CROOKWELL 2 WIND FARM

BIRD AND BAT ADAPTIVE MANAGEMENT PLAN

Crookwell Development Pty Ltd

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CONTENTS

TABLES

FIGURES

APPENDICES

1. INTRODUCTION

1.1. Background

Development consent was originally granted in June 2005 for the Crookwell 2 Wind Farm (C2WF) with up to 46 wind turbines and associated infrastructure (DA 176-8-2004-i) – a wind farm located across a 2,088-hectare area centred 14km south-east of Crookwell township in the Southern Tablelands of New South Wales. In 2008, approval was sought (Mod-1) to modify the development consent by substituting larger turbines for those previously approved, relocating 20 of the 46 turbines and providing an alternate access road via Woodhouselee Road. This modification to the development consent was subsequently approved in July 2009. Given subsequent further developments in wind turbine technology, Crookwell Development Pty Ltd — the proponent for the C2WF — now seek approval to modify the Mod-1 development consent by further increasing the size of the proposed wind turbines. The revised proposal (Mod-2) also includes a reduction in the total number of turbines from 46 to 32, along with re-alignment of the access tracks and cabling to service the remaining turbines.

As part of the approval process for the proposed Mod-2, the Office of Environment and Heritage (OEH) requested in a letter to Crookwell Development Pty Ltd dated 14 November 2016 that a Bird and Bat Adaptive Management Plan (BBAMP) be developed in accordance with Condition 84 of the Development Consent. Crookwell Development Pty Ltd first commissioned Brett Lane & Associates Pty Ltd to develop this BBAMP following pre-construction Bird Utilisation Surveys which were undertaken in February and November 2017 at the site.

It is important to note that while the Bird Utilisation Surveys that inform this plan were undertaken for a broader survey area including the area of Crookwell 2 Wind Farm (C2WF) as well as the proposed Crookwell 3 Wind Farm (C3WF), only Crookwell 2 Wind Farm (C2WF) is subject to this BBAMP. Boundaries of C2WF and C3WF are shown in Figure 1.

1.2. Requirements of BBAMP

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

1.2.1. NSW state provisions

"Bird and Bat Monitoring and Management

84. *Bird and Bat Adaptive Management Program must be prepared and undertaken, which takes account of bird/bat monitoring methods identified in the current editions of AusWEA Best Practice Guidelines for the Implementation of Wind Energy Projects in Australia and Assessing the Impacts of Wind farms on Birds - Protocols and Data Set Standards. The Program must be undertaken by a suitably qualified expert, approved by the Director General.*

The Program must incorporate ***Monitoring, and a Decision Matrix*** *that clearly sets out how the Proponent will respond to the outcomes of monitoring. It must:*

- ***(a)*** *Incorporate an ongoing role for the suitably qualified expert;*
- ***(b)*** *Set out monitoring requirements. The requirements must account for natural and human changes to the surrounding environment that might*

influence bird and/or bat behaviour such as changes in land use practices, and significant changes in water levels in nearby water bodies;

(c) Incorporate a decision making framework that sets out specific actions and when it may be required to reduce identified impacts on bird and bats;

(d) Set out available mitigation measures;

(e) Incorporate reporting requirements on the outcomes of monitoring, on the application of the decision making framework, the need for mitigation measures, progress with implementation of such measures, and their success. Reports must be prepared on an annual basis, from the commencement of operation, and must be prepared within 2 months of the end of the reporting period and be provided to the Director General. The Director General may vary the reporting requirement or period by notice in writing to the Applicant;

(f) Identify any necessary mitigation measures and implementation strategy including, but not limited to, those referred in Condition 82.

The Applicant is required to implement reasonable and feasible mitigation measures where the need for further action is identified through the Bird and Bat Adaptive Management Program.

This BBAMP has been developed to fulfil the requirements of Condition 84 of the Project Approval and subject to approval by Department of Planning and Environment (DPE) it will be implemented during the development and initial operation of the C2WF.

1.2.2. Compliance Summary

Table 1 sets out which sections of this BBAMP addresses the specific requirements of Condition 84 of the 2005 NSW approval.

Table 1: Sections within the BBAMP that respond to Condition of Consent 84 for C2WF

Condition number	Abbreviated condition details	BBAMP Section/s
84 (a)	*Include at least 12 months of current (or updated) baseline data on threatened and 'at risk' bird and bat species and populations in the locality that could potentially be affected by the development, including updated surveys for raptors and baseline mapping of any raptor nests identified on the site.*	4
84 (b)	*Incorporate an ongoing role for the suitably qualified expert.*	1.1
84 (c)	*Set out monitoring requirements. The requirements must account for natural and human changes to the surrounding environment that might influence bird and/or bat behaviour such as changes in land use practices, and significant changes in water levels in nearby water bodies.*	4.1 to 4.6
84 (d)	*Incorporate a decision making framework that sets out specific actions and when it may be required to reduce identified impacts on bird and bat.*	6
84 (e)	*Set out available mitigation measures.*	5, 6.3

84 (f)	*Incorporate reporting requirements on the outcomes of monitoring, on the application of the decision making framework, the need for mitigation measures, progress with implementation of such measures, and their success. Reports must be prepared on an annual basis, from the commencement of operation, and must be prepared within 2 months of the end of the reporting period and be provided to the Secretary. The Secretary may vary the reporting requirement or period by notice in writing to the Applicant.*	4.7, 6.4
84 (g)	*Identify any necessary mitigation measures and implementation strategy including, but not limited to, those referred in Condition 83.*	5, 6.3, 6.4

1.3. BBAMP Objectives

The overall aim of this BBAMP is to provide a program for monitoring the impacts on birds and bats from the C2WF and an overall strategy for managing and mitigating any significant bird and bat impacts arising from the operation of C2WF.

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 (CEC 2013).

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 changes to the population of at-risk birds and/ or bats that can reasonably be attributed to the operation of the project, including pre- and post-construction (operational phase) presence;
- To directly record impacts on birds and bats through carcass surveys;
- 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 (WTE), and include monthly mortality assessments, periodic local population censuses and bird utilisation surveys (BUS);
- To detail specific and potential mitigation measures and related implementation strategies to reduce 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 and their success.

The strategy employed is 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

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

- 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. The expert approved by the Secretary of the DPE will be in charge of the design of monitoring, as well as training of personnel, data analysis, interpretation, formulating adaptive management measures and reporting.

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. At the time of writing, BL&A has prepared and/or implemented approved management plans for White Rock, Cullerin, Gullen Range, Taralga, Capital I and Woodlawn wind farms in NSW (BL&A 2011a & c, 2014, 2016), and Bald Hills, Macarthur, Berrybank, Crowlands, Hawkesdale, Lal Lal, Mt Gellibrand, Mt Mercer, Mortlake South and Ryan's Corner wind farms in Victoria (BL&A 2009, 2011b, 2012a-d, 2013a-c).

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. This BBAMP has incorporated learning and experience from past plans and incorporates the latest approaches to monitoring wind farm impacts on birds and bats.

In order to ensure the efficacy of this adaptive management plan, all activities undertaken will be subject to regular review and reporting by the suitably qualified expert who is approved by the DPE.

1.4. Site Description

C2WF is located across a 2,088-hectare area centred 14 km south-east of Crookwell in the Southern Tablelands of New South Wales. C2WF (Mod-2) comprises 32 wind turbines and associated infrastructure (Figure 1).

It lies on a series of higher ridges that have been used for decades for sheep and cattle grazing. The majority of the area has been either completely or mostly cleared of its original native vegetation. As a consequence of the long grazing history, this vegetation lacks a diverse understorey and indigenous ground cover and introduced pasture grasses have come to dominate the ground cover.

Exotic grassland (improved pasture) dominates the study area, with small patches of native vegetation on and adjacent to the site. Large patches of woodland habitat occurred mostly outside the wind farm boundary. A few smaller patches were scattered throughout the site, mostly in the north and west. Much of the area has been subject to past clearing. Consequently, many of the trees present are of a comparatively young age, or are of a 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 canopy-dwelling honeyeaters and insectivores dominating. Low bird diversity and abundance reflected the lack of extensive treed habitat within and surrounding the wind farm site. 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 Plan.

No major waterbird habitat occurs on the wind farm site or in the locality. As water storages, Pejar Dam, Lake Pejar and Lake Edward do not provide suitable habitat for a wide diversity or high abundance of waterbirds and shorebirds that typically require gentle sloping shorelines, substantial areas of fringing vegetation and mudflats for feeding (URS 2004a).

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 in the wooded slopes in the southern and north-western parts of the site.

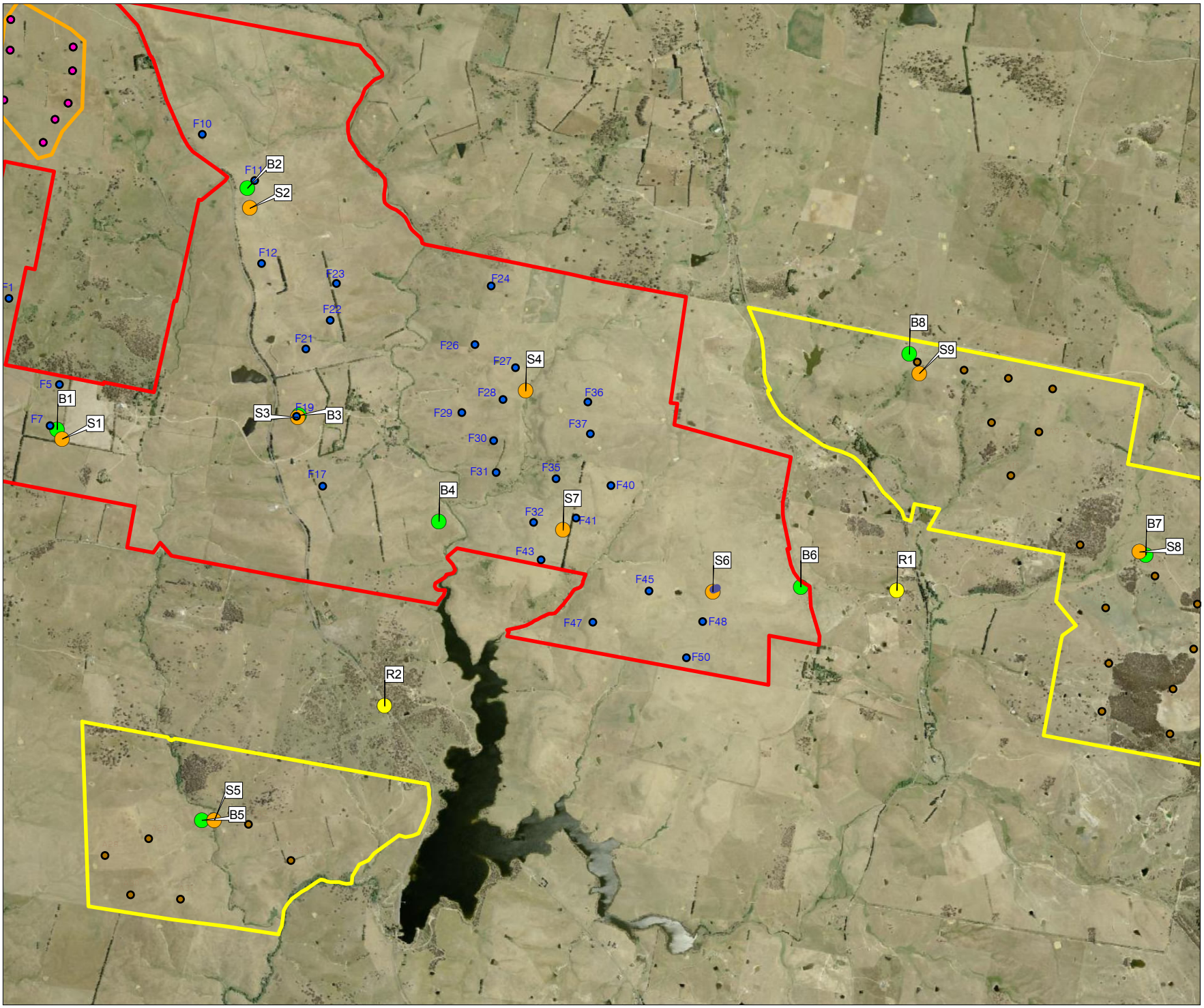

Figure 1: BUS and bat survey sites

Project: Crookwell 2 and 3 Windfarm
Client: Crookwell Development Pty Ltd
Date: 3/08/2018

Legend

- Site Boundary - Crookwell 1 (Existing)
- Site Boundary - Crookwell 2
- Site Boundary - Crookwell 3
- BUS locations (Impact Sites)
- BUS locations (Reference Sites)
- BAT recording site
- Crookwell 1 Existing Turbines
- Crookwell 2 Approved Turbines to be upgraded
- Crookwell 3 Proposed Turbines Pending Approval

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1.5. Pre-construction investigations of birds and bats

Pre-construction bird and bat utilisation surveys were undertaken in late summer and spring 2017 across a broad survey area that included the area of Crookwell 2 Wind Farm (C2WF) as well as the proposed Crookwell 3 Wind Farm (C3WF). The methods and results of these investigations are summarised in Section 2.

Only Crookwell 2 Wind Farm (C2WF) is subject to this BBAMP.

1.6. Additional information

This BBAMP was prepared by a team from Brett Lane & Associates Pty Ltd including; Teisha Lay (Zoologist), Peter Lansley (Zoologist), Khalid Al-Dabbagh (Zoologist), Bernard O'Callaghan (Senior Ecologist and Project Manager), Alan Brennan (Senior Ecologist and Project Manager) and Brett Lane (Principal Consultant).

2. PRE-CONSTRUCTION BIRD AND BAT INFORMATION

The results of investigations outlined in Section 1.5 above are summarised in this section of the BBAMP. This information has informed the risk assessment in Section 3.

2.1. Bird utilisation surveys

Bird utilisation surveys (BUS) were undertaken within the C2WF during two seasons: in February (summer) and November (spring) 2017. These surveys used a fixed-point bird count method to collect bird utilisation data at numerous sites for 15-minute intervals. Full details of the methodology used for the BUS at C2WF are detailed in the *Crookwell 2 & 3 Wind Farms Bird and Bat Utilisation Surveys Report* (BL&A 2018).

A summary of the results of both the February and November 2017 bird utilisation surveys are provided in Table 2.

Table 2: Summary of Bird Utilisation Survey (BUS) results – February and November 2017

Bird Utilisation Survey (BUS)	Feb 2017	Nov 2017
No. of bird species recorded at the windfarm	78	73
No. of bird species recorded during the formal BUS (as a % of all birds recorded)	55 (70%)	65 (89%)
Total no. of bird counts (individual flights) at impact sites	2567	2041
Range of bird density at impact sites (No. of birds/ha/hour)	6.9 - 18.5	8.0 - 16.4
% of all birds counted at RSA height (including reference sites)	7%	14.42%
% of bird observations at RSA height at impact sites only	5.10%	16%
No. of raptor species recorded at the wind farm	4	7
No. of raptor species recorded during the formal BUS	4	6
% of raptor observations at RSA height (impact sites only)	46%	72%
% of raptors recorded at RSA height / all birds recorded (impact sites only)	<1%	<1%
No. of threatened birds recorded at the wind farm	1	3
No. of threatened birds recorded during the formal BUS	1	2

The species diversity compared well with other wind farms in the area (e.g. Gullen Range WF) and constituted mainly of a combination of birds of open grasslands/stock grazing paddocks and some woodland birds.

Of the species recorded, Common Starlings made up the largest number of bird flights counted on the impact sites across both surveys.

The five most common birds recorded at the impacts sites in February 2017 were:

- Common Starling (15.8%);
- Raven spp. (12.0%);
- Australian Magpie (12.0%);
- Yellow-rumped Thornbill (9.0%); and
- Crimson Rosella (8.1%).

The five most common birds recorded at the impacts sites in November 2017 were:

- Common Starling (30%);
- Little Raven (14.5%);
- Australian Magpie (7.6%);
- Galah (4.3%); and
- Australian Raven (3.8%).

Of the species recorded at turbine sites in the February 2017 BUS, 13 species were seen flying at Rotor Swept Area (RSA). Of all bird flights observed at turbine sites during the February 2017 BUS, only 5.1% (132/2567 flights) were at RSA height.

Of the species recorded at turbine sites in the November 2017 BUS, 24 species were seen flying at Rotor Swept Area (RSA). Of all bird flights observed at turbine sites during the November 2017 BUS, 16% (325/2041 flights) were at RSA height.

Raptors

During the February 2017 BUS four raptors were recorded including:

- Brown Falcon;
- Nankeen Kestrel;
- Wedge-tailed Eagle; and
- Australian Hobby.

During the November 2017 BUS seven raptors were recorded including:

- Brown Falcon;
- Brown Goshawk;
- Nankeen Kestrel;
- Peregrine Falcon;
- Swamp Harrier;
- Wedge-tailed Eagle; and
- Whistling Kite.

Brown Falcon and Nankeen Kestrel were found to be the most abundant raptor species at C2WF based on the results of both the February and November 2017 BUS. Resident pairs were also observed flying throughout the wind farm. Wedge-tailed Eagles were also observed, however, their utilisation rate of the wind farm across all heights was low. Overall, the number of raptors was low in relation to the total number of birds recorded during the BUS (<1% during both February and November 2017). However, the percentage of raptors at RSA compared to all birds recorded at RSA height was high (46% in February 2017 and 72% in November 2017). This is a not an uncommon finding, compared to other wind farms.

Waterbirds

Seven waterbird species were recorded during the February 2017 BUS and eight waterbirds were recorded in the November 2017 BUS. Of these, the most common across both surveys was Australian Wood Duck, a very common farmland waterbird. A full list of the waterbirds recorded is provided in BL&A (2018). All were considered common waterbirds.

Threatened bird species

Most birds found to utilise the wind farm site were common birds.

Of the species recorded during the February 2017 BUS, one species listed under the NSW *Biodiversity Conservation Act 2016*, (formerly TSC Act 1995) was recorded:

- Varied Sittella

All records of Varied Sittella in February 2017 BUS were below RSA height.

Three species listed under the NSW *Biodiversity Conservation Act 2016* were recorded during the November 2017 BUS:

- Dusky Woodswallow;
- Varied Sittella; and
- Diamond Firetail.

During the November 2017 BUS, 90% of these species counts were recorded below RSA height.

2.2. Bat utilisation studies

These surveys used bat detectors to record bat calls at nine fixed locations across C2WF and C3WF. Of the nine sites surveyed, the site at the wind mast was set up for simultaneous recordings of bats: one at 50 metres height and one at ground level.

Bat surveys were undertaken within the C2WF in two seasons: in autumn (March to April 2017) to coincide with the autumn migration period of the threatened Eastern Bentwing Bat (EBB), and then in spring-summer (27th November and 5th December 2017) to again coincide with the EBB spring-summer migration. This timing was determined in consultation with Dr Doug Mills of the OEH (Queanbeyan office). Dr Mills has been closely monitoring EBB migration and breeding at the Wee Jasper and Drum caves in NSW (the nearest known maternity caves to the wind farm site). The bat survey comprised a significant effort during the migration period of the EBB — the time when this species is most likely to be present on the wind farm site.

The autumn 2017 bat survey comprised the use of 10 bat detectors, including eight Songmeters (at Sites 1 to 7) and two Anabats (at Sites 8 and 9).

The spring-summer 2017 bat survey comprised the use of 10 SongMeters. SM2s were used at Sites 1 to 4. SM4s were used at Sites 6 to 10.

During the spring-summer survey, four sites produced an acceptable number of records deemed suitable for analysis. Full details of the methodology used for the bat surveys are detailed in the *Crookwell 2 & 3 Wind Farms Bird and Bat Utilisation Surveys Report* (BL&A 2018).

A summary of the results of the autumn and spring-summer 2017 bat surveys are provided separately below.

Autumn 2017 bat survey results summary

- Ten bat species and one species complex were identified;
- Bats utilising the site were species that are common and widespread on farms in south-eastern Australia.
- Two species listed as vulnerable on the NSW TSC Act 1995 were recorded, being:

  - Eastern Bentwing Bat (EBB). However, this species was not positively identified on its own, but rather as part of a species complex with Forest Bats.
  - Yellow-bellied Sheathtail Bat (YSB) - based on a single call only.
- Bats differed in flight height — the Eastern Freetail and Long-eared bats were the two species recorded at RSA height (between 30 and 160 m above ground), while the White-striped Freetail Bat commonly known as the species flying at this height, was recorded but from one call only.
- No threatened bat species were recorded at RSA height.
- At the met-mast site, two bat recorders were set up (one at 50m above the ground and one at ground level) to allow for concurrent recording of bat activity above and at ground level. Based on the data at the met mast recorders in autumn 2017, where 253 calls were recorded at ground level, only 24 were recorded 50m above the ground (approx. 10%). This data shows that most bat activity was recorded below RSA height.

Spring-summer 2017 bat survey results summary

- Ten bat species and one species complex were identified during November–December 2017 — exactly the same list of species recorded in the previous March 2017 survey.
- Bats utilising the site were species that are common and widespread on farms in south-eastern Australia.
- Two species listed as vulnerable on the NSW TSC Act 1995 were recorded, being:
  - Eastern Bentwing Bat (EBB). However, this species was not positively identified on its own, but rather as part of a species complex with Forest Bats.
  - Yellow-bellied Sheathtail Bat (YSB) - based on records from five calls only.
- Bats differed in flight height — the White-striped freetail Bat and four other common species were the species recorded at RSA height. Unlike in March 2017, the White-striped Freetail Bat, commonly known as a species flying at this height, was the most abundant species recorded at RSA heights in the current survey.
- Importantly, no threatened bat species were recorded at RSA height.
- At the met-mast site, two bat recorders were set up (one at 50m above the ground and one at ground level) to allow for concurrent recording of bat activity above and at ground level. Based on the data at the met mast recorders in spring-summer 2017, only one species, the White-Striped Freetail Bat was recorded at 50 metres above the ground. While this species was recorded from 159 calls at ground level, only 37 were recorded at 50m above the ground (approx. 23%). This data shows that most bats activity was recorded below RSA height and suggests that bats have a low level of collision risk.

3. RISK ASSESSMENT FOR CROOKWELL 2 WIND FARM

3.1. Introduction to the risk assessment

OEH requested that an updated risk assessment be completed in its letter, dated 14 November 2016, to Crookwell Development Pty Ltd. Further refinements to the risk assessment have been undertaken following correspondence from OEH on the draft BBAMP in June 2018.

The aim of this risk assessment is to guide the development of the BBAMP for the C2WF 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:

- Species or groups of concern have been short-listed based on their likelihood of occurrence at the site;
- Two impact pathways 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 pathway for each species or group of concern;
- Impact consequence criteria have been developed and applied to each impact pathway for each species or group of concern; and
- The risk level for each species or group of concern from the two impact pathways has been determined consistent with a risk matrix.

As some groups, such as bats, many raptors and waterbirds behave in similar ways, their risk profile is the same and species within these groups are not assessed separately. Any species in these groups are considered to be subject to the level of risk assessed for their group.

3.2. Introduction to the Risk Assessment for Crookwell 2 Wind Farm

To ascertain the species of concern that may occur on the C2WF site the following sources were used:

- The NSW Bionet Atlas Search tool (OEH 2017a), using an approximate 30 by 30 kilometre search region using the following co-ordinates (North: 34.40 West: 149.42 East: 149.75 South: 34.68, decimal degrees) centred over the proposed C2WF site (searched 16 March 2017);

- NSW Bionet species records data from map sheet 8828, Goulburn (OEH 2017b). This covers the area 34° 30' to 35° 00' S, 149° 30' to 150° 00' E, including the entire wind farm footprint in the north-western corner of the map sheet. Searched 14 March 2017;
- The EPBC Act Protected Matters Search Tool (PMST) using a search region with an area with a radius of ten kilometres from the approximate centre point of the study area using coordinates: latitude 34° 32' 34" S and longitude 149° 34' 57" E (Department of the Environment and Energy 2017). Searched 14 March 2017;
- Previous ecological reports e.g. URS (2004a, 2004b), BL&A (2015) and BL&A (2017); and
- TSC Act threatened species schedules (NSW Scientific Committee 2016).

3.3. Species and groups of concern

Species of concern include the following.

- Species listed as threatened on legislation or according to an authoritative source (e.g. state environment department list);
- Species known to be particularly prone to collision with operating turbines or sensitive to disturbance; and
- Species for which a concentration of population significance occurs on the site and that behaves in a way that might put it at risk from the wind farm.

From the forgoing information sources, a list of species with potential to occur in the search region was generated. Of these, a short-list of species of concern was then generated based on the likelihood of occurrence on the C2WF site itself given the habitat present on the site, distribution of species and previous wildlife records and surveys undertaken at the site.

The original site assessments (URS 2004a,b; BL&A 2015) identified threatened and listed 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) which were not originally considered have been identified through the current review. Similarly, some species or groups reviewed earlier are no longer considered at risk in the C2WF region, based on updated data. The rationale for the inclusion of the shortlisted species and groups can be found in the next section (Section 4). The short-listed species and groups are listed below:

EPBC Act Listed Migratory Species

- White-throated Needletail

EPBC Act listed threatened birds

- Regent Honeyeater (Critically endangered)
- Swift Parrot (Critically endangered).

TSC Act listed threatened birds

- Barking Owl (Vulnerable)
- Diamond Firetail (Vulnerable)

- Dusky Woodswallow (Vulnerable)
- Flame Robin (Vulnerable)
- Gang-gang Cockatoo (Vulnerable)
- Little Eagle (Vulnerable)
- Scarlet Robin (Vulnerable)
- Speckled Warbler (Vulnerable)
- Varied Sittella (Vulnerable)

TSC Act listed threatened bats

- Eastern Bent-wing Bat (Vulnerable)
- Eastern Falsistrelle (Vulnerable)

Non–listed species

- White-striped Freetail Bat
- Wedge–tailed Eagle
- Other raptors
- Waterbirds

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 ISO31000 Risk Assessment Standard (Rollason *et al* 2010).

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 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

Likelihood	Consequence				
	Negligible	*Low*	*Moderate*	*High*	*Severe*
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 aforementioned sources 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 scores
- Risk rating
- Comments relating to risk rating scores

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

Table 6: Bird and Bat Risk Assessment – Crookwell 2 Wind Farm

Value to be protected	Reason for inclusion	Threatened species status	Hazard or Source Event	Likelihood of Risk Event	Consequences	Risk Rating	Comments
Birds							
Australian Painted Snipe *Rostratula australis*	Species or species habitat may occur within area	Endangered - EPBC Act & TSC Act	Collision with operating wind turbines.	Unlikely	Negligible	Negligible	Shallow terrestrial freshwater habitats with fringing aquatic vegetation, such as sedges, rushes and reeds, and may also utilise dams with suitable vegetative cover (Marchant and Higgins 1993). The lack of suitable wetland habitats in and around C2WF indicates that this species is unlikely to be affected by the presence of wind turbines in the area.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Barking Owl *Ninox connivens*	Species recorded from the wind farm region (OEH 2017a)	Vulnerable - TSC Act	Collision with operating wind turbines.	Unlikely	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 and more open areas. Species has declined in southern Australia and now occurs in a wide but sparse distribution in NSW (OEH 2017c) including only one record from the search region (OEH 2017a). It is unlikely that this species commonly flies at RSA height, however, should turbine strike occur to individuals flying within the turbine blade height, it is highly likely that only a very small number of birds would be affected.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Black-faced Monarch *Monarcha melanopsis*	Species or species habitat likely to occur within area	Migratory - EPBC Act	Collision with operating wind turbines.	Unlikely	Negligible	Negligible	Breeds in spring and summer in rainforest and wet forest in coastal lowlands of Cape York Peninsula and along the coastal fall of the Great Dividing Range in Queensland, New South Wales and eastern Victoria. Sometimes occur in dry sclerophyll forest and woodland of the inland slopes. Spends winter in New Guinea (Higgins et al. 2006). Not expected to collide with turbines since it is a forest species normally restricted to foraging and nesting in trees.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Curlew Sandpiper *Calidris ferruginea*	Species or species habitat may occur within area	Critically endangered – EPBC Act Endangered - TSC Act	Collision with operating wind turbines.	Unlikely	Negligible	Negligible	Breeds in northern hemisphere and occurs in Australia mostly from spring to autumn in open shallow wetlands, including intertidal zones (Higgins and Davies 1996). A lack of suitable habitat in the C2WF area indicates it would be unlikely to experience mortality as a result of collision with a turbine.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Diamond Firetail *Stagonopleura guttatus*	Species recorded from the wind farm region (OEH 2017a)	Vulnerable - TSC Act	Collision with operating wind turbines.	Unlikely	Low	Negligible	Occur in south-eastern Australia south of the tropics (Higgins et al. 2006), including all regions of New South Wales (Morris et al. 1981). Inhabits mainly woodlands and also occurs in dry forests, along watercourses and in farmland areas (Morris et al. 1981; Higgins et al. 2006). 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). It is therefore considered at very low risk. This species was recorded incidentally (outside the formal BUS count) at the site during the November 2017 bird survey. All records of Diamond Firetail at the site were below RSA height.
			Indirect disturbance, including barrier effects.	Unlikely	Low	Negligible	
Dusky Woodswallow *Artamus cyanopterus*	Species recorded from the wind farm region OEH 2017a)	Vulnerable - TSC Act	Collision with operating wind turbines.	Unlikely	Low	Negligible	Endemic to southern and eastern Australia 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, heathland and modified landscapes (Higgins *et al.* 2006). This species was recorded from multiple sites during the November 2017 BUS. Most (90%) of the records of this species were below RSA height, with birds largely recorded flying within the canopy of trees. Given the low occurrence of records at RSA height (10%), the risk from collision is considered to be low.
			Indirect disturbance, including barrier effects.	Unlikely	Low	Negligible	
Eastern Curlew *Numenius madagascariensis*	Species or species habitat may occur within area	Critically endangered – EPBC Act	Collision with operating wind turbines.	Unlikely	Negligible	Negligible	Breeds in the northern hemisphere. When in Australia, inhabits sheltered coasts, especially estuaries, embayment, harbours, inlets and coastal lagoons with large intertidal mudflats or sandflats, often with beds of sea grass; occasionally on open inland wetlands (Higgins and Davies 1996). Unlikely to be affected by C2WF due to a lack of suitable habitat in the region.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Flame Robin *Petroica phoenicea*	Species recorded from the wind farm	Vulnerable - TSC Act	Collision with operating wind turbines.	Rare	Negligible	Negligible	Breeds mostly in forests and woodlands of the high country of south-eastern Australia and Tasmania, dispersing to more open habitats in the autumn and winter when they often occur in farmland at low altitudes

Value to be protected	Reason for inclusion	Threatened species status	Hazard or Source Event	Likelihood of Risk Event	Consequences	Risk Rating	Comments
	region (OEH 2017a)		Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	(Higgins & Peter 2002). There is potential for this species to occur at C2WF however it spends the majority of its time on or near the ground and is considered unlikely to fly at RSA heights.
Fork-tailed Swift *Apus pacificus*	Species or species habitat likely to occur within area	Migratory - EPBC Act	Collision with operating wind turbines.	Unlikely	Negligible	Negligible	Aerial migrant from north-east Asia, occurring in southern Australia from October to April. Potentially at risk from collisions with turbines since it forages ar RSA height and above. This species has rarely if ever been recorded as a casualty of wind turbines in Australia. The number of potential collisions, compared with the overall population of this common species (Higgins 1999), suggest impacts on its population would be minimal.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Gang-gang Cockatoo *Callocephalon fimbriatum*	Species recorded from the wind farm region (OEH 2017a)	Vulnerable - TSC Act	Collision with operating wind turbines.	Unlikely	Negligible	Negligible	Restricted to Victoria and New South Wales north to around Newcastle, along the coast and ranges (Barrett et al. 2003). In summer generally in tall mountain forests and woodlands including subalpine snow gum woodlands and occasionally in temperate rainforests and regenerating forests. In winter occur at lower altitudes in drier, more open Eucalyptus woodland (Higgins 1999). There is potential for this species to visit the C2WF during winter in woodland habitats and may fly at RSA height occasionally however the frequency of mortality is not expected to be high enough to impact on its regional population.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Latham's Snipe *Gallinago hardwickii*	Species or species habitat may occur within area	Migratory - EPBC Act	Collision with operating wind turbines.	Unlikely	Negligible	Negligible	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, etc. It has been known to use wetlands with a variety of cover, including tussock grasslands, lignum, sedges, reeds and rushes, woodlands and sclerophyll forests and known to occur in some areas over 1000 metres altitude (e.g. in montane bogs, Morris et al. 1981). This species may fly at RSA height through the lack of suitable habitat in the C2WF region and the lack of casualties at Australian wind farms to date suggests its population is at low risk from operating wind farms.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Little Eagle *Hieraaetus morphnoides*	Species recorded from the wind farm region (OEH 2017a)	Vulnerable - TSC Act	Collision with operating wind turbines.	Unlikely	Negligible	Negligible	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 (NSW Scientific Committee 2010a). The species has not yet 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*	Species recorded from the wind farm region (OEH 2017a)	Vulnerable - TSC Act	Collision with operating wind turbines.	Unlikely	Negligible	Negligible	Occur along the eastern seaboard of Australia in open forests and woodlands as well as urban areas where suitable foraging trees exist. This common species may fly at RSA height and therefore be susceptible to collision, however there are few records in the vicinity of C2WF (OEH 2017a,b) and it is expected to suffer minimal impact from the wind farm.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
other raptors	Species recorded from the wind farm region (OEH 2017a)	not listed	Collision with operating wind turbines.	Almost certain	Low	Low	Turbine strikes by commonly occurring raptors are likely, based on experience at other wind farms in south-eastern Australia. This is particularly relevant to Brown Falcon and Nankeen Kestrel which were the two most recorded raptors at the C2WF site during the February and November 2017 Bird Utilisation Surveys (BL&A 2018). Other common raptors recorded at the site during the baseline surveys included Australian Hobby, Brown Goshawk, Peregrine Falcon, Swamp Harrier and Whistling Kite. Black-shouldered Kite and Collared Sparrowhawk whilst not recorded may also be a risk of collision with turbines. The widespread and common status of these species makes population impacts unlikely. Such 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	
Painted Honeyeater *Grantiella picta*	Species or species habitat likely to occur within area	Vulnerable – EPBC Act & TSC Act	Collision with operating wind turbines.	Unlikely	Negligible	Negligible	Inhabits dry open forest and woodlands and mainly feeds on the fruits of mistletoe. Strongly associated with mistletoe around the margins of open forests and woodlands (Higgins et al. 2001). The paucity of records in the region (OEH 2017a, OEH 2017b) suggests it is unlikely to be greatly affected by turbines of C2WF.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Powerful Owl *Ninox strenua*	Species recorded from	Vulnerable - TSC Act	Collision with operating wind turbines.	Unlikely	Negligible	Negligible	Occurs in mainland south-eastern Australia in forests and woodlands along the coast Great Divide, and parts of the inland slopes (Higgins 1999). A paucity of suitable wooded habitat at C2WF indicates it would rarely fly across the wind farm so its susceptibility to collision is expected to be low.

Value to be protected	Reason for inclusion	Threatened species status	Hazard or Source Event	Likelihood of Risk Event	Consequences	Risk Rating	Comments
	the wind farm region (OEH 2017a)		Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Regent Honeyeater *Anthochaera phrygia*	Species or species habitat likely to occur within area	Critically endangered EPBC Act and TSC Act	Collision with operating wind turbines.	Unlikely	Low	Negligible	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). This species usually flies within the tree canopy and would rarely visit the C2WF site.
			Indirect disturbance, including barrier effects.	Unlikely	Low	Negligible	
Rufous Fantail *Rhipidura rufifrons*	Species or species habitat likely to occur within area	Migratory - EPBC Act	Collision with operating wind turbines.	Rare	Negligible	Negligible	Breeds in spring and summer in rainforest, wet sclerophyll forest and gullies from Cape York Peninsula south along the Great Dividing Range to Victoria. Occur less commonly in drier forest and on the inland slopes. Spends winter in Queensland and southern New Guinea (Higgins et al. 2006). This species prefers shady areas and dense foliage, so is considered unlikely to be at risk from collisions with turbines.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Satin Flycatcher *Myiagra cyanoleuca*	Species or species habitat known to occur within area	Migratory - EPBC Act	Collision with operating wind turbines.	Unlikely	Negligible	Negligible	Breeds in spring and summer in dry and wet forest in Tasmania, Victoria and New South Wales along the Great Dividing Range. May also breed in Queensland in Wet Tropics and the south-east. Spends winter in New Guinea and islands to its east (Higgins et al. 2006). Since it is a tree dweller, it is not expected to be at risk from colliding with turbines.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Scarlet Robin *Petroica boodang*	Species recorded from the wind farm region (OEH 2017a)	Vulnerable - TSC Act	Collision with operating wind turbines.	Rare	Negligible	Negligible	Lives in open forests and woodlands. During winter, it visits more open habitats, such as grasslands, and can be seen in farmland and urban parks and gardens at this time (Higgins & Peter 2002). This species does not fly at RSA height.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Speckled Warbler *Chthonicola sagittatus*	Species recorded from the wind farm region (OEH 2017a)	Vulnerable - TSC Act	Collision with operating wind turbines.	Rare	Negligible	Negligible	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). This species mainly forages on the ground or the lower woodland strata and is not known to fly at RSA height, hence, it would not be impacted by C2WF
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Superb Parrot *Polytelis swansonii*	Species or species habitat may occur within area	Vulnerable – EPBC Act & TSC Act	Collision with operating wind turbines.	Unlikely	Negligible	Negligible	Occurs in riparian River Red Gum forests and adjacent areas of box eucalypt vegetation from the Murrumbidgee and Murray Rivers northwards to the Namoi Valley. Breed in hollow branches or trunks of tall eucalypts within 9 km of feeding areas. Mostly feed in box woodlands and wooded farmlands; less often in riparian forests (Higgins 1999). There are four records from the C2WF region, all from well south of Crookwell in the Gunning and Bredalbane areas (OEH 2017a). It would therefore appear unlikely to be impacted by collision with C2WF turbines.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Swift Parrot *Lathamus discolor*	Species or species habitat may occur within area	Critically endangered - EPBC Act Endangered – TSC Act	Collision with operating wind turbines.	Unlikely	Low	Negligible	Prefers a narrow range of eucalypts in NSW, including White Box, 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. At this time it mostly lives north of the Great Dividing Range in Victoria (Emison *et al.* 1987; Higgins 1999; Kennedy and Tzaros 2005). In some years most birds disperse north into New South Wales, along the inland slopes and the south and central coasts. Potential to occur at C2WF however there are no records from the surrounding search region which indicates it would be a rare occurrence and therefore unlikely to be impacted.
			Indirect disturbance, including barrier effects.	Unlikely	Low	Negligible	
Varied Sittella *Daphoenositta chrysoptera*	Species recorded from the wind farm	Vulnerable - TSC Act	Collision with operating wind turbines.	Unlikely	Low	Negligible	Active species inhabiting most of mainland Australia in eucalypt forests and woodlands. It 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). Distribution in NSW is nearly continuous from the coast to the far west

Value to be protected	Reason for inclusion	Threatened species status	Hazard or Source Event	Likelihood of Risk Event	Consequences	Risk Rating	Comments
	during baseline bird surveys (BL&A 2018)		Indirect disturbance, including barrier effects.	Unlikely	Low	Negligible	(Morris et al. 1981; Barrett et al. 2003). Its population size in NSW is uncertain but is believed to have undergone a moderate reduction over the past several decades (OEH 2017Ac). This species was recorded from one turbine site during both the February and November 2017 baseline bird utilisation surveys, for which al (100%) of the records of this species were below RSA height, with birds largely recorded flying within the canopy of trees. The Varied Sittella is unlikely to fly at RSA height and hence likely to experience minimal impacts from C2WF.
Waterbirds	Species recorded from the wind farm region (OEH 2017a)	not listed	Collision with operating wind turbines.	Unlikely	Low	Negligible	Habitats on the C2WF site for waterbirds are limited to small farm dams, although the larger Pejar Reservoir is close to the southern boundary. 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 frequently.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Wedge-tailed Eagle *Aquila audax*	Species recorded from the wind farm region (OEH 2017a)	not listed	Collision with operating wind turbines.	Almost certain	Moderate	Moderate	The Wedge-tailed Eagle is the species most exposed to collision risk due to its common status and habit of soaring and circling at RSA height while foraging. Several birds of this species have been struck at other wind farms in NSW and Victoria. Disturbance is not an issue, with the eagle breeding successfully as close as 200 metres from operating wind turbines. The regular incidence of collisions has the potential to affect the regional population.
			Indirect disturbance, including barrier effects.	Unlikely	Low	Negligible	
White-throated Needletail *Hirundapus caudacutus*	Species or species habitat likely to occur within area	Migratory - EPBC Act	Collision with operating wind turbines.	Likely	Low	Low	Breeds in north-east Asia and migrates to Australia in the austral spring and summer. Forages aerially and is known to follow storm systems and fronts. Occasional mortality has been recorded on other wind farms in its range. 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 (Higgins 1999), although no recent estimates of population are available.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Yellow Wagtail *Motacilla flava*	Species or species habitat may occur within area	Migratory - EPBC Act	Collision with operating wind turbines.	Unlikely	Negligible	Negligible	Breeds in the northern hemisphere and occurs as a summer visitor mostly to tropical and subtropical areas of Australia in short grass or muddy areas often near water (Higgins et al. 2006). In New South Wales it is occasional in the summer first recorded in 1979 and mostly at the lower Hunter estuary (Morris et al. 1981; Higgins et al. 2006). Its general rarity in southern Australia, coupled with a paucity of suitable habitat at C2WF suggest it is unlikely to collide with turbines at C2WF and suffer any consequent loss in its overall population.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Bats							
Eastern Bent-wing Bat *Miniopterus schreibersii oceanensis*	Species recorded from the wind farm region (OEH 2017a)	Vulnerable - TSC Act	Collision with operating wind turbines.	Unlikely	Low	Negligible	Conservatively recorded as part of a species complex with Forest Bats. Roosts in caves during the day, dispersing over a range of forest, woodland and grassland habitats at night. This species could collide with turbines as it is known to fly at RSA height (Churchill 2008). It is possible that small numbers of this species may frequent the C2WF site or cross the area during migration between maternity and wintering caves.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Eastern False Pipistrelle *Falsistrellus tasmaniensis*	Species recorded from the wind farm region (OEH 2017a)	Vulnerable - TSC Act	Collision with operating wind turbines.	Unlikely	Low	Negligible	Occur in south-eastern Australia along the coast and Great Divide from around Brisbane to Mt Gambier; also Tasmania. Prefers moist forested habitats with trees taller than 20 metres. Roosts in tree hollows but has also been found roosting in buildings or under loose bark. Flies within or just below the canopy in gaps, along tracks, and also in open areas (Churchill 1998, 2008). Since this species tends to avoid small forested remnants (Churchill 2008), its risk from the C2WF which is mainly open country with a few small remnant treed areas, is expected to be insignificant.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Grey-headed Flying-fox *Pteropus poliocephalus*	Foraging, feeding or related	Vulnerable - EPBC Act	Collision with operating wind turbines.	Unlikely	Low	Negligible	Occur in mainland south-eastern Australia. The national population is fluid, moving along the east coast dependent on food resources. Widespread throughout range in summer, contracting to coastal lowlands north of the Hunter Valley and occasionally found on the south coast and north-west slopes of NSW in winter,

Value to be protected	Reason for inclusion	Threatened species status	Hazard or Source Event	Likelihood of Risk Event	Consequences	Risk Rating	Comments
	behaviour may occur within area		Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	associated with winter flowering eucalypts and Spotted Gum *Corymbia maculata*. Much nightly movement to foraging sites from daytime camps, usually within 15km of their day roost site. The single record from the wider region, in Goulburn in January 2017 (OEH 2017b), suggests the species may reach C2WF rarely, and therefore it is at minimal risk from population impacts.
Large-eared Pied Bat *Chalinolobus dwyeri*	Species or species habitat may occur within area	Vulnerable - EPBC Act	Collision with operating wind turbines.	Unlikely	Low	Negligible	Occur from Rockhampton, Queensland to Bungonia, NSW, from the coast to the inland slopes in a variety of forest and woodland. Often occur in areas of extensive cliffs and caves, their preferred roosting habitat (Churchill 2008; OEH 2017a). Mapping and one regional record (from Marulan; OEH 2017b,c) suggest that the species would be at the edge of its range in the Crookwell area and be minimally affected by C2WF.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	
Yellow-bellied Sheathtail-bat *Saccolaimus flaviventris*	At southern end of range. Recorded in baseline bat surveys at C2WF.	Vulnerable - TSC Act	Collision with operating wind turbines	Unlikely	Low	Negligible	This species was recorded in the autumn 2017 bat survey from one call and during the spring-summer 2017 bat surveys from five calls. Numbers of this species in the area are therefore considered to be low, and large viable populations are more likely to be found in very large forest remnants away from the site. Given the low number of calls recorded, the likelihood of turbine collision is considered to be low.
			Indirect disturbance, including barrier effects	Unlikely	Negligible	Negligible	
White-striped Freetail Bat *Tadarida australis*	Species recorded from the wind farm region (OEH 2017a)	not listed	Collision with operating wind turbines.	Almost certain	Low	Low	Occurs in a wide range of habitats, including forest, woodland, shrubland, grassland and urban areas (Churchill 1998, 2008). This species is known to fly 50 metres or so above the ground which puts it at risk of collision and it has been recorded colliding with turbines in other areas of NSW (BL&A, unpubl. data). It is abundant and widespread and potential collisions at the C2WF site are considered unlikely to have a significant impact to the regional population.
			Indirect disturbance, including barrier effects.	Unlikely	Negligible	Negligible	

Notes: TSC Act = Threatened Species Conservation Act; EPBC Act = Environment and Protection of Biodiversity and Conservation Act; * = Preliminary Determination by the NSW Scientific Committee.

3.6. Risk assessment discussion

The risk associated with wind turbine collision and indirect effects at the C2WF for most birds and bats was rated as **negligible**. The exceptions are described below.

Given the occurrence of collisions involving Wedge-tailed Eagles (WTE) at many wind farms but a low incidence of disturbance, risks to this species arise from likely collisions. Given the foregoing and the presence of eagles at most wind farms, including their successful breeding within 200 metres of operating turbines (BL&A, unpubl. data), the overall risk to the Wedge-tailed Eagle was therefore considered to be **moderate**.

Based on experience with other wind farms in eastern Australia collision by other common occurring raptor species is likely. Other raptor species recorded during the baseline bird surveys at C2WF included Australian Hobby, Brown Goshawk, Peregrine Falcon, Swamp Harrier and Whistling Kite. Additional raptors that may collide with turbines at the C2WF site include Black-shouldered Kite and Collared Sparrowhawk. 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 'other raptors' is considered to be **low** as these species are widespread and have a common status which makes regional population impacts unlikely.

The White-throated Needletail flies regularly at turbine height and flocks would pass over the C2WF site during the summer months. Collisions have been recorded at wind farms elsewhere in NSW and Australia. Whilst the likelihood of collision is considered likely, the overall risk to this species from the C2WF is considered to be **low** as the species is widespread and numerous in eastern and south-eastern Australia.

Two threatened bat species, Eastern Bent-wing Bat (EBB) and Yellow-bellied Sheathtail Bat (YSB) have been recorded (one conservatively) in the C2WF baseline bat surveys. The EBB has a maternity cave at Wee Jasper located approximately 100 kilometres south-west of C2WF. This species disperses up to 300 kilometres from maternity caves on migration to their wintering caves. This species was conservatively recorded as part of a species complex with Forest Bats. Small numbers of this species may cross the C2WF site during migration between maternity and wintering caves. The EBB population is considered to be at **negligible** risk from collision with turbines. The YSB was only recorded from a small number of calls at the C2WF site and large viable populations are more likely to occur in large forest remnants. Similarly to EBB, the YSB population is considered to be at **negligible** risk from collision with turbines.

Given the occurrence of collisions involving the common and widespread White-striped Freetail Bat at many wind farms, collision risk has been considered specifically for this non-listed species. Whilst the likelihood of collision is considered almost certain, the widespread abundance of the White-striped Freetail Bat resulted in the overall risk to the species from collision being **low**.

3.7. Conclusions from the Risk Assessment for Crookwell 2 Wind Farm

The surveys of the C2WF and surrounding wind farm sites to date, combined with the knowledge generated at operating wind farms elsewhere in Australia (BL&A unpubl. data), indicate that collision rates are typically very low. This risk assessment indicates that no significant population-wide impacts are anticipated for species or groups of concern.

This assessment found that the following species or groups may experience some, non-negligible risk to their populations from colliding with turbines at C2WF:

- Wedge-tailed Eagle – **moderate** risk
- Other raptors – **low** risk
- White-throated Needletail – **low** risk
- White-striped Freetail Bat – **low** risk

Many of the NSW threatened species (TSC Act) screened in this risk assessment are not at risk from the C2WF. The three threatened bird species recorded during the baseline surveys, Varied Sittella, Dusky Woodswallow and Diamond Firetail were all largely recorded below RSA height and are not considered to be at risk from the C2WF.

Woodland birds and bats do not regularly fly at RSA height and therefore do not encounter turbines very often.

This risk assessment indicates that a small proportion of the species and groups of concern (three out of 28 bird species or species groups and one out of five bats) have more than a negligible risk of being affected by collision with operating turbines once the C2WF is constructed. No birds or bats are at major risk from indirect effects, such as disturbance or barrier effects. The BBAMP for the C2WF therefore focuses on monitoring the impacts of the project on Wedge-tailed Eagle, other raptors, White-throated Needletail, and White-striped Freetail Bat.

4. OPERATIONAL PHASE SURVEYS

A range of approaches will be utilised post-construction, i.e. the operational phase of the project, to meet the requirements of the relevant condition of consent (84).

The main approaches to implementing the BBAMP will be:

- Post-construction bird utilisation survey using the same survey points and effort as the pre-construction surveys to identify any differences in bird activity on the site;
- A statistically robust carcass–monitoring program (random or stratified random sampling design) to detect birds and bats that collide fatally with wind turbines as a basis for an estimate of overall bird and bat mortality rates at the C2WF;
- Specific management contingencies for key species and groups identified in the risk assessment and/or initiated due to a specific impact trigger (see Section 6); and
- Mitigation measures to reduce the possible interactions between birds and bats, and operating wind turbines.

Sections 4.1 to 4.3 describe the survey methodologies to be implemented once C2WF becomes operational.

Carcass-searches are expected to be carried out for a total of two years following commencement of the operational phase of the C2WF, with a review and compilation of all monitoring data gathered in the two years to determine if further, more targeted, surveys will be required following the first two years; or if reduced monitoring effort is justified.

4.1. Monitoring 'at risk' groups

Experience from other wind farms indicates that ongoing bird utilisation surveys (BUS) provide varying levels of information. A baseline was generated in the pre-construction surveys in 2017 on bird utilisation of the site. A review of this information combined with information from other sources has been collated in the risk assessment and is considered to provide an adequate pre-construction baseline to compare future changes.

More specific and targeted monitoring of "at risk" groups as presented below, and monitoring (linked to impact triggers) would provide more useful information within an adaptive management framework for addressing the bird and bat impacts of the wind farm.

The key "at risk" groups have been identified through the risk assessment (see Section 3). These include:

- **Wedge-tailed Eagles (WTE)** - A moderate risk to WTE has been assessed (Table 6). Accordingly, it is important that mitigation measures are implemented, where practicable, to reduce WTE being attracted to the vicinity of the turbines and that further information is compiled on the WTE population on the wind farm site and the flight behaviours that could present a risk to WTE.
- **Other raptors and White-throated Needletail**
- **White-striped Freetail Bat**

The onsite occurrence of the above "at risk" species will be recorded during post-construction bird and bat utilisation surveys to be undertaken at the site during the first two years of operation. Any mortality of these species will be identified through monthly carcass searches to be undertaken for the first two years of operation.

In the event that threatened birds or threatened bats are found during carcass searches, or incidentally, an appropriate response will be identified in consultation with OEH, as described in the procedure in Section 6 of this BBAMP.

4.1.1. Birds of Prey (Raptors)

After operations commence, monthly monitoring of eagle flight movements and breeding activity is required to determine whether operating turbines affect the behaviour of eagles. This will inform the level of risk to the local population from possible impacts of the wind farm. This raptor monitoring can be incorporated into the initial two-year monthly carcass monitoring program and will initially operate for the first two years of operational monitoring.

Information recorded will include, as a minimum:

- Date location and duration of observation period;
- Time and duration of flight;
- No. and age of birds;
- Flight height above ground (range);
- Flight behaviour;
- Habitat over which the flight was observed;
- Flight behaviour observed included soaring, directional flight (flapping), circling, gliding and diving; and
- Other occasional behaviours included feeding, territorial displays, fighting and perching.

Flight paths will be plotted as accurately as possible on large-scale aerial photographs of the site.

The monitoring of birds as outlined above is likely to vary with potentially higher utilisation in spring-summer-autumn. However, consistent monitoring across all seasons will enable the identification of possible seasonal changes.

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 initial two-year monthly carcass monitoring will monitor their presence and record any impacts from the C2WF.

In addition, during the monthly carcass monitoring searches, if a flock of Needletail moves through the site, the numbers of birds and the zone of movement (where ascertainable) will be plotted on the large-scale aerial photographs of the site.

The same information will be recorded for any observed flight paths of Needletail as described above for raptors.

4.2. Post-construction bird and bat surveys

Pre-construction bird utilisation surveys were conducted at C2WF in February and November 2017, and pre-construction bat surveys were conducted in autumn and spring-summer 2017.

Post-construction Bird utilisation surveys for C2WF will be undertaken for the first two years of operation to allow for a comparison in bird utilisation at the site. Post-construction surveys will replicate the methodology and seasonal timing of the pre-construction bird utilisation

surveys undertaken in 2017 to provide an accurately comparable set of data, as detailed in the following section.

Post-construction bat utilisation surveys are not considered to be justified for C2WF given the low number of threatened bats recorded during the baseline pre-construction surveys. Particularly, the baseline bat surveys only recorded two listed bats: the Eastern Bent-wing Bat (EBB) (only as part of a complex with the Forest Bats) and Yellow-bellied Sheathtail Bat (YSB), both in very low numbers. Given the low numbers of calls recorded for these species, it is considered unlikely that the C2WF site provides a key migration route for the EBB. The YSB are not considered to occur in high numbers due to lack of large forested areas in the site.

As such, no post-construction bat surveys are required for C2WF.

Details of post-construction bird utilisation surveys for C2WF are detailed below.

4.2.1. Post-construction Bird Utilisation Surveys

Post-construction Bird Utilisation Surveys will be undertaken in summer and spring (two seasons) for the first two years of operation of the C2WF. Methods employed for this survey will replicate the methods of the baseline bird utilisation surveys as followed:

- The fixed-point bird count method will be used to collect bird utilisation data involved an observer stationed at a survey site for 15 minutes.
- During this period, all birds observed within 200 metres will be recorded. The species, the number of birds and the height of the bird when first observed will be documented. For species of concern (threatened species, waterbirds and raptors), the minimum and maximum heights will also be recorded.
- Flight heights will be reported relative to the rotor swept area (RSA) height as followed:
  - **A =** Below RSA (< 30 metres above ground)
  - **B =** At RSA (30 – 160 metres above ground)
  - **C =** Above RSA (> 160 metres above ground)
- Flight heights will be recorded at 10 m intervals between 0 and 40 metres and at 20 metre intervals above 40 metres and up to 160 metres.
- Ten fixed sites will be surveyed (replicating the sites surveyed in the baseline 2017 BUS). This includes eight impact sites (near and among turbines) and two reference sites.

Locations of fixed Bird Utilisation Survey (BUS) points are shown in Figure 1.

4.3. 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, the mortality rate for that particular threatened species may also be estimated, subject to sufficient data being available.

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 event (see below).

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.

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 of the 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, which can be used to understand actual bird and bat impacts.

The search protocol has been designed to detect optimally key species of interest and also any other species that have fatally collided with turbines. The consistent application of this protocol will ensure that statistically robust, spatially and temporally consistent data are collected on bird and bat mortality.

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 4.3.3).

Human detectability of carcasses is also a potential confounding variable and protocols have been developed to control for this factor in the final mortality estimates. Section 4.3.4 provides more detail on these issues.

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 will be generated and applied.

- Trials for scavenging and detectability rates for Wedge-tailed Eagles have been conducted in southern NSW. These will be used to represent large birds.
- 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 have been scheduled accordingly.

Similar methods have been recommended in a number of other approved bird and bat monitoring programs in New South Wales and Victoria (see section 1.3 for examples). 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 unpubl. data from ten projects), knowledge of experimental design and statistical analysis, and recent feedback from the regulatory authorities.

Mortality detection is proposed to be carried out for two years of C2WF operation. After each year of mortality monitoring, a detailed report will be prepared reviewing the mortality detection program and providing recommendations for the future in response to confirmed issues.

The following sections outline:

- **Turbine site selection for survey** (Section 4.3.1): how the wind turbines will be selected for a search
- **Search protocol** (section 4.3.2): 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 4.3.3): definition of scavenging and how experimental trials will be conducted
- **Detectability and trials** (Section 4.3.4): definition of detectability and the experimental trial methodology
- **Incidental search protocol:** (Section 0): 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 4.3.6): general outline of how the data will be analysed to gain estimates of bird and bat mortality.

4.3.1. Turbine Selection

Turbines will be selected based on the rules below, which are based on a 'stratified random' sampling design.

- Each turbine within a stratum has an equal chance of being selected for the searches (randomly selected by 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.

To ensure a valid dataset for statistical analysis, the mortality detection search will be based on 16 turbines (representing 50% of the turbines at the C2WF), split into the four operational areas of C2WF (North east, North west, South East and South West – 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.

In addition, five carcass search reference sites will be chosen and searched. Please note, as pre-construction carcass searches of turbine sites *and* reference sites were not undertaken, applying a BACI standard sampling design and analysis is now not possible.

4.3.2. Search protocol

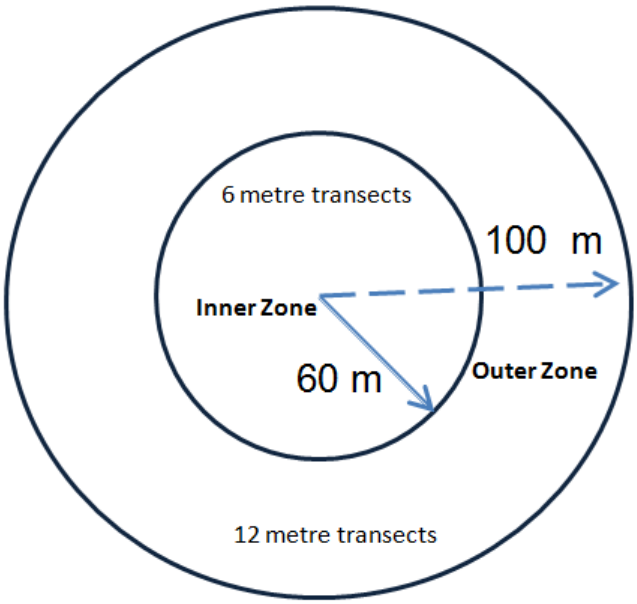
The search area beneath each turbine has been determined to best detect bats and medium to large bird carcasses, based on the turbine dimensions (Hull & Muir 2010). Based on the Hull and Muir model (2010) 95% of bat carcasses are found within 65 metres of the turbine, and carcasses of medium to large birds are reasonably evenly distributed out to 100 metres. Carcasses of very large birds (Wedge-tailed Eagle) may be found a little further out, but 95% are within 115 metres of the turbine. As turbine RSA diameter has increased since these studies, a larger search zone for large birds is warranted

Given this evidence, inner and outer circular search zones have been designated. The inner zone targets the detection of carcasses of bats and small to medium and large sized birds. In the inner zone, a circle is formed with a 60-metre radius from the turbine and transects are spaced every six metres across this circle (Figure 2).

The outer zone will comprise the zone between the 60 metre and 120 metre radius circles. Although they are still recorded in the inner zone, the outer zone will ensure the adequate detection of carcasses of medium to larger sized birds, which can fall further away from turbines. Search transects in the outer zone are spaced at 12 metres and carried out from the edge of the inner zone out to the edge of the outer zone (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 bats and the bird species of concern.

In each stratum, all sampled turbines will be searched out to 120 metres once per month. A second follow-up search, a 'pulse search' will be undertaken to 60 metres once a month within several days of the first search to detect additional mortality of bats and birds. The selected turbines will be searched monthly and the order of turbines searched will be randomized, however the same turbines will be searched each month.

Figure 2: Inner and outer 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, 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; and
- Weather (including recent extreme weather events, if any), visibility, maintenance to the turbine and any other factors that may affect carcass discovery.

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 2 business days for the possible reporting of an impact on a threatened species within 3 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 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.

It may be necessary for the wind farm operator to obtain a permit from OEH under the *National Parks and Wildlife Act 1974* to handle and keep native wildlife (even dead wildlife) as part of the monitoring program. An application for this permit may need to be submitted in a timely manner to ensure approval has been obtained prior to commissioning of the turbines. It is likely that personnel undertaking activities consistent with this BBAMP once approved by DPE will not be acting illegally in handling and keeping wildlife carcasses. However, this will be clarified in advance of this requirement with OEH.

4.3.3. Scavenger rates and trials

It will be important to ascertain the rate at which carcasses are removed by scavengers. This can be used to develop a 'correction factor' that informs the estimate of 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 will be defined as a carcass that does not appear to have been scavenged by a vertebrate scavenger. A partially eaten carcass will be any skeletal or flesh remains found. Feather and fur spots will be defined by their presence and the absence of any other remains (a feather spot being a cluster of five or more feathers). Intact or partial carcasses and feather/fur spots will all be recorded as a 'find'. However, the scavenger correction factor will not be applied to fur and feather spots as these are most likely to represent the remains of carcasses after they have been scavenged.

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

Table 7: Timing for scavenger trials

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

Scavenger Trials will be undertaken by a trained person 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 will be the same as in the search protocol (above) and will be located under operating turbines, selected based on the methodology outlined in Section 4.3.2.

To determine potentially different scavenging rates on birds and bats, two size categories of carcass will be used. Based on current mortality estimation software requirements, every endeavour will be made to find ten carcasses of each size category (Table 8). Improvements on this method would require an impractical and unlikely availability of required carcass numbers, and do not lead to a commensurate improvement in the statistical power of estimates.

Table 8: Number of carcasses in each size category

Micro-bat	Medium to Large Birds
10	10

The trials will be conducted at the same randomly-selected turbine sites used for mortality searches (see section 4.4.1). The carcasses will be checked daily for the first five days, then every 48 hours for the following four days and then every three days until they disappear or at the end of 30 days (see Table 9 9).

Table 9: Scavenger trial search timetable

Day
Day 1: Anytime
Day 2: Anytime
Day 3: Anytime
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 provided below.

- 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 (see Symbolix 2012 for more detailed explanation).
- A mix of small and medium to very large native 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 60 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 at seasonally different times 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 will not be conducted as trails have already generated specific findings for WTEs that demonstrate a low level of scavenging of these carcases and a high level of detectability that is consistent across the year.

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.

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

4.3.4. Detectability (Observer) trials

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

Detectability trials will be undertaken to assess the probability that a searcher will detect an existing carcass, given the prescribed mortality search protocol detailed for monthly carcass searches in section 4.3.2 (i.e. searching along the six metre and 12 metre transects). The most efficient use of time is therefore to conduct the detectability trials concurrently with the monthly searches. As humans are reliant on visual cues to determine carcass location, the two visibility categories of low and high grass cover will be compared (as described in section 4.3.4).

To account for observer variability in detecting carcasses, only personnel who have carried out monthly searches at C2WF will be involved in the detectability trials. Detection efficiency (percentage of carcasses detected) will then be incorporated into later analyses that derive mortality estimates. The number of carcasses to be employed in each trial is detailed in Table 10 and explained below. The carcass controller (a person not involved in monthly carcass searches who can act consistent with this method) will throw each carcass into the air and allow it to land on the ground to simulate at least some of the fall and the potential ruffling of fur and feathers. The carcass controller will note the placement of carcasses (via GPS) and is free to decide how many are deployed under each turbine, however all bats should be located within the inner, 60 metre search zone.

Table 10: Number of replicates per season for detectability trials, given factors of size and visibility

	Micro-bat	Medium bird
Long grass	10	10
Short grass	10	10

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 or small native birds that have the same general body shape, colour and appearance should be substituted for bats).

If sufficient carcasses cannot be obtained, then stuffed, realistic-looking artificial substitutes may 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 and the number of introduced predators on site. As these trials can be undertaken separately from scavenger trials, artificial substitutes may be ideal. Note, however, that it is considered to be more time efficient and cost effective to undertake scavenger and observer trails concurrently.

4.3.5. Incidental Carcass Protocol

Personnel at the C2WF may from time to time find carcasses within the wind farm site during normal day-to-day activities. In this case, the carcass will be handled according to the carcass detection protocol outlined in section 4.3.2. All wind farm personnel will be made aware of this carcass handling protocol as part of their HS&E training and induction. A carcass search data sheet (Appendix 1) will be completed for each incidental carcass found.

4.3.6. Analysis of results and mortality estimation

The results of the mortality monitoring surveys will be analysed in order 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 program is designed to provide an acceptably accurate and precise estimate of wind farm related bird and bat mortality within two years, so a full analysis and estimate will be provided in the second annual report, together with recommendations on the scope of future monitoring, if required.

All data will be analysed to provide the average estimated mortality of birds and bats, their standard error (variability) and ranges for the C2WF. The mortality rate of each species (if estimates of individual species are possible) and size class detected will be calculated after two years of data have been collected. 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. 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.

4.4. 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 technical and field methods. C2WF will ensure that it engages suitably qualified and trained people to supervise and implement the monitoring program.

A suitably experienced and qualified ecologist will be appointed and approved by DPE in relation to the implementation of this BBAMP. The approved ecologist will oversee in detail and be leading site implementation of the program including the carcass searches, searcher efficiency trials and scavenger trials. Any person undertaking searches will be trained and supervised by approved ecologist who is familiar with the techniques and has applied them at other sites. The searcher will receive training from the qualified ecologist in the following areas:

- Turbine searches i.e. transect spacing in inner and outer zones, number and location of turbines to search and transect search methods;
- Equipment usage i.e. GPS;
- Data recording; and
- Species identification.

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

The first searcher efficiency trial will be initiated and set up by the ecologist, who will also train a separate person (the 'carcass controller') to run searcher efficiency 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.

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

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

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.

4.5. 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 site 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) 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.

- Crookwell Veterinary Surgery — 220 Goulburn St, Crookwell NSW 2583 (02) 4832 1977
- WIRES, Southern Tablelands — (02) 4822 3888
- RSPCA ACT — (02) 6287 8113
- Canberra Connect — 13 22 81
- Wildcare Queanbeyan — (02) 6299 1966

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

4.6. Reporting and Review Meetings

In accordance with the Condition of Consent 84 (f), reports will be submitted to the Secretary and OEH on an annual basis. An annual report will be prepared within three months of the completion of the first year of operations phase monitoring. This report will summarise

finding for the first year of surveys and provide recommendations for adjustments of protocols.

The more detailed second year annual report will focus on presenting the results of the mortality searches and recommending refinements, where necessary to monitoring activities if required. OEH will participate in a review of the second years annual results to determine if further monitoring is warranted. Matters to be addressed in the second-year annual report will include, but will not be limited to:

- A brief description of the management prescriptions implemented and identification of any modifications made to the original management practices.
- The survey methods (including list of observers, dates and times of observations);
- Estimates of bird and bat mortality rates (avifauna impacted per turbine per year);
- Maps of turbines, indicating which ones produced carcasses of species of concern;
- A discussion of any turbines where numerous carcasses have been found analysing potential factors influencing bird and bat strike, e.g. landscape position and habitat in close proximity.
- Seasonal and annual variation in the number and composition of bird and bat strikes, where detectable including consolidated tables of carcasses and species records from individual monthly reports;
- A review of the risk assessment based on the results of BBAMP investigations;
- 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 summary of livestock carcass removal for the purposes of predator reduction;
- Details of any landowner feral animal control programs 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 local, 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.

4.6.1. 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 a different agreement is reached with the Secretary, 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.

At the end of the second year of operation phase monitoring, overall summary assessment will be made of all the data obtained during this phase, and details of the management practices implemented, as well as recommended adjustments for ongoing monitoring. The results of the review and its implications will be discussed with OEH.

Annual reports prepared beyond the second year 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 annual reports following the first year of operational phase monitoring and will be based on the outcomes of monitoring surveys and any impacts, in consultation with OEH.

Following the end of formal carcass monitoring after the end of the second year of operation, any ongoing avifauna strike will be identified by incidental carcass finds by wind farm personnel.

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 84 (g).

The overall objective of mitigation measures is to ensure that the operation C2WF 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 C2WF should be incorporated into the plan as part of adaptive management, in consultation with the OEH.

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 matters.

A moderate risk to WTE has been identified for C2WF. 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 to look for large carcasses within 200 metres of each turbine.
    - Additional, opportunistic observations by operators during normal inspections and work routines and by landowners as they travel around their properties 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 and landowner 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 following identification of carrion on site in between monthly searches.
  - Carcass occurrence and removal will be recorded in a "management log book" maintained by C2WF asset manager.

- During lambing season (usually late autumn / winter) young lambs are susceptible to death. Therefore, if possible and subject to agreement of landowners, lambing will be restricted in paddocks at least 200 metres away from turbines, where practicable, to reduce the risk that raptors (Wedge-tailed Eagles in particular) are attracted close to the turbines.
- In order to reduce collision risks to birds, where practical and with landowner agreement, the practice of grain feeding of stock within 200 metres of turbines should be minimised as it could cause draw additional parrots and other birds to the site.
- Any feral animal control on the wind farm site should involve the removal and appropriate disposal of resulting carcasses in a timely manner.
- If a large active rabbit presence 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 'management log' will be provided in the annual monitoring reports.

The need for continuation of the carcass removal program and effort required will be assessed after one year of operation. 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 search zones (i.e. not beneath turbines) the intense program may be discontinued or reduced considerably, subject to agreement from OEH. 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 and bats colliding with all structures (Longcore, et al. 2008). Most bird mortality at communication towers 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).

Bats are also attracted to the increased numbers of insects that may congregate near bright light sources.

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 (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).

For the above reasons, building lighting should be baffled and directed to avoid excessive light spillage and security lighting should be baffled to direct it towards the area requiring lighting and not skyward.

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 is met, 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.

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 (see section 1.1 for details).

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 approved expert.

6.1. Threatened Species

6.1.1. Definition of Impact Trigger and Unacceptable Impact

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

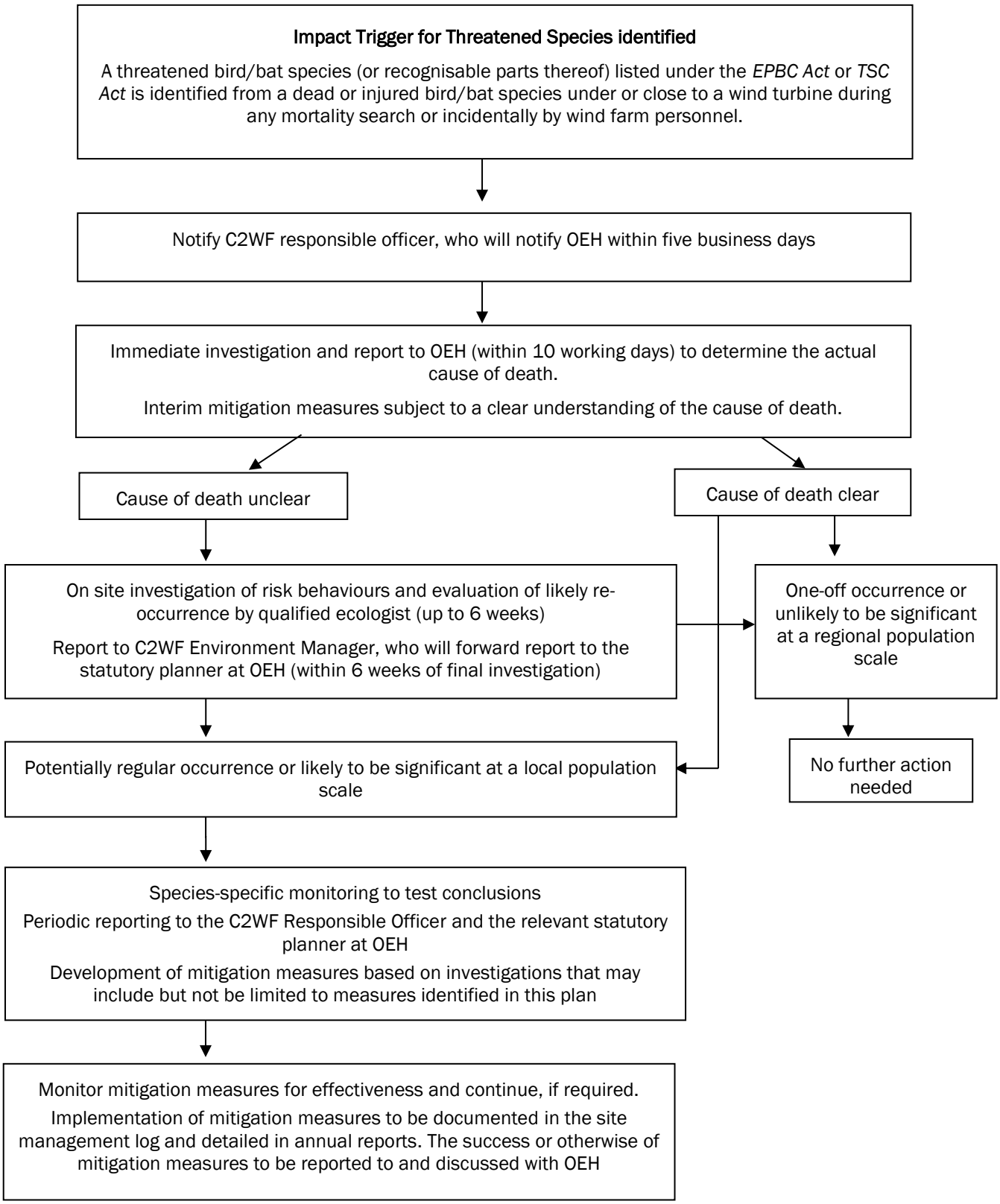
Impact Trigger for Threatened Species: A threatened bird/bat species (or recognisable parts thereof) listed as threatened under the Commonwealth *EPBC Act* or NSW *Threatened Species Conservation Act 1995*, is found dead or injured under or close to a wind turbine during any mortality search or incidentally by wind farm personnel.

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 3 will be followed. This section complies with Condition C84 (d) of the conditions of approval.

- Immediate reporting of the occurrence of an impact trigger to C2WF's responsible manager, who will report it to the relevant statutory planner at OEH within five business days of it being recorded;
- Immediate investigation (to be completed within 10 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 ensure that the mitigation is 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.

Figure 3: Decision making framework for identifying and mitigating impact triggers for threatened species



- If following this investigation, the fatality is deemed to be a one-off occurrence or the ongoing risk is unlikely to be significant at a population scale, further action is not considered necessary. This decision will be made in consultation with OEH and will be determined based on available evidence and using a precautionary approach. Note that the successful execution of this requirement relies upon OEH providing timely and definitive input to this process.
- 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. If these investigations suggest that the impact trigger was a one-off event or 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 OEH, based on available evidence.
- If the onsite investigation suggests that the impact trigger may be a regular occurrence, species-specific monitoring will be required. This monitoring will be developed in consultation with OEH. During the species-specific monitoring period, periodic reports will be provided to C2WF and OEH.
- 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 OEH. Any required investigation, and recommended management and supplementary mitigation measures, will be documented in the project management log and detailed in annual reports. This log will be available for inspection by OEH or on the request of the Secretary DPE.

It is recommended that the DPE approved specialist for implementation of the BBAMP be responsible for implementation of this decision-making framework and to discuss decision making with OEH and DPE.

6.2. Non-threatened Species

6.2.1. Definition of Impact Trigger and Unacceptable Impact

The circumstances that define an impact trigger and significant impact for non-threatened birds and/or bats under this Management Plan is detailed below. Note that only those native species not listed as protected in the local government areas, 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: A total of four or more bird or bat carcasses, or parts thereof, of the same species in two successive searches at the same turbine of a non-threatened species (excluding Sulphur-crested Cockatoos, galahs, crows and ravens and introduced bird species).

Note that although the impact trigger does not include ravens, magpies, White Cockatoos, corellas, pipits and introduced species, detected mortalities for these species will still be reported as part of the annual reporting process.

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:

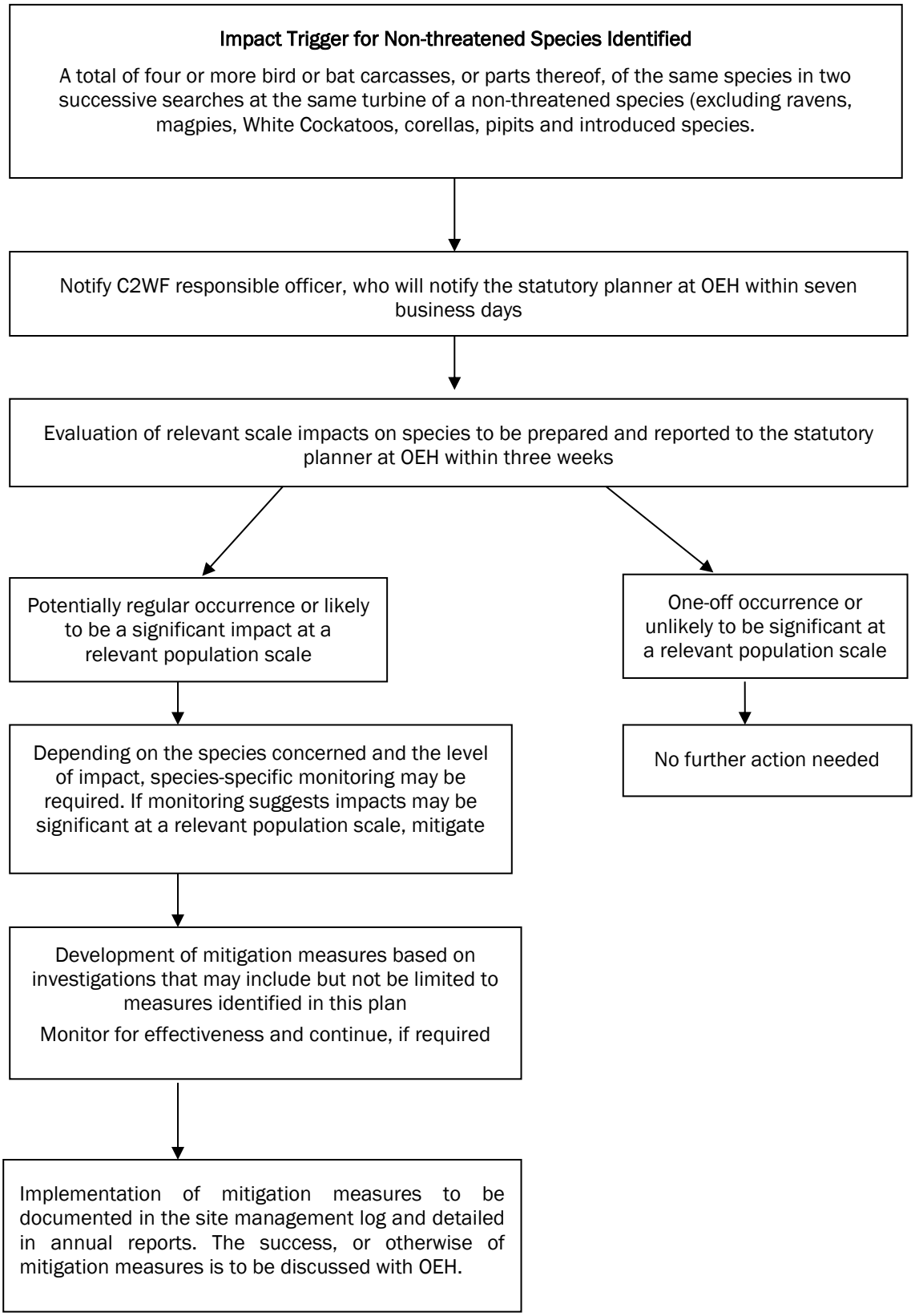
- OEH will be **notified** of the impact trigger within seven days of recording the event. An appropriate scale to consider population effects of the impact trigger will be agreed between OEH and the proponent on a case-by-case basis with consideration given to the species in question.
- An **evaluation**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

If the evaluation indicates that the event was a one-off occurrence or 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 4).

If the event is deemed to be a potentially regular occurrence or 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 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 OEH. Any required investigation, and recommended management and supplementary mitigation measures, will be documented in the site management logs and detailed in annual reports. This log will be available for inspection by OEH or on the request of the Secretary DPE.

Figure 4: 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 OEH in the event that an impact trigger occurs. The purpose of supplementary mitigation measures will be to prevent the impact from continuing to occur. Specific mitigation measures will be implemented depending 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 trigger will be, therefore 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. Note that in implementing mitigation measures, a suite of measures that may or may not include those in Table 11 would need to be implemented, depending on management response to particular circumstances.

Although it is unknown what supplementary mitigation measures may be required in response to a particular situation, some hypothetical examples are provided in Table 11 below. These are examples of potential issues not considered to-date but describe useful and tested responses from other wind farms in addressing the issues. Should these be implemented as a management response at C2WF the response of birds and bats to these measures will be recorded.

The purpose of investigations will be to identify clearly the most relevant and effective mitigation measures.

In the event that turbine shutdown as a mitigation approach for a specific species management objective is considered necessary by DPE, it will be based on specific advice from OEH and agreed with the proponent. Turbine shutdown should be considered as a last resort, once all mitigation options are exhausted. This information should include, but not be limited to:

- Ongoing acceptable impacts, including the level of risk to the species' population at any scale, 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.

Table 11: Supplementary mitigation measures in the event of an unacceptable impact trigger occurring

Hypothetical cause of impact	Mitigation Measure[2]	Likelihood of impact continuing following mitigation	Time to implementation
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.
	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) or, if risk is high, supplementary feeding		Implement according to agreed plan
Farming practice attracts threatened species to risky areas (e.g. grain feeding of stock)	Investigate whether farming practice is a contributing factor and if so, subject to landowner agreement relocate farming further from turbines to reduce risk	Low	Immediately
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 in the event that threatened species are experiencing unacceptable impacts.	Low	Immediately low visibility is identified as the cause of unacceptable impacts on threatened species.
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, or • Remove lights, where practicable • All lights switched off except when needed for service work	Low	If lights can be switched off, this should occur immediately. Alternative measures should be implemented as soon as practicable after recording the impact trigger.
Attraction to small dams on site	Subject to landowner agreement, fill in dam and provide alternative stock watering arrangements	Low	Implement as soon as possible after recording the impact trigger if the dam is the cause of the problem.
Nest site close to turbine	Discourage nesting close to turbines	Low	Prior to breeding season.

[2] 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 3 and 4, and may not include any of these examples if they are not relevant.

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	Pre-construction • Bird surveys - Feb and Nov 2017 (Completed) • Bat surveys – Autumn and spring-summer 2017 (Completed)	Adequate baseline bird and bat utilisation surveys have been undertaken, in consultation with OEH as followed: • Bird utilisation surveys undertaken as described in this BBAMP – Feb and Nov 2017. • Bat utilisation surveys undertaken as described in this BBAMP – Autumn and spring-summer 2017. •	Yes
Post-Construction surveys	Post-construction bird utilisation surveys	Operational phase	• Bird utilisation surveys undertaken twice yearly for the first two years of operation of C2WF, replicated at the same two seasons as the baseline BUS (summer and spring).	
Mortality monitoring	50% of turbines to be surveyed each month to 100 metres in accordance with the inner- and outer zone search protocol. The same turbines will be searched each month for a period of 24 months, following which the need for further surveys will be reviewed based on the results of the first two years of monitoring.	Operational phase monthly until end of 24 months	• Operational phase mortality surveys undertaken monthly at least 18 turbines for at least two years, with a review after the first years 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 should 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 full year of monitoring	
	Obtaining operational phase bird and bat mortality data	Operational phase	• As per results of the mortality monitoring in this BBAMP	
Annual Reports	Preparation of Annual Reports to be submitted to Secretary and OEH for the first two years after the completion of a year's monitoring activities.	Operational phase– after years one and two.	• Annual reports for the first two years 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	
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 management log book • 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.		If mortality at turbines near light sources significantly exceeds that of activity at unlit turbines, type and duration of lighting will need to be reviewed, subject to security and OH&S limitations.	
	Remove permanent lights on buildings and sub-stations to avoid light spillage and visibility from above.			

Management objectives	Management activities and controls	Timing	Performance criteria for measuring success of methods	Completed (yes/no)
	Baffle security lighting to avoid light spillage and visibility from above.			
	Use of deterrents – Where required, overhead powerlines should have marker balls and/or flags where they cross waterways		No incidental records of bird mortality from power line collision around waterways.	

7. REFERENCES

AusWEA (2005) Wind Farms and Birds: Interim Standards for Risk Assessment, prepared by Brett Lane & Associates Pty Ltd and Aria Environmental Pty Ltd for AusWEA

American Bird Conservancy 2014, http://www.abcbirds.org/newsandreports/stories/080319_oil.html Accessed 25th January 2014.

Arnett EB, Erickson WP, Kerns J and Horn J 2005. Relationships between bats and wind turbines in Pennsylvania and West Virginia: An assessment of fatality search protocols, patterns of fatality, and behavioural interactions with wind turbines. A final report submitted to the Bats and Wind Energy Cooperative. Bat Conservation International. Austin, Texas, USA.

Barrett G, A Silcocks, S Barry, R Cunningham & R Poulter 2003, *New Atlas of Australian Birds*, Royal Australasian Ornithologists' Union, Melbourne.

Beier, P 2006. Effects of artificial night lighting on terrestrial mammals. Pp 19-42 In "Ecological Consequences of Artificial Night Lighting". (Rich, C. and T. Longcore, eds.). Island Press. Washington, D.C.

Brett Lane and Associates 2009, Bald Hills Wind Farm, Bat and Avifauna Management Plan, Report No. 9067 (2.0), September 2009.

Brett Lane & Associates 2011a, Capital Wind Farm, Bird and Bat Adaptive Management Program, Report No. 9142 (1.2) approved in Dec 2009 and revised in 2010 and 2011. Prepared for Renewable Power Ventures Ltd (now Infigen).

Brett Lane & Associates 2011b, Mt Gellibrand Wind Farm, Bird and Avifauna Management Plan, prepared for Acciona Energy Oceania Ltd, Report No. 8229 (4.13), approved December 2011.

Brett Lane & Associates 2011c, Woodlawn Wind Farm, Bird and Bat Adaptive Management Program, prepared for Infigen Energy Ltd, Report No. 11035 (1.4), October 2011.

Brett Lane & Associates 2012a, Hawkesdale Wind Farm, Bird and Avifauna Management Plan, prepared for Union Fenosa Wind Australia Ltd, Report No.9067 (2.4), February 2012.

Brett Lane and Associates 2012b, Mount Mercer Wind Farm, Bat and Avifauna Management Plan, Report No. 8076 (2.8), approved September 2012.

Brett Lane & Associates 2012c, Mortlake South Wind Farm, Bird and Avifauna Management Plan, prepared for Acciona Energy Oceania Ltd, Report No.12020 (1.16), approved December 2012.

Brett Lane & Associates 2012d, Ryan Corner Wind Farm, Bird and Avifauna Management Plan, prepared for Union Fenosa Wind Australia Ltd, Report No.9067 (4.4), February 2012.

Brett Lane & Associates 2013a, Berrybank Wind Farm, Flora and Fauna Management Plan, Report No. 7152 (10.8) approved in August 2013. Prepared for Berrybank Development Ltd.

Brett Lane & Associates 2013b, Crowlands Wind Farm, Bird and Bat Management Plan, prepared for Pacific Hydro, Report No. 11176 (1.10), April 2013.

Brett Lane & Associates 2013c, Lal Lal Wind Farm, Bird and Bat Management Plan, prepared for WestWind Energy Ltd, Report No. 6150 (5.0), February 2013.

Brett Lane & Associates 2014, Taralga Wind Farm, Construction Environmental Management Plan, Report No. 8129 (1.12). Prepared for CBD Energy, January 2014.

Brett Lane & Associates 2015, "Crookwell Stage 2 Wind Farm: Supplementary Ecological Impact Assessment of Proposed Modifications (MOD2)", report prepared for Crookwell Development Pty Ltd by BL&A, Hawthorn East, Victoria.

Brett Lane & Associates 2017, "Crookwell 2 and 3 Wind Farms: Bird and Bat Utilisation Surveys", report prepared for Crookwell Development Pty Ltd by BL&A, Hawthorn East, Victoria.

Brunner, H, Loyd, JW and Coman, BJ 1975. Fox scat analysis in a forest park in south-eastern Australia, *Australian Wildlife Research*, 2: 147-154.

Catling, PC 1988. Similarities and contrasts in the diets of foxes, *Vulpes vulpes*, and cats, *Felis catus*, relative to fluctuating prey populations and drought, *Australian Wildlife Research,* 15: 307-317.

Churchill, S 1998. *Australian Bats*, 1st Ed, New Holland, Sydney.

Churchill, S 2008, *Australian Bats*, 2nd Ed, Jacana Books, an imprint of Allen & Unwin, Crows Nest, New South Wales.

Clean Energy Council (CEC) 2013. Best Practice Guidelines for Implementation of Wind Energy Projects in Australia. Clean Energy Council, Australia.

DoTEE (Department of the Environment and Energy) 2017, *EPBC Act Protected Matters Search Tool*, Commonwealth Department of the Environment, viewed 14th March 2017, http://www.environment.gov.au

Emison, WB, Beardsell, CM, Norman, FI Loyn, RH, & Bennett, SC 1987, *Atlas of Victorian Birds,* Department of Conservation, Forests and Lands & Royal Australasian Ornithologists Union, Melbourne.

Ferguson-Lees, J & Christie, DA 2001, *Raptors of the World*, Christopher Helm Publishers.

Gauthreaux Jr., S A & Belser C G 2006. Effects of artificial night lighting on migrating birds. Pp 67–93. In "Ecological Consequences of Artificial Night Lighting". (Rich, C. and T. Longcore, eds.). Island Press. Washington, D.C.

Higgins, PJ (ed) 1999, *Handbook of Australian, New Zealand and Antarctic Birds, Volume 4: Parrots to Dollarbird*, Oxford University Press, Melbourne.

Higgins, PJ & Davies, SJJF (eds) 1996, *Handbook of Australian, New Zealand & Antarctic Birds,* Volume 3 Snipe to Pigeons, Oxford University Press, Melbourne.

Higgins, PJ, Peter, JM & Steele, WK (eds) 2001, *Handbook of Australian, New Zealand and Antarctic Birds, Volume 5: Tyrant-flycatchers to Chats*, Oxford University Press, Melbourne.

Higgins, PJ & Peter, JM (eds) 2002, *Handbook of Australian, New Zealand and Antarctic Birds, Volume 6: Pardalotes to Shrike-thrushes*, Oxford University Press, Melbourne.

Higgins, PJ, Peter, JM & Cowling, SJ (eds) 2006, *Handbook of Australian, New Zealand and Antarctic Birds*, Volume 7: Boatbill to Starlings, Oxford University Press, Melbourne.

Hull, C L & Muir, S, 2010, Search areas for monitoring bird and bat carcasses at wind farms using a Monte-Carlo method. Austr. J. Env. Management 17:77-87.

Hull, C L, E M Stark, Peruzzo, C and Sims, C C, 2013, Avian collisions and two wind farms in Tasmania, Australia. NZ J Zool 40:47-62

Kennedy, SJ & Tzaros, CL 2005, Foraging ecology of the Swift Parrot *Lathamus discolor* in the Box-ironbark forests and woodlands of Victoria, *Pacific Conservation Biology* 11, 158 – 173.Marchant, S & Higgins, PJ (eds) 1993, *Handbook of Australian, New Zealand and Antarctic Birds, Volume 2, Raptors to Lapwings*, Oxford University Press, Melbourne.

Longcore, T, Rich, C & Gauthreaux Jr., S 2008, Height, guy wires, and steady-burning lights increase hazard of communication towers to nocturnal migrants: A review and meta-analysis, The Auk, 125(2): 485-492.

Marchant, S & Higgins, PJ (eds) 1993, Handbook *of Australian, New Zealand and Antarctic Birds, Volume 2, Raptors to Lapwings*, Oxford University Press, Melbourne.

Morris AK, AR McGill & G Holmes 1981, *Handlist of Birds in New South Wales*, New South Wales Field Ornithologists Club, Sydney.

NSW Scientific Committee 2010, Little Eagle Hieraetus morphnoides (Gould, 1841) - vulnerable species listing, http://www.environment.nsw.gov.au, viewed 15th March 2017.

NSW Scientific Committee 2016, Threatened Species Conservation Act Schedules 1, 2 and 3, http://www.environment.nsw.gov.au, viewed 16th March 2017.

Office of Environment and Heritage (OEH) 2017a, *NSW BioNet*, NSW Office of Environment and Heritage, viewed 16th March 2017, http://www.bionet.nsw.gov.au

Office of Environment and Heritage (OEH) 2017b, *NSW BioNet*: *Goulburn Mapsheet no. 8828*, NSW Office of Environment and Heritage, viewed 14th March 2017, http://www.bionet.nsw.gov.au

Office of Environment and Heritage (OEH) 2017c, *Threatened species profile search*, NSW Office of Environment and Heritage, viewed 15th March 2017, http://www.environment.nsw.gov.au

Pizzey, G & Knight, F 2003, *Graham Pizzey & Frank Knight: The Field Guide to the Birds of Australia*, HarperCollins Publishers, Australia.

Rollason, V, Fisk, G, Haines, P 2010, *Applying the ISO31000 Risk Assessment Framework to Coastal Zone Management,* Proceedings of the 20th NSW Coastal Management Conference.

Tzaros, C 2005, Wildlife of the Box-Ironbark Country. CSIRO Publishing, Melbourne.

URS 2004a, *A Survey and Impact Assessment of the Terrestrial Flora and Fauna of the Proposed Crookwell 2 Wind Farm*, prepared for Wind Farm Joint Venture by URS, July 2004.

URS 2004b, *Crookwell 2 Wind Farm: Environmental Impact Statement*: Volume 1 Main Report, Volume 2 Appendices and Volume 2A Appendices, July 2004.

Appendix 1: Carcass Search Data Sheet

Crookwell 2 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**				
Crookwell 2 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				