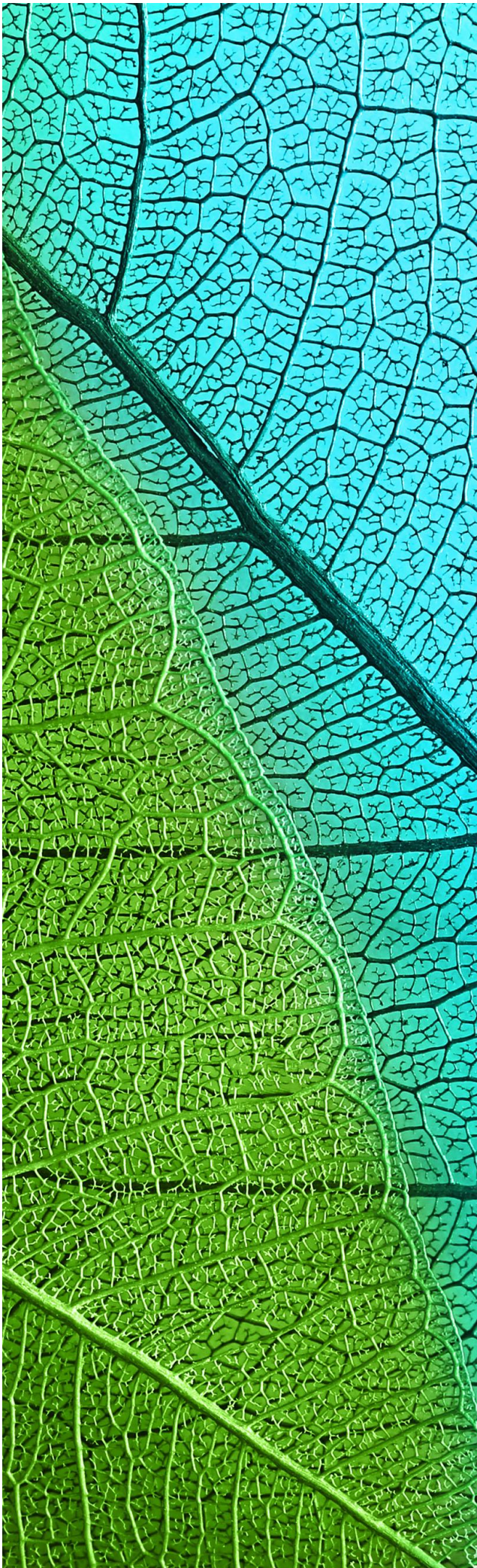




**PLANNING and ENVIRONMENT ACT
MOYNE PLANNING SCHEME**

**PERMIT NO. 20060221-2
CODNITION 30
MODIFIED ENDORSED PLAN
Sheet 1 of 71**

Signed:  for
MINISTER FOR PLANNING
Date: 3 JUNE 2024

Hawkesdale Wind Farm

Bat and Avifauna Management Plan

**Prepared for Hawkesdale Asset Pty
Ltd as trustee for Hawkesdale Asset
Trust (HAPL), a wholly owned
subsidiary of Global Power
Generation Australia Pty Ltd
(GPGA)**

May 2024
Report No. 14144 (17.7)



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Contents

1. INTRODUCTION	1
1.1. BAMP Objectives.....	4
1.2. Site description.....	4
2. PRE-CONSTRUCTION MONITORING PROGRAM	8
2.1. Previous studies	8
2.1.1. Desktop review	8
2.1.2. Ecological assessment.....	8
2.1.3. Bat Survey 2007	9
2.1.4. Updated Desktop Assessment	10
3. ROUTINE REPORTING, REVIEW MEETINGS, DATA ACQUISITION AND PERSONNEL	16
3.1. Routine reporting and review meetings.....	16
3.2. Data acquisition/submission and personnel involved.....	17
4. POST CONSTRUCTION UTILISATION SURVEY PROGRAM.....	19
4.1. Brolga risk assessment surveys	19
4.1.1. Breeding season Brolga monitoring.....	21
4.1.2. Reporting	22
4.2. Southern Bent-wing Bat risk assessment surveys	24
4.2.1. Methodology	24
4.2.2. Analysis and assessment	24
4.2.3. Reporting	25
5. POST CONSTRUCTION MORTALITY DETECTION PROGRAM	26
5.1. Mortality detection	26
5.1.1. Trained personnel	27
5.1.2. Turbine selection.....	27
5.1.3. Search protocol	28
5.1.4. Scavenger rates and trials.....	31
5.1.5. Detectability trials.....	34
5.1.6. Analysis and data limitations.....	35
5.2. Incidental Carcass Protocol	36
5.3. Injured Bird and Bat Protocol	36
6. POST CONSTRUCTION INTENSIVE MONITORING AND MORTALITY ESTIMATES PROGRAM.....	37
6.1. Intensive Southern Bent-wing Bat monitoring program.....	37
6.2. Mortality estimation	37

Current mortality estimates require the following.....	37
7. IMPACT TRIGGERS, MITIGATION AND OFF-SETS	39
7.1. Raptor risk reduction measures.....	39
7.2. Definition of impact trigger	40
7.3. Mitigating significant impacts.....	40
7.4. Impact triggers for Southern Bent-wing Bat	42
7.5. Offsetting significant impacts	48
8. COMPLIANCE SUMMARY	51
9. TIMEFRAMES AND RESPONSIBLE PERSONELL.....	52
10. REFERENCES	54
11. GLOSSARY	57

Tables

Table 1: Location and distance of Southern Bent-wing Bat maternity and non-maternity caves in relation to the Hawkesdale site (Table adapted from ACCIONA Energy (2009)).....	7
Table 2: Threatened bird and bat species likely to occur on the Hawkesdale wind farm site (BL&A 2010) (updated with most recent listings as of submission of this report).....	13
Table 3: Timing for scavenger trials	32
Table 4: Number of replicates for each scavenger trial.....	32
Table 5: Number of replicates per season for detectability trials, given two factors of size and visibility	34
Table 6: Mortality of Southern Bent-wing Bat at wind farms in Victoria (known till January 2024).....	42
Table 7: Turbines within 600 metres of each individual turbine	46
Table 8: Sections within the BAMP that comply with the conditions of the Planning Permit for Hawkesdale Wind Farm	51
Table 9: Approximate timeline for surveys and reporting after commissioning of turbine chains (below referred as operation) on the Hawkesdale Wind Farm	52

Figures

Figure 1: Hawkesdale Wind Farm illustrating pre-construction bird utilisation survey points.	6
Figure 2: Brolga breeding sites and wetlands	23
Figure 3: Visual representation of 'scent cones'	29
Figure 4: Scent detection dog search pattern	30
Figure 5: Operational procedure for investigating impact triggers.....	50

Appendices

Appendix 1: Carcass data-sheet for any carcass searches, scavenger and detectability trials and incidental finds	58
Appendix 2: Symbolix letter 24 November 2020	59

1. INTRODUCTION

Nature Advisory Pty Ltd (formerly Brett Lane and Associates Pty. Ltd. (BL&A)) and Symbolix Pty. Ltd. were engaged by Hawkesdale Asset Pty Ltd as trustee for Hawkesdale Asset Trust (HAPL), a wholly owned subsidiary of Global Power Generation Australia Pty Ltd (GPGA) to develop a Bat and Avifauna Management Plan (BAMP) for the Hawkesdale Wind Farm in accordance with conditions in the Hawkesdale Wind Farm Planning Permit (Permit No.:20060221). The BAMP was prepared, submitted to the satisfaction of the Minister for Planning, and endorsed by the Department of Energy, Environment and Climate Action (DEECA, formerly DELWP) to form part of the original wind farm permit. An amended planning permit was issued 21 December 2017 (Permit No.: 20060221-B) and as such Nature Advisory was engaged by HAPL, a wholly owned subsidiary of GPGA to amend the BAMP according to the conditions in the new permit.

The BAMP has since been amended in accordance with the amended planning permit issued for Hawkesdale Wind Farm on 20 October 2022 (Permit No. 20060221-2). This BAMP is required to be approved by the Minister for Planning prior to the commissioning of the first turbine in accordance with condition 30 of the amended planning permit.

The approved Hawkesdale Wind Farm site lies in south-western Victoria, immediately south of Hawkesdale Township and approximately 50 kilometres north of Port Fairy. The approved wind farm would include 23, 4.2-megawatt wind turbines of up to 180 metres above natural ground level. The land is presently used for sheep and cattle grazing and has been subjected to a long history of agricultural activity. The entire site comprises cleared grazing land with a limited number of small areas that support remnant native vegetation.

The Minister for Planning has issued an amended planning permit for the use and development of the land and removal of native vegetation for the Hawkesdale Wind Farm (Moyne Planning Scheme, Permit Number: 20060221-2). Under the conditions of this permit, bird and bat targeted surveys and a BAMP must be prepared to the satisfaction of the Minister for Planning in consultation with the DELWP Environment Portfolio (now DEECA). When approved by the Minister the plan will be endorsed to form part of the amended permit. These conditions state that:

- “28. Within 3 months of the issue of this amended permit, unless extended by the Minister for Planning, a methodology must be prepared for a targeted assessment to determine the utilisation of the site by the threatened bird and bat species identified in the report titled, *Hawkesdale Wind Farm Application for Planning Permit by Gamesa Energy Australia/TM E Australia Volume 1 – Main Report and Volume 2 – Annexes, September 2006*. A methodology for the assessment, shall be developed in consultation with the DELWP Environmental Portfolio to the satisfaction of the Minister for Planning.
29. The targeted assessment must be carried out, to the satisfaction of the Minister for Planning, during the period between the approval of the methodology and the commissioning of the last turbine.
30. Prior to the commissioning of the turbine, and based on the findings of the targeted assessment, a Bat and Avifauna Management Plan (BAMP) to the satisfaction of the Minister for Planning must be prepared in consultation with the DELWP Environmental Portfolio and must be submitted to and approved by the Minister for Planning. When approved the plan will be endorsed and will then form part of the permit. The BAMP must include:

- (a) *a statement of the objectives and overall strategy for managing and mitigating any significant bird and bat strike arising from the wind energy facility operations;*
 - (b) *a monitoring program of at least 2 years duration, either commencing upon the commissioning of the last turbine of the first stage of the approved development and use (if any) or alternatively, such other time of commencement as is to the satisfaction of the Minister for Planning. The monitoring program must include surveys during the breeding and migratory seasons to ascertain:*
 - (i) *the presence, behaviour and movements of any Brolga, especially breeding pairs in the vicinity of the wind energy facility;*
 - (ii) *the presence, behaviour and movements of the Southern Bent-wing bat in the vicinity of the wind energy facility;*
 - (iii) *the species and number, age and sex (if possible) and date of any birds and bat mortality arising from the wind energy facility operations;*
 - (iv) *procedures for the reporting of any detected threatened bird or threatened bat mortality arising from the operation of the wind energy facility to the DELWP Environmental Portfolio and the responsible authority within 7 days of becoming aware of any mortality;*
 - (v) *seasonal and yearly variation in the number of bird and bat mortalities arising from the operation of the wind energy facility;*
 - (vi) *whether bird and bat mortalities were at lit or unlit turbines;*
 - (vii) *the efficacy of searches for carcasses of birds and bats and information on the rate of removal of carcasses by scavengers, so that correction factors can be determined to enable calculations of the total number of mortalities;*
 - (viii) *procedures for regular removal of carcasses likely to attract raptors to areas near turbines; and*
 - (ix) *requirements for periodic reporting, within agreed timeframe of the findings of the monitoring to the DELWP Environmental Portfolio, the responsible authority and the local community;*
 - (c) *recommendations in relation to a mortality rate for specified species which would trigger the requirement for responsive mitigation or offset measures to be undertaken by the proponent to the satisfaction of the Minister for Planning; and*
 - (d) *a strategy developed in consultation with DELWP Environmental Portfolio and to the satisfaction of the Minister for Planning to mitigate or offset any impacts in relation to the threatened or significantly affected native bird or bat species detected during monitoring. Measures to offset the impact may include management or improvement of habitat or breeding sites away from the wind energy facility in the region to improve breeding productivity, or other offsets to the satisfaction of the Minister for Planning.”*
31. *Following the completion of the two-year monitoring program in condition 30, a report must be prepared by the operator of the wind energy facility setting out the findings of the program and in particular assessing any cumulative impact of the wind energy facility on bird and bat species, to the satisfaction of the Minister for Planning. The report should be generally in*

accordance with Windfarm collision risk for birds: Cumulative risks for threatened and migratory species, Department of Environment and Heritage (2006) and any general framework for cumulative impact studies if issued by the minister for planning at the end of the two-year monitoring program.

32. *If, after consideration of this report, the Minister for Planning directs that further investigation of potential or actual impacts on birds and bats is to be undertaken, the extent and details of the further investigation must be prepared in consultation with DELWP Environmental Portfolio and to the satisfaction of the Minister for Planning, and the investigation must be carried out to the satisfaction of the Minister for Planning.*

This BAMP is based on a previous version of the BAMP developed in consultation with DEECA (formerly Department of Environment, Land, Water and Planning (DELWP)) over the last 10 years. Versions of the BAMP were provided to the then Department of Sustainability and Environment (DSE) (now DEECA) in 2012 and agreement reached on content. DEECA provided comments on the plan in 2019 which this current version of the BAMP addresses.

This BAMP details objectives and strategies that meet the requirements of the above approval conditions. Commissioning is proposed to be undertaken in stages. As such, the methodology of the BAMP will be applied to each turbine chain as it is completed, rather than on completion of the entire wind farm. The implementation of the plan must be overseen by a qualified ecologist/ecological consultancy with relevant tertiary degrees or experience. The qualified ecologist(s), employed by the wind farm operator, will be responsible for overseeing and implementing the BAMP according to the provisions stipulated in this document. This Plan is divided into three main sections: Compliance; DEECA specified assessments; and Compliance mitigation and summary. These are further subdivided as follows and written in-text:

Compliance – See Section 8 below for a table of compliance

Section 2 details the pre-construction bird and bat monitoring programs;

Section 3 specifies the routine reporting and review meetings;

Section 4 provides an outline of the aims and methodology of the post-construction utilisation surveys for the two species of concern;

Section 5 details the aims and methodology of the post-construction mortality surveys for the two species of concern.

DEECA specified assessments

Section 6 outlines intensive Southern Bent-wing Bat mortality surveying and details post-construction mortality estimate calculation for the two species of concern;

Compliance mitigation and summary

Section 7 discusses raptor risk reduction measures and describes what is considered to be an ecological significant impact and outlines a general procedure for implementing species-specific mitigation and offset measures;

Section 8 & 9 provide a compliance summary and an approximate timeline of the work.

This plan was prepared by a team from Brett Lane & Associates Pty. Ltd., comprising Khalid Al-Dabbagh (Ecologist and Ornithologist), Davide Coppolino (Senior Ecologist), Megan Price (Zoologist),

Gabrielle Roy (Zoologist), Dr Sergio Nolasco Plasier (Zoologist), Jackson Clerke (Zoologist and Project Manager), Brett Lane (Managing Director) and Stuart Muir (Statistician: Symbolix Pty. Ltd.).

1.1. BAMP Objectives

The overall aim of this BAMP is to ensure that operation of the Hawkesdale Wind Farm will not prejudice the survival of populations of bat and bird species of concern, including:

- *Southern Bent-wing Bat*;
- *Brolga*; and
- *Any bat or bird species listed on the Australian Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act), the Victorian Flora and Fauna Guarantee Act 1988 (FFG Act) or the Advisory list of Threatened Vertebrate Fauna in Victoria - 2013.*

The objectives will be achieved by establishing monitoring and management protocols, consistent with the methods provided in Australian Wind Energy Association (2005), adapted, where appropriate, based on more up to date knowledge.

The specific objectives of this plan, derived from the planning permit condition, are listed below, and the sections of this plan that address them are also indicated.

- Measure the numbers of birds and bats, specifically in regards to the Brolga and Southern Bent-wing Bat, affected by the operation of the Hawkesdale Wind Farm commencing after each turbine chain becomes operational (Section 5);
- Provide a context for measuring the impact of the Hawkesdale Wind Farm on the Brolga and any bird species of concern listed on state and Australian legislation (Section 4.1);
- Provide a context for measuring the impact of the Hawkesdale Wind Farm on the Southern Bent-wing Bat and any bat species of concern listed on state and Australian legislation (Section 4.2); and
- Establish protocols and procedures for identifying, reporting, and mitigating any bird and bat impacts of the Hawkesdale Wind Farm, including any significant impacts (Section 8).

1.2. Site description

The site lies immediately south of Hawkesdale Township and approximately 50 km north of Port Fairy (approx. centre 38° 7'S, 142° 21'E). The wind farm site is approximately 2,000 hectares in area would include a total of 23 wind turbines (Figure 1). The land is presently used for sheep and cattle grazing and has a long history of agricultural use and activity. The entire site is cleared grazing land with a limited number of small remnant areas of native vegetation and is regularly grazed by livestock.

The study site comprises a combination of flat areas and low, undulating hills and is between 125 and 155 m above sea level. The flat and hilly areas consist mainly of grazing paddocks covered with various exotic grasses and they are therefore highly disturbed. Very little native vegetation existed on the site; however, some eucalypt trees are planted either on their own or growing within lines of pines used as windbreaks. Most of the eucalypt trees on site were non-indigenous species.

An old and deserted railway line traversed the wind farm site at its eastern section running in a north-south direction. Exotic trees and pines are planted along most of its length together with small linear remnant of native trees mostly Blackwood. The wind farm site is also traversed by the Austin Creek which runs in a north to south-westerly direction. The creek was dry with very little water at parts through its length within the wind farm. The creek valley was wide at parts, but mainly covered with

exotic grasses with few aquatic vegetation growing in the middle of creek course although mostly dry particularly the reed beds. This ephemeral creek can be dry for up to eight months of the year.

The northern end of the creek is partly dammed and a small to medium sized wetland is formed. The water pond contained few emergent types of vegetation, but most of its edges were bare and subjected to trampling by watering stock. In addition to Austin Creek, the wind farm site also contained a number of stock watering dams, most were devoid of vegetation and with bare edges. The dams were observed to attract few common farmland ducks.

A review of Southern Bent-wing Bat roosting locations in south-west Victoria indicated that 14 caves were of significant value to the species (Table 1). Seven of the 14 caves lie within a 70 km radius of the site (the known SWBW dispersal range in one night; Bush *et al.* 2022, van Harten *et al.* 2022).

Figure 1: Map of Hawkesdale Wind Farm showing the location of the bird utilisation survey points

Project: Hawkesdale Wind Farm
Client: Global Power Generation Australia
Date: 15/06/2023

- Hawkesdale WF boundary
- Turbine location
- Bus Utilization Points
- Reference Points

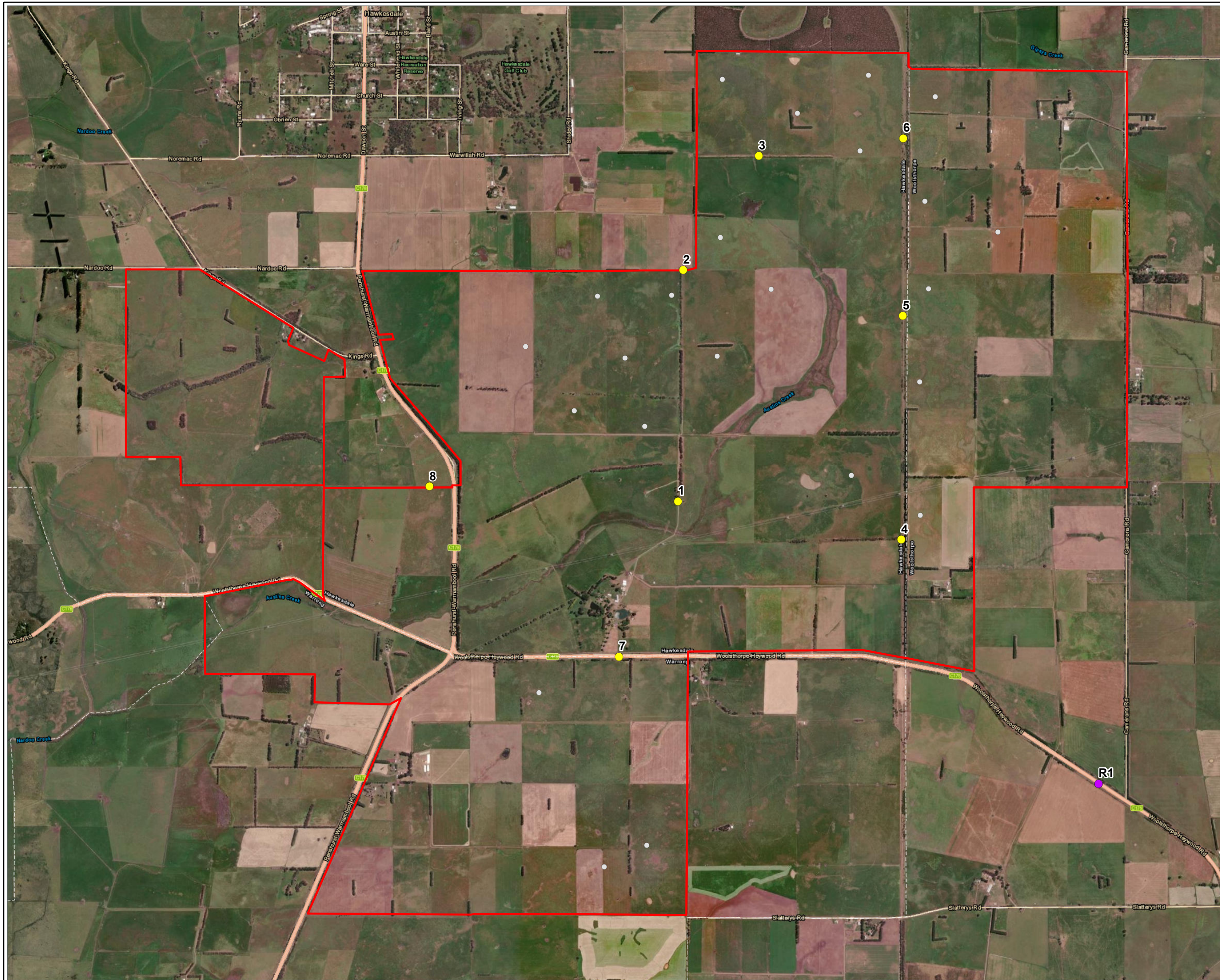


Table 1: Location and distance of Southern Bent-wing Bat maternity and non-maternity caves in relation to the Hawkesdale site (Table adapted from ACCIONA Energy (2009))

Region (ranked distance from site)	Location name	Approx. distance from site (km)	2009 status
Grasmere	Grasmere Cave	25	Large numbers - high conservation value
Yambuk	Yambuk Cave	35	Still used as an important roost
Mt Eccles National Park	Harman's Cave	40	Still used as an important roost
Byaduk	Church Cave	40	A few bats, many at other times
Cape Volney	Panmure Cave	40	Large numbers - high conservation value
Warrnambool	Starlight Cave	40	Primary maternity roost known from Victoria, used by about 17,000-18,000 bats. One of only three maternity sites known for this species
Timboon	Timboon Cave	65	Indicated as roost cave by DEECA
Bats Ridge National Park	Tom-the-Cheap Cave	80	Usually lots of bats
Porndon	Porndon Arch	85	Still used as an important roost
Portland	Cape Bridgewater Sea Cave	90	Maternity site used by about 1,000-1,500 bats
Lower Glenelg National Park	Un-named (McLennan's Punt?)	105	Reasonable numbers
Cape Volney	Un-named	110	Still used as an important roost
Cape Patton	Un-named	145	Still used as an important roost
Lorne	Cumberland River Cave	160	Still used as an important roost

2. PRE-CONSTRUCTION MONITORING PROGRAM

2.1. Previous studies

A number of investigations were undertaken between 2005 and 2007 to document the pre-construction usage of the wind farm site by birds and bats and meet the Permit Conditions 28 and 29. These included:

- A desktop review carried out by Environmental Resources Management (ERM) Australia;
- Hawkesdale Wind Farm Ecological Assessment, ERM Australia (2006);
- A bat survey carried out by Greg Richards and BL&A in 2007; and
- Pre-construction bird and bat studies undertaken as part of the Risk Assessment Method and based on comments of DSE in 2009 (see BL&A 2010). This was undertaken in relation to the Permit Condition 17 of the initial permit (now referenced as Condition 28 and 29 of the amended permit). This condition which required a targeted assessment to be undertaken, to the satisfaction of the Minister for Planning, of listed threatened bird and bat species likely to utilise the site.

2.1.1. Desktop review

A desktop assessment of the site was undertaken in July 2005. This included a review of existing background literature, relevant databases, and consultation with local interest groups and DEECA staff.

The desktop assessment indicated that 18 bird, seven mammal, three reptile, two fish and one frog species may occur on, or in the vicinity of, the wind farm site. Of the 31 species, 23 are listed under the EPBC Act and 19 under the FFG Act.

The desktop report concluded that most of these species were either unlikely to occur or had a low likelihood of occurrence on the wind farm site. However, ten of the 30 species were considered more likely to occur on study area. These included:

- **Birds:** Latham's Snipe (*Gallinago hardwickii*), Eastern Great Egret (*Ardea alba*), Brolga (*Grus rubicundus*) and Nankeen Night Heron (*Nycticorax caledonicus*);
- **Mammals (bats):** Southern Bent-wing Bat (*Miniopterus orianae bassanii*), Large-footed Myotis (*Myotis macropus*), White-striped Freetail Bat (*Austronomus australis*) and Grey-headed Flying-fox (*Pteropus poliocephalus*);
- **Reptiles:** Glossy Grass Skink (*Pseudomoia rawlinsoni*) and Swamp Skink (*Egernia conventryi*); and
- **Amphibians:** Growling Grass Frog (*Litoria raniformis*).

2.1.2. Ecological assessment

An ecological study was undertaken by ERM for Gamesa Energy Australia/TMEA between July 2005 and June 2006.

Three field trips to study area were undertaken (18–21 July; 21–25 Nov. 2005; and 26–28 June 2006) to assess key biological features. This included general and targeted assessments of flora and fauna across the entire site. Fauna observations are summarized below.

Birds: A total of 25 bird species were recorded during the field assessments. Eighteen of these were native and four were introduced species. None of the species identified were listed as rare or threatened within Victoria.

The most common birds recorded included native ravens, Australian Magpies, Magpie-larks, Willie Wagtails and Welcome Swallows as well as introduced European Skylarks and European Goldfinches. In addition, few woodland bird species were common at study area including the Sulphur-crested Cockatoo, Long-billed Corella and Yellow-tailed Black-cockatoo.

No waterbirds were recorded at Austin's Creek during the assessments. Waterbirds recorded in the vicinity, and flying over the wind farm included Australian White Ibis, Straw-necked Ibis, Pacific Black Duck and Australian Wood Duck. These species were considered likely to occur in study area. No waterbird nests were seen in the study area.

Mammals: Sightings and evidence of the Red Fox, European Rabbit and Hare were recorded in the study area. No evidence of native ground-dwelling mammals was recorded in the study area. Basalt rock, stone piles, vegetation cover and debris were generally absent across study area. Therefore, the wind farm site was considered to be unlikely to provide suitable habitat for native ground-dwelling mammals.

Bats: Species confirmed to occur in the wind farm area included Gould's Wattled Bat, Chocolate Wattled Bat and the White-striped Free-tailed Bat. The Southern Free-tailed Bat and Southern Forest Bat were assessed as likely to occur, although insufficient calls (passes) were available to confirm their presence. The Large-footed Myotis, Little Forest Bat and an unidentified Long-eared Bat also had the potential to occur in the wind farm boundary, although this could not be confirmed from the available data.

Reptiles and Amphibians: The following four frog species were recorded during the diurnal frog searches undertaken by ERM in November 2005: Spotted Marsh Frog, Striped Marsh Frog, Southern Brown Tree Frog and Common Eastern Froglet.

No reptiles were recorded during the assessments despite active searching under loose rocks and debris in study area and within the rail reserve.

2.1.3. Bat Survey 2007

Greg Richards and Associates Pty Ltd and Nature Advisory undertook further investigations of the bat fauna on the wind farm site during February 2007. Results of this survey are reported by G. Richards in his witness statement prepared for TME Australia (2007). The survey was carried out over 11 nights (14 – 24 February 2007) from two habitats (Austin's Creek and the railway reserve) within the wind farm boundary. The study recorded ten bat species, seven of which were common and secure bat species. One of the recorded species was widespread but uncommon and two were listed threatened species. The bat species of concern (i.e., with regards to state and federal legislation and policies) within the wind farm site are described below.

- The **Southern Bent-wing Bat** is listed as critically endangered under the EPBC Act, threatened under the FFG Act and endangered on the DSE Advisory List of Threatened Fauna in Victoria. It was recorded on 22 occasions over the sampling period, only at Austin's Creek, and not at the railway reserve site. It was recorded on eight of the 11 survey nights. Greg Richards and associates (2007) found that bats usually follow large patches of remnant vegetation in their movements and did not migrate in mass but dispersed gradually in small groups. Southern Bent-wing Bats may use the wind farm site sporadically during the autumn migration and that a small proportion of the bat population may continually forage in the wind farm site while passing through.
- The **Large-footed Myotis** is listed as near-threatened on the DSE Advisory List. It is a unique bat that forages over water. This species was recorded in the study area on three occasions over 11

nights, averaging 0.3 per night or one bat every 3.6 nights. As this species forages only over water, it is unlikely that it will be significantly affected by the wind farm as the site has little to no standing water.

- The **White-striped Free-tailed Bat** is a common, widespread species. It is a species that flies high and undoubtedly within the rotor-swept-area of wind turbines, exposing it to collision risk with operating wind turbines. It was recorded on 56 occasions with an average about five calls recorded per night.
- The **Eastern Falsistrelle** (*Falsistrellus tasmaniensis*) was recorded once in the wind farm boundary, from five calls over the eleven nights, averaging one pass through the sampling site every two nights. The species is uncommon but not listed under any threatened species lists.

The report found that impacts on the bat populations are not expected to be significant. Most of the bats utilising the wind farm site were found to be common and secured species. Impacts on the Critically Endangered Southern Bent-wing Bat is not expected to be significant as firstly: only a small part of the bat population in south-western Victoria would be expected to pass through the wind farm site, and secondly, the passage of bats through the wind farm site seems to be irregular, preferring to move through remnant vegetation patches (not present near turbines) and some seem to avoid the area altogether. Overall, the study concluded that there would be little to no impact on threatened bat species or common bat populations as a result of the Hawkesdale Wind Farm.

Since this study, further information on the occurrence of the Southern Bent-wing Bat has been obtained from the pre-construction bird and bat monitoring surveys by Dr. Greg Richards who summarised:

“The bat fauna of the Hawkesdale Wind farm is typical of what is expected in farmlands, particularly those with few mature scattered trees that can provide roosting sites. The dominant species for most of the year were common widespread species that are normally found to dominate the bat fauna in wind farm sites in similar predominantly agricultural settings (BL&A, unpublished data). ...

Records of the species at Hawkesdale wind farm indicated that part of the migrating population flies across terrain to the north of the direct migratory line, including sections of the vegetated parts of the wind farm site.

During the initial survey that took place between February 14th and 24th 2007, a recording time comparable to the late February records of 2010, the number of the Southern Bent-wing Bat was very low. A maximum of 22 calls were recorded from two sites within the wind farm. This low level of the activity may indicate one of two scenarios. Either bats migrate at different times during the different years or while migrating bats do not necessarily pass through the wind farm site each year and instead select alternative routes. In either case the passing or presence of the threatened bats in the wind farm site could either be irregular or peak at different times of their post-breeding migration.” (BL&A 2010).

[Updated information regarding the 2010 bat surveys](#)

Similar results were found regarding calls and activity; however, the number of Southern Bent-wing Bat calls was more than the 2007 survey. Calls for this species totalled 447 over a month of surveying. Therefore; the BAMP has been focussed to consider the impact on this species.

[2.1.4. Updated Desktop Assessment](#)

In 2009, an updated desktop assessment was undertaken, covering a search region which included the wind farm and a surrounding ten-kilometre radius.

This assessment was limited to recording listed threatened bird and bat species likely to occur in the wind farm site. The following sources were consulted for this desktop assessment:

- The Atlas of Victorian Wildlife (AVW), a database administered by the DSE (now replaced by the DEECA administered Victorian Biodiversity Atlas) (updated June 2007); and
- The EPBC Act Protected Matters Search Tool (DEWHA 2009).

Seventeen species of listed threatened fauna, including 15 bird and two bat species were considered to be likely to occur in the search region. These are listed in Table 2, which includes a description of their habitat preferences and likelihood of occurrence on the wind farm site.

Of the 15 bird species, three species are nationally threatened (EPBC Act listed), five species are threatened at the state level (DSE 2007) and eight species are listed as migratory species under the EPBC Act.

Seven of the 15 threatened bird species were assessed as unlikely to occur in the wind farm site due to a lack of suitable habitat and are not discussed further. Those that were considered to be likely to occur on site are described below. Note that in the October 2009 pre-construction bird surveys of wetlands on and within 10 kilometres of the Hawkesdale wind farm site, no threatened waterbirds were observed other than the Brolga (see below).

Brolga: This species is known to inhabit freshwater, vegetated wetlands on the Western Victorian Volcanic Plains of Victoria. Nesting and flocking sites of Brolgas are known in the region, but most are more than 20 kilometres away from the wind farm site. The AVW contained five records from the search region from an unnamed locality north of the wind farm site. Taking into consideration these are all situated at the same location, it is likely they are duplicates. The records date from 1991.

During the pre-construction bird surveys (BL&A 2010) one Brolga was found at a wetland on Fitzgerald's Road, approximately eight kilometres north-west of the wind farm site. No other evidence of Brolga activity was found during the survey.

It is possible that Brolga use Austin's Creek as a temporary stopover site. In this case they would fly across the wind farm site. However, considering records of this species are relatively rare in the immediate vicinity, and the limited area of suitable habitat within the wind farm boundary, this is unlikely to occur regularly. For the same reasons, Brolgas are unlikely to breed regularly in or within several kilometres of the wind farm boundary.

Whiskered Tern: The AVW contained two records from the search region, the last of which was in 2001. Both records were from a locality approximately seven kilometres to the north-east of the wind farm. The study area offers limited suitable habitat; therefore, the tern is only likely to temporarily visit the wind farm site during the summer months when wetlands hold water.

Australian Shoveler and Hardhead: The AVW contained two records of the Australian Shoveler dated back to 1987 and one recent record (2006) of the Hardhead from the search area. Parts of Austin's Creek may provide temporary habitat for these ducks and therefore, both ducks may occasionally visit the wind farm site.

Magpie Goose: This species is uncommon and was reintroduced to Victoria in the 1960s and 1970s. The AVW contained one old record (1988) from an area more than one kilometre to the north of the wind farm site. The species is unlikely to regularly visit the wind farm site.

Eastern Great Egret: The egret is widespread in most parts of Victoria and may turn up in any suitable wetland habitats. The species is not threatened because of decline in population numbers, but rather

because of limited breeding ground available to the species in Victoria. The egret has not been recorded previously for the area, including the wind farm site. However, the limited habitat on Austin's Creek may occasionally attract individual egrets to visit and forage in the study area. Such visits would be temporary and infrequent. Therefore, the wind farm is unlikely to have a significant impact of this species at the population level.

Latham's Snipe: This species is migratory and is found in Australia during August–early January. It is widespread and most of its population occurs in Victoria. Although not recorded for the search region (DSE 2007), it is highly likely that few individuals might visit Austin's Creek within the wind farm site. It is difficult to measure impacts on this species associated with the wind farm as the species is highly mobile and would be likely to visit the wind farm site irregularly and for short periods only.

In addition to above bird species, two species of threatened bats were found to occur in the wind farm boundary. These species are described below.

Southern Bent-wing Bat: During the bat survey undertaken in 2007, this species was recorded on 22 occasions over the 11- day sampling period. All records were from Austin's Creek (Greg Richards and BL&A). It was recorded on eight of the 11 survey nights. One to four calls were recorded per night with an average of two calls per night. These results indicated a very low level of activity and were similar to the results from monitoring of wind farms elsewhere in the district. The report concluded that there would be no significant impact at the Hawkesdale Wind Farm upon the Victorian population of the Southern Bent-wing Bat from turbine collision. The Southern Bent-winged Bat was also recorded in the 2009 and 2010 survey.

Large-footed Myotis: This is a unique bat that forages exclusively over water and roosts predominantly in underground structures (Churchill 2008). It was recorded on three occasions over 11 nights during the 2007 bat survey, averaging 0.3 records per night (Greg Richards and BL&A 2010). The species is rare in south-west Victoria, and as the bat report suggested, there would be very little impact on this species from the operation of wind turbines at the Hawkesdale wind farm, due to a low level of activity and the tendency for this species to only forage at permanent sources of open water and to roost in structure located very close to foraging areas (Campbell 2009).

Table 2: Threatened bird and bat species likely to occur on the Hawkesdale wind farm site (BL&A 2010) (updated with most recent listings as of submission of this report)

Common Name	Scientific Name	Conservation status			Habitat	Likelihood of occurrence
		EPBC	DSE	FFG		
Birds						
Australasian Shoveler	<i>Anas rhynchos</i>		VU		Large and deep permanent bodies of water and aquatic flora abundant. Also occurs on billabongs, watercourses and flood waters on alluvial plains, freshwater meadows, shallow swamps, reed swamps, wooded lakes, sewage farms and farm dams.	Habitat limited, low probability of occurrence
Australian Painted Snipe	<i>Rostratula australis</i>	VU	CE	CE	Lowlands on shallow freshwater swamps with emergent vegetation and flooded saltmarshes.	lack of habitats, unlikely to occur
Brolga	<i>Grus rubicunda</i>		VU	E	Wetlands that include permanent open water and deep freshwater marsh.	Habitat present, moderate likelihood of occurrence
Eastern Great Egret	<i>Ardea modesta</i>		VU		Permanent water bodies on flood plains; shallows of deep permanent lakes, either open or vegetated with shrubs or trees; semi-permanent swamps with tall emergent vegetation (e.g. <i>Typha</i>) and herb dominated seasonal swamps with abundant aquatic flora.	Limited Habitat, moderate probability of occurrence present
Hardhead	<i>Aythya australis</i>		VU	V	Inhabits large, deep waters where vegetation is abundant; particularly deep swamps and lakes, pools and creeks. Also occur on freshwater meadows, seasonal swamps with abundant aquatic flora, reed	Habitat limited, low probability of occurrence

Common Name	Scientific Name	Conservation status			Habitat	Likelihood of occurrence
		EPBC	DSE	FFG		
					swamps, wooded lakes and swamps, rice fields, and sewage ponds.	
Latham's Snipe	<i>Gallinago hardwickii</i>	M	NT		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.	moderate probability of occurrence present
Magpie Goose	<i>Anseranas semipalmata</i>		NT	V	Terrestrial and aquatic habitats, but activities centered on wetlands, mainly those on floodplains of rivers.	Habitat limited, low probability of occurrence
Musk Duck	<i>Biziura lobata</i>		VU		It inhabits terrestrial wetlands, estuarine habitats and sheltered inland waters. Almost entirely aquatic; preferring deep water of large swamps, lakes and estuaries, where conditions are stable and aquatic flora abundant	Habitat absent, unlikely to occur
Rufous Fantail	<i>Rhipidura rufifrons</i>	M			Mostly in dense, moist habitats or mid-stories in moist gullies; usually in wet eucalypt forests, less often in dry forests or woodlands.	Habitat absent, unlikely to occur
Satin Flycatcher	<i>Myiagra cyanoleuca</i>	M			Inhabits eucalypt forests, particularly wet sclerophyll forests, and often in gullies or near watercourses. Also in eucalypt woodlands with open understorey.	Habitat absent, unlikely to occur
Swift Parrot	<i>Lathamus discolor</i>	EN	EN	CE	Prefers a narrow range of eucalypts in Victoria, including White Box (<i>Eucalyptus albens</i>), Red Ironbark (<i>E. sideroxylon</i> ; , <i>E. tricarpa</i>) and Yellow Gum (<i>E. lucoxylon</i>), as well as River Red Gum (<i>E.</i>	Uncommon in SW Victoria, lack of habitats, unlikely to occur

Common Name	Scientific Name	Conservation status			Habitat	Likelihood of occurrence
		EPBC	DSE	FFG		
					camaldulensis), when this species supports abundant 'lerp'.	
Whiskered Tern	<i>Chlidonias hybridus</i>		NT		Inhabit shallow terrestrial freshwater wetlands, either permanent or ephemeral, including lakes, swamps, river pools, reservoirs, sewage farms and others.	Habitat present, moderate likelihood of occurrence
White-bellied Sea-Eagle	<i>Haliaeetus leucogaster</i>	M	VU	E	This species is a bird of maritime habitats, terrestrial large wetlands and coastal lands of tropical and temperate Australia and offshore islands, ranging far inland only over large rivers and wetlands.	Habitat absent, unlikely to occur
White-throated Needletail	<i>Hirundapus caudacutus</i>	V	VU	V	Almost exclusively aerial, occur over most types of habitats, but more often over wooded habitats, mainly open forests.	Habitat absent, unlikely to occur
Mammals						
Large-footed Myotis	<i>Myotis macropus</i>		NT		Always associated with permanent, usually slow flowing, water bodies. Records come from wide range of vegetation communities associated with water.	Recorded on site during 2007 bat survey (Greg Richards and BL&A)
Southern Bent-wing Bat	<i>Miniopterus orianae bassanii</i>	CE	CE	CE	Roosts in caves during the day, dispersing over a range of habitats at night. Its feeding areas tend to be associated with major drainage systems.	Recorded on site during 2007 and 2010 bat surveys (Greg Richards and BL&A 2010)

Notes: Rainbow Bee-eater has been de-listed as migratory and is no longer considered as part of the above assessment.

3. ROUTINE REPORTING, REVIEW MEETINGS, DATA ACQUISITION AND PERSONNEL

3.1. Routine reporting and review meetings

This section of the plan outlines the reporting arrangements for the BAMP. Specific reporting guidelines may also be discussed in their respective sections (e.g., Brolga reports in that section), and therefore further clarification should be sought in those sections if sufficient detail is not provided below. Review meetings may be required after reports are submitted and therefore the actual date of these meetings will be determined in the future.

Reporting outlined in this section must be undertaken by a qualified ecologist with a relevant tertiary degree as a minimum.

Brolga activity reports will be prepared in January (for the preceding breeding season) summarising the findings from the targeted Brolga investigations. The aim of the report is to understand Brolga population, movements and habitat usage within the vicinity of the wind farm and whether the wind farm is having significant impact on any of these aspects. This will further inform risks to the species and the requirement for adaptive management of the wind farm and further mitigation measures that may be required. This will include but not be limited to information on:

- The results of monitoring of Brolga occurrence in wetlands on the wind farm site and within the area of concern around it;
- The results of any behavioural monitoring of breeding birds;
- The results of any home range mapping;
- Identification of any risk behaviour that may put birds at risk of colliding with turbines (defined based on observed movement directions, flight speeds and heights, and distances from turbines);
- An assessment of the likely risk to breeding or flocking Brolgas from the wind farm; and
- Discussion of feasible mitigation measures, if required.

A **first-year report** will be prepared after twelve months of monitoring during post-commissioning. The purpose of the report is to present the results from the first year of monitoring, identifying any significant impacts arising from the operation of the wind farm that may require mitigation, and reviewing the monitoring methods and recommending refinements, if necessary, for the second year. Matters to be addressed in the first report include but will not be limited to:

- Summary of post-construction survey and carcass search results, including scavenger and searcher efficiency trials, total survey days and comparison of lit and unlit sites (if applicable);
- Changes to, and final protocol of, the experimental methodology, for example, alterations to duration and frequency and areas sampled;
- A summary of observations of any threatened species monitoring, including the results of the targeted Brolga and Southern Bent-wing Bat monitoring and a summary of any significant impacts according to the protocol later in this section of the plan;
- Once available, this report will be presented to a review meeting with DEECA and the Responsible Authority. The results of the carcass searches (including the scavenger and observer efficiency trials) will be reviewed and refinements to the monitoring program will be agreed;
- The first-year report will be presented to DEECA and the Responsible Authority within two months of completion of 12 months of mortality monitoring. Reports will be supplied in both digital and hard copy.

The **two-year report** will comprehensively outline two years of monitoring and provide findings on the impacts of avifauna and provide recommendations for mitigation measures and additional monitoring requirements, and will include the following:

- Detailed survey methods (including list of observers, dates and times of observations);
- Results of the Brolga breeding surveys;
- Results of the bat survey in general and of the threatened Southern Bent-wing Bat in particular;
- Estimates of Brolga and bat mortality rates (birds and bats per turbine per year), and detected numbers for all other species recorded during the carcass searches;
- Any other mortality recorded on site but not during designated carcass searches (i.e., incidental records by site personnel, etc.);
- A discussion of the results, including:
 - Whether indirect impacts on bird use of the site are of significance at a regional, state or national level, or if listed species were affected;
 - Whether the level of mortality was ecologically significant or affected listed species of birds (including the Brolga) or bats;
 - Any differences between years that may have arisen due to wet and dry conditions;
 - Whether continuation of the monitoring program after two years is warranted and, if so, in what form;
 - Any discernible differences in collision rates between lit and unlit turbines, where relevant; and
 - Any recommendations for reducing mortality, if necessary.

If a significant impact on birds or bats is detected before scheduled reporting is due then Hawkesdale Asset Pty Ltd as trustee for Hawkesdale Asset Trust (HAPL), a wholly owned subsidiary of Global Power Generation Australia Pty Ltd (GPGA) will notify DEECA and the responsible authority via email: PEA.energyproject@delwp.vic.gov.au

Following completion of the two years of monitoring, results will be reviewed by DEECA and the Responsible Authority to determine whether further monitoring and reporting is required.

3.2. Data acquisition/submission and personnel involved

This section of the plan outlines the acquisition/submission of data and personnel involved in the field work, report writing and background research for the BAMP. Data for all work conducted for the BAMP will be available to DEECA and other relevant authorities in both electronic and hard-copy format. Electronic submission of relevant data will coincide with the reports (above in section 4.1); however, it must be understood that some data will be in a very raw format and mid-collection. The submission of the data does not replace the summary of information and data outlined in the individual reports but is in addition to and is in accordance with DEECA requests. This data acquisition and submission applies to all following sections and therefore unless otherwise stated the procedure for inclusion of data follows the above guidelines.

Any data or report submissions to DEECA should be made through email at: PEA.energyproject@delwp.vic.gov.au

All personnel who have worked in the field and office to contribute to this management plan thus far are experienced and qualified ecologists or statisticians (i.e., min. Bachelor degree with Honours, many with PhD). Qualifications and training of all personnel involved are readily available and

available on request. Training is very thorough and involves background theoretical training, knowledge of policies and other administrative matters (e.g., OHSE) and technical/field training (e.g. equipment, species identification).

Ecologists assigned to conducting carcass searches (Section 5) should have experience with carcass searches in Australia, including the identification of the Southern Bent-wing Bat and Brolga. If unqualified personnel are involved in carcass searches this will be stated within the relevant section of this plan, and training to these individuals will be given by such qualified personnel as outlined above.

Unqualified individuals who have been adequately trained in the methods outlined in Section 5.1.3 may only be used in carcass searches, only qualified and experienced ecologists may be used in any other monitoring activities outlined in this management plan.

All carcass monitoring search tracks recorded via GPS (Section 5.1.3) will be provided in shapefile with annual reports.

4. POST CONSTRUCTION UTILISATION SURVEY PROGRAM

This section of the plan describes the objectives and methods of the post construction utilisation surveys to be undertaken once operations commence at Hawkesdale Wind Farm. The main objectives are to:

1. Determine the population and general activity of the two species of concern (i.e., Brolga and Southern Bent-wing Bat) on the wind farm site, with reference to the regional population and activity/movements of individuals.
2. Determine if either of these two species of concern has altered their activity or population numbers have changed post construction.

Each of the two species of concern has different survey requirements and therefore there is a section dedicated to firstly, the Brolga and secondly, the Southern Bent-wing Bat. All personnel involved in utilisation surveys will be trained and qualified ecologists with strong field experience. Qualifications and training details will be available, on request, by any interested party.

4.1. Brolga risk assessment surveys

The aim of the Brolga risk assessment surveys is to document the occurrence of breeding and flocking Brolga on and near the wind farm site to ascertain if any urgent mitigation or offset measures are required. In particular, the surveys will aim to ascertain the likelihood of regular occurrence of Brolga in areas where they may collide with wind turbines. As there are no known Brolga flocking sites within five kilometres and wetlands in the area are ephemeral, there is no need to undertake Brolga flocking surveys (January – June), as Brolga are not present in the area during the flocking season. There is potential for ephemeral wetlands to hold sufficient water for Brolga to occur in rare, higher than average rainfall years. An assessment of potential flocking sites created by high rainfall will be undertaken in January each year. Based on this assessment, any potential for ephemeral wetlands that may support Brolga flocking will be subsequently surveyed using methods designed in consultation with DEECA. The Brolga breeding season is from July – December and this is the time when regular surveys will be undertaken.

The Brolga risk assessment survey will commence during the first month the wind farm becomes operational (defined as being the first chain of turbines is operational) if during the breeding season. If the wind farm becomes fully operational outside the breeding season it will commence in the following July and will cover two breeding seasons over two years in accordance with condition 30.b) (i), Brolga surveys will be conducted for a minimum of two years at which point their continuation will be assessed by the Minister for Planning, based on the results presented in the final monitoring report. The methodology for any continuation of sampling must be developed in consultation with DEECA.

The surveys will involve a targeted breeding season survey within the wind farm site and out to a minimum 3.2 kilometres from the wind farm boundary.

DEECA (South West Region) will be immediately notified by email within three business days of the surveys completion if Brolga are observed during the targeted surveys at PEA.energyproject@delwp.vic.gov.au.

If one or more Brolgas is detected on the wind farm site during operation, this will be *immediately* (within three business days) reported to the relevant authorities,

together with sighting details, such as behaviour, foraging behaviour and use of the site, where relevant.

Brolga surveys will be undertaken by a suitably qualified ecologist.

4.1.1. Breeding season Brolga monitoring

The breeding season monitoring program (July to December inclusive) will be undertaken monthly and include the components described below:

Wetland assessment:

- All DEECA listed wetlands within 3.2 kilometres of the wind farm site will be assessed (Figure 2), subject to private land access arrangements (trespassing is illegal), for Brolga breeding suitability. Access to wetlands on private land will be sought and the use of drones discussed, however if access is denied the potential viability of wetland's potential to form habitat may remain unknown. Satellite imagery or viewing from public roads using telescopes will be attempted but detailed assessment may be impossible beyond this. This will be noted as a limitation and taken into consideration in annual reporting when reviewing the results of the monitoring program. Wetlands not suitable will be ruled out from further surveys. Any wetlands observed or noted from aerial photography that are not included in the DEECA wetland layer will be mapped and assessed accordingly;
- An assessment of wetlands for their potential to be used as breeding sites by Brolga on and within 3.2 kilometres of the wind farm site will preferably be done after winter-spring rainfall (August–September) has been sufficient to fill wetlands and promote the growth of aquatic vegetation; and
- DEECA wetland mapping will be reviewed to identify potential Brolga breeding habitats within the survey area. This will allow for unsuitable wetlands to be ruled out of the survey regime. Unsuitable wetlands may meet one or more of the following criteria (DSE 2011):
 - Permanently drained; and/or,
 - Planted with trees.

Potential breeding sites:

- All potential breeding sites identified through the wetland assessment will be surveyed by observers on foot or from a vehicle (to avoid disturbance), where feasible (i.e., accessibility permitting) while remaining beyond brolga flight initiation distance (FID: distance that a bird will flee an oncoming predator), estimated to about 200 metres, to avoid interrupting normal behaviour;
- Observers will use binoculars and telescopes to obtain sufficient data quality. Sites will be surveyed as comprehensively as possible (i.e., roaming surveys AusWEA 2005) due to the wide dispersal of individual Brolgas in a given area;
- Sites will include all wetlands on and within 3.2 kilometres of the wind farm site and paddocks surrounding these wetlands;
- These sites will be surveyed monthly from July to December; and
- Any nest building, courtship behaviour and other reproductive activities will be noted. These behaviours are quite obvious and do not require close inspection to verify.

Detailed behavioural observations:

- Where confirmed breeding is identified at any wetland on the wind farm site or within 3.2 kilometres, more detailed observations will be triggered. If breeding activity is recorded, this triggers the requirement to complete a two-day monitoring event on a fortnightly basis until the end of breeding (i.e., fledging or failure);
- The behaviour of individual Brolga found breeding in the search area will be recorded and information collected on active movement, that is, if they take flight, are in flight or are travelling

on foot between areas (i.e., not foraging, resting, vigilant). The start and finish times of all observations will be recorded;

- Variables to be recorded will include distance (m) and direction (bearing) travelled (i.e., absolute and in relation to turbines, plotted on a map), flight height (m), number of Brolga and their origin and destination, as well as the habitat at the destination (e.g. wetland, pasture, cropland);
- If possible, the number of juveniles and/or adults within the group will be noted, otherwise the number of individuals will be estimated and recorded; and
- Other information that will be recorded will include location (GPS), weather and condition and water level of the breeding wetland. The aim will be to provide an overall picture of the individuals' home range around a breeding site over the course of the breeding season.

Analysis and assessment:

- Flight information (e.g., distance, bearing) will be plotted on maps to determine whether any Brolgas regularly use flight paths close to the turbines (this will aid in identifying any collision risk);
- General location and wetland quality information will provide information for home range mapping;
- As Brolga have high site fidelity (i.e., return to favourite breeding sites frequently), a daily maximum population estimate can be calculated (also mean, standard error and range) for the area of concern; and
- Breeding sites and movement data can provide information regarding possible disturbance to Brolga.

4.1.2. Reporting

At the completion of each breeding season survey, a report will be prepared and submitted to DEWLP (now DTP) and the Minister for Planning analysing the data gathered and describing the behaviour of flocking and breeding Brolga and the range of their movements in relation to operating wind turbines. This report will provide a review of Brolga behaviour, including breeding and flocking activities, habitat use and home range mapping in the immediate and adjacent area and will outline whether there are any gaps in the knowledge or in the survey methodology (i.e., possibly warranting an increase in the duration or frequency of surveys). The prepared report must be submitted within one month of completion of the surveys.

Figure 2: Brolga breeding wetlands within 5km radius of Hawkesdale Wind Farm

Project: Hawkesdale Wind Farm
Client: Global Power Generation Australia
Date: 15/06/2023

 Hawkesdale WF boundary

 Turbine location

 Hawkesdale WF buffer - 3200m

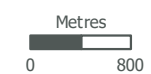
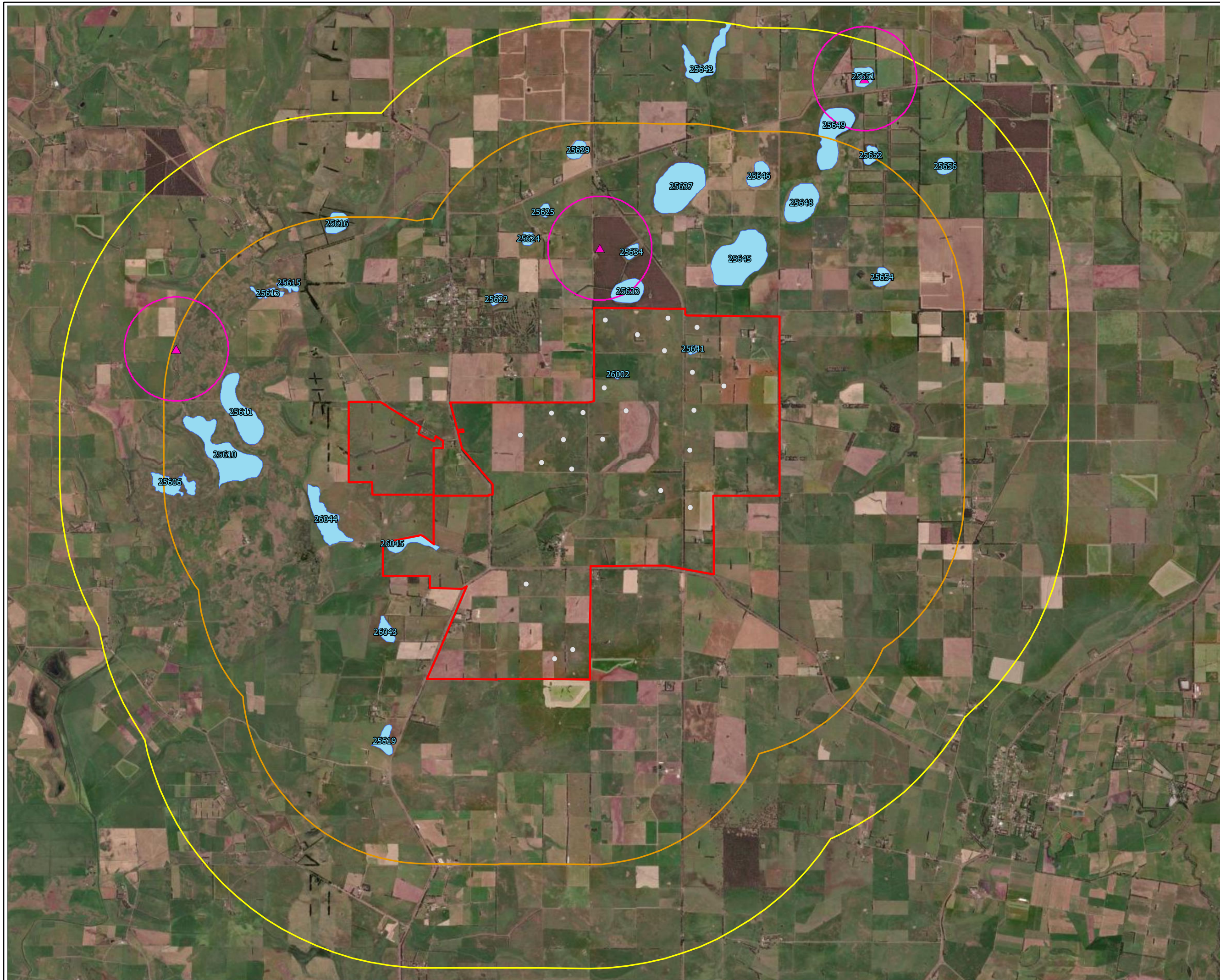
 Hawkesdale WF buffer - 5000m

 Breeding record accuracy buffer - 900m

VBA Brolga breeding records

 Breeding site

 DELWP wetlands - not identified as breeding wetland



PO Box 337, Camberwell, VIC 3124, Australia
www.natureadvisory.com.au
03 9815 2111 - info@natureadvisory.com.au

4.2. Southern Bent-wing Bat risk assessment surveys

A bat detector survey, with emphasis on the Southern Bent-wing Bat, will be undertaken at Hawkesdale Wind Farm after the first turbine chain becomes operational. The timing of each survey period is designed to coincide with periods when the Southern Bent-wing Bat is likely to be present and utilising the wind farm site. The aim of the survey is to gain a better understanding of the species' usage of the site, particularly in regard to flight heights and activity levels around operational turbines. This will inform further risk assessment on the species and determine the need for any adaptive mitigation measures required after operations have commenced. Surveys will be conducted for a minimum of two years at which point the Minister for Planning will determine if further surveys are required. Such timing includes two individual seven-week survey periods as follows:

- Late summer and early autumn (February to March inclusive) to coincide with the period of increased inter-cave movement from the maternity caves to non-maternity caves; and
- Spring (October to November inclusive) to coincide with increased foraging activity of bats with warming conditions and increased inter-cave movements as the bats return to the maternity caves to breed.

4.2.1. Methodology

Survey periods will cover two seven-week surveys during the key periods outlined above when Southern Bent-wing Bats are most actively moving across the landscape between non-maternity and maternity caves. Ultrasonic bat records (e.g., Wildlife Acoustics Song Meter) will be deployed to cover all habitat stratification present within the wind farm (i.e., in or adjacent pasture, waterbodies, woodland).

Bat detectors will be deployed to simultaneously record bat calls at height and at ground-level. In order to achieve this, paired bat detectors will be installed (i) at ground-level at the base of operating turbines (or in adjacent habitat) and (ii) at nacelle height. Nacelle height installation must be undertaken by qualified turbine technicians, with the bat detector microphone installed outside (on the underside) of the nacelle pointing down and away from the blades. Nature Advisory will instruct the qualified turbine technician in the appropriate placement and operation of the bat detectors prior to installation to ensure consistent and accurate data collection. This methodology has been successfully implemented in targeted bat detector surveys conducted at operational turbines at Salt Creek Wind Farm in Victoria (Nature Advisory unpublished data).

This methodology (paired bat detectors installed at ground-level and at nacelle height) will be employed at three turbines that are located in representative habitat of the wind farm; totalling six bat detectors.

4.2.2. Analysis and assessment

Echolocation calls recorded during the bat detector surveys will be used to investigate the presence and relative activity of all bat species listed under the FFG Act and EPBC Act, as well as non-listed species that are known to collide with operational turbines (e.g. White-striped Free-tailed Bat). During the call analysis, a particular focus will be placed on the Southern Bent-wing Bat. Calls produced by common, widespread bat species may be filtered out during the data analysis process.

The information from each bat detector provides information on the locations across the study area where activity is occurring (e.g., calls produced by a certain species are only recorded from one location at any one time, or at multiple locations across different nights). However, the actual number of individual bats of any species moving through the site cannot be calculated, because multiple calls

could be produced by one individual bat passing by a single detector multiple times, or by multiple individuals passing the detector once.

Echolocation call data will be sent to a qualified and experienced expert for analysis.

4.2.3. Reporting

Bat detector survey data will be provided to DEECA BSW within eight weeks of conclusion of seasonal surveys, and survey results will be incorporated in the annual mortality monitoring report. Methods used for call analysis and the expert conducting the analyses must be included in the reporting. All calls identified as Southern Bent-wing Bat must include time of recording and include example call sequences. Weather conditions during the survey periods must also be documented.

Bat detector survey results will be prepared at the end of both the first and second year of monitoring. Results will be reviewed and discussed with DEECA. As per DEECA's instructions, reporting will include the number of calls identified as Southern Bent-wing Bat per night at each site, number and percentage of calls that were unidentifiable, number and percentage of calls that were identified to Southern Bent-wing Bat species complex level (i.e., calls may have been produced by either Southern Bent-wing Bat or other species with similar call characteristics, namely Little Forest Bat, Southern Forest Bat, Large Forest Bat, Chocolate Wattled Bat), reference calls used, and reporting of any significant timing in the pattern of when calls are recorded throughout the night. This information may provide useful background that informs mitigation measures, if required.

5. POST CONSTRUCTION MORTALITY DETECTION PROGRAM

This section of the plan describes the objectives and methods of the post construction mortality detection program to be undertaken once operations commence at Hawkesdale Wind Farm. The program will be conducted for a minimum of two years at which point their continuation will be assessed by the Minister for Planning, based on the results presented in the final monitoring report. The methodology for any continuation of sampling must be developed in consultation with DEECA. This program aims to comply with conditions of the planning permit.

5.1. Mortality detection

The purpose of detecting mortality is to determine the actual impact of the wind farm on the regional avifauna (e.g., number of deaths per year). Mortality is defined as any dead bird or bat detected beneath a wind turbine. Collision by birds and bats with wind turbines will be monitored through a rigorous carcass-search program for a minimum period of two years after operations commence. It is assumed that any dead bird or bat detected beneath a turbine and within the “search zone” has died as a result of collision or interaction with a turbine.

The fatality monitoring also aims to detect patterns (e.g., peak times) as a basis for determining significant impacts and informing adaptive mitigation. In addition, there are only two species of concern, Brolga and Southern Bent-wing Bat. Therefore, the search protocol has been limited to these two species and although other carcasses/species will be recorded, these species have not been considered while designing the protocol.

To provide accurate mortality rates it is essential that the program is scientifically and statistically robust. A number of factors can affect mortality rates and therefore if they are not controlled for within the methodology, they will be incorporated into later statistical modelling as covariables or random factors. A scavenged carcass may increase the variability in mortality rates and thus carcasses will be assessed for possible scavenging and rates will be estimated from experimental trials. Human detectability of carcasses is also a potential confounding variable and protocols have been developed to control or incorporate this error. Before all searching begins the turbines selected for searching will be surveyed for existing carcasses. If carcasses are found, they may be retained for use in later scavenger/detectability trials.

The following sections outline:

- **Trained personnel:** The minimum requirements for person/s involved in conducting post-construction monitoring;
- **Turbine selection:** how the wind turbines will be selected for a search;
- **Search protocol:** the size of area beneath turbines to be searched and how this will be done;
- **Scavenger rates and trials:** definition of scavenging and how experimental trials will be conducted;
- **Detectability:** definition of detectability and the experimental trial methodology;
- **Analysis:** general outline of how the data will be analysed.

5.1.1. *Trained personnel*

Personnel involved in implementing the post construction mortality detection program must either be an experienced and suitably qualified ecologist or be adequately trained by a suitably qualified ecologist according to the methods outlined in the following sections.

If personnel are to be trained, then training must be provided by a qualified ecologist experienced in implementing mortality monitoring at other wind farms. Searchers would be trained in the methods below and supervised on site for the first month of searches to the satisfaction of the attending ecologist.

The qualified ecologist will conduct an audit of trained searches after three months of monitoring to ensure a professional standard. If searches or results are unsatisfactory then retraining may be required or training of new personnel.

The ecologist will be retained to identify or verify the species of all bird and bat carcasses found by trained searches remotely or on site if required to ensure correct identification.

Only a qualified ecologist will conduct scavenger and efficiency trials (section 5.1.4 & 5.1.5).

Relevant reporting on the mortality monitoring program will be undertaken by a qualified ecologist.

The qualifications and training records of all personnel involved in monitoring can be provided to DEECA Environment prior to the commencement of monitoring, upon request.

Any scent detection dog and dog handler will be trained by an experienced trainer.

5.1.2. *Turbine selection*

The target population are the turbines themselves and all the proposed turbines will be included in the carcass search monitoring program. It is the turbines that proxy for the farm, and not the search area nor the carcass detections. The following meta-information will be recorded for each of the 23 proposed wind turbines:

- location (easting northing),
- location in chain,
- curvature of chain,
- distance to nearest neighbour,
- identification of nearest neighbour,
- local vegetation,
- distance to any relevant ecological interface.

5.1.3. Search protocol

The search area beneath each turbine has been determined to best detect Brolga and Southern Bent-wing Bat carcasses based on the turbine dimensions (Hull & Muir 2010).

Based on the Hull and Muir (2010) model, 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 or Brolga) may be found a little further out, but 95% are within 115 metres of the turbine.

Given this evidence, inner and outer circular search zones have been designated. The inner zone will cover a radius of 60 metres from the base of the turbine to target the detection of carcasses of bats and small to medium and large sized birds. 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.

Scent detection dog team protocol

It is recommended that searches be undertaken by a scent detection dog team. Paula et al. (2011) found that dogs trained to find bird and bat carcasses under turbines were far more accurate when compared with humans in controlled trials (92% vs 9%) while Mathews et. al. (2013) found that dogs found up to 53% more bats on the ground when compared with humans, and completed surveys over the same area in 25% less time.

Turbines will be searched once a month out to 120 metres; however, no inner and outer zone designation is required for scent dog method.

A scent dog does not ‘look’ for carcasses but finds them via scent. Therefore, it does not need to cover as much ground as if it were looking with its eyes but only needs to cover enough ground to encounter all possible ‘scent cones’ within the search area. The scent cone is the area downwind of the target, in this case a carcass, in which the scent will drift with the wind. So, if the wind is strong; the scent will drift further but in a narrower scent cone, and if the wind is light; the scent cone will be wider but will not drift as far. In the case of strong wind, then transects will need to be narrow to ensure scent cone areas will be encountered. Transects of approximately 20 metres wide will be adequate to cover an area in moderate wind conditions. This could be reduced to 10-15 metres in strong wind (Figure 3).

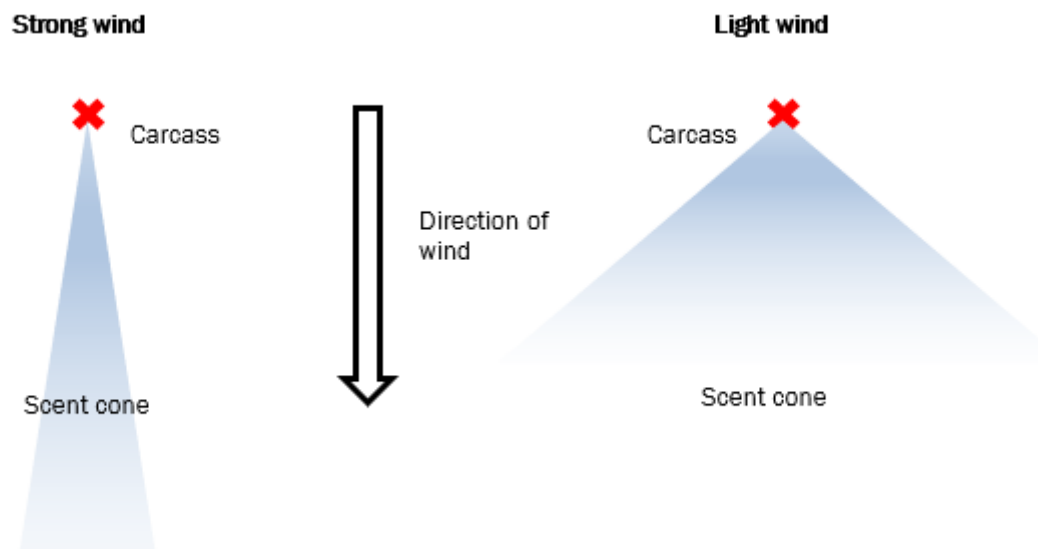


Figure 3: Visual representation of 'scent cones'

The handler will start down wind of the turbine and walk into the wind allowing the dog to freely zig zag across the searcher's transects, using commands to control how far the dog moves to each side of the transect (i.e., 20 metres). Then repeat this at a slower pace when walking the return transect that would be with the wind (Figure 4). The searcher does not need to reach the edge of the radius upwind of the area as any carcass scent there would drift down into the transects.

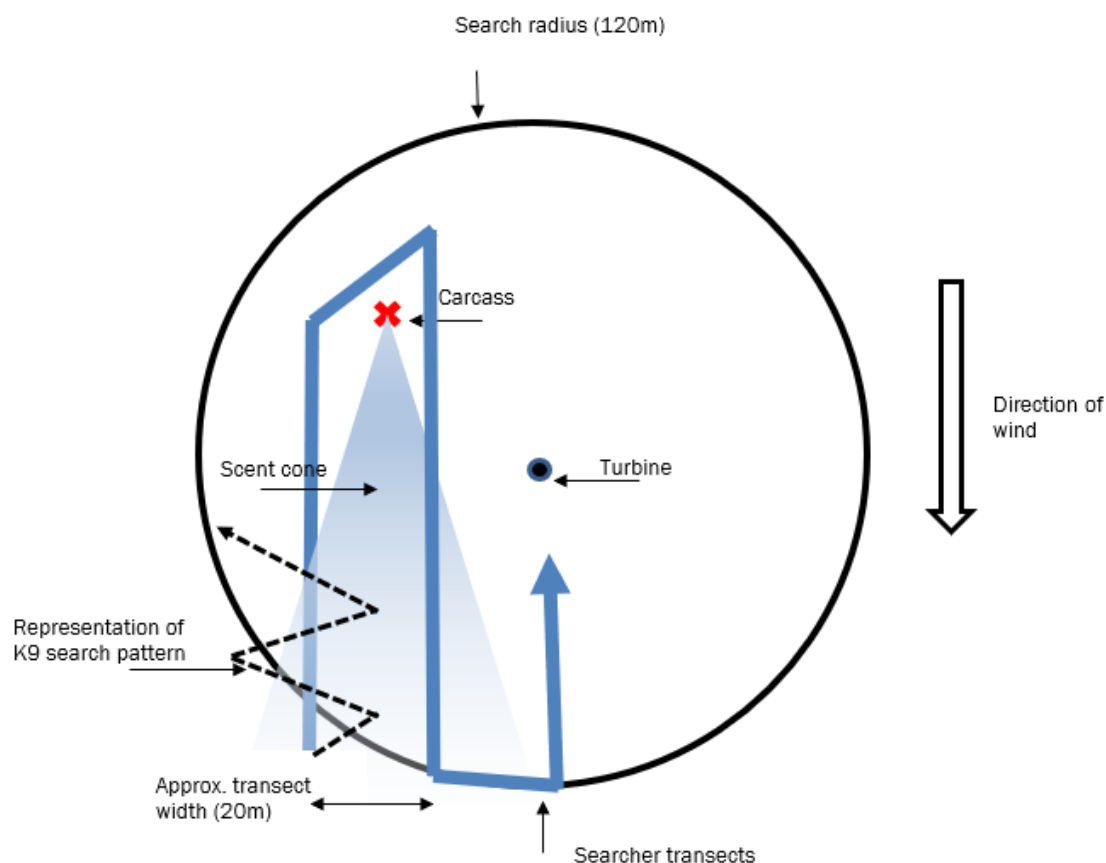


Figure 4: Scent detection dog search pattern

All search transects conducted (by human and/or scent dog) will be recorded via GPS and tracks to be made available on request and submitted to DEECA as required.

Search regime

All turbines will be searched out to 120 metres once per month. The order of turbines searched will be randomized between searches.

In order to ensure accurate detection of bats in particular, a secondary ‘pulse’ search will be undertaken every month of the monitoring program. A recent study of Southern Bent-wing Bat ecology found that, although the species’ activity is reduced in the winter months, significant activity is still detected in winter, including intercave movements, suggesting some level of foraging activity continues throughout the year (van Harten et al. 2022). After the initial 12-month pulse search period, the requirement for another 12 months of pulse searches will be reviewed in the first annual report depending on the species and numbers of bats being found as mortalities.

Pulse searches entail searching the ‘inner zone’ (out to 60 metres) again two to three days after the initial search. This ensures bats are unlikely to be missed and can also provide insight into the frequency of bats flying into turbines.

Search methods will follow those outlined above.

Carcass detection protocol

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

- GPS position, distance in metres and compass bearing of the carcass from the base of 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;
- Weather (including recent extreme weather events, if any), visibility, maintenance to the turbine and any other factors that may affect carcass discovery; and
- If the species is not able to be immediately identified as there is not a qualified ecologist on-site (i.e., an incidental find), photographs will be provided to the qualified ecologist within 2 business days of the find for identification and the ecologist must reply within 5 business days for the possible reporting of an impact on a threatened species within 2 business days of confirmation.

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

- The carcass will be removed from the site to avoid re-counting;
- The carcass will be handled by personnel wearing rubber gloves, packed into a plastic bag, then wrapped in a sheet of newspaper then in a second plastic bag;
- The carcass will be clearly labelled by including a copy of its completed carcass search data sheet in the second plastic bag to ensure that its origin can be traced at a later date, if required; and
- The double-bagged and wrapped 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 later scavenger and detectability trials.

DEECA, South-West Region, will be provided with an electronic copy of the completed carcass search data-sheet for all recorded carcasses of threatened species within three days. It will be necessary for the wind farm operator to obtain from DEECA a permit under the state *Wildlife Act 1975* to handle and keep native wildlife (even dead wildlife) as part of the monitoring program. An application for this permit will be submitted in a timely manner to ensure approval has been obtained prior to commissioning of the relevant turbine chains.

5.1.4. 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 (mortality rate). Scavengers can include ground-based animals, such as foxes and rats (more likely to detect carcasses by scent), as well as aerial scavengers such as birds of prey and ravens (more likely to detect them visually). The scavenger trial described below is designed to ascertain the scavenging rate, usually expressed as average carcass duration in the field.

An intact carcass will be defined as a carcass that does not appear to have been scavenged by a vertebrate scavenger. A partially eaten carcass will be any skeletal or flesh remains found. Feather 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 spots will all be recorded as a 'find'. However, the scavenger correction factor will not be applied to feather spots as these are most likely to represent the remains of carcasses after they have been scavenged.

Scavenger trials will be undertaken twice per year for the first two years of operational phase monitoring. The objective of having two trials per year is to account for different seasonal 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 3, below.

Table 3: 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

Scavenger Trials will be undertaken by a trained person (Section 5.1.1) to determine the rate of loss by scavengers, and the nature of removal by scavengers (e.g., an early peak in scavenging a peak after carcasses have been in place for a period of time). The search area for scavenger trials will be 120m from the base of the turbine under the turbines selected for carcass monitoring. Large birds can fall anywhere within the 120-metre radius and therefore, birds will be placed anywhere within the search radius. Bats on the other hand, typically only fall out to about 60 metres and will therefore only be placed within the 60-metre radius (Section 5.1.3).

To identify potentially different scavenging rates, three categories of carcass will be used (Table 4). Based on current mortality estimation software requirements, every endeavour will be made to find all carcasses of each category. Improvements on this method would require an impractical and unlikely availability of required carcass numbers, and do not lead to a commensurate improvement in the statistical power of estimates. See Appendix 2, Symbolix letter 17 November 2020.

Brolga equivalent carcasses have not been provided as a category of carcass for scavenger trial purposes for a number of valid reasons. Firstly, it is unknown what would constitute a viable substitute carcass for such a large bird. For example, Wedge-tailed Eagles on average are not scavenged at all, instead decomposing in situ, whereas other large birds (i.e., a Raven or Falcon) might be scavenged quite quickly, so it is unclear if either would be appropriate. Next, it is not permitted to source uncleaned poultry (i.e., plucked, gutted etc) in Victoria, and cleaned poultry is not a statistically viable substitute for deceased birds (Symbolix 2020).

As such; it is proposed that the category 'Large Birds' in general be used instead. Symbolix letter (Appendix 2) supports this approach.

Table 4: Number of replicates for each scavenger trial

Vegetation condition	Micro-bat	Medium sized birds	Large birds (large raptor size)
Short grass	10	10	10
Long grass	10	10	10

Thirty carcasses in total will be randomly placed under different selected turbines for each season. This can be done by generating random numbers function in Microsoft Excel. For example; a number 0 and 30 can represent how many steps a person takes around the base of the turbine, starting at the turbine entrance, and then another number between 0 and 120 can represent how many metres the person then walks away from the turbine. Thus, providing a random location within the search radius.

Scavenger trials will be undertaken via motion sensor camera traps. Cameras can be mounted on vegetation, nearby objects such as fence posts, or mounted on steel pickets away from farm tracks or areas likely to be ploughed during farming activities. Carcasses will be placed three to five meters from the camera and the camera set to record any images of scavengers removing the prey. This will ensure greater accuracy in determining how long a carcass remains in the field. Additionally, it will remove the added bias issue of humans constantly checking carcasses, which may deter scavengers such as foxes which are naturally cautious of humans.

Additional information on scavenger trials is provided below.

- A mix of small and medium to large 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 search area. Carcasses will be thrown in the air and allowed to land on the ground to simulate at least some of the fall and allow for ruffling of fur or feathers.
- Carcasses used in the 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.

Conducting 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 only be conducted once per year due to lack of availability of suitable carcasses for a technically sound trial. Experience from other wind farms indicates a low level of scavenging of these carcasses and a high level of detectability that is consistent across the year (BL&A, unpubl. data).

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 the number of birds that may collide with turbines.

5.1.5. Detectability trials

Detectability trials are conducted to test the rate at which the trained scent detection dogs detect carcasses under wind turbines. This enables a correction factor to be applied in calculating the rate at which turbines strike birds and bats.

To account for observer variability in detecting carcasses, only personnel who have carried out monthly searches at Hawkesdale Wind Farm 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 5 and explained below. The carcass controller (a person not involved in monthly carcass searches) will throw each carcass into the air and allow it to land on the ground to simulate at least some of the fall and the potential ruffling of fur and feathers. The carcass controller will note the placement of carcasses (via GPS) and is free to decide where and how many are deployed under each turbine, however all bats should be located within the inner, 60 metre search zone.

Table 5: Number of replicates per season for detectability trials, given two factors of size and visibility

Vegetation condition	Micro-bat	Medium sized birds	Large birds (large raptor size)
Long grass	10	10	10
Short grass	10	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 rather than birds should be substituted for bats as birds do not have the same body shape, colour and appearance).

If sufficient carcasses cannot be obtained, then stuffed, realistic-looking artificial substitutes 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. Artificial substitutes cannot be used for dogs.

Ecologists will notify DEECA, five days prior, of the actual timeline of all experimental trials (searches, scavenger and detectability) so that DEECA have the opportunity to observe the trials.

The review provided by Symbolix (Appendix 2) considered a previous BAMP version which has since been superseded, in which the number of microbats proposed for trials was 20. The review outlines that 10 carcasses per size class is the minimum amount required for a statistically sound correction factor in regards to scavenger rates. As such, this number is proposed in the current BAMP version for both correction factors. This number is accepted by DEECA.

5.1.6. Analysis and data limitations

The results of the carcass searches 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;
- Separate estimated annual mortality rates for all birds and all bats (and for particular species, if required) including an estimate of the number of carcasses per turbine per year; and
- Any detected spatial or temporal variation in the number of bird and bat strikes.

The search results will be detailed in the first annual report and the detailed analysis and estimates in the second annual report. The latter will identify 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 the 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 Hawkesdale Wind Farm. The mortality rate of each species (if estimates for individual species are possible) and size class detected will be calculated after two years. 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 periods between turbine searches. 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.

5.2. Incidental Carcass Protocol

Personnel operating the Hawkesdale Wind Farm may from time to time find carcasses within the wind farm site. In this case, the person concerned will respond in the way described below.

- The site manager will immediately (same day) be informed and, for each carcass, will arrange that it:
 - GPS position recorded;
 - Have the distance and compass bearing of the carcass from the wind turbine tower based measured and recorded;
 - Be removed from the site to avoid re-counting;
 - Be handled by trained personnel wearing rubber gloves, packed into a plastic bag, wrapped in newspaper, then put into a second plastic bag; and
 - Be transferred to a freezer at the site office for storage so the carcass or partial remains will be identified by a suitably qualified and experienced ecologist and used in observer efficiency and scavenger trials, if suitable.
 - If the find is made within five days prior to a scheduled carcass search, the carcass will be left *in situ* but photographed and position recorded (GPS).

A carcass search data sheet (Appendix 1) will be completed for each incidental carcass found. All bird and bat carcasses (not used for experimental trials) found beneath turbines during searches and incidental finds will be retained (frozen) for at least 12 months and offered to DEECA or as per wildlife permit permissions.

5.3. Injured Bird and Bat Protocol

All onsite staff and monitoring personnel will be advised of the correct procedure for assisting injured wildlife. All ecologists are very familiar with the correct and ethical treatment of injured wildlife and are often able to provide necessary care to aid in quick release (e.g., dehydration, shock). Contact details of local veterinary staff and wildlife carers will be provided 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.

Wind farm personnel who find injured wildlife will be required to report the find to the wind farm site manager, who will require a trained person to place the animal immediately into a dark place (e.g., box or cloth bag) for transfer to the nearest veterinarian (list to be maintained at the wind farm office).

6. POST CONSTRUCTION INTENSIVE MONITORING AND MORTALITY ESTIMATES PROGRAM

The following section outlines targeted monitoring for priority species as requested by DEECA, in addition to Planning Permit requirements.

6.1. Intensive Southern Bent-wing Bat monitoring program

This section outlines a protocol for targeted carcass searches for the Southern Bent-wing Bat as per instructions from DSE (now DEECA) and Dr Lindy Lumsden (DEECA's Arthur Rylah Research Institute). The data collected from this program cannot be incorporated with the above mortality surveys or mortality estimates as it can only provide information about the particular turbines selected for the program and for the two intense survey periods. Additionally, the data cannot be generalised to the entire wind farm or any other wind farms.

The intensive monitoring periods will be in February to March (inclusive) and again in October to November (inclusive). The surveys can be run in conjunction with the above mortality surveys and if a turbine is selected for both purposes the data can be replicated and used for both. Dr Lumsden has requested that eight of the turbines be selected within the Hawkesdale Wind Farm site. These turbines have been selected for proximity to forested area and permanent water sources. Selected turbines consist of: A1, A2, A3, A4, A5, A7, A19 & A20.

The intensive monitoring will only survey the 60-metre inner search zone with four-meter transect spacings, as per the pulse searches, as this encompasses the impact detection zone of microbats (Arnett et al 2005, Hull and Muir 2010). These searches will be undertaken weekly (four searches a month) and can incorporate the initial standard monthly search and pulse search (Section 5.1.2).

The intensive survey will follow search protocols outlined above in Section 5.1.3.

The data will be available to DEECA and Dr Lumsden in hard-copy or electronic form and the information incorporated as a separate data appendix in the annual reports.

6.2. Mortality estimation

A priority specified by DEECA, is to report modern, statistically robust mortality projections for the entire site. It is acknowledged that this is a current and dynamic aspect of research and that the outcomes from such programs may be equally dynamic and so offer little potential for compliance monitoring at this stage.

Due to the rapidly advancing techniques, the adherence to consistent recording of meta-data (data about the underlying data) is paramount, as are correct, statistically valid selection processes. There are two species of concern, and mortality estimates are targeted to these species.

To ensure statistically robust estimates are generated, all survey and data management protocols must be unbiased and controlled. If these conditions are met, then the results could potentially be generalised to other sites within Victoria and any information gained may be applicable (possibly with some caveats that can be determined from the process itself) to other developments.

Current mortality estimates require the following

- Sampling protocol (to enable generality and scaling-up to site-wide estimate): section 5.1.1;
- Modelling protocol (to account for losses): sections 5.1.4 and 5.1.5 and statistical modelling; and

- Search protocol (to collect the raw data in a consistent fashion compatible with the two protocols above): section 5.1.3.

The projected mortality rate will be generated through modeling the scavenger losses and detectability and using sampling inference to account for the selection and stratification. Currently, the most appropriate model is that of Huso (2010).

It is unnecessary for the purposes of the BAMP to detail the analysis process, which should be flexible and respond to specifics of the data collected. However, the basic premise of these approaches is to calculate the expected counts of carcasses, accounting for modeled losses (both scavenger and detection) and to account for sampling fraction, stratification and density proportioned areas to produce an estimate of “arrivals,” or true mortality.

Due to the intensive data load required, this will be done for the two species of interest (if possible) and those other species detected (i.e., carcasses) that fall into the large bird and micro-bat categories. Finally, as the analysis process needs to be flexible and respond to the data collected, we are unable to predict the format of the results (e.g., estimated fatality/turbine/year).

7. IMPACT TRIGGERS, MITIGATION AND OFF-SETS

Mitigating and offsetting significant impacts on birds and bats is an important requirement of the planning permit and one of the key aims of this Bat and Avifauna Management Plan.

Planning permit condition 30 (d) called for a procedure for managing and mitigating any significant impacts from bird and bat strikes. It is also proposed to report these, if and when they occur, to DEECA within the specified timeframe at the email address: PEA.energyproject@delwp.vic.gov.au/

7.1. Raptor risk reduction measures

The planning permit condition calls for carcass removal to reduce the attractiveness of the site to birds of prey and, therefore reduce the chances of fatal collisions by this group of birds. A procedure for carrion removal is provided below.

To provide for the regular removal of carcasses likely to attract raptors to areas near turbines the procedures below will be adopted.

- Weekly inspections of the entire wind farm site by onsite personnel will be undertaken to search for any stock, introduced or native mammal (e.g., kangaroos, foxes, rabbits) and bird or bat carcasses that may attract raptors within 250 metres of turbines;
- Any incidental finds of birds and bats will follow the *Incidental Carcass Protocol* (depending on carcass location);
- Any carcasses and/or remains found will be immediately (within hours) collected and quickly disposed of in a manner that will avoid attracting raptors close to turbines (e.g., burying them in a designated location, burning provided correct permits/laws are met). All disposal efforts will be carried out far from turbines;
- Carcass occurrence and removal will be recorded in a “management log book” maintained by the wind farm operator.;
- Rates at which carrion are found will be reviewed, in consultation with DEECA, after three months of wind farm operations commencing to ascertain if the carrion removal schedule needs to be refined; and
- An annual summary of carcass removal, based on the ‘management log’ will be provided in the first year and final year monitoring program reports to DEECA, and the Responsible Authority.
- The need for continuation of the carcass removal program will be assessed after two years 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) the intense program may be discontinued or reduced considerably subject to agreement from DEECA.

- Rabbit control will be considered in the event of high numbers of Wedge-tailed Eagle strikes. This will limit the prey availability of this species. This can include, baiting, shooting and warren ripping.

7.2. Definition of impact trigger

An impact trigger is where there is evidence of death or injury to native birds and/or bats by collision or other interaction (e.g., barotrauma) with turbines. A significant impact on birds and/or bats, for the purposes of non-scheduled reporting is defined as circumstances where:

- In any two successive monthly carcass searches, a total of four or more native bird or bat carcasses (or parts thereof) of non-threatened species (excluding introduced species) are found at the same turbine; and/or
- A threatened bird/bat species (or recognisable parts thereof) listed under the EPBC Act, FFG Act or Advisory List of Threatened Vertebrate Fauna in Victoria – 2013, is found dead or injured within the wind farm site during any mortality search or incidentally by wind farm personnel.

7.3. Mitigating significant impacts

Mitigation involves the prevention, avoidance and/or reduction of the risk of a significant impact. Generally, the aim is to take actions in advance to avoid a significant impact. The following provides a framework for mitigating significant bird and bat impacts of the Hawkesdale Wind Farm. The relationship between these activities is shown in Figure 5. The activities include:

Immediate reporting (two business days) of a significant impact to wind farm management and to DEECA (via email: PEA.energyproject@delwp.vic.gov.au) followed by discussions of requirements and aims of investigations;

- An Investigation within 10 business days by an appropriately qualified ecologist of the occurrence on site of the affected bird or bat species to identify the particular risk behaviours that could lead to collisions. This must include consultation with a relevant species ecology expert and DEECA. A site field assessment of suitable habitat on and near the site should be undertaken, unless not relevant (i.e., some aerial species which would not utilise habitat on or near site). An investigation is necessary to determine the actual cause of death/injury (in the unlikely event that the animal was, for example, shot). The very rapid investigation will assess the most effective mitigation and will ensure that the mitigation is implemented correctly and quickly (within 10 days), subject to a clear understanding of the cause of the impact trigger. This process will involve a meeting between the ecologist concerned, the wind farm operator, and DEECA to discuss species-specific requirements;
- Responsive mitigation and if this is not possible, offsetting measures will be implemented; however, mitigation (and also offsetting) cannot replace the loss of one individual of a species of concern; and
- The investigation and following activities will also focus on the evaluation of likelihood of further occurrences and impacts and may indicate a requirement for further targeted surveying.

The intent is for mitigation requirements to be resolved within four weeks of the investigation.

Additional general mitigation measures must be implemented from the commencement of operations at the wind farm and include;

- Farmers would be requested to not spread grain supplement feed for stock within 250 metres of turbines. This attracts foraging birds which may collide with the above turbines. This agreement should be established ahead of operations commencing.

- Any lighting of turbines in general must be baffled as to limit attracting insects at night, which in turn will attract bats.

Subject to an assessment of the level of risk of impacts of significance continuing, mitigation will be implemented, in consultation with the DEECA, which may include but not be limited to:

- Habitat assessment, modification, vegetation planting/removal;
- Changes in land use practices (including stock management) near turbines;
- No or reduced cropping/sowing around or near turbines;
- Bird deterrence;
- Increasing turbine and powerline conspicuousness by rotor patterns, marking and/or audible signals/echolocation;
- Changes to lighting of turbines; and/or
- Temporary turbine shutdown for high-risk periods/locations;
- Technology activated temporary shutdown (e.g., sensors detect approaching objects).
- Technology activated temporary shutdown (e.g., sensors detect approaching individuals of the species of concern, subject to validation).

An impact trigger of a Southern Bent-wing Bat will result in the implementation of an appropriate mitigation method in consultation with DEECA (Figure 5). As an immediate precautionary action, low wind-speed curtailment (i.e., increasing turbine cut-in speed) will be applied to any turbine associated with a mortality event. Low wind-speed curtailment has been shown to be an effective approach to mitigate bat mortality at wind farms around the world (Arnett *et al.* 2016, Wellig *et al.* 2018, Whitby *et al.* 2021, Lloyd *et al.* 2023), including Australia (Bennett *et al.* 2022). It is noted that the Bennett *et al.* (2022) study found that approximately 80% of all bat strikes occurred during January to April, thus low wind speed cut in this plan is targeted to this time period. In case of an additional mortality event occurring at a same turbine where low wind-speed curtailment has already been implemented, an increase in cut-in speed will be applied. This hierarchical and precautionary approach of immediate response was developed by Nature Advisory following feedback from DEECA to address specific triggers actions for Southern Bent-wing Bat, and it is detailed in Section 7.4.

Up-to-date information on mortalities of Southern Bent-winged Bats at four operational wind farms in Victoria was provided to Nature Advisory during discussions with DTP and DEECA (held on 12th of October 2023). These four wind farms all have a minimum Rotor Swept Area (RSA) that is lower than the minimum RSA planned for HDWF (i.e., 44 metres). Unpublished analyses of carcass search results from operational wind farms carried out by Nature Advisory shows that mortality of bats decreases with increasing height of the lower minimum RSA. It is also known that there are fewer records of Southern Bent-wing Bat calls recorded when bat detectors are placed at RSA heights. Thus, it is anticipated that the potential impact on the Southern Bent-winged Bat is likely to be relatively lower in comparison to previous wind farms in which mortalities have been recorded. The minimum RSA of these wind farms in comparison with the minimum RSA of HDWF is detailed as follows.

- Macarthur Wind Farm – min RSA of 23 meters (21 meters lower than HDWF);
- Cape Nelson North Wind Farm – min RSA of 33.5 meters (10.5 meters lower than HDWF);
- Dundonnell Wind Farm – min RSA of 39 meters (5 meters lower than HDWF); and
- Salt Creek Wind Farm – min RSA of 24 meters (20 metres lower than HDWF).

Depending on the outcomes of the investigations (see Figure 5), further mitigation actions could include increasing cut-in speed or shutdowns during periods of higher bat activity, if required. Additionally, should three mortalities be identified within the duration of this plan, HAPL will commit to consult with DEECA to review the BAMP. The purpose of these consultations will be to reassess the BAMP and explore the testing of alternative mitigation measures, such as acoustic deterrents, including consultation on the implementation and empirical assessment of the effectiveness of any proposed mitigation program.

Immediate mitigation (e.g., above techniques) may be required if Brolgas are significantly impacted and will be implemented under the supervision of a qualified ecologist in consultation with DEECA and in a prompt manner (Figure 5). Significant impacts may be one-off or cluster events and therefore the mitigation procedure should follow steps outlined in Figure 5. It is difficult to anticipate how a significant impact may arise and therefore what mitigation would be required. However, if a significant impact is detected, the cause may be evident immediately (e.g., particular land use practice) in which case immediate mitigation must be implemented, as described. Where a solution is not immediately evident, it will be the subject of investigation and subsequent response.

A significant impact (as defined in Section 7) will represent an ‘incident’ within the HAPL EH&S system and the appropriate internal incident reporting procedures will be used. This will be followed within two business days by reporting as described in Figure 5 to DEECA. Additionally, all actions will be developed and implemented in consultation with and agreement from DEECA.

7.4. Impact triggers for Southern Bent-wing Bat

Background

The Southern Bent-wing Bat (SBWB) is listed as “critically engendered” in Victoria under the FFG Act and Federally under the EPBC Act (TSSC 2021). The SBWB is small (~15 g), insectivorous bat that roosts in a network of ~70 roost caves located across a restricted distribution (19,452 km²) from southwestern Victoria to southeastern South Australia (DELWP 2020). SBWBs gather in late spring and early summer at maternity caves to give birth and raise their young, and then disperse in autumn to use non-breeding caves throughout the cooler parts of the year (Churchill 2008). The three known maternity caves are located near Naracoorte in South Australia, Warrnambool and Portland in Victoria (Southern Bent-wing Bat National Recovery Team 2022).

Mortality has been documented at three monitored wind farms in SW Victoria as follows (Table 6).

Table 6: Mortality of Southern Bent-wing Bat at wind farms in Victoria (known till January 2024)

Wind Farm	Completed	No of turbines	Hub	Min RSA	Blade	Mortality (raw numbers)	Notes
Cape Nelson North/Sir William Grant wind farm	2015	23	80	=80-46.5=33.5	46.5	6	This wind farm is adjacent to a known roosting cave for SBWB
McArthur WF	2013 (mortality recorded 2014-2015)	140	85	23	56	2	Drawn for the annual reports n monitoring
Wind farm east of Starlight Cave	(mortality recorded in			24m		1	Information provided by pers comm

	autumn 2020)						
TOTAL						9	

Impact Trigger Level 1

A single or a number of Southern Bent-winged Bats are recorded dead within 60 metres of a turbine within a single event (for the purposes of the trigger this may be over a search period of up to five days (the length of the search period))

Actions in response to Impact Trigger Level 1

In the event of each individual SWBW mortality identified:

- **Additional carcass searches to determine extent of the impact**
 - Search all turbines within 1 km of the turbine where each carcass was recorded, that have not already been searched on the same day, to a radius of 60 metres from the base of the turbine.
 - If a subsequent carcass is recorded during that search, all turbines within 1 km of that find, that have not already been searched on the same day, will be searched to a radius of 60 metres.
 - The findings of the searches will be recorded and reported upon as detailed below.
- **Adaptive mitigations-Assignment of risk**
 - Any turbine where a carcass of the SBWS is recorded will be labelled as a “high risk” turbine.
 - The assignment of “high risk” will be for a period of two years from the date of assigning “high risk”.
 - If there are no further mortalities at the turbine for two years the risk will be re-assigned to “low” risk.
- **High risk turbines**
 - Any “high risk” turbine will be included in all subsequent turbine searches for two years from the date of assigning “high-risk”.
 - Any turbine assessed as high risk will be operated with a low wind speed cut-in of 4.5 metres / second for the period of November - May.
 - Will be included in the intensive monitoring program as detailed in Section 6.1 of the BAM Plan.
- **Incident Investigation**
 - Upon the mortality event, an investigation will commence with five days and the report submitted to the Responsible Authority and DEECA within 28 days.
 - The investigation will seek to assess any relevant attributes associated with the SBWB mortality/event.
 - The report will identify factors including:
 - Date and time of mortality,
 - Identify, if possible, wind direction and speed when bat was struck,
 - Weather conditions,
 - Description of the season,
 - Location of mortality in relation to habitat, vegetation and water sources,
 - Proximity of nearest known SBWB roost caves, and

- Analysis of any other mortality on the site.
- Overall the report will compile all relevant information and provide report on:
 - Conclusions of investigation in regards to risk to SBWB and likelihood of occurrence on site,
 - Recommendations for future actions to mitigate impacts on the SBWB, and
 - Options for other mitigation including deterrents.

Impact Trigger Level 2

A single or a number of Southern Bent-winged Bats are recorded dead within 100 metres of a turbine within a single event (for the purposes of the trigger this may be over a search period of up to five days (the length of the search period) of a turbine assigned as “high risk” under Trigger 1.

Actions for Impact Trigger Level 2

- **Additional carcass searches to determine extent of the impact**
 - Search all turbines within 1 km of the turbine where each carcass was recorded, that have not already been searched on the same day, to a radius of 60 metres from the base of the turbine.
 - If a subsequent carcass is recorded during that search, all turbines within 1 km of that find, that have not already been searched on the same day, will be searched to a radius of 60 metres.
 - The findings of the searches will be recorded and reported upon as detailed below.
- **Adaptive mitigations-Assignment of risk**
 - Any turbine where a carcass of the SBWS is recorded will be labelled as a “high risk – Trigger 2” turbine.
 - The assignment of “high risk will be for a period of two years from the date of assigning “high risk- T2”.
 - If there are no further mortalities at the turbine for two years the risk will be re-assigned to low risk.
- **High risk turbines-T2**
 - Any “high risk-T2” turbine will be included in all subsequent turbine searches for two years from the date of assigning “high-risk-T2”.
 - Any turbine assessed as high risk will be operated from dusk until dawn at a low wind speed cut-in of 4.5 metres / second + 1.5 m/s (an increase low wind cut in speed of 1.5 m/s in additional to the Trigger 1) for the period of November - May.
 - Will be included in the intensive monitoring program as detailed in Section 6.1 of the BAM Plan.
- **Incident Investigation**
 - Upon the mortality event, an investigation will commence within five days and the report submitted to the Responsible Authority and DEECA within 28 days.
 - The investigation will seek to assess any relevant attributes associated with the SBWB mortality/event.
 - The report will identify factors including:

- Date and time of mortality,
- Identify, if possible, wind direction and speed when bat was struck,
- Weather conditions including description of the season,
- Location of mortality in relation to habitat, vegetation and water sources,
- Proximity of nearest known SBWB roost caves, and
- Analysis of any other mortality on the site.
- Overall the report will compile all relevant information and provide report on:
 - Conclusions of investigation in regards to risk to SBWB and likelihood of occurrence on site,
 - Recommendations for future actions to mitigate impacts on the SBWB, and
 - Options for other mitigation including deterrents.

Impact Trigger Level 3

Where a third strike has been recorded of Southern Bent-winged Bats within 100 metres of a turbine within a single event (for the purposes of the trigger this may be over a search period of up to five days (the length of the search period). HAPL will revisit the efficacy of this plan in consultation with DEECA.

Actions for Impact Trigger Level 3

- **Additional carcass searches to determine extent of the impact**
 - Search all turbines within 1 km of the turbine where each carcass was recorded, that have not already been searched on the same day, to a radius of 60 metres from the base of the turbine.
 - If a subsequent carcass is recorded during that search, all turbines within 1 km of that find, that have not already been searched on the same day, will be searched to a radius of 60 metres.
 - The findings of the searches will be recorded and reported upon as detailed below.
- **Adaptive mitigations-Assignment of risk**
 - ○ Once there has been a third strike, any turbine where a carcass of the SBWS is recorded will be labelled as a “high risk – Trigger 3” turbine.
 - Any turbine within 600 metres of the turbine where Tigger Level 3 was recorded will have turbines operating with a 4.5 m/s cut in speed applied while the T3 impact turbine is considered as “high risk” (see Table 7 for a description of proximity).
 - The assignment of “high risk will be for the period of time HAPL revisits the efficacy of the plan with DEECA, or a period of two years from the date of assigning “high risk-T3” (whichever date is shorter).
 - If there are no further mortalities at the turbine for two years the risk will be re-assigned to “low” risk.
- **High risk turbines – T3**
 - Any “high risk-T3” turbine will be included in all subsequent turbine searches for two years from the date of assigning “high-risk-T3”.
 - Any turbine assessed as “high-risk-T3” will be operated with a dusk until dawn low wind speed cut-in of 6.0 m/ for the period of November - May.
 - Will be included in the intensive monitoring program as detailed in Section 6.1 of the BAM Plan.
- **Incident Investigation**

- Upon the mortality event, an investigation will commence with five days and the report submitted to the Responsible Authority and DEECA within 28 days.
- The investigation will seek to assess any relevant attributes associated with the SBWB mortality/event.
- The report will identify factors including:
 - Date and time of mortality,
 - Identify, if possible, wind direction and speed when bat was struck,
 - Weather conditions,
 - Description of the season,
 - Location of mortality in relation to habitat, vegetation and water sources,
 - Proximity of nearest known SBWB roost caves, and
 - Analysis of any other mortality on the site.
- Overall the report will compile all relevant information and provide report on:
 - Conclusions of investigation in regards to risk to SBWB and likelihood of occurrence on site,
 - Recommendations for future actions to mitigate impacts on the SBWB, and
 - Options for other mitigation including deterrents.
- Overall, these turbines will continue to implement cut-in speed for the durations indicated above or may be reduced in future consultation with DEECA in a review and amendment of the plan.

Table 7: Turbines within 600 metres of each individual turbine

Turbine	Turbines within 600 m
WTG1	WTG2, 4, 5
WTG2	WTG1
WTG3	WTG4
WTG4	WTG1, 3, 5
WTG5	WTG1, 4
WTG7	WTG8, 9
WTG8	WTG7
WTG9	WTG7
WTG11	--
WTG14	WTG15
WTG15	WTG14
WTG19	WTG20,21
WTG20	WTG19, 22
WTG21	WTG19, 22,23, 24
WTG22	WTG20, 21
WTG23	WTG21, 24, 26
WTG24	WTG21, 23, 25, 27
WTG25	WTG24, 27
WTG26	WTG23, 27
WTG27	WTG24, 25, 26
WTG28	--
WTG30	WTG31

WTG31	WTG30
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7.5. Offsetting significant impacts

It is difficult to predict what form a significant impact might take and what species it may involve and hence, the type of offsetting which may be required. Potential offset options for the two species of concern would be markedly different. A few possible offsets include:

- Habitat/wetland rehabilitation (Brolga);
- Roosting and maternity cave rehabilitation (bat);
- Increasing food availability away from wind farm site (Brolga);
- Increasing diurnal structure conspicuousness, rotor patterns (Brolga);
- Using acoustics to deter bats and other nocturnal fauna at night (bats);
- Implementation of trials using new technological mitigation measures, in collaboration with universities or other research institutions; and
- Allocation of funding towards research and conservation of impacted species.

In the event of the first Trigger Level 1, the project will allocate an anticipated \$25,000 (AUD) toward a Southern Bent-wing Bat offset research fund or the National Southern Bent-wing Bat recovery program. This amount is a one-off payment and will be made within three months of the first reported impact trigger. Evidence of this contribution will be provided to the Department of Transport and Planning (DTP) and DEECA. Additional offset options will be researched and discussed with DEECA as required.

A generalised framework is described below to ensure that if significant impacts cannot be completely mitigated, then off-setting arrangements can be discussed and agreed with the relevant authorities.

Arrangements for agreeing on offsetting measures are summarised below.

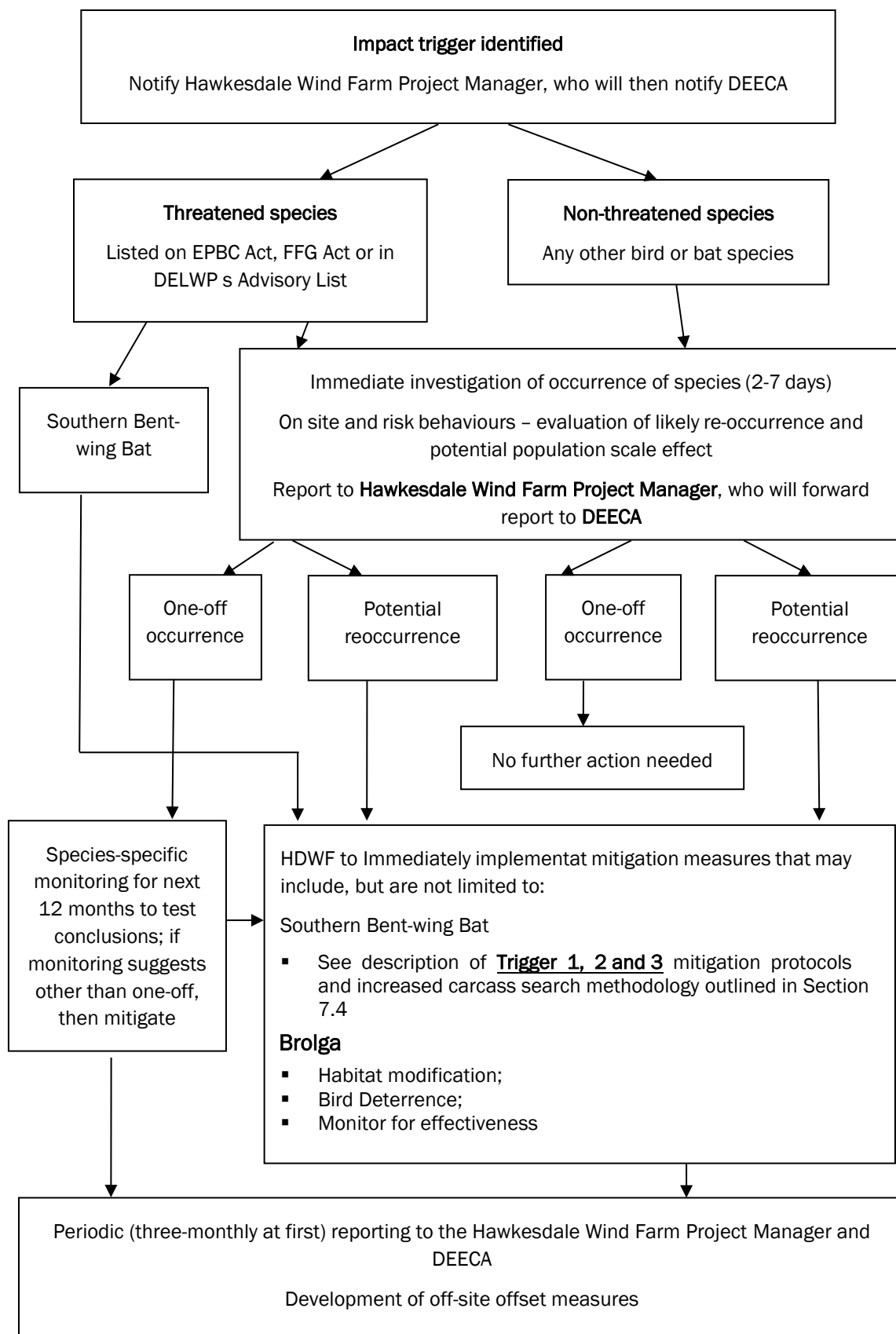
- Should a significant impact not be mitigated through on-site management then offsetting off-site would be triggered.
- A meeting would be organised between HAPL and the relevant authorities and government (e.g., DEECA) experts to discuss and agree offset options.
- Offsetting would be commensurate with the level of impact (to be determined after the investigations undertaken as part of the mitigation protocol in Figure 5).
- Offsets must be initiated within 12 months of the detection of a significant impact and continued for as long as a significant impact continues that cannot be mitigated through on-site management. Offsets will be monitored and evaluated for their effectiveness and any alterations will be made accordingly to achieve the desired outcomes (in consultation with the relevant authorities).

In the case of the Brolga, the regional framework for impact assessment established by DEECA provides an excellent basis for agreeing offset measures (DSE 2011). This framework is based on a Population Viability Assessment that can model the population impacts of wind farm effects, as well as the population impacts of mitigation and offsetting.

Impacts on Brolga from the operation of Hawkesdale Wind Farm must be net zero. If impacts are detected (i.e., one Brolga mortality), mitigation measures must be put in place in consultation with DEECA to ensure that this impact can be offset, including a management plan which stipulates for objectives, timeframes, actions (such as those suggested above), monitoring and regular reporting, with provisions for amendments and adaptation where necessary.

A similar approach will be considered for Southern Bent-wing Bat. As this species is known to be present at the Hawkesdale Wind Farm site, it is considered that any mortality cannot be defined as a “once off” when considered over the life of the wind farm. Upon a trigger occurring, immediate mitigation measures are required to be developed and implemented in consultation with DEECA to mitigate impacts to the species. Mitigation measures such as turbine curtailment and ultrasonic acoustic deterrents will also be considered in addition to the suggestion above, in areas where turbines have been identified as having a heightened risk of collisions or where impact triggers have been met. However, these measures would also require further investigation in consultation with DEECA to provide the most effective implementation. Suitable curtailment protocol to increase the cut-in speed at which turbines operate during higher risk periods has been effectively used to mitigate microbat mortality (Bennett et al. 2022). It is noted that the Bennet et al (2022) study found that approximately 80% of all bat strikes occurred during January to April, thus low wind speed cut in is proposed plan is targeted to this time period.

Figure 5: Operational procedure for investigating impact triggers



8. COMPLIANCE SUMMARY

The following Table 8 indicates the sections of the BAMP that comply with the specific conditions outlined in the Planning Permit (no. 20060221-2). The conditions of the permit have been abbreviated but their full and correct wording can be found in the introduction.

Table 8: Sections within the BAMP that comply with the conditions of the Planning Permit for Hawkesdale Wind Farm

Condition number	Abbreviated condition details	BAMP Section/s
28	Methodology prepared for a targeted assessment	2
29	Targeted assessment carried out	2
30a	Statement of aims and strategies for managing and mitigating significant bird and bat strike	1 & 7
30b (i)	Presence, behaviour, and movement of Brolga, especially breeding pairs	4.1
30b (ii)	Presence and activity of Southern Bent-wing Bats in the vicinity	4.2
30b (iii)	Species and number of bird and bat strikes	5
30b (iv)	Procedures for reporting of bird/bat strikes to the DEECA within 7 days	3.1, 4.2.3, 7
30b (v)	Seasonal and yearly variation in the number of bird/bat strikes	5
30b (vi)	Bird/bat strikes at lit or unlit turbines	5
30b (vii)	Efficacy of searches for carcasses and <i>where practicable</i> , information on scavenger rates, so that the total number of mortalities can be corrected for	5
30b (viii)	Procedures for regular removal of carcasses likely to attract raptors	7.1
30b (ix)	Periodic reporting, within agreed timeframes, of monitoring to DEECA and the local community	3.1
30c	Recommendations in relation to a mortality rate which would trigger mitigation measures to be undertaken to the satisfaction of the Minister for Planning	7
30d	Strategy to offset impacts detected during monitoring to the satisfaction of the Minister for Planning	7
31 & 32	Reporting and reviewing procedures, where the Minister for Planning will then determine whether further investigations are to be undertaken	3.1

9. TIMEFRAMES AND RESPONSIBLE PERSONELL

The table outlines a general timeline for the post-construction monitoring surveys and reporting (Table 9).

Table 9: Approximate timeline for surveys and reporting after commissioning of turbine chains (below referred as operation) on the Hawkesdale Wind Farm

Process	Details	Start	Finish	Initial minimum duration	Report timing	Person/s responsible
Implementation of this BAMP	Oversee the full and complete implementation of all post construction monitoring activities according to the provisions outlined in this document	Commencement of turbine operation	24 months post operation	Two years	As per relevant monitoring activity below	Qualified ecologist/ ecological consultancy contracted by the wind farm operator
Brolga breeding surveys	The first monthly breeding surveys will commence on the first day of July after turbines are operational. The second will commence the following year.	July	December	Two years	One month after completion of surveys	Qualified ecologist (Section 4.1.1)
Southern Bent-wing Bat surveys	Surveys will begin in whichever month (Feb/Oct) follows turbine operation	February	March	Two years	Incorporated into annual reports	Qualified ecologist (4.2)
		October	November			
Mortality surveys	All turbines surveyed within one week per month every month for two years			Two years	Incorporated into annual reports	Qualified ecologist or specially trained searcher (Section 5.1.1)
Scavenger trials	Experimental trial designed to determine scavenging rate	Post-operation of turbines	-	Two years	Incorporated into annual reports	Qualified ecologist (Section 5.1.4)

Detectability trials	Experimental trial designed to determine detectability rate	Post slab laying	Operation of turbines	Two years	Incorporated into annual reports	Qualified ecologist (Section 5.1.5)
Targeted Southern Bent-wing Bat mortality surveys	Migratory intensive surveying (two periods included on right): eight turbines to be determined by Dr Lumsden. Each turbine core area searched twice (within two days) per month	February	March	One year	Incorporated into annual reports	Qualified ecologist or specially trained searcher (Section 5.1.1)
		October	November			
First year report	Comprehensive report of surveying methods and results (given mid-collection). Possible review of methodology. Discussion may include recommendations				Two months after 12 months of surveying	Qualified ecologist (Section 3)
Second year report	Comprehensive report of 24 months of surveying methods and results. Discussion will include (but not limited to) any significant impacts that may influence review proceedings.				Two months after 12 months of surveying	Qualified ecologist (Section 3)
Incidental reports	Any significant impacts outlined in section 7 may require immediate email within two business days reporting (and action) to DEECA and relevant authorities.				2-7 days of impact	Qualified ecologist (Section 3)

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11. GLOSSARY

Bias (statistical)	there are several forms of bias that can be introduced to scientific studies, namely, selector bias in which the replicates (turbines) are chosen where their probability of selection is not equal
Confounding variable	a variable that may influence the data to such an extent that it would alter outcomes; it is crucial to control its effects in design or analysis
Corvid	a species belonging to the Corvidae family; e.g. ravens, crows
Covariable	a variable that may influence the data, that is not relevant to the objectives of the investigation but which must be controlled for in design or analysis
Detectability	the probability that a searcher will detect an existing carcass
Ephemeral	lasting for short periods; the river does not flow for most of the year
Factor	a categorical independent variable; categories of interesting levels, e.g. a factor may be size and its levels are small, medium and large
GPS	Global Positioning Satellite
Power analysis	a statistical procedure to determine the number of required subjects (replicates) in a study in order to show a significant difference at a predetermined level of significance and size of effect
Raptor	a bird of prey; e.g. eagles, falcons and owls
Replicates	the number of subjects in a study or per level, the number cannot be too few as you cannot make any definite conclusions
Searcher	an ecologist that will search for carcasses in the mortality programs
Significant difference	a statistical term referring to a difference between two or more variables or groups; it is based on the assumption that the two or more variables are the same and therefore if you find there is a pre-determined level of difference you can accept they are statistically different. This is a very simple definition, for more information, there are many online dictionaries
Significant impact	generally a reduction in the number of individuals in a population; a more refined definition is impossible here as they are species-specific
Species of concern	the Brolga and the Southern Bent-wing Bat
Sample/study population	as it is impossible to gather information from an entire population (i.e. like sampling all human height >6 billion people), this is reduced to a sample of the entire population and as long as assumptions and random sampling (etc.) are adhered to conclusions can be made about the study population and related to the entire population
Variable	a parameter that varies, there are different types of variables, but generally it is a parameter you are interested in (also called the dependent or response variable: as it responds to a factor or independent variable)
Variation	many values calculate an average, therefore the actual data varies; the variation is a general term to refer to the calculated variation of the data (also sometimes called error, but error is also a more complex phenomenon)

Appendix 1: Carcass data-sheet for any carcass searches, scavenger and detectability trials and incidental finds

HAWKESDALE WIND FARM – MORTALITY MONITORING PROGRAM: CARCASS DATA-SHEET*					
Details above the heavy line will be collected for each site searched. All details below the line are required if a carcass is found.					
Collector:		Date:		Start Time:	Finish Time:
Turbine identifier (incl. lit/unlit):					
Vegetation	Description (inc. vege type):				
	Ave. height:	Density: Very Dense / Dense / Moderate / Sparse / Very Sparse			
Temperature:		Wind direction/speed:		Humidity:	
Search purpose (e.g. scavenger trial):		If scheduled search; search completed: Yes / No			
Onsite works in last 5 days:					
Weather conditions in last 5 days:					
Comments:					
Carcass details	Time:	Coordinates:			Substrate:
Distance from Tower(m):		Bearing from Tower (deg):			
Species common name:				Sex/age?:	
Scientific name:					
Photo Taken**	Yes / No				
Carcass condition:					
Signs of injury:					
How old is carcass estimated to be	<24 hrs	1-3 days	> 3 days	Other:	
Other Notes: (incl. presence of stock)					
Please note: detailed information about each turbine (e.g. distance from water bodies) will be collected once; therefore the “turbine identifier” refers back to the information stored. Post Find Actions: 1. Place carcass in sealable plastic bag then wrap it in newspaper and take to freezer at site office. 2. A copy of this completed form will be sent to the Regional Director, South West Region, Department of Sustainability and Environment, within seven days of the date of the carcass find. 3. One form should be completed for each carcass found 4. **Please attach photo to this form					

Appendix 2: Symbolix letter 24 November 2020



symbolix

making your data work harder

To: Jackson Clerke
Nature Advisory
Via email

Ref #: BLARCAH20201117b

Date: 24 November 2020

CC:

Re: Hawkesdale Wind Farm - Mortality Program Review

To whom it may concern:

Thank you for requesting our review of the proposed Post Construction Mortality Detection Program at Hawkesdale Wind Farm, in south-western Victoria. This letter outlines the scope of the review, our appraisal of the study, and final comments.

Scope of works

We were engaged by Nature Advisory, on behalf of Global Power Generation Australia Pty Ltd, to:

- Review the proposed design of the Post Construction Mortality Detection Program (including carcass searches, scavenger loss and searcher efficiency trials) for Hawkesdale Wind Farm, VIC.
- Prepare a letter of advice regarding the efficacy of the proposed design, referencing statistical adequacy.
- Comment on the intensive Southern Bent-wing Bat survey program
- Comment on the use of brolga carcass equivalents in the scavenger trials

In reviewing the documentation, we refer specifically to the following documents:

- Hawkesdale Wind Farm Bat and Avifauna Management Plan (Brett Lane & Associates [2018](#)) (hereafter *BAM Plan*)
- We specifically refer to:
 - Section 5.1 *Mortality detection* and subsections;
 - Section 6.1 *Intensive Southern Bent-wing Bat monitoring program*;

- Other sections only as relevant to the sections under review.
- “Hawesdale BAM Plan DELWP comments.docx” - word document from DELWP to Nature Advisory (undated)

Appraisal of the mortality study program

What are the required objectives for the Mortality Program?

Under the amended planning permit for the wind farm, the BAM Plan's Mortality Program must deliver:

- *a monitoring program of at least 2 years duration, either commencing upon the commissioning of the last turbine of the first stage of the approved development and use (if any) or alternatively, such other time of commencement as is to the satisfaction of the Minister for Planning. The monitoring program must include surveys during the breeding and migratory seasons to ascertain:*
 - [. . .]
 - *seasonal and yearly variation in the number of bird and bat mortalities arising from the operation of the wind energy facility;*
 - *the efficacy of searches for carcasses of birds and bats and information on the rate of removal of carcasses by scavengers, so that correction factors can be determined to enable calculations of the total number of mortalities;*

In addition, targetted carcass searches for the Southern Bent-wing Bat are required as per requested from DELWP and Dr Lindy Lumsden (ARI).

In the BAM Plan the response to this requirement is to propose:

- A structured survey program designed to estimate the total mortality of birds and bats (and species/size groups if sufficient carcasses found).
- An intensive survey program at specific times of year and turbines, targetting the Southern Bent-wing bats.

Appraisal of the design

We briefly assess the design of the various component surveys designed to quantify searcher efficiency, scavenger rate, and mortality.

Statistical adequacy - searcher efficiency

We refer to Section 5.1.5 *Detectability trials* of the BAM Plan.

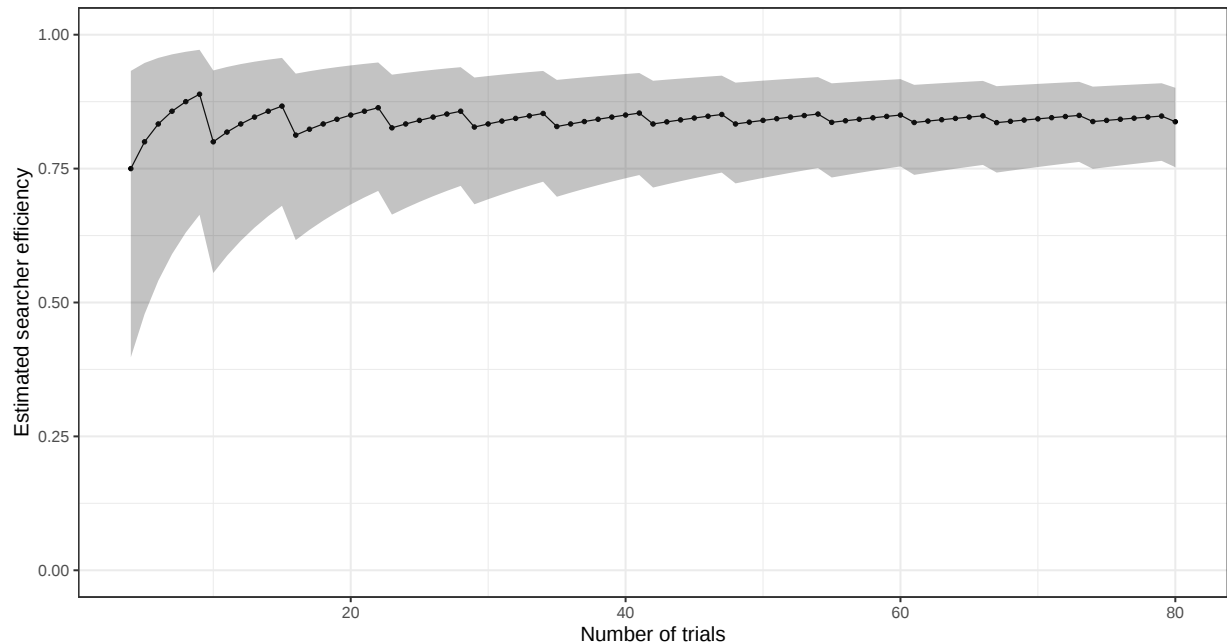


Figure 1: Estimated searcher efficiency (proportion of carcasses found) with 95% confidence bound for a given number of trials. Assumes an overall efficiency of 84.3%.

The above chart (Figure 1) has been calculated (Clopper 1934) as a scenario to highlight the issues with detectability trials. We have assumed that the “true” observer efficiency is 84.3%.

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

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

Although the mechanism for generating time to scavenge is different to searcher efficiency, a similar result holds in that case also.

The number of replicates (20 microbats, 10 medium birds, and 10 large birds) proposed is statistically reasonable for the searcher efficiency, and will give appropriate confidence intervals for input into mortality estimation.

Statistical adequacy - scavenger rate trials

We refer to Section 5.1.4 *Scavenger rates and trials* of the BAM Plan.

We measure time to scavenger loss with on-ground trials and analysis using standard survival study methods ((Kaplan and Meier 1958), (Terry M. Therneau and Patricia M. Grambsch 2000)). These are needed as the exact time to scavenge may not be known (e.g. interval-censored times, or carcasses persisting to the end of the trial).

If we assume an exponential loss function for carcasses, the relative standard error (RSE) is a simple function of the number of carcasses lost: $RSE = 1/\sqrt{n}$. As Figure 2 shows, the precision is not vastly improved by increasing the numbers of trials.

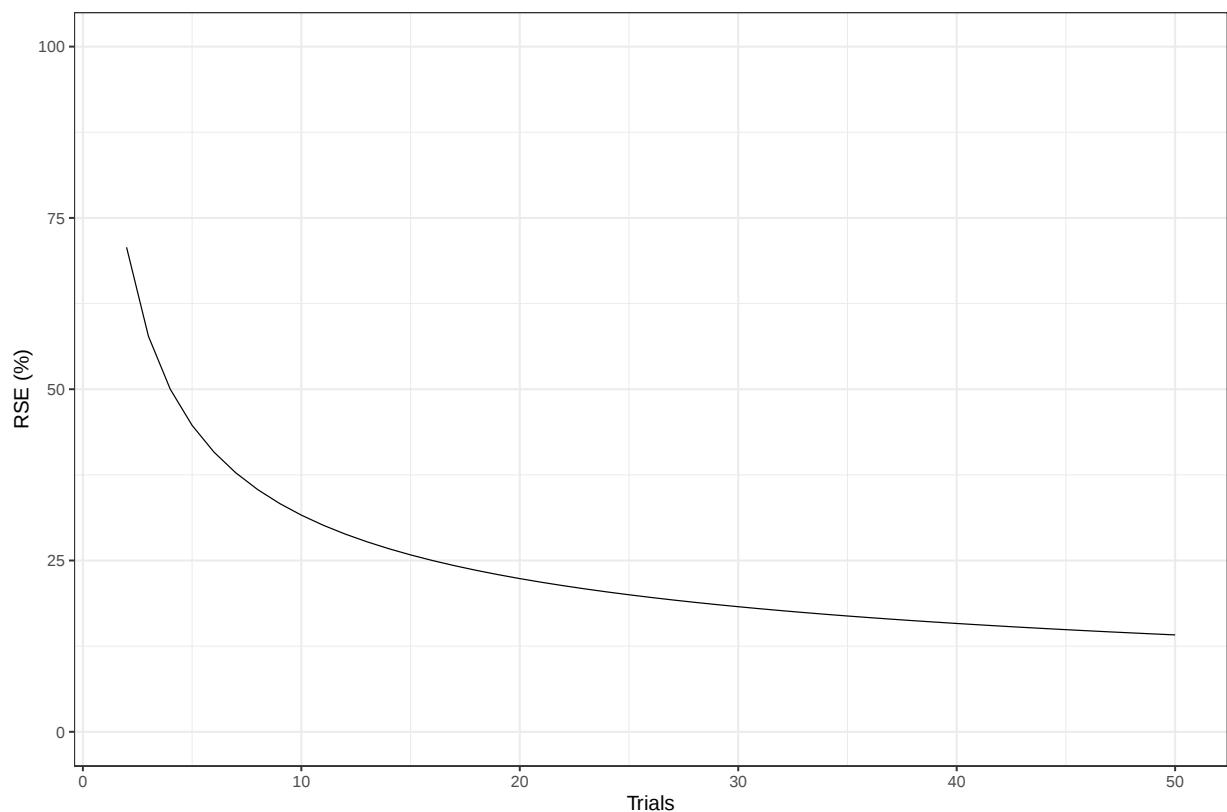


Figure 2: Relative standard error of scavenger rate as a function of carcasses lost

We would recommend 10 replicates per species class as a minimum. **The survey design proposed exceeds this for bats and concurs for birds, and therefore we conclude it is statistically sound.**

Statistical adequacy - carcass searches

We refer to Section 5.1.2 *Turbine selection* and 5.1.3 *Search protocol* of the BAM Plan.

The proposed carcass surveys will sample one half of the turbines (minimum). There is no strict statistical rule for the right number of turbines sampled. It is more important to ensure the turbines are selected at random (assuming all turbines are accessible). This is the only way to enable an unbiased estimate of mortality. The survey will run for a minimum of two years, and has at least one survey per month, capturing seasonal variation on-site.

We also recommend the same turbines are searched each month. Having a consistent minimum time between searches minimises the variability in estimating the change a carcass has been

lost to scavenge since the last survey.

The survey (as proposed in the BAM Plan) complies with these suggestions, and is statistically sound.

The proposed search areas (60m inner zone, and 120m outer zone) will capture 95% of the fall zone for bats and 95% of the fall zone for birds, according the models implemented from (Hull and Muir 2010).

Selection and timings

The three component surveys above are based on a single geographical site stratum. The land cover on the site is characterised as cleared grazing land with a limited number of small remnant areas of native vegetation (BAM Plan Section 1 *Introduction*). The choice of a single stratum is reasonable in this case.

Selecting turbines at random for the carcass search sample will ensure a unbiased sample of the turbines This is required to achieve a unbiased estimate of site mortality.

The searcher efficiency and scavenger rate trials will be timed to occur at times of the year that represent low vegetation load versus high vegetation load. This is a reasonable compromise between running multiple trials throughout the year, but still sampling the range of conditions that impact detection/scavenge activity.

Appraisal of the intensive bat survey

We refer to Section 6.1 *Intensive Southern Bent-wing Bat monitoring program* of the BAM Plan.

It has been requested by DELWP and Dr Lindy Lumsden (ARI) that intensive carcass searches for the Southern Bent-wing Bat are undertaken in Feb-Mar, and Oct-Nov. There are 8 selected turbines for this program, which are in proximity to forested areas and permanent water. These turbines will be searched weekly in the 60m inner zone during the intensive survey period, using standard search protocols.

We discuss this separately to the general mortality study appraisal, as this is non-standard survey procedure.

The selection of turbines and timing of surveys for this program is non-random. Therefore, the any analyses on this subset of turbines cannot be generalised to the whole of the farm, other Victorian sites, or other time periods. The data cannot be combined with the general mortality data.

As standard search protocols are used, an estimate of total Southern Bent-wing bat mortality can be obtained for the selected turbines and time periods only, using searcher efficiency and scavenger rate results from the general trials.

To summarise:

The DELWLP proposed change (Nature Advisory, [n.d.](#)) from monthly pulsed surveys to weekly surveys does not weaken the survey design, and is a statistically valid change. We caution that this data cannot be used to determine mortality for the period for the whole site (as the turbines are not statistically sampled but chosen in a biased way, based on assumption of higher risk). If a mortality estimate is carried out on these data, it is only applicable to the turbines and date ranges of the weekly surveys.

Comment on brolga equivalents in the scavenger and detectability trials

We note the recent request from DELWP to amend the scavenger and detectability trials to include 10 brolga equivalent carcasses.

It's not possible or ethical to source brolga carcasses for this trial and (we understand from conversations with Nature Advisory Ecologists) large birds like turkeys would have to be purchased live and culled by the field crews.

It's outside the scope of our professional training to quantify the ethical and OH&S implications of this request; suffice to say that we will not certify a design that requires ecologists to undertake animal slaughter without full ethics clearance and a very strong research justification. Contributing inputs to a statistical model for the purpose of furthering our research knowledge of the cumulative impacts of wind farms is not a strong enough justification, in our professional view as statisticians and environmental practitioners.

What are the implications if brolga-equivalent carcasses are not sourced?

- Mortality estimates can use scavenger / detectability rates determined from the large bird or general bird cohort in the proposed trials.
 - We do not know for certain the scavenge rate or searcher efficiency for brolgas. We do know that another roughly brolga-sized large bird, the Wedge-tailed Eagle, has a very long time to carcass loss (Stark [2020](#)). Other birds / large birds in general (e.g. raven sized) do not have as long time to carcass loss as the WTE. We also know that birds (in general) have a high rate of detection in Victoria.
 - This suggests that using general bird / large bird rates as a proxy for brolga would result in an underestimate of time to scavenge and a corresponding **overestimate** of mortality for brolga species. That is, we would tend to predict more brolga mortalities than then the actual. This is manageable with clear communication of the analysis assumptions when analysis is done.
- The Operational Procedures in the plan require immediate investigation upon **detection** of any threatened species, including Brolga.
 - As there is already a management plan based on actual counts of carcasses the

role of the mortality estimation for broilgas is one of knowledge gathering rather than direct management or compliance. That is, the mortality estimates are useful for determining inputs for any future landscape scale cumulative research DELWP wishes to conduct.

With these considerations in mind we do not support the requirements to include broilga proxies in the study.

Final remarks

The survey program represents standard statistical best practice for estimating mortality at a wind farm, and satisfies the condition of the permit. It is consistent with other sites in Victoria, which enables future combined analysis. The pulse survey protocol over summer/autumn accounts for the shorter scavenge times expected for bat species.

The weekly carcass searches during October-November and February-March will use the same field protocols as the main survey. The data from these surveys will *“be available to DELWP and Dr Lumsden in hard-copy or electronic form and the information incorporated as a separate data appendix in the annual report”* (Brett Lane & Associates [2018](#)). It is appropriate to treat this as a separate survey - the biased selection of turbines precludes its inclusion in an estimate of total site mortality.

The scavenger and detectability trials as proposed represent current best practice for these adjunct surveys. We do not support for the inclusion of broilga proxies in addition to the carcass sizes proposed. The statistical benefit does not outweigh the potential OH&S and ethical issues involved with sourcing carcasses of that size.

Regards,



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