Bird and Bat Adaptive Management Plan

Crudine Ridge Wind Farm

21 October 2025

SQUADRON ENERGY

Final

Revision Control

Revision	Date	Issue	Author	Reviewed	Approved	Description
2.6	16/11/2017	Final/Issued	Brett Lane & Associates Peter Lansley, Bernard O'Callaghan	BL&A Bernard O'Callaghan	BL&A Brett Lane	Approved by OEH (now CPHR)
3	19/11/24	Final Draft	Eco Logical Australia Lachlan Metzler	ELA Tom Kelly	ELA Tom Kelly	Sent to CPHR for consultation
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Confidentiality

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1 Introduction

1.1 Background

Crudine Ridge Wind Farm (CRWF; the Project) is located 40 kilometres south of Mudgee and 50 kilometres north of Bathurst in the central tablelands of New South Wales. In March 2011, Crudine Ridge Wind Farm Pty Ltd (CRWF Pty Ltd – the Proponent) proposed a 116-turbine wind farm covering 17 properties in the central Tablelands of NSW at this location. The NSW Department of Planning, Housing and Infrastructure(DPHI) gave approval for up to 77 turbines on 10 May 2016. On 4 April 2017, the Commonwealth Minister for the Environment and Energy approved a wind farm of up to 37 turbines, selected from 57 approved turbine locations, under the EPBC Act with conditions. The location of the CRWF is shown in Figure 1 and the Approved Project Infrastructure is presented in Figure 2.

Condition 22, Schedule 3 of the NSW approval requires the preparation of a Bird and Bat Adaptive Management Plan (BBAMP). The EPBC Act approval condition 1a) requires that the approval holder prepare the BBAMP to address potentially affected protected matters. These requirements are outlined in the following section.

The first BBAMP was prepared by Brett Lane & Associates Pty Ltd (BL&A) on behalf of Crudine Ridge Wind Farm (CWF) and reviewed by the Office of Environment and Heritage (OEH) (now the Conservation Programs, Heritage and Regulation branch within the NSW Department of Climate Change, Energy, the Environment and Water (CPHR of NSW DCCEEW)) and the Commonwealth Department of the Environment and Energy (DOEE) (now the Cth Department of Climate Change, Energy, the Environment and Water (Cth DCCEEW)). The BBAMP v2.6, dated November 2017 (BBAMP2017) was approved by the CPHR on 16 November 2017.

Following two years of implementation of the BBAMP2017, the Year 2 Annual Bird and Bat report (prepared by Eco Logical Australia Pty Ltd, 11 August 2023) recommended a revised monitoring program, consistent with Section 4.7.1 of the BBAMP2017.

This BBAMP is the updated version of BBAMP2017, reflecting the revised monitoring program that will be implemented from Year 3 onwards.

1.2 Requirements of BBAMP

The specific requirements of the BBAMP are presented below extracted from the approval conditions.

1.2.1 NSW approval

“Bird and Bat Monitoring and Management

[Condition] 22. Prior to the commencement of construction, the Applicant shall prepare a Biodiversity Management Plan for the development to the satisfaction of the Secretary. This plan must:

22 (a) be prepared in consultation with OEH and DoEE; and,

22 (b) include a Bird and Bat Adaptive Management Plan (BBAMP), that includes:

- baseline data on bird and bat populations in the locality that could potentially be affected by the development, particularly ‘at risk’ species and threatened species;
- a detailed description of the measures that would be implemented on site for minimising bird and bat strike during operation of the development, including:
  - minimising the availability of raptor perches;
  - prompt carcass removal
  - controlling pests

- using best practice methods for bat deterrence, including managing potential lighting impacts;
- adaptive management of turbines to reduce mortality; and:

Condition 22 (c)

- include a detailed program to monitor and report on the performance of these measures over time, including annual reporting of bird and bat strike monitoring or as otherwise directed by the Secretary."

This BBAMP fulfils the requirements of Condition C22 (a)-(c) of the Project Approval, and subject to BBAMP approval by DPHI, will be implemented during the operation of the CRWF.

1.2.2 EPBC Act approval

In relation to birds and bats protected under the EPBC Act, the EPBC Act Condition of Approval 1 (a) requires that the Proponent implement the above NSW approval condition *"where they relate to monitoring, managing, mitigating, avoiding, offsetting, recording, or reporting on, impacts to protected matters."*

This BBAMP addresses this approval condition in relation to EPBC Act listed bird and bat species.

1.2.3 Compliance Summary

The following table details which sections of this BBAMP addresses specific requirements outlined in the relevant Condition of Approval 22 above.

Table 1 Sections within the BBAMP that respond to Condition of Approval 22 for Crudine Ridge Wind Farm.

Condition number	Abbreviated condition details	BBAMP Section/s
C22 (b)	Include baseline data on bird and bat populations in the locality that could potentially be affected by the development, particularly 'at risk' species.	Section 3
Condition C22 (b)	Detailed description of measures that would be implemented on site to minimise bird and bat mortality, namely:	
	Minimising availability of raptor perches	5.3
	Prompt carcass removal	4.4
	Controlling pests	5.1
	Using best practice methods for bat deterrence; including managing potential lighting impacts	5.2
	Adaptive management of turbines to reduce mortality	6.1, 6.2, 6.3
C22 (c)	Monitor and report these measures over time including submitting reports to the Secretary on an annual basis	4.7

Figure 1 Location of the Crudine Ridge Wind Farm

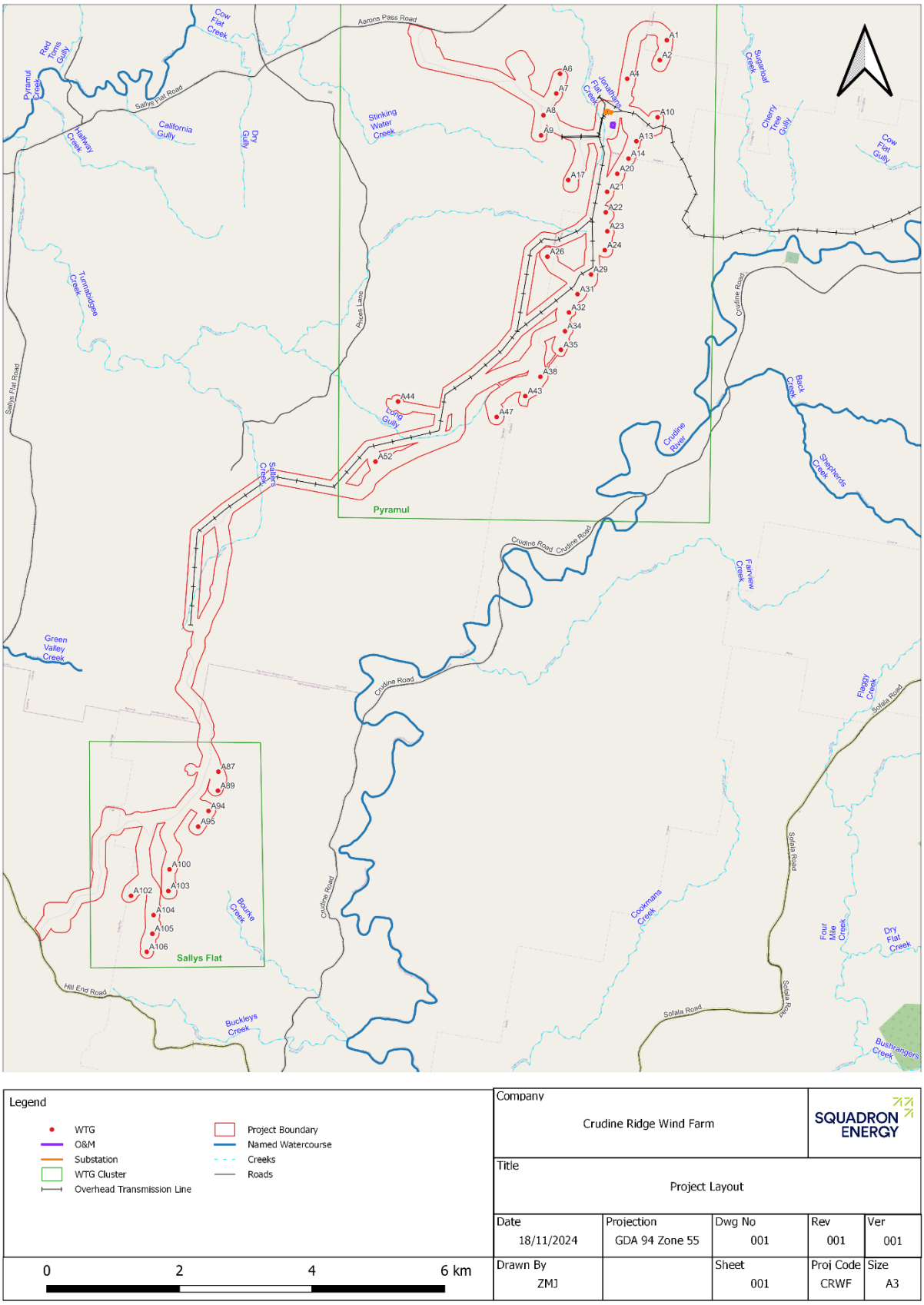

Figure 2 Layout of Crudine Ridge Wind Farm

1.3 BBAMP Objectives

The overall aim of this BBAMP is to provide a program for monitoring the impacts on birds and bats from CRWF and a strategy for managing and mitigating any significant bird and bat impacts arising from the operation of CRWF.

This is 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 Wind Energy Projects (CEC 2018).

The specific objectives of this BBAMP, derived from the conditions of approval, are set out below.

- To implement a monitoring program capable of detecting any impacts to 'at-risk' birds and bats that can reasonably be attributed to the operation of the project;
- To directly record impacts on birds and bats through a targeted carcass search sampling protocol and prompt carcass removal;
- To document an agreed decision-making framework that outlines the specific actions to be taken and possible mitigation measures implemented to understand and reduce any impacts on bird and bat populations identified as a result of the monitoring, or in the event that an impact trigger[1] is detected;
- To detail specific monitoring for 'at risk' bird and bat groups, such as the Wedge-tailed Eagle, and include seasonal carcass searches and periodic species-specific surveys;
- Minimising raptor activity in the area through controlling pests and minimising availability of raptor perches;
- Using best practice methods for bat deterrence; including managing potential lighting impacts;
- To detail specific and potential mitigation measures and related implementation strategies to mitigate any detected significant impacts on birds and bats; and
- To identify matters to be addressed in periodic reports on the outcomes of monitoring, the application of the decision-making framework, mitigation measures adopted and their result.

The strategy employed to ensure that any impact triggers and/or unacceptable impacts are detected includes the following:

- Operational phase carcass searches under operating turbines;
- Statistical analysis of the results of carcass searches; and
- Reporting.

This management program uses an adaptive management approach. Therefore, management measures can be amended to ensure more effective management and mitigation are implemented in response to the findings of monitoring. Personnel undertaking the carcass searches will be adequately trained to undertake the monitoring.
This BBAMP is based on the experience gained from the preparation and implementation of approved management plans to monitor and mitigate the impacts of wind farm operation on birds and bats at numerous wind farms in New South Wales and Victoria by the specialist consultancies engaged to prepare the BBAMP, conduct the monitoring, analyses of the results and preparation of the reports.

The approach developed for monitoring impacts on birds and bats has been refined from experience gained from other BBAMPs, their preparation, data review, and feedback from regulators and approval authorities.

In order to ensure the efficacy of this adaptive management program, all activities undertaken will be subject to regular review and reporting by the Proponent.

[1] Definition of 'impact trigger' is detailed in section 6.2.1

1.4 Consultations in the development of the BBAMP

Initial consultation with both CPHR and Cth DCCEEW in relation to the BBAMP2017 was undertaken to ensure the plan was prepared with the relevant guidance and support of the State and Commonwealth environmental authorities.

In accordance with the approved BBAMP2017, the monitoring program was implemented for 24 months of operation, and two annual monitoring reports were prepared:

- Year 1 Annual Monitoring report for June 2021-June 2022
- Year 2 Annual Monitoring report for June 2022-June 2023.

On 16 August 2023 and 5 September 2023, CPHR and DPHI respectively indicated they were satisfied with the Year 2 Annual Monitoring report and noted the proposed changes to the monitoring plan.

This updated BBAMP2024 therefore reflects the recommendations of the Year 2 Annual Monitoring report and was reviewed by the CPHR and DPHI.

Pursuant to Condition 22 of Schedule 3, the Secretary of the DPHI confirmed that consultation with the Cth DCCEEW was not required, given the proposed changes to the monitoring program would not have any material impact on the likelihood of observing any Commonwealth listed threatened species, as monitoring would continue at all turbines in the middle of each season.

1.5 Site Description

The Project is located in the Central Tablelands region of NSW (Figure 1), south of Mudgee and north of Bathurst, bounded by the localities of Pyramul, Sallys Flat, Crudine and Aarons Pass. The turbines extend 16 kilometres from the south-west to the north east along Crudine Ridge in two clusters known as Sallys Flat and Pyramul. The individual turbine positions are on land with elevations ranging from 890 metres to 1,000 metres Australian Height Datum (AHD).

CRWF lies on a series of higher ridges that have been used for decades for sheep and cattle grazing and the majority of the area has been largely cleared of its original native vegetation. As a consequence of the long grazing history, most of the development envelope lacks a diverse understorey and indigenous ground cover, and introduced pasture grasses now dominate the ground cover. Much of the area has been subject either to past clearing or selective timber-getting. Consequently, some of the trees are comparatively young, or are of species that have fewer hollows suitable for hollow-dependent fauna, such as possums, gliders and large owls.

The avifauna of the site is typical of this part of NSW, with the most abundant species adapted to farmland habitats with scattered woodland remnants, such as magpies, ravens, currawongs and rosellas. In the wooded areas, canopy-dwelling honeyeaters and insectivores predominate.

Knowledge of the bat fauna in the region is developing as more survey work is done as part of assessments for proposed wind farms in the area. Some of the slopes of some of the steeper ridges still support a relatively intact tree canopy that would provide foraging habitat for insectivorous bats. More details of the birds and bats of the site can be found in section 2 of this BBAMP.

Habitat quality for birds and bats is considered to be low in the largely cleared parts of the site, moderate in most wooded areas and moderate to high where wooded slopes remain in parts of the site.

1.6 Pre-construction investigations of birds and bats at Crudine Ridge wind farm

During the pre-approval and pre-construction phases of the development, investigations were undertaken by Eco Logical Australia Pty Ltd (ELA). The data was collected during surveys between November 2008 and October 2011. The methods and results of these investigations were included in the Ecological Assessment Report (ELA 2012) prepared for the CRWF Environmental Assessment and are summarised in section 2.

1.7 Additional information

The BBAMP2017 was prepared by a team from Brett Lane & Associates Pty Ltd including; Peter Lansley (Senior Zoologist), Bernard O'Callaghan (Senior Ecologist and Project Manager) and Brett Lane (Principal Consultant).

This updated BBAMP2024 has been prepared by a team from Eco Logical Australia Pty Ltd including Tom Kelly (Associate Ecologist) and Lachlan Metzler (Ecologist).

2 Baseline bird and bat information

The results of previous investigations are summarised in this section of the BBAMP. This information has informed the risk assessment in Section 3.

2.1 Bird surveys

2.1.1 Bird survey methodology

The methods and results of the bird surveys are outlined in the ecological assessment report by ELA (2012) and summarised below. The data were collected from November 2008 to October 2011.

Bird surveys were undertaken by ELA (2012) in accordance with Department of Environment and Conservation (DEC) *Threatened Biodiversity Survey and Assessment Guidelines* Working draft (DEC 2004a) and included “species requiring survey” as determined by the Biobanking Credit Calculator (ELA 2012). Biobanking surveys were carried out for three threatened bird species, namely Gang-gang Cockatoo *Callocephalon fimbriatum*, Little Eagle *Hieraaetus morphnoides*, and Spotted Harrier *Circus assimilis* (ELA 2012). No bats required a Biobanking Survey.

Diurnal bird surveys and opportunistic surveys in October and November 2008 and January 2009 were used to record common and threatened bird species. Desktop review also involved searches of the BirdLife Australia (formerly Birds Australia) atlas database, NSW Bionet database, and records of the Bathurst Regional Council for records of threatened species in the wind farm footprint and surrounding district (ELA 2012). Targeted surveys were carried out searching for Bush Stone-curlew *Burhinus grallarius* in November 2008.

Diurnal bird surveys were undertaken in accordance with the DEC draft guidelines utilising the area search method. Observers undertook a 20-minute bird survey every 2 ha throughout the wind farm footprint and surrounds. Diurnal bird surveys and incidental observations were carried during 17-19 and 24- 27 November 2008, 20-21 and 23 January 2009. Diurnal bird surveys were completed during different times of the day, but generally occurred during morning hours or evening. All species heard and/or observed were recorded. A total of 50 diurnal bird surveys at 14 sites were undertaken, totalling 34.83-person hours.

Bush Stone Curlew surveys were undertaken via call playback on the 24-27 November 2008. Nocturnal surveys were also conducted for Powerful Owl during November, January, March and October totalling 15 nights at 3 sites and for Barking Owl over 12 nights at 2 sites. Spotlighting was undertaken during November 2008 and January and March 2009. DEC guidelines state:

- *At each call playback site an initial listening period of 10 to 15 minutes should be undertaken, followed by a spotlight search for 10 minutes to detect any animal in the immediate vicinity. The calls of each target species should then be played intermittently for 5 minutes, followed by a 10-minute listening period. After all the calls have been played, another 10 minutes of spotlighting and listening must be conducted in the vicinity to check for birds that are attracted by the calls but are not vocalising.*

Results

A total of 93 bird species were recorded during surveys, one of which was introduced. These species are listed in Appendix A of ELA (2012). The study area supports potential foraging habitats throughout all seasons, as well as breeding and roosting habitat for a wide variety of bird species. Hollow bearing trees, suitable for breeding and roosting by birds and bats also occurred in a variety of areas, although were more limited in availability compared with older forests and woodlands. Habitat for wetland bird species was limited to farm dams. Key findings are summarised below.

- Owl species recorded included
  - Southern Boobook Ninox novaeseelandiae.

- Raptor species recorded included:
  - Nankeen Kestrel *Falco cenchroides*;
  - Wedge-tailed Eagle *Aquila audax*;
  - Black-shouldered Kite *Elanus axillaris*; and
  - Brown Falcon *Falco berigora*.
- Six threatened woodland species were recorded in the study area:
  - Brown Treecreeper (eastern subspecies) *Climacteris picumnus victoriae*;
  - Diamond Firetail *Stagonopleura guttata*;
  - Hooded Robin *Melanodryas cucullata cucullata*;
  - Little Lorikeet *Glossopsitta pusilla;*
  - Scarlet Robin *Petroica boodang*; and
  - Speckled Warbler *Chthonicola sagittata* .
- Two other threatened bird species which were considered likely to occur in the study area are listed below, based on ELA (2012) and NSW Bionet (2017) but these were not recorded:
  - Black-chinned Honeyeater Melithreptus gularis; and
  - Regent Honeyeater Anthochaera phrygia.
- A further 11 threatened species were considered to have potential to occur in the study area based on the existence of suitable habitat and historical records in the surrounding region, however, none were recorded:
  - Bush Stone-curlew *Burhinus grallarius*;
  - Flame Robin *Petroica phoenicea;*
  - Gang-gang Cockatoo *Callocephalon fimbriatum*;
  - Little Eagle *Hieraaetus morphnoides;*
  - Spotted Harrier *Circus assimilis;*
  - Superb Parrot *Polytelis swainsonii;*
  - Swift Parrot *Lathamus discolor;*
  - Varied Sittella *Daphoenositta chrysoptera;*
  - White-throated Needletail *Hirundapus cadacutus*
  - Barking Owl *Ninox connivens*; and
  - Powerful Owl *Ninox strenua.*
- Ten EPBC Act listed migratory species were identified as potentially occurring from an EPBC Act protected matters search within the study area (ELA 2012). One of these, the Regent Honeyeater *Anthochaera phrygia* was delisted as migratory for the purposes of the Act on 26 November 2013, so is not treated in this section. Three further species were recently (9 June 2016) delisted as migratory species under the Act – the Rainbow Bee-eater *Merops ornatus*, Great Egret *Ardea alba* and Cattle Egret *Ardea ibis*, and are not considered further. Of the remainder, potential habitat occurred for two species:
  - White-throated Needletail *Hirundapus ca*dacutus; and
  - Satin Flycatcher *Myiagra cyanoleuca*.

- A 2017 and updated 2024 search of NSW Bionet records, along with a review of bird survey data recorded during operational monitoring at the CRWF, added the following listed threatened species that were either recorded or have the potential to occur at the CRWF:
  - Dusky Woodswallow Artamus cyanoptera
  - Glossy Black-Cockatoo Calyptorhynchus lathami
  - Painted Honeyeater Grantiella picta
  - Southern Whiteface Aphelocephala leucopsis
  - Square-tailed Kite Lophoictinia isura

2.2 Bird Utilisation Surveys from Year One Operational Monitoring

The Bird Utilisation Survey (BUS) method involves a fixed point 15-minute survey undertaken by one observer, where the abundance of all species visible and/or audible will be recorded along with a range of covariate data including:

- Estimated flight height (in metres)
- Estimated distance from observer
- Bird behaviour (e.g. Flying above canopy; On ground; Nesting).

BUS were conducted in spring 2021 (17 - 27 September) and Autumn 2022 (5 - 6 April). The 14 BUS sites were previously established and surveyed in 2008 and 2009 as part of the CRWF Ecological Assessment (ELA 2012). Each site was surveyed twice across separate days in spring and once in autumn to capture the seasonal variation likely to influence bird species assemblages, richness and abundance.

A total of 56 bird species were recorded during spring 2021 BUS, with a total of 68 species recorded during follow up BUS undertaken in autumn 2022. Combined, the total bird species richness recorded during operational phase BUS was 78 species.

Proximity to turbines did not appear to influence species richness at BUS sites. Proximity and extent of woodland vegetation appeared a more important determinant of species richness at BUS sites.

Acanthiza chrysorrhoa (Yellow-rumped Thornbill) was the most abundant species during the operational phase BUS with a total of 132 individuals recorded, whilst the Australian Magpie was the most common species having been recorded a total of 47 times across all 14 sites.

Seven threatened species, all listed as vulnerable under the BC Act were recorded during operational phase BUS, along with six raptor species.

- Threatened bird species observed:
  - Brown Treecreeper (eastern subspecies) Climacteris picumnus victoriae
  - Diamond Firetail Stagonopleura guttata
  - Dusky Woodswallow Artamus cyanopterus
  - Flame Robin Petroica phoenicea
  - Scarlet Robin Petroica boodang
  - Speckled Warbler Chthonicola sagittata
  - Varied Sittella Daphoenositta chrysoptera
- Raptor species observed:
  - Black-shouldered Kite *Elanus axillaris*
  - Brown Falcon *Falco berigora*

- Collared Sparrowhawk *Accipiter cirrocephalus*
- Nankeen Kestrel Falco *cenchroides*
- Wedge-tailed Eagle *Aquila audax*
- Whistling Kite *Haliastur sphenurus*

Overall, operational phase BUS results were comparable to pre-approval bird survey results based on total and common species richness, as well as both threatened and raptor species richness. The overall results of operational phase BUS monitoring do not indicate any significant changes to bird utilisation or species assemblages due to the operation of the CRWF.

For all individual birds recorded during operational phase BUS, 5.2% were recorded as flying within the turbine Rotor Swept Area (RSA) of 20 – 160 m.

The Wedge-tailed Eagle was the most abundant (four individuals) and common (three records across three sites) raptor species recorded flying within the RSA. Australian Raven was the most abundant (22 individuals) and common (seven records across six sites) species recorded flying within the RSA, followed by the Australian Magpie. Both of these species, along with the Wedge-tailed Eagle, were recorded as confirmed fatalities during carcass monitoring.

The relatively low percentage of birds recorded flying within the RSA is also reflected in the bird behaviour results, with only 8.4% of birds recorded ‘flying above the canopy’. The predominant observed behaviour of birds during the operational phase BUS was of birds ‘flying within the canopy’ and ‘in tree’, or a combination of these behaviours. This observed behaviour, along with the typically low height of the canopy across the CWRF (6-12 m) and the relatively low percentage of birds flying within the RSA, is indicative of the overall low risk posed by the operation of the CRWF on the majority of bird species and general bird activity.

2.3 Bat Utilisation studies

2.3.1 Bat survey methodology

Harp trapping and ultrasonic AnaBat recordings at a minimum of six locations were made to record any microchiropteran bat species in the study area during November 2008, January 2009 and March 2011., totalling 16 AnaBat nights and 12 trap nights over the duration. At the same time, nocturnal and opportunistic spotlighting took place for the Grey-headed Flying-fox Pteropus poliocephalus.

In addition, database searches covered the Commonwealth DSEWPAC (now Cth DCCEEW) databases (e.g. Species Profile and Threats or SPRaT and Protected Matters Search Tool), NSW Bionet and records of the Bathurst Regional Council.
The guidelines state:

- Ultrasonic detection is most effective when operated from a laptop computer. Recordings made onto a tape recorder frequently produce poor quality, ambiguous calls requiring the investigator to nominate the range of species to which the call could be attributed. Ultrasonic detectors can be operated automatically with the use of time delay switches and are able to operate throughout the night without attendance by an operator. This significantly increases the chance of detecting a greater percentage of the species inhabiting the area. Investigators should be appropriately skilled and experienced in analysing bat calls, particularly in the local area. It is essential that the investigator undertaking call analysis have access to a library of reference calls relevant to the region being surveyed, given the presence of within-species regional variation.
- Harp or bat traps suited to areas where there are restricted flyways along tracks, in forests or over water. However, the use of harp traps amongst vegetation outside flyways is recommended as an additional measure to capture bats that prefer cluttered habitats (Ellis pers. comm. 2002). Curtains of plastic or fabric can be erected surrounding the traps to direct bats into the trap, and a curtain below the trap is recommended. Refer to section 5.3.6(ii)(c) for information relating to the checking of harp traps.

2.3.2 Results

Thirteen microbat species were detected for which habitat was present across the study area.

An additional five potential species may have been recorded based on ultrasonic recordings – it may be difficult to differentiate between some groups of species using this method.

- The most common species recorded included:
  - Chocolate Wattled Bat *Chalinolobus morio*;
  - Gould's Wattled Bat *Chalinolobus gouldii*;
  - Little Forest Bat *Vespadelus vulturnus*; and
  - White-striped Freetail Bat *Tadarida australis*.
- Six threatened bat species were recorded or possibly recorded, based on ultrasonic recordings:
  - Large-eared Pied Bat *Chalinolobus dwyeri*;
  - Little Pied Bat *Chalinolobus picatus*;
  - Eastern (Large) Bentwing-bat *Miniopterus orianae oceansis*;
  - Yellow-bellied Sheathtail-bat *Saccolaimus flaviventris*;
  - Corben's Long-eared Bat *Nyctophilus corbeni* [assumed possible presence based on call of *Nyctophilus* sp.]; and
  - Eastern Cave Bat *Vespadelus troughtoni*.
- One other listed threatened bat was considered potentially to occur at CRWF based on modelling inherent in the EPBC Act Protected Matters Search Tool (PMST), the ELA (2012) assessment and availability of habitat in the region:
  - Grey-headed Flying-fox *Pteropus poliocephalus.*
- Hollow-bearing trees within the study area provide roosting habitat for the majority of threatened bat species recorded. However, there were no caves recorded on the area assessed for the wind farm (ELA 2012) but a cave possibly suitable for roosting cave-dwelling bats (e.g. Eastern Bentwing-bat or Eastern Cave Bat) was reported to occur on a property to the south of the wind farm and a limestone mine at Kandos, 14 km east of the wind farm study area provided a roost site for Eastern Bent-wing Bat (OEH 2011a in ELA 2012).

3 Risk assessment

3.1 Introduction to the risk assessment

The aim of this risk assessment is to guide the development of the BBAMP for the CRWF by identifying those species or groups considered potentially at risk from either collision with turbines or disturbance by the operation of the wind farm. The outcomes of this risk assessment enable more targeted monitoring and management measures to be included in the BBAMP, focussing on species and groups at greater risk.

Wind farm impacts on birds and bats can arise from three potential pathways:

- Direct collision of birds and bats with operating wind turbine blades or towers at rotor swept area (RSA) heights;
- Disturbance effects that exclude birds and bats from habitat; and
- Barrier effects that limit bird and bat movements between essential resources, such as foraging and roosting areas.

The risk assessment has followed the procedure for risk assessment of AS/NZS ISO 31000 2009. The assessment has been undertaken as follows:

- Bird and bat species and groups of concern have been short-listed based on their likelihood of occurrence at the site, whether they are listed threatened or migratory species in NSW (under the *Biodiversity Conservation Act 2016*), under the EPBC Act, or based on their known vulnerability of wind farm impacts;
- Two impact categories have been assessed: a) collision with turbines; and b) indirect effects (including both disturbance and barrier effects);
- Impact likelihood criteria have been developed and applied to each impact categories for each species or group of concern;
- Impact consequence criteria have been developed and applied to each impact categories for each species or group of concern; and
- The risk level for each species or group of concern from the two impact categories has been determined consistent with a risk matrix.

This chapter presents the results of this risk assessment under the headings below.

Section 3.2 summarises the sources of information used to understand the likelihood of occurrence of each species or group on the CRWF site and their likely behaviour on the site;

Section 3.3 provides an overview of the risk assessment method adopted, including the likelihood and consequence criteria and the risk matrix;

Section 3.4 presents the results and conclusions of the risk assessment and identifies the focus of the BBAMP for CRWF.

3.2 Data sources for Risk Assessment for Crudine Ridge Wind Farm

To ascertain the species of concern that may occur on the CRWF site the following sources were used:

- The NSW Bionet Atlas Search tool (OEH 2017), using an approximate 48 by 48 kilometre search region centred over the proposed CRWF site (searched in June 2017). This search was bounded by co-ordinates 32.73° to 33.16°South and from 149.45° to 149.98°East.
- The EPBC Act Protected Matters Search Tool (PMST), using a search region that included the approximate central point of the proposed site (32.9431°S, 149.6772°E) and a 30 kilometre radius buffer zone (Department of the Environment and Energy 2017); and
- The Ecological Assessment of the CRWF site during the period 2008 to 2011 (ELA 2012).

There are currently no operational wind farms within 50 kilometres of the study area, the closest being Blayney Wind Farm approximately 70 kilometres to the south-west. The publicly available documentation on other planned wind farms of the western slopes of the Great Divide in NSW was scrutinised and has been incorporated into this risk assessment, e.g. Bodangora Wind Farm.

3.3 Species and groups of concern

Species of concern include the following:

- Species listed as threatened on legislation;
- Species known to be particularly prone to collision with, or sensitive to disturbance from, operating turbines;
- Species for which a population concentration, or a population of significance, occurs on the site and that species may exhibit “risk behaviour” that leads to the potential for collision with wind turbines; or
- Native bird and bat species known to occupy the CRWF site and considered to have moderate to high collision risk (ELA 2012).

From the foregoing information sources, a list of species with potential to occur in the search region was generated. Of these, a shortlist of species of concern was then generated based on the likelihood of occurrence on the CRWF site itself given the habitat present on the site and occurrence of the species in the search region. Appendix 2 contains the full list of threatened bird and bat species and likelihood of occurrence at the Crudine Ridge Wind Farm.

The original site assessments (ELA 2012) identified listed threatened and migratory species likely to occur on the site, some of which were detected during on-site fauna survey work. Although this has been taken into consideration, a number of additional species and groups, including non-threatened species/groups, have been identified through the current review that were not originally considered. The detailed rationale for the inclusion of the shortlisted species and groups can be found in Section 3.33.3. The short-listed species and groups are listed below in Table 2.

In addition, at the request of CPHR, non-listed native bird and bat species identified as being at moderate or high risk of collision in the initial site assessment (ELA 2012) have also been short listed and included in the risk assessment (Table 6).

Table 2 Risk assessment - Assessed bird and bat species

EPBC Act Listed Migratory Species
▪ Fork–tailed Swift ▪ White-throated Needletail (Vulnerable – EPBC) ▪ Satin Flycatcher
EPBC Act and BC Act listed threatened birds
▪ White-throated Needletail (Vulnerable – EPBC & BC) ▪ Brown Treecreeper (eastern subspecies) (Vulnerable – EPBC & BC) ▪ Diamond Firetail (Vulnerable – EPBC & BC) ▪ Gang-gang Cockatoo (Endangered – EPBC & BC) ▪ Hooded Robin (south-eastern form) (Endangered – EPBC & BC) ▪ Painted Honeyeater (Vulnerable – EPBC– BC) ▪ Regent Honeyeater (Critically Endangered – EPBC & BC) ▪ Swift Parrot (Critically Endangered – EPBC & Endangered BC Act) ▪ Superb Parrot (Vulnerable – EPBC & BC Act)
EPBC Act and BC Act listed threatened bats
▪ Corben’s Long-eared Bat (Vulnerable – EPBC & BC Act) ▪ Large-eared Pied Bat (Endangered – EPBC & BC Act) ▪ Grey-headed Flying-fox (Vulnerable – EPBC & BC Act)
BC Act listed threatened birds
▪ Barking Owl (Vulnerable) ▪ Black–chinned Honeyeater (Vulnerable) ▪ Bush Stone-Curlew (Endangered) ▪ Dusky Woodswallow (Vulnerable) ▪ Flame Robin (Vulnerable) ▪ Little Eagle (Vulnerable)

▪ Little Lorikeet (Vulnerable) ▪ Powerful Owl (Vulnerable) ▪ Scarlet Robin (Vulnerable) ▪ Speckled Warbler (Vulnerable) ▪ Spotted Harrier (Vulnerable) ▪ Varied Sittella (Vulnerable)
BC Act listed threatened bats
▪ Eastern (Large) Bent-wing Bat (Vulnerable) ▪ Eastern Cave Bat (Vulnerable) ▪ Eastern False Pipistrelle (Vulnerable) ▪ Yellow-bellied Sheathtail-bat (Vulnerable). ▪ Little Pied Bat (Vulnerable)
Bird species (NSW Parks and Wildlife Act)
▪ Wedge–tailed Eagle ▪ Musk Lorikeet ▪ Crimson Rosella ▪ Eastern Rosella ▪ Nankeen Kestrel ▪ Black-shouldered Kite ▪ Brown Goshawk ▪ Whistling Kite ▪ Brown Falcon ▪ Australian Wood Duck ▪ Australian Pipit ▪ White-winged Chough ▪ Laughing Kookaburra ▪ Australian Magpie ▪ Spotted Pardalote ▪ Waterbirds – includes ducks, herons, swans, ibis and other wetland associated species
Bat species (NSW Parks and Wildlife Act)
▪ Chocolate Wattled Bat ▪ Gould's Wattled Bat ▪ Little Forest Bat ▪ White-striped Freetail Bat

Note that in the non-listed species of birds and bats only a selection of the full species diversity was assessed for impacts. This selection is considered to cover all foraging guilds that may experience impacts, e.g. raptors other than Wedge-tailed Eagle and listed threatened raptors; parrots; large farmland omnivores that may fly at RSA height e.g. magpies, ravens, currawongs and kookaburra; nocturnal species (owls, frogmouths, owlet-nightjar), arboreal insectivores (e.g. Grey Fantail, Spotted Pardalote) and nectarivores (e.g. Red Wattlebird). Three other foraging guilds, aerial insectivores, small seed-eaters and bark-foragers are represented by the migratory or threatened White-throated Needletail, Diamond Firetail and Varied Sittella respectively, so that most or all of the foraging guilds have been covered in this assessment.

The risk assessment process was applied to all the foregoing species and groups.

3.4 Risk Assessment Process

The risk assessment process was based on the Risk Evaluation Matrix Model used to measure the overall risk of a potential impact event, in this case birds or bats striking wind turbine blades or being deterred from using part of the wind farm due to disturbance. 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 AS/NZS ISO 31000 Risk Assessment Standard (Standards Australia 2009).

The assessment requires criteria to be developed for likelihood and consequence. These criteria are provided respectively in Table 3 and Table 4.

Table 5 shows the risk levels used and how they are determined from the assessed likelihood and consequence levels.

Table 3 Likelihood criteria for a risk event to occur

Likelihood	Description
Certain	It is very probable that the risk event could occur in any year (>95%)
Almost Certain	It is more probable than not that the risk event could occur in any year (>50%)
Likely	It is equally probable that the risk event could or could not occur in any year (50%)
Unlikely	It is less probable than not that the risk event could occur in any year (<50%)
Rare	It is improbable that the risk event could occur in any year. (<5%) The risk event is only theoretically possible, or would require exceptional circumstances to occur.

Table 4 Consequence Criteria

Negligible	Low	Moderate	High	Severe
Occasional individuals lost but no reduction in local or regional population viability.	Repeated loss of small numbers of individuals but no reduction in local or regional population viability.	Moderate loss in numbers of individuals, leading to a minor reduction in localised or regional population viability for between one and five years.	Major loss in numbers of individuals, leading to reduction in regional or state population viability for between five and ten years.	Extreme loss in numbers of individuals, leading to reduction in regional or state population viability for a period of at least 10 years

Table 5 Risk matrix defining risk level based on likelihood and consequence

		Consequence				
		Negligible	Low	Moderate	High	Severe
Likelihood	Certain	Negligible	Low	High	Severe	Severe
	Almost Certain	Negligible	Low	Moderate	High	Severe
	Likely	Negligible	Low	Moderate	High	High
	Unlikely	Negligible	Negligible	Low	Moderate	High
	Rare	Negligible	Negligible	Negligible	Low	Low

The relevant likelihood and consequence levels were determined by using data recorded from the wind farm site and with reference to any available information on the local and regional status of the species and bird groups concerned.

3.5 Risk Assessment Results

Table 6 provides the results of the likelihood and consequence assessment based on the inputs from the sources mentioned in Section 2,two years of operational monitoring and includes the following information as part of the risk assessment process:

- Environmental value to be protected
- Reasons for Inclusion

- Threatened species status
- Hazard or source event
- Consequence score and likelihood score
- Risk rating
- Comments relating to risk ratings

Table 6 includes a summary of the previous findings for each considered species or group, and their relevance to the assessment.

The risk associated with wind turbine collision and indirect effects at the CRWF for most birds and bats continues to be rated as **negligible**, following two years of operational monitoring.

The risk rating for the following species has not changed from the BBAMP2017: .

The **White-throated Needletail** flies regularly at turbine height and flocks may pass over the CRWF site during the summer months, although none were observed during the two years of operational monitoring. Collisions have been recorded at wind farms elsewhere in NSW and Australia (BL&A, unpubl. data). The risk to this species from the CRWF is considered to be **low** as the species the species has not been recorded on site, despite it being known to occur in the wider region. It is noted the species overall population is in decline, however this is primarily related to the widespread and continued loss of breeding habitat in Siberia (Tarburton 2014).

The **Regent Honeyeater** inhabits dry box-ironbark eucalypt forests near rivers and creeks on inland slopes of the Great Dividing Range. This species usually flies within the tree canopy and would rarely fly at RSA height during local foraging and breeding, but could fly at heights of up to 50 metres above ground during migration. It is regular in the Capertee Valley some 40 kilometres to the south-east and also in the Mudgee-Wollar area 50 kilometres to the north (Geering 2006; ELA 2012), so may occur intermittently in the vicinity of CRWF. Likelihood of collision is rare, but given the consequence of the loss of one individual the overall risk rating is **low** rather than negligible**.** The risk rating of low is considered highly conservative given the paucity of records nearby.

The **Swift Parrot** prefers a narrow range of eucalypts in NSW, including White Box, Red Ironbark, Mugga Ironbark, Grey Box and Yellow Gum as well as River Red Gum when this species supports abundant ‘lerp’. Breeds in Tasmania and migrates to the mainland of Australia for the autumn, winter and early spring months. It lives mostly north of the Great Dividing Range (Emison et al. 1987; Higgins 1999; Kennedy and Tzaros 2005). There are no records from the surrounding region and its potential to occur at the CRWF site is considered very low. The likelihood of collision is rare, but given the consequence of the loss of one individual the overall risk rating is **low** rather than negligible**.** The risk rating of low is considered highly conservative given the absence of records nearby.

No other listed threatened or migratory bird species was considered to have a risk rating above **negligible**.

Given the occurrence of collisions involving **Wedge-tailed Eagle** (WTE) at many wind farms, this species is addressed in this risk assessment. There is a low incidence of disturbance and WTEs consistently inhabit most wind farms, including successful breeding within 200 metres of operating turbines (BL&A, unpubl. data). With a total of 12 mortalities recorded within the initial two year monitoring period and potentially more given the results of mortality estimation modelling detailed in the Year 2 Annual monitoring report, the likelihood of a risk event occurring meets the definition of the ‘Almost Certain’ category given that, it is very probable that the risk event could occur in any year (>95%). As such, the risk to the Wedge-tailed Eagle from turbine collision is considered to be **High**.

Based on experience with other wind farms in eastern Australia collisions of commonly occurring raptor species are likely. Commonly occurring **raptor** species recorded to collide with turbines include Nankeen Kestrel, Whistling Kite, Brown Falcon and Black-shouldered Kite (BL&A, unpubl. data). These species appear not to be deterred by the presence of operating wind turbines and occur regularly at other wind farms in NSW. Overall, the risk from collision with turbines to these raptors is considered to be **low** as these species are widespread and have a common status that makes significant population impacts unlikely.

A number of species identified by the previous ecological assessment (ELA 2012), EPBC Act Protected Matters Search Tool (DoEE 2017) and the regional search of NSW BioNet Atlas records (OEH 2017a) as potentially at risk were not considered in detail in this assessment due to a lack of available habitat in and around the Project site:

- Australasian Bittern
- Australian Painted Snipe
- Black Falcon
- Black-breasted Buzzard
- Black-faced Monarch
- Blue-billed Duck
- Curlew Sandpiper
- Eastern Curlew
- Malleefowl
- all other wetland bird species listed as migratory under the EPBC Act in the search region.

The above species are not likely to occur at the wind farm so their populations are considered unlikely to be affected by operating turbines, disturbance or barriers and they are not considered further in this BBAMP.

In addition, some waterbird species were recorded during the original ecological assessment (ELA 2012), namely Australasian Grebe, Australian Wood Duck, Eurasian Coot, Pacific Black Duck and Straw-necked Ibis. These common species have been treated together as ‘waterbirds’ in the risk assessment species table.

Owing to the lack of extensive wetland habitats around the Project site, waterbird species both individually and as a group are at minimal risk of suffering measurable population impacts resulting from colliding with turbines at this wind farm.

All bat species, other than the species indicated below, were considered as a risk rating of **negligible**. The **White-striped Freetail Bat** and **Little Forest Bat** is a common and widespread bat species known to fly at turbine height that is almost certain to be impacted each year; however the population consequences are considered to be low. The collision related impact is therefore considered to be of **low** risk for the species, rather than negligible.

Table 6 Bird and Bat Risk Assessment – Crudine Ridge Wind Farm

Value to be Protected	Reasons for Inclusion	BC Act Listing	EPBC Act Listing	Impact Pathway	Likelihood of Risk Event	Consequence	Risk Rating	Comments
Barking Owl *Ninox connivens*	Species or species habitat likely to occur within area	Vulnerable	Not listed	Collision with operating wind turbines.	Rare	Negligible	Negligible	Inhabits woodland and open forest, including fragmented remnants and partly cleared farmland. It is flexible in its habitat use, and hunting can extend into closed forest or more open areas. Although common in parts of northern Australia, the species has declined greatly in southern Australia and now occurs with a wide but sparse distribution in NSW (OEH 2017b). It is unlikely that this species commonly flies within the height range of wind turbine blades as it obtains its food predominantly from the ground and moves about the landscape by flying between trees or wooded patches, rarely above canopy height (Schedvin 2007).
				Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Black-chinned Honeyeater *Melithreptus gularis gularis*	Species or species habitat likely to occur within area	Vulnerable	Not listed	Collision with operating wind turbines.	Rare	Negligible	Negligible	Prefers open woodland and forest dominated by box-ironbark (Higgins *et al* 2001). This species has the potential to occur at the CRWF site although it is not known to regularly fly at RSA height.
				Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Brown Treecreeper (eastern subspecies) *Climacteris picumnus victoriae*	This species was recorded at the Crudine Ridge WF site (ELA 2012)	Vulnerable	Vulnerable	Collision with operating wind turbines.	Rare	Low	Negligible	It occurs in woodlands dominated by *Eucalyptus* spp., especially stringybarks or other rough-barked eucalypts, usually with open grassy understorey (Higgins *et al.* 2001). This species has been recorded at the CRWF site and usually occurs in the lower canopy and on the ground, and would not fly at RSA height.
				Indirect disturbance, including barrier effects.	Unlikely	Unlikely	Negligible	
Bush Stone-Curlew *Burhinus grallarius*	Species or species habitat has potential to occur within area	Endangered	Not listed	Collision with operating wind turbines.	Rare	Negligible	Negligible	Nocturnal species which occurs in open forests and woodlands with sparse grassy ground layer where it nests on the ground (OEH 2017b). Rare or extinct in much of its former range in southern Australia through still common in the north. Predicted to occur in Bathurst region and recorded for the Mudgee area, but no records in search region or well surveyed Capertee Valley to the east (Geering 2006; OEH 2017b). Not known to fly at turbine height; unlikely to occur regularly at CRWF despite the presence of suitable habitat.
				Indirect disturbance, including barrier effects.	Rare	Negligible	Negligible	
Diamond Firetail *Stagonopleura guttata*	This species was recorded at the Crudine Ridge WF site (ELA 2012)	Vulnerable	Vulnerable	Collision with operating wind turbines.	Rare	Negligible	Negligible	Found in box-ironbark forests and woodlands and also occurs along watercourses and in farmland areas (Emison *et al.* 1987; Tzaros 2005). This species has been recorded at the CRWF site and has been recorded regularly inhabiting farmland around wind turbines in southern NSW where it has never been observed flying at RSA height or colliding with turbines (BL&A, unpubl. data).
				Indirect disturbance, including barrier effects.	Rare	Negligible	Negligible	
Dusky Woodswallow *Artamus cyanopterus cyanopterus*	Species or species habitat likely to occur within area	Vulnerable	Not listed	Collision with operating wind turbines.	Rare	Negligible	Negligible	Occurs in dry open sclerophyll forests and woodlands, usually dominated by eucalypts. Often found on the edges or in clearings of forest and woodland and sometimes recorded in shrubland and heathland and other various modified landscapes (Higgins et al 2006). This species may occasionally fly at RSA height but usually flies within the canopy.
				Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Flame Robin *Petroica phoenicea*	Species or species habitat likely to occur within area	Vulnerable	Not listed	Collision with operating wind turbines.	Rare	Negligible	Negligible	Breeds in the high country of south-eastern Australia including Tasmania in forest and woodland, and moves to lower more open country such as farmland in autumn and winter (Higgins and Peter 2002). No records for search region (OEH 2017a) but may occur in small numbers. Forages on the ground and uses open perches in or below the tree canopy including fences and buildings; not known if species flies at RSA height.
				Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Fork-tailed Swift *Apus pacificus*	Species or species habitat likely to occur within area	Not listed	Listed migratory species	Collision with operating wind turbines.	Unlikely	Negligible	Negligible	Aerial, over inland plains, sometimes above foothills or in coastal areas, over cliffs and urban areas (Higgins 1999). Occurs over a wide part of Australia and infrequently in the area, often following weather fronts. Flies at turbine height. Collision likely to be infrequent due to irregularity of occurrence. Small numbers possibly affected do not represent a significant proportion of the total
				Indirect disturbance,	Unlikely	Negligible	Negligible	

Value to be Protected	Reasons for Inclusion	BC Act Listing	EPBC Act Listing	Impact Pathway	Likelihood of Risk Event	Consequence	Risk Rating	Comments
				including barrier effects.				population, estimated as at least in the tens of thousands (Department of the Environment 2015b).
Gang-gang Cockatoo *Callocephalon fimbriatum*	Species or species habitat likely to occur within area	Endangered	Endangered	Collision with operating wind turbines.	Unlikely	Negligible	Negligible	Breed in tall mountain forests and Snow gum woodland; occasionally rainforest. In autumn and winter move to lower, drier and more open woodland; may then feed in suburban gardens on introduced trees such as Hawthorn (Higgins 1999; OEH 2017b). Recorded from search region (OEH 2017a) so may occur in the CRWF footprint and has potential to fly at RSA height.
				Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Glossy Black-Cockatoo *Calyptorhynchus lathami*	Species or species habitat has potential to occur within area	Vulnerable	Vulnerable	Collision with operating wind turbines.	Unlikely	Negligible	Negligible	Occurs uncommonly in forests and woodlands of eastern Australia where it feeds almost exclusively on Casuarinas (Higgins 1999; OEH 2017b). One record from search region (OEH 2017a) so may occur in the CRWF footprint and has potential to fly at RSA height.
				Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Hooded Robin (south-eastern form) *Melanodryas cucullata cucullata*	This species was recorded at the Crudine Ridge WF site (ELA 2012)	Endangered	Endangered	Collision with operating wind turbines.	Rare	Negligible	Negligible	Occur mostly in open Grey Box, White Box, Yellow Box, Yellow Gum and Ironbark woodlands with pockets of saplings or taller shrubs, an open shrubby understorey, sparse grasses and patches of bare ground and leaf-litter, with scattered fallen timber (Higgins and Peter 2002; Tzaros 2005). This species generally confines itself to areas of wooded country and does not fly at RSA height.
				Indirect disturbance, including barrier effects.	Rare	Negligible	Negligible	
Little Eagle *Hieraaetus morphnoides*	Species or species habitat likely to occur within area	Vulnerable	Not listed	Collision with operating wind turbines.	Rare	Negligible	Negligible	The Little Eagle is distributed throughout the Australian mainland except in the most densely forested parts of the Great Dividing Range (Marchant and Higgins 1993). In the 1990s, the Little Eagle was estimated globally as numbering tens of thousands to as many as 100 000 birds (Ferguson-Lees & Christie 2001), but in recent decades, the Little Eagle is believed to have undergone a moderate reduction in population size in NSW (OEH species listing advice). Turbine strikes of this raptor species could occur, however the species has not been recorded at the CRWF site and has only been recorded in very low numbers (three records) in the surrounding areas. The species has not been recorded colliding with wind turbines and occurs in NSW at very low population densities so regular collision is unlikely.
				Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Little Lorikeet *Glossopsitta pusilla*	This species was recorded at the Crudine Ridge WF site (ELA 2012)	Vulnerable	Not listed	Collision with operating wind turbines.	Rare	Negligible	Negligible	The Little Lorikeet is distributed widely across the coastal and Great Divide regions of eastern Australia from Cape York to South Australia. NSW provides a large portion of the species' core habitat (OEH 2016b). Little Lorikeet are at risk of colliding with turbines given their fast flight patterns and that they may fly at RSA height particularly when moving between feeding areas (ELA 2011). There are no records of Little Lorikeets colliding with wind turbines. Their wide distribution and episodic occurrence in the area (coinciding with eucalypt flowering events, which are sporadic) ensures they would rarely collide with turbines.
				Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Painted Honeyeater *Grantiella picta*	Species or species habitat likely to occur within area	Vulnerable	Vulnerable	Collision with operating wind turbines.	Rare	Low	Negligible	Inhabits box-ironbark forests and woodlands and mainly feeds on the fruits of mistletoe. Strongly associated with mistletoe around the margins of open forests and woodlands. Occurs at few localities. (Higgins *et al.* 2001; Tzaros 2005). This species usually flies within the tree canopy and would rarely visit the CRWF site.
				Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Powerful Owl *Ninox strenua*	Species or species habitat likely to occur within area	Vulnerable	Not listed	Collision with operating wind turbines.	Unlikely	Low	Negligible	The Powerful Owl occurs mainly on the coastal side of the Great Dividing Range from Mackay to south-western Victoria. In NSW, it is widely distributed throughout the eastern forests from the coast inland to the tablelands, with scattered records on the western slopes and plains suggesting occupancy prior to land clearing (OEH 2017b). This species is hollow dependent and inhabits open and tall wet sclerophyll forests with sheltered gullies and old growth forest with dense understorey. It is also found in dry forests with box and ironbark eucalypts and River Red Gum. Large old trees with hollows are required by this species for nesting (Higgins 1999; Soderquist *et al.* 2002). For most of its life,
				Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	

Value to be Protected	Reasons for Inclusion	BC Act Listing	EPBC Act Listing	Impact Pathway	Likelihood of Risk Event	Consequence	Risk Rating	Comments
								the Powerful Owl restricts its activities to forested habitat and does not fly often over open country. Dispersing juvenile owls may fly longer distances, including over open country, such as where turbines are located. The lack of records at CRWF and in nearby areas, possibly due to the sparse nature of the woodland in the area, make collision and disturbance an unlikely event.
Regent Honeyeater *Anthochaera phrygia*	Species or species habitat likely to occur within area	Critically Endangered	Critically Endangered	Collision with operating wind turbines.	Rare	Moderate	Low	Inhabits dry box-ironbark eucalypt forests and casuarinas near rivers and creeks on inland slopes of the Great Dividing Range and occasionally near the coast (OEH 2017b). Known to occur in Capertee Valley to the south-east and Mudgee – Wollar area north of CRWF as well as the search region covering CRWF (Geering 2006; OEH 2017a,b). Can occur in small remnant patches or in mature trees in farmland or partly cleared agricultural land (Higgins *et al*. 2001). This species usually flies within the tree canopy but may do so during migratory movements and is expected to rarely visit the CRWF site based on the overall rarity of the species.
				Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Scarlet Robin *Petroica boodang*	This species was recorded at the Crudine Ridge WF site (ELA 2012)	Vulnerable	Not listed	Collision with operating wind turbines.	Rare	Negligible	Negligible	The Scarlet Robin lives in open forests and woodlands in Australia. During winter, it will visit more open habitats such as grasslands and will be seen in farmland and urban parks and gardens at this time. Flight height studies elsewhere (ELA 2011) indicate that Scarlet Robin flies at heights of 20 metres or less. This is below the RSA height.
				Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Speckled Warbler *Chthonicola sagittata*	This species was recorded at the Crudine Ridge WF site (ELA 2012)	Vulnerable	Not listed	Collision with operating wind turbines.	Unlikely	Low	Negligible	It inhabits dry eucalypt forests and woodlands, especially those with box-ironbark eucalypt associations. It is also found in River Red Gum woodlands (Higgins and Peter 2002; Tzaros 2005). This species has been recorded at the CRWF site however it confines its activity to the understorey and ground of woodlands and does not fly at RSA height.
				Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Spotted Harrier *Circus assimilis*	Species or species habitat likely to occur within area	Vulnerable	Not listed	Collision with operating wind turbines.	Unlikely	Low	Negligible	The Spotted Harrier prefers open woodlands that do not obstruct low flight, and natural and exotic grasslands in arid and semi-arid areas (Higgins and Davies 1996). There is one instance of the species colliding with a wind turbine elsewhere in NSW. Due to the irregular occurrence of this species on the CRWF site, this most likely would only happen rarely. The widespread distribution of this species in Australia makes it highly unlikely that a rare collision event would have any population consequences.
				Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Swift Parrot *Lathamus discolor*	Species or species habitat likely to occur within area	Endangered	Critically Endangered	Collision with operating wind turbines.	Rare	Moderate	Low	The Swift Parrot depends on a narrow range of flowering eucalypts in NSW for its predominant food of nectar and 'lerp', including White Box, Red Ironbark, Mugga Ironbark, Grey Box and Yellow Gum, as well as River Red Gum when this species supports abundant 'lerp'. It breeds in Tasmania and migrates to the mainland of Australia for the autumn, winter and early spring months. It lives mostly north and west of the Great Dividing Range (Emison *et al.* 1987; Higgins 1999; Kennedy and Tzaros 2005). There is potential for it to occur at the CRWF site however there are no records from the surrounding region and the dominant vegetation
				Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Varied Sittella *Daphoenositta chrysoptera*	Species or species habitat likely to occur within area	Vulnerable	Not listed	Collision with operating wind turbines.	Rare	Negligible	Negligible	The Varied Sittella is sedentary and inhabits most of mainland Australia except the treeless deserts and open grasslands. Distribution in NSW is nearly continuous from the coast to the far west. The Varied Sittella's population size in NSW is uncertain but is believed to have undergone a moderate reduction over the past several decades. (OEH 2017b). It inhabits eucalypt forests and woodlands flying at canopy level. The Varied Sittella forages in groups, flying into the tree canopy and working down the branches and the trunk, probing through the bark in search of insects (Pizzey & Knight 2003). This species would not fly at RSA height.
				Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Wedge-tailed Eagle *Aquila audax*	This species was recorded at the Crudine Ridge WF site (ELA 2012)	N/A	N/A	Collision with operating wind turbines.	Certain	Moderate	High	The Wedge-tailed Eagle is the species most exposed to collision risk due to its common habit of soaring and circling at height while foraging. This species is regularly struck at other wind farms in south-eastern Australia (BL&A, unpubl. data). Disturbance is not an issue, with the eagle breeding successfully as close as 200 metres from operating wind turbines. The regular incidence of collisions
				Indirect disturbance,	Unlikely	Negligible	Negligible	

Value to be Protected	Reasons for Inclusion	BC Act Listing	EPBC Act Listing	Impact Pathway	Likelihood of Risk Event	Consequence	Risk Rating	Comments
				including barrier effects.				has the potential to affect the regional population, although mobile sub-adults are over-represented in struck birds (BL&A, unpubl. data)..
White-throated Needletail *Hirundapus caudacutus*	Species or species habitat likely to occur within area	Vulnerable	Listed migratory species and Vulnerable	Collision with operating wind turbines.	Likely	Low	Low	The White-throated Needletail is known to follow storm systems and fronts. On other wind farms in its range is has been found to collide with turbines. It typically flies at and above RSA height. Loss of a small number of individuals each year is not considered to be of significance as the species is numerous in Australia (OEH 2016b), with population estimates in the tens of thousands (e.g. Higgins 1999).
				Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Other raptors	Commonly occurring raptor species were recorded at the Crudine Ridge WF site	N/A	N/A	Collision with operating wind turbines.	Likely	Low	Low	Turbine collisions involving commonly occurring raptors, such as Brown Falcon, Nankeen Kestrel and Black-shouldered Kite are likely, based on experience at other wind farms in south-eastern Australia (BL&A, unpubl. data). The widespread and common status of these species makes population impacts unlikely. These species appear not to be deterred by the presence of operating wind turbines and occur regularly at other wind farms in NSW.
				Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Waterbirds	Commonly occurring waterbird species were recorded at the Crudine Ridge WF site	N/A	N/A	Collision with operating wind turbines.	Unlikely	Low	Negligible	Habitats on the CRWF site for waterbirds are limited to small farm dams. No large concentrations of waterbirds occur nearby. Experience at other wind farms in NSW indicates few waterbirds collide with turbines, even near large waterbird concentrations (e.g. Lake George), where birds confine most of their activities to the wetlands and don't move across farmland in large numbers frequently.
				Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Other birds – non-listed								
Australian Raven *Corvus coronoides*	This species was recorded at the Crudine Ridge WF site (ELA 2012)	Not listed		Collision with operating wind turbines.	Likely	Negligible	Negligible	Common species occurring in southern and eastern Australia in most terrestrial habitats such as forest and farmland (Higgins et al. 2006). Often fly at turbine height but rarely collide (BL&A unpubl. data). Unlikely to experience population decline due to wind turbines.
				Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Crimson Rosella *Platycercus elegans*	This species was recorded at the Crudine Ridge WF site (ELA 2012)	Not listed		Collision with operating wind turbines.	Likely	Negligible	Negligible	Common species occurring from southern Queensland to south eastern Australia (Birdlife Australia 2016). Woodland species, may fly high at times. Not migratory (ELA 2011)
				Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Eastern Rosella *Platycercus eximius*	This species was recorded at the Crudine Ridge WF site (ELA 2012)	Not listed		Collision with operating wind turbines.	Likely	Negligible	Negligible	Common species occurring from southern Queensland to south eastern Australia (Birdlife Australia 2016). Woodland species, may fly high at times. Not migratory (ELA 2011)
				Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Grey Fantail *Rhipidura albiscapa*	This species was recorded at the Crudine Ridge WF site (ELA 2012)	Not listed		Collision with operating wind turbines.	Unlikely	Negligible	Negligible	Common through most of Australia, southern populations migrate north in autumn (Higgins et al. 2006). Known turbine casualty in NSW (BL&A unpubl. data) however the loss of tiny numbers colliding with turbines has no measurable impact on the species' population.
				Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Nankeen Kestrel *Falco cenchroides*	This species was recorded at the Crudine Ridge WF site (ELA 2012)	Not listed		Collision with operating wind turbines.	Likely	Low	Negligible	Wide spread and common to grasslands (Birdlife Australia 2016) and known to hover at RSA height. Thought to be partially migratory (ELA 2011)
				Indirect disturbance,	Unlikely	Negligible	Negligible	

Value to be Protected	Reasons for Inclusion	BC Act Listing	EPBC Act Listing	Impact Pathway	Likelihood of Risk Event	Consequence	Risk Rating	Comments
				including barrier effects.				
Black-shouldered Kite *Elanus axillaris*	This species was recorded at the Crudine Ridge WF site (ELA 2012)	Not listed		Collision with operating wind turbines.	Unlikely	Low	Negligible	High flying and soaring species, nomadic in nature (Birdlife Australia 2016). Common to grass and woodlands (ELA 2011). Low records on site make it unlikely to encounter turbines.
				Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Red Wattlebird *Anthochaera carunculata*	This species was recorded at the Crudine Ridge WF site (ELA 2012)	Not listed		Collision with operating wind turbines.	Unlikely	Negligible	Negligible	Common species of wooded habitats and leafy urban areas (Higgins ert al. 2001). Could be at risk from colliding with turbines but any casualties would result in minimal impacts on its populations.
				Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Laughing Kookaburra *Dacelo novaeguineae*	This species was recorded at the Crudine Ridge WF site (ELA 2012)	Not listed		Collision with operating wind turbines.	Unlikely	Negligible	Negligible	Common woodland and grassland species. Flys mainly at canopy height but may fly higher over open spaces (Birdlife Australia 2016).
				Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Brown Falcon *Falco berigora*	This species was recorded at the Crudine Ridge WF site (ELA 2012)	Not listed		Collision with operating wind turbines.	Unlikely	Low	Negligible	Usually forages from perches but occasionally will hover or soar and great height. Known to move according to conditions in the region (Birdlife Australia 2016). Common to agricultural areas.
				Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Australian Magpie *Cracticus tibicen*	This species was recorded at the Crudine Ridge WF site (ELA 2012)	Not listed		Collision with operating wind turbines.	Likely	Negligible	Negligible	Widespread species common to agricultural areas and woodlands (Birdlife Australia 2016). Known to fly at RSA height and collides with turbines (BL&A unpub. data)
				Indirect disturbance, including barrier effects.	Rare	Negligible	Negligible	
Pied Currawong *Strepera graculina*	This species was recorded at the Crudine Ridge WF site (ELA 2012)	Not listed		Collision with operating wind turbines.	Likely	Negligible	Negligible	Widespread species common in farmland, forests and woodlands (Higgins et al. 2006). Known to fly at RSA height and likely to collide with turbines but number would be small and overall populations would be minimally affected.
				Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Spotted Pardalote *Pardalotus punctatus*	This species was recorded at the Crudine Ridge WF site (ELA 2012)	Not listed		Collision with operating wind turbines.	Unlikely	Negligible	Negligible	Small woodland bird that prefers to stay within established eucalypt canopy (Birdlife Australia 2016). It is unlikely to encounter turbines.
				Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Tawny Frogmouth *Podargus strigoides*		Not listed		Collision with operating wind turbines.	Likely	Negligible	Negligible	Nocturnal species, breeds from August to December. Known to catch insects in flight (Birdlife Australia 2016).
				Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	

Value to be Protected	Reasons for Inclusion	BC Act Listing	EPBC Act Listing	Impact Pathway	Likelihood of Risk Event	Consequence	Risk Rating	Comments
Southern Boobook *Ninox novaeseelandiae*	This species was recorded at the Crudine Ridge WF site (ELA 2012)	Not listed		Collision with operating wind turbines.	Unlikely	Negligible	Negligible	Widespread throughout Australia (Higgins 1999). May fly at turbine height when dispersing or moving between foraging areas. Any casualties are unlikely to have adverse effects on overall population.
				Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Australian Owlet-Nightjar *Aegotheles cristatus*	This species was recorded at the Crudine Ridge WF site (ELA 2012)	Not listed		Collision with operating wind turbines.	Unlikely	Negligible	Negligible	Widespread throughout Australia (Higgins 1999). Small species that is unlikely to fly at turbine height, usually foraging on insects at or below canopy height. Any casualties are unlikely to have adverse effects on overall population.
				Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Bats								
Corben's Long-eared Bat *Nyctophilus corbeni*	This species is assumed to occur at the Crudine Ridge WF site (ELA 2012)	Vulnerable	Vulnerable	Collision with operating wind turbines.	Unlikely	Low	Negligible	Occur on the inland slopes and plains in the Murray–Darling basin (OEH 2017b). Occupy a range of habitats including cypress pine, buloke, mallee and box-ironbark woodlands; roost in tree-hollows. When foraging, is a relatively slow flier often at understorey level and even taking prey on ground (OEH 2017b). There are no records of this species striking wind turbines to date, although it has the potential to fly at RSA height. The low numbers in the region make it unlikely to encounter turbines regularly or be regularly disturbed by them.
				Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Eastern Bentwing Bat *Miniopterus schreibersii oceanensis*	This species was recorded at the Crudine Ridge WF site (ELA 2012)	Vulnerable	Not listed	Collision with operating wind turbines.	Unlikely	Low	Negligible	Roosts in caves during the day, dispersing over a range of habitats at night. Its feeding areas tend to be associated with forests, wetlands and waterways. This species could collide with turbines as it is known to fly at RSA height. It is likely that small numbers of this species occur in the region. Population consequences are therefore considered to be low.
				Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Eastern Cave Bat *Vespadelus troughtoni*	This species was recorded at the Crudine Ridge WF site (ELA 2012)	Vulnerable	Not listed	Collision with operating wind turbines.	Unlikely	Low	Negligible	The Eastern Cave Bat is found in a broad band on both sides of the Great Dividing Range from Cape York to northern NSW. Occasional records as far south as far as southern NSW including CRWF (ELA 2012; OEH 2017b). Very little is known about the biology of this uncommon species although it mainly occurs in open forests or woodland with rocky areas or cliffs (OEH 2017b). It is not known if it flies at RSA height in open country. Its local and regional population is considered to be at low risk from CRWF since only small numbers are likely to inhabit the area which is close to the southern limit of its normal range.
				Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Eastern False Pipistrelle *Falsistrellus tasmaniensis*	This species was recorded at the Crudine Ridge WF site (ELA 2012)	Vulnerable	Not listed	Collision with operating wind turbines.	Unlikely	Low	Negligible	Species occurs in coastal south-eastern Australia. Prefers wet habitats with trees taller than 20 metres (Churchill 2008). Roosts in tree hollows but has also been found roosting in buildings or under loose bark. No records from search region; populations unlikely to be affected by CRWF due to rarity or absence from area.
				Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Yellow-bellied Sheathtail Bat *Saccolaimus flaviventris*	This species was recorded at the Crudine Ridge WF site (ELA 2012)	Vulnerable	Not listed	Collision with operating wind turbines.	Unlikely	Low	Negligible	Known to occur in urban, agricultural semi-arid and tall wet forest habitats (OEH 2017b). Occurs in a range of habitats from rainforest to arid shrubland, roosts in tree-hollows. There are no records of this species from the search region (OEH 2017a) but it was recorded during fieldwork from CRWF (ELA 2012). When foraging for insects, flies high and fast over the forest canopy, but lower in more open country. There are no records of this species striking wind turbines to date, although it has the potential to fly at RSA height. The low numbers in the region make it unlikely to encounter turbines regularly or be regularly disturbed by them.
				Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Chocolate Wattled Bat *Chalinolobus morio*		Not listed	Not listed	Collision with operating wind turbines.	Likely	Negligible	Negligible	Common and widespread across much of southern Australia; occur in a variety of wooded and treeless habitats (Churchill 2008). Potentially at risk from flying

Value to be Protected	Reasons for Inclusion	BC Act Listing	EPBC Act Listing	Impact Pathway	Likelihood of Risk Event	Consequence	Risk Rating	Comments
	This species was recorded at the Crudine Ridge WF site (ELA 2012)			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	at RSA height, although any population impacts would be negligible owing to the species' abundance.
Gould's Wattled Bat *Chalinolobus gouldii*	This species was recorded at the Crudine Ridge WF site (ELA 2012)	Not listed	Not listed	Collision with operating wind turbines.	Likely	Negligible	Negligible	Common and widespread species. Juveniles will disperse from December or January which may result in higher mortalities. Not migratory. Nests in tree hollows or buildings. Flies within canopy and sub canopy, will pass over open areas and can forage up to 15km from roosts (ELA 2011). Any population impacts would be negligible owing to the species' abundance.
				Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
				Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Large-eared Pied Bat *Chalinolobus dwyeri*	This species was recorded at the Crudine Ridge WF site (ELA 2012)	Endangered	Endangered	Collision with operating wind turbines.	Unlikely	Negligible	Negligible	Occur from central Queensland to southern highlands of NSW, in a variety of forest and woodland types often near rocky areas; the species roosts in caves or mine shafts (Churchill 2008). It is rare and has a patchy distribution in NSW (OEH 2017b). Known to fly at 6-10 metres height (Churchill 2008); not known if it flies at RSA height but is unlikely to collide with turbines regularly around CRWF owing to its overall rarity.
				Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Little Forest Bat *Vespadelus vulturnus*	This species was recorded at the Crudine Ridge WF site (ELA 2012)	Not listed	Not listed	Collision with operating wind turbines.	Certain	Low	Low	Widespread, common species of south-eastern Australia and Tasmania, inhabiting a variety of wooded habitats. Mostly fly between 3 and 8 metres above ground (Churchill 2008), so unlikely to collide with turbines often.
				Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Little Pied Bat *Chalinolobus picatus*	This species was recorded at the Crudine Ridge WF site (ELA 2012)	Vulnerable	Not listed	Collision with operating wind turbines.	Unlikely	Negligible	Negligible	Species mainly occurs on the plains of the Murray-Darling basin in dry forests, woodlands and chenopod shrubland (Churchill 2008; OEH 2017b). Juveniles will disperse from March which may result in higher mortalities. Not migratory. Nests in tree hollows or buildings and caves, will roost near water. Flies within canopy, can forage up to 34km from roosts (ELA 2011).
				Indirect disturbance, including barrier effects.	Rare	Negligible	Negligible	
White-striped Freetail Bat *Tadarida australis*	This species was recorded at the Crudine Ridge WF site (ELA 2012)	Not listed	Not listed	Collision with operating wind turbines.	Almost certain	Low	Low	Common across Australia. Migrates to northern regions during winter (Churchill 2008), suggested that it does not hibernate (Menkhorst 1995). Flies above the canopy and roosts in hollows. Ranges up to 50 km in a night; susceptible to turbine collision. Juveniles disperse from January and the peak migration months are March and October when higher mortalities may occur (Churchill 2008; ELA 2011; BL&A unpubl. data). Any population impacts would be negligible owing to the species' abundance.
				Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	

Notes: BSC Act = Biodiversity Conservation Act; EPBC Act = Environment and Protection of Biodiversity and Conservation Act

3.6 Conclusions from the Risk Assessment

The surveys of the Project site and surrounding wind farm sites to date (inclusive of two years of operational monitoring at CRWF), combined with the knowledge generated at operating wind farms elsewhere in Australia (BL&A and NA unpubl. data), indicate that collision rates are typically very low and this risk assessment indicates that no significant population-wide impacts are anticipated for species of concern from the CRWF.

Raptors are known to be vulnerable to collision with operating wind turbines. A number of raptor species have been recorded at the Project site during surveys. The Wedge-tailed Eagle is the most exposed to collision risk due to its common habit of soaring and circling at height while foraging. Nankeen Kestrel, Brown Falcon and Black-shouldered Kite have also occasionally collided with the CRWF turbines but based on experience elsewhere and the mortalities recorded at CRWF, yearly occurrences are unlikey. *The risks to Wedge-tailed Eagle and "raptors" as a group is addressed in this BBAMP.*

White-throated Needletail is a migratory species considered to have similar flight behaviour to raptors. It flies regularly at or above turbine height and flocks may pass over the CRWF site during the summer months, although none have been observed to date at CRWF. Collisions have been recorded at wind farms elsewhere in NSW and Australia. The risk to this species from the CRWF is considered to be *low* as the species is widespread in eastern and south-eastern Australia. Currently, it is noted the species population is in continued decline, however this is primarily related to deforestation in the species breeding grounds in Siberia (Tarburton 2014) and it is unlikely that occasional collisions with turbines at CRWF will significantly contribute to population decline. Its conservation status is listed as vulnerable at Commonwealth and NSW State level, and it is a listed migratory species at the Commonwealth level.

In relation to the Swift Parrot and Regent Honeyeater, the risk rating of *low* is considered as highly conservative given the paucity of records nearby.

Overall, the risk to bats is considered as *negligible*, however the common and widespread White-striped Freetail Bat and the Little Forest Bat is almost certain to collide with turbines-with an overall risk assessment of *low*.

Many of the species listed under the BC Act screened in this risk assessment are not considered to be at risk from the operation of CRWF. Threatened woodland birds and bats do not regularly fly at RSA height and therefore do not encounter turbines very often. No birds or bats were considered to be at risk from indirect effects, such as disturbance or barrier effects.

This risk assessment indicates the following groups will be the focus of monitoring in the BBAMP:

- Wedge-tailed Eagle and other raptors;
- White-throated Needletail; and
- Microbats, including the White-striped Freetail Bat and Little Forest Bat.

4 Operational phase surveys

The main approaches to implementing the BBAMP will be:

- Specific approaches for investigating and managing species and groups identified as having a higher than negligible risk of impacts in the risk assessment and/or initiated due to a specific impact trigger (see section 6);
- A targeted carcass monitoring program to detect birds and bats that collide fatally with wind turbines to estimate overall bird and bat mortality rates at the CRWF; and
- Mitigation measures to reduce the possible interactions of birds and bats with operating wind turbines.

Sections 4.1 to 4.3 describe the survey methodologies that will be implemented during operation of the Project.

Carcass-searches were carried out for a total of two years following commencement of CRWF operations and a review and compilation of all monitoring data gathered after the second year was used to develop a targeted monitoring program for the ongoing operational years The need for continued monitoring will be reviewed with State and Commonwealth agencies.

4.1 Monitoring ‘at risk’ groups

The key “at risk” groups identified through the risk assessment (see Section 3) are the focus of monitoring in the BBAMP, and these are summarised below.

- **Wedge-tailed Eagle and other raptors;**
  A High risk to WTE has been assessed (Table 6). A low risk has been assessed to other raptors. Accordingly, it is important that further information is compiled on the WTE population on the wind farm site and that WTE nests are recorded, as well as the flight behaviours that could place WTE at risk. In addition, mitigation measures are to be implemented, where practicable, to reduce WTEs being attracted to the area near turbines including removal of possible food sources. In addition, information will be gathered during the surveys described below on other raptors to improve understanding of wind farm impacts on them.
- **White-throated Needletail**
  A low risk has been assessed for this species. On site occurrence of this species will be recorded during the targeted raptor surveys described below; and
- **White-striped Freetail Bat**.
  A low risk has been assessed for this species. Impacts on this species will be monitored through mortality searches (see Section 4.4).
- **Little Forest Bat**.
  A low risk has been assessed for this species. Impacts on this species will be monitored through mortality searches (see Section 4.4).

More specific and targeted monitoring of “at risk” groups is presented below. This monitoring will provide information within an adaptive management framework for addressing the bird and bat risks and impacts of the wind farm.

If threatened birds or threatened bats are found during carcass searches, or incidentally by wind farm personnel, an appropriate response will be identified in consultation with CPHR, as described in the procedure in Section 6 of this BBAMP.

Specific monitoring of these groups is outlined below.

4.1.1 Wedge-tailed Eagle and Birds of Prey (Raptors)

During CRWF operations, seasonal monitoring (January, April, July and October) of eagle and raptor movements and breeding activity will be undertaken..

Information recorded will include, as a minimum:

- Date, location and duration of observation period,
- Time and duration of flight,
- Number and age of birds observed,
- Flight height above ground,
- Flight behaviour,
- Habitat over which the flight was observed,
- Flight behaviour observed, included soaring, directional flight (flapping), kiting, circling, gliding and diving, and
- Other occasional behaviours observed and to be recoded may include feeding, territorial displays, fighting and perching.

In addition, during the breeding season (July to November), roaming searches will be undertaken within 2 km of the wind farm to identify WTE and raptor nests. Both flight paths and nests will be plotted accurately on large-scale aerial photographs of the site during observations.

A series of adaptive management measures are proposed in this BBAMP to reduce the potential for high numbers of raptors to use the site. These are outlined in Section 5 below.

4.1.2 Migratory Species

White-throated Needletail typically flies at and above RSA height. The seasonal carcass monitoring will monitor their presence and any impacts likely to occur from the CRWF (see section 3.3).

In addition, during the seasonal carcass monitoring searches, if a flock of needletails moves through the site, the numbers of birds and the zone of movement (where ascertainable) will be recorded and plotted on maps.

4.2 Bird utilisation surveys

Baseline (Environmental Assessment) surveys were conducted at CRWF. In accordance with AusWEA guidelines, post-construction surveys were completed in the first year of operational monitoring (in Spring and Summer-Autumn to replicate the pre-construction surveys) to ascertain if any changes in species composition and abundance would occur after operations commenced. Results are discussed in Section 2.2.

4.3 Bat Surveys

Initial baseline bat surveys (ELA 2011) detected a variety of bat species across three seasons: May (autumn), September (spring) and December (summer), including a number of BC Act listed species. No threatened bat species was assessed as above a negligible risk (Table 6), furthermore no threatened bat impact trigger events occurred during the two years of operational monitoring, as such, operational phase bat surveys are not considered necessary.

4.4 Carcass searches

The purpose of carcass searches is to determine the actual impact of the wind farm on birds and bats by attempting to estimate the annual number of birds and bats that collide fatally with turbines. Mortality rates can be estimated for all bird species combined, and all bat species combined. If threatened species are found underneath a turbine, given it is a rare event, the mortality rate for that particular threatened species cannot be estimated, unless it occurs frequently, which is highly unlikely.

Mortality is defined as any dead bird or bat detected under a wind turbine and within a distance of the turbine in which carcasses could potentially fall if struck. 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 wind farm 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 (see below).

Implementation of bird and bat monitoring programs in Australia is still developing (since 1998), and the techniques described here are based on the number of programs already implemented (e.g. Hull *et al*. 2013, BL&A and ELA unpubl. data from other projects), knowledge of experimental design and statistical analysis, and recent feedback from the regulatory authorities.

Collision by birds and bats with wind turbines will be monitored through a statistically rigorous carcass-search program for a minimum period of two years. 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. The accuracy and precision of this estimate depends fundamentally on maintaining a statistically valid and rigorous sampling regime.

It will be assumed that any intact dead bird or bat, or bird feather spot (defined as a clump of five feathers or more), detected beneath a turbine has died as a result of collision or interaction with a turbine, unless there are obvious signs of another cause of death (e.g. being shot). 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 later).

Ongoing monitoring of mortality from blade strike at operating wind farms typically serves to: (i) provide data that can inform adaptive management to reduce collision risk (i.e. patterns of mortality related to seasonal changes or local conditions); and (ii) detect mortality of threatened and non-threatened bird and bat species, at the impact trigger level (see Section 6) to trigger investigation of mitigation strategies and measures.

To derive accurate mortality rates it is essential that the program is scientifically and statistically robust. A number of 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.

A scavenged carcass may increase the variability in mortality rate estimates and thus carcasses will be assessed for possible scavenging and rates will be estimated from experimental trials (section 4.4.3).

Human detectability of carcasses is also a potential confounding variable and detectability trials were completed in year one monitoring to measure this factor. Protocols have been developed to control for this factor in the final mortality estimates. Section 4.4.3 provides more detail on this issue.

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

- Very few carcasses are found under wind turbines in Australia compared with Northern Hemisphere wind farms (i.e. on average, less than half the number in the Northern Hemisphere based on BL&A data across ten wind farms);
- 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 turbines and those found along roads and other legal sources. It is illegal to source un-cleaned carcasses from poultry producers.
- For statistical reasons, it is likely to be very difficult to determine more than the grossest of differences in scavenging rate or detectability across the year and there is no evidence in the literature for significant differences between seasons in scavenger activity. Therefore, annual scavenger and detectability correction factors were generated after the Year One monitoring was completed and will be applied in the assessment of results in future annual monitoring reports.
- It is known that detectability will be easier in short grass at the dry time of the year compared with in longer grass at the wet time of the year, and trials were scheduled to cover both periods.

Similar methods have been recommended in a number of other approved bird and bat monitoring programs in New South Wales and Victoria .

Mortality detection was carried out for the first two years of CRWF operation. After two years of mortality monitoring, a detailed report was prepared reviewing the mortality detection program and providing recommendations for the future monitoring in response to confirmed issues. This BBAMP has been updated to reflect the recommendations of the Year Two annual monitoring report.

The following sections outline:

- **Turbine site selection for carcass searches** (Section 4.4.1): how the wind turbines will be selected for a search
- **Search protocol** (section 4.4.2): the size of area beneath turbines to be searched and how this area will be systematically searched and results recorded
- **Scavenger rates and trials** (Section 4.4.3): definition of scavenging and how experimental trials will be conducted
- **Detectability and trials** (Section 4.4.4): definition of detectability and the experimental trial methodology
- **Incidental search protocol:** (Section 4.4.54.4.5): outlining the procedure to be adopted in the event of an incidental carcass or feather spot find by wind farm personnel outside the formal carcass-searches.
- **Analysis and mortality estimation** (Section 4.4.6): general outline of how the data will be analysed to gain estimates of bird and bat mortality.

4.4.1 Turbine Selection

Following the first two years of monitoring, which was based on the stratified random' sampling design (described in Appendix 3), the ongoing monitoring at CRWF operations will cover all 37 turbines.

4.4.2 Search protocol

All 37 turbines will be searched out to 60 metres seasonally (January, February, March, April, July, October). Surveying each turbine to 60 m rather than a subset of turbines to 100 m is considered a favourable approach given over 85% of all carcasses recorded during the two year initial operational monitoring period were recorded within 60 m of the turbine. For Wedge-tailed Eagle, the species with the largest potential fall zone, the maximum distance a carcass was recorded from a turbine was 75 m, which given the size of the species, would still be visible in most instances whilst surveying a 60 m radius search zone.

Search transects are spaced at 6 metres and carried out from the center of the zone out to the edge (see Figure 3). Given that the defined transect spacing and total search area are based on experience and evidence from previous studies (e.g. Arnett *et al*. 2005, Hull and Muir 2010) they are considered to be ample to detect bird and bat species of concern determined from the risk assessment.

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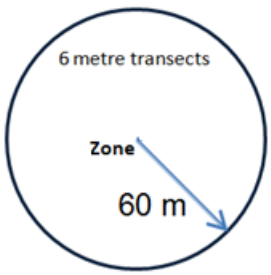
Figure 3 60 metre carcass search zones underneath the turbines



Carcass detection protocol

If a carcass is detected (a 'find') the following variables will be recorded in the carcass search data sheet (see Appendix 1):

- GPS position, distance in metres and compass bearing of the carcass from the wind turbine tower;
- Substrate and vegetation under the carcass, particularly if it was found on a track or hard-stand area without vegetation as this may assist in quantifying the number of carcasses not found in areas where ground cover makes carcasses less visible;
- Species, age, number, sex (if possible) signs of injury and estimated date of strike;
- Weather (including recent extreme weather events, if any), visibility, maintenance to the turbine and any other factors that may affect carcass discovery; and
- If the species is not able to be immediately identified as there is not a qualified ecologist on-site (i.e. an incidental find), photographs will be provided to the qualified ecologist within 2 business days of the find for identification and the ecologist must reply within 5 business days for the possible reporting of an impact on a threatened species within 2 business days of confirmation.

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

- The carcass will be removed from the site to avoid re-counting;
- The carcass will be handled by personnel wearing rubber gloves, packed into a plastic bag, wrapped in newspaper, put into a second plastic bag;
- The carcass will be clearly labelled to include the carcass search data sheet to ensure that its origin can be traced at a later date, if required; and
- The carcass will be transferred to a freezer at the site office for storage so a second opinion on the species identity may be sought, if necessary, and for use in scavenger and/or detectability trials.

4.4.3 Scavenger rates and trials

Scavenger trials were undertaken twice in the first year of operational phase monitoring. The objective of having two trials was to account for different vegetation conditions, so one was held when the grass was long and one when the grass was short. The two periods for scavenger trials are shown in the Table 7, below.

It is 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 wind farm impacts on birds and bats. 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 trial described below is designed to ascertain the scavenging rate, usually expressed as average carcass duration.

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

Table 7 Timing for scavenger trials

Vegetation condition	Likely time period	Weather	Stocking
Short grass	Winter (e.g. July)	Cold weather	Heavy stock levels
Long grass	Late Spring (e.g. November)	Follow rain and higher temperatures	Light stock levels

After the scavenger trials, the need and frequency of further scavenger and detectability trials will be reviewed and discussed with CPHR.

Scavenger Trials

Scavenger Trials were undertaken by a trained person to initially layout the trial (see Section 4.5) to determine the probability of scavenging loss, and the nature of scavenger removal (e.g. an early peak in scavenging, or scavenging that peaks after carcasses have been in place for a period of time). The search area for scavenger trials was the same as in the search protocol for year One and was located at eight of the same 19 randomly selected turbines of the Year One monitoring program.

To determine potentially different scavenging rates on birds and bats, four size categories of carcass were used. Where exact carcasses for each size class were unable to be sourced, appropriate replicates were used including mice and rats, as surrogates for microbats and small birds. Different scavengers are active at different times of day and this was accounted for by placing carcasses out during the early morning and late afternoon. This reduced the potential for bias in the search intervals. Based on current mortality estimation software requirements, every endeavour was made to find ten carcasses of each size category (Table 8). Statistical advice indicates that meaningful improvements on this method would require an impractical carcass numbers that are unlikely to be available but that this does not lead to a commensurate improvement in the statistical power of scavenging rate estimates.

Table 8 Number of replicates for each scavenger trial

Time	Micro-bat	Small birds	Medium sized birds	Large birds (large raptor size)
Early Morning	10	10	10	5

Carcasses from each size class were randomly placed within areas of varying ground cover (e.g. turbine pad, short grass, long grass) and surrounding vegetation (e.g. grassland, woodland) within the 60 m inner search zone across a total of eight turbines. Each carcass was checked twice daily for the first three days, then daily for two days, then every 48 hours for the following four days and then every three days until they disappeared or the end of the 30-day trial was reached (see Table 9). The site staff are expected to continue monitoring beyond day 5 of the trial. Remote motion-sensitive cameras were also placed on remaining carcasses at the end of Day One of the April 2022 trial, to record the nature and precise timing of scavenging

Table 9 Scavenger trial search timetable

Day (Time)
Day 1: Early morning
Day 1: Late afternoon
Day 2: Early morning
Day 2: Late afternoon
Day 3: Early morning
Day 3: Late afternoon
Day 4: Anytime
Day 5: Anytime
Day 7: Anytime
Day 9: Anytime
Day 12: Anytime
Day 15: Anytime
Day 18: Anytime
Day 21: Anytime
Day 24: Anytime
Day 27: Anytime
Day 30: Anytime

Additional procedures for scavenger trials are described in Appendix 4.

The number of carcasses per animal and size category is based on obtaining a reasonable level of statistical confidence in the estimate of average carcass duration, as reflected in software requirements for current mortality estimation processes, whilst seeking to minimise the number of carcasses used, as they can be difficult to source. Large numbers of carcasses (e.g. on-site, road-kill) are difficult to obtain and it may be very complicated to find alternative sources (e.g. farmed and culled animals). It is also possible that large numbers of carcasses, more size categories and more replicates may attract more scavengers to the area. Previous studies (e.g. Molsher *et al*. 2000) have shown that fox prey use is related to availability and therefore more foxes may be attracted to the area if more carcasses are used, thereby biasing the resulting correction factor. In addition, raptors are potentially more susceptible to collision when preying on carrion beneath turbines. However, it is necessary to conduct these trials under turbines as some scavengers may alter their behaviour in response to the turbines. The final scavenger trial design is therefore 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 birds that may collide with turbines.

4.4.4 Detectability (Observer) trials

As outlined above, all searches were supervised by a qualified ecologist and undertaken by trained ecologists or personnel trained and regularly assessed by the ecologist.

Detectability trials were undertaken to assess the probability that a searcher will detect an existing carcass. To maximise efficiency, these trials were undertaken concurrently with the monthly carcass searches and scavenger trials in August 2021 and April 2022 (i.e. searching along the six-metre and 12-metre transects). As humans are reliant on visual cues to determine carcass location, the two visibility categories of low and high grass cover were compared.

To account for observer variability in detecting carcasses, only personnel who have carried out monthly searches at CRWF were involved in the detectability trials. Detection efficiency (percentage of carcasses detected) was then incorporated into later analyses that derive mortality estimates. The number of carcasses employed in each trial is detailed in Table 10 and explained below. The carcass controller (a person not involved in monthly carcass searches who can act consistent with this method) threw each carcass into the air and allowed 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 noted the placement of carcasses (via GPS) and was free to decide how many were deployed under each turbine.

Table 10 Observer trial results for both August 2021 and April 2022 trials and total detection rate for each carcass class

Trial period	Micro-bat	Small birds	Medium sized birds	Large birds (large raptor size)
Long grass / vegetated August 2021	2/8	5/10	9/10	5/5
Short grass April 2022	8/10	9/10	10/10	5/5
Total detection rate (5)	55	70	95	100

The first observer trial undertaken in August 2021 recorded a microbat detection rate of 25%, 50% for small birds, 90% for medium birds and 100% for large birds. The second trial undertaken in April 2022 recorded a microbat detection rate of 80%, 90% for small birds and 100% for medium birds and large birds. Combined, the results from both trials indicate an increased detection rate with increased carcass size, as expected and recorded at other Australian wind farms (Stark and Muir 2020) (Table 10). With the exception of the large bird carcass size class which recorded an 100% detection rate in both trials, all other carcass size classes recorded an improved detection rate from the first to second trial.

Additional considerations for detectability trials are described in Appendix 5.

4.4.5 Incidental Carcass Protocol

Personnel at the CRWF may from time to time find carcasses within the wind farm site during normal day-to-day O&M activities. In this case, the carcass will be handled according to the carcass detection protocol outlined in section 4.4.2. All wind farm personnel will be made aware of this carcass handling protocol as part of their HS&E training and induction. If the find is made within five days prior to a scheduled carcass search, the carcass will be left *in situ* but photographed and its position recorded (GPS). A carcass search data sheet (Appendix 1) will be completed for each incidental carcass found.

4.4.6 Analysis of results and mortality estimation

The results of the mortality monitoring surveys will be analysed to provide information on:

- The species, number, age and sex (if possible) of birds and bats being struck by the turbines.
- Any variation in the number of bird and bat strikes.

The results will be detailed in the annual report and will provide a basis for identifying if further detailed investigations or mitigation measures are required.

Statistically robust projections of bird and bat mortality for the entire wind farm site will be presented, based on the data collected from mortality searches. It is acknowledged that this is a current and dynamic aspect of research and that the outcomes from such programs may be equally dynamic. The current updated program is designed to provide an acceptably accurate and precise estimate of wind farm related bird and bat mortality based on results and analysis of two years of monitoring,.

All data will be analysed to provide the average estimated mortality of birds and bats, their standard error (variability) and ranges for the CRWF. The mortality rate of each species and size class detected (if estimates are possible) will be calculated after every two years of data have been collected in each two year monitoring cycle. If possible, the standard error and range of these estimates will be reported. Note that it may not be possible practically to provide this due to the likely low number of carcasses detected. Where this is an issue, it will be reported. Mortality estimates will also take into consideration the actual operational time of the turbines (obtained from the project operator).

The estimated mortality rate will be generated by modelling the scavenger losses and results of the human detectability trials, and using sampling inference to account for the selection and stratification of turbines where applicable. The data from the scavenger and detectability trials will be analysed using relevant techniques based on Generalised Linear Modelling (GLM) and (censored) Survival Analysis. Censored measurements are only partially known, such as the exact time of mortality or the exact time to scavenge loss (see, for example, Kaplan & Meier (1958)). In addition to providing mortality estimates, this analysis will determine if any of the factors (i.e. size class or habitat stratification of turbine sites) are significant, where possible.

4.5 Personnel Involved

This section of the plan outlines the personnel involved and any training required for the field work and report writing necessary for this BBAMP. All personnel working on this Plan will be trained thoroughly, including background theoretical training, knowledge of policies and other administrative matters (e.g. OH&S), and in technical and field methods. CRWF will ensure that it engages suitably qualified and trained people to supervise and implement the monitoring program.

Any person undertaking searches will be trained and supervised by an ecologist who is familiar with the techniques and has applied them at other sites. The qualified ecologist will supervise the initial carcass search to ensure that field methods are being undertaken correctly. The qualified ecologist will be responsible for identifying any recorded carcasses from photographs or from specimens transferred to the freezer on site after searches.

If for some reason a trained searcher is unable to undertake the monthly searches as planned (due to illness etc) a backup person will be identified in advance. If a backup person is required to undertake searches, they will also be trained and supervised by a qualified ecologist.

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

Annual reports and all investigations resulting from an impact trigger (see section 6) will be prepared by the approved qualified ecologist and subject to an internal peer review process.

4.6 Injured Bird and Bat Protocol

All on-site staff and monitoring personnel will be advised of the correct procedure for assisting injured wildlife. Wind farm personnel who find injured wildlife will be required to report the find to the wind farm operations manager, who will be required to place the animal immediately into a dark place (e.g. box or cloth bag, if safe to do so kept in a dark room, if available) for transfer to the nearest wildlife carer or veterinarian.

Contact details of local veterinary staff and wildlife carers are provided below 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.

- Mudgee Veterinary Hospital, 104 Market Street, Mudgee (24 hours) (02) 6372 2105
- Church Street Veterinary Hospital, 138 Church Street, Mudgee, 02 6372 6780
- WIRES 1300 094 737
- RSPCA: Central West Supporter Group Wildlife Emergencies 1300 094 737

This Injured Bird and Bat Protocol is valid for the operational life of the wind farm.

4.7 Reporting and Review Meetings

In accordance with Project Approval Condition C22 reports will be submitted to the Secretary and CPHR, on an annual basis for the first five years and every two years after. Similarly, the annual report will be submitted to the Commonwealth Department of Environment and Energy under condition 10 of their approval under the EPBC Act.

An annual/biennial report will be prepared within three months of the completion of the annual/biennial operational monitoring. The annual/biennial report will focus on presenting the results of the previous 12 months/24 months of investigations and recommending refinements to monitoring activities, if required.

The annual/biennial report will present the analysis of data collected. Matters to be addressed in the annual/biennial report will include, but will not be limited to:

- The survey methods (including list of observers, dates and times of observations);
- Results of carcass searches and incidental carcass observations
- Estimates of bird and bat mortality rates (birds/bats per turbine per year) based on statistical analysis;
- Seasonal and annual variation in the number and composition of bird and bat strikes, where detectable;
- Any other mortality recorded on site but not during designated carcass searches (i.e. incidental records by site personnel);
- Identification of any unacceptable impacts or impact triggers, and application of the decision-making framework and relevant adaptive management measures.
- A brief description of the management prescriptions implemented and identification of any modifications made to the original management practices.
- A summary of livestock carcass removal for the purposes of predator reduction;
- Details of any feral animal control programs reported by landowners and their timing;

- A discussion of the results, including:
  - Whether indirect impacts on bird and bat use of the site are of significance at a regional, state or national level, or if species of concern have been affected.
  - Bird risk reduction measures.
  - Any further recommendations for reducing mortality, if necessary.
  - Whether the level of mortality was unacceptable for affected listed ('at risk') species of birds or bats.
  - Usage of the wind farm area by 'at risk' species and factors influencing this (ie. climatic, geographical and infrastructure).
  - Analysis of the effectiveness of the decision-making framework.
  - Recommendations for further monitoring.

4.7.1 Review of BBAMP and adjustment of monitoring regimes

The BBAMP will be reviewed and reported upon on an annual basis for the first five years and every two years after that, unless otherwise agreed by the Secretary of DPHI. The reporting will focus on the BBAMP in terms of its effectiveness together with consideration of the intensity of effort and resourcing, and emerging understanding of the level of risk to avifauna.

Annual reports prepared beyond the first two years, as to be agreed with DPHI, will include the results of any monitoring activities undertaken for that year and a discussion regarding any impact triggers or unacceptable impacts identified, mitigation measures implemented and application of the decision-making framework (see section 6). As this management plan is adaptive, further refinements to the program will be included in the annual/biennial reports and will be based on the outcomes of monitoring surveys and any impacts, in consultation with State and Commonwealth agencies

The BBAMP may also be required to be reviewed in response to the occurrence of an incident, the submission of an audit report, or modification to the conditions of the NSW Development Consent, in accordance with Condition 4 of Schedule 5 of the NSW Development Consent. Revision of the BBAMP will be undertaken to the satisfaction of the Secretary of the DPHI.

Pursuant to Condition 10 of Schedule 5, the approved BBAMP and approved annual/biennial monitoring reports will be made available on the Project website.

5 Mitigation measures to reduce risk

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 6 as a threshold of impact on birds or bats that triggers an investigation and/or management response. This section outlines measures that will be undertaken during operation of the wind farm to prevent or reduce the potential for an impact to occur, and addresses condition of approval C22.

The overall objective of mitigation measures is to ensure that the operation of CRWF does not lead to significant impacts on threatened or non-threatened birds and bats. Any future novel or new mitigation measures that are identified to be of potential benefit for birds and bats at the CRWF will be incorporated into the plan as part of adaptive management, in consultation with the CPHR.

5.1 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 include:

- Grain feeding can be an "attractant" for parrots; and
- Carrion and rabbits can be an "attractant" to raptors in the area.

Thus, this section proposes possible mitigation measures to address these issues.

A High risk to WTE has been identified for CRWF. The WTE and other raptors forage for carrion (dead and decaying flesh of an animal) and also on small mammals, rabbits, etc. In order to reduce the risk of raptors colliding with turbines, a regular carrion removal program will be implemented during operations, to reduce the attractiveness of the site to raptors and therefore reduce the potential for fatal collisions by this group of birds. This program will focus on an area of a minimum of 200 metres around turbines, where safe, feasible and practical. The procedures below will be adopted:

- A designated suitable person will be appointed (such as a wind farm employee or landowner) to perform the function of Carrion Removal Coordinator who will undertake the activities described below.
  - Monthly inspections of the wind farm site to search for any stock, introduced or native mammal and bird carcasses (to be recorded as incidental finds) that may attract raptors (e.g. kangaroos, pigs, goats, foxes, rabbits, dead stock). This search will be undertaken via vehicle and visual checks in addition to using binoculars (where available) to look for large carcasses within 200 metres of each turbine.
  - Additional, opportunistic observations by operators during normal inspections and work routines as they travel around the CRWF provides further opportunity to identify and report carcasses of stock or feral animals so that timely collection can be undertaken to remove them. This can be addressed by operator protocols.
  - Any carcasses and/or remains found that are within 200 metres of turbines, will be collected and disposed of as soon as possible, in a manner that will avoid attracting raptors close to turbines.
  - Consult with landowner or site or asset manager in relation to the appropriate disposal of collected carrion, to be located at least 200 metres away from the closest turbine.
  - Wind energy facility maintenance staff and landowners will be required to notify the Carrion Removal Coordinator immediately following identification of carrion on site in between monthly searches.
  - Carcass occurrence and removal will be recorded in a monthly inspection records maintained by the CRWF operations manager.
- Site staff will receive extra training on identifying and promptly removing wildlife, livestock, and pest animal carcasses to help reduce raptor activity around the wind farm

- During lambing season (usually late autumn / winter) young lambs are susceptible to death. Therefore, if possible and subject to agreement and action of landowners, lambing will be encouraged in paddocks at least 200 metres away from turbines, where practicable, to reduce the risk that raptors are attracted closer to the turbines.
- To reduce collision risks to birds, where practical and with landowner agreement, the practice of grain feeding of stock within 200 metres of turbines will be minimised as it could draw additional parrots and other grain-eating birds towards turbines.
- Any feral animal control on the wind farm site will involve the removal and appropriate disposal of resulting carcasses in a timely manner.
- If an active rabbit burrow within 200 metres of a turbine is observed during monitoring surveys, it may be necessary to conduct an integrated rabbit control program (to reduce site attractiveness to Wedge-tailed Eagles) within 200 metres of turbines. Methods to control rabbits include borrow destruction, poisoning and shooting. Any rabbit control program will require cooperation and agreement from the landowner.
- An annual summary of carcass removal, based on the monthly inspection records will be provided in the annual BBAMP reports.

The need for continuation of the carcass removal program and effort required will be assessed in the annual report. In general, the criteria for continuation will be based on the frequency of carcass finds. For example, if carcass frequency is particularly low (e.g. one or two per quarter) outside of turbine impact zones (i.e. not beneath turbines) the intense program may be discontinued or reduced considerably, subject to agreement with CPHR. Alternatively, if peaks occur at specific times or locations where there are turbines with intervening periods of low numbers, the effort may be focussed on the peak periods and/or locations.

5.2 Lighting on turbines and buildings

It has long been known that sources of artificial light attract birds, as evidenced by night-migrating birds in North America and Europe. Lighting is probably the most important factor under human control that affects mortality rates of birds colliding with all structures (Longcore, et al. 2008). Most bird mortality at communication towers in the United States for example, occurs in poor weather with low cloud in autumn and spring, i.e. during migration periods (Longcore, et al. 2008).

It is postulated that bright lights may temporarily blind birds, particularly those accustomed to flying at night or in low light conditions, causing them to fly toward the light source and collide with the structure (Gauthreaux and Belser 2006). They would appear prone to saturation of their retinas, causing temporary blindness when subjected to bright light (Beier 2006) and mortality of both birds and bats can result from collisions with lit structures. Birds can also become disoriented or ‘trapped’ in the field of light (Longcore *et al.* 2008).

Measures to reduce the impact of lighting include using low pressure sodium or mercury lamps with UV filters to reduce brightness. The colour of lighting may also be important. Some studies have found that red lights resulted in a lower mortality than white lights in birds (Longcore *et al*. 2008), but more recent research on oil rigs at sea suggests that blue or green lights may result in lower mortality than red or white lights (American Bird Conservancy 2014).

As a precaution, building and other infrastructure lighting will be baffled and will be directed groundward to avoid excessive light spillage. Security lighting will be baffled and will be directed towards the area requiring lighting and not skyward. The WTGs will not have permanent external lighting.

5.3 Minimise raptor perches on turbines

The turbines have been designed to minimise the availability of raptor perches, by reducing the number and length of horizontal external structures on turbine towers and nacelles. The project’s turbines have smooth aerodynamic designs with enclosed nacelles and hub that does not provide perching opportunities for raptor species.

5.4 Minimise nesting close to turbines

To discourage nesting of raptors near turbines, if confirmed raptor nesting occurs within 200 metres of a turbine, the nesting event will be permitted to take place and run its course. After breeding is completed and outside the current breeding season, the nesting tree will be considered for removal or nest relocation unless inconsistent with project approval requirements, and upon consultation with CPHR.

6 Impact triggers and decision-making framework

This section identifies the circumstances that will result in notification, further investigation and additional mitigation for both threatened and non-threatened birds and bats ('impact triggers'). If an impact trigger occurs, there must be an investigation into the cause of the impact, and whether the event was likely to be a one-off occurrence or occur regularly.

The impact trigger may be an unacceptable impact in itself, or may lead to an unacceptable impact if it continues. A definition for "unacceptable impact" has not been provided, but rather once an impact trigger has been met a process is initiated to consider and define acceptable impacts for particular species.

Note that the approach developed in this section is based on the preparation of numerous bird and bat monitoring programs for wind farms in both New South Wales and Victoria, and up to date feedback from regulators on the implementation of approved plans.

Ultimately, the asset manager will be responsible for implementation of this BBAMP and the decision-making that goes with it, with technical support provided by the expert.

6.1 Threatened Species

6.1.1 Definition of Impact Trigger

Generally, an impact trigger is where there is evidence of death or injury to threatened birds and/or bats by collision or other interaction with turbines. Under this program, the circumstances that define an impact trigger for threatened birds and/or bats are detailed below.

Impact Trigger for Threatened Species: A threatened/bat species (or recognisable parts thereof) listed as threatened (not migratory) under the Commonwealth *EPBC Act* or NSW *Biodiversity Conservation Act 2017*, is found dead or injured within 150[2] metres of a wind turbine during any mortality search or incidentally by wind farm personnel.

An impact trigger being met will lead to an immediate investigation which will follow the process outlined in Section 6.1.2.

6.1.2 Decision Making Framework and Reporting

If a threatened species impact trigger occurs, further investigation will immediately be triggered and the decision-making framework outlined below and in Figure 4 will be followed. This section complies with Condition C22 of the conditions of approval.

- Immediate reporting, upon positive identification, of the occurrence of an impact trigger to CRWF's responsible manager, who will report it to the relevant statutory planner at CPHR (Dubbo) within two business days of it being notified;
- Immediate investigation (to be launched within 5 business days of the first observation, and to be completed within 10 business days) by an appropriately qualified ecologist to determine the cause of death or injury. If the cause of death is considered to be due to turbine collision, an investigation will be undertaken to identify any particular risk behaviours that could have led to the collision and an evaluation of the likelihood of further occurrences. The impact trigger may be one-off or cluster events.
- The rapid 10-day investigation will assess, if possible, the most effective mitigation and will plan mitigation that can be implemented correctly and quickly. The investigation will aim to provide a clear understanding of the cause of the impact, where required, informed by on-site investigations of the occurrence of the species on the wind farm site.
- If following this investigation, the fatality is deemed to be a one-off occurrence and the ongoing risk is unlikely to be significant at a population scale, further action is not considered necessary. This

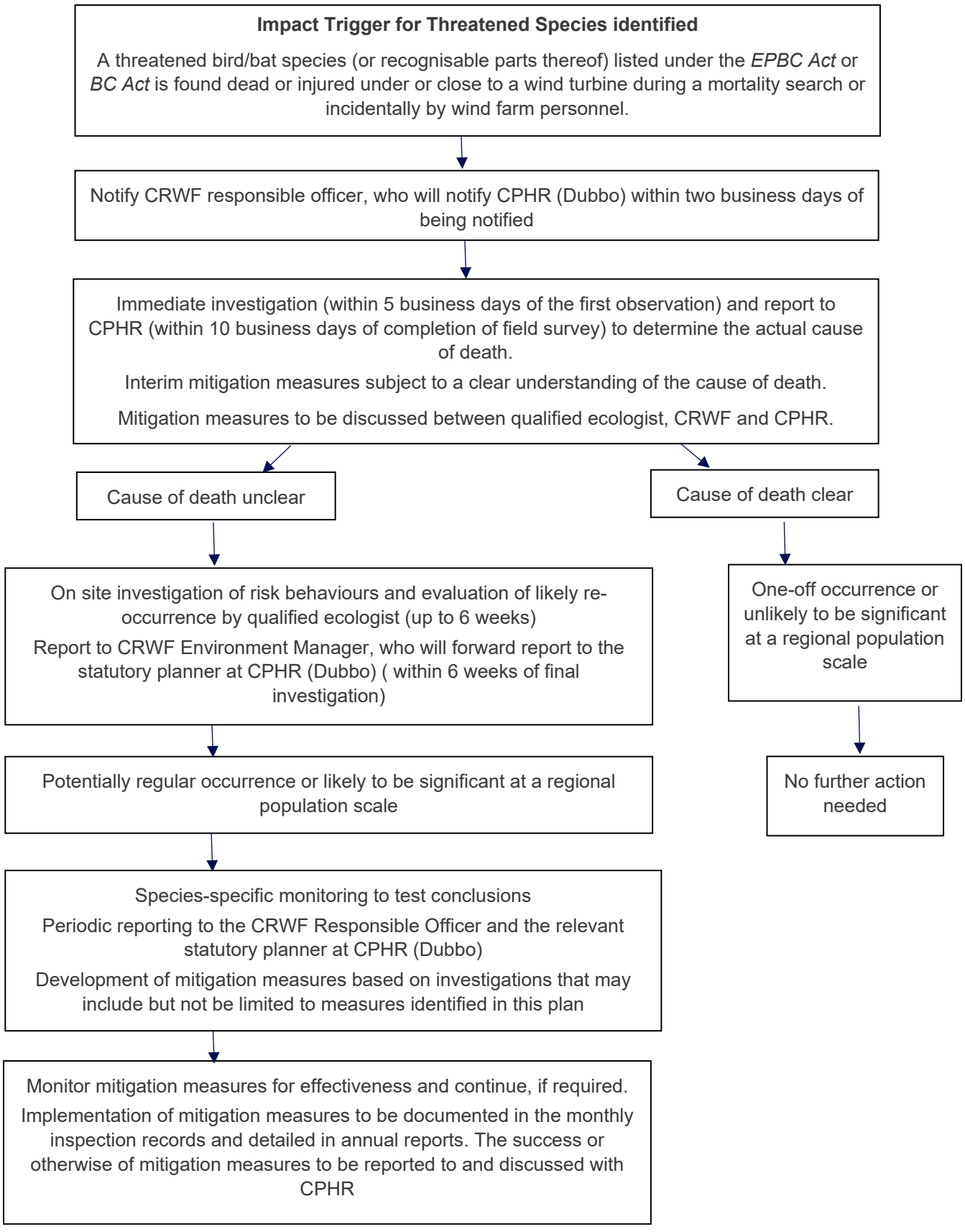
[2] 150metres is based on an impact fall zone of large birds up to 100 metres (Hull and Muir 2014) with potential for a scavenger to move the carcass up to 150 metres from the turbine.

decision will be made in consultation with CPHR and will be determined based on available evidence and using a precautionary approach. If no response has been received from CPHR within 20 business days the report on the investigation will be considered to be accepted.

- If the cause of the impact trigger is not clear, further on-site investigation of risk behaviours and evaluation of likely re-occurrence will be required over the following weeks (up to 6 weeks). If these investigations suggest that the impact trigger was a one-off event and the ongoing risk is unlikely to be significant at a population scale, no further action would be necessary. This decision will be determined in consultation with CPHR, based on available evidence.
- If the onsite investigation suggests that the impact trigger may be a regular occurrence, species-specific monitoring may be required. During the species-specific monitoring period, periodic reports will be provided to CRWF and CPHR.
- Where required, responsive mitigation measures will be developed and, as agreed with relevant agencies, implemented in a timely manner. Examples of mitigation measures may include but are not limited to those outlined in Sections 5 and 6.3.

Any evaluation of impacts and decisions regarding mitigation measures and further investigations required will be undertaken in consultation with CPHR. Any required investigation, and recommended management and supplementary mitigation measures, will be documented in the monthly inspection records and detailed in annual reports. The relevant monthly inspection record will be available for inspection by CPHR or on the request of the Secretary DPHI.

Figure 4 Decision making framework for identifying and mitigating impact triggers for threatened species



6.2 Non-threatened Species

6.2.1 Definition of Impact Trigger

The circumstances that define an impact trigger and significant impact for non-threatened birds and/or bats under this Management Plan are detailed below. Note that native species not listed as protected, namely Sulphur-crested Cockatoos, galahs, crows and ravens and introduced bird species are not considered of conservation significance and are therefore not subject to adaptive mitigation or this impact trigger.

Impact Trigger for Non-threatened Species (excluding WTE): A total of four or more bird or bat carcasses, or parts thereof, of the same non-threatened species are recorded at the same turbine in two successive searches (excluding ravens, magpies, sulphur-crested cockatoos, corellas, and introduced species.).

Note that although the impact trigger does not include ravens, magpies, sulphur-crested cockatoos, corellas, and introduced species, detected mortalities for these species will still be recorded and reported.

Impact Trigger for WTE: A total of three or more WTE carcasses, or parts thereof, are recorded at the same turbine in one carcass search, then a follow up survey will be completed at this turbine the following month to monitor for any additional WTE carcasses. If one or more WTE carcasses are detected in that survey, then the Non-threatened species impact trigger has occurred.

6.2.2 Decision Making Framework

In the event that an impact trigger for non-threatened species is detected the following steps will be followed:

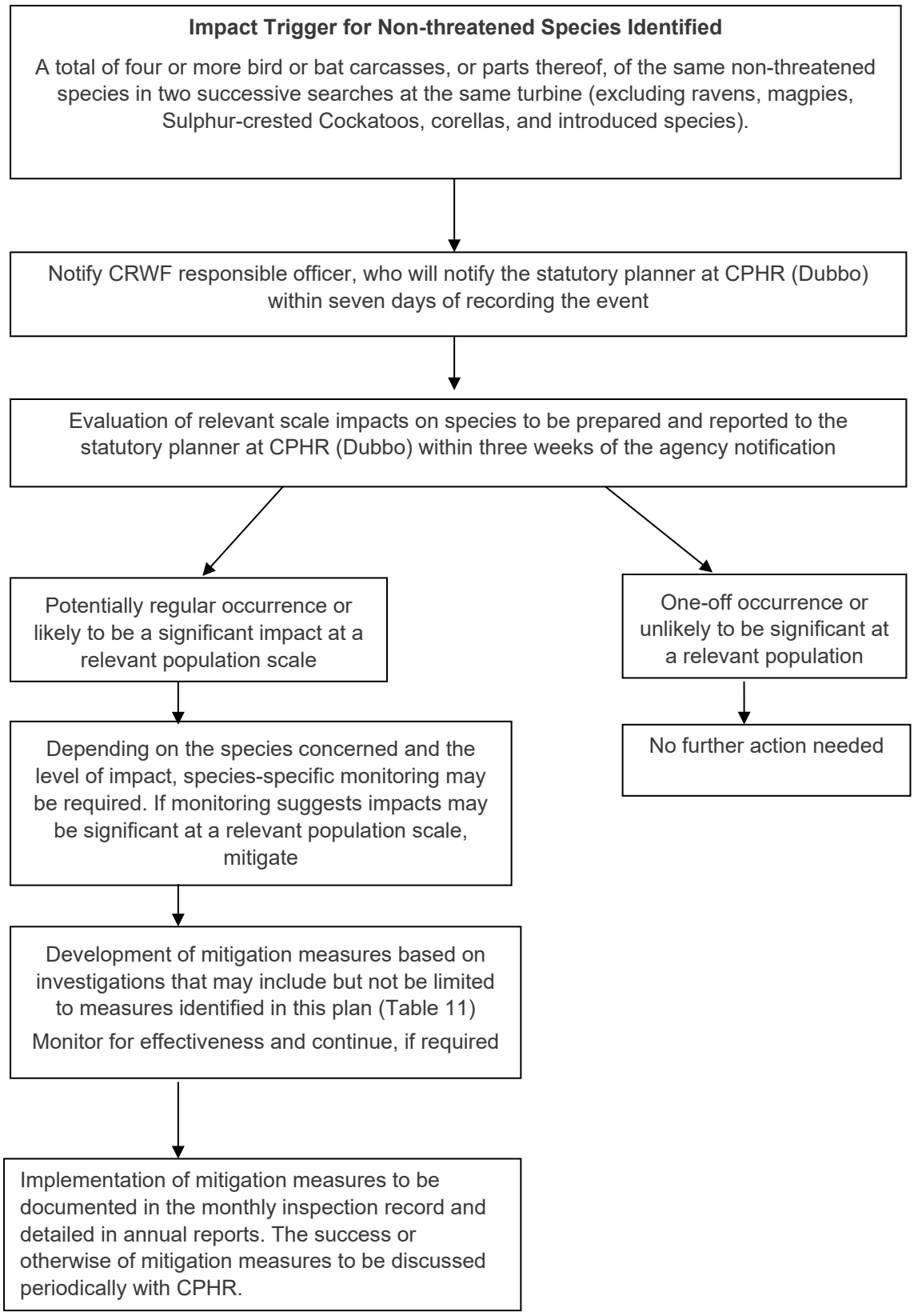
- CPHR(Dubbo) will be **notified** of the impact trigger within seven days of recording the event. An appropriate scale to consider population effects of the impact trigger will be agreed between CPHRand the Proponent on a case-by-case basis with consideration given to the species in question.
- An **evaluation** of impacts to the non-threatened species will be undertaken.
- A **report** on the investigation will be delivered to the relevant statutory personnel at CPHR (Dubbo) within three weeks of the agency notification.

If the evaluation indicates that the event was a one-off occurrence and is unlikely to be an unacceptable impact at a relevant population scale for the species in question, no further action will be necessary (as outlined in Figure 5).

If the event is deemed to be a potentially regular occurrence and is likely to lead to an unacceptable impact on the species in question, species-specific monitoring may be required (Figure 4). If further monitoring confirms that impacts are likely to lead to an unacceptable impact on the species, mitigation measures will be required. Potential mitigation measures are outlined in Table 11, however specific mitigation measures will be determined based on the species involved and the outcome of investigations.

Any evaluation of impacts and decisions regarding mitigation measures and further investigations required will be undertaken in consultation with and agreement from CPHR. Any required investigation, and recommended management and supplementary mitigation measures, will be documented in the monthly inspection record and detailed in annual reports. The relevant monthly inspection record will be available for inspection by CPHR or on the request of the Secretary DPHI.

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



6.3 Supplementary Mitigation Measures

Supplementary mitigation measures will be implemented in consultation with CPHR if an impact trigger occurs. The purpose of supplementary mitigation measures will be to prevent the impact from continuing to occur. The mitigation measures adopted will depend on the nature, cause and significance of any impact recorded and in response to the results of investigations of the event and of the species concerned on the wind farm site.

It is difficult at this stage to know what the cause of an unacceptable impact will be. Possible examples of impacts and potential mitigation measures specific to the impact trigger, and the time taken to implement these measures, are detailed in Table 11. A suite of measures that may or may not include those in Table 11 would need to be implemented, depending on the circumstances. These describe useful and tested responses from other wind farms. Should these be implemented as a management response at CRWF the response of birds and bats to these measures will be recorded.

Turbine shutdown will be considered as a last resort, once all mitigation options are exhausted.

Information needed to inform consideration of turbine shutdown will include but not be limited to:

- Ongoing acceptable impacts, including the level of risk to the species' regional and overall populations, where known;
- The findings of detailed investigations undertaken in response to the impact trigger, focussing on the species' use of the immediate area around affected turbines;
- Clear scope for on-going monitoring to identify triggers for turbine shut-down;
- Agreed triggers for turbine shutdown *and* restart; and
- Reporting and consultation arrangements.

6.4 Specific management objectives, activities, timing and performance criteria

Table 12 summarises specific management objectives, activities, timing and performance criteria for the implementation of this BBAMP. It can be used for monitoring and reporting on the implementation of this plan in annual reports.

Table 11 Examples of supplementary mitigation measures in the event of an unacceptable impact occurring

Hypothetical cause of impact	Mitigation Measure[3]	Likelihood of impact continuing following mitigation	Time to implementation	Responsibility
Foraging source identified that attracts threatened species and "at risk" species to impact areas	Consider the use of acoustics (ie. loud music/irregular noise) to discourage birds from foraging in this location where such noise would not impact neighbours	Low	Implement as soon as possible.	CRWF Pty Ltd – the Proponent
	Encourage species into alternative areas outside of the wind farm boundary, where available, through the use of social attraction techniques offsite (decoys and audio playback systems)		Implement according to agreed plan	CRWF Pty Ltd – the Proponent
Wind/rain/fog causing low visibility	If low visibility at the site is identified as an issue, carcass searches may be repeated during periods of low visibility to measure mortality rates. Temporary shutdown of those turbines found to cause the problem may be necessary during periods of extreme low visibility – to be implemented only if threatened species are experiencing unacceptable impacts.	Low	Immediately low visibility is identified as the cause of unacceptable impacts on threatened species.	BBAMP monitoring specialist
Attraction to lights on the wind farm site	Avoid high intensity lighting within the wind farm site (e.g. use of light hoods) or switch off lighting temporarily while species is on or near the wind farm site. Alternative measures include: • Synchronise any flashing lights, • Use red rather than white or yellow lights, • Remove lights, where practicable or • All lights switched off except when needed for service work	Low	If lights can be switched off, this will occur immediately. Alternative measures will be implemented as soon as practicable after recording the impact trigger.	CRWF Pty Ltd – the Proponent

[3] Note that the mitigation measures in this table are examples of what may be possible. Ultimately, the chosen mitigation measure will be identified as part of the impact-trigger investigations shown in Figures 5 and 6, and may not include any of these examples if they are not relevant.

Hypothetical cause of impact	Mitigation Measure[3]	Likelihood of impact continuing following mitigation	Time to implementation	Responsibility
Nest site close to turbine	Discourage raptor nesting close to turbines. If confirmed raptor nesting occurs within 200 meters, allow the breeding attempt to finish, then consider relocation or removal during the non-breeding season, unless inconsistent with project approvals, and upon consultation with CPHR.	Low	Prior to breeding season.	CRWF Pty Ltd – the Proponent

Table 12 Specific management objectives, activities, timing and performance criteria

Management objectives	Management activities and controls	Timing	Performance criteria for measuring success of methods	Completed (yes/no)
Baseline surveys	Obtaining pre-construction baseline bird and bat utilisation data	Operational phase Bird survey	• Bird utilisation surveys (point count and transect surveys) undertaken as described in this BBAMP • Bat utilisation surveys not considered necessary	
	Obtaining operational phase bird and bat mortality data	Operational phase	• As per results of the mortality monitoring in this BBAMP.	
Mortality monitoring	37 turbines to be surveyed one month seasonally to 60 metres. The turbines will be searched for a period of 12 months, following which the need for further surveys will be reviewed based on the results of the annual monitoring report.	Operational phase monthly until end of 12 months	• Operational phase mortality surveys undertaken one month seasonally at 37 turbines for at 12 months, with a review after the annual report to determine if a change in the methodology is required.	
	Calculating annual mortality of birds and bats per turbine based on operational phase repetition of monitoring activities. Mortality estimates will include correction factors from scavenger and detector efficiency trials.	Operational phase at the end of the first two years of mortality monitoring	• Scavenger and detector efficiency trials undertaken • Estimates of mortality for birds and bats made after two years of monitoring	
Annual Reports	Preparation of Annual Reports to be submitted to Secretary of DPHI, Cth DCCEEW and CPHR after the completion of a year's monitoring activities.	Operational phase– annually for the first five years and every two years thereafter	• Annual reports delivered within three months of completion of yearly monitoring. • Annual reports to include (but not be limited to) results of monitoring surveys for that year, any impact triggers or unacceptable impacts identified, mitigation measures implemented, application of the decision-making framework and recommendations for the following year. • Further annual reports upon agreement	

Management objectives	Management activities and controls	Timing	Performance criteria for measuring success of methods	Completed (yes/no)
Mitigation measures to reduce risk	Carrion removal program - stock and kangaroo carcasses will be removed from within 200 metres of wind turbines on a monthly basis and disposed of.	During operation	• Carcasses removed • Activity recorded in monthly inspection record • Increase frequency of stock and kangaroo carcass removal and disposal if required	
	Subject to landowner agreement, restrict lambing to paddocks at least 200m from turbines.		• No increase in raptor mortality during lambing season	
	Subject to landowner agreement, stock will not be fed grain underneath turbines		• No increase in bird mortality due to grain underneath turbines	
Mitigation measures to reduce risk	Pest control program - Implement rabbit control if the carrion removal program suggests rabbit carcasses are an issue, subject to landowner agreement	During operation	• Monitor effectiveness of rabbit control and, where bird mortality is clearly related to rabbit numbers, increase the effectiveness of rabbit control	
	Minimising external lighting. If required. There are only low levels of lighting on the wind farm during operation.	During operation	Protection of offset site located in woodland habitat.	
	Minimize and shield permanent lights on buildings and sub-stations to avoid 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, aviation safety and OH&S limitations.	
	Baffle security lighting to avoid light spillage and visibility from above.			
	Use of deterrents – Where required, overhead powerlines will have marker balls and/or flags where they cross waterways		No incidental records of bird mortality from power line collision around waterways.	

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Appendix A Carcass search datasheet

CRUDINE RIDGE 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 **Do not move a carcass until the details below have been completed**				
Crudine Range WF				
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 (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 (ie. sex/age of bird):				
Post Find Actions: 1. Place carcass in sealable plastic bag then wrap it in newspaper and take to freezer at site office.				
* One form should be completed for each carcass found				
** Please attach photo to this form				

Appendix B Threatened Bird and Bat Species likelihood of occurrence at the Crudine Ridge Wind Farm

Common Name	Scientific Name	BC Act	EPBC Act	Habitat	Number of records**	Likelihood of occurrence
Australasian Bittern	*Botaurus poiciloptilus*	E	E	Densely vegetated freshwater wetlands of south-eastern and south-western Australia, including the Riverina of NSW (Marchant & Higgins 1990; OEH 2017b).	0	No suitable habitat on site - unlikely to occur.
Australian Painted Snipe	*Rostratula australis*	E	CE	Generally inhabits shallow terrestrial freshwater wetlands, including temporary and permanent lakes, swamps and claypans. They also use inundated or waterlogged grassland or saltmarsh, dams, rice crops, sewage farms and bore drains. Typical sites include those with rank emergent tussocks of grass, sedges, rushes or reeds, or samphire; often with scattered clumps of lignum Muehlenbeckia or canegrass or sometimes tea-tree (Melaleuca). Sometimes utilises areas that are lined with trees, or that have some scattered fallen or washed-up timber.	0	No suitable habitat on site - unlikely to occur.
Barking Owl	*Ninox conniven s*	V		Eucalyptus dominated forests and woodlands, commonly near water-bodies, such as streams and rivers, and requires hollow trees for nesting and trees with dense foliage for roosting (Higgins 1999).	2	Suitable dry woodland and forest habitat on site. Potential to occur.
Black Falcon	*Falco subniger*	V		Occurs across the open plains of eastern and northern Austraila – in NSW mainly west of the Great Divide (Marchant and Higgins 1993). Avoids forest.	1	No suitable habitat on site - unlikely to occur.
Black- breasted Buzzard	*Hamirostra melanosternon*	V		Occurs across the open plains and savannas of inland and northern Australia; in NSW almost exclusively west of the Great Divide (Marchant and Higgins 1993). Avoids forest.	1	No suitable habitat on site - unlikely to occur.

Common Name	Scientific Name	BC Act	EPBC Act	Habitat	Number of records**	Likelihood of occurrence
Black- chinned Honeyeater (eastern subspecies)	*Melithreptus gularis gularis*	V		Typically occurs in open forests and woodlands dominated by box and ironbark eucalypts (Higgins et al 2001).	1	Suitable dry woodland and forest habitat on site. Potential to occur.
Black-faced Monarch	*Monarcha melanopsis*		M (Bonn)	Rainforests, eucalypt woodlands, coastal scrub and damp gullies (Higgins et al. 2006).	0	No suitable habitat on site - unlikely to occur.
Brown Treecreeper (eastern subspecies)	*Climacteris picumnus victoriae*	V	V	Woodlands dominated by eucalyptus, especially Stringybarks or other rough- barked eucalypts usually with open grassy understorey (Higgins et al. 2001)	9	Suitable dry woodland and forest habitat on site. Recorded on site.
Curlew Sandpiper	*Calidris ferruginea*	E	CE	Intertidal mudflats and shorelines of freshwater wetlands, mainly coastal (Higgins and Davies 1996).	0	No suitable habitat on site - unlikely to occur.
Diamond Firetail	*Stagonopleura guttata*	V	V	Commonly found in box-ironbark forests and woodlands and also occurs along watercourses and in farmland areas. Widespread but scattered. Populations had declined in Victoria since the 1950s. (Emison et al. 1987; Tzaros 2005).	5	Suitable dry woodland and forest habitat on site. Recorded on site.
Eastern Curlew	*Numenius madagascariensis*		CE	Intertidal mudflats and shorelines of freshwater wetlands, mainly coastal (Higgins and Davies 1996).	0	No suitable habitat on site - unlikely to occur.
Fork-tailed Swift	*Apus pacificus*		M (CAMBA, JAMBA, ROKAMBA)	The species can occur in wet sclerophyll forest but mainly prefers open forest or plains. It is almost exclusively aerial and feeds up to hundreds on metres above the ground, but can feed among open forest canopy. The species breeds internationally and seldom roosts in trees and is unlikely to be impacted by the development (Higgins et al 2006).	0	Suitable habitat on site - potential to occur.
Gang-gang Cockatoo	*Callocephalon fimbriatum*	E	E	Breed in tall wet forest of Great Divide or coast; in autumn and winter disperse to lower, drier areas (Higgins 1999; OEH 2017b).	2	Suitable habitat on site - potential to occur.
Glossy Black-Cockatoo	*Calyptorhynchus lathami*	V	V	The species is dependent on Allocasuarina; prefer woodlands dominated with allocasuarina or open eucalypt forests with middle stratum of allocasuarina (Higgins 1999).	1	Suitable habitat on site - potential to occur.

Common Name	Scientific Name	BC Act	EPBC Act	Habitat	Number of records**	Likelihood of occurrence
Hooded Robin (south- eastern form)	*Melanodryas cucullata cucullata*	E	E	Occur mostly in open Grey Box, White Box, Yellow Box, Yellow Gum and Ironbark woodlands with pockets of saplings or taller shrubs, an open shrubby understorey, sparse grasses and patches of bare ground and leaf-litter, with scattered fallen timber. The population has declined throughout range, especially since the early 1980s. This species typically occurs north of the great divide in shrubland or woodland dominated by acacias. (Higgins and Peter 2002; Tzaros 2005).	1	Suitable dry woodland and forest habitat on site. Recorded on site.
Latham's Snipe	*Gallinago hardwickii*		M (CAMB A, JAMB A, ROKA MBA)	Occurs in wide variety of permanent and ephemeral wetlands; it prefers open freshwater wetlands with dense cover nearby, such as the edges of rivers and creeks, bogs, swamps, waterholes. The species is wide spread in southeast Australia and most of its population occurs in Vic. Except in the northwest of the state (Naarding 1983; Higgins and Davies 1996).	0	No suitable habitat on site - unlikely to occur.
Little Eagle	*Hieraaetus morphnoides*	V		Over wooded and forested lands and open country of Aust. Range extending into arid zone. Most abundant in open forest and woodland.	2	Suitable habitat on site - potential to occur.
Little Lorikeet	*Glossopsitta pusilla*	V		Mainly dry, open sclerophyll forests and woodlands, usually dominated by Eucalyptus. Often near waterbodies such as creeks, lakes and swamps.	0	Suitable dry woodland and forest habitat on site. Recorded on site.
Malleefowl	*Leipoa ocellata*	E	V	Mallee woodlands of southern Australia including NSW west of the Great Divide (OEH 2017b).	0	No suitable habitat on site - unlikely to occur.
Painted Honeyeater	*Grantiella picta*	V	V	Inhabits box-ironbark forests and woodlands and mainly feeds on the fruits of mistletoe. Strongly associated with mistletoe around the margins of open forests and woodlands. Occurs at few localities. Uncommon breeding migrant from further north, arriving in October and leaving in February. (Higgins et al. 2001; Tzaros 2005).	1	Suitable habitat on site - potential to occur.
Powerful Owl	*Ninox strenua*	V		Open and tall wet sclerophyll forests with sheltered gullies and old growth forest with dense understorey. They are also found in dry forests with box and	1	Suitable habitat on site - potential to occur.

Common Name	Scientific Name	BC Act	EPBC Act	Habitat	Number of records**	Likelihood of occurrence
				ironbark eucalypts and River Red Gum. Large old trees with hollows are required by this species for nesting. In Victoria, the Powerful Owl is widespread, having been recorded from most of the state. However, throughout its range it is uncommon and occurs in low densities. (Higgins 1999; Soderquist et al. 2002).		
Regent Honeyeater	*Anthochaera phrygia*	CE	CE	Inhabits dry box-ironbark eucalypt forests near rivers and creeks on inland slopes of the Great Dividing Range. It could also occur in small remnant patches or in mature trees in farmland or partly cleared agricultural land (Higgins et al. 2001). Records from search region.	8	Suitable habitat on site - potential tooccur.
Rufous Fantail	*Rhipidura rufifrons*		M (Bonn)	Primarily found in dense, moist habitats. Less often present in dry sclerophyll forests and woodlands (Higgins et al. 2006).	0	No suitable habitat - unlikely to occur.
Satin Flycatcher	*Myiagra cyanoleuca*		M (Bonn)	Tall forests and woodlands in wetter habitats but not in rainforest (Higgins et al. 2006)	0	No suitable habitat - Potential to occur.
Scarlet Robin	*Petroica boodang*	V		Eucalypt woodlands forest with open understorey (Higgins and Peter 2002).	6	Suitable open woodland and forest habitat on site. Recorded on site.
Speckled Warbler	*Chthonicola sagittata*	V		Inhabits dry eucalypt forests and woodlands, especially those with box-ironbark eucalypt associations. It is also found in River Red Gum woodlands. The species is uncommon; populations have declined since the 1980s. (Higgins and Peter 2002; Tzaros 2005).	9	Suitable habitat on site. Recorded on site.
Spotted Harrier	*Circus assimilis*	V		It prefers open woodlands that do not obstruct low flight, and natural and exotic grasslands in arid and semi arid areas (Higgins and Davies 1996).	0	Suitable habitat on site - potential to occur.
Superb Parrot	*Polytelis swainsonii*	V	V	Inhabit riverine woodlands (eucalypt and cypress pine), foothills and nearby farmland; population south		Wind farm site appears to be outside area of

Common Name	Scientific Name	BC Act	EPBC Act	Habitat	Number of records**	Likelihood of occurrence
				of Yass area migrate north in autumn and winter to northern New South Wales.		migration; no records for search region; unlikely to occur regularly
Swift Parrot	*Lathamus discolor*	E	CE	Prefers a narrow range of eucalypts in NSW, including White Box, Red Ironbark, Mugga Ironbark, Grey Box and Yellow Gum as well as River Red Gum when this species supports abundant 'lerp'. Breeds in Tasmania and migrates to the mainland of Australia for the autumn, winter and early spring months. It lives mostly north of the Great Dividing Range (Emison et al. 1987; Higgins 1999; Kennedy and Tzaros 2005).	0	Suitable habitat on site - potential to occur.
Varied Sittella	*Daphoenositta chrysoptera*	V		Eucalypt woodland and forest with a shrubby and/or grassy understorey (Higgins and Peter 2002).	0	Suitable habitat on site - potential to occur.
White- throated Needletail	*Hirundapus caudacutus*	V	M (CAMBA, JAMBA, ROCAMBA)	Aerial, over all habitats, but probably more over wooded areas, including open forest and rainforest. Often over heathland and less often above treeless areas such as grassland and swamps or farmland (Higgins 1999).	1	Suitable habitat on site - potential to occur.
Yellow Wagtail	*Motacilla flava*		M (CAMBA, JAMBA, ROCAMBA)	Extremely uncommon migrant. Few sightings in Victoria. Mostly occurs in well- watered open grasslands on the fringes of wetlands. Roosts in mangroves and other dense vegetation (DotE 2015).	0	No suitable habitat - unlikely to occur.
Corben's Long-eared Bat	*Nyctophilus corbeni*	V	V	Dry woodland and shrubland communities in semi-arid regions (Menkhorst 1995; OEH 2017b).	9	Suitable habitat on site - potential to occur and possibly recorded on site by ultrasound recording (ELA 2012).
Eastern Bentwing Bat	*Miniopterus schreibersii oceanensis*	V		Roosts in caves during the day, dispersing over a range of habitats at night. Its feeding areas tend to be associated with major drainage systems (Menkhorst	9	Suitable habitat on site. Recorded on site.

Common Name	Scientific Name	BC Act	EPBC Act	Habitat	Number of records**	Likelihood of occurrence
				1995).		
Eastern Cave Bat	*Vespadelus troughtoni*	V		Tropical mixed woodland and wet sclerophyll forest on the coast and the dividing range but extend into drier forest of the western slopes and inland areas (Churchill 2008).	0	Suitable habitat on site. Recorded on site.
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*	V		Sclerophyll forests from the Great Dividing Range to the coast, prefer wet habitats where trees are greater than 20 metres high (Churchill 2008).	1	Habitat on site may be too dry for this species. Potential to occur.
Grey- headed Flying-fox	*Pteropus poliocephalus*	V	V	Brisbane, Newcastle, Sydney and Melbourne are occupied continuously. Elsewhere, during spring, they are uncommon south of Nowra and widespread in other areas of their range. Roosts in aggregations of various sizes on exposed branches. Roost sites are typically located near water, such as lakes, rivers or the coast. Roost vegetation includes rainforest patches, stands of Melaleuca, mangroves and riparian vegetation, but colonies also use highly modified vegetation in urban and suburban.	0	No breeding sites in the study area - unlikely to occur.
Large- eared Pied Bat	*Chalinolobus dwyeri*	E	E	Dry sclerophyll woodland and forest and also occur in sub-alpine woodland, the edge of rainforest and wet sclerophyll forest (Churchill 2008).	0	Outside its normal distribution range - unlikely to occur.
Little Pied Bat	*Chalinolobus picatus*	V		Mainly occur on the plains of the Murray-Darling basin in dry forests, woodlands and chenopod shrubland (Churchill 2008; OEH 2017b).	0	Probably Recorded on site by ultrasound recording ELA 2012).
Yellow- bellied Sheathtail Bat	***Saccolaimus flaviventris***	**V**		**Known to occur from urban, agricultural semi-arid and tall wet forest habitats (Menkhorst 1995).**		**Suitable habitat on site. Recorded on site.**

Appendix C Turbine selection ‘stratified random’ sampling design

During the first two years of bird and bat carcass monitoring, turbines were selected based on the rules of ‘stratified random’ sampling design.

- Each turbine within a stratum has an equal chance of being selected for the searches (selected by random number generation table);
- No stratum can have less than three turbines; and
- Once the turbines have been selected, the selection will not change.

The results from each stratum will be analysed separately to establish if there are differences in estimated mortality between them. They will then be combined for a whole-of-wind-farm mortality estimate using appropriate statistical methods for stratified estimates with constant selection probabilities within strata.

Each stratum will be defined by its location, proximity to forest, ridges. Landforms that are potentially “high risk” should be included in the process above. Fifty percent of the turbines from each stratum will be chosen. This will ensure that the total mortality estimate for the wind farm will not be biased by turbine strata that are over or under represented.

In addition, to ensure a valid dataset for statistical analysis, the mortality detection search will be based on 19 turbines (representing over 50% of the turbines at the CRWF), the strata will be split into along the Ridge in two clusters known as Sallys Flat and Pyramul and operational areas of CRWF (with turbines randomly selected from these clusters– comprising the two chains of ridges).

The number of turbines searched has been determined based on what will provide the most accurate mortality rate given the high variability in detected carcasses shown on other wind farms, and that humans will have search limits (e.g. OH&S). Each turbine that is selected for the searches will have the following recorded:

- Location (easting, northing)
- Distance to nearest turbine
- Identification number of nearest turbine
- Local vegetation (type, height, and density during each search to document change in vegetation cover over time)
- Distance to key habitat feature, such as dam/wetland or waterway, or woodland remnant.

Appendix D Additional procedures for scavenger trials

- The scavenger trials will be set up by the approved qualified ecologist, with searches being undertaken by the trained searcher.
- The timing of searches is based on experience and regulatory approval at a number of other wind farms (BL&A unpublished records) where scavenger trials have been undertaken that show almost all carcasses have been scavenged within five to ten days. More frequent monitoring than that proposed herein will not significantly affect consideration of scavenging and its impact on mortality estimates.
- A mix of small and medium to very large bird and bat carcasses (if available) will be obtained for use in the scavenger trial. Where carcasses of the species of concern cannot be found, a similar-sized and coloured substitute will be used to reduce bias by visual predators.
- Latex gloves will be worn at all times 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 100 metre search area, depending on the search protocol for that turbine. 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 trial 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.

Conduct of two scavenger trials in different seasons is designed to account for occasional winter/spring increase 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 little but 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. 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.

Scavenger trials for large raptors was conducted once per 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 large carcases and a high level of detectability that is consistent across the year.

Appendix E Additional considerations for detectability trials

Analysis indicates that there is a large confidence interval on the estimate of searcher efficiency, even for a high number of trials (plus or minus ten percent 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), using a number of carcasses that is logistically manageable and aligned with the number and timing of scavenger trials. Statistical confidence analysis indicates that this will result in a reasonably precise detectability estimate after one year, and optimal precision after two.

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

If sufficient carcasses cannot be obtained, then stuffed, realistic-looking artificial substitutes can be used. As humans are entirely visual searchers, it is not essential to use real carcasses as long as the substitutes appear similar once on the ground. Additionally, the artificial substitutes will not attract scavengers and should not increase the likelihood of raptor collisions or the number of scavengers on the site. As these trials can be undertaken separately from scavenger trials, artificial substitutes may be ideal (i.e. mice substituted for bats). Note, however, that it is considered to be more time efficient and cost effective to undertake scavenger and detectability (observer) trials concurrently.

The detectability trial will be initiated and set up by the ecologist, who will also train a separate person (the ‘carcass controller’) to run detectability trials. 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.

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