarbird	*Philemon citreogularis*
Brown Honeyeater	*Lichmera indistincta*
Blue-faced Honeyeater	*Entomyzon cyanotis*
White-throated Honeyeater	*Melithreptus albogularis*
Yellow Honeyeater	*Stomiopera flava*
Lewin's Honeyeater	*Meliphaga lewinii*
Noisy Miner	*Manorina melanocephala*

Common Name	Scientific Name
Red-browed Pardalote	*Pardalotus rubricatus*
Striated Pardalote	*Pardalotus striatus*
White-throated Gerygone	*Gerygone olivacea*
Western Gerygone	*Gerygone fusca*
White-browed Scrubwren	*Sericornis frontalis*
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*
White-bellied Cuckoo-shrike	*Coracina papuensis*
Varied Triller	*Lalage leucomela*
Rufous Whistler	*Pachycephala rufiventris*
Grey Shrike-thrush	*Colluricincla harmonica*
Australasian Figbird	*Sphecotheres vieilloti*
Pied Currawong	*Strepera graculina*
Australian Magpie	*Gymnorhina tibicen*
Pied Butcherbird	*Cracticus nigrogularis*
Willie Wagtail	*Rhipidura leucophrys*
Grey Fantail	*Rhipidura fuliginosa*
Torresian Crow	*Corvus orru*
Leaden Flycatcher	*Myiagra rubecula*
Magpie-lark	*Grallina cyanoleuca*
Lemon-bellied Flycatcher	*Microeca flavigaster*
Mistletoebird	*Dicaeum hirundinaceum*
Chestnut-breasted Mannikin	*Lonchura castaneothorax*
Double-barred Finch	*Taeniopygia bichenovii*

Appendix 3: Clarke Creek Wind Farm Bird Utilisation Survey data, March 2017

Site	E1			E2			E3			E4			E5			E6			E7			E8			E9			E10						
Species\Height	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	Total	Total A	Total B	Total C
Australian Magpie	7			12			7			10			15			5						4			4			9			73	73	0	0
Australian Pelican																													24		24	0	24	0
Black-faced Cuckoo-shrike				2									1			2															5	5	0	0
Blue-faced Honeyeater																			2									2			4	4	0	0
Brown Falcon																									1						1	1	0	0
Brown Honeyeater										2																					2	2	0	0
Crested Shrike-tit							1			1																					2	2	0	0
Double-barred Finch																						2									2	2	0	0
Eastern Yellow Robin	6												1			2			2												11	11	0	0
Grey Butcherbird	1						3			3																		3			10	10	0	0
Grey Falcon																			1												1	1	0	0
Grey Shrike-thrush	2															1			2												5	5	0	0
Laughing Kookaburra				4			2			2			4			3															15	15	0	0
Leaden Flycatcher	2																		2												4	4	0	0
Lewin's Honeyeater																2															2	2	0	0
Little Corella										4																					4	4	0	0
Little Friarbird							3			2			3																		8	8	0	0
Mistletoebird																6			11												17	17	0	0
Nankeen Kestrel														1		1	1														3	1	2	0
Noisy Friarbird	1			3			7			3			5						2			2									23	23	0	0
Pale-headed Rosella	4									2									4												10	10	0	0
Peregrine Falcon																			1	2											3	1	2	0
Pheasant Coucal	2															1															3	3	0	0
Pied Butcherbird				5						1						2									2			6			16	16	0	0
Pied Currawong	9			4			9			5			7			7			2	4		4						6			57	53	4	0
Rainbow Bee-eater				16			2						17			20			30			127			5			8			225	225	0	0
Rainbow Lorikeet	46			33			72			12			36			24			10			10			5			38			286	286	0	0
Red-backed Button-quail	3																														3	3	0	0
Red-backed Fairywren	6																														6	6	0	0
Red-winged Parrot	6																														6	6	0	0
Scaly-breasted Lorikeet				7																											7	7	0	0
Spangled Drongo							3												1												4	4	0	0
Spotted Pardalote	6						2			4																					12	12	0	0
Striated Pardalote							2			14			9									2									27	27	0	0
Sulphur-crested Cockatoo																						1									1	1	0	0
Tawny Frogmouth				2																											2	2	0	0
Torresian Crow	2			15			5			9			7			15			10			28			14			18			123	123	0	0
Varied Sittella	12																														12	12	0	0
Wedge-tailed Eagle					1											2				2		3	2						1		11	5	6	0
White-browed Scrubwren																7															7	7	0	0
White-throated Honeyeater	8						6			3			3																		20	20	0	0
Grand Total	123	0	0	103	1	0	124	0	0	77	0	0	108	1	0	100	1	0	80	8	0	183	2	0	31	0	0	90	25	0	1057	1019	38	0

Note: A=below RSA height <40 metres, B=at RSA height 40-220 metres, C= >220 metres

Appendix 4: Clarke Creek Wind Farm Bird Utilisation Survey data, September 2017

Site	E1			E10			E11			E12			E2			E3			E4			E5		
Species\Height	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Australian Magpie	6			20			3						9			6			8					
Black-faced Cuckoo-shrike				1									3											
Black-faced Woodswallow				50																				
Blue-faced Honeyeater																								
Brown Falcon					1																			
Brush Cuckoo				1			7																	
Buff-rumped Thornbill				5						6									2			9		
Cicadabird							2																	
Double-barred Finch				12																				
Fairy Gerygone																								
Fantailed Cuckoo																								
Figbird																								
Forest Kingfisher																1								
Grey Fantail																								
Grey Shrike-thrush							1			3						2			2					
Laughing Kookaburra	6			3			1						1			4			5					
Leaden Flycatcher							1			3									1					
Lewin's Honeyeater										3						2								
Little Friarbird										1														
Mistletoebird				5																				
Nankeen Kestrel	1																							
Noisy Friarbird													3											
Pale-headed Rosella													2									2		
Pallid Cuckoo							1																	
Peaceful Dove																								
Pheasant Coucal																			2					
Pied Butcherbird				2						5			3											
Pied Currawong	11			16			13			12			11			10			6			6		
Rainbow Bee-eater	7			27			14			30			5											
Rainbow Lorikeet	10			8			4						18			5			24			10		
Red-backed Fairywren	5			27			7			16			13											
Red-tailed Black Cockatoo																								
Rufous Fantail				2																				
Rufous Whistler																								
Scaly-breasted Lorikeet																			2					
Striated Pardalote										4			2			4			2					
Sulphur-crested Cockatoo				3							2		2	2					1					
Torresian Crow	6			7			7						11			16			7					
Varied Triller				3			3			3												2		
Wedge-tailed Eagle														1										
Whistling Kite				1																				
White-bellied Cuckoo-shrike	1												1									2		
White-browed Scrubwren							3			9												1		
White-throated Honeyeater																9								
White-winged Triller																								
Yellow-throated Miner				2																				
Grand Total	53	0	0	195	1	0	67	0	0	95	2	0	84	3	0	59	0	0	62	0	0	32	0	0

Site	E6			E7			E8			E9			P1			P10			P11			P12		
Species\Height	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Australian Magpie				1						21									4					
Black-faced Cuckoo-shrike	1												1			1			1			1		
Black-faced Woodswallow																								
Blue-faced Honeyeater																								
Brown Falcon	1	1						2									1							
Brush Cuckoo																								
Buff-rumped Thornbill				3			5						2			1			3					
Cicadabird																								
Double-barred Finch																								
Fairy Gerygone																								
Fantailed Cuckoo																			1					
Figbird																						7		
Forest Kingfisher																								
Grey Fantail																								
Grey Shrike-thrush				1						1			1						1					
Laughing Kookaburra							3			6														
Leaden Flycatcher	1																							
Lewin's Honeyeater				7			4												1			1		
Little Friarbird																						1		
Mistletoebird																								
Nankeen Kestrel	1																							
Noisy Friarbird							2																	
Pale-headed Rosella										6														
Pallid Cuckoo							2																	
Peaceful Dove																						1		
Pheasant Coucal																								
Pied Butcherbird										9									1			6		
Pied Currawong				2	2		4			21			4			1			1			3		
Rainbow Bee-eater							12			32				2					3			4		
Rainbow Lorikeet	6			4			14			8						10			1					
Red-backed Fairywren				8			16									7								
Red-tailed Black Cockatoo										17														
Rufous Fantail																								
Rufous Whistler							1												2					
Scaly-breasted Lorikeet																								
Striated Pardalote													2			4			1					
Sulphur-crested Cockatoo										1						1								
Torresian Crow										11			1			2								
Varied Triller										1												1		
Wedge-tailed Eagle		3						1																
Whistling Kite																								
White-bellied Cuckoo-shrike																								
White-browed Scrubwren							1												6					
White-throated Honeyeater																								
White-winged Triller				9			1																	
Yellow-throated Miner																								
Grand Total	10	4	0	35	2	0	65	3	0	134	0	0	11	2	0	27	1	0	26	0	0	25	0	0

Site	P2			P3			P4			P5			P6			P7			P8			P9						
Species\Height	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	Total	Total A	Total B	Total C
Australian Magpie																									78	78	0	0
Black-faced Cuckoo-shrike	1			2																		10			22	22	0	0
Black-faced Woodswallow																									50	50	0	0
Blue-faced Honeyeater				1						1															2	2	0	0
Brown Falcon													1												7	2	5	0
Brush Cuckoo																									8	8	0	0
Buff-rumped Thornbill																									36	36	0	0
Cicadabird																									2	2	0	0
Double-barred Finch																									12	12	0	0
Fairy Gerygone																2									2	2	0	0
Fantailed Cuckoo																									1	1	0	0
Figbird																2									9	9	0	0
Forest Kingfisher																									1	1	0	0
Grey Fantail							2																		2	2	0	0
Grey Shrike-thrush																									12	12	0	0
Laughing Kookaburra							1																		30	30	0	0
Leaden Flycatcher							1																		7	7	0	0
Lewin's Honeyeater							1									5			9			1			34	34	0	0
Little Friarbird																									2	2	0	0
Mistletoebird																									5	5	0	0
Nankeen Kestrel																									2	2	0	0
Noisy Friarbird																									5	5	0	0
Pale-headed Rosella	2																								12	12	0	0
Pallid Cuckoo																									3	3	0	0
Peaceful Dove																2									3	3	0	0
Pheasant Coucal																									2	2	0	0
Pied Butcherbird										1												2			29	29	0	0
Pied Currawong	1						1									1						4			130	128	2	0
Rainbow Bee-eater																									136	134	2	0
Rainbow Lorikeet	1			1			1			4			2			3						2			136	136	0	0
Red-backed Fairywren																									99	99	0	0
Red-tailed Black Cockatoo																									17	17	0	0
Rufous Fantail																									2	2	0	0
Rufous Whistler																						1			4	4	0	0
Scaly-breasted Lorikeet							3																		5	5	0	0
Striated Pardalote							1																		20	20	0	0
Sulphur-crested Cockatoo							1																		13	9	4	0
Torresian Crow	1			2			1						1							2		1			76	74	2	0
Varied Triller																						2			15	15	0	0
Wedge-tailed Eagle																				3					8	0	8	0
Whistling Kite																									1	1	0	0
White-bellied Cuckoo-shrike																									4	4	0	0
White-browed Scrubwren																									20	20	0	0
White-throated Honeyeater							1																		10	10	0	0
White-winged Triller													1												11	11	0	0
Yellow-throated Miner																									2	2	0	0
Grand Total	6	0	0	6	0	0	14	0	0	6	0	0	5	0	0	15	0	0	9	5	0	23	0	0	1087	1064	23	0

Note: A=below RSA height <40 metres, B=at RSA height 40-220 metres, C = above RSA height >220 metres

Nature Advisory

Appendix 5: Clarke Creek Wind Farm Bird Utilisation Survey data, April 2020

Site	E1			E10			E2			E3			E4			E5			E6			E7			E9			Green3			Green4			N1			N2			N3			N4			N5			N6			N7			N8		
Species\Height	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Australian Magpie	6						3			2			1			6			8			2			2									1									1			3								
Australian Pelican														1																																									
Black-faced Cuckoo-shrike										1						6									2						1			1			3									3						3			1		
Blue-faced Honeyeater										3																																								1					
Brown Falcon		1																	2																						1													
Brown Gerygone																2			1																																				
Brown Goshawk																																																					
Brown Honeyeater	7						3												11			1															1						5			1								
Brown Treecreeper																																																					
Cockatiel																15																																						
Double-barred Finch																			19																																			
Fan-tailed Cuckoo																1			4																																			
Forest Kingfisher																																																					
Great bowerbird																									1																														
Grey Fantail				2															8																																			
Grey Shrike-thrush							2			1																																												
Grey-crowned Babbler																																										5												
Laughing Kookaburra	1									4						2			3															1			1						3			11			4					
Leaden Flycatcher																									1																												
Lewin's Honeyeater							2						1						1									2			5																						
Little Friarbird																																																2			4					
Mistletoebird																									1																												
Nankeen Kestrel																																																				
Noisy Friarbird							6			10						4			4			1																		1			4			4			1					
Noisy Miner																			3																																		
Olive-backed Oriole										1																																											
Pale-headed Rosella				2												1																										11			9			2					
Peaceful Dove										1			1						2																																		
Pheasant Coucal	1						1			6			6						5			1						1									1									1								
Pied Butcherbird				2						2			1			5			3																					3			4			2			1					
Pied Currawong	2			3			4			18			17			1			14			1			3	2								1			2			3			7			2			4			12		
Rainbow Bee-eater													6			2			8			2						3	3		6															12								
Rainbow Lorikeet	5			36						12			8						5			1			21									2						4			18			12						2					
Red-backed Button-quail																1																																						
Red-backed Fairywren													1			4												4																											
Red-browed Finch																			5																																				
Red-tailed Black Cockatoo																																																					
Red-winged Parrot																																																					
Restless flycatcher																			1																																				
Rufous Whistler										1									1																																				
Sacred Kingfisher										1																																												
Satin Flycatcher																																																					
Scaly-breasted lorikeet																																																					
Scarlet Honeyeater																						1																																
Shining Bronze Cuckoo																									1																												
Spangled Drongo										1						3			2						1						3						1			3												
Striated Pardalote	2						11			5									15			1						1									1															
Sulphur-crested Cockatoo							3													2		2															2											1		6			
Superb Fairywren													1																																								
Tawny Frogmouth																																																				
Torresian Crow																2			1																																			
Torresian Crow				2									1						1						2												1						1			1			1			3		
Tree Martin																																																				
Varied Sittella																																																				
Varied Triller																															1																					
Wedge-tailed Eagle		2			2			1	1		1			2																				2			1															
White-bellied Cuckoo-shrike																																																			4		
White-browed Treecreeper																																																4					
White-throated Honeyeater							5			3						4			10			3						2			1															3			3					
White-throated Treecreeper																																																				
White-winged Triller																																		3												1					
Yellow Thornbill																																																				
Grand Total	24	3	0	47	2	0	40	1	1	72	1	0	44	3	0	59	0	0	137	2	0	16	0	0	35	2	0	13	3	0	17	0	0	10	2	0	14	0	0	20	0	0	45	1	0	49	0	0	51	1	0	43	0	0	4	0	0

Note: A=below RSA height <40 metres, B=at RSA height 40-220 metres, C = above RSA height >220 metres

Site	North Ridge 3			North Ridge 4			P1			P2			P3			P4			P5			P6			South Ridge 3			South Ridge 4						
Species\Height	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	Total	Total A	Total B	Total C
Australian Magpie				1			4			2			11						1			1									**60**	60	0	0
Australian Pelican																															**1**	0	1	0
Black-faced Cuckoo-shrike	6			8																		1			2			1			**61**	61	0	0
Blue-faced Honeyeater																															**4**	4	0	0
Brown Falcon																															**4**	2	2	0
Brown Gerygone										3						1						9									**16**	16	0	0
Brown Goshawk				1																								1			**2**	2	0	0
Brown Honeyeater				1			3			6						3						1			2			2			**50**	50	0	0
Brown Treecreeper																			2												**2**	2	0	0
Cockatiel																															**15**	15	0	0
Double-barred Finch																			5												**24**	24	0	0
Fan-tailed Cuckoo																															**5**	5	0	0
Forest Kingfisher																															**1**	1	0	0
Great bowerbird																															**1**	1	0	0
Grey Fantail				3			3																		1			3			**27**	27	0	0
Grey Shrike-thrush																									2			1			**8**	8	0	0
Grey-crowned Babbler																															**5**	5	0	0
Laughing Kookaburra							1						1			1									5			1			**45**	45	0	0
Leaden Flycatcher				2																					2			4			**9**	9	0	0
Lewin's Honeyeater																												1			**12**	12	0	0
Little Friarbird																												1			**7**	7	0	0
Mistletoebird				1																		3			6			2			**13**	13	0	0
Nankeen Kestrel				1																											**2**	2	0	0
Noisy Friarbird				7			1			2			2			1			3			2			3						**58**	58	0	0
Noisy Miner							3			2																					**8**	8	0	0
Olive-backed Oriole																									1						**2**	2	0	0
Pale-headed Rosella																						1									**28**	28	0	0
Peaceful Dove																															**6**	6	0	0
Pheasant Coucal							1			3			1			2												1			**32**	32	0	0
Pied Butcherbird				5									2																		**31**	31	0	0
Pied Currawong				4			22			10			5			5						2						1			**152**	150	2	0
Rainbow Bee-eater				4	6					2						4									2						**70**	61	9	0
Rainbow Lorikeet				4						6						19	9								14			23			**207**	198	9	0
Red-backed Button-quail				1												1									3						**6**	6	0	0
Red-backed Fairywren				4																											**13**	13	0	0
Red-browed Finch																															**5**	5	0	0
Red-tailed Black Cockatoo								3																							**3**	0	3	0
Red-winged Parrot				1																											**2**	2	0	0
Restless flycatcher																															**1**	1	0	0
Rufous Whistler				4						1															4			2			**30**	30	0	0
Sacred Kingfisher																															**1**	1	0	0
Satin Flycatcher																															**2**	2	0	0
Scaly-breasted lorikeet																3															**5**	5	0	0
Scarlet Honeyeater							2			1												2									**6**	6	0	0
Shining Bronze Cuckoo																															**1**	1	0	0
Spangled Drongo																															**14**	14	0	0
Striated Pardalote				1			6			5																					**53**	53	0	0
Sulphur-crested Cockatoo																	3								5			3	1		**28**	21	7	0
Superb Fairywren																															**1**	1	0	0
Tawny Frogmouth																															**2**	2	0	0
Torresian Crow										7						1	1		1												**13**	12	1	0
Torresian Crow	1																														**17**	17	0	0
Tree Martin																										1					**1**	0	1	0
Varied Sittella																															**1**	1	0	0
Varied Triller																															**1**	1	0	0
Wedge-tailed Eagle																															**12**	1	10	1
White-bellied Cuckoo-shrike																															**4**	4	0	0
White-browed Treecreeper																															**4**	4	0	0
White-throated Honeyeater				14												2			2						2			6			**75**	75	0	0
White-throated Treecreeper										2						2															**4**	4	0	0
White-winged Triller																															**4**	4	0	0
Yellow Thornbill																1			4												**5**	5	0	0
Grand Total	7	0	0	67	6	0	46	3	0	52	0	0	22	0	0	46	13	0	18	0	0	22	0	0	54	1	0	53	1	0	1282	1236	45	1

Note: A=below RSA height <40 metres, B=at RSA height 40-220 metres, C = above RSA height >220 metres

Appendix 6: Clarke Creek Wind Farm Bird Utilisation Survey data, October 2020

Site	E1			E10			E2			E3			E4			E5			E6			E9			Green 3			Green 4			N1			N2			N3			N4			N5			N6			N7			N8		
Species/Height	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Australasian Pipit																																																			1		
Australian Magpie	1			6															5			5						1									2			23						1			2					
Black-faced Cuckoo-shrike				1						2			4									2									1									2									8			4		
Blue-faced Honeyeater	1									4			1			3																									5						2			1		
Brown Falcon																1			1																																	
Brown Goshawk																																																			
Brown Honeyeater																																																			
Brown Quail													6																																						
Brown Thornbill																			1																																	
Brush Cuckoo										1																																									
Buff-rumped Thornbill										2																																									
Channel-billed Cuckoo										1																																									
Cockatiel																																																			
Common Cicadabird																1			1																																	
Dollarbird																																																			
Double-barred Finch																																																			
Fan-tailed Cuckoo																			1									3																									
Forest Kingfisher																2			1																									4											
Golden Whistler													1			1																																					
Golden-headed Cisticola																																																		2		
Grey Shrike-thrush										2			2			3			1									1																		1								
Laughing Kookaburra				2						2			2			2			2																																1		
Leaden Flycatcher																																																			
Lewin's Honeyeater				1						1						3			4						1			7						1																	
Little Shrike-thrush																												2																								
Mistletoebird																												3						2														2					
Nankeen Kestrel																																																			
Noisy Friarbird				1												2															2																		3			1		
Pacific Baza								1																																												
Pale-headed Rosella				1			1			2												1																					3											
Pheasant Coucal	1						1																																													
Pied Butcherbird	1			3						1						1			3			2			1			1			1			1												4					2					
Pied Currawong	9			16			12			16			20			6			7			1			3			8						2			1			3	1		4						2			1		
Rainbow Bee-eater																						2			4			10	10															4				1			1		
Rainbow Lorikeet				4			4			4			4			5			2	3		2																					2						2	1		4	2	
Red-backed Button-quail																																																			
Red-backed Fairy-wren	5			12															3																									3									11		
Red-winged Parrot																												5			4												6			1			2					
Rufous Fantail																																																			
Rufous Whistler										2			1									2			1			3						1																	
Sacred Kingfisher																									1																											
Satin Flycatcher																									1			1																							2		
Scarlet Honeyeater	1																																																		
Shining Bronze-Cuckoo																1												1																							
Silvereye																																		6																	
Spangled Drongo																2																																			
Spotted Pardalote										2																																									
Striated Pardalote																																																			
Stubble Quail																						1																													2		
Sulphur-crested Cockatoo	4			2			3			1			1																					2						1			1			1					
Torresian Crow	4			11	5		6			6	2		8			1			1			2	2					1			2	1					4	3			2						5	2		7		
Varied Sittella																																																		2		
Varied Triller																			2									1						3									7			2					
Wedge-tailed Eagle														1	1		1				1																															
Weebill																																																			
Whistling Kite													1																																						
White-breasted Woodswallow																																																		
White-naped Honeyeater																																																		
White-throated Honeyeater										12			8			5									8			4																						3		
White-throated Needletail	18						2							6		2																																			
White-throated Treecreeper										2																																									
Yellow-faced Honeyeater																																		1																	
Total	45	0	0	60	5	0	29	1	0	63	2	0	59	7	1	41	1	0	35	4	0	20	2	0	20	0	0	52	10	0	9	1	0	20	0	0	7	3	0	29	3	0	39	0	0	12	0	0	28	4	0	42	3	0

Site	North Ridge 3			North Ridge 4			P1			P2			P3			P4			P5			P6			South Ridge 3			South Ridge 4						
Species/Height	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	Grand Total	Total A	Total B	Total C
Australasian Pipit																															**1**	0	0	0
Australian Magpie	2			3			1	1		2			1						5			1									**62**	61	1	0
Black-faced Cuckoo-shrike				3			1			2			1						1			2									**34**	30	0	0
Blue-faced Honeyeater	6			6			1			3			3			3			4			1			2						**46**	45	0	0
Brown Falcon														1			1															**4**	2	2	0
Brown Goshawk				1																											**1**	1	0	0
Brown Honeyeater				1																								1			**2**	2	0	0
Brown Quail																															**6**	6	0	0
Brown Thornbill																															**1**	1	0	0
Brush Cuckoo																															**1**	1	0	0
Buff-rumped Thornbill							10	24								2									4						**42**	18	24	0
Channel-billed Cuckoo																															**1**	1	0	0
Cockatiel																			1												**1**	1	0	0
Common Cicadabird																1															**3**	3	0	0
Dollarbird							1									1															**2**	2	0	0
Double-barred Finch																	1														**1**	0	1	0
Fan-tailed Cuckoo																												3			**7**	7	0	0
Forest Kingfisher													1			2															**10**	10	0	0
Golden Whistler																															**2**	2	0	0
Golden-headed Cisticola	1																														**3**	1	0	0
Grey Shrike-thrush	1			3						2									3			2									**21**	21	0	0
Laughing Kookaburra	1			1						1			1			3			1			3						2			**24**	23	0	0
Leaden Flycatcher																2															**2**	2	0	0
Lewin's Honeyeater				1												3									2						**24**	24	0	0
Little Shrike-thrush																															**2**	2	0	0
Mistletoebird																									3			3			**13**	13	0	0
Nankeen Kestrel																			1												**1**	1	0	0
Noisy Friarbird	3			9			1						8			3			4			3			2			3			**45**	44	0	0
Pacific Baza																															**1**	0	1	0
Pale-headed Rosella	2			1									1			7			1												**20**	20	0	0
Pheasant Coucal	1			1																		4						4			**12**	12	0	0
Pied Butcherbird				1									1									6			1						**30**	28	0	0
Pied Currawong	1			3			4			8	1		8			4			1			3			6			10			**161**	158	2	0
Rainbow Bee-eater	1			4	1			5			13		14				2					1	1			13		16	15		**118**	56	61	0
Rainbow Lorikeet	6			5			1						3				6		7	1		1			2			12			**83**	66	11	0
Red-backed Button-quail										2																					**2**	2	0	0
Red-backed Fairy-wren							1									9									5			3			**52**	41	0	0
Red-winged Parrot	3			1																					4						**26**	26	0	0
Rufous Fantail																1												3			**4**	4	0	0
Rufous Whistler				1																					1						**12**	12	0	0
Sacred Kingfisher																															**1**	1	0	0
Satin Flycatcher																									2						**6**	6	0	0
Scarlet Honeyeater																															**1**	1	0	0
Shining Bronze-Cuckoo																															**2**	2	0	0
Silvereye																															**6**	6	0	0
Spangled Drongo																															**2**	2	0	0
Spotted Pardalote							1																								**3**	3	0	0
Striated Pardalote				4						2			1			4			3												**14**	14	0	0
Stubble Quail																															**3**	1	0	0
Sulphur-crested Cockatoo	1			1										5		3	1								1			1			**29**	23	6	0
Torresian Crow	3			2			1	1		3	2		4			6	4		2			2						1			**106**	75	24	0
Varied Sittella																															**2**	2	0	0
Varied Triller																															**15**	15	0	0
Wedge-tailed Eagle									1					2						2	3		1								**13**	0	8	5
Weebill	3																														**3**	3	0	0
Whistling Kite																															**1**	1	0	0
White-breasted Woodswallow		1																													**1**	0	1	0
White-naped Honeyeater																			2												**2**	2	0	0
White-throated Honeyeater	2			4			1			1			3			11						1			5			3			**71**	68	0	0
White-throated Needletail		49															11		31			2									**121**	55	66	0
White-throated Treecreeper										2															3						**7**	7	0	0
Yellow-faced Honeyeater																															**1**	1	0	0
Total	37	50	0	56	1	0	24	31	1	28	16	0	50	8	0	65	26	0	67	3	3	32	2	0	43	13	0	65	15	0	1293	1035	208	5

Note: A=below RSA height <40 metres, B=at RSA height 40-220 metres, C = above RSA height >220 metres

Appendix 7: Regional Ecosystem and habitat descriptions of each survey point, Clarke Creek Wind Farm, 2020

Site	RE and Description	Lat	Long
E1	8.12.7a/8.12.9 Corymbia citriodora +/- Eucalyptus portuensis +/- Eucalyptus drepanophylla (or Eucalyptus crebra) open forest on hill slopes and undulating plateaus, on Mesozoic to Proterozoic igneous rocks	-22.51692	149.337738
E2	8.12.7a/8.12.9 Corymbia citriodora +/- Eucalyptus portuensis +/- E. drepanophylla (or E. crebra) open forest on hill slopes and undulating plateaus, on Mesozoic to Proterozoic igneous rocks	-22.520031	149.340105
E3	8.12.7c Corymbia citriodora +/- Eucalyptus portuensis +/- E. crebra open forest on hill slopes and undulating plateaus	-22.570658	149.33717
E4	8.12.7c Corymbia citriodora +/- Eucalyptus portuensis +/- E. drepanophylla (or E. crebra) open forest on hill slopes and undulating plateaus	-22.568171	149.337054
E5	11.12.1 E. crebra stunted woodland canopy height 6m Cover 20-30%/Semi-evergreen vine thicket and microphyll vine forest on igneous rocks	-22.60905	149.306313
E6	Stunted acacia and ironbark height to 6m Cover 5-20%	-22.612573	149.304753
E7	E. crebra, sparse, with Acacia and hibuscus understory	-22.92388	149.50825
E8	E. crebra, sparse, with Acacia and hibuscus understory	-22.92864	149.51215
E9	E. crebra low open woodland 7-10m high, with Brachychiton populnea and grassy understorey, expansive views down slope to north, and drops away to SEVT on steep slope to south	-22.794012	149.42669
E10	Telecommunications tower clearing with slopes and views to north east and south. Scrubby undergrowth, Corymbia citriodora and E. crebra woodland to west	-22.8077	149.43158
E11	Near telecommunications tower, scrubby acacia	-22.8848	149.48916
E12	Scrubby acacia thicket opening to southward facing vine thicket	-22.8908	149.49116
N1	E. crebra woodland 8-12m high, on steep rocky ground with views to southwest	-22.89653	149.47121
N2	Top of slope in E. crebra woodland 8-12m high with patches of vine thicket on steep slope to north and south, views to north and west	-22.90332	149.47496
N3	Cleared track ridgeline. Sparse, low, open woodland of mainly E. crebra. Northern aspect	-22.80218	149.42311
N4	Cleared track on ridgeline. Sparse, low, open woodland of mainly E. crebra. Northern aspect	-22.80187	149.42663
N5	E. crebra woodland from 10-15m high with grassy understorey and steep slopes to east and west	-22.91224	149.49799
N6	E. crebra woodland from 10-15m high with grassy understorey and steep slopes to east and west	-22.91548	149.49896

Site	RE and Description	Lat	Long
N7	Eucalyptus crebra woodland 8-12m high on east side of ridge with grassy understorey, view to east across SEVT on steep upper slopes	-22.86094	149.4536
N8	Eucalyptus crebra woodland 8-12m high in open grassy area on north facing slope	-22.85749	149.45329
Green 3	Eucalyptus crebra open woodland 8-15m high with grassy understorey and isolated patch of scrub on outcropping rock at crest (one large Ficus platypoda), view down rideline to south	-22.93248	149.4955
Green 4	Eucalyptus crebra open woodland on localised rocky crest to south, views to south and west, rises Bottle Tree scrub on steep slope across gully to east	-22.93741	149.49756
North Ridge 3	Open grassland paddock of Heteropogon contortus, Melinus repens, with scattered Eucalyptus crebra woodland and wattle patches	-22.86331	149.4596
North Ridge 4	Eucalyptus crebra woodland 8-15m with rocky outcrop areas with SEVT to Northwest, slopes away with expansive views to southwest	-22.86857	149.46299
South Ridge 3	Eucalyptus crebra open woodland 8-14m high with grassy understorey (Heteropogon contortus/Dichanthium spp), with patches of Notelaea and wattle, slopes down ridge to south and drops away east and west on steep slopes	-22.90965	149.49489
South Ridge 4	Rocky ridgetop with vine forest patches (Euroschinus falcatus, Ficus platypoda, Denhamia disperma etc), views over rocky cliff edge to east, slopes down ridgeline into Eucalyptus crebra woodland to south	-22.90515	149.49397
P1	Spotted gum woodland with ironbark and acacia canopy to 12m Cover 25%	-22.52311	149.346438
P2	Spotted gum woodland with iron bark and flowering acacia canopy to 12m Cover 40%	-22.528942	149.345091
P3	11.12.1 canopy 7m Cover 30%	-22.572685	149.337199
P4	Shrubby, little canopy 11.12.1 canopy 10% height 6m	-22.576408	149.337652
P5	11.12.1 canopy 6m 20%	-22.604938	149.307476
P6	11.12.1 lots of long grass canopy to 5m Cover 20%	-22.598999	149.309743

Appendix 4: Suitable substitute carcasses for detectability and scavenger trials

The following species and species groups are considered suitable to use as substitutes for usage in scavenger and detectability trials if no sufficient natural carcasses are available:

- Mice (for bats)
- Birds collected in pest control programs i.e. Noisy Miner, Common Myna, Common Starling.