HAWKESDALE WIND FARM

BAT AND AVIFAUNA MANAGEMENT PLAN

Union Fenosa Wind Australia Pty. Ltd.

BL&A Brett Lane & Associates Pty. Ltd.
Ecological Research & Management
25 Burwood Road, Hawthorn, Vic. 3122
P O Box 74, Richmond, Vic. 3121
Ph. (03) 9815 2111
Fax. (03) 9815 2685

In association with:

symbolix

February 2012

Report No. 9067 (2.4)

CONTENTS

1. INTRODUCTION 1
1.1. BAM Plan Objectives 3
1.2. Site description 3
2. PRE-CONSTRUCTION MONITORING PROGRAM 7
2.1. Previous studies 7
2.1.1. Desktop review 7
2.1.2. Ecological assessment 7
2.1.3. Bat Survey 2007 8
2.1.4. Updated Desktop Assessment 10
3. ROUTINE REPORTING, REVIEW MEETINGS, DATA ACQUISTITION AND PERSONNEL 14
3.1. Routine reporting and review meetings 14
3.2. Data acquisition/submission and personnel involved 15
4. POST CONSTRUCTION UTILISATION SURVEY PROGRAM 17
4.1. Brolga risk assessment surveys 17
4.1.1. Breeding season Brolga monitoring 17
4.1.2. Flocking season Brolga monitoring 19
4.1.3. Brolga reporting 19
4.2. Southern Bent-wing Bat risk assessment surveys 20
4.2.1. Methodology 20
4.2.2. Analysis and assessment 20
4.2.3. Reporting 20
5. POST CONSTRUCTION MORTALITY DETECTION PROGRAM 21
5.1. Mortality detection 21
5.1.1. Turbine selection 21
5.1.2. Search protocol 22
5.1.3. Scavenger rates and trials 24
5.1.4. Detectability trials 25
5.1.1. Analysis and data limitations 26
5.2. Incidental Carcass Protocol 26
5.3. Injured Bird and Bat Protocol 27
6. POST CONSTRUCTION INTENSIVE MONITORING AND MORTALITY ESTIMATES PROGRAM 28
6.1. Intensive Southern Bent-wing Bat monitoring program 28
6.2. Mortality estimation 28

7. SIGNIFICANT IMPACT, MITIGATION AND OFF-SETS 30
7.1. Raptor risk reduction measures 30
7.2. Definition of significant impacts 30
7.3. Mitigating significant impacts 31
7.4. Offsetting significant impacts 32
8. COMPLIANCE SUMMARY 35
9. APPROXIMATE TIMELINE 36
10. REFERENCES 38
11. GLOSSARY 41
12. APPENDICES 43

FIGURES

Figure 1: Hawkesdale Wind Farm illustrating pre-construction bird utilisation survey points. 5
Figure 2: Carcass search zone, two target areas: outer Brolga search zone with 12m spaced transects and inner Southern Bent-wing Bat (SBWB) core with 4m spaced linear transects. 23
Figure 3: Operational procedure for mitigating significant impacts. 34

TABLES

Table 1: Location and distance of Southern Bent-wing Bat roosting and maternity caves in relation to the Hawkesdale site (Table adapted from ACCIONA Energy (2009)) 6
Table 2: Threatened bird and bat species likely to occur on the Hawkesdale wind farm site. 12
Table 3: Number of replicates for each of the two factors within the scavenger trials 24
Table 4: Detectability trials given two factors of size and visibility 25
Table 5: Sections within the BAM Plan that comply with the conditions of the Planning Permit for Hawkesdale Wind Farm. 35
Table 6: Approximate timeline for surveys and reporting after commissioning of turbines on the Hawkesdale Wind Farm 36

APPENDICES

Appendix 1: Carcass data-sheet; to be used for any carcass searches, scavenger and detectability trials and incidental finds 43
Appendix 2: Documents referred to in pre-construction surveys: A desktop review carried out by Environmental Resources Management (ERM) Australia. 44
Appendix 3: Documents referred to in pre-construction surveys: Hawkesdale Wind Farm Ecological Assessment, ERM Australia (2006). 45

Appendix 4: Documents referred to in pre-construction surveys: A bat survey carried out by Greg Richards and BL&A in 2007. 46

Appendix 5: Documents referred to in pre-construction surveys: 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). 47

1. INTRODUCTION

Brett Lane and Associates Pty. Ltd. (BL&A) and Symbolix Pty. Ltd. was engaged by Union Fenosa Wind Australia Pty. Ltd. to develop a Bat and Avifauna Management Plan (BAM Plan) in accordance with conditions in the Moyne Shire Council planning permit. This report is required for the construction of the proposed Hawkesdale Wind Farm.

The proposed Hawkesdale Wind Farm site lies in south-western Victoria, immediately south of Hawkesdale Township and approximately 50 kilometres north of Port Fairy. The proposed wind farm would include 31 two-megawatt wind turbines. 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 a planning permit for the construction of the Hawkesdale Wind Farm (Moyne Planning Scheme, Permit Number: 20060221). Under the conditions of this permit, bird and bat targeted surveys and a BAM Plan must be prepared. These conditions state that:

> *16. Within 3 months of the issue of this permit, unless extended by the Minister for Planning, a methodology must be prepared for a targeted assessment to determine the utilization 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/TME Australia Volume 1 – Main Report and Volume 2 – Annexes, September 2006*. A methodology for the assessment, which is generally in accordance with* Wind Farm and Birds: Interim Standards for Risk assessment, AusWEA (2005)*, shall be developed in consultation with the Department of Sustainability and Environment to the satisfaction of the Minister for Planning.*
>
> *17. 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.*
>
> *18. Prior to the commissioning of the turbine and based on the findings of the targeted assessment, a Bat and Avifauna Management Plan (BAM Plan) to the satisfaction of the Minister for Planning must be prepared in consultation with the Department of Sustainability and Environment, and must be submitted to and approved by the Minister for Planning. When approved the plan will be indorsed and will then form part of the permit. The BAM Plan must include:*
>
> - *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;*
> - *a monitoring program of at least two years duration from the commissioning of the last turbine including surveys during the breeding and migratory seasons to ascertain:*
> - *the presence, behaviour and movements of any Brolga, especially breeding pairs in the vicinity of the wind energy facility;*
> - *The presence, behaviour and movements of the Southern Bent-wing bat in the vicinity of the wind energy facility;*
> - *the species and number of birds and bat strikes;*

- *Procedures for reporting of any bird and bat strikes to the Department of Sustainability and Environment within 7 days of becoming aware of any strike;*
- *seasonal and yearly variation in the number of bird and bat strikes;*
- *whether bird and bat strikes were at lit or unlit turbines;;*
- *the efficacy of searches for carcasses of birds and bats, and where practicable, 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;*
- *procedures for regular removal of carcasses likely to attract raptors to areas near turbines; and*
- *requirements for periodic reporting, within agreed timeframe of the findings of the monitoring to the Department of Sustainability and Environment and the local community;*

- *recommendations in relation to a mortality rate for specified species which would trigger the requirement for responsive mitigation measures to be undertaken by the proponent to the satisfaction of the Minister for Planning; and*
- *a strategy to offset any impacts detected during monitoring. Measures to offset the impact may include management or improvement of habitat or breeding sites away from the wind farm in the region to improve breeding productivity, or other offsets to the satisfaction of the Minister for Planning."*

This BAM plan details objectives and strategies that meet the requirements of these approval conditions. It is divided into three main sections, Compliance assessments, DSE-specified assessments and Compliance mitigation and summary. These are further subdivided as follows and written in-text:

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.

DSE-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) and Brett Lane (Principal Consultant) and Stuart Muir (Statistician: Symbolix Pty. Ltd.).

1.1. BAM Plan Objectives

The overall aim of this Bird and Avifauna Plan 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 - 2007*.

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 after operations commence (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 proposed wind farm site is approximately 2000 hectare in area would include a total of 31 two-megawatt 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.

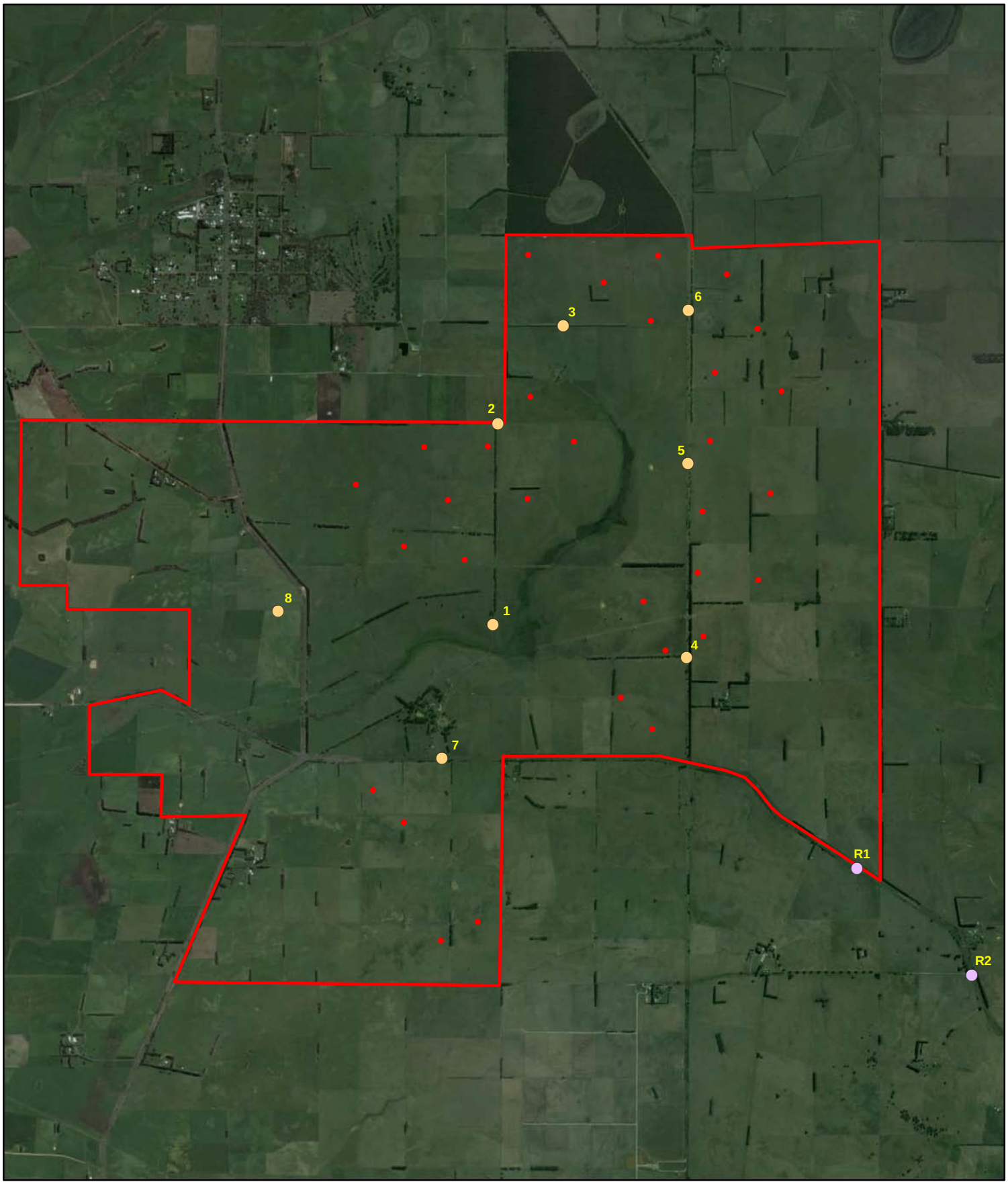
The study site comprises a combination of flat areas and low, undulating hills and is between 125 and 155 m above sea level. The flat and hilly areas consist mainly of grazing paddocks covered with various exotic grasses and they are therefore highly disturbed. Very little native vegetation existed on 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 devote 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 13 caves were of significant value to the species (Table 1). Six of the 13 caves lie within a 40 km radius of the site.



Meters
0 750 1,500 3,000

Legend

- Study Area Boundary
- Bird Utilization Points
- Reference Points
- Turbines

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

Project: Hawkesdale Wind Farm

Client: Union Fenosa Wind Australia Pty Ltd

Project No.: 9067	Date: 06/04/2010	Created by: K. Al Dabbagh / D. Soldatos

BL&A Brett Lane & Associates Pty. Ltd.
Ecological Research & Management
Experience Knowledge Solutions
605 Nicholson Street
PO Box 592, Carlton North
VIC 3054 Australia
ph (03) 9387 5008 | fax (03) 9387 6115
blane@ecologicalresearch.com.au
www.ecologicalresearch.com.au

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

Region (ranked distance from site)	Location name	Coordinates		Approx. distance from site (km)	2009 status
		South	East		
Grasmere	Grasmere Cave	38°16	142°32	25	Large numbers - high conservation value
Yambuk	Yambuk Cave	38°19	142°04	35	Still used as an important roost
Mt Eccles National Park	Un-named	38°04	141°55	40	Still used as an important roost
Byaduk	Church Cave	37°55	142°00	40	A few bats, many at other times
Cape Volney	Panmure Cave	38°19	142°44	40	Large numbers - high conservation value
Warrnambool	Starlight Cave	38°25	142°35	40	Now is the only maternity colony known from Victoria, one of only two maternity sites known for this species
Bats Ridge National Park	Tom-the-Cheap Cave	38°20	141°30	80	Usually lots of bats
Porndon	Porndon Arch	38°18	143°17	85	Still used as an important roost
Portland	Cape Bridgewater Sea Cave	38°24	141°25	90	Still used as an important roost
Lower Glenelg National Park	Un-named (McLennan's Punt?)	38°00	141°10	105	Reasonable numbers
Cape Volney	Un-named	38°46	143°16	110	Still used as an important roost
Cape Patton	Un-named	38°42	143°50	145	Still used as an important roost
Lorne	Cumberland River Cave	38°45	144°00	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 proposed wind farm site by birds and bats. These included:

- A desktop review carried out by Environmental Resources Management (ERM) Australia (Appendix 2);
- Hawkesdale Wind Farm Ecological Assessment, ERM Australia (2006) (Appendix 3);
- A bat survey carried out by Greg Richards and BL&A in 2007 (Appendix 4).
- 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) (Appendix 5).

The findings from these works are summarised below.

2.1.1. Desktop review

A desktop assessment of the study area was undertaken in July 2005. This included a review of existing background literature, relevant databases and consultation with local interest groups and DSE 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 proposed 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 schreibersii bassanii*), Large-footed Myotis (*Myotis adversus*), White-striped Freetail Bat (*Tadarida 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 proposed 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 proposed wind farm area included Gould's Wattled Bat, Chocolate Wattled Bat and the White-striped Mastiff Bat. The Southern Freetail Bat and Southern Forest Bat were assessed as likely to occur, although insufficient calls (passes) were available to confirm their presence. Fishing Bat, Little Forest Bat and an unidentified Long-eared Bat also had the potential to occur in the proposed 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: the 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 BL&A 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 proposed wind farm boundary. The study recorded ten bats 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. 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 Freetail 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 proposed 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.

Impacts on the bat populations are not expected to be significant. Most of the bats utilizing the wind farm site were found to be common and secured species. Impacts on the threatened Southern Bent-wing Bat is also not expected to be large since; first: only small part of the bat population in south-western Victoria (Vic. Population: ~15000 bats) 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 proposed Hawkesdale Wind Farm. Mitigation measures will be implemented to further reduce impact, if necessary.

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 (see Appendix 1). To summarise:

"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 BAM Plan 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 proposed 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 proposed wind farm boundary. The following sources were consulted for this desktop assessment:

- The Atlas of Victorian Wildlife (AVW), a database administered by the DSE (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 birds 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 proposed wind farm boundary due to a lack of suitable habitat and are not discussed further (see Table 2). 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 proposed 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 proposed 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 proposed 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 proposed 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 proposed 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 proposed wind farm site. It is difficult to measure impacts on this species associated with the proposed wind farm as the species is highly mobile and would be likely to visit the proposed 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 proposed wind farm boundary. These species are described below.

Southern Bent-wing Bat: During the bat survey undertaken in 2007 (Greg Richards and BL&A) this bat was recorded on 22 occasions over the 11 day sampling period. All records were from Austin's Creek. 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 Bentwing Bat from turbine collision.

Large-footed Myotis: This is a unique bat that forages over water. 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). The species is rare in Victoria, and as the bat report suggested, there would be very little impact on this species from the operation of wind turbines at the proposed Hawkesdale wind farm, due to a low level of activity.

Table 2: Threatened bird and bat species likely to occur on the Hawkesdale wind farm site.

Common Name	Scientific Name	Conservation status			Habitat	AVW Records	Likelihood of occurrence
		EPBC	DSE	FFG			
Birds							
Australasian Shoveler	*Anas rhynchotis*		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.	1 (1984–1987)	Habitat limited, low probability of occurrence
Australian Painted Snipe	*Rostratula australis*	VU	CE	L	Lowlands on shallow freshwater swamps with emergent vegetation and flooded saltmarshes.	No records	lack of habitats, unlikely to occur
Brolga	*Grus rubicunda*		VU	L	Wetlands that include permanent open water and deep freshwater marsh.	5 (1991)	Habitat present, moderate likelihood of occurrence
Eastern Great Egret	*Ardea modesta*	M	VU	L	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. *Typha*) and herb dominated seasonal swamps with abundant aquatic flora.	No records	Limited Habitat, moderate probability of occurrence present
Hardhead	Aythya australis		VU		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 swamps, wooded lakes and swamps, rice fields, and sewage ponds.	1 (2006)	Habitat limited, low probability of occurrence
Latham's Snipe	*Gallinago hardwickii*	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.	No records	moderate probability of occurrence present
Magpie Goose	*Anseranas semipalmata*	M	NT	L	Terrestrial and aquatic habitats, but activities cantered on wetlands, mainly those on floodplains of rivers.	1 (1988)	Habitat limited, low probability of occurrence
Musk Duck	*Biziura lobata*		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	No records	Habitat absent, unlikely to occur

Common Name	Scientific Name	Conservation status			Habitat	AVW Records	Likelihood of occurrence
		EPBC	DSE	FFG			
					flora abundant		
Rainbow Bee-eater	*Merops ornatus*	M			Usually in open or lightly timbered areas, often near water. In open dry forests, woodlands and shrublands.	No records	Habitat absent, unlikely to occur
Rufous Fantail	*Rhipidura rufifrons*	M			Mostly in dense, moist habitats or mid-stories in moist gullies; usually in wet eucalypt forests, less often in dry forests or woodlands.	No records	Habitat absent, unlikely to occur
Satin Flycatcher	Myiagra cyanoleuca	M			Inhabits eucalypt forests, particularly wet sclerophyll forests, and often in gullies or near watercourses. Also in eucalypt woodlands with open understorey.	No records	Habitat absent, unlikely to occur
Swift Parrot	*Lathamus discolor*	EN	EN	L	Prefers a narrow range of eucalypts in Victoria, including White Box (Eucalyptus albens), Red Ironbark (E. sideroxylon; , E. tricarpa) and Yellow Gum (E. lucoxylon), as well as River Red Gum (E. camaldulensis), when this species supports abundant 'lerp'.	No records	Uncommon in SW Victoria, lack of habitats, unlikely to occur
Whiskered Tern	*Chlidonias hybridus*		NT		Inhabit shallow terrestrial freshwater wetlands, either permanent or ephemeral, including lakes, swamps, river pools, reservoirs, sewage farms and others.	2 (1991 & 2001)	Habitat present, moderate likelihood of occurrence
White-bellied Sea-Eagle	Haliaeetus leucogaster	M	VU	L	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.	No records	Habitat absent, unlikely to occur
White-throated Needletail	*Hirundapus caudacutus*	M			Almost exclusively aerial, occur over most types of habitats, but more often over wooded habitats, mainly open forests.	No records	Habitat absent, unlikely to occur
Mammals							
Large-footed Myotis*	*Myotis macropus*		NT		Always associated with permanent, usually slow flowing, water bodies. Records come from wide range of vegetation communities associated with water.	No records	Recorded on site during 2007 bat survey (Greg Richards and BL&A)
Southern Bent-wing Bat	*Miniopterus schreibersii bassanii*	CE	EN		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.	No records	Recorded on site during 2007 bat survey ((Greg Richards and BL&A)

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

3.1. Routine reporting and review meetings

This section of the plan outlines the reporting arrangements for the Bat and Avifauna Management Plan. 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.

Brolga activity reports will be prepared in January (for the preceding breeding season) and July (flocking season) each year, summarising the findings from the targeted Brolga investigations. This will include but not be limited to information on:

- The results of monitoring of Brolga occurrence in wetlands on and the wind farm within the area of concern around it;
- The results of any behavioural monitoring of breeding or flocking 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. This will focus on presenting the results from the first year of monitoring, 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 the Regional Manager, South West Region, Department of Sustainability and the Environment (or their delegate) 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 DSE 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 will include the following:

- Detailed survey methods (including list of observers, dates and times of observations);
- Results of the Brolga breeding and flocking 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 discernable 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 Union Fenosa Wind Australia Pty. Ltd. will notify the Regional Manager, South West Region, Department of Sustainability and Environment via email (see section 0).

Following completion of the two years of monitoring, results will be reviewed by DSE 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 BAM Plan. Data for all work conducted for the BAM Plan will be available to DSE 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 DSE 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.

All personnel working in the field and office 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. Dr Khalid Al-Dhabbagh, Teisha Sloane and Curtis Doughty are the very experienced ecologists assigned to conduct carcass

searches, but the actual identities of ecologists is yet to be determined due to scheduling requirements. 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). The three ecologists assigned to conducting carcass searches have many years experience with carcass searches across Australia, including the identification of the Southern Bent-wing Bat and Brolga. Personnel of equivalent qualifications and experience should be involved if an alternative company is commissioned to implement the BAM Plan. If unqualified personnel are involved in any of the post construction monitoring programs (not carcass searches) this will be stated within the relevant section of this plan, otherwise all personnel (or observers), unless stated, will be trained and qualified ecologists.

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 Brolgas 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.

The Brolga risk assessment survey will commence immediately (i.e. within 7 days) after wind farm operations commence. In accordance with condition 16.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 DSE.

The surveys will involve two parts: 1) a targeted breeding season survey within the wind farm site and out to a minimum 3 km from the outer wind turbines; and 2) a flocking season survey within the wind farm and out to a minimum of 5 km from the outer wind turbines. The DSE Regional Manager (South West Region) will be immediately notified by email if Brolgas are detected within the site or breeding or flocking is identified within 3 or 5 km, respectively, of the wind farm. Each part of the program is described below.

4.1.1. Breeding season Brolga monitoring

The breeding season monitoring program (July to December) will include the components described below:

Wetland assessment:

- An assessment of wetlands, their habitat quality and potential for use as breeding sites by the Brolga on and within 3 km of the wind farm site will preferably be done after winter-spring rainfall (August–September) had been sufficient to fill wetlands and promote the growth of aquatic vegetation.;
- Wetland mapping from DSE will be reviewed to identify potential Brolga habitats within the survey area.

Potential breeding sites:

- All sites 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 km of the wind farm site and paddocks surrounding these wetlands.
- These sites will be surveyed fortnightly from July to December
- 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 km of a turbine, more detailed observations will be triggered.
- The behaviour of individual Brolgas found breeding in the search area will be recorded on average twice per fortnight 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 Brolgas 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;
- 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 Brolgas 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.
- Breeding sites and movement data can provide information regarding possible disturbance to Brolgas.

4.1.2. Flocking season Brolga monitoring

The flocking season survey will involve the activities described below.

General flocking:

- Sites will be surveyed by observers using binoculars and telescope while on foot (i.e. beyond FID). The number and approximate composition of the flock will be estimated and recorded (i.e. adults, juveniles, chicks);
- All current and potential flocking sites (i.e. permanent or larger wetlands) on and within 5 km of the wind farm site would be surveyed fortnightly from December until June. The roaming survey method would be the same as for the breeding season.

Detailed flocking observations:

- If Brolgas were found to flock (*sensu* DSE 2011) at a site within 5 km of the wind farm site then a detailed survey would be undertaken to document their behaviour and foraging movements from the flocking site;
- This will involve weekly observations to investigate Brolga behaviour and in particular whether movements around the flocking site could bring birds into areas where there was a risk of collision with wind turbines. These observations will comprise a minimum of, on average, two full days/fortnight (dawn to dusk) complemented by incidental observations by wind farm site personnel appropriately trained by a qualified and experienced ecologist. Hourly observations will be undertaken by ecologists as a minimum and the start and finish times of all observations will be recorded.
- Variables to be recorded will include distance, direction and height of each flight (m) plotted on a map, time and weather conditions (wind, speed, direction, temperature) during each observation, activity of birds (e.g. foraging, sociality), habitat flown to and from, and locations of birds to nearest 100m or better (approx. GPS).

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);
- Whether flocks regularly use flight paths crossing the wind farm will be determined, which may trigger mitigation measures;
- Flocking population estimates will be made as the population of Brolgas in the area may change during the flocking season.

4.1.3. Brolga reporting

At the completion of each survey season, a report will be prepared and submitted to DSE and the Minister for Planning analysing the data gathered and describing the behaviour of flocking and breeding Brolgas 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.

4.2. Southern Bent-wing Bat risk assessment surveys

A bat survey, with emphasis on the Southern Bent-wing Bat will be undertaken at Hawkesdale Wind Farm site after wind farm operations commence. The timing of the surveys is designed to coincide with periods when the Southern Bent-wing Bat is likely to be present and utilising the wind farm site. 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 periods of the year as follows:

- Late summer survey (mid-February to mid-March) to coincide with the migration from the maternity caves to the overwintering caves; and
- Spring survey (October - November) to coincide with increased activity of bats with warming conditions after their return to the maternity caves.

4.2.1. Methodology

The Anabat® ultrasonic bat detectors will be used using a similar survey design as the pre-construction surveys (Greg Richards Pty. Ltd. 2006 and 2007). Changes to survey design involve location of units and the number of recording nights. Bat calls will be recorded every night for six weeks in eight locations (per survey season). Two of these units will remain fixed for the six weeks, in locations close to vegetation and in “bat flight hot spots”. These will be identified in consultation with DSE. The other two will be moved every two weeks to semi-randomly assigned locations in other areas of the wind farm. Some units will be fixed at height within range of the rotor sweep zone, but this depends on the number of wind monitoring masts (yet to be determined). This may provide information on bat activity at the same height as the rotor swept area of the wind turbines. The actual location of the static and mobile units will be determined closer to the commencement of surveys and in consultation with DSE.

4.2.2. Analysis and assessment

The information from the acoustic surveys will be used to determine general bat species occurrence and specifically the presence of the Southern Bent-wing Bat. The information from each static or mobile Anabat unit may provide the location of activity (e.g. calls only recorded from one location at any one time). However, the actual number of individual bats moving through the site cannot be calculated as many calls can be produced by one individual passing many times or many individuals.

4.2.3. Reporting

Southern Bent-wing Bat survey results will be incorporated in the annual mortality monitoring report. Results will be prepared at the end of both the first and second year of monitoring. Results will be reviewed and discussed with DSE. As per DSE instructions, reporting will include the number of calls identified per species per night at each site, number and percentage of calls that were unidentifiable, number and percentage of calls that were identified to species complex level, reference calls used, and reporting of any significant timing patterns of calls 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 DSE. 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 proposed 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, the 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:

- **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. Turbine selection

The target population are the turbines themselves and the sample population will be one third of the entire turbine number. It is the turbines that proxy for the farm, and not the search area nor the carcass detections. The turbines will be spatially divided into two strata;

potentially higher collision risk and low risk. The perceived risk (high or low) of the turbines will be determined at a later date based on proximity to vegetation and wetlands (where the Brolga and Southern Bent-wing Bat are more likely to occur). There are several conditions that will apply so that the mortality rates from the sample population can be scaled up to the entire site. These are:

1. Each turbine within a stratum has an equal chance of being selected for the searches (randomly selected by number generation table);
2. No stratum can have less than three turbines. We calculate that for the Hawkesdale Wind Farm the low risk stratum can have three while the higher risk will have a minimum of eight;
3. Once the turbines have been selected, there can be no change.

A minimum of 11 turbines will be selected for searches, this number has been calculated based on, firstly, what will provide the most accurate mortality rate given high variability shown on other wind farms, and secondly, that humans will have search limits (e.g. OHSE). Each turbine that is selected for the searches will have the following meta-information recorded:

- 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

The total number of turbines will be fixed to be at least 11. However the sampling fraction within the strata may be adjusted. Such changes will be based on statistical rigour, and reported appropriately.

5.1.2. Search protocol

The search area beneath each turbine has been determined to best detect Brolga and Southern Bent-wing Bat carcasses. A square search zone surrounding the turbine will be formed by GPS and/or visual markers into two target search zones (Figure 2). The first core zone targets the detection of Southern Bent-wing Bats, where the square is formed at 60 m from the turbine and linear transects will be spaced at 4 m. The outer area will aim at detecting the much larger bodied Brolga and be formed at 120 m from the turbine but not including the core, with linear transects being spaced at 12 m. This transect spacing and total search area will be ample to detect the two species of concern and are based on previous studies (e.g. Arnett et al. 2005, Hull and Muir 2010). All of the search area ($120m^2$) will be traversed each month, there are no foreseeable circumstances where this would not be possible on this farm.

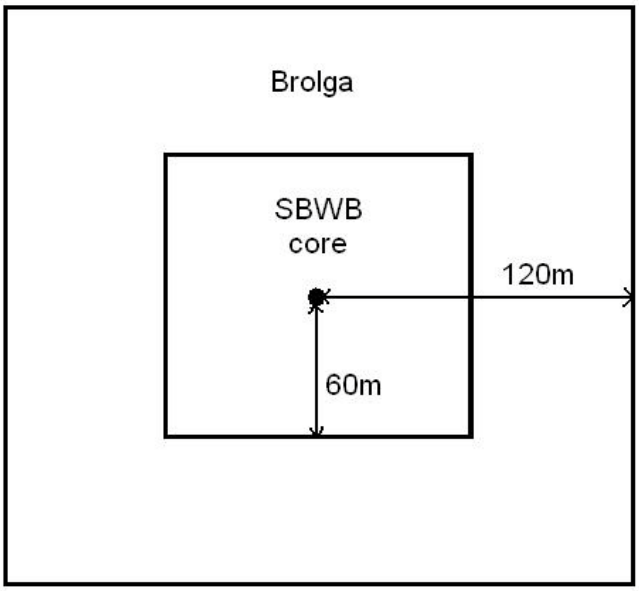


Figure 2: Carcass search zone, two target areas: outer Brolga search zone with 12m spaced transects and inner Southern Bent-wing Bat (SBWB) core with 4m spaced linear transects.

The total distance walked by a searcher within the core zone will be 3.6 km and the same distance will be traversed by the searcher in the outer zone. Two ecologists will walk the two zones in tandem and swap roles every new turbine. To ensure that all other possible confounding variables are controlled, ecologist searcher behaviour will be standardised (i.e. clothing, speed) and they will use GPS and markers to ensure that they follow the same path every time. The order of turbines searched will be randomized. The entire search area beneath each turbine will be sampled once per month, but the core will be re-sampled after no more than two nights after the initial pass to decrease the likelihood of missing scavenged bat carcasses.

If a carcass is detected the following variables will be recorded (see Appendix 1):

- GPS position, distance and compass bearing of the carcass from the wind turbine tower;
- Substrate and vegetation, particularly if it was found on a track or hard-stand area without vegetation as this may assist in quantifying the number of carcasses not found in areas where ground cover makes carcasses less visible;
- Weather, visibility, maintenance to the turbine and any other factors that may affect carcass discovery.

The carcass will be handled according to the following procedure:

- Be removed from the site to avoid re-counting;
- Be handled by personnel wearing rubber gloves, packed into a plastic bag, wrapped in newspaper, put into a second plastic bag; and
- Be transferred to a freezer at the site office for storage so a second opinion on the species identity may be sought if necessary and for use in scavenger and/or detectability trials;

The Department of Sustainability and Environment's Regional Manager, South-West Region (in Ballarat) will be provided with a copy of the completed carcass search data-sheet for all recorded carcasses within seven days. It will be necessary for the wind farm operator to

obtain from the Department of Sustainability and Environment 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 turbines.

5.1.3. Scavenger rates and trials

An intact carcass will be defined as a carcass that does not appear to have been scavenged by a vertebrate predator. Carcasses that have decomposed due to insect activity or weather exposure remain on the landscape for a very long time and it is highly unlikely that these carcasses would have been missed during searches. A partially eaten carcass will be any skeletal or flesh remains found. Feather and fur spots will be defined by their presence and the absence of any remains. Intact or partial carcasses and feather/fur spots will all be recorded as a "find" in accordance with the above protocol (section 5.1.2).

Trials

To use estimated scavenger rates the important factor is not the average time to loss (a single value), but the probability of a carcass being scavenged for all possible times. The search area will be the same as in the search protocol (above) and will be located under operating turbines. To determine the scavenge rates on Brolgas and Southern Bent-wing Bats, we will use two size categories. Where carcasses of these species cannot be found, a similar sized substitute will be used. Different scavengers are active at different times of day and we will account for this by placing carcasses out during the morning and evening. This will reduce the potential for bias in the intervals. Based on current software requirements we will use 10 carcasses of each size category (Table 3).

Table 3: Number of replicates for each of the two factors within the scavenger trials.

	Micro-bat (SBWB)	Large bird (Brolga)
Morning	5	5
Evening	5	5

The first five of each category will be placed under one of the 10 turbines in the morning (i.e. one carcass per turbine: remembering that the turbine is the unit for replication). Before placing the evening carcasses, the morning 10 will be checked, then each of the carcasses will be checked every 12 hours for the first three days, then daily for two days, then every 48 hours for the following six days and then once at the end of this 14 day period. As season (or visibility in different vegetation) may be a factor, this will be repeated in following seasons (i.e. traditional summer, autumn, winter, spring) in the first year.

However, the scavengers that are likely to be present (and of concern) on the wind farm site fall into two broad categories; visual and olfactory. The visual are usually raptors and corvids and these will detect carcasses in almost any vegetation (as long as they can access it) as they are rapid onset scavengers that will monitor the area for movement and once they see the animal fall will detect its location regardless of vegetation. Olfactory scavengers, including mammalian predators (e.g. foxes) and corvids will "smell" the carcass and will locate it without the use of visual cues.

It is necessary to conduct these trials under turbines as some scavengers may alter their behaviour in response to the turbines.

5.1.4. Detectability trials

These trials aim to determine the likelihood that a searcher will detect an existing carcass, given the prescribed search pattern. These trials are based on the 4 and 12 m transects being walked by searchers. It is unnecessary for these trials to search the same area as the above search protocols as we are not testing transect widths. It is essential that these trials reflect the landscape and not the area being searched in the mortality surveys. Therefore small plots can be established on/near proposed turbine pads before the turbines are installed.

In accordance with the overall aim of the mortality surveys we will be testing the detectability of the two size categories, of the species of concern. In addition, as humans are reliant on visual cues to determine carcass location, we will compare two visibility categories. Victoria generally has two distinct seasons, wet and dry, and therefore vegetation falls into two broad categories of high and low. Based on power analysis (see GLOSSARY) the number of carcasses to be used for each of the factors was calculated with a confidence level of 95% (Table 4).

Table 4: Detectability trials given two factors of size and visibility

	Micro-bat (SBWB)	Large bird (Brolga)
Long grass	20	10
Short grass	20	10

To account for individual observer variability, each of the three searchers will be involved in the trials and this variable will then be incorporated into later statistical analyses. Reverse stepwise techniques will correctly allocate the observer effect into either a factor, or a random effect. Using proposed turbine locations (this design can be conducted before the actual turbine is operating) all bat and 25% of the Brolga carcasses will be placed within the 60 m zone. The remaining carcasses will to be distributed though the outer zone. Trials will be performed as per the mortality search protocol. Carcasses will be thrown in the air and allowed to land on the ground to simulate at least some of the fall and allow the potential ruffling of feathers. Multiple trials will be run, with non-specified numbers of placed carcasses in them. The total number of carcasses will be at least the values of Table 4. The controller is free to decide how many are deployed in each trial, based upon local conditions.

The controller of the carcasses will note the placement of carcasses (GPS), and can collect and re-distribute (for each searcher) the carcasses to generate the required number of replicates (being carcasses laid out). Searchers will not observe each other's trials, but it is unavoidable that searchers are aware it is a trial for at least three reasons. A "blind" trial is unnecessary and costly for no perceived benefit. Firstly, substitute carcasses may have to be used, such as mice or bought turkeys and therefore it would be impossible to conduct a "blind" trial. Secondly, to streamline surveying efforts, these can be conducted before the turbines become operational and post-commissioning efforts are focused on actual mortality detection. Lastly, there is no reason to suspect that searchers will be anything less than vigilant and alert so a placebo effect need not be countered. If, for any reason, additional ecologists (i.e. not the three stated earlier) are required to undertake mortality searches, additional detectability trials will also be conducted.

Ecologists will notify DSE, 5 days prior, of the actual timeline of all experimental trials (searches, scavenger and detectability) so that DSE have the opportunity to observe the trials.

5.1.1. Analysis and data limitations

All data will be analysed to provide the average, standard error (variability) and range (of the study turbine population). The data from the scavenger and detectability trials will be analysed using relevant techniques based on GLM (Generalised Linear Modelling α-priori <0.05) and censored survival techniques. This will determine if any of the factors are significant and their inclusion pertinent and required. If selected turbines are to be lit (as yet undetermined) this covariable will be included in the model.

It is difficult to provide the actual format (e.g. fatalities/turbine/year) of the results, in this current BAM Plan, as it is subject to the results of the experimental trials and the variability of the data. As we cannot predict the results (and have no pilot studies), we are only able to state that they will be reported in a way that gives as much information as possible but with an accurate interpretation of the data. As stated above we will be able to provide the number, average and other basic statistics of recorded fatalities per study population for the sampling time/effort, but we are uncertain whether this data can be generalized to a larger population. All species carcass data will be analysed and presented with species-specific information.

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 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 (see Appendix 2) 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 DSE or as per wildlife permit permissions. Any unclaimed carcasses will be offered to DSE prior to disposal.

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 are 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 components of this program are considered additional to those needed to meet the compliance requirements of the planning permit condition for the project but DSE requires them to be part of this plan and they are therefore included.

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 and Dr Lindy Lumsden (DSE'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 generalized to the entire farm or any other wind farms.

The intensive monitoring periods will be in February to March and again in October to November. 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, the location of which will be determined at a later date. The intensive monitoring will only survey the core zone (same size as mortality surveying) as this encompasses the impact detection zone of micro Bats (Arnett et al 2005 and Hull and Muir 2010). These cores will be visited every four days, for 28 days (total of eight surveys).

The cores zones will be walked at 4 metre spaced linear transects, as per the standard mortality surveys.

The data will be available to DSE 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 the DSE, 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 meta-data collections (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 be a statistically robust estimate, all protocols must be unbiased and controlled. If these conditions are met then the results can 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 5.1.3 and 5.1.4 and statistical modelling; and

- Search protocol (to collect the raw data in a consistent fashion compatible with the two protocols above): section 5.1.2.

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). There are at least two new techniques in the pipeline from windfarms around the world, which are expected to be peer reviewed and published before 2013 (Huso, 2012 pers.comm).

It is unnecessary for the purposes of the BAM Plan 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 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. SIGNIFICANT IMPACT, 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 18 (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 occurred, to the Regional Manager, South-West Region, Department of Sustainability and Environment within four to seven days.

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 and bird carcasses that may attract raptors (e.g. kangaroos, foxes, rabbits);
- 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 Hawkesdale Development Pty. Ltd.;
- Rates at which carrion are found will be reviewed, in consultation with DSE, 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 the Regional Manager, South West region, Department of Sustainability and Environment, 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 DSE.

7.2. Definition of significant impacts

Generally, a significant impact is where there is evidence of death or injury to 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, two or more bird or bat carcasses (or parts thereof) of non-threatened species are found at a turbine (i.e. a total of four or more carcasses in two successive searches); 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 – 2007, is found dead or injured within the wind farm site during any mortality search or incidentally by wind farm personnel.

More specifically, a significant impact on a species of concern for the purposes of non-scheduled reporting is defined as:

- Any dead or injured Brolga or Southern Bent-wing Bat found beneath turbines, whether in scheduled searches or incidentally; and/or
- Either of these species identified dead or injured on the wind farm site during operation.

If one or more Brolgas is detected on the wind farm site during operation, this will be *immediately* reported to the relevant authorities, together with sighting details, such as behaviour, foraging behaviour and use of the site, where relevant. Such an occurrence would represent a significant potential for an impact on this species and it will require the same mitigation response as finding the carcass of a threatened species under a wind turbine during the monitoring program.

Any one of the three circumstances will trigger a mitigation response.

If Brolga are detected during Brolga risk assessment surveys DSE will be immediately notified, however if these Brolga are detected offsite no mitigation response is required.

All on-site wind farm staff will be familiarised with the identifying features of a Brolga (e.g. posted photos and descriptions) and with protocols for immediate reporting of such incidences. Reporting arrangements for significant impacts are described in the next section of this plan.

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 3. The activities include:

- Immediate reporting (2 days) of a significant impact to wind farm management and to the Regional Manager, South-West Region, Department of Sustainability and Environment (via email) followed by discussions of requirements and aims of investigations;
- Investigation 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. 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 7 days), subject to a clear understanding of the cause of the significant impact. This process will be involve a meeting between the ecologist concerned and the DSE 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 may indicate a requirement for further targeted surveying.

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

- Habitat 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).

Immediate mitigation (e.g. above techniques) may be required if Brolgas and/or Southern Bent-wing Bats are significantly impacted and will be implemented under the supervision of a qualified ecologist in consultation with DSE and in a prompt manner (see Figure 3). Significant impacts may be one-off or cluster events and therefore the mitigation procedure should follow steps outlined in Figure 3. 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 Union Fenosa Wind Australia Pty. Ltd. 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 3 to the Regional Manager, South-West Region, Department of Sustainability and Environment. Additionally, all actions will be developed and implemented in consultation with and agreement from DSE.

7.4. 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); and
- Using acoustics to deter bats and other nocturnal fauna at night (bats).

Therefore, 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.

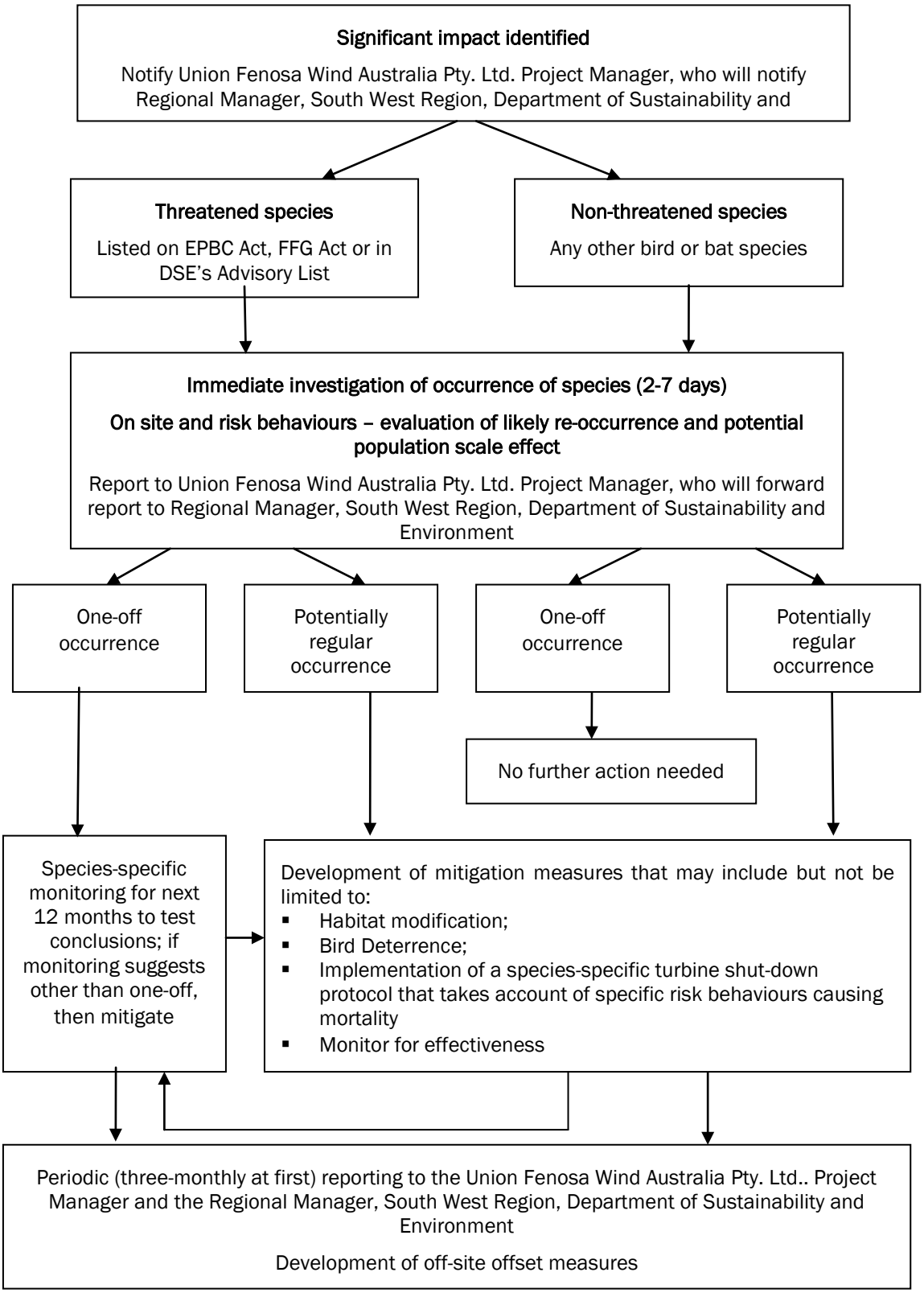
- Should a significant impact not be mitigated through on-site management then offsetting off-site would be triggered.
- A meeting would be organised between Union Fenosa Wind Australia Pty. Ltd. and the relevant authorities and government (e.g. DSE) experts to discuss and agree offset options.

Offsetting would be commensurate with the level of impact (to be determined after the investigations undertaken as part of the mitigation protocol in Figure 3.

- 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 recent regional framework for impact assessment established by the Department of Sustainability and Environment 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.

Figure 3: Operational procedure for mitigating significant impacts.



8. COMPLIANCE SUMMARY

The following Table 5 indicates the sections of the Bat and Avifauna Management Plan that comply with the specific conditions outlined in the Planning Permit (no. 20060221). The conditions of the permit have been abbreviated but their full and correct wording can be found in the introduction.

Table 5: Sections within the BAM Plan that comply with the conditions of the Planning Permit for Hawkesdale Wind Farm.

Condition number	Abbreviated condition details	BAM Plan Section/s
18a	Statement of aims and strategies for managing and mitigating significant bird and bat strike	1, 70
18b (i)	Presence, behaviour and movement of Brolga, especially breeding pairs	2
18b (ii)	Presence and activity of Southern Bent-wing Bats in the vicinity	4.2
18b (iii)	Species and number of bird and bat strikes	5
18b (iv)	Procedures for reporting of bird/bat strikes to the DSE within 7 days	3.1, 4.1.34.2. 3, 7
18b (v)	Seasonal and yearly variation in the number of bird/bat strikes	5
18b (vi)	Bird/bat strikes at lit or unlit turbines	5
18b (vii)	Efficacy of searches for carcasses and *where practicable*, information on scavenger rates, so that the total number of mortalities can be corrected for	5
18b (viii)	Procedures for regular removal of carcasses likely to attract raptors	7.1
18b (ix)	Periodic reporting, within agreed timeframes, of monitoring to DSE and the local community	3.1
18c	Recommendations in relation to a mortality rate which would trigger mitigation measures to be undertaken to the satisfaction of the Minister for Planning	7
18d	Strategy to offset impacts detected during monitoring to the satisfaction of the Minister for Planning	7
19 & 20	Reporting and reviewing procedures, where the Minister for Planning will then determine whether further investigations are to be undertaken	3.1

9. APPROXIMATE TIMELINE

The table outlines a general timeline for the post-construction monitoring surveys and reporting (Table 6).

Table 6: Approximate timeline for surveys and reporting after commissioning of turbines on the Hawkesdale Wind Farm.

Process	Details	Start	Finish	Report timing
Brolga breeding surveys	The first breeding surveys will commence on the first day of July after turbines are operational. The second will commence the following year.	July	December	One month after completion of surveys
Brolga flocking surveys	The first flocking surveys will commence on the first day of December after turbines are operational. The second will commence the following year.	December	June	One month after completion of surveys
Southern Bent-wing Bat surveys	Surveys will begin in whichever month (Feb/Oct) follows turbine operation	February	March	Incorporated into annual reports
		October	November	
Mortality surveys	Approximately one-third of turbines surveyed within one week per month every month for two years			Incorporated into annual reports
Scavenger trials	Experimental trial designed to determine scavenging rate	Post-operation of turbines	-	Incorporated into annual reports
Detectability trials	Experimental trial designed to determine detectability rate	Post slab laying	Operation of turbines	Incorporated into annual reports
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	Incorporated into annual reports
		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
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
Incidental reports	Any significant impacts outlined in section 7 may require immediate reporting (and action) to DSE and relevant authorities.	2-7 days of impact

10. REFERENCES

ACCIONA Energy 2009, Mortlake Wind Farm, Preliminary Documentation (EPBC: 2008/4128), July 2009

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

Australian Wind Energy Association (AusWEA) 2005, *Wind Farms and Birds: Interim Standards for Risk Assessment*. Report prepared by: Brett Lane and Associates and AIRA Professional Services; Report No. 2003.35(2.2), July 2005.

Brett Lane and Associates 2005, W*ind Farms and Birds, Interim Standards for Risk Assessment*, prepared for Australian Wind Energy Association, Report no. 2003.35 (2.2), July 2005.

Brett Lane and Associates 2009a, *Hawkesdale Wind Farm: Bird and bat risk assessment method*, a report prepared for Union Fenosa Wind Australia Pty. Ltd., Report No. 9067 (1.1), June 2009.

Brett Lane and Associates 2009b, *Hawkesdale Wind farm, pre-construction fauna surveys*. Report No. 9067 (3.2), June 2010.

Department of Environment, Water, Heritage and the Arts 2009, *Environmental Protection and Biodiversity Conservation Act 1999, Protected Matters Search Tool*. Department of Environment, Water, Heritage and the Arts, Canberra, viewed 5th September 2009, <http://www.deh.gov.au/erin/ert/epbc/imap/map.html>

Department of Sustainability and Environment 2007, *Advisory List of Threatened Vertebrate Fauna*, Department of Sustainability and Environment. East Melbourne, Victoria.

Department of Sustainability and Environment (DSE) 2011. *Interim Guidelines for the Assessment, Avoidance, Mitigation and Offsetting of Potential Wind Farm Impacts on the Victorian Brolga Population*, Department of Sustainability and Environment. East Melbourne, Victoria.

Environmental Resources Management Australia 2006, *Hawkesdale Wind Farm Ecological Assessment*, a report for Gamesa Energy Australia/TMEA, July 2006.

Greg Richards and Associates 2007, Expert witness statement of G. Richards prepared for TME Australia.

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

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

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

Hull, C, Muir, S 2010 'Search areas for monitoring bird and bat carcasses using a Monte Carlo method.' *Australasian Journal of Environmental Management* 17: 77 – 87.

Huso, M. 2010 An estimator of wildlife fatality from observed carcasses, Environmetrics DOI:10.1002/env.1052

Johnson, GD, Erickson, WP, Strickland, MD, Shepherd, MF, Shepherd, DA & Sarappo, SA 2003, 'Mortality of bats at a large-scale wind power development at Buffalo Ridge, Minnesota.' *American Midland Naturalist* 150: 332–342.

Marchant, S & Higgins, PJ (eds) 1990, *Handbook of Australian, New Zealand and Antarctic Birds,* Volume 1: Ratites to Ducks', Oxford University Press, Melbourne.

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

Menkhorst, P 1995, *Mammals of Victoria*, Oxford University Press, Melbourne.

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)

12. APPENDICES

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

HAWKESDALE WIND FARM – MORTALITY MONITORING PROGRAM: CARCASS DATA-SHEET*			
Please fill out all details above the heavy line for each site searched. All details below the line are required if a carcass is found.			
Collector:	Date:	Start Time:	Finish Time:
Turbine identifier (incl. lit/unlit):			
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: Scientific name:	Sex/age?:		
Photo Taken**	Yes / No		
Carcass condition: Intact, Scavenged, Feather spot:	Describe:		
Signs of injury:			
How old is carcass estimated to be (tick category):	<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: Documents referred to in pre-construction surveys: A desktop review carried out by Environmental Resources Management (ERM) Australia.

Appendix 8.1 Methodology

ERM undertook a desktop assessment of the biological values of the site and its surrounds. The information gathered during the desktop assessment was verified during a preliminary site assessment. A secondary assessment was undertaken during Spring to further assess the biological values of the site and to carry out targeted flora and fauna assessments. A tertiary assessment was undertaken to assess the layout relative to the known biological values of the site, and consider appropriate mitigation measures. An assessment of the trees to be removed from within the shelterbelts was undertaken. A preliminary assessment of the power line route and access points onto the site was also undertaken.

Desktop Assessment – July 2005

The purpose of the desktop assessment was to understand the biological values on the site and in the vicinity, and identify significant species that may occur at the site, either permanently or on a seasonal basis.

Literature Review

Information regarding threatened species and other environmentally significant resources within the area was obtained from the following sources:

- Department of Environment and Heritage (DEH) *Protected Matters Search Tool* (online) for matters of National Environmental Significance listed under the *EPBC Act*;
- Department of Sustainability and Environment (DSE) – *Atlas of Victorian Wildlife* (search area: five minute block of latitude and longitude centred on the study site);
- DSE - *Flora Information System* (search area: five minute block of latitude and longitude centred on the study site); and
- Information regarding the likely occurrence of Ecological Vegetation Classes (EVC) within the site was inferred from mapping provided by DSE (DSE 2003).

Liaison with DSE

ERM ecologists have also liaised with DSE officers Andrew Pritchard, Philip Du Guesclin and Garry Peterson regarding the biodiversity on the site and surrounding area.

Preliminary Assessment – July 2005

An ecologist undertook the preliminary site assessment on 18-21 July 2005 by. This assessment was undertaken in order to understand the biological features and habitat values on the site. It also provided information which allowed ERM to develop the appropriate methodology for the secondary assessment during spring.

Flora

The site was traversed on foot to confirm the distribution and general quality of vegetation. Some incidental records of flora were recorded.

Plant nomenclature follows Ross and Walsh (2003) and Walsh and Entwisle (1996a, 1996b, 1999). Where plant species could not be confidently identified in the field, specimens were collected and sent to the National Herbarium of NSW for identification. The National Herbarium of NSW was used as it is generally has a shorter waiting period for identification of samples than the Royal Botanic Gardens Melbourne.

Fauna

The majority of the site was traversed and direct sightings of fauna were recorded. Indirect evidence (eg. scats and tracks) and possible nest sites, roosting sites and other potential breeding habitat were also noted.

Limitations

The preliminary assessment was undertaken in winter. This is not considered an ideal season for surveying many species of plants. Many plant species could not be confidently identified due to the absence of flowering material. The assessment was limited to those plant species that could be readily identified or those species which retained adequate reproductive material (flowering material). Similarly, many fauna species (such as frogs and reptiles) are less active in cooler weather.

In addition, some fauna which migrate seasonally or have particular habitat preferences may also not be present at this time.

Secondary Assessment – November 2005

Two ecologists undertook a preliminary site assessment from 21-25 November 2005. The purpose of the visit was to investigate the key biological features present at the site (such as water bodies and significant stands of vegetation). It included a targeted assessment of areas that may support significant flora and fauna identified during the desktop and preliminary assessments. The site assessment also allowed input into the wind farm design.

Spring is considered to be the optimal time for a flora and fauna assessment. This is because:

- Some plant life forms (such as orchids) are most likely to be present;
- Plants are more likely to be flowering during this period, allowing for more accurate identification;
- Some fauna species are more active during periods of warmer weather. For example, bats are more likely to be feeding on warmer nights and reptiles are more likely to be active (including basking) in warmer temperatures; and
- Migratory birds and water bird numbers are likely to be highest in southern Victoria during this period.

The weather conditions over this period are provided in *Table 8.1*.

Table 8.1 Weather Conditions for the Secondary Survey Period 21-25 November 2005.

Date	Diurnal Weather Conditions (taken at approximately 13:00)		Nocturnal Weather Conditions (taken at approximately 20:00)	
21 November 2005	Temperature (°C)	N/A	Temperature (°C)	14
	General cloud cover	N/A	General cloud cover	Cloudy
	Wind	N/A	Wind	Moderate, from SW
22 November 2005	Temperature (°C)	21	Temperature (°C)	17
	General cloud cover	Light – 20%	General cloud cover	Cloudy – 90%
	Wind	Light, persistent from S	Wind	Light, from S
23 November 2005	Temperature (°C)	22	Temperature (°C)	16
	General cloud cover	Very little – 10%	General cloud cover	Moderate – 60%
	Wind	Moderate, from SE	Wind	Light, from SE
24 November 2005	Temperature (°C)	25	Temperature (°C)	18
	General cloud cover	Very Little – 10%	General cloud cover	Little – 15%
	Wind	Light, from SE	Wind	Light, from SE
25 November 2005	Temperature (°C)	33	Temperature (°C)	N/A
	General cloud cover	Very Little – 10%	General cloud cover	N/A
	Wind	Light, from N	Wind	N/A

Flora

The site was traversed on foot to confirm the distribution and general quality of vegetation. The Random Meander Method (Cropper 1993) was adopted to provide an overview of threatened species on site. This assessment technique has been designed for surveying large areas and for locating rare and threatened species. In addition, areas that had the highest likelihood of containing threatened flora (i.e. Austins Creek) were targeted and investigated.

Plant nomenclature follows Ross and Walsh (2003) and Walsh and Entwisle (1996a, 1996b, 1999). Where plant species could not be confidently identified in the field, specimens were collected and sent to the National Herbarium of NSW for

identification. The National Herbarium of NSW was used as it is generally has a shorter waiting period for identification of samples than the Royal Botanic Gardens Melbourne.

Fauna

Incidental fauna records were noted throughout the site. In addition, targeted assessments were undertaken in areas determined to have the highest likelihood of containing threatened fauna such as Austins Creek, shelterbelts, the Rail Reserve, under rocks and debris. Survey effort is shown in *Figure 8.1.*

Incidental Records

Incidental records of fauna were kept throughout the site assessment. Indirect evidence (eg. scats and tracks) possible nest sites, roosting sites and other potential breeding habitat were also recorded.

Elliott Trapping

Elliott trapping was carried out over two consecutive nights (21 – 22 November 2005) at the site. Twenty Elliott traps were placed within the Rail Reserve for two consecutive nights, providing a total of 40 trap-nights.

The Rail Reserve was considered to be the area most likely to support ground-dwelling mammals and reptiles at the site. This was due to the structural variability associated with the vegetation, debris and rocks within this area. The location and number of Elliot traps at each survey point is shown in *Figure 8.1)*.

The bait used during the survey period consisted of rolled oats, peanut butter and honey. A small amount of tuna oil was added to this bait mix for the second night to entice fauna into the traps.

Active Searching

Rocks and debris were rolled to search for fauna. This was undertaken opportunistically across the site, but greatest time was spent within the Rail Reserve, shelterbelts and Austins Creek. An estimated four person hours was spent actively searching.

Frog Census

Diurnal frog searches were undertaken throughout Austins Creek on 22 and 23 November 2005.

Nocturnal call-playback for Growling Grass Frog was also undertaken at approximately midnight at two points along Austins Creek on 22 and 24 November 2005. Each census involved the assessor sitting and quietly listening for 10 minutes, followed by 5 minutes of call playback, followed by a further 10 minutes of quiet listening.

A nocturnal search for frogs was undertaken along Austins Creek after the call-playback on 22 and 24 November 2005.

ANABAT Recording

ANABAT recording was undertaken on two consecutive nights (21–22 November 2005) at the Rail Reserve. ANABAT recorders were placed amongst native overstorey vegetation along the Rail Reserve (see *Figure 8.1*). ANABAT recorders were left in the same place for the two consecutive nights, providing a total of 4 census-nights. The area was selected as it represents possible "flyways" and foraging areas for bats whilst feeding. Data from the ANABAT recorders was sent to Glenn Hoye, Fly By Night Surveys Pty Ltd for analysis.

Limitations

Despite the survey effort, the determination of the presence/absence of flora and fauna cannot be definitively determined from his assessment. A judgement on the likelihood of occurrence of threatened fauna was made based on the

As indicated, a formal, intensive fauna survey of the entire site was not carried out due to time constraints. However, an informed judgement was made on the likelihood of significant fauna species occurring within the study site. This was based on:

- the results of the previous desktop assessment;
- the experience of the assessors; and
- the extent and condition of habitat features on and in the vicinity of the site.

Tertiary Assessment – June 2006

GEA/TMEA was provided with results and recommendations from the secondary flora and fauna assessment. The data was subsequently used in the development of the draft wind turbine layout.

ERM undertook a tertiary assessment between the 26 and 28 June 2006 to consider the impact of the Wind Farm layout on the biological features of the site, and to determine the most appropriate mitigation measures.

The species, Diameter at Breast Height (DBH) and direct and indirect evidence of fauna were recorded from indigenous vegetation within the shelterbelts proposed to be removed.

A preliminary assessment of the extent of vegetation within the power line and access point footprint was also undertaken. An ecologist traversed the proposed footprint on foot or in a vehicle. Habitat features such as ephemeral and permanent waterbodies, rocks, native vegetation were noted in these areas.

Incidental records of flora and fauna were also recorded.

Appendix 8.3 Consolidated List of Fauna

Status Notes:

CST	Conservation status in Victoria	NT	Near Threatened
ESP	Conservation status in Australia	M	Migratory
FFG	Status under the FFG Act	R/C	Restricted colonial breeding or roosting
CE	Critically Endangered	Ins	Insufficient data
EN	Endangered	Ext	Presumed extinct
VU	Vulnerable	L	Listed under the FFG Act
R	Rare	T	Listed as a threatening process (FFG Act)
LR	Low risk / near threatened	*	Introduced
LO	Listed – Overfly Marine Area	Cmp	Comprising several taxa
CD	Conservation Dependent	Ssp	Sub-species

Common Name	Scientific Name	ESP	CST	FFG	Identified During Desktop Assessment	Recorded During Field Assessment
BIRDS						
Australasian Bittern	*Botaurus poiciloptilus*		EN	L	√	
Australasian Shoveler	*Anas rhynchotis*		VU		√	
Australian Magpie	*Gymnorhina tibicen*				√	√
Australian Painted Snipe	*Rostratula australis*	VU	CE	L	√	
Australian Pipit	*Anthus australis*					√
Australian Raven	*Corvus coronoides*					√
Australian Shelduck	*Tadorna tadornoides*				√	
Australian White Ibis	*Threskiornis molucca*				√	√
Australian Wood Duck	*Chenonetta jubata*					√
Black Swan	*Cygnus atratus*				√	
Blue-billed Duck	*Oxyura australis*		EN	L	√	
Blue-winged Parrot	*Neophema chrysostoma*					√
Brolga	*Grus rubicundus*	M	VU	L	√	
Cattle Egret	*Ardea ibis*	LO			√	
Clamorous Reed Warbler	*Acrocephalus stentoreus*				√	
Common Blackbird	*Turdus merula*		*		√	√
Common Starling	*Sturnus vulgaris*		*		√	√
Corvids	*Corvus spp*					√
Dusky Moorhen	*Gallinula tenebrosa*				√	
European Goldfinch	*Carduelis chloris*		*		√	√
Fork-tailed Swift	*Apus pacificus*	LO			√	

Common Name	Scientific Name	ESP	CST	FFG	Identified During Desktop Assessment	Recorded During Field Assessment
Freckled Duck	*Stictonetta naevosa*		EN	L	√	
Galah	*Cacatua roseicapilla*				√	
Great Egret	*Ardea alba*	LO	VU	L	√	
Grey Fantail	*Rhipidura fuliginosa*				√	
Grey Teal	*Anas gracilis*				√	
Hardhead	*Aythya australis*	VU			√	
Hoary-headed Grebe	*Poliocephalus poliocephalus*				√	
House Sparrow	*Passer domesticus*				√	√
Latham's Snipe	*Gallinago hardwickii*	M	NT		√	
Laughing Kookaburra	*Dacelo novaeguineae*				√	
Little Grassbird	*Megalurus gramineus*					√
Little Pied Cormorant	*Phalacrocorax melanoleucos*				√	
Little Raven	*Corvus mellori*				√	√
Long-billed Corella	*Cacatua tenuirostris*				√	√
Magpie Goose	*Anseranas semipalmata*	LO	VU		√	
Magpie-lark	*Grallina cyanoleuca*				√	√
Masked Lapwing	*Vanellus miles*				√	
Musk Duck	*Biziura lobata*		VU		√	
Orange-bellied Parrot	*Neophema chrysogaster*	EN	CE	L	√	
Pacific Black Duck	*Anas superciliosa*				√	√
Painted Snipe	*Rostratula benghalensis s. lat.*	M, LO			√	
Purple Swamphen	*Porphyrio porphyrio*				√	
Rainbow Bee-eater	*Merops ornatus*	LO			√	
Raven	*Corvus spp*					√
Red Wattlebird	*Anthochaera carunculata*				√	
Richard's Pipit	*Anthus novaeseelandiae*				√	
Rufous Fantail	*Rhipidura rififrons*	M, LO			√	
Rufous (Nankeen) Night Heron	*Nyctiorax caledonicus*		NT		√	
Satin Flycatcher	*Myiagra cyanoleuca*	M			√	
Skylark	*Alauda arvensis*		*			√
Straw-necked Ibis	*Threskiornis spinicollis*				√	√
Stubble Quail	*Coturnix pectoralis*					√
Sulphur-crested Cockatoo	*Cacatua galerita*					√
Swift Parrot	*Lathamus discolor*	EN	EN	L	√	
Wedge-tailed Eagle	*Aquila audax*				√	√
Welcome Swallow	*Hirundo neoxena*					√
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	M, LO	VU	L	√	
Whiskered Tern	*Chlidonias hybridus*		NT		√	
White-faced Heron	*Egretta novaehollandiae*				√	
White-necked Heron	*Ardea pacifica*				√	
White-plumed Honeyeater	*Lichenostomus penicillatus*				√	
White-throated Needletail	*Hirundapus leucogaster*	M			√	
Willie Wagtail	*Rhipidura leucophrys*					√
Yellow-billed Spoonbill	*Platalea flavipes*				√	
Yellow-tailed Black-	*Calyotorhynchus*					√

Common Name	Scientific Name	ESP	CST	FFG	Identified During Desktop Assessment	Recorded During Field Assessment
Cockatoo	*funereus*					
MAMMALS						
Brown Hare	*Lepus capesis*		*		√	
Cat	*Felis catus*		*		√	√
Chocolate Wattled Bat	*Chalinolobus morio*					√
Domestic Dog	*Canis familiaris*		*			√
Domestic Cattle	*Bos sp*		*			√
Domestic Sheep	*Ovis aries*		*			√
European Rabbit	*Oryctolagus cuniculus*		*			
Fat-tailed Dunnart	*Sminthopsis crassicaudata*		LR		√	
Gould's Wattled Bat	*Chalinolobus gouldii*					√
Grey-headed Flying-fox	*Pteropus poliocephalus*	VU			√	
Hare	*Lepus capensis*		*			
House Mouse	*Mus musculus*		*		√	
Long-nosed Potoroo	*Potorous tridactylus*	VU	EN	L	√	
Platypus	*Ornithoryhnchus anatinus*				√	
Red Fox	*Vulpes vulpes*		*			√
Smoky Mouse	*Pseudomys fumeus*	EN			√	
Southern Bent-wing Bat	*Miniopterus schreibersii bassanii*	CD	EN	L	√	
Southern Forest bat	*Vespadelus regulus*					√
Southern Freetail Bat	*Mormopterus planiceps*					√
Spotted-tailed Quoll (SE mainland population)	*Dasyururs maculatus maculatus*	EN	EN	L	√	
White-striped Freetail Bat	*Tadarida australis*				√	√
FROGS						
Common Froglet	*Crinia signifera*					√
Growling Grass Frog	*Litoria raniformis*	VU	VU	L	√	
Southern Brown Tree Frog	*Litoria ewingii*				√	√
Spotted Marsh Frog	*Limnodynastes tasmaniensis*					√
Striped Marsh Frog	*Limnodynastes peroni*					√
Whistling Tree Frog	*Litoria verreauxi verreauxi*					
REPTILES						
Glossy Grass Skink	*Pseudemoia rawlinsoni*		NT		√	
Striped Legless Lizard	*Delma impar*	EN	EN	L	√	
Swamp Skink	*Egernia coventryi*		VU	L	√	
FISHES						
Australian Grayling	*Protroctes maraena*	VU	VU	L	√	
Common Galaxias	*Galaxias maculatus*				√	
Dwarf Galaxias	*Galaxiella pusilla*	VU	VU	L	√	
Mountain Galaxias	*Galaxias olidus*			L	√	
Southern Pigmy Perch	*Nannoperca australis*				√	

Common Name	Scientific Name	ESP	CST	FFG	Identified During Desktop Assessment	Recorded During Field Assessment
√ = Present						

Annex G

EPBC Act

Summary	
Threatened Species:	17
Migratory Species:	6
Listed Marine Species:	12
Invasive Species:	None
Whales and Other Cetaceans:	None
Threatened Ecological Communities:	None
Heritage	
World Heritage Properties:	None
Australian Heritage Sites:	None
Wetlands	
Ramsar sites: (Internationally important)	None
Nationally Important Wetlands:	None
National Pollutant Inventory	
Reporting Facilities:	None
Airsheds:	None
Catchments:	None
Protected Areas	
Reserves and Conservation Areas:	None
Regional Forest Agreements:	1

Threatened Species [Dataset Information]	Status	Comments
Birds		
Lathamus discolor Swift Parrot	Endangered	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe	Vulnerable	Species or species habitat may occur within area
Fishes		
Galaxiella pusilla Dwarf Galaxias	Vulnerable	Species or species habitat likely to occur within area
Prototroctes maraena Australian Grayling	Vulnerable	Species or species habitat likely to occur within area
Frogs		
Litoria raniformis Southern Bell Frog, Growling Grass Frog, Warty Bell Frog, Green and Golden Frog	Vulnerable	Species or species habitat may occur within area
Mammals		
Dasyurus maculatus maculatus (SE mainland population) Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population)	Endangered	Species or species habitat likely to occur within area
Miniopterus schreibersii bassanii Southern Bent-wing Bat	Conservation Dependent	Species or species habitat may occur within area

Potorous tridactylus tridactylus Long-nosed Potoroo (SE mainland)	Vulnerable	Species or species habitat may occur within area
Pseudomys fumeus Konoom, Smoky Mouse	Endangered	Species or species habitat may occur within area
Pteropus poliocephalus Grey-headed Flying-fox	Vulnerable	Species or species habitat likely to occur within area
Plants		
Carex tasmanica Curly Sedge	Vulnerable	Species or species habitat likely to occur within area
Glycine latrobeana Purple Clover, Clover Glycine	Vulnerable	Species or species habitat likely to occur within area
Prasophyllum frenchii Maroon Leek-orchid, Slaty Leek-orchid, Stout Leek-orchid, French's Leek-orchid	Endangered	Species or species habitat likely to occur within area
Senecio psilocarpus Swamp Fireweed, Smooth-fruited Groundsel	Vulnerable	Species or species habitat likely to occur within area
Taraxacum cygnorum Coast Dandelion	Vulnerable	Species or species habitat likely to occur within area
Thelymitra epipactoides Metallic Sun-orchid	Endangered	Species or species habitat likely to occur within area
Thelymitra matthewsii Spiral Sun-orchid	Vulnerable	Species or species habitat likely to occur within area

Migratory Species [Dataset Information]	Status	Comments
Migratory Terrestrial Species - Birds		
Haliaeetus leucogaster White-bellied Sea-Eagle	Migratory	Species or species habitat likely to occur within area
Hirundapus caudacutus White-throated Needletail	Migratory	Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher	Migratory	Breeding likely to occur within area
Rhipidura rufifrons Rufous Fantail	Migratory	Breeding may occur within area
Migratory Wetland Species - Birds		
Gallinago hardwickii Latham's Snipe, Japanese Snipe	Migratory	Species or species habitat may occur within area
Rostratula benghalensis s. lat. Painted Snipe	Migratory	Species or species habitat may occur within area

Listed Marine Species [Dataset Information]	Status	Comments
Birds		
Anseranas semipalmata Magpie Goose	Listed - overfly marine area	Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift	Listed - overfly marine area	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Listed - overfly marine area	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Listed - overfly marine area	Species or species habitat may occur within area

Gallinago hardwickii Latham's Snipe, Japanese Snipe	Listed - overfly marine area	Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle	Listed	Species or species habitat likely to occur within area
Hirundapus caudacutus White-throated Needletail	Listed - overfly marine area	Species or species habitat may occur within area
Lathamus discolor Swift Parrot	Listed - overfly marine area	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater	Listed - overfly marine area	Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher	Listed - overfly marine area	Breeding likely to occur within area
Rhipidura rufifrons Rufous Fantail	Listed - overfly marine area	Breeding may occur within area
Rostratula benghalensis s. lat. Painted Snipe	Listed - overfly marine area	Species or species habitat may occur within area

Other

Regional Forest Agreements [Dataset Information]
Note that all RFA areas including those still under consideration have been included.

West Victoria RFA, Victoria

Appendix 3: Documents referred to in pre-construction surveys: Hawkesdale Wind Farm Ecological Assessment, ERM Australia (2006).

8 ECOLOGICAL ASSESSMENT

8.1 PURPOSE

This Section describes the biological features of the site and its surrounds. It also describes the potential ecological impacts and proposed mitigation and monitoring measures designed to minimise potential impacts of the development on the biological values of the site and vicinity.

8.2 REGULATORY FRAMEWORK

8.2.1 Planning Guidelines

The Planning Guidelines (SEAV 2003) require that the flora and fauna recorded at a site should be considered in relation to:

- whether the species and communities are protected under the *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)* or the *Flora and Fauna Guarantee Act 1988 (FFG Act)*;
- the sensitivity of any significant species of flora or fauna recorded on the site or likely to occur on the site to disturbance caused by the wind farm infrastructure; and
- the potential loss or modification of habitat of species protected under the *EPBC Act* or the *FFG Act*.

Appropriate surveys are required where species listed under the *EPBC Act* or the *FFG Act* are considered reasonably likely to be present on the site:

- the Department of Environment and Heritage (DEH) will determine whether the project is a controlled action and if it is a controlled action (under the *EPBC Act)* DEH may direct the conditions under which the project can proceed. Such conditions may include additional site assessment;
- where species are listed under *FFG Act* or appear on the Department of Sustainability and Environment (DSE) Advisory Lists of Threatened Flora and Fauna[1] , surveys are to be conducted at the appropriate time within the 12 months preceding the lodging of the planning permit application. The Department of Sustainability and Environment (DSE) should be consulted on the timing of the surveys within the 12 month period; and

---

[1] Species on the *Advisory List of Threatened Vertebrate Fauna in Victoria – 2003* (DSE 2003) and the *Advisory List of Rare of Threatened Plants in Victoria – 2005* (DSE 2005) are termed threatened species within this Report.

- surveys for other species of flora or fauna will not be required, except where the proponent is already required to carry out a flora or fauna survey as a requirement for *EPBC Act* or *FFG Act* listed species.

These surveys are used to assist with refining the location of the infrastructure to avoid those locations where the likelihood of presence of significant species is high and to manage the risk of impact on any such listed species or communities. Ongoing monitoring (for an agreed period) may be required as a permit condition. An Environmental Management Plan may provide for the development of reasonable and cost effective steps to minimise any ongoing risks.

Survey work should determine:

- the actual and likely presence of species;
- whether they are likely to be adversely impacted by the proposed wind energy facility; and
- appropriate mitigation measures.

8.2.2 *Legislative Requirements*

Commonwealth Environment Protection and Biodiversity Conservation Act 1999

One of the main aims of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)* is to provide for the conservation of biodiversity and the protection of the environment, particularly those aspects that are considered to be matters of national environmental significance. Relevant matters include:

- Ramsar wetlands of international significance;
- nationally listed threatened species and ecological communities;
- listed migratory species; and
- National Heritage Places.

Under the Act, actions that are likely to have a significant impact upon matters of national environmental significance will require approval from the Department of Environment and Heritage (DEH) on behalf of the Federal Environment Minister. An action includes any project, development, undertaking, activity or series of activities.

GEA/TMEA referred the Hawkesdale project to DEH in May 2005. The Department determined that the project was not a controlled action.

Victorian Flora and Fauna Guarantee Act 1988

The Victorian *Flora and Fauna Guarantee Act 1988* (FFG Act) was established to provide a legal framework for enabling and promoting the conservation of all of Victoria's native flora and fauna, and to enable management of potentially threatening processes. On private land, the project must have regard for any Action Plans proclaimed under the *FFG Act.* An FFG permit to 'take' (remove) protected flora and fauna from public land is required under the Act.

Victorian Catchment and Land Protection Act 1994

The *Catchment and Land Protection Act 1994* (CALP Act) is the principal legislation relating to the management of pest plants and animals in Victoria.

The site is located in the Glenelg Catchment Management Region of Victoria (Faithfull 2004). Within this region, seven species of plants are declared Regionally Prohibited weeds and 41 plants are declared Regionally Controlled Weeds (Faithfull 2004).

Victoria's Native Vegetation Management – A Framework for Action

Victoria's Native Vegetation Management – A Framework for Action (the Framework) was incorporated into the Victorian Planning Provisions in July 2003. Under the Framework, the key goal for native vegetation in Victoria is for "a reversal across the entire landscape, of the long-term decline in the extent and quality of native vegetation, leading to a Net Gain" (DNRE 2002).

For any development proposal that involves native vegetation clearance, a three-step approach must be demonstrated in order to apply the principles of Net Gain. This involves:

1. Avoiding adverse impacts, particularly by avoiding vegetation clearance.

2. Where impacts cannot be avoided, exploring appropriate options to minimise those impacts.

3. Identifying appropriate offset options in response to clearing (DNRE 2002).

8.3 METHODOLOGY

ERM undertook a desktop assessment of the biological values of the site and its surrounds. The methodology has generally reflected that contained in the *Wind Farms and Birds - Interim Standards for Risk Assessment* (Auswind 2005). The information gathered during the desktop assessment was verified during subsequent field assessments.

8.3.1 *Desktop Assessment – July 2005*

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

The purpose of the desktop assessment was to identify significant species with the potential to occur at the site, either permanently or on a seasonal basis.

Literature Review

Information regarding threatened species and other environmentally significant resources within the area was obtained from the following sources:

- Department of Environment and Heritage (DEH) *Protected Matters Search Tool* (online) for matters of National Environmental Significance listed under the *EPBC Act*;
- Department of Sustainability and Environment (DSE) – *Atlas of Victorian Wildlife* (search area: five minute block of latitude and longitude centred on the study site);
- DSE - *Flora Information System* (search area: five minute block of latitude and longitude centred on the study site); and
- Information regarding the likely occurrence of Ecological Vegetation Classes (EVC) within the site was inferred from mapping provided by DSE (DSE 2003b).

Liaison with DSE

ERM ecologists have also liaised with DSE officers Andrew Pritchard (flora), Philip Du Guesclin (avifauna) and Gary Peterson (herpetofauna) regarding the biological values of the site and surrounding area.

8.3.2 *Field Assessment*

Following a desktop assessment in July 2005, four site assessments were undertaken. A summary of each assessment is provided in *Table 8.1*. Additional detail on the flora and fauna site assessments carried out at the site is provided in *Annex 8.1.* A map of the survey points showing targeted species census points are shown in *Figure 8.1*.

Figure 8.1 Fauna Survey Sites November 2005

This page has intentionally been left blank

Table 8.1 Summary of Flora and Fauna Field Assessments at the Site at Hawkesdale Wind Farm, July 2005 to June 2006

Assessment	Date	Purpose	Flora	Fauna
Preliminary	18-21 July 2005	• To refine understanding of biological features and potential environmental values of the site. • To provide information to allow ERM to develop appropriate methodology for the secondary assessment.	• Site traversed on foot to confirm the distribution and general quality of vegetation. Incidental flora recorded.	• Incidental observations and indirect evidence of fauna recorded throughout site. • Possible nest sites, roosting sites and other potential breeding habitat noted throughout site.
Secondary	21-25 November 2005	• Investigate key biological features such as water bodies and significant stands of vegetation present at the site. • Undertake targeted assessment of areas that may support significant flora and fauna identified during the desktop survey. • To provide information to allow input into micro-siting of wind turbines, substations and access tracks • Identify areas that would qualify as Habitat Zones in accordance with the Vegetation Framework (DNRE 2002, DSE 2004).	• Site traversed on foot to confirm the distribution and general quality of vegetation, with particular attention paid to areas likely to support a diversity of native vegetation and habitat types. Incidental records noted. • Targeted searched carried out in areas identified during the desktop assessment as most likely to support threatened species (namely Rail Reserve and wetland areas). • Areas considered to be habitat zones (remnant vegetation) mapped.	• Incidental observations and indirect evidence of fauna recorded throughout site. • Possible nest sites, roosting sites and other potential breeding habitat noted throughout site. • Twenty Elliott traps placed in the Rail Reserve adjoining the site. Elliott trapping carried out over two consecutive nights, giving 40 trap nights. • Active searches for reptiles under debris, rocks, areas with the highest cover of native understorey vegetation (including the Rail Reserve). • Diurnal searches for frogs undertaken along Austins Creek. • Frog call playback on two nights. Spotlighting followed. • Two ANABAT recorders placed in Rail reserve over two consecutive nights, providing a total of four ANABAT census nights (see *Figure 8.1* for location).

Tertiary	26-28 June 2006	• To determine the impacts of the development on biological values, and to determine appropriate mitigation measures. • To provide input into any further micrositing of infrastructure. • To provide preliminary feedback on the biological values within the proposed power line route from Hawkesdale to the Macarthur substation. • To provide preliminary feedback on the biological values within the proposed access points onto the site.	• The areas in close proximity to native vegetation, waterbodies and shelterbelts were traversed and notes taken. • Areas of native vegetation to be removed from shelterbelts was noted. Species, Diameter at Breast Height (DBH) and the presence of tree allows or stick nests was noted for all indigenous trees to be removed. • The power line route was traversed and biological features were noted. • The access points were viewed and the vegetation within the proposed footprint was noted.	• Incidental observations and indirect evidence of fauna recorded throughout these assessment areas.

8.4 RESULTS

8.4.1 *Recognised Biological Values within the vicinity of the site*

The site is located within the Moyne Shire. DSE have mapped the Sites of biodiversity Significance within Moyne Shire (DNRE 2001b). The areas proposed to be covered by Environmental Significance Overlays within 40 km of the site are provided in *Table 8.1* and shown in *Figure 8.2*.

Table 8.2 Areas proposed to be covered by an Environmental Significance Overlay located within 40 km of the Site

Proposed Overlay	Location	Distance from the Site	Justification
ESO 2(1)	Merri River	Approximately 10 km east of the site (at the closest)	Is an aquatic system with high biodiversity values/links. Contains freshwater meadows and riparian vegetation containing Red Gums *Eucalyptus camaldulensis*. It contains platypus *Ornithorhynchus anatinus* and other threatened fish spp.
ESO 2 (2)	Hopkins River	Approximately 30 km east of the site (at the closest)	Is an aquatic system with high biodiversity values/links. Riparian vegetation includes Red Gums. It contains platypus and other threatened fish spp.
ESO 2(4)	Eumerella River	Approximately 30 km northwest of the site (at the closest)	Threatened fish species. Breeding site for threatened waterbirds. Riparian vegetation including Aquatic Herbland/Plains Sedgy Wetland Mosaic EVC. Koala *Phascolarctos cinereus* habitat corridor
ESO 2(5)	Kelly's Swamp	Approximately 30 km south of the site	Hooded Plover *Thinornis rubricollis* and Magpie Goose *Anseranas semipalmata* flocking site. Also contains other threatened waterbirds and flora.
ESO 2(8)	Moyne River	Approximately 6 km west of the site (at the closest)	It contains high biodiversity values and habitat for the threatened Mountain Galaxias *Galaxias olidus*.
ESO 2(9)	Stonefield Rd swamp	Approximately 18 km north west of the site	An assemblage of threatened waterbirds.
ESO 2 (10)	Hawkesdale (2 sites)	Approximately 3.5 km northwest of the site	High biodiversity values/links and Woolly Tea-tree *Leptospermum lanigerum* remnants
ESO 2(11)	Shaw River	Approximately 20 km west of the site (at the closest)	High biodiversity values/links and supports Yarra Pygmy Perch *Nannoperca obscura*.
ESO 2(12)	Tower Hill	Approximately 18 km south of the site	Is wildlife reserve listed on the Directory of Important Wetlands (Holmes 2001). It is breeding and/or flocking site for several threatened waterbird species, Barking Owl *Ninox connivens* and other birds of prey as well as Growling Grass Frog *Litoria raniformis*.
ESO 2(13)	Island Swamp	Approximately 30 km southwest of the site	Considered by DSE to be a Deep Freshwater Marsh. It contains an assemblage of threatened waterbirds. ERM have studied this area for the proposed Ryan Corner Wind Farm. Threatened fauna recorded at the site includes Great Egret *Ardea alba*, Intermediate Egret *Ardea intermedia*, Hardhead *Aythya australis*, Little Egret *Egretta garzetta nigriceps*, Latham's Snipe *Gallinago hardwickii*, Brolga *Grus rubicunda*, Royal Spoonbill *Platalea regia*, Glossy Ibis *Plegadis falcinellus* and possibly Southern Bent-wing Bat *Miniopterus schreibersii bassanii*.

Proposed Overlay	Location	Distance from the Site	Justification
ESO 2(17)	Powling Street Swamp	Approximately 36 km south of the site	High biodiversity values/links and contains a depleted wetland type. Latham's Snipe and Great Egret frequent this site.
ESO 2(20)	Lake Cartcarrong	Approximately 15 km southeast of the site.	High biodiversity values. Contains habitat to threatened species of flora. It is a Whiskered Tern *Chlidonias hybridus* nesting site and provides habitat to other threatened waterbirds including Musk Duck *Biziura lobata,* Hardhead and Australasian Shoveler *Anas rhynchotis* (DSE 2005d).
ESO 2(22)	Lake Connewarren and Blind Creek Lake	Approximately 35 km east of the site.	High biodiversity values/links including a remnant of Plains Grassy Woodland EVC. It supports an assemblage of threatened waterbirds, and is a Common Greenshank *Tringa nebularia* flocking site.
ESO 2(28)	Connewarren wetland	Approximately 30 km east of the site.	High biodiversity values/links. Is a depleted wetland type that supports threatened waterbirds. Flocking site for Australasian Shoveler.
ESO 3(2)	Hamilton Highway/Ti-tree Creek	Approximately 30 km northeast of the site.	Habitat for Striped Legless Lizard *Delma impar.*
ESO 3(4)	Killarney	Approximately 29 km south of the site	High biodiversity values. Provides habitat for Orange-bellied Parrot *Neophema chrysogaster* and other migratory waterbirds. Is a Hooded Plover breeding site. Remnant EVC classified as threatened.
ESO 3(13)	Cockatoo Swamp	Approximately 20km west of the site	Brolga breeding site
ESO 3(15)	Griffith Island/Pea Soup	Approximately 35 km south of the site.	High biodiversity values/links. It is a breeding and flocking site for a range of threatened and migratory waterbirds. It contains an EVC classified as vulnerable.
ESO 3(16)	Pallister's (5 sites)	Approximately 30 km southwest of the site.	Provides habitat to Pretty Hill Leek-orchid *Prasophyllum* sp. aff. *diversiflorum* and Basalt Leek-orchid *Prasophyllum* sp. aff. *frenchii A* and other threatened flora. Habitat for Powerful Owl *Ninox strenua* and a Brolga nest site.
ESO 3(21)	Yambuk Lake	Approximately 40 km southwest of the site.	Habitat for Orange-bellied Parrot, Great Egret and Hooded Plover. It is a flocking site for Sanderling *Calidris alba* and other threatened waterbirds (including some listed under CAMBA and JAMBA conventions. Contains remnant EVC classified as endangered.
ESO 3(24)	Dunmore	Approximately 15 km west of the site.	Whiskered Tern breeding site.
ESO 3(27)	Chatsworth, Hexham Rd, Hexham	Approximately 38km north east of the site.	Brolga breeding site.
ESO 3(34)	Poyntons Road Willatook	Approximately 10k m west of the site.	Brolga breeding site.
ESO 3(35)	Connewarren marsh	Approximately 34 km east of the site.	Brolga breeding site.
ESO 3(38)	Belfast Lough and Moyne River	Approximately 30 km south of the site.	Potential Orange-bellied Parrot habitat as the site contains remnant saltmarsh. Black-winged Stilt *Himantopus himantopus* breeding site. Assemblage of other threatened waterbirds.
ESO 3(49)	Caramut East	Approximately 32 km northeast of the site.	Brolga breeding site.
ESO 3(50)	Boortkoi Lane, Caramut East	Approximately 32 km northeast of the site.	Brolga breeding site.
Source: DNRE (2001b)			

Figure 8.2 Sites of Recognised Biological Value

This page has intentionally been left blank

There are areas adjoining the site that are subject to a proposed Vegetation Protection Overlay (DNRE 2001). These are described in *Table 8.3* and are shown on *Figure 8.2*.

These areas contain patches of remnant vegetation (formerly termed Habitat Zones as described in DSE (2006b, c, d). They are also considered to represent modified remnants of Western (Basalt) Plains Grassland community, a community listed under the *FFG Act*.

Table 8.3 Areas proposed to be covered by a Vegetation Protection Overlay located within the Site boundary

Proposed Overlay	Location	Justification
VPO 1(76)	Hawkesdale disused rail reserve. Runs north-south bisecting the eastern portion of the site (although located outside the site boundary)*.	High biodiversity values/links that contains native grasslands including Grassy Woodland EVC. It is not known to support any threatened flora. It is considered to be part of "Priority Site 1" (DSE 2005d). Glossy Grass Skink *Pseudemoia rawlinsoni* has been recorded within the southern portion of the Rail reserve approximately 3km off-site. ERM has undertaken field assessments within this area. The site is approximately 20metres wide. It contains a slightly raised ridge approximately 5m wide, which was historically the rail line. This track is currently used by farm vehicles. Sheep graze some of the rail line and were seen on the site during the assessment. Patches of native and exotic vegetation cover the rail reserve, however overstorey vegetation is generally limited to either side of the ridge. Overstorey vegetation includes Blackwood *Acacia melanoxylon*, Black Wattle *Acacia mearnsii*, several mature Silver Banksia *Banksia marginata* and some exotic Polar *Populus* sp. Indigenous midstorey includes some Prickly tea-tree *Leptospermum continentale* and Sweet Bursaria *Bursaria spinosa*. Exotic species such as Toowoomba Canary Grass *Phalaris aquatica*, Cocksfoot *Dactylis glomerata*, Yorkshire Fog *Holcus lanatus* and White Clover *Trifolium repens* were generally more abundant at the southern section, which appeared to be more heavily grazed, and used by vehicles. Native species particularly Bracken *Pteridium esculentum* Kangaroo Grass *Themeda triandra* and Spear Grass *Austrostipa* spp and Wallaby Grass *Austrodanthonia* spp were generally more abundant in the northern portion of the reserve. Flax-lily *Dianella* spp and *Acaena* spp were also regularly recorded. No permanent or ephemeral waterbodies were recorded in this area. An access track is proposed to intersect this road reserve however it is located at gates used by the adjoining landowners. It is located in an area without an overstorey and dominated by an exotic understorey.
VPO 2(104)	Penshurst - Warrnambool Road corridor, Warrong (includes Cutts Road). Bisects the western and southern portions of the site (although located outside the site boundary)*.	High biodiversity values/links that contains remnant grasslands including the Grassy Woodland EVC. It is known to support threatened flora. Two proposed access points intersect this road reserve. A field assessment of these areas was undertaken during June 2006. Results from this assessment is discussed in section 8.5.6.
Source: DNRE (2001b) * Shown on *Figure 8.2*		

Anecdotal information suggests that a Wedge-tailed Eagle *Aquila auda*x nest may be located within a shelterbelt on a freehold property approximately 10 km southwest of the site[2].

8.4.2 *Biological Features on the Site – Habitat types*

The biological features/habitat types of the site to fit into three categories: Open Paddock/Pasture, Wetlands and Overstorey Vegetation. These areas are shown in *Figure 8.3*.

Open Paddock/Pasture

The majority of the site is classified as Open Paddock. These areas are dominated by pasture grasses and weeds, due to the agricultural use of the site. The ground is undulating however it does not contain any discrete ridges or knolls that contain a significant proportion of basalt surface rock. Very few examples of native understorey grasses were recorded on the site. The vegetation of the site is dominated exotic pasture grasses and weeds including Sweet Vernal-grass *Anthoxanthum odoratum,* Perennial Rye Grass *Lolium perenne*, Yorkshire Fog *Holcus lanatus,* White Clover *Trifolium repens,* Hare's Tail Grass *Lagurus ovata* and Rough Dogstail *Cynosurus echinatus*.

Open paddock without structural complexity associated with other vegetation or basalt rock provides limited fauna habitat. It provides foraging habitat for farmland and meadow birds such as Australian Magpie *Gymnorhina tibicen*, Skylark *Alauda arvensis*, Corvids *Corvus* spp, Stubble Quail *Coturnix pectoralis*. Australian White Ibis *Threskiornis molucca* and Straw-necked Ibis *Threskiornis spinicollis* are likely to forage in Open Paddock areas on the site. Raptors that hunt ground-dwelling prey would also forage over the site.

Wetlands

A drainage line known as Austins Creek passes runs through the approximate middle of the site. It is the only waterbody recorded on the site. The location of the Austins Creek is shown in *Figure 8.3.*

---

[2] Local resident (name withheld) pers comm. June 2006.

Figure 8.3 Biological Features

This page has intentionally been left blank

Austins Creek is inundated year-round, fed by surface overflow, and a natural spring. A dam in the top of the catchment of Austins Creek appears to be seasonally filled. Austins Creek does not appear to link to other drainage lines off the site. It becomes more braided, difficult to discern, and more dominated by weeds in the lower reaches of the Creek on the site.

A perched wetland area is located approximately half way along Austins Creek. This area is the widest point of Austins Creek and contains a low cover abundance of weeds.

Common Reed *Phragmites australis,* Water-ribbons *Triglochin procera* and Bullrush *Typha* sp dominate Austins Creek, with very little open water. Sedges *Carex* spp, Spike-rush *Eleocharis* spp and Rushes *Juncus* spp are scattered throughout the Austins Creek, but more highly concentrated in the perched wetland. Hedge Wattle *Acacia verticillata* and a couple of small patches of Woolly Tea-tree are present alongside the reeds and rushes. Overstorey trees along the creek include planted Willow *Salix* sp. Silver Poplar *Populus alba* and one indigenous Swamp Gum *Eucalyptus ovata.* Toowoomba Canary Grass, Capeweed *Arctotheca calendula,* Hawthorn *Crataegus monogyna* and Wild Oats *Avena barbata* are weeds and have a higher abundance along the creek than elsewhere on the site.

Austins Creek has a well-defined boundary. It is considered the only remnant patch of vegetation on the site (DNRE 2002, DSE 2006b). Remnant patch is defined as "*an area of vegetation, with or without trees, where less than 75% of the total understorey plant cover is weeds or non-native plants*" or "*an area of treed vegetation where the density of the trees is such that canopy tree cover is at least at benchmark canopy cover*" (DSE 2006b)

Austins Creek provides habitat for frogs and may provide habitat to fishes. Austins Creek may provide foraging habitat to some species of waterbirds, however, the general lack of open water on the site suggests that it provides marginal habitat to many of the threatened species described below (Section 8.4.7).

Overstorey Trees

The site contains a number of shelterbelts. *Figure 8.3* shows the overstorey vegetation within shelterbelts.

Many of the shelterbelts consisted of Monterey Cypress *Cupressus macrocarpa,* however some plantations also consisted of Australian native species and indigenous species. Australian native species observed to be planted within shelterbelts included Blue Gum *Eucalyptus globulus*, Spotted Gum *Eucalyptus maculata*, Yellow Gum *Eucalyptus leucoxylon*, Mahogany Gum *Eucalyptus botryoides*, Sugar Gum *Eucalyptus cladocalyx*, Red-flowering Gum E*ucalyptus ficifolia*, Cedar Wattle *Acacia elata* and Needlewoods *Hakea* spp. Indigenous species included Manna Gum *Eucalyptus viminalis*, Blackwood and Black Wattle.

Understorey vegetation within the shelterbelts is dominated by exotic species particularly those from the adjoining paddock/pasture such as Barley Grass *Hordeum* sp. and Perennial Rye Grass.

All trees are deemed to have biological value to wildlife. The trees within the shelterbelts are generally the same age and do not contain hollows. The potential for these shelterbelts to support hollow-bearing mammals of birds is therefore limited.

The shelterbelts are likely to provide shelter, nesting and foraging opportunity for birds and mammals. However, they are unlikely to provide important movement or dispersal corridors to threatened species of arboreal or ground-dwelling mammals as they do not link patches of remnant vegetation in the vicinity.

Indigenous trees on the site are considered 'Scattered Trees' (DSE 2006b). Scattered trees are defined as "*trees that occur at densities below the benchmark densities and are within areas where at least 75% of the total understorey plant cover is weeds or non-native plants*" (DSE 2006b).

8.4.3 Ecological Vegetation Classes

The site is generally cleared agricultural land predominantly used for livestock grazing. It is not possible to accurately discern any relict EVCs due to the highly modified vegetation on the site.

DSE mapping indicates that five EVCs are likely to have occurred on the site (DSE 2003b). EVC 642: Basalt Shrubby Woodland would have been the most widespread EVC on the site, making up the majority of the land that is now grazed and considered to be Open Paddock/Pasture. EVCs EVC 53: Swamp Scrub; EVC 705: Basalt Creek line Shrubby Woodland; EVC 691 Aquatic Herbland/Plains Sedgy Wetland Mosaic; EVC 125: Plains Grassy Wetland are mapped as occurring in areas in, or in association with Austins Creek (DSE 2003b).

DSE has not mapped any EVCs as currently present on the site (DSE 2003b).

The grassland associated with the Rail Reserve is most likely a modified remnant of EVC 642: Basalt Shrubby Woodland. This EVC is generally described as '*Eucalypt-dominated woodland … with an understorey of shrubs and grasses, presumed originally quite species-rich.* [This EVC]…*occurs on well-drained to seasonally damp fertile soils in higher rainfall areas of volcanic plain*' (DSE 2005c).

Given the highly modified nature of the drainage line, no EVCs are an appropriately fit when compared to the benchmark. Historical mapping indicates that the vegetation occurring along the drainage line is probably a remnant of EVC 705: Basalt Creek line Shrubby Woodland. This EVC is generally described as '*Shrub-dominated low eucalypt woodland to 10 m tall, with a range of grasses, sedges and herbs in the understorey.* [This EVC]…*occurs on heavy soils along low-gradient boggy drainage lines on relatively high rainfall volcanic plains*'.

Both EVC 642: Basalt Shrubby Woodland and EVC 705: Basalt Creek-line Shrubby Woodland are considered 'Endangered' within the Victorian Volcanic Plain bioregion (DSE 2003b).

8.4.4 *Flora Species*

A consolidated list of the flora species recorded during the desktop assessment and field assessments is attached as *Annex 8.2*. Thirty native plant species (7 naturalised) were recorded across the site. Fifteen exotic flora species were also recorded.

8.4.5 *Threatened Flora*

The desktop assessment revealed that 19 plant species listed under the *EPBC Act* or the *Advisory List of Rare or Threatened Plants in Victoria* (DSE 2005a) may occur on, or in the vicinity of, the site. Nine are listed on the *EPBC Act* and 10 are listed under the Schedule 2 of the *FFG Act*. None of these species were recorded on the site during the site surveys.

Table 8.4 is a summary of the likelihood of occurrence for 19 species that have were identified in the desktop assessment as potentially occurring on the site.

The majority of the vegetation on the site is highly modified. This decreases the likelihood of encountering threatened flora species. The Rail Reserve and road reserves adjoining the site boundary are less modified, and have a higher likelihood of supporting threatened flora. However, species which are associated with soils that are permanently or seasonally inundated may have a higher likelihood of occurrence on the site, in the vicinity of Austins Creek on the site, especially the perched wetland as this area appears to be less utilised by grazing livestock.

Three species shown in Table 8.3 are considered to have a moderate (or higher) likelihood of occurrence within the Rail Reserve adjacent to the site; Golden Cowslips *Diuris behrii*, Clover Glycine *Glycine latrobeana* and Basalt Peppercress *Lepidium hyssopifolium* but not on the freehold portion of the site.

Six species shown in *Table 8.4* have a low-moderate (or higher) likelihood of occurrence on the site. These include Western Water-starwort *Callitriche cyclocarpa*, Curly Sedge *Carex tasmanica*, Southern Bristle-sedge *Chorizandra australis*, Swamp Fireweed *Senecio psilocarpus,* Pretty Hill Leek-orchid and Basalt Leek-orchid. These species are known to be located in, or near soils that are permanently or seasonally inundated. Pretty Hill Leek-orchid and Basalt Leek-orchid are known to be tolerant of high nutrient concentrations such as conditions seen with grazing and application of superphosphate. All other species have an unlikely or low likelihood of occurrence on the site as their habitat requirements are not met.

Table 8.4 Threatened Flora Species Recorded on, or in the Vicinity of, the Site at Hawkesdale

Species Name	Common Name	Victorian Conservation Status	National Conservation Status	Habitat Preferences (Sources: Gray and Knight 2001; Walsh and Entwisle 1999; 1996; 1994)	Habitat Present on Site	Likelihood of Presence within the Site or within the Riverside Road reserve
Adriana tomentosa var. tomentosa	Eastern Bitter-bush	Rare		Only isolated occurrences in south-western Victoria, and more records in East Gippsland. Generally occurs in riparian areas.	Yes	Low likelihood in Austins Creek. Unlikely elsewhere due to inappropriate habitat and long-term agricultural pressures.
Callitriche cyclocarpa	Western Water-starwort	Vulnerable, FFG Listed	Vulnerable	Grows in damp and swampy habitats. Also found in River Red Gum open woodland with an open grassy understorey along river banks, and with wallaby grasses on ground less-frequently inundated.	Yes	Low-moderate likelihood in Austins Creek. Unlikely elsewhere due to inappropriate habitat and long-term agricultural pressures.
Cardamine gunnii s.s.	Tuberous Bitter-cress	Presumed Extinct, FFG Listed		Lowland swamps	Yes	Unlikely. No recent records of this species.
Carex tasmanica	Curly Sedge	Vulnerable, FFG Listed	Vulnerable	Seasonally wet, heavy clayey soils north of Melbourne and further to the west.	Yes	Low-moderate likelihood in Austins Creek. Unlikely elsewhere due to inappropriate habitat and long-term agricultural pressures.
Chorizandra australis	Southern Bristle-sedge	Poorly Known		In swamps and around waterholes	Yes	Low-moderate likelihood in Austins Creek. Unlikely elsewhere due to inappropriate habitat and long-term agricultural pressures.
Diuris behrii	Golden Cowslips	Vulnerable		Grassland and open woodland. Population recently recorded on Basalt soils south of the site.	Yes	Low likelihood on the site due to long-term agricultural pressures. Moderate likelihood in Rail Reserve.
Diuris palustris	Swamp Diuris	Vulnerable, FFG Listed		Swampy depressions within grassland or open woodland communities.	Yes	Low likelihood in Austins Creek. Unlikely elsewhere due to inappropriate habitat and long-term agricultural pressures.
Glycine latrobeana	Clover Glycine	Vulnerable, FFG Listed	Vulnerable	Grassy woodland; plains grassland; box woodland; dry sclerophyll forest.	Yes	Low likelihood elsewhere on the site due to long-term agricultural pressures. Moderate likelihood in Rail Reserve.
Lachnagrostis filiformis (perennial variety)	Wetland Blown-grass	Poorly Known		Wide variety of habitats, usually on poorly drained or seasonally wet sites.	Yes	Low likelihood as it has not been recorded from Basalt Plains soil types.
Lachnagrostis punicea subsp. filifolia	Purple Blown-grass	Rare, FFG Listed		Swamps. Only records are near Hawkesdale and Buckleys Swamp near Hamilton	Yes	Low likelihood in Austins Creek. Unlikely elsewhere due to inappropriate habitat and long-term agricultural pressures.

Species Name	Common Name	Victorian Conservation Status	National Conservation Status	Habitat Preferences (Sources: Gray and Knight 2001; Walsh and Entwisle 1999; 1996; 1994)	Habitat Present on Site	Likelihood of Presence within the Site or within the Riverside Road reserve
Lepidium hyssopifolium	Basalt Peppercress	Endangered, FFG Listed	Endangered	Basalt plains. The species occurs in woodland with a grassy understorey and grassland.	Yes	Low likelihood on the site elsewhere on the site due to long-term agricultural pressures. Moderate likelihood in Rail Reserve.
Prasophyllum sp. aff. *diversiflorum**	Pretty Hill Leek-orchid	Endangered		Occurs on heavy black loamy soil prone to inundation. Known to occur approximately 22km south of the site at Pretty Hill Flora Reserve and Riverside Road.	Yes	Moderate likelihood in Austins Creek. Low likelihood elsewhere on the site due to inappropriate habitat and long-term agricultural pressures. Low likelihood in Rail Reserve.
Prasophyllum sp. aff. *frenchii* A*	Basalt Leek-orchid	Endangered		Tea-tree heath; wattle tea-tree scrub; valley sclerophyll forest. Predominantly in or near coastal swamps. Nearest record is approximately 8km south-east of site along Koroit-Woolsthorpe Roa (DSE 2005d)..	Yes	Moderate likelihood in Austins Creek. Low likelihood elsewhere on the site due to inappropriate habitat and long-term agricultural pressures. Low likelihood in Rail Reserve.
Prasophyllum spicatum	Dense Leek-orchid	Endangered	Vulnerable	Coastal heath and sandhills; tea-tree heath.	No	Unlikely due to inappropriate habitat.
Senecio psilocarpus	Swamp Fireweed	Vulnerable	Vulnerable	Herb-rich winter-wet swamps south and west from Ballarat, growing on volcanic clays or peaty soils.	Yes	Moderate likelihood in Austins Creek. Unlikely elsewhere on the site due to inappropriate habitat and long-term agricultural pressures.
Stackhousia aspericocca	Rough-nut Stackhousia	Poorly Known		Sandy heathy woodlands or sandy mallee communities	No	Unlikely due to inappropriate habitat.
Taraxacum cygnorum	Coast Dandelion	Endangered, FFG Listed	Vulnerable	Confined to woodland and scrub on limestone in the south west.	No	Unlikely due to inappropriate habitat.
Thelymitra epipactoides	Metallic Sun-orchid	Endangered, FFG Listed	Endangered	Coastal areas but also inland in fertile loams, scrubby heaths or near swampy depressions.	No	Unlikely as it has not been recorded from Basalt Plains soil types.
Thelymitra matthewsii	Spiral Sun-orchid	Vulnerable, FFG Listed	Vulnerable	Slightly elevated sites in well-drained soils in light to dense forest. Less common on coastal sandy flats.	No	Unlikely likelihood due to inappropriate habitat and long-term agricultural pressures.

Table Notes:

1. 'Unlikely' = No preferred habitat on the site and/or outside the species' known distribution.
2. 'Low' = Some preferred habitat present on the site, but species is either not known from the area or it outside its recognised distribution (based on local records).
3. 'Moderate' = Site contains some of the preferred habitat which may support a population of the species.
4. 'High' = Site contains the preferred habitat which is likely to support a population of the species.
5. 'Present' = Species directly observed on the site or recently recorded at the site. Preferred habitat is present on the site.

*was listed under the *EPBC Act* prior to the nomenclature name change (Helena Mills Ecological Communities Section, DEH *pers comm*. 11 April 2004).

8.4.6 *Fauna Species*

A consolidated list of fauna species recorded at the site during the desktop assessment and field assessments is contained in *Annex 8.3*.

Avifauna

A total of 25 bird species were recorded during the field assessments carried out by ERM. Eighteen are native and 4 are exotic. None of the species identified are regarded as rare or threatened within Victoria (DSE 2003b).

Open paddock areas at the site provide foraging for common ground foraging bird species. Species recorded include Ravens *Corvus spp.,* Australian Magpie, Magpie-lark *Grallina cyanoleuca*, Willie Wagtail *Rhipidura leucophrys*, Welcome Swallow *Hirundo neoxena,* and the introduced Skylark *Alauda arvensis* and European Goldfinch *Carduelis chloris.*

No waterbirds were recorded at Austins Creek during the assessments. Waterbirds recorded in the vicinity, and flying over the site include Australian White Ibis *Threskiornis molucca*, Straw-necked Ibis *Threskiornis spinicollis*, Pacific Black Duck *Anas superciliosa* and Australian Wood Duck *Chenonetta jubata*. These species are considered likely to occur on the site. No waterbird nests were seen at the site.

Woodland birds seen on or in the vicinity of the site include Sulphur-crested Cockatoo *Cacatua galerita*, Long-billed Corella *Cacauta tenuirostris* and Yellow-tailed Black-cockatoo *Calyotorhynchus funereus.*

These results are consistent with those for the proposed Woolsthorpe Wind Farm which is located 4 km south east of the Hawkesdale site. The Woolsthorpe site is situated in a predominantly agricultural landscape with generally flat to gently undulating topography. It is pastureland almost totally devoid of native vegetation.

Bird utilisation surveys undertaken in 2004 at the Woolsthorpe site found that the dominant birds at the site were common introduced farm birds (e.g. Skylards and European Goldfinch). No species of national, state or regional significance were observed reflecting the highly altered nature of the habitat and predominance of agricultural land uses (Brett Lane and Associates 2004).

The results are also consistent with those of the proposed Macarthur Wind Farm which is located 22 km to the north west. The Macarthur site is undulating with the vast majority of the site having been grazed with the majority of the vegetation replaced by exotic pastures. It does however, contain some indigenous vegetation, principally along drainage lines.

Bird utilisation surveys at Macarthur found that the most abundant bird species were common farmland species and that no threatened bird species are likely to occur regularly in the area (Brett Lane and Associates 2005).

Mammals

Livestock observed on the site included domestic cattle *Bos sp*. and sheep *Ovis aries*. The Red Fox *Vulpes vulpes,* Feral Cat *Felis catus*, domestic dog *Canis familiaris*, European Rabbit *Oryctolagus cuniculus* and Hare *Lepus capensis* were directly or indirectly recorded on the site.

No evidence of native ground-dwelling mammals was recorded at the site, despite some Elliott trapping being undertaken in an area considered the most likely to support ground-dwelling mammals; the Rail reserve. Basalt rock, stone piles, vegetation cover and debris is generally absent across the site. The site is therefore unlikely to provide suitable habitat to support native ground-dwelling mammals.

ANABAT results were highly variable. That is, of the two ANABATs placed on site for two consecutive nights (total of four census nights), two did not record any calls, one recorded 3 calls and the other recorded 145 calls. This anomaly is not unusual, particularly given the location of the ANABAT recorder - within the Rail Reserve - which contains overstorey vegetation, and could be considered a "flyway" by bats.

The bats that were confirmed on the ANABAT recorder are Gould's Wattled Bat *Chalinolobus gouldii*, Chocolate Wattled Bat *Chalinolobus morio* and the White-striped Mastiff Bat *Tadarida australis* forage over the site.

The ANABAT records showed that the Southern Freetail Bat *Mormopterus planiceps,* Southern Forest Bat *Vespadelus regulus* were probably using the site, although insufficient calls (passes) were available to confirm their presence. Fishing Bat *Myotis macropus,* Little Forest Bat *Vespadelus vulturnus* and an unidentified Long-eared Bat *Nyctophilus* sp. were also possibly utilising the site although this could not be confirmed from the data available.

Fishing Bat is 'Near Threatened' on the DSE Advisory List of threatened Fauna (DSE 2003a). It is generally more abundant in south-western Victoria than other parts of the State, however, it is generally recorded in close proximity to waterbodies[3]. This makes the "possible" presence of this species within the Rail Reserve (where the ANABAT detector was placed) less likely, unless moving to of from Austins Creek.

A detailed bat assessment was completed at the proposed Macarthur Wind Farm located 35 km north east of the Hawkesdale site (Lane 2005). The Macarthur Wind Farm is located on land with similar biological features as the Hawkesdale site, generally open paddocks/pastures with few overstorey trees and some waterbodies on site.

The results of this study indicate that the species of bat at the Macarthur Wind Farm site are similar to those recorded on the Hawkesdale site.

---

[3] Lindy Lumsden, Fauna Officer - Bat Specialist, DSE pers comm. August 2006.

The study identified eight species with the most dominant species being the White-striped Freetail Bat and Southern Freetail Bat. These species accounted for 100 of the 160 identifiable calls taken over 50 detector-nights. The Southern Bent-wing Bat was recorded on 7 of the 160 identifiable calls.

Other species located on site include the Long-eared Freetail Bat *Nyctophilius spp* (likely to be *N. geoffroyi* and *N. gouldi*), Southern Forest Bat, Chocolate Wattled Bat and Large Forest Bat *Vespadelus darlingtoni* (which was the only species not recorded at the Ryan Corner site). Fishing Bat, which may occur on the Ryan Corner site, was not recorded at Macarthur site.

Mr Glenn Richards, Wildlife Research and Ecological Assessment Consultants, undertook the ANABAT analyses noted the low number of calls on the site and attributes the low number of calls to "*the depauperate bat habitat in the project area, which is understood to be primarily open pasture. There is every possibility that many, if not all, bats were commuting through the open agricultural landscape to access foraging habitat near the project area, such as the dam*".

Herpetofauna

Four species of frog were recorded during the diurnal frog searches undertaken by ERM in November 2005. In particular, the Spotted Marsh Frog *Limnodynastes tasmaniensis* Striped Marsh Frog *Limnodynastes peronii,* Southern Brown Tree Frog *Litoria ewingii* and Common Eastern Froglet *Crinia signifera* were recorded from Austins Creek.

Despite active searching under loose rocks and debris on the site and within the rail Reserve, no reptiles were recorded during the assessments.

Fishes

The site contains permanent water. However, it was noted to be quite shallow, and did not feed any other waterbodies or drainage lines. That is, Austins Creek becomes increasingly braided and dry in its extremities located on the site. Austins Creek may provide habitat to native species such as Common Galaxias *Galaxias maculatus*, Tupong *Pseudophritis urvilli* and Southern Pygmy-perch *Nannoperca australis* which have been recorded in the region, and may inhabit slow moving waterways.

8.4.7 Threatened Fauna

Table 8.5 provides a summary of the likelihood of occurrence of threatened fauna on and in the vicinity of the site. The site assessment refined this data and assessed the potential for threatened species to utilise the site.

The desktop assessment revealed that 18 bird species, 7 mammals, 3 reptiles, 2 fishes and 1 frog listed under the *EPBC Act* or *Advisory List of Threatened Vertebrate Fauna in Victoria* (DSE 2003a) may occur on, or in the vicinity of the

site. Of the 31 species, 23 are listed under the *EPBC Act* and 19 are listed under the Schedule 2 of the *FFG Act*.

None of these species were recorded on be present on the site. However, 10 of the 30 species have a 'moderate' likelihood of occurrence on the site. These include:

- four bird species; Latham's Snipe, Great Egret, Brolga and Rufous (Nankeen) Night Heron;
- three mammal species (Southern Bent-wing Bat, Fishing Bat and Grey-headed Flying-fox *Pteropus poliocephalus)*;
- two reptile species (Glossy Grass Skink and Swamp Skink *Egernia coventryi*); and
- one frog species (Growling Grass Frog).

Figure 8.4 shows the threatened fauna species within a 50 km radius of the site.

Table 8.5 Threatened Fauna Species Recorded on, and in the Vicinity of, the Site at Hawkesdale ("Listed – Overfly Marine Species" have been omitted from this Table)

Species Name	Common Name	Victorian Conservation Status*	National Conservation Status#	Habitat Preferences (Sources: Emison et al. 1987; Menkhorst and Knight 2001; Strahan 1995; Inland Fisheries Service 2000;Robinson 1998, DNRE 2001a, NSW Parks and Wildlife 1999; DEH 2006c, Wilson and Swan 2004)	Habitat Present on Site	Likelihood of Occurrence
Birds						
Anas rhynchotis	Australasian Shoveler	Vulnerable	Migratory	Large, shallow lakes, prefer well-vegetated freshwater swamps. Species recorded at Lake Cartcarrong, and approximately 4 km north of the site (DSE 2005d).	Yes	Low likelihood in Austins Creek. Unlikely elsewhere on the site due to lack of habitat. May fly over site.
Anseranas semipalmata	Magpie Goose	Vulnerable	Migratory	Large seasonal wetlands and well-vegetated dams with rushes and sedges; wet grasslands and floodplains. Captive re-release from Tower Hill. Species recorded approximately 4 km north-west of subject site (DSE 2005d).	Yes	Low likelihood in Austins Creek. Unlikely elsewhere on the site due to lack of habitat. May fly over site.
Ardea alba	Great Egret	Vulnerable, FFG Listed		Intertidal mudflats, inland lakes, swamps and rivers; also farm dams and artificial wetlands	Yes	Moderate likelihood in Austins Creek.
Biziura lobata	Musk Duck	Vulnerable	Migratory	A diving duck that prefers deep waters of lakes, swamps and impoundments. Sometimes saline wetlands and tidal estuaries and bays. Number of records of species in local area, with nearest occurrence approximately 4 km north of the subject site (DSE 2005d).	No	Unlikely. No suitable habitat. May fly over site.
Botaurus poiciloptilus	Australasian Bittern	Endangered, FFG Listed	-	Freshwater wetlands, including swamps, lakes, impoundments, rivers or creeks, or rank pastures and drainage ditches. Requires dense vegetative cover.	Yes	Low likelihood in Austins Creek. Unlikely elsewhere on the site due to lack of habitat. May fly over site.
Chlidonias hybridus	Whiskered Tern	Low Risk, Near Threatened	-	Summer migrants to Victoria. Shallow freshwater swamps and fresh or brackish lakes, favouring waters with low emergent vegetation. Species recorded near Minjah – Hawkesdale Road (approximately 6 km north east of site) and approximately 7 km north east of site (DSE 2005d).	Yes	Low likelihood in Austins Creek. Unlikely elsewhere on the site due to lack of habitat. May fly over site.
Gallinago hardwickii	Latham's Snipe	Low Risk, Near Threatened	Migratory	Heavily vegetated freshwater swamps, pools or ditches in heaths or subalpine herblands. Species recorded west of Lake Cartcarrong, (DSE 2005d).	Yes	Moderate likelihood at Austins Creek and grasslands in the vicinity. May fly over site.

Species Name	Common Name	Victorian Conservation Status*	National Conservation Status#	Habitat Preferences (Sources: Emison et al. 1987; Menkhorst and Knight 2001; Strahan 1995; Inland Fisheries Service 2000;Robinson 1998, DNRE 2001a, NSW Parks and Wildlife 1999; DEH 2006c, Wilson and Swan 2004)	Habitat Present on Site	Likelihood of Occurrence
Grus rubicunda	Brolga	Vulnerable, FFG Listed	Migratory	Shallow wetlands, farm dams, flooded areas, margins of lakes, pastures, grasslands, crops and stubbles. Nearest breeding sites located approximately 7 km north east of site, and at Poyntons Rd, Willatook (DSE 2005d).	Yes	Moderate likelihood at Austins Creek and grasslands in the vicinity. May fly over site.
Haliaeetus leucogaster	White-bellied Sea-Eagle	Vulnerable, FFG Listed	Migratory	Coastal islands, coastal lakes and along some inland rivers and lakes.	No	Unlikely. No suitable habitat. May fly over site.
Hirundapus caudacutus	White-throated Needletail		Migratory	Aerial, mainly eastern Australia often associated with coastal and mountain regions.	Yes	Low. May fly over site.
Lathamus discolor	Swift Parrot	Endangered, FFG Listed	Endangered	Winter migrants to Victoria. Box-ironbark, particularly where Red Ironbark is well represented.	No	Unlikely. No suitable habitat. May visit plantation to the north of the site. May fly over site.
Myiagra cyanoleuca	Satin Flycatcher		Migratory	Tall and medium open forests.	No	Unlikely. No suitable habitat. May fly over site.
Neophema chrysogaster	Orange-bellied Parrot	Critically Endangered, FFG Listed	Endangered	Breed in southwest Tasmania, migrate to Victoria in winter, occupying coastal saltmarshes and adjacent grasslands or shrublands.	No	Unlikely. No suitable habitat.
Nyctiorax caledonicus	Rufous (Nankeen) Night Heron	Near Threatened		Mainly nocturnal (forages and flies at night). Forages at waterbodies, preferably permanent waterbodies). Recorded approximately 4km south of site (DSE 2005d).	Yes	Moderate likelihood at Austins Creek. Unlikely elsewhere on the site due to lack of habitat. May fly over site.
Oxyura australis	Blue-billed Duck	Endangered, FFG Listed	Migratory	Deep, permanent, well-vegetated swamps.	No	Unlikely. No suitable habitat. May fly over site.
Rhipidura rufifrons	Rufous Fantail		Migratory	Wet forested regions, occasionally more open forests.	No	Unlikely. No suitable habitat. May fly over site.
Rostratula australis	Australian Painted Snipe	Critically Endangered, FFG Listed	Vulnerable	Uncommon summer visitors to Victoria. Lowlands on shallow freshwater swamps with emergent vegetation, and flooded saltmarshes.	Yes	Low likelihood in wetlands. Unlikely elsewhere on the site due to lack of habitat. May fly over site.
Stictonetta naevosa	Freckled Duck	Endangered, FFG Listed	Migratory	Open freshwater or brackish wetlands.	Yes	Low likelihood in wetland. Unlikely elsewhere on the site due to lack of habitat.
Mammals						

Species Name	Common Name	Victorian Conservation Status*	National Conservation Status#	Habitat Preferences (Sources: Emison et al. 1987; Menkhorst and Knight 2001; Strahan 1995; Inland Fisheries Service 2000;Robinson 1998, DNRE 2001a, NSW Parks and Wildlife 1999; DEH 2006c, Wilson and Swan 2004)	Habitat Present on Site	Likelihood of Occurrence
Dasyurus maculatus maculatus (SE mainland population)	Spotted-tail Quoll	Endangered, FFG Listed	Endangered	Coastal heath and scrub, dry and wet sclerophyll forest, rainforest. Generally a forest-dependent species requiring large intact areas of vegetation.	No	Unlikely. No suitable habitat.
Miniopterus schreibersii bassanii	Southern Bent-wing Bat	Endangered, FFG Listed	Conservation Dependent	Broad range of habitat types including forest through to open grasslands. A cave bat that hibernates during winter. May inhabit a range of wintering caves or temporary roosts in proximity to the site.	Yes	Moderate - High. May forage over site. No caves of "sink-holes" on the site that would be suitable as temporary roost sites.
Myotis macropus	Fishing Bat	Low Risk, Near Threatened		Broad range of habitat types as long as they are near water. Although they are aerial foragers, they also feed on fish or insects within water by raking there feet across the water surface	Yes	High. ANABAT detector results show a possible presence. Most likely to utilise Austins Creek area of the site.
Potorous tridactylus tridactylus	Long-nosed Potoroo (SE mainland)	Endangered, FFG Listed	Vulnerable	In Victoria, mostly inhabits coastal heathy woodland. Requires dense cover for shelter adjoining more open foraging sites.	No	Unlikely. No suitable habitat.
Pseudomys fumeus	Smoky Mouse	Endangered, FFG Listed	Endangered	Sparse and patchy in dry sclerophyll forest on ridges with heath and tussock-grass understorey, coastal heath and sub-alpine heath.	No	Unlikely. No suitable habitat.
Pteropus poliocephalus	Grey-headed Flying-fox	Vulnerable, FFG Listed	Vulnerable	Variety of habitats including rainforest, mangroves, paperbark swamps, wet and dry sclerophyll forest and cultivated areas. Forage on fruits and blossoms, typically from the family Myrtaceae, and fruit trees. Most population exists east of Geelong.	Yes	Low-moderate. May forage on the site in low numbers (relative to populations recorded elsewhere in the state).
Sminthopsis crassicaudata	Fat-tailed Dunnart	Low Risk, Near Threatened	-	A variety of habitats including, tussock and hummock grassland, gibber plain, saltbush and bluebush plains, claypans, rough pasture and the edges of stubble paddocks. May persist in rocky knolls, rock piles, stone fences and debris at the agricultural sites. Species recorded at several sites east of Woolsthorpe (DSE 2005d).	Yes	Low likelihood at site due to lack of rocky habitat. Moderate likelihood along Rail Reserve.
Reptiles						

Species Name	Common Name	Victorian Conservation Status*	National Conservation Status#	Habitat Preferences (Sources: Emison et al. 1987; Menkhorst and Knight 2001; Strahan 1995; Inland Fisheries Service 2000;Robinson 1998, DNRE 2001a, NSW Parks and Wildlife 1999; DEH 2006c, Wilson and Swan 2004)	Habitat Present on Site	Likelihood of Occurrence
Pseudemoia rawlinsoni	Glossy Grass Skink	Near Threatened		Forests, woodlands, heaths and grasslands. Preferree habitat includes swamp and lake edges, soaks, marshes and creeklines with dense vegetation, rocks or debris Nearest record is approximately 3.5 km south of site, along the Rail Reserve (DSE 2005d).	Yes	Moderate likelihood at Austins Creek. Moderate likelihood in Rail Reserve.
Egernia coventryi	Swamp Skink	Vulnerable, FFG Listed		Low-lying wetlands, swamp margins, tea-tree thickets and saltmarsh.	Yes	Low-moderate likelihood at Austins Creek. Unlikely elsewhere on the site due to lack of habitat.
Delmar impar	Striped Legless Lizard	Endangered, FFG Listed	Vulnerable	Native grasslands and grassy woodland although Has been recorded in exotic pasture. Favours rocky knolls or crevices in soil. .	Yes	Low likelihood on the site due to lack of habitat.
Fishes						
Galaxiella pusilla	Dwarf Galaxias	Vulnerable, FFG Listed	Vulnerable	Still or slow moving waters.	Yes	Low-moderate likelihood in Austins Creek.
Prototroctes maraena	Australian Grayling	Vulnerable, FFG Listed	Vulnerable	Clear gravely streams; deep slow flowing.	No	Unlikely. No suitable habitat.
Frogs						
Litoria raniformis	Growling Grass Frog	Vulnerable, FFG Listed	Vulnerable	Permanent lakes, swamps, dams and lagoons; very wet areas in woodland and shrubland.	Yes	Moderate likelihood in Austins Creek. Unlikely elsewhere on the site due to lack of habitat.

Table Notes:

* Listed on the '*Advisory List of Threatened Vertebrate Fauna in Victoria – 2003*'

\# Listed under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*

1. 'Unlikely' = No preferred habitat on the site. Species will not be present on the site at any time or season.
2. 'Low' = Some of the preferred habitat present on the site. Species may infrequently visit the site on-route for foraging but will not roost or otherwise depend on habitats on the site for their survival. Migratory and aerial foraging birds may fly over the site.
3. 'Moderate' = Site contains some of the preferred habitat to support a population of the species.
4. 'High' = Site contains the preferred habitat which is likely to support a population of the species, including roost sites.
5. 'Present' = Species directly observed on the site or recently recorded at the site. Preferred habitat is present on the site.

8.5 POTENTIAL IMPACTS

The potential impacts associated with the proposed Hawkesdale Wind Farm include bird collision, bat collision and removal/modification of habitat for flora, ground-dwelling fauna, arboreal mammals and avifauna which nest in trees within the shelterbelts.

8.5.1 *Wind Farm Design*

The wind farm layout design has considered the biological features of the site. That is, the design has considered the outcomes of the assessment, and turbines have been located within open paddock areas as far as practicable. In particular:

- None of the turbines or other infrastructure will require removal of modification of Austins Creek. The nearest turbine is located approximately 500 m away from Austins Creek. An existing track which is approximately 20 m wide will be upgraded however this will not require any native vegetation removal.

- Turbines and other infrastructure have been sited away from shelterbelts as far as practicable. However, due to constraints associated with wind turbulence, some vegetation within shelterbelts will require removal. Some of one of the shelterbelts will also require removal for the substation. Three of the seven shelterbelts proposed for removal contain indigenous and Australian native shrubs and trees, while the other four are composed of Monterey Cypress. Vegetation removal from shelterbelts is shown in *Figure 8.5*.

- An access track crossing of the Rail Reserve which bisects the site is proposed. An area was selected that contains lower biological values than its surrounds. This crossing point is located at two of the landowner's gates and is dominated by exotic understorey. No native vegetation removal is anticipated for this track.

- Where possible, access points onto the site have been located at existing access ways used by the landowners. This reduces the requirement to create new tracks across the road reserve and therefore minimising native vegetation removal. One access track is proposed to be located at a road reserve which does not contain an existing track.

Potential impacts of the proposed development on threatened flora and fauna at the site are discussed below.

Figure 8.4

This page has intentionally been left blank

Figure 8.4 Proposed Vegetation Removal within Shelterbelts

This page has intentionally been left blank

8.5.2 *Potential Impacts on Threatened Flora*

Five threatened species of flora have a low-moderate (or higher) likelihood of occurrence on the site. These include Western Water-starwort, Curly Sedge, Swamp Fireweed, Pretty Hill Leek-orchid and Basalt Leek-orchid. These species are associated with soils that are permanently or seasonally inundated. Species associated with grasslands or woodlands have an unlikely to low likelihood of occurrence as they are not represented on the site, and their habitat requirements are no longer met.

The potential to impact on these species is therefore limited to direct and indirect impacts on Austins Creek. No development requires the removal or alteration of native vegetation within Austins Creek. The nearest turbine is approximately 500 m away from Austins Creek. The access track that intersects the site will be limited to the land bridge that the landowner currently has on the site, and regularly uses for the movement of livestock.

Indirect impacts to threatened flora (if present) may occur due to alterations in the drainage at the site. In particular, increases in runoff during construction, or due to increased hard surfacing. This may also cause increased nutrient and sediment movement towards the low-lying areas of the site including Austins Creek.

Disturbance and alterations to drainage on the site may lead to increased weed cover at exposed and low-lying areas. This may adversely affect the threatened species that may occur on site.

GEA/TMEA proposes to cross the Rail Reserve which bisects the site. The area selected has been assessed in April 2006, and subsequently reviewed by DSE. It is located at an area approximately 5 m wide where landowners currently have gates and drive vehicles into the Reserve. This area of the Reserve is dominated by exotic understorey, and was observed to be grazed by sheep (albeit probably a low grazing pressure). The disturbances and subsequent vegetation modification over time, and the preliminary site assessment suggest that the crossing point footprint (within the Rail Reserve) is considered to have a low likelihood of supporting threatened flora.

GEA/TMEA has committed to a series of mitigation measures to minimise potential impacts to Austins Creek and threatened flora. These are discussed in Section 8.6. Should these measures be followed, the potential for an impact threatened flora would be expected to be low.

8.5.3 *Potential Impacts on Threatened Avifauna*

Four species are considered to have a moderate likelihood of occurrence at the site, Latham's Snipe, Great Egret, Brolga and Rufous (Nankeen) Night Heron *(Table 8.5*). Bird behaviour at wind farms is discussed below.

Due to the relative infancy of the wind farm industry in Australia compared with overseas, little monitoring data exists for Australian Wind Farms. It is therefore difficult to accurately determine potential impacts associated with the Hawkesdale Wind Farm. Furthermore, there has been considerable variability in the impacts associated with established wind farms.

The likelihood of bird collision has been shown to be variable (Hunt 2002, Langston and Pullan 2002). Bird of prey collisions have been higher at sites where prey items are abundant and bird behaviour has not greatly changed after the erection of the turbines (Hunt 2002). Risks are also more apparent for larger birds with slow wing-beat rate, and poorer manoeuvrability in the air. The likelihood of collision is increased at times of poorer visibility (e.g. night, fog) and strong winds (Richardson 1998, Tulp *et al* 1999). Species that fly at night may be more susceptible to collision with turbines.

Many recent studies have demonstrated that birds are able to detect and avoid collision with wind turbines by altering height, direction and speed (Meredith *et al*. 2002, Lane 2005a, Langston and Pullan 2002, De Lucas *et al*. 2004). More modern wind farms, with larger turbines, spaced further apart, represent a lower risk of collision (Meredith *et al*. 2002).

Preliminary data from the bird avoidance study at the nearby Codrington Wind Farm has shown that species flying at wind turbine height avoided collision with the turbines by flying between them, resulting in a bird collision rate estimated at 0.8 and 1.6 birds per generator per year (Meredith *et al*. 2002). Birds recorded during the mortality study as having collided with turbines at Codrington include Skylark, Australian Magpie and a Brown Falcon. Magpie Goose feathers were also recorded (Meredith *et al*. 2002).

The site is located in close proximity to the proposed Woolsthorpe Wind Farm. Lane (2004b) has undertaken a bird utilisation at that site, which is comparable to that of Hawkesdale. That is, the vegetation of the site is predominantly pasture, but undulates and contains low-lying areas which are fed by surface runoff. Lane (2004b) found that woodland birds dominated were the most abundant species. Long-billed Corella and Raven spp accounted for over 85 percent of all birds fling at Rotor Sweep Area. Raptors were not common during the surveys, one Wedge-tailed Eagle was recorded on one occasion. Waterbirds were recorded in low numbers and included species common to farmland settings such as Australian Shelduck, Australian Wood Duck and Pacific Black Duck, White-necked heron, White-faced Heron and Straw-necked Ibis. No species of national, state or regional significance were observed on the site during the bird utilisation studies, however, some were recorded incidentally (ducks listed as migratory species) however, the impact of the proposed wind farm on these species would be insignificant at a regional population scale and the risk to raptors and waterbirds is likely to be low (Lane 2004b).

The likelihood of collision with wind farm turbines for Rufous (Nankeen) Nigh Heron, Latham's Snipe, Brolga and Wedge-tailed Eagle is discussed below.

Brolga

Brolgas have a population of between 20,000 and 100,000 individuals, distributed around northern and south eastern Australia. Of this, 500-700 individuals are thought to reside in south western Victoria. Birds breed between July and December. Brolgas form flocks during January. They may then move to staging sites for a period of time, before finding breeding sites again in May/June (Lane 2004a).

Preferred habitat includes deep freshwater marshes and permanent open water as these provide drinking, foraging and roosting habitat requirements (DSE 2006a)

Breeding and flocking sites are kept on the *Victorian Brolga Breeding and Flocking Site Database*. This database is not publicly available, however, it is referred to in Lane (2004a) for the proposed Macarthur Wind Farm, approximately 18km west of the site. Brolga breeding sites are recorded in DNRE (2001b) and shown in *Table 8.2* and Brolga breeding sites within 40 km of the site are shown in *Figure 8.2*. These include (in descending order of proximity to the site):

- Poyntons Road Willatook, approximately 10 km west of the site.
- Cockatoo Swamp, approximately 20 km west of the site.
- Pallister's (5 sites), approximately 30 km south-west of the site.
- Caramut East, approximately 32 km north-east of the site.
- Boortkoi Lane, Caramut East, approximately 32 km north-east of the site.
- Connewarren Marsh, approximately 34 km east of the site.
- Chatsworth, Hexham Rd, Hexham, approximately 38 km north-east of the site.

In addition, Lane (2004a) shows:

- a breeding record on Minjah–Hawkesdale Road, approximately 6 km north east of the site;
- a breeding and 8 flocking sites near Lake Linlithgow 30-40 km north of the site;
- two breeding records near Mount Napier State Park, approximately 25-35 km north west of the site; and

- a number of other breeding and flocking records extending from Pallister's Reserve and Bartlett Swamp, approximately 30 km south west of the site, extending further west towards Tyrendarra up to Heywood.

Other observations are scattered throughout the Moyne Shire. They are generally concentrated at northeast and southwest of the site.

Brolga has not been recorded on the site. They are unlikely to roost or breed at the site. The site provides marginal habitat for this species as it does not contain suitable foraging sites. However, Brolga has a moderate likelihood of occurrence on the site. It may fly over the site when flying between waterbodies and flocking or breeding sites in the vicinity.

Brolga may be at greater risk with extreme climatic conditions or when this species moves at low light (during dawn or dusk) or foggy conditions. Furthermore, large waterbirds with a slow wing-beat are known to be more susceptible to such obstacles as they are less manoeuvrable (Richardson 1998).

Improved confidence in Brolga utilisation of the site could be achieved through a targeted Brolga census and utilisation study. However, the absence of preferred habitat on the site reduces the likelihood of occurrence and therefore the likelihood of collision. Further surveys are being conducted as part of the assessment for the Ryan Corner Wind Farm and will be available in the consideration of the Hawkesdale project.

Great Egret

The Great Egret is widespread across Australia, utilising a wide range of permanent and temporary wetlands. It generally forages within waterbodies and is unlikely to forage on pasture grass. It generally nests colonially in trees at, or near, permanent water bodies.

Great Egret is not known to breed at the site. A breeding record for this species is known to exist approximately 35 km south of the site[4], and other breeding records are located to the northern parts of the state (Barrett et al 2003, Emison et al 1987).

The site is thought to represent marginal habitat (opportunistic feeding habitat) for Great Egret due to the absence of large waterbodies, and low vegetative cover for foraging. Individuals may fly over the site when moving to preferred habitat or roost sites within the area, but the risk of collision by this species is considered to be low.

Latham's Snipe

Latham's Snipe is a summer migrant to Victoria from Japan and Eastern Russia, where it is known to breed in their summer. In Victoria, it generally

[4] Philip Du Guesclin, Fauna Officer, DSE pers comm. May 2005.

forages within freshwater and brackish wetlands close to and in vegetative cover. The majority of Latham's Snipe are recorded at wetlands near the coast, however, the nearest record is near Lake Cartcarrong, approximately 15 km from the study site (DSE 2005d).

The majority of the site is heavily grazed (and in some paddocks cultivated and cropped). These areas are unlikely to provide the habitat for this species. This species is considered to have a moderate likelihood of opportunistic occurrence in Austins Creek on the site.

The migratory route for this species is likely to be seasonally dependent and, influenced by localised climatic conditions. It may fly at turbine height during migration.

Wedge-tailed Eagle

The Wedge-tailed Eagle is common and widespread throughout Victoria. These Eagles typically nest in open woodlands. No nests were recorded on the site. The home range of a pair may cover a range of habitats from woodland to heath to open farmland.

Wedge-tailed Eagles are known to nest or have nested at Saint Helens Flora Reserve; in Terka Road and at Pallister's Reserve[5]. It is not known whether these nests are still active. A pair of Wedge-tailed Eagles is regularly recorded from Tower Hill, approximately 20 km south of the site[6] and Pallisters Reserve (Atlas of Victorian Wildlife). Anecdotal evidence suggests that there may be a nest 10 km southwest of the site[7], however this was not be located during the assessment.

It is likely that the wind farm is located within the foraging range of a pair of Wedge-tailed Eagles, and possibly multiple pairs, as the home range of this species varies according to prey density and nest site location.

Bird utilisation rates are used to compare Wedge-tailed Eagle density across wind farms. Wedge-tailed Eagles were not recorded at any time during the site assessments, suggesting that the utilisation of Wedge-tailed Eagles at this site is low.

Studies at wind farms have demonstrated that birds are able to detect and avoid collisions with wind generators by changing flight patterns (Lane 2005a, Meredith 2002, Janss 1998). Such observations have been made at both the Codrington and Toora Wind Farms, where Wedge-tailed Eagles were observed flying betweens the turbines (Lane 2005a, Meredith 2002).

---

[5] Andrew Pritchard, Flora Officer, DSE, pers comm. July 2006

[6] Philip Du Guesclin, Fauna Officer, DSE pers comm. May 2006.

[7] Local resident (name withheld) pers comm. June 2006.

Overall, the risk of Wedge-tailed Eagles colliding with turbines at the Ryan Corner Wind Farm is considered to be low.

Based on the similar habitat features and the proximity of the site, the potential impacts on avifauna would be similar to those for the proposed Woolsthorpe Wind Farm. In that case it was concluded that most of the site would only be of local significance to birds and that the impact on EPBC listed or migratory species would be insignificant at a regional population scale (Brett Lane and Associates 2004).

Given the similarities in site conditions and identified species, the potential impacts would also be similar to those for the Macarthur Wind Farm. In that instance it was concluded that no species or community listed under the *EPBC Act, FF Act* would be significantly affected and that no birds listed on the DSE advisory list of threatened vertebrate fauna would fly across the wind farm site in numbers regularly enough to be significantly affected (Brett Lane and Associates 2005).

8.5.4 *Potential Impacts on Threatened Mammals*

The Southern Bent-wing Bat, Fishing Bat and Grey-headed Flying Fox are the only mammals that have a moderate likelihood of being present at the site. Fat-tailed Dunnart has a moderate likelihood of occurrence within the Rail Reserve.

Fishing Bat

Fishing Bats are found in a wide range of habitats, as long as they are near water. They have been recorded within mangroves, paperbark swamps, riverine monsoon forest, rainforest, wet and dry sclerophyll forest, open woodland and River Red gum woodland (Churchill 1998).

Although there are not any records of Fishing Bats within 50 km of the site on the Atlas of Victorian Wildlife, south-western Victoria is known to support this species[8]. Fishing Bats are commonly cave dwellers, but are also known to roost in tree hollows, amongst vegetation or within man-made structures such as bridges, tunnels or mines, generally in close proximity to water (Churchill 1998). No evidence of roosting sites was sound on the site, and this species is unlikely to roost at the site. A range of caves or sinkholes within the area may support this species. Species mostly forage over open water, feeding on insects and small fish they catch by raking their feet across the water surface. However, they are also aerial foragers feeding on insects.

This species may have been recorded at the site, however, this could not be confirmed by specialist sub-consultant Glenn Hoye due to the low numbers, and clarity in frequency of the data. In any case, the species is considered to

[8] Lindy Lumsden, Fauna Officer, DSE pers comm. August 2006.

have a high likelihood of occurrence at the site. It is likely to occur in low densities due to the absence of large open waterbodies to forage over. Further bat monitoring would be expected to improve the understanding of bat utilisation and potential impacts at the site.

Grey-headed Flying-fox

Grey-headed Flying Foxes are found in a range of habitats including rainforest, mangroves, paperbark swamps, wet and dry sclerophyll forest and cultivated areas. Grey-headed Flying-foxes usually congregate in large camps during summer, but disperse during winter. The largest numbers within the Victorian population are east of Geelong.

The major food source is eucalypt blossom (as well as other species from the family Myrtaceae) and native fruits from a variety of tree species. They will also feed on cultivated fruit trees.

The site, specifically the shelterbelts containing Eucalypts, is considered to provide habitat for individuals which have dispersed during winter. The site is unlikely to support a large colony of Flying-foxes due to the relatively low abundance of food, when compared with reserves, plantations or orchard and urban areas. The site is on the western limits of the range of the species and there is only one record of this species within a 50 km radius of the site (at Dennington) (Atlas of Victorian Wildlife).

The site does contain preferred habitat for Grey-headed Flying-foxes. Small groups may fly over the site when moving between camps. The impact of this wind farm on the Victorian population of the species is expected to be low.

Southern Bent-wing Bat

The Lake Gillear bat maternity cave is thought to support approximately 10,000-15,000 Southern Bent-wing Bat individuals. It is located approximately 45 km south east of the site. The Thunder Point Blowhole at Warrnambool was the other maternity cave in Victoria, however, it is no longer used by this species due to a partial collapse approximately 5 years ago. The Naracoorte Cave in South Australia located approximately 180 km north-west of the site, supports 100,000 – 200,000 Southern Bent-wing Bats (DEH 2006b).

The distribution of this species is essentially coastal and its foraging areas are thought to be associated with major drainage systems although records have shown that this species may extend into central Victoria around the Ballarat-Castlemaine area (DEH 2006b). Healthy adults may forage up to 40 km from caves, juveniles and pregnant females are likely to forage 20-25 km from these caves[9].

---

[9] Lindy Lumsden, Fauna Officer, DSE pers comm. December 2005.

Southern Bent-wing Bat has a series of wintering and staging caves. Known caves utilised by this species include Byaduk (approximately 40 km north-west of the site), and a small number of caves along the southern coast stretching from Warrnambool to Portland. They may also use temporary caves or sinkholes within the area. There is no suitable wintering or staging caves for this species on the site, however, this species is likely to forage over the site, from wintering or staging caves in the region, particularly during the warmer months of the year.

Preferable foraging areas are above waterbodies, or near overstorey trees which are more likely to contain prey items of moths and insects. The scarcity of these habitats and the ANABAT detector results suggest that the site contains marginal Southern Bent-wing bat habitat. Further monitoring of bats would improve the rigour of these results and provide greater insight into bat utilisation on the site.

As indicated previously low numbers of Southern Bent-wing Bats were recorded at the nearby Macarthur Wind Farm site. In that instance the risk to the species was considered negligible based on the results and experiences at other wind farms (Brett Lane and Associates 2005). Given the site similarities the risks at Hawkesdale are also likely to be negligible. However as part of further summer time surveys associated with the Ryan Corner project, further assessments will be make to gain a better appreciation of the potential risks to Southern Bent-wing Bats at Hawkesdale.

This species is known to fly at variable heights[10]. It may range from a few metres off the ground to many times canopy height (Churchill 1998). This species is at greater risk of collision than other species which would fly at lower heights over open areas.

8.5.5 *Potential Impacts on Threatened Herpetofauna*

The threatened herpetofauna species with a 'moderate' likelihood of occurring at the site are the Swamp Skink, Glossy Grass Skink and Growling Grass Frog. None of these species were recorded at the site during the assessment carried out by ERM.

Swamp Skink

The Swamp Skink is widely distributed throughout the southern portion of Victoria (Wilson and Swan 2003). The preferred habitat includes low-lying wetlands, swamps, salt marshes and heaths bound by vegetative cover. It is unlikely to occur in pasture areas (Wilson & Swan 2003). This species has been recorded at Lake Pertobe, Warrnambool and Merri River, Warrnambool, south of the site (Atlas of Victorian Wildlife).

---

[10] Lindy Lumsden, Fauna Officer, DSE pers comm. August 2006.

The only area considered appropriate for support Swamp Skink is the areas of Austins Creek that contain emergent vegetation.

The wind farm development is not expected to compromise the habitat of this species, and therefore potential impacts on individuals and the species population (if present) are therefore expected to be low.

Glossy Grass Skink

The Glossy Grass Skink is widespread throughout coastal areas and the high plains of Victoria. It may occupy a range of habitats however, preferred habitat includes swamp and lake edges, soaks, marshes and creek lines with dense vegetation, rocks or debris (Wilson and Swan 2003). It is unlikely to occur in open paddock/pasture areas which do not contain scattered rocks or debris.

Areas that may support this species are therefore considered to be Austins Creek and Rail Reserve (located alongside the site boundary). The Glossy Grass Skink has been recorded at two locations near the site. They both are located on the extension of the Rail Reserve south of the site. The nearest is approximately 3.5 km away, and the other is approximately 6 km from the site (DSE 2005d).

The wind farm development is not expected to compromise the habitat of this species, and therefore potential impacts on individuals and the species population (if present) are therefore expected to be low.

Growling Grass Frog

Growling Grass Frog is typically found at or in close proximity to permanent water bodies that contain emergent vegetation (Robinson 1998). A number of records are included in the 50 km radius of the site with a concentration at Tower Hill and two records north-east of Hexham approximately 30 km from the site (Atlas of Victorian Wildlife).

Austins Creek is the only area of the site that meets the habitat requirements of Growling Grass Frog. Moist soaks, depressions or drainage lines that may form near Austins Creek may provide dispersal routes to or from the site for this species.

The wind farm development is not expected to compromise the potential habitat of this species, and therefore potential impacts on individuals and the species population (if present) are therefore expected to be low.

Potential Impacts of Road Access Points

It is considered that the location of the wind turbines and access tracks does not significantly impact on areas of local biological significance provided construction and operational conditions are met. The following mitigation and monitoring measures are proposed.

Mitigation measures to be employed in the pre construction and design phase include:

- Undertake a bat monitoring survey in January and February to determine bat utilisation of the site. The methodology is to be determined in consultation with DSE, but should include a combination of ANABAT detectors on the ground, and some mounted at height. It should be a minimum of 60 census nights.

- As part of the Ryan Corner Wind Farm project, undertake further investigations of the status of Brolgas in the region.

- Prepare and implement an EMP that specifies the required weed management works and any offset works. The plan will include management and monitoring measures consistent with AusWEA's Best Practice Guidelines (2002).

- Undertake supplementary flora surveys in areas where the turbines or tracks are moved by more than 100 m from the current site layout (*Figure 8.5*), particularly in areas adjacent to the Rail Reserve and wetland areas. These surveys should be conducted in spring/summer prior to any clearing or site works commencing.

- Install high visibility temporary fences around Austins Creek (where it contains native vegetation) and around shelterbelts which are to be retained prior to construction. This will prevent access of vehicles into the area, and minimise damage to these areas.

- Where practical, construct the turbine base, access tracks and power cables during the warmer months of the year, when ephemeral wetlands are dry, and reptiles are most active. This will minimise impacts on local fauna, reduce the disturbance to soil and ground flora and minimise sediment mobilisation.

- Where vegetation clearance is necessary, topsoil and vegetation will be stockpiled in open paddock areas, as far away from Austins Creek and the Rail reserve as practicable. Areas for stockpiling topsoil and spoil will be identified in the EMP. Stockpile sites will be maintained to minimise the spread of weeds and pathogens.

- Imported fill (if required) will be weed and pathogen free.

- A wash down area should be established. It will be maintained to prevent the spread of weeds.

- All construction personnel will be briefed on the ecological sensitivities of the site as part of their site induction.

- Vehicles should enter and leave the site via defined routes and utilise constructed roads where ever possible to minimise off site damage and the potential for weed spread. The movement of vehicles/machinery from weed-contaminated to non-contaminated areas should be minimised during the construction phases (particularly when weeds are flowering or in seed).

- Areas of exposed soil should be minimised during the construction phase. Disturbed areas should be revegetated as soon as possible after construction using indigenous species to supplement and enhance local ecological values and to prevent conditions favouring weed establishment.

- Implement appropriate measures to prevent the introduction of invasive/weed species including those listed under the *Catchment and Land Protection Act 1994*.

- Sediment management techniques will be employed to control runoff during and post-construction.

- Trenches or holes should not be left open overnight. Trenches will be filled as soon as practicable after excavation. Any trenches or holes will be thoroughly checked for trapped wildlife in the following morning. Trapped wildlife will be collected and placed in the nearest appropriate habitat.

Mitigation measures to be employed in the operational phase include:

- Implement an EMP that specifies the required revegetation works, weed management works and any offset works identified during the net gain assessment. The plan will include management and monitoring measures consistent with AusWEA's Best Practice Guidelines (2002).

- Equipment used at the site should be weed and pathogen free (as far as practicable).

- Vehicles should enter and leave the site via defined routes and utilise constructed roads where ever possible to minimise off site damage and the potential for weed spread.

- Implement appropriate measures to prevent the introduction of invasive/weed species including those listed under the *Catchment and Land Protection Act 1994*.

- Best practice soils and sediment control will be installed where an erosion risk is identified. Erosion control activities will include the use of sediment fences down slope of exposed soil and stockpiles (particularly near the drainage line and wetland area), the minimisation of soil disturbance and the rapid revegetation of disturbed areas.

- Where night lighting is required, install lights that do not attract insects, bats and birds at night.

- A bird monitoring program will be implemented over a 12 month period from the commencement of operation of the wind farm to determine the incidence of bird collision. This monitoring program should include quarterly surveys of three day duration occurring seasonally to account for breeding and migratory populations. The results of the surveys will be compared to base data. Possible deterrent measures will be identified if necessary. Subject to the findings of the surveys, the monitoring program could be extended for a further 12 months.

- A bat monitoring program will be implemented over a 12 month period from the commencement of operation of the wind farm to determine the incidence of bat collision. This monitoring program should include two yearly surveys over the spring/summer period to account for breeding and migratory populations. The results of the surveys will be compared to base data. Possible deterrent measures will be identified if necessary. Subject to the findings of the surveys, the monitoring program could be extended for a further 12 months.

- Site staff will monitor bird and bat strike monthly during first 12 months of wind farm operation, and quarterly in following 24 months of operation, via carcass searches at base of turbines, to consider operational impacts and requirement for on-going monitoring and/or additional mitigation measures. Assessment to be completed in conjunction with DSE.

- Take any injured birds or bats discovered at the site to a veterinarian or animal shelter.

- Prepare a management plan that minimises the potential for erosion or damage to native vegetation during the decommissioning phase.

8.7 LEGISLATIVE COMPLIANCE

8.7.1 Catchment and Land Protection (CALP) Act (1994)

The *CALP Act* is the principle legislation relating to the management of pest plants and animals in Victoria. Under this Act, landowners have a responsibility to avoid causing or contributing to land degradation, including taking all reasonable steps to conserve soil, protect water resources, eradicate regionally prohibited weeds, prevent the growth and spread of regionally controlled weeds and where possible, eradicate established pest animals, as declared under the Act.

The proponents' obligations under the *CALP Act* will be met through the development of an Environmental Management Plan (EMP) for the site which will detail pest plant and animal management strategies.

8.7.2 *Flora and Fauna Guarantee Act 1988*

A permit from DSE is required to 'take' flora species that are listed under the *FFG Act*. A permit is not required under the *FFG Act* for private land, unless listed species are present and the land is declared 'critical habitat' for the species.

An application for the removal of native vegetation on public land will be referred to DSE.

8.7.3 *Victoria's Native Vegetation Management – A Framework for Action*

Areas containing sufficient native vegetation to qualify as 'remnant vegetation' (in accordance with the DSE 2006b, c, d) were mapped during November 2005 assessments. The only area on the site that qualifies as remnant vegetation is Austins Creek. No vegetation will be removed from this area, demonstrating compliance with the objectives of the step approach to Net Gain (DNRE 2002).

The proposed native (indigenous) vegetation removal is limited to the indigenous trees within the shelterbelts. Victorian Planning Provision 52.17 states that a permit is not required to remove, destroy or lop native vegetation that is within shelterbelts (DSE 2006e).

No offsets are expected to be required for vegetation removal on the site.

8.8 *CONCLUSION*

The majority of the study site contains exotic grass species over modified pasture and is currently grazed by cattle and sheep. No threatened flora or fauna species were recorded during the field assessment. However, potential habitat is present where remnant indigenous vegetation occurs at Austins Creek. Five threatened species of flora have a low-moderate (or higher) likelihood of occurrence on this area of the site. These include Western Water-starwort, Curly Sedge, Swamp Fireweed, Pretty Hill Leek-orchid and Basalt Leek-orchid. In addition, several species of frog and reptiles may also inhabit this area. These include Growling Grass Frog, Swamp Skink and Glossy Grass Skink.

The Rail Reserve which dissects the site (but does not form part of the site) is also considered an area of biological value (DNRE 2001b).

No native vegetation will be removed from Austins Creek or the Rail Reserve, as the turbines and other infrastructure is located in areas of open paddock/pasture. Therefore, the potential impact on terrestrial flora and fauna values in these areas (when managed in accordance with an EMP) is expected to be low.

Construction of the site substation and ten wind turbines will involve the removal of seven shelterbelts, including three which contain Australian native and indigenous trees and shrubs. GEA/TMEA propose to offset this vegetation removal in consultation with Moyne Shire and DSE to determine an appropriate number and location of plantings.

GEA/TMEA has committed to a series of mitigation measures and additional works to avoid/manage potential impacts such as flora removal, habitat damage, alteration to drainage, introduction of weeds or soil disturbance. Efforts to mitigate the impact of the proposed development on flora and fauna include:

- timing construction activities to minimise the impacts of flora and fauna and the likelihood of erosion at the site;
- avoidance of biological features such as wetland areas and road reserve areas, including a buffer zone around the wetland area;
- micro-siting turbines to locations dominated by agricultural pasture (i.e. areas with little biological value);
- development of an Environmental Management Plan (EMP) for the site which details pest plant and animal management, appropriate revegetation strategies and erosion and sediment control measures;
- best practice management in relation to flora and fauna at the site (including threatened species which may potentially occur on site) during both the construction and operation phases; and
- best practice soil and sediment control to minimise erosion and impacts on drainage at the site.

Appendix 4: Documents referred to in pre-construction surveys: A bat survey carried out by Greg Richards and BL&A in 2007.

1. BAT SURVEY

1.1. Introduction

In a previous investigation, Greg Richards and Brett Lane and Associates surveyed the bat fauna on the Hawkesdale 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 site. The study recorded ten species of bats, seven of which were common and secure bat species, one of which was widespread but uncommon and two of which were threatened species. The bat species of concern on site were the Southern Bentwing Bat and the Large-footed Myotis. The first bat is considered Critically Endangered under the EPBC Act, threatened under the FFG Act and endangered on the DSE Advisory List of Threatened Fauna in Victoria (DSE 2007). The second bat is considered Near-threatened on the DSE Advisory List but is not listed on the FFG Act.

The current bat survey was intended to complement earlier findings and to emphasis the status and use of the wind farm by the two above mentioned threatened bat species. The work was carried out in two stages; in the first stage, bats were recorded from four locations within the wind farm site and in the second stage records were made from additional five locations, bringing the total number of sites to nine. The second stage was carried out as a result of a request from the *Department of Sustainability and Environment* to expand on the sites of bat recordings.

The first stage of the survey was undertaken over the period 5th until 12th October, 2009, in which the survey covered seven nights of recording from four sites. The second stage was carried out over three periods, 9th – 16th, 16th – 23rd February, and 20 – 26th April 2010, also covering seven nights for each period from five sites. The total time of recording from the two stages amounted to 1260 hours of recording or 105 detector nights.

The design of the recording times was intended to account for the seasonal differences in composition and activity of bats over the wind farm site; with particular emphasis on the activity and movement of the threatened Southern Bentwing Bat.

The nearest maternity cave of the Southern Bentwing Bat to the wind farm site is the Starlight Cave near Warrnambool (Vic.). Bats spend their breeding season at the cave then migrate to their wintering caves at Byaduk and Mt Eccles. During their migration, some of the population may pass over the wind farm; hence the above timing of records was designed to account for such movements (for more details see below).

The following sections describe the methods used and present the results of the bat survey.

1.2. Methods

Automated Anabat® (Titley Electronics, Ballina, NSW) bat detectors that record the species-specific echolocation calls of free-flying bats were used at four sampling points that were representative of the habitats near wind turbine locations on the proposed wind farm site. The detectors were programmed to commence operation approximately 30 minutes before dusk, and to cease approximately 30 minutes after dawn.

The Anabat unit was connected to a Compact Flash Storage ZCAIM unit that recorded each bat echolocation call, along with the time and date of each call, on a compact flash card.

Calls from the units were downloaded and sent to Greg Richards (Greg Richards & Associates, Canberra, ACT) and Greg Ford (Consultant Ecologist, Balance Environmental, Toowoomba, Qld) for identification. The files from the recording sites were viewed in Anabat software (Chris Corben, USA), which provides a sonogram display of frequency versus time. Call identification was based on a key developed by comparing the characteristics of bat search calls within reference calls from known species recorded across Australia. Identification is largely based on changes to frequency patterns over time, especially as the characteristic frequency changes. Only those recordings that contained at least two definite and discrete calls were classified as bat calls. For most species, a call sequence of several seconds in duration is required before identification can be made confidently.

The identification of echolocation calls from microbats in south-eastern Australia is facilitated by the fact that many calls are species-specific. However, not all species can be consistently or reliably identified. There is a large overlap in the call characteristics of some species and many calls are attributable only to species "complexes" and not to single species.

A significant limitation in the use of this technique is that it is not possible to census bats accurately. That is, the Anabat unit may record 10 calls of a particular species but it is not known if this represents 10 individuals or one individual flying past 10 times. Therefore, it is not possible to determine utilisation rates as it is for birds.

1.2.1. Timing and location of the survey

The bat survey was conducted in two stages as follows:

- Stage 1: Recording of bats was carried out over seven nights between 5th and 12th October 2009 (thereafter referred to as period 1). During this period, four Anabat systems operated concurrently from four sites (1 – 4).

- Stage 2: Recording of bats was carried out over three lots of seven nights; the first between 9th and 16th February (period 2), the second between 16th and 23rd February (period 3), and the third period between the 20th and 27th April 2010 (period 4). During periods 2 and 3, four Anabat systems operated concurrently from four sites and in period 4, three Anabat systems recorded from three sites (period 2: site 5A, B, C, 6; period 3: sites 5D, 7, 8, 9; and period 4: sites 5B, 7 and 9).

For both stages, nine sampling points were selected to represent habitat where turbines are proposed to be located (see Figure 4). The location and characteristics of the recording sites are described below.

Site A1: Located close to a line of old pines and some eucalypt trees (Sugar Gum) and overlooking an open paddock through which Austin Creek runs. The creek was nearly dry.

Site A2: Located in an area similar to that of site A1, where the Anabat receiver was overlooking an open paddock and a small expansion of Austin Creek with water and native vegetation. The water pond was about 200 m from the Anabat site.

Site A3: located on a deserted railway line close to a line of old pines and overlooking large open paddock.

Site A4: Located on the same railway line, but at a place with some Blackwood and some rain accumulated ponds.

Site 5: The wind mast was located in almost a central position within the wind farm site. It is located in an open grazing field without trees in the surroundings. On the wind mast the following heights were used for recordings:

- **5A**: at 50 m high facing up (that is the receiver facing up)
- **5B**: at 50 m high facing down
- **5C**: On ground
- **5D**: at 20 m high facing up

Site 6: Located in the southern section of the wind farm in an open paddock close to large and old pines.

Site 7: Located in the northern section of the wind farm close to a line of young pines overlooking large grazing paddock.

Site 8: this point was set up along a line of mature eucalypt trees (Sugar Gum) and overlooking a grazing paddock; this site is very similar to site no 1.

Site 9: Located on the south-eastern section of the wind farm side (southern side of the deserted railway line) on the side of line of old and large pines overlooking grazing paddock.

1.3. Results of the survey

1.3.1. Species Recorded

A total of 11 bat species were recorded during the four surveys from the nine recording sites. Ten species were recorded during the October survey, and an additional species was added during the February surveys. These are listed in Table 6, together with their conservation significance, period and sites at which they were recorded.

Of the 11 species recorded at the wind farm site; eight were widespread, common and secured species, two were uncommon but widespread (Inland Broad-nosed Bat, Eastern falsistrelle) and one species, the Common Bentwing Bat is considered as threatened species (Menkhorst 1995).

In the preliminary survey carried out during February 2007 (Richards 2007), ten species were recorded, including eight common and widespread bats and two threatened species (Table 1). The same species were again recorded to occur in the study area during the current investigation, except for the absence of the threatened Large-footed Myotis (*Myotis macropus*). The latter is a unique bat that forages over water, and given that hardly any open water bodies are currently available at Hawkesdale wind farm site, it is not unusual that it would no longer be found in wind farm site.

Table 1: Bat species identified from calls recorded over a period of 11 consecutive nights at the proposed Hawkesdale Wind Farm in February 2007; species are ranked in order of relative abundance (Table reproduced from Richards 2007).

COMMON NAME	SPECIES	TOTAL CALLS
Southern Freetail Bat	*Mormopterus* sp. 4	807
Southern Forest Bat	*Vespadelus regulus*	649
Little Forest Bat	*Vespadelus vulturnus*	307
Longeared Bats	*Nyctophilus* spp.	100
Gould's Wattled Bat	*Chalinolobus gouldii*	61
White-striped Freetail bat	*Tadarida australis*	56
Chocolate Wattled Bat	*Chalinolobus morio*	47
Southern Bentwing Bat	*Miniopterus orianae bassanii*	22
Eastern Falsistrelle	*Falsistrellus tasmaniensis*	5
Large-footed Myotis	*Myotis macropus*	3

The common species of bats were recorded from various sections of the wind farm and were not particularly restricted to certain habitat within the wind farm site although there was a tendency for the bats to be more concentrated in treed areas (Table 6); however, the wind farm site was fairly uniform in its habitat except for the deserted railway line which contained few native vegetation and old pines. The uncommon Inland Broad-nosed bat was recorded only from three sites and the Eastern falsistrelle from four of the nine surveyed sites.

Long-eared bats are difficult to distinguish to species level, and hence are grouped under their genus name. The species that are likely to occur at the site are *Nyctophilus geoffroyi* and *N. gouldi*. The Southern Freetail Bat is currently under taxonomic revision and a specific name is as yet not available.

The threatened Common Bentwing Bat comprises three sub-species: The northern Australian form (subspecies *Miniopterus orianae orianae*); an eastern Australia form known as the Eastern Bentwing Bat that occurs from Cape York to central Victoria (subspecies *M. o. oceanensis*); and a form known as the Southern (Common) Bentwing Bat that occurs in south western Victoria and south eastern South Australia (subspecies *M. o. bassanii*).

The last subspecies is listed as threatened by DSE (2007). The subspecies is also listed on the Victorian *Flora and Fauna Guarantee Act 1988* and considered as conservation dependant on the EPBC Act nationally threatened species (see below for more details).

In addition to bat species which were positively identified, there were records of other calls that could not reliably be identified to a certain species, mainly due to partial or complete overlap of their call frequencies. In the current survey, there were records of at least five species complexes, such as Southern Freetail Bat species 2/4, Chocolate Wattle Bat/Southern Freetail Bat, Chocolate Wattle Bat/ Inland Broad-nosed Bat, Gould's Wattle bat/Little Forest Bat and Southern Bentwing Bat/forest bat species. Species complexes were not used in analysis of bat activity.

Table 2: Species of bats recorded during the impact assessment of the Hawkesdale Wind Farm site. * October survey was carried out between 5–11, 2009; February surveys between 9–16 and 16–23; and April survey between 20–27, 2010.

Common name	Scientific name	Date Recorded*	Sites of records	Conservation status
Chocolate Wattle Bat	*Chalinolobus gouldii*	Oct., Feb., April	1, 2, 3, 4, 5, 6, 7, 8, 9	common, secured
Southern Forest Bat	*Vespadelus regulus*	Oct., Feb.	1, 2, 3, 4, 5, 6, 7, 8, 9	common, secured
Large Forest Bat	*Vespadelus darlingtoni*	Oct., Feb., April	1, 2, 3, 4, 5, 6, 7, 8, 9	common, secured
Little Forest Bat	*Vespadelus vulturnus*	Oct., Feb.	1, 2, 3, 4, 5, 6, 7, 8, 9	common, secured
Common Bentwing Bat	*Miniopterus orianae bassanii*	Oct., Feb., April	1, 4, 5, 6, 7, 8, 9	**Threatened species**
Long-eared Bat	*Nyctophilus* sp/spp	Oct., Feb., April	1, 2, 3, 4, 5, 6, 7, 9	common, secured
White-striped Freetail Bat	*Austronoumus australis*	Oct., Feb. April	2, 4, 5, 6, 7, 8, 9	common, secured
Gould's Wattle Bat	*Chalinolobus morio*	Oct., Feb. April	3, 4, 6, 7, 8, 9	common, secured
Southern Freetail Bat	*Mormopterus* sp/spp	Oct., Feb. April	1, 2, 3, 4, 6, 8, 9	common, secured
Inland Broad-nosed Bat	*Scotorepens balstoni*	Oct., Feb. April	2, 7, 9	Uncommon, widespread
Eastern falsistrelle	*Falsistrellus tasmaniensis*	Oct., April	6, 7, 8, 9	Uncommon, widespread

1.3.2. Bat Activity

Bat activity at Hawkesdale Wind Farm compares well with other wind farms in similar settings, with the main activity for most part of the year originating from common and widespread species. Bat activity during the four periods of recording varied between the different species and between the recording sites. Although records of bat calls cannot be taken as measure of absolute activity or abundance, it can be used in a very general sense as reflecting on the bats activity and abundance. Below is a summary of findings at each of the four periods of recording:

Period 1: October 5–11, 2009

The number of calls recorded over the seven nights of the survey varied between a total of 143 calls at site 3 to 1922 calls at site 4 (table 2). Site 4 attracted most activity (61% of all calls) probably because of the presence of more native species of trees and small rain accumulated water pools compared to sites 2 and 3 where there were mainly pines trees surrounding the recording location. Site 1 was similar to 2 and 3 but included a line of mature Sugar Gums near its recording site.

The ten species of bats varied in their relative activity as measured by number of calls recorded. The Large Forest Bat was by far the most common bat on the wind farm site with its calls constituting about 60% of all bat calls. The next common species were the Southern Freetail Bat (14.5%), Southern Forest Bat (12.6%) and Long-eared Bats (6.4%). The

remaining species were less abundant and their total calls over the seven nights of recording varied between 1 and 95 calls (0.03–3.0%).

The number of the threatened Common Bentwing Bat calls was very low compared to the calls of other bats; calls which were definitely identified to belong to this species totalled 6 calls over the seven nights of recording (average 0.9 calls per night), indicating that the number of these bats using the wind farm site could not be more than a maximum of six individuals over the seven nights of recording (6 calls may indicate a minimum of one individual bat passing six times in front of the recording Anabat receiver or a maximum of six individuals). In addition to above, there were a total of 35 calls (5calls/night) that were inseparable between the bentwing and the forest bats. The number of these mixed calls was also low indicating that only few individuals of the Bentwing bat could not be identified. Calls of the threatened species were recorded from two sites only, sites 1 and 4 (table 6).

Calls of the uncommon Inland broad-nosed Bat were insignificant and the species can hardly be considered as part of the bat fauna of the Hawkesdale wind farm during this period of the year.

Table 3: Bat activity at Hawkesdale Wind Farm during the period 5–11 October 2009 (period 1).

Species	No. calls at sites (n=7 nights)				Total calls	Average/ night
	site 1	site 2	site 3	site 4		
Chocolate Wattle Bat	6	9	5	11	31	4.4
Southern Forest Bat	348	12	1	36	397	56.7
Large Forest Bat	454	17	101	1296	1868	266.9
Little Forest Bat	8	1	7	79	95	13.6
Southern Bentwing Bat	3	0	0	3	6	0.9
Long-eared Bat	28	27	11	134	200	28.6
White-striped Freetail Bat	0	1	0	1	2	0.3
Gould's Wattle Bat	0	0	15	22	37	5.3
Southern Freetail Bat	1	125	2	328	456	65.1
Inland Broad-nosed Bat	0	1	0	0	1	0.1
Total calls	867	196	143	1922	3128	446.9
Total files	998	240	202	2134	3574	510.6

Period 2: February 9–16, 2010

The number of calls recorded varied between a total of 21 calls at site 5 to 226 calls at site 6 (table 3). Site 6 attracted most activity (91% of all calls) probably because of the presence of native trees and old pines (potential roosting areas) close to the recording spot compared to site 5 which was in middle of grazing paddocks lacking any trees in its surrounding area. Recording at site 5 was made by utilizing the wind mast where the Anabat receivers were set up at different heights.

During February, the eleven species of bats varied in their relative activity as measured by number of calls recorded. The Large Forest Bat was the most common bat on the wind farm site with its calls constituting about 39% of all bat calls followed by the Southern Bentwing

Bat with its calls constituting 30% of all bat calls. The remaining species were less abundant and their total calls over the seven nights of recording varied between 2 and 18 calls (0.8–7.0%).

The number of the threatened Common Bentwing Bat calls was relatively high compared to the calls of other bats; calls which were definitely identified to belong to this species totalled 74 calls over the seven nights of recording (average 10.6 calls per night) and almost all calls were recorded at site 6, except for three calls recorded at the ground level near the wind mast. The activity of the threatened Southern Bentwing Bat was much higher during this time of year compared to activity during the October survey.

Calls of the uncommon Eastern falsistrelle were insignificant and the species can hardly be considered as part of the bat fauna of the Hawkesdale wind farm at this time of the year. The Inland broad-nosed Bat was not recorded during the February survey.

Table 4: Bat activity at Hawkesdale Wind Farm during the period 9–16 February 2010 (period 2).

Species	No. calls at sites (7 nights)				Total calls	Average/ night
	site 5A-50 m up	site 5B-50 m down	site 5C-ground	site 6		
Chocolate Wattle Bat	0	0	0	2	2	0.3
Southern Forest Bat	0	0	0	18	18	2.6
Large Forest Bat	0	0	1	96	97	13.9
Little Forest Bat	1	0	0	15	16	2.3
Southern Bentwing Bat	0	0	3	71	74	10.6
Long-eared Bat	0	0	1	4	5	0.7
White-striped Freetail Bat	10	3	2	2	17	2.4
Gould's Wattle Bat	0	0	0	7	7	1.0
Southern Freetail Bat	0	0	0	11	11	1.6
Inland Broad-nosed Bat	0	0	0	0	0	0.0
Eastern falsistrelle	0	0	0	2	2	0.3
Total calls	11	3	7	226	247	35.3
Total files	13	5	12	666	696	99.4

Period 3: February 16 – 23, 2010

The number of calls recorded over the seven nights of the survey varied between a total of one calls at site 5 (wind mast) to 511 calls at site 9 (table 4). Site 9 attracted most activity (52% of all calls) probably because of the presence of large and old pine trees that can provide shelter and roosting site for the bats compared to sites 7 and 8. Site 5 (wind mast) did not attract any bat activity being in the middle of a grazing paddock without any trees.

The 11 species of bats varied in their relative activity as measured by number of calls recorded. The Southern Bentwing Bat was the most common bat on the wind farm site with its calls constituting about 66.5% of all bat calls, followed by the Large Forest Bat with its

calls constituting 51% of all bat calls. The remaining species were less abundant and their total calls over the seven nights of recording varied between 10 and 84 calls (2–16%).

The number of the threatened Common Bentwing Bat calls was again relatively high compared to the calls of other bats during this period of recording; calls which were definitely identified to belong to this species totalled 340 calls over the seven nights of recording (average 48.6 calls per night) and almost all calls (79%) were recorded at site 9. The activity of the threatened Southern Bentwing Bat was much higher during this time of year compared to activity during both the early February 2010 and October 2009 surveys.

Calls of the uncommon Inland broad-nosed Bat and Eastern falsistrelle were higher than before and were at a level similar to other common species.

Table 5: Bat activity at Hawkesdale Wind Farm during the period 16–23 February 2010 (period 3).

Species	No. calls at sites (7 nights)				Total calls	Average/ night
	site 5D-20 m up	Site 7	Site 8	site 9		
Chocolate Wattle Bat	0	15	31	38	84	12.0
Southern Forest Bat	0	4	45	11	60	8.6
Large Forest Bat	0	16	223	22	261	37.3
Little Forest Bat	0	2	2	38	42	6.0
Southern Bentwing Bat	1	25	46	268	340	48.6
Long-eared Bat	0	3	0	34	37	5.3
White-striped Freetail Bat	0	2	3	17	22	3.1
Gould's Wattle Bat	0	5	2	42	49	7.0
Southern Freetail Bat	0	2	9	28	39	5.6
Inland Broad-nosed Bat	0	2	0	8	10	1.4
Eastern falsistrelle	0	0	31	5	36	5.1
Total calls	1	76	390	511	978	139.7
Total files	4	253	1439	1168	2864	409.1

April 20 –26, 2010

The number of calls recorded over the seven nights of the survey varied between a total of 11 calls at site 5D (wind mast) to 93 calls at site 9 (table 5). Site 7 and 9 attracted most of the activity (43.8% and 50.2% of all calls, respectively) probably because of the presence of large trees that can provide shelter and roosting site for the bats compared to sites 5B. Site 5B (wind mast) did not attract much bat activity being in the middle of a grazing paddock without any trees.

The nine species recorded to occur during this period varied in their relative activity as measured by number of calls recorded. The Chocolate Wattle Bat was the most common bat on the wind farm site with its calls constituting about 22.2% of all bat calls, followed by the White-striped Freetail Bat and Southern Freetail Bat, with calls from both constituting 17.3%

each of all bat calls. The remaining species were less abundant and their total calls over the seven nights of recording varied between 3 and 27 calls (1.6–14.5%).

The number of the threatened Common Bentwing Bat calls dropped significantly in this period compared to the previous periods of recording; calls which were definitely identified to belong to this species totalled 27 calls over the seven nights of recording (average 3.9 calls per night) and calls were almost equally recorded between sites 7 and 9. The calls of the threatened bat was recorded on three out of the seven nights of recording at site 5, four nights at site 7 and 2 nights at site 9.

Calls of the uncommon Inland broad-nosed Bat and Eastern falsistrelle were similar to that of the previous period and generally were at low levels compared to the other common bat species.

Table 6: Bat activity at Hawkesdale Wind Farm during the period 20–27 April 2010 (period 4).

Species	No. calls at sites (7 nights)			Total Calls	Average/ night
	site 5C-ground	site 7	site 9		
Chocolate Wattle Bat	1	30	10	41	5.9
Southern Forest Bat				0	0.0
Large Forest Bat	0	15	1	16	2.3
Little Forest Bat				0	0.0
Southern Bentwing Bat	3	10	14	27	3.9
Long-eared Bat	3	4	8	15	2.1
White-striped Freetail Bat	4	1	27	32	4.6
Gould's Wattle Bat	0	10	2	12	1.7
Southern Freetail Bat	0	3	29	32	4.6
Inland Broad-nosed Bat	0	6	1	7	1.0
Eastern falsistrelle	0	2	1	3	0.4
Total calls	11	81	93	185	26.4
Total files	28	328	192	548	78.3

Height distribution of bats

The height distribution of bats was studies by placing the Anabat receivers at various heights utilizing the 80 m high wind mast for this purpose. Receivers were placed at the following heights:

- At 50 m high with the receiver facing up;
- At 50 m high with the receiver facing down;
- At 20 m high with receiver facing up; and
- On the ground beneath the wind mast.

The first two heights and that on the ground were recorded concurrently during period 2 (9–16 February, 2010) and the 20 m high recording was carried out in period 3 (16–23 February, 2010). Bat calls was again measured on ground level in Period 4.

The results showed that of the eleven species utilizing the wind farm site, the White-striped Freetail Bat was almost the only species flying at heights over 50 m over ground (Table 6B&C). Experience from other wind farms confirm that this species was also the species recorded at rotor swept area heights (RSA heights), i.e. over 40 m (Brett Lane & Associates; unpubl. data).

The threatened Southern Bentwing Bat was not recoded flying at heights above 50 m; there was only one record of the bat from a height over 20 m but lower than 50 m. Bentwing bats usually fly at tree canopy heights in treed area and within six metres of ground in more open grassland areas (Churchill 2008).

Summary of findings

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 part of the year were common widespread species that are normally found to dominate the bat fauna in wind farms of similar settings (Brett Lane & Associates, Unpubl. data).

Table 6 shows that bat activity in October (as measured by the number of calls) was much higher than the activity in February. It was dominated by the Large Forest Bat (possible roost site near recording area) and the Southern Forest Bat. Both of these species and the remaining bats recorded were common and widespread species. In October hardly any threatened species were recorded utilizing the wind farm site.

In the February and April records, bat calls from the three periods were much less than that of October and originated from common and widespread species; however, an unexpected progressive surge in the numbers of the threatened Southern Bentwing bat was noticed in February. This increase in the utilization rate of the threatened bat is in fact coinciding with the time of the fall migration of these bats from their maternity caves at Warrnambool (Starlight Cave) to their wintering caves at Byaduk and Mt Eccles (for more details see below).

Table 7: Summary of calls recorded at the nine sites. The threatened species is the Southern Bentwing Bat. * Total for threatened species; ** Average for threatened species. Records made over seven nights for each of the four periods of recording.

Recording Sites	Period of recording	Total No. of Calls/site	Average / night	Total calls/ period	Average / night
site 1	Period (1)	867	123.9	3128	446.9
site 2		196	28.0		
site 3		143	20.4		
site 4		1922	274.6		
site 5	Period (2)	22	3.1	248	35.4

Recording Sites	Period of recording	Total No. of Calls/site	Average / night	Total calls/ period	Average / night
site 6		226	32.3		
site 7	Period (3)	76	10.9	977	139.6
site 8		390	55.7		
site 9		511	73.0		
Site 5B	Period (4)	11	1.6	185	26.4
Site 7B		81	11.6		
Site 9B		93	13.3		

(1) Recording period 5–11 October 2009; (2) 9–16 February; (3) 16–23 February; 20 – 27 April, 2010.
Note: Records were made from site 5 on both the second and third period of recording but period three was not included in table since only one call was recorded for site 5 (wind mast @ 20 m high).

1.3.3. The status of the Southern Bentwing Bat

The Southern Bentwing Bat occurs widely across western and south-western Victoria. Its local distribution largely determined by the availability of caves, mine shafts or tunnels suitable as roosting sites. This bat 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. In Victoria, They usually forage over forested areas but also occur widely on the sparsely-treed Volcanic Plain (Menkhorst and Lumsden 1995; Richards 2006).

In spring and summer, they congregate in "maternity caves" where the females give birth to and raise their young. In autumn and winter, after the young are weaned, these bats disperse over a large region of south-eastern Australia. Small numbers of this species have been found roosting during the day in inland and coastal cliff caves, as well as disused mine shafts (Duncan *et al*. 1999; Menkhorst 1995).

The nearest maternity cave of the Southern Bentwing Bat to the Hawkesdale wind farm site is the Starlight Cave near Warrnambool (Vic.). In 2007, it was estimated that approximately 10,000 adult and 4000 young bats occupied the Starlight Cave (Richards 2007). Bats recorded at the wind farm site most probably breed in these caves and visit the wind farm site for only short period during spring and autumn migrations towards and back from their winter roosting caves at Byaduk and Mt Eccles caves.

The Hawkesdale Wind Farm site lies to the north of the direct line of movements between the maternity and wintering caves of the Southern Bentwing Bat. It is approximately 34 km from Starlight Cave and 30 km from Byaduk and Mt Eccles caves. It is not known whether the Hawkesdale Wind Farm would be on a migration path, but it is likely, as mentioned above, that part of the migrating bats do actually pass through the wind farm site.

The Southern bentwing Bats usually move and congregate at the maternity Caves as early as August, and by October, almost all the regional population of the bat would be at the cave. Breeding take place during October and November and in Starlight cave in December. Bats remain at the maternity cave and start dispersing in April (Churchill 2008). This life cycle

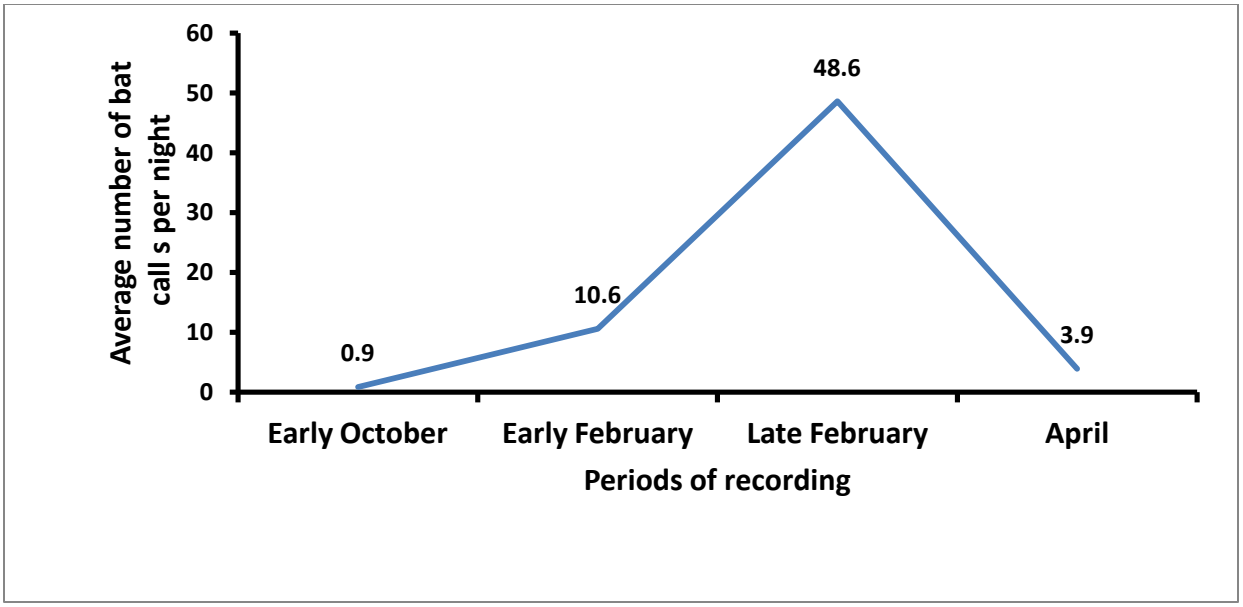
pattern is not fully supported by field evidence; Richards (2007) studied bat movements between Starlight Cave and the wintering caves at Byaduk and Mt. Eccles and found that movements of bats out of the maternity cave commence as early as February and continue through April; he also found that bats usually follow large patches of remnant vegetation in their movements. Bats did not migrate in mass, but bats dispersed gradually in small groups.

At Hawkesdale Wind Farm, the number of the Southern Bentwing Bat fluctuated widely between the four periods of the survey (Figure ?). While numbers were very low in October 2009 (6 calls in seven nights of recording, or 0.9 calls/night; see table ?), they increased to approximately 74 calls over the seven nights or 10.4 calls per night in early February (Table ?). The numbers further increased to a maximum of 340 calls or 48.6 calls per night in late February (table ?), and then dropped sharply to 27 calls over the seven nights of recording or 3.9 calls per night during April 2010 (Table).

During the serge of the Southern Bentwing Bat numbers in February, the bulk of the calls were made from recording sites that contained old and mature trees, particularly old pines, and only few calls were made from open treeless site such as site 5. As mentioned above, these bats prefer foraging in treed areas or areas of combined vegetation and open wetlands.

The pattern of change in the threatened bat species seems to coincide with the pattern of movements of these bats between their maternity and wintering caves. Richards (2007) found that bats commence dispersal from Starlight Cave in early February and continue through March and part of early April. He also found that the bulk of bats travelled over remnant vegetation patches south of the direct line between Starlight cave and the wintering caves at Byaduk and Mt. Eccles caves.

Figure 1: The relative abundance of bats during the four recording periods at Hawkesdale Wind farm.



Records of the threatened bats at Hawkesdale Wind Farm indicated that part of the migrating population also fly across terrain to the north of the direct migratory line, including sections of the vegetated parts of the wind farm site.

For the return journey from the wintering sites towards the Starlight cave maternity cave, which takes place mostly during October, no serge in numbers of the threatened bats were noticed passing through the wind farm site. In fact bat numbers were the lowest compared to the other recording periods (Figure).

The above findings indicated that the Threatened Southern Bentwing Bat is likely to use the wind farm site during the autumn migration and that part of the bat population would continually forage in the wind farm site while passing through. The period of the most intensive use of the wind farm site seems to be during late February and early March depending on suitable weather conditions. This period may cover up to four weeks each year.

Based on above, a carefully planned mitigation measure should be adopted to minimise impacts on the threatened Southern Bentwing Bat.

Duncan, A., Baker, G.B and Montgomery, N. (1999) *The Action Plan for Australian Bats*. Department of Environment and Heritage, Canberra.

Appendix 5: Documents referred to in pre-construction surveys: 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).

HAWKESDALE WIND FARM

PRE-CONSTRUCTION BIRD AND BAT SURVEYS

Union Fenosa Wind Australia Pty. Ltd.

BL&A Brett Lane & Associates Pty. Ltd.
Ecological Research & Management
25 Burwood Road, Hawthorn, Vic. 3122
P O Box 74, Richmond, Vic. 3121
Ph. (03) 9815 2111
Fax. (03) 9815 2685

June 2010

Report No. 9067 (3.2)

CONTENTS

1. INTRODUCTION 1
2. SITE DESCRIPTION 2
3. BROLGA AND OTHER THREATENED WATERBIRDS SURVEY 3
3.1. Introduction 3
3.2. Existing information and survey methods 3
3.2.1. Source of information 3
3.3. Ecology of the threatened birds 3
3.3.1. Brolga 3
3.3.2. Whiskered Tern 4
3.3.3. Australian Shoveler 5
3.3.4. Hardhead 5
3.3.5. Magpie Goose 5
3.3.6. Eastern Great Egret 6
3.3.7. Latham's Snipe 6
3.4. Previous records 7
3.5. Field Methodology 7
3.6. Results of the survey 8
3.6.1. Habitat assessment 8
3.6.2. Sightings of threatened wetland birds 8
3.6.3. Potential Impacts on the Brolga and other threatened waterbirds 8
4. BIRD UTILISATION SURVEY 10
4.1. Methods 10
4.1.1. Fixed-point bird count method 10
4.1.2. Locations of survey points 11
4.1.3. Incidental observations 11
4.1.4. Limitations 11
4.2. Results of the bird utilisation survey 13
4.2.1. Representativeness of the survey 13
4.2.2. Bird Observations 14
4.2.3. Flight height 15
4.2.4. Birds of Prey (Raptors) 16
4.2.5. Waterbirds 16

4.3. Conclusions 17
5. BAT SURVEY 24
5.1. Introduction 24
5.2. Methods 25
5.2.1. Timing and location of the survey 25
5.3. Results of the survey 28
5.3.1. Species Recorded 28
5.3.2. Bat Activity 30
5.3.3. Summary of findings 35
5.4. Summary of results for the Southern Bent-wing Bat 36
6. REFERENCES 39

TABLES

Table 1: Times of day when points* were counted during each survey day. 10

Table 2: Summary of numbers of individual birds and their height distribution seen on surveys points at the Hawkesdale Wind farm site. A=below rotor swept area (RSA) height (30 m); B= at RSA height (30-140 m); C= above RSA height (>140 m). 18

Table 3: The number of birds counted at each of the survey points at Hawkesdale Wind farm. A=below rotor swept area (RSA) height (30 m); B= at RSA height (30-140 m); C= above RSA height (>140 m). 21

Table 4: Species flying at rotor swept area height (B) during bird utilisation surveys at the Hawkesdale Wind farm. 22

Table 5: Numbers and importance of birds of prey and waterbirds at the Hawkesdale Wind farm. A, B and C as in Table 2. 23

Table 6: Bat species identified from calls recorded over a period of 11 consecutive nights at the proposed Hawkesdale Wind farm in February 2007; species are ranked in order of relative abundance (Table reproduced from Richards 2007a). 28

Table 7: Species of bats recorded during the impact assessment of the Hawkesdale Wind farm site 29

Table 8: Bat activity at Hawkesdale Wind farm during the period 5th–11th October 2009 (period 1). 30

Table 9: Bat activity at Hawkesdale Wind farm during the period 9th – 16th February 2010 (period 2). 31

Table 10: Bat activity at Hawkesdale Wind farm during the period 16th – 23th February 2010 (period 3). 32

Table 11: Bat activity at Hawkesdale Wind farm during the period 20th – 27th April 2010 (period 4). 33

Table 12: Summary of calls recorded at the nine sites of Hawkesdale Wind farm. Records made over seven nights for each of the four periods of recording.. 35

FIGURES

Figure 1: Map of the Hawkesdale Wind farm site showing the approximate location of bird utilisation survey impact points. 12

Figure 2: The cumulative number of species of birds recorded during consecutive counts at the observation points on the Hawkesdale Wind farm. 13

Figure 4: Map of the Hawkesdale Wind farm site showing the approximate location of the bat survey recording points. 27

Figure 4: The relative abundance of bats during the four recording periods at Hawkesdale wind farm during October 2009 to April 2010. 38

APPENDICES

Appendix 1: Bird and bat species that occur or are likely to occur in the Hawkesdale Wind farm study area based on AVW records and field observations.. 43

1. INTRODUCTION

The Minister for Planning has issued a planning permit for the construction of a wind farm at Hawkesdale (Moyne Planning Scheme, Permit Number: 20060221). Under Condition 17 of this permit, a targeted assessment must be undertaken, to the satisfaction of the Minister for Planning, of listed threatened bird and bat species likely to utilise the site. This must be completed prior to the commissioning of the last turbine in the wind farm.

Brett Lane and Associates Pty. Ltd. (BL&A) was engaged by Union Fenosa Wind Australia Pty. Ltd., to undertake the targeted assessment of the wind farm. Three assessments were therefore completed between October 2009 and April 2010. These included:

- Brolga and other threatened waterbirds survey (Section 3);
- Bird Utilisation Survey (section 4); and
- Threatened bat survey (section 5).

Methods used for these surveys were generally in accordance with 'Wind Farms and Birds: Interim Standards for Risk Assessment' (AusWEA 2005), and were carried out in consultation with the Department of Sustainability and Environment (DSE), consistent with the risk assessment methodology developed in response to Condition 16 of the project planning permit.

The methods adopted were also undertaken consistent with feedback and comments from the Department of Sustainability and Environment, specifically the following:

- Email comments by Richard Hill on 1st October 2009; and
- Further written comments on bats on 19th November 2009.

The assessments were completed by a team from BL&A, comprising Khalid Al-Dabbagh (Ecologist and Ornithologist), and Brett Lane (Principal Consultant).

2. SITE DESCRIPTION

The site lies in south-western Victoria, immediately south of Hawkesdale Township and approximately 50 kilometres north of Port Fairy. The proposed wind farm site is approximately 2000 hectares in area and would include a total of 31 two-megawatt wind turbines.

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.

The study area comprised a combination of flat areas and low, undulating hills and suppored grazing paddocks with various exotic grasses. The vegetation in the study area was therefore highly modified and disturbed, supporting very little native vegetation. There were some eucalypt trees, most of which are not indigenous growing within lines of pines used as windbreaks.

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 had been planted along most of its length. with the line also supported a small, linear remnant of native trees, mostly Blackwood (*Acacia melanoxylon*).

The wind farm site was also traversed by Austin's Creek, which runs in a north to south-westerly direction. The creek was almost dry within the wind farm site at the time of the surveys. The creek valley was wide in parts, but was mainly covered with exotic grasses with limited aquatic vegetation growing in the middle of the mostly dry creek course comprising small reed beds.

The northern end of the creek is partly dammed and a small to medium sized wetland is formed. This contained little emergent aquatic vegetation and most of its edges were bare and subjected to trampling by stock.

In addition to Austin's Creek, the wind farm site also contained a number of stock watering dams. Most were devoid of vegetation and had bare edges. The dams were observed to attract a small number of common duck species.

3. BROLGA AND OTHER THREATENED WATERBIRDS SURVEY

3.1. Introduction

In a previous desktop review carried out by Environmental Resources Management (ERM) Australia and presented in their "Hawkesdale wind farm ecological assessment" of 2006, they recognised the following four listed threatened bird species as likely to occur in the wind farm site:

- Brolga;
- Latham's Snipe;
- Eastern Great Egret; and
- Nankeen Night Heron.

The desktop review was subsequently updated and a new list was compiled. The following species were considered likely to occur at the wind farm site (see Bat and Avifauna Management Plan, BL&A 2010):

- Brolga;
- Whiskered Tern;
- Australian Shoveler;
- Hardhead;
- Eastern Great Egret; and
- Latham's Snipe.

The current survey was designed to target the above threatened species with emphasis on the Brolga, as it is the most threatened of the species. Any other threatened species, where found, are also considered.

3.2. Existing information and survey methods

3.2.1. Source of information

Existing information on the listed threatened bird species and the flocking and breeding behaviour of Brolgas in south-western Victoria was obtained from the literature, DSE and Ballarat University. Information sources included:

- Atlas of Victorian Wildlife (AVW);
- Southwest Victorian Brolga Flocking Site Database (R. Sheldon database); and
- Breeding and flocking season surveys kindly supplied by Philip Du Guesclin, formerly of the DSE, Portland.

3.3. Ecology of the threatened birds

3.3.1. Brolga

The Australian population of the Brolga is estimated to be 20 000 – 100 000, of which approximately 600 to 650 occur in Victoria (DSE Brolga information leaflet).

The majority of the Brolga population in Victoria is found in the southwest of the State: a count in 1992 recorded 635 individuals, only 60-70 of which were in the northern part of the state (Du Guesclin 2003). More recent count of the flocking sites during 2006 and 2007 resulted in a maximum of 576 brolgas (Du Guesclin, pers. comm.).

Brolgas form flocks outside the breeding season. Birds move to flocking sites during the summer and autumn months, from December to early May, and prefer to flock at wetlands that include permanent open water and deep freshwater marsh (Du Guesclin 2001, Marchant and Higgins 1993). The timing of flocking and dispersal to the breeding grounds may vary and may be related to the availability and distribution of surface water, depending on rainfall. In addition, birds may remain at breeding sites throughout the year, including during the flocking season (Marchant & Higgins 1993).

Brolgas begin to disperse from flocking sites to their breeding areas in late autumn and winter (Du Guesclin 2003). The breeding season is from July to December. Breeding territories have been reported to be up to 265 ha in size in Victoria (Marchant and Higgins 1993).

Preferred nesting sites are shallow freshwater marshes and freshwater meadows; prefer shallow marshes <0.5 m deep, with emergent vegetation; also use freshwater meadows <0.3 m deep dominated by annual herbs or rushes (Marchant and Higgins 1993). Breeding occur between July and December in response to winter/spring rainfall. Breeding territories contain a pair and young, and males aggressively defend their territories.

In Victoria, the range of the Brolga has contracted over time as a consequence of wetland drainage and loss of habitat due to agricultural development since European settlement. Currently birds have been found in the south-west and in the north of the State along parts of the Murray River. Its former range included northeast Victoria, Gippsland and Melbourne. Approximately 75% of breeding sites in Victoria are found on volcanic plains in the southwest of the state (Du Guesclin 2003).

Brolga movements in south-western Victoria are incompletely understood. Regular movements in south-eastern Australia occur between flocking and breeding sites. Local movements can also take place when birds are moving between night time roosting sites and feeding sites, in response to rainfall and the availability of food. Long-distance movements may take place in very dry years and populations may move from dry inland wetlands to wetlands associated with the Murray River (Marchant and Higgins 1993). In very wet seasons, birds may remain at breeding sites throughout the year and not move to flocking sites.

The Brolga is considered as vulnerable in Victoria (DSE 2007) and listed under the *Flora and Fauna Guarantee Act* (FFG Act).

3.3.2. Whiskered Tern

The Whiskered Tern inhabits shallow, freshwater wetlands, either permanent or ephemeral, including lakes, swamps, river pools, reservoirs, sewage farms, large dams, flooded saltmarsh and farmland. It is usually found in wetlands supporting

abundant submerged and emergent aquatic vegetation. It often breeds in seasonally flooded shallow wetlands and other inundated flats, in waters up to one metre deep.

The tern is gregarious and is usually found in small flocks when feeding, roosting or moving. It usually forages on wetlands with vegetated margins or emergent aquatic plants. When feeding it flies at five to ten metres above water (Higgins and Davies 1996).

In Victoria, the tern is widespread in west of the state with fewer records elsewhere. The Whiskered Tern is considered as Near Threatened in Victoria but it is not listed under the Victorian FFG Act (DSE 2007).

3.3.3. Australian Shoveler

This duck prefers large, deep permanent bodies of water where conditions are stable and aquatic flora abundant. It also occurs on billabongs, watercourses and flood waters on alluvial plains, freshwater meadows, shallow swamps, reed swamps, wooded lakes, sewage farms and farm dams. It usually prefers freshwater habitats but occasionally occurs in large numbers on brackish or saline lakes.

The Australasian Shoveller breeds in grassy sites near freshwater wetlands, both temporary and permanent. It usually occurs in association with other ducks and feeds in pairs or small groups. The species has probably declined in eastern Australia since European settlement due to wetland drainage, grazing and trampling by livestock (Marchant and Higgins 1990). The Australian Shoveler is considered to be vulnerable in Victoria (DSE 2007).

3.3.4. Hardhead

The Hardhead is a duck that mainly inhabits non-marine wetlands and prefers large, deep areas where vegetation is abundant; particularly deep swamps and lakes, pools and creeks, even fast flowing flood waters. It also occurs on freshwater meadows, seasonal swamps with abundant aquatic flora, reed swamps, wooded lakes and swamps, rice fields, and sewage ponds.

The Hardhead breeds in densely vegetated wetlands, either permanent of deep floodwaters, usually in swamps with high levels of organic matter, complex flora and diverse invertebrate populations. It moves in pairs or small flocks, occasionally in larger flocks. The Hardhead has declined in much of its range since its breeding habitat has been reduced by drainage, diversion of water for irrigation and flood mitigation (Marchant and Higgins 1990).

The Hardhead is considered to be vulnerable in Victoria, but it is not listed under the FFG Act (DSE 2007).

3.3.5. Magpie Goose

This goose inhabits non-marine wetlands in monsoonal regions of Australia. It formerly occurred in comparable numbers in temperate south-east Australia. Although its distribution is determined by presence of water, it is equally at home in aquatic or terrestrial habitats, often walking and grazing on land near wetlands.

The goose disappeared from Victoria by 1911, mainly due to grazing of reed swamps used for breeding. In Victoria, the goose was reintroduced to near Geelong in 1964 and further introductions took place in 1973 at Tower Hill, Kyabram, Sale, and Kerang, but the last two introductions failed (Marchant and Higgins 1990). A small population occurs in south western Victoria.

The species is considered as Near Threatened in Victoria and is listed under the FFG Act (DSE 2007).

3.3.6. Eastern Great Egret

This species occurs in marine and inland wetland habitats and forages in shallow water. It prefers permanent water bodies on flood plains; the shallows of deep permanent lakes, either open or vegetated with shrubs or trees; semi-permanent swamps with tall emergent vegetation (e.g. *Typha*) and herb dominated seasonal swamps with abundant aquatic flora. It also uses freshwater meadows, flooded grasslands, pasture and agriculture land,deep swamps vegetated with cane grass, reeds, sedges or trees, and large farm dams.

The Eastern Great Egret breeds in wetlands with fringing or flooded trees or in other tall vegetation, in which nests are built. It is widespread in most parts of Victoria and may turn up in any suitable wetland habitat. The species is not threatened because of decline in population numbers, but rather because of the limited breeding areas available to the species in Victoria (Marchant and Higgins 1990).

This species is considered to be vulnerable in Victoria (DSE 2007) and is listed under the FFG Act.

3.3.7. Latham's Snipe

The Latham's Snipe is migratory and is found in Australia between August and February. The species is wide-spread in south-east Australia and most of its population occurs in Tasmania, Victoria, south eastern South Australia and southern New South Wales. It occurs further north during northward migration. It is not common in the north-west of Victoria.

This snipe occurs in a wide variety of permanent and ephemeral wetlands; it prefers open freshwater wetlands with dense cover nearby, such as the edges of rivers and creeks, bogs, swamps, waterholes, etc. It has been known to use wetlands with a variety of cover, including tussock grasslands, lignum, sedges, reeds and rushes, woodlands and sclerophyll forests.

It forages at night, and during the day shelters in any available plant association. It feeds on soft mud or in shallow water at the edges of wetlands, either in the open or on bare mud between vegetation. It readily uses modified or artificial habitats, including pasture, ploughed paddocks, sewage farms, drainage ditches, and farm dams (Higgins and Davies 1996).

It disperses over a very wide area and is rarely found in large flocks or concentrations in any one place. Most frequently suitable habitat is occupied by single birds or a group of less than 12 birds. This means even small soaks or wet patches can support a snipe. On the other hand, extensive marshes with good

cover for shelter may support larger numbers of birds (though never in flocks) and 50 snipe or more could be flushed from such areas (Naarding 1983).

This species is listed as Near Threatened in Victoria (DSE 2007). It is also listed under JAMBA in Japan and Australia, and as a migratory species under Federal EPBC Act.

3.4. Previous records

Previous records of the threatened bird species likely to occur on the proposed wind farm are held in the AVW. Records considered for the current survey were those occurring within 10 kilometres of the proposed Hawkesdale wind farm boundary.

Brolga: There were five records in the AVW, all in the same location and date, suggesting duplicates. One of the five records was marked as breeding. According to the Hawkesdale 1:50 000 topographic map (7321 N), the record could have originated from a large farm dam approximately ten kilometres north of the wind farm site.

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 north-east of the wind farm site.

Australian Shoveler and Hardhead: The AVW contained two records of the first species dated back to 1987 and one recent record (2006) of the second species from the search region. Records of both ducks were from an area more than ten kilometres to the north of the wind farm site.

Magpie Goose: The AVW contained one old record (1988) from an area more than ten kilometres to the north of the wind farm site.

Eastern Great Egret: The egret has not been recorded previously for the search region.

Latham's Snipe: The snipe has not been recorded for the search region.

3.5. Field Methodology

To provide additional information on the status, distribution and possible breeding of the Brolga and the other listed threatened waterbirds on wetlands in the vicinity of the proposed Hawkesdale wind farm, a roaming field survey (AusWEA 2005) was undertaken over two days (7th and 12th of October 2009). The area surveyed was within ten kilometres from the edge of the proposed wind farm site and covered the various types of wetlands found within this area. The wetlands were surveyed during the Brolga breeding season (July to December) and at a time of year when migratory waterbirds are known to be present in inland wetlands (Lane 1987)..

As far as possible, all wetlands within the designated search region were visited and surveyed. Many wetlands which were marked on the 1:50 000 topographic map sheets were dry during the survey and supported no wetland bird species. Many wetlands had been permanently drained and were unlikely to support any wetland birds in the future..

3.6. Results of the survey

3.6.1. Habitat assessment

Of all the potential wetlands, particularly those which were recently filled with water after the recent rains in the region, only two wetlands were assessed to be potentially suitable for breeding Brolgas or as providing habitat for the other threatened waterbird species; these two wetlands were:

- A medium sized shallow freshwater marsh located at Fitzgerald Road, approximately eight kilometres north-west of the wind farm site. The wetlands was inhabited by several pairs of breeding swans, Australian Shelduck, Masked lapwings, Black-winged Stilts, and few Pacific Black Ducks and Grey Teals.
- A large sized freshwater swamp located at the end of Rutledges Road, approximately six kilometres north-east of the wind farm site. Although, this wetland was potentially suitable for Brolgas, no birds were recorded there. However, few common farmland waterbirds were seen on the wetland including swans, shelducks and black ducks.

In addition to above, a small expansion of Austin's Creek, located in the northern section of the wind farm site was also considered as possible habitat for listed threatened waterbirds. The wetland was several hectares in size and included emergent vegetation, particularly sedges, although most of its edges were bare and trampled by stock. The wetland was also partly dammed to hold water for stock.

3.6.2. Sightings of threatened wetland birds

One Brolga was sighted during this survey. The individual was observed flying over the Fitzgerald Road wetland at approximately 60 metres high. It flew past this location in a north-westerly direction. Two large wetlands lying outside the ten kilometre search radius in the line of the Brolga flight were visited but the bird was not observed at these wetlands. This wetland was visited again on two more evenings and no brolga was seen there.

No other threatened waterbird species were seen during the survey.

3.6.3. Potential Impacts on the Brolga and other threatened waterbirds

There were no sightings of breeding Brolgas. One historical breeding record occurs in the search region, situated approximately ten kilometres from the proposed wind farm. Most other records are 20 to 30 kilometres north of the Hawkesdale wind farm. Habitat suitable for Brolga breeding may occur along Austin's Creek within the wind farm site but it has not been sighted here during any of the impact assessment investigations and it is considered trampled and disturbed, and of lower habitat quality than many wetlands used elsewhere by Brolgas.

Similarly, none of the threatened waterbirds targeted was sighted in this survey. Historical records were scarce or lacking for two of the listed threatened waterbirds.

In conclusion, the lack of regular historical records of th threatened waterbirds targeted in this survey, together with the limited availability of habitat on or near the Hawkesdale wind farm site, makes it highly unlikely that significant impacts on these species will arise as a consequence of construction of a wind farm at the Hawkesdale site

4. BIRD UTILISATION SURVEY

The bird utilisation survey was undertaken over five days between October 6th and 11th 2009.

This bird utilisation survey has been undertaken consistent with the requirements for a "Level One" bird risk assessment in accordance with 'Wind farms and Birds - Interim Standards for Risk Assessment' issued by the Australian Wind Energy Association (AusWEA 2005). This approach has been endorsed in the Association's latest (2007) Best Practice Guidelines.

The methods used and the results of the survey are presented in this section of the report.

4.1. Methods

4.1.1. Fixed-point bird count method

A total of 10 fixed survey points were established; eight of these were considered impact points and were located in the wind farm site, and two points were considered reference points and were located outside the wind farm area in almost similar habitats (see Figure 1).

The fixed-point bird count method involved an observer stationed at a survey point for 15 minutes. During this period, all bird species and numbers of individual birds observed within 200 metres were recorded. Species, number, distance from the observation point and flight height were documented, with flight height being classified as below, at or above rotor swept area height (RSA height). Four height options for turbine heights were proposed for Hawkesdale Wind farm. These heights varied between 30 – 35 metres above ground at the lower end of turbines and 125 –130 metres at the highest tip of the turbines. In the current study RSA height lies between 30 and 130 metres above the ground.

During the surveys, each point was counted ten times. Points were counted at different times of the day to allow for time-of-day differences in bird movements and activity. Table 1 indicates when each point was counted on each survey day. This schedule ensured that all points were visited equally at different times of day. Each point was counted a total of ten times.

Table 1: Times of day when points* were counted during each survey day.

Day	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10
	8:00	8:30	9:00	9:30	10:00	10:30	11:00	11:30	12:00	12:30
1	1	2	3	4	5	6	7	8	R 1	R 2
2	2	3	4	5	6	7	8	R 1	R 2	1
3	3	4	5	6	7	8	R 1	R 2	1	2
4	4	5	6	7	8	R 1	R 2	1	2	3
5	5	6	7	8	R 1	R 2	1	2	3	4
	T11	T12	T13	T14	T15	T16	T17	T18	T19	T20
	13:30	14:00	14:30	15:00	15:30	16:00	16:30	17:00	17:30	18:00
1	1	2	3	4	5	6	7	8	R 1	R 2

Day	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10
	8:00	8:30	9:00	9:30	10:00	10:30	11:00	11:30	12:00	12:30
2	2	3	4	5	6	7	8	R 1	R 2	1
3	3	4	5	6	7	8	R 1	R 2	1	2
4	4	5	6	7	8	R 1	R 2	1	2	3
5	5	6	7	8	R 1	R 2	1	2	3	4

* See Figure 1 for survey point locations.

4.1.2. Locations of survey points

Figure 1 shows the location of the bird utilisation survey points. The survey points were spaced as evenly as possible, subject to access, across the wind farm to get representative coverage. The comparative homogeneity of habitat at the wind farm site made it easy to choose survey points that were representative.

At the Hawkesdale site, impact points were established as far as possible on elevated ground, allowing a clear view of surrounding areas, and were placed in areas where wind turbines were proposed to be located (Figure 1).

4.1.3. Incidental observations

In addition to the observations during formalised, fixed-point counts, incidental observations of waterbirds and raptors were also made while moving about the wind farm site. Emphasis was placed on observing birds that were moving about the site at RSA height.

4.1.4. Limitations

This bird utilisation survey was undertaken in spring 2009. At this time of year, many birds that normally spend the winter in flocks were in pairs as were still engaged in breeding activities. Some species, such as, magpies and ravens, had already started forming feeding flocks after almost finishing their breeding season.

At this time of year, most migratory bird species, including the summer visitors and some passage migrants, were already in the region. However, most of these species, except for the Brown Songlark, were confined to the woodland or ephemeral wetland habitats and were not observed moving across the wind farm site regularly.

For these reasons, the utilisation rates and species abundances recorded during the current survey are considered to be representative of the site and a strong basis on which to undertake a Level One risk assessment of the proposed Hawkesdale Wind farm.

Figure 1: Map of the Hawkesdale Wind farm site showing the approximate location of bird utilisation survey impact points.

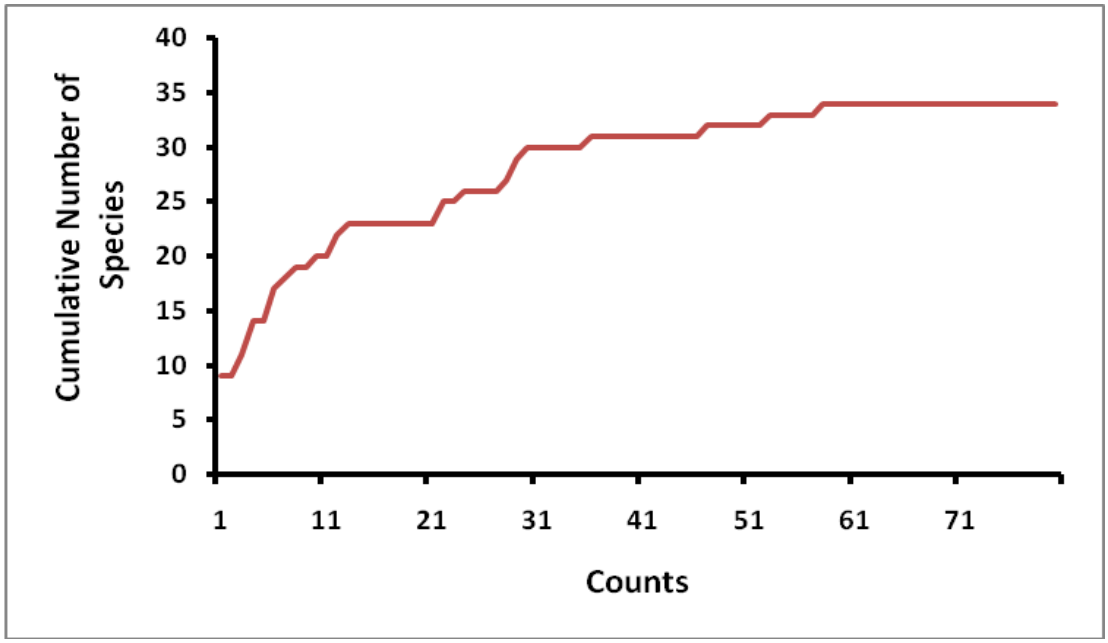
4.2. Results of the bird utilisation survey

This section presents the bird utilisation survey results.

4.2.1. Representativeness of the survey

The cumulative number of species observed from the consecutive fixed-point bird counts conducted at the observation points during the survey period has been plotted (See Figure 2). This revealed that the number of new species observed at the wind farm sites almost levelled off after about 40 counts, after which the occasional new species was found. Over 75% of species were found after less than 50% of the surveys. This suggests that the surveys collectively provided a representative picture of the diversity of bird species flying over the wind farm site during the survey period. Species recorded incidental to the fixed point counts either have very low utilisation rates or do not occur regularly on the parts of the wind farm site on which turbines are to be placed.

Figure 2: The cumulative number of species of birds recorded during consecutive counts at the observation points on the Hawkesdale Wind farm.



The adequacy of using 15 minutes as an interval to record the presence of birds during bird utilisation surveys was investigated in an earlier study at another wind farm site (Brett Lane and Associates Pty. Ltd., unpublished data). This showed that 82 to 100 percent (average 88 percent) of species actually seen in one hour of surveying were seen in the initial 15 minutes of observation. Based on this result, the period of 15 minutes used in the formal bird utilisation surveys generated representative data on the bird species in the area during the survey.

4.2.2. Bird Observations

The *Atlas of Victorian Wildlife* (AVW) predicted 61 species of birds for the search region. Of the number expected to use the wind farm study area, 45 species were recorded during field work, including those recorded accidentally while moving between impact points, and 38 species of birds were actually recorded from the eight impact points and the two reference points while carrying out the bird utilisation survey (Appendix 1).

The species observed during the counts were common farmland birds (see Appendix 1). Bird abundance and diversity during the bird utilisation survey were lower than at many wind farm sites surveyed similarly in other parts of south eastern Australia (Brett Lane & Associates Pty. Ltd., unpubl. data).

The species diversity and numbers of birds observed during the survey at the impact points are shown in Table 2A. Some 36 species of birds were observed utilising the proposed turbine sites during the survey.

The number of species recorded at each impact point ranged between 11 and 21 species. There was a tendency for species numbers to be slightly higher at observation points 5 and 6, where more diverse habitats occurred compared with the other points.

Table 2A presents a list of the species observed during the bird utilisation survey and the numbers in which they were seen in each height zone. The most abundant species at the impact sites were:

- Raven spp., mainly Little raven;
- Australian Magpie;
- Eurasian Skylark; and
- Long-billed Corella.

These four species, including the introduced species (Eurasian Skylark), were the most abundant species and they accounted for over 53 percent of the individual birds counted. Their numbers varied between 270 to 459 birds per observation point (total count from the ten counts at each point) and they were common in all parts of the study area. The first four species were followed by another four species (Straw-necked Ibis, European Goldfinch, Red Wattlebird, Superb Fairywren) for which abundance was between 143 and 190 birds. All eight species accounted for over 77 percent of individual birds counted at impact points during the survey. The abundance of the remaining species ranged between one and 110 birds and their distribution among the observation points was uneven depending on the presence of their preferred habitat, such as the proximity of trees. The abundant species were, predictably, common farmland birds, species that are broadly distributed in farmland areas across south-eastern Australia.

The ranking of species by abundance was almost the same at all observation points, with the Raven spp. and Australian Magpie being the most common resident farmland bird at all points (see Table 2A). The mix of bird species at each point reflected the extent of patches of either native trees or exotic pines within

the counting area. Point no 3 had a mixture of eucalypt trees and pines and open paddocks, and point no 6 included patches of native Blackwood, together with open paddocks.

At the reference points (Table 2B), the first four species formed more than 80 percent of all birds seen on the reference points. The first four most abundant birds were almost the same as those at the impact points, with the exception of the European Goldfinch, which occupied the fourth position in terms of abundance (Table 2B).

Table 3 shows the distribution of bird numbers among the survey points. The total number of birds counted at the impact points varied between a minimum total of 239 birds at point 4 to a maximum total of 558 birds at point 6, with an average total of about 360 birds per point at the impact points (total of ten counts at each point). The higher number at point 3 was mainly due to the presence of large numbers of magpies, ravens, and a large flock of starlings, while at point number 6 the passing of a large flock of ibises (100 birds) over the counting area during the formal bird count.

4.2.3. Flight height

In the bird utilisation survey, bird heights were classified as below (0–30 m), at (31–140), and above (> 141 m) rotor swept area (RSA). Results shown in table 2 indicated that the majority of birds (*c.* 88%) were found below RSA heights, with *c.* 7.6% at and *c.* 4.2% above RSA heights. The above distribution of heights involved all birds recorded during the bird utilisation survey, including those seen perched in trees.

Table 4 shows the numbers of individual birds of each species observed flying at Rotor Swept Area (RSA) height. During the survey period, a total of 219 individual birds of 19 species were observed flying at RSA height at the impact points, or about 7.6 percent of the total number of birds counted.

The most abundant species observed flying at RSA height were:

- Long-billed Corella;
- Raven spp. (mainly Little Raven);
- Red Wattlebird;
- Eurasian Skylark; and
- Australian Magpie.

These five species accounted for over 75 percent of the birds counted at RSA height, with corellas comprising the highest proportion of these flights (27.7%). All bird species flying at RSA height were common farmland birds.

Long-billed Corellas usually fly low when flying short distances, but fly high at RSA heights when moving between paddocks or when dispersing to their feeding grounds from their roosting sites, particularly early in the morning. The large pines surrounding the farm homestead were noted as the preferred roosting site for the corellas, and from there they spread to the paddocks for feeding, crossing

observation points in their way, particularly point no. 7 which was the nearest to the roosting site..

Ravens (mainly Little Raven) at this time of year are in varying sized flocks. They usually fly close to the ground when foraging, but at times fly at RSA heights when moving long distances between paddocks or to and from their roost sites. Most ravens were observed roosting in the large pine trees scattered throughout the wind farm site.

Red Wattlebirds are woodland birds usually restricted to trees; however, during the bird utilisation survey, a relatively large number of wattlebirds were moving about between the lines of Sugar Gums used as windbreaks and flew at RSA heights.

Skylarks are basically ground birds. They are not usually found flying at RSA height, except during the breeding season (September to February), when males ascend to heights above 40 metres and perform a territorial song.

Magpies, as skylarks, are ground birds and they do not usually fly at RSA heights. However, at times magpies would take to the wing and fly at RSA heights, particularly when chasing one another or territorial rivals.

The remaining 14 birds at RSA heights comprised three birds of prey, eight farmland birds, and three waterbirds. Birds of prey and waterbirds, groups most likely to be observed regularly flying at RSA height, are discussed later in more detail. The remaining farmland birds may occasionally fly at RSA heights although they usually prefer flying closer to the ground.

The presence of birds at RSA height at the 8 impact points varied between 9 birds at points 5 and 50 at point 7 (Table 4). In common with the total number of birds at the observation points, there were no particular patterns of distribution of birds at RSA height.

4.2.4. Birds of Prey (Raptors)

Few birds of prey were observed on the site. During the formal bird counts at the impact points, three species were seen flying within the survey area. The Brown Falcon was the most abundant species and unlike other raptors, this species flies mostly below RSA heights (Brett Lane and Associates, unpubl. data). No Wedge-tailed Eagles were observed during the survey of the Hawkesdale wind farm site.

The number of raptors was low in relation to the total number of birds recorded during the survey. Raptors formed 0.38 percent of all individuals surveyed on the wind farm site and 2.3 percent of birds seen at RSA height (Table 5).

4.2.5. Waterbirds

The waterbirds recorded as part of the bird utilisation survey are shown in Table 5. Two-hundred and eight individuals belonging to five species were recorded (7.2% of all birds). Of these, 190 individuals were Straw-necked Ibis. Ibises are very common farmland waterbirds, usually roost in trees close to wetlands and forage in open paddocks during the day. They are gregarious birds, known to move and forage in flocks and breed colonially. At the wind farm site, a small flock

of c. 40 birds were seen feeding in paddocks and at times resting at the Austin's Creek northern small wetland, but none observed roosting within the wind farm site. A large flock of ibises (c. 100 birds) was once seen flying across the wind farm site at a height exceeding 200 metres above ground.

The remaining waterbirds recorded during the bird utilisation survey formal counts were common species, including the White-faced Heron and few ducks. A small flock of these ducks were resident on a large farm dam close to the homestead.

Five of the most common farmland waterbirds species were observed during the utilisation survey (table 5).

The proposed Hawkesdale Wind farm site contained two naturally occurring water bodies and a small number of farm dams. The first of the naturally occurring wetlands was the Austin's Creek. The creek was mostly dry during the current investigation.

The second of the naturally occurring wetlands is an expansion of the Austin's Creek at its northern end within the wind farm site. The water pond contained few emergent aquatic plants and was found to harbour several common waterbirds (Appendix 1). None of the waterbirds found on this pond was a threatened species, either under national or state conservation legislation.

The wind farm site also included a number of farm dams; these were used mainly for stock watering. Dams were devoted of aquatic vegetation with bare and trampled edges. A small number of common farmland ducks, such as Australian Wood and Pacific Black Ducks were observed to use these dams.

4.3. Conclusions

The conclusions from this bird utilisation survey of the Hawkesdale Wind farm are presented below.

- The proposed wind farm site is a largely altered agricultural landscape supporting a low diversity and abundance of common, predominantly opportunistic and adaptable native and introduced bird species.
- The site supports bird species and relative abundances of bird species similar to farmland settings elsewhere in south-eastern Australia.
- The site supports small numbers of birds of prey and waterbirds, groups considered more vulnerable to collision with operating wind turbines.
- Surrounding areas support similar habitat to the wind farm site and the level of bird usage and species present are likely to be comparable. Therefore, indirect impacts from the site are likely only to affect common species of farmland birds.
- No threatened species of birds were observed on or near the wind farm site and habitats on the site are not considered suitable to support significant numbers on a regular basis.
- Use of the wind farm site by migratory species listed on the Commonwealth EPBC Act is likely to be very low as habitat availability and quality for these species is comparatively low..

Table 2: Summary of numbers of individual birds and their height distribution seen on surveys points at the Hawkesdale Wind farm site. A=below rotor swept area (RSA) height (30 m); B= at RSA height (30-140 m); C= above RSA height (>140 m).

A– Impact points

Species	P1			P2			P3			P4			P5			P6			P7			P8			Total			Grand Total	% Imp.
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C		
Raven spp.	44	2	0	20	4	0	120	2	0	40	6	0	26	4	0	53	0	0	36	10	0	88	4	0	427	32	0	459	15.9
Australian Magpie	39	0	0	22	0	0	106	0	0	30	6	0	58	2	0	57	14	0	44	0	0	58	0	0	414	22	0	436	15.1
Eurasian Skylark	8	0	0	68	14	0	46	6	0	10	0	0	26	0	0	30	0	0	20	0	0	38	6	0	246	26	0	272	9.4
Long-billed Corella	16	8	0	0	0	0	0	0	0	4	2	0	5	0	0	0	0	0	170	32	0	21	12	0	216	54	0	270	9.4
Straw-necked Ibis	0	0	0	0	0	0	40	0	20	0	0	0	0	0	0	0	12	100	0	0	0	18	0	0	58	12	120	190	6.6
European Goldfinch	6	0	0	0	0	0	38	0	0	22	0	0	42	0	0	32	0	0	31	4	0	10	0	0	181	4	0	185	6.4
Red Wattlebird	12	0	0	80	26	0	4	6	0	6	0	0	16	0	0	22	0	0	4	0	0	0	0	0	144	32	0	176	6.1
Superb Fairywren	0	0	0	0	0	0	12	0	0	33	0	0	25	0	0	44	0	0	20	0	0	0	0	0	134	0	0	134	4.6
Crimson Rosella	5	0	0	10	0	0	23	2	0	13	0	0	7	0	0	48	2	0	0	0	0	0	0	0	106	4	0	110	3.8
Common Starling	12	2	0	0	0	0	50	0	0	2	0	0	20	0	0	0	0	0	6	2	0	0	4	0	90	8	0	98	3.4
Welcome Swallow	30	6	0	0	2	0	0	0	0	8	0	0	18	0	0	0	0	0	4	0	0	4	0	0	64	8	0	72	2.5
Yellow-rumped Thornbill	0	0	0	0	0	0	0	0	0	10	0	0	31	0	0	8	0	0	10	0	0	0	0	0	59	0	0	59	2.0
Brown Thornbill	0	0	0	0	0	0	14	0	0	22	0	0	2	0	0	18	0	0	2	0	0	0	0	0	58	0	0	58	2.0
Magpie-lark	14	0	0	0	0	0	2	0	0	6	0	0	6	0	0	4	0	0	14	0	0	4	0	0	50	0	0	50	1.7
Yellow-faced Honeyeater	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	42	0	0	0	2	0	0	0	0	42	2	0	44	1.5
Willie Wagtail	9	0	0	0	0	0	6	0	0	0	0	0	9	0	0	8	0	0	4	0	0	0	0	0	36	0	0	36	1.2
Red-rumped Parrot	4	0	0	6	0	0	4	0	0	0	0	0	8	0	0	12	0	0	0	0	0	0	0	0	34	0	0	34	1.2
White-plumed Honeyeater	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	34	0	0	0	0	0	0	0	0	34	0	0	34	1.2
Galah	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	2	2	0	30	2	0	32	1.1
Noisy Miner	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32	0	0	32	1.1
Australasian Pipit	12	0	0	10	0	0	2	1	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0	0	28	1	0	29	1.0
White-faced Heron	0	0	0	0	0	0	0	0	0	2	4	0	3	0	0	1	0	0	0	0	0	0	0	0	6	4	0	10	0.3
Brown Falcon	0	0	0	1	0	0	1	2	0	0	0	0	1	0	0	2	1	0	1	0	0	0	0	0	6	3	0	9	0.3

Species	P 1			P 2			P 3			P 4			P 5			P 6			P 7			P 8			Total			Grand Total	% Imp.
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C		
Eastern Rosella	4	0	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	8	0.3
Grey Fantail	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	7	0	0	7	0.2
Grey Shrike-thrush	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0	4	0	0	0	0	0	0	0	0	7	0	0	7	0.2
White-winged Chough	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	6	0.2
Yellow-tailed Black Cockatoo	0	0	0	2	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	6	0.2
Brown Songlark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	2	0	0	4	1	0	5	0.2
Masked Lapwing	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	4	0.1
Striated Fieldwren	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	4	0	0	4	0.1
Sulphur-crested Cockatoo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	4	0	0	4	0.1
Australian Wood Duck	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0.1
Pacific Black Duck	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0.1
Brown Goshawk	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0.0
Nankeen Kestrel	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0.0
Total	260	18	0	225	46	0	470	19	20	220	19	0	306	9	0	428	30	100	387	50	0	247	28	0	2543	219	120	2882	100.0
No. of species at the point	16			12			16			17			19			21			17			11			36				

B – Reference Points

Species	R 1			R 2			R 2			Grand Total	% Imp.
	A	B	C	A	B	C	A	B	C		
Raven spp.	204	8	0	36	2	0	240	10	0	250	43.9
Eurasian Skylark	54	1	0	36	0	0	90	1	0	91	16.0
Australian Magpie	36	0	0	43	2	0	79	2	0	81	14.2
European Goldfinch	18	0	0	16	4	0	34	4	0	38	6.7

Species	R 1			R 2			R 2			Grand Total	% Imp.
	A	B	C	A	B	C	A	B	C		
Red Wattlebird	0	2	0	26	0	0	26	2	0	28	4.9
Sulphur-crested Cockatoo	2	0	0	12	0	0	14	0	0	14	2.5
Superb Fairywren	7	0	0	7	0	0	14	0	0	14	2.5
Brown Thornbill	10	0	0	0	0	0	10	0	0	10	1.8
Australian Shelduck	0	0	0	2	4	0	2	4	0	6	1.1
Crimson Rosella	0	0	0	5	0	0	5	0	0	5	0.9
Australasian Pipit	2	0	0	2	0	0	4	0	0	4	0.7
Long-billed Corella	2	0	0	0	2	0	2	2	0	4	0.7
Magpie-lark	0	0	0	4	0	0	4	0	0	4	0.7
Welcome Swallow	0	0	0	4	0	0	4	0	0	4	0.7
Yellow-faced Honeyeater	0	4	0	0	0	0	0	4	0	4	0.7
White-faced Heron	0	0	0	1	2	0	1	2	0	3	0.5
Common Starling	0	0	0	2	0	0	2	0	0	2	0.4
Dusky Woodswallow	0	2	0	0	0	0	0	2	0	2	0.4
Nankeen Kestrel	0	2	0	0	0	0	0	2	0	2	0.4
Red-rumped Parrot	0	0	0	0	2	0	0	2	0	2	0.4
Willie Wagtail	1	0	0	0	0	0	1	0	0	1	0.2
Total	336	19	0	196	18	0	532	37	0	569	100.0
No. of species at the point	11			16			21				

Table 3: The number of birds counted at each of the survey points at Hawkesdale Wind farm. A=below rotor swept area (RSA) height (30 m); B= at RSA height (30-140 m); C= above RSA height (>140 m).

Impact points	No. of birds at			Total	% of total birds	% at RSA heights	% RSA of total birds	Bird Density*
	A	B	C					
POINT 1	260	18	0	278	9.6	6.5	0.6	0.9
POINT 2	225	46	0	271	9.4	17.0	1.6	0.9
POINT 3	470	19	20	509	17.7	3.7	0.7	1.6
POINT4	220	19	0	239	8.3	7.9	0.7	0.8
POINT 5	306	9	0	315	10.9	2.9	0.3	1.0
POINT 6	428	30	100	558	19.4	5.4	1.0	1.8
POINT 7	387	50	0	437	15.2	11.4	1.7	1.4
POINT 8	247	28	0	275	9.5	10.2	1.0	0.9
Total	2543	219	120	2882	100.0	7.6	7.6	1.1
REFERENCE 1	336	19	0	355	62.4	5.4	3.3	1.1
REFERENCE 2	196	18	0	214	37.6	8.4	3.2	0.7
Total	532	37	0	569	100.0	6.5	6.5	0.9

* Relative density of birds = Birds per hectare per hour.

Table 4: Species flying at rotor swept area height (B) during bird utilisation surveys at the Hawkesdale Wind farm.

Species	P 1	P 2	P 3	P 4	P 5	P 6	P 7	P 8	Total RSA birds	Birds at All heights	% RSA birds	% birds At RSA heights	% RSA birds of all birds
	B	B	B	B	B	B	B	B					
Long-billed Corella	8	0	0	2	0	0	32	12	54	270	20.0	24.7	1.9
Raven spp.	2	4	2	6	4	0	10	4	32	459	7.0	14.6	1.1
Red Wattlebird	0	26	6	0	0	0	0	0	32	176	18.2	14.6	1.1
Eurasian Skylark	0	14	6	0	0	0	0	6	26	272	9.6	11.9	0.9
Australian Magpie	0	0	0	6	2	14	0	0	22	436	5.0	10.0	0.8
Straw-necked Ibis	0	0	0	0	0	12	0	0	12	190	6.3	5.5	0.4
Common Starling	2	0	0	0	0	0	2	4	8	98	8.2	3.7	0.3
Welcome Swallow	6	2	0	0	0	0	0	0	8	72	11.1	3.7	0.3
European Goldfinch	0	0	0	0	0	0	4	0	4	185	2.2	1.8	0.1
Crimson Rosella	0	0	2	0	0	2	0	0	4	110	3.6	1.8	0.1
White-faced Heron	0	0	0	4	0	0	0	0	4	10	40.0	1.8	0.1
Brown Falcon	0	0	2	0	0	1	0	0	3	9	33.3	1.4	0.1
Yellow-faced Honeyeater	0	0	0	0	0	0	2	0	2	44	4.5	0.9	0.1
Galah	0	0	0	0	0	0	0	2	2	32	6.3	0.9	0.1
Pacific Black Duck	0	0	0	0	2	0	0	0	2	2	100.0	0.9	0.1
Australasian Pipit	0	0	1	0	0	0	0	0	1	29	3.4	0.5	0.0
Brown Songlark	0	0	0	0	0	1	0	0	1	5	20.0	0.5	0.0
Brown Goshawk	0	0	0	0	1	0	0	0	1	1	100.0	0.5	0.0
Nankeen Kestrel	0	0	0	1	0	0	0	0	1	1	100.0	0.5	0.0
Total RSA birds	18	46	19	19	9	30	50	28	219	2882	7.6	100.0	7.6

Table 5: Numbers and importance of birds of prey and waterbirds at the Hawkesdale Wind farm. A, B and C as in Table 2.

Species	Number of birds at			Total	% of all birds	% at RSA heights	* % of all RSA birds	* % RSA birds of all birds
	A	B	C					
Birds of Prey								
Brown Falcon	6	3	0	9	0.312	33.3	1.4	0.1
Brown Goshawk	0	1	0	1	0.035	100.0	0.5	0.0
Nankeen Kestrel	0	1	0	1	0.035	100.0	0.5	0.0
Total birds of prey	**6**	**5**	**0**	**11**	**0.38**	45.5	2.3	0.2
Waterbirds								
Straw-necked Ibis	58	12	120	190	6.6	6.3	5.5	0.4
White-faced Heron	6	4	0	10	0.3	40.0	1.8	0.1
Masked Lapwing	4	0	0	4	0.1	0.0	0.0	0.0
Australian Wood Duck	2	0	0	2	0.1	0.0	0.0	0.0
Pacific Black Duck	0	2	0	2	0.1	100.0	0.9	0.1
Total waterbirds	**70**	**18**	**120**	**208**	**7.22**	8.7	8.2	0.6

* Total number of birds at RSA heights = 219 birds
Total number of all birds at the wind farm site recorded during the bird utilisation survey = 2882 birds

5. BAT SURVEY

5.1. Introduction

In a previous investigation (February 2007), Greg Richards and BL&A surveyed the bat fauna at the Hawkesdale Wind farm. Results of this survey are reported by G. Richards in his witness statement prepared for TME Australia (2007a). The survey was carried out over 11 nights (14 – 24 February 2007) at two habitats (Austin's Creek and the railway reserve) within the wind farm site. The study recorded ten bat species, seven of which were common and secure bat species, one of which was widespread but uncommon and two of which were listed threatened species. The bat species of concern on site were the Southern Bent-wing Bat (*Miniopterus orianae bassanii*)and the Large-footed Myotis (*Myotis macropus*). The first bat is considered Critically Endangered under the EPBC Act, threatened under the FFG Act and endangered on the DSE Advisory List of Threatened Fauna in Victoria (DSE 2007). The second bat is considered Near-threatened on the DSE Advisory List but is not listed on the FFG Act.

The current bat survey was intended to complement earlier findings and to investigate further the status and use of the wind farm by the two above mentioned threatened bat species. The work was carried out in two stages. In the first stage, bats were recorded from four locations within the wind farm site and in the second stage records were made from an additional five locations, bringing the total number of sites to nine. The second stage was carried out as a result of a request from the DSE to expand on the number of sites where bat recording was undertaken.

The first stage of the survey was undertaken between October 5th and 12th 2009. The second stage was carried out over three periods, October 9th to 16th 2009, February 16th to 23rd 2010, and April 20th to 26th 2010. The total time of recording from the two stages amounted to 1260 hours of recording or 105 detector nights.

The choice of recording times was intended to account for the seasonal differences in composition and activity of bats over the wind farm site; with particular emphasis on the activity and movement of the threatened Southern Bent-wing Bat.

The nearest maternity cave of the Southern Bent-wing Bat to the wind farm site is the Starlight Cave near Warrnambool (Vic.), approximately 34 kilometres south of the site. Bats spend their breeding season at the cave then migrate to their wintering caves at Byaduk and Mt Eccles over late summer and autumn, returning again in spring. During their migration, some of the population may pass over the wind farm, hence the timing of recording, designed to account for such movements (for more details see below).

The following sections describe the methods used and present the results of the bat survey.

5.2. Methods

Automated Anabat® (Titley Electronics, Ballina, NSW) bat detectors that record the species-specific echolocation calls of free-flying bats were used at nine sampling points that were representative of the habitats near proposed wind turbine locations on the proposed wind farm site. The Anabat unit was connected to a Compact Flash Storage ZCAIM unit that recorded each bat echolocation call, along with the time and date of each call, on a compact flash card.

Calls from the units were downloaded and sent to Greg Richards (Greg Richards & Associates, Canberra, ACT) and Greg Ford (Consultant Ecologist, Balance Environmental, Toowoomba, Qld) for identification. The files from the recording sites were viewed in Anabat software (Chris Corben, USA), which provides a sonogram display of frequency versus time. Call identification was based on a key developed by comparing the characteristics of bat search calls within reference calls from known species recorded across Australia. Identification is largely based on changes to frequency patterns over time, especially as the characteristic frequency changes. Only those recordings that contained at least two definite and discrete calls were classified as bat calls. For most species, a call sequence of several seconds in duration is required before identification can be made confidently.

The identification of echolocation calls from microbats in south-eastern Australia is facilitated by the fact that many calls are species-specific. However, not all species can be consistently or reliably identified. There is a large overlap in the call characteristics of some species and many calls are attributable only to species "complexes" and not to single species.

A significant limitation in the use of this technique is that it is not possible to census bats accurately. That is, the Anabat unit may record ten calls of a particular species but it is not known if this represents ten individuals or one individual flying past ten times.

5.2.1. Timing and location of the survey

The bat survey was conducted in two stages as follows:

- Stage 1: Recording of bats was carried out over seven nights between 5th and 12th October 2009 (thereafter referred to as period 1). During this period, four Anabat systems operated concurrently from four sites (1 – 4).
- Stage 2: Recording of bats was carried out over three periods of seven nights; the first between 9th and 16th February 2010 (period 2), the second between 16th and 23rd February 2010 (period 3), and the third period between 20th and 27th April 2010 (period 4). During periods 2 and 3, four Anabat systems operated concurrently from four sites and in period 4, three Anabat systems recorded from three sites (period 2: site 5A, B, C, 6; period 3: sites 5D, 7, 8, 9; and period 4: sites 5B, 7 and 9).

The detectors were programmed to commence operation approximately 30 minutes before dusk, and to cease approximately 30 minutes after dawn.

Across both stages, a total of nine points were sampled to represent habitat where turbines are proposed to be located (see Figure 4). The location and characteristics of the recording sites are described below.

Site A1: Located close to a line of old pines and some eucalypt trees (Sugar Gum) and overlooking an open paddock through which Austin's Creek runs. The creek was nearly dry.

Site A2: Located in an area similar to that of site A1, where the Anabat receiver was overlooking an open paddock and a small expansion of Austin's Creek with water and native vegetation. The wetland was about 200 metres from the Anabat site.

Site A3: Located on a deserted railway line close to a line of old pines and overlooking large open paddock.

Site A4: Located on the same railway line, but at a place with some Blackwood and some rain accumulated ponds.

Site 5: The wind mast was located in almost a central position within the wind farm site. It is located in an open grazing field without trees in the surroundings. On the wind mast the following heights were used for recordings:

- 5A: at 50 metres high with the microphone facing up;
- 5B: at 50 metres high with the microphone facing down
- 5C: On ground
- 5D: at 20 metres high with the microphone facing up

Site 6: Located in the southern section of the wind farm in an open paddock close to large and old pines.

Site 7: Located in the northern section of the wind farm close to a line of young pines overlooking large grazing paddocks.

Site 8: this point was set up along a line of mature eucalypt trees (Sugar Gum) and overlooking a grazing paddock; this site is very similar to site no 1.

Site 9: Located on the south-eastern section of the wind farm site (southern side of the disused railway line) on the edge of a line of large, old pines overlooking grazing paddocks.

Figure 3: Map of the Hawkesdale Wind farm site showing the approximate location of the bat survey recording points.

5.3. Results of the survey

5.3.1. Species Recorded

Eleven bat species were recorded during Anabat® surveys from the nine recording sites. Ten species were recorded during the October survey, and an additional species was recorded during the February surveys. These are listed in Table 6.

Of the 11 species recorded at the wind farm site; eight were widespread, common and secure species, two were uncommon but widespread (Inland Broad-nosed Bat, Eastern False Pipistrelle) and one species, the Southern Bent-wing Bat is considered a threatened species (DSE 2007) and is listed on the Federal EPBC Act and state FFG Act.

In the earlier survey carried out during 14–24 February 2007 (Richards 2007a), ten species were recorded, including eight common and widespread bats and two threatened species (Table 6). The same species were again recorded to occur in the study area during the current investigation, except for the absence of the threatened Large-footed Myotis. The latter is a unique bat that forages over water, and given that hardly any open water bodies are available at Hawkesdale wind farm site, it is not unusual that it would not be found regularly on the wind farm site.

Table 6: Bat species identified from calls recorded over a period of 11 consecutive nights at the proposed Hawkesdale Wind farm in February 2007; species are ranked in order of relative abundance (Table reproduced from Richards 2007a).

COMMON NAME	SPECIES	TOTAL CALLS
Southern Freetail Bat	*Mormopterus* sp. 4	807
Southern Forest Bat	*Vespadelus regulus*	649
Little Forest Bat	*Vespadelus vulturnus*	307
Longeared Bats	*Nyctophilus* spp.	100
Gould's Wattled Bat	*Chalinolobus gouldii*	61
White-striped Freetail bat	*Tadarida australis*	56
Chocolate Wattled Bat	*Chalinolobus morio*	47
Southern Bent-wing Bat	*Miniopterus orianae bassanii*	22
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*	5
Large-footed Myotis	*Myotis macropus*	3
Total		2,057

The common species of bats were recorded from various parts of the wind farm site and were not restricted to specific habitats. There was a tendency for the bats to be more regularly recorded in treed areas (Table 7). The wind farm site was fairly uniform in its habitat except for the deserted railway line which contained limited areas of native vegetation and old pines. The uncommon Inland Broad-nosed bat was recorded from three sites and the Eastern False Pipistrelle from four of the nine surveyed sites.

Long-eared bats are difficult to distinguish to species level, and hence are grouped under their genus name. The species that are likely to occur at the site areLesser and Gould's Longeared Bats (*Nyctophilus geoffroyi* and *N. gouldi*). The Southern Freetail Bat is currently under taxonomic revision and a specific name is as yet not available.

The Common Bent-wing Bat comprises three sub-species: The northern Australian form (subspecies *Miniopterus orianae orianae*); an eastern Australia form known as the Eastern Bent-wing Bat that occurs from Cape York to central Victoria (subspecies *M. o. oceanensis*); and a form known as the Southern Bent-wing Bat that occurs in south western Victoria and south eastern South Australia (subspecies *M. o. bassanii*). This sub species is considered threatened (see earlier).

In addition to bat species which were positively identified, there were records of other calls that could not reliably be identified as a particular species, mainly due to partial or complete overlap of their call frequencies. In the current survey, there were records of at least five species complexes, such as Southern Freetail Bat species 2/4, Chocolate Wattle Bat/Southern Freetail Bat, Chocolate Wattle Bat/ Inland Broad-nosed Bat, Gould's Wattle Bat/Little Forest Bat and Southern Bent-wing Bat/forest bat species. Species complexes were not used in analysis of bat activity.

Table 7: Species of bats recorded during the impact assessment of the Hawkesdale Wind farm site. * October survey was carried out between 5th – 11th, 2009; February surveys between 9th – 16th and 16th – 23rd; and April survey between 20th – 27th, April 2010.

Common name	Scientific name	Date Recorded *	Sites of records	Conservation status
Chocolate Wattle Bat	*Chalinolobus gouldii*	Oct., Feb., April	1, 2, 3, 4, 5, 6, 7, 8, 9	common, secured
Southern Forest Bat	*Vespadelus regulus*	Oct., Feb.	1, 2, 3, 4, 5, 6, 7, 8, 9	common, secured
Large Forest Bat	*Vespadelus darlingtoni*	Oct., Feb., April	1, 2, 3, 4, 5, 6, 7, 8, 9	common, secured
Little Forest Bat	*Vespadelus vulturnus*	Oct., Feb.	1, 2, 3, 4, 5, 6, 7, 8, 9	common, secured
Southern Bent-wing Bat	*Miniopterus orianae bassanii*	Oct., Feb., April	1, 4, 5, 6, 7, 8, 9	Threatened species
Long-eared Bat	*Nyctophilus* sp/spp	Oct., Feb., April	1, 2, 3, 4, 5, 6, 7, 9	common, secured
White-striped Freetail Bat	*Austronoumus australis*	Oct., Feb. April	2, 4, 5, 6, 7, 8, 9	common, secured
Gould's Wattle Bat	*Chalinolobus morio*	Oct., Feb. April	3, 4, 6, 7, 8, 9	common, secured
Southern Freetail Bat	*Mormopterus* sp/spp	Oct., Feb. April	1, 2, 3, 4, 6, 8, 9	common, secured
Inland Broad-	*Scotorepens*	Oct., Feb.	2, 7, 9	Uncommon,

Common name	Scientific name	Date Recorded *	Sites of records	Conservation status
nosed Bat	*balstoni*	April		widespread
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*	Oct., April	6, 7, 8, 9	Uncommon, widespread

5.3.2. Bat Activity

Bat activity at Hawkesdale wind farm compares well with other wind farms in similar settings, with the activity for most part originating from common and widespread species. Bat activity during the four periods of recording varied between the different species and between the recording sites. A summary is provided below of findings for each of the four periods of recording.

Period 1: October 5th – 11th, 2009

The number of calls recorded over the seven nights of the survey varied between a total of 143 calls at site 3 to 1922 calls at site 4 (Table 8). Site 4 attracted most activity (61% of all calls) probably because of the presence of more native species of trees and small rain accumulated water pools compared with sites 2 and 3 where there were mainly pines trees surrounding the recording location. Site 1 was similar to 2 and 3 but included a line of mature Sugar Gums nearby.

The ten species of bats varied in their relative activity as measured by the number of calls recorded. The Large Forest Bat was by far the most common bat on the wind farm site, with its calls constituting about 60% of all bat calls. The next most recorded species were the Southern Freetail Bat (14.5%), Southern Forest Bat (12.6%) and Long-eared Bats (6.4%). The remaining species were less abundant and their total calls over the seven nights of recording varied between 1 and 95 calls (0.03–3.0%).

The number of the threatened Southern Bent-wing Bat calls was very low compared with the calls of other bats. The number of calls attributed to this species totalled six calls over seven recording nights at two sites (1 and 4) (Table 8). In addition to above, it was not possible to distinguish between the bent-wing and forest bats for 35 calls. Regardless, Southern Bent-wing Bat activity at the proposed wind farm site is relatively low.

On two Inland Broad-nosed Bat calls were recorded for the suggesting this species' activity at the proposed wind farm is very low.

Table 8: Bat activity at Hawkesdale Wind farm during the period 5th–11th October 2009 (period 1).

Species	No. calls at sites (n=7 nights)				Total calls	Average/ night
	Site 1	Site 2	Site 3	Site 4		
Chocolate Wattle Bat	6	9	5	11	31	4.4
Southern Forest Bat	348	12	1	36	397	56.7
Large Forest Bat	454	17	101	1296	1868	266.9

Little Forest Bat	8	1	7	79	95	13.6
Southern Bent-wing Bat	3	0	0	3	6	0.9
Long-eared Bat	28	27	11	134	200	28.6
White-striped Freetail Bat	0	1	0	1	2	0.3
Gould's Wattle Bat	0	0	15	22	37	5.3
Southern Freetail Bat	1	125	2	328	456	65.1
Inland Broad-nosed Bat	0	1	0	0	1	0.1
Total calls	867	196	143	1922	3128	446.9
Total files	998	240	202	2134	3574	510.6

Period 2: February 9th – 16th, 2010

The number of calls recorded during this period varied between 21 calls at site 5 and 226 calls at site 6 (Table 9). Site 6 attracted most activity (91% of all calls) probably because of the presence of native trees and old pines (potential roosting areas) close to the recording location compared with site 5 which was in the middle of grazing paddocks lacking any trees in the surrounding area. Recording at site 5 was made by utilising the wind mast where the Anabat receivers were set up at different heights (see earlier).

During February, the eleven bats species varied in their relative activity measured by number of calls recorded. The Large Forest Bat was the most common bat on the wind farm site with its calls constituting about 39% of all bat calls followed by the Southern Bent-wing Bat with its calls constituting 30% of all bat calls. The remaining species were less abundant and their total calls over the seven nights of recording varied between 2 and 18 calls (0.8–7.0%).

The number of the threatened Southern Bent-wing Bat calls was relatively high compared with the calls of other bats; calls which were definitely identified to belong to this species totalled 74 calls over the seven nights of recording (average 10.6 calls per night) and almost all calls were recorded at site 6, except for three calls recorded at ground level near the wind mast. The activity of the threatened Southern Bent-wing Bat was much higher during this period compared with activity during the October survey.

Only two calls were recorded for the uncommon Eastern False Pipstrelle. This indicates that this species' activity is low in the proposed wind farm.

Table 9: Bat activity at Hawkesdale Wind farm during the period 9th – 16th February 2010 (period 2).

Species	No. calls at sites (7 nights)				Total calls	Average / night
	site 5A-50 m up	site 5B-50 m down	site 5C-ground	site 6		
Chocolate Wattle Bat	0	0	0	2	2	0.3
Southern Forest Bat	0	0	0	18	18	2.6
Large Forest Bat	0	0	1	96	97	13.9

Species	No. calls at sites (7 nights)				Total calls	Average / night
	site 5A-50 m up	site 5B-50 m down	site 5C-ground	site 6		
Little Forest Bat	1	0	0	15	16	2.3
Southern Bent-wing Bat	0	0	3	71	74	10.6
Long-eared Bat	0	0	1	4	5	0.7
White-striped Freetail Bat	10	3	2	2	17	2.4
Gould's Wattle Bat	0	0	0	7	7	1.0
Southern Freetail Bat	0	0	0	11	11	1.6
Inland Broad-nosed Bat	0	0	0	0	0	0.0
Eastern False Pipistrelle	0	0	0	2	2	0.3
Total calls	11	3	7	226	247	35.3
Total files	13	5	12	666	696	99.4

Period 3: February 16th – 23rd, 2010

The number of calls recorded over the seven nights of the survey varied between a total of one call at site 5 (wind mast) to 511 calls at site 9 (Table 10). Site 9 attracted most activity (52% of all calls) probably because of the presence of large and old pine trees that can provide shelter and roosting site for the bats compared with sites 7 and 8. Site 5 (wind mast) did not attract any bat activity being in the middle of a grazing paddock without any trees.

The 11 species of bats varied in their relative activity as measured by number of calls recorded. The Southern Bent-wing Bat was the most common bat on the wind farm site with its calls constituting about 66.5% of all bat calls, followed by the Large Forest Bat with its calls constituting 51% of all bat calls. The remaining species were less abundant and their total calls over the seven nights of recording varied between 10 and 84 calls (2–16%).

The number of the threatened Southern Bent-wing Bat calls was again relatively high compared with the calls of other bats during this period of recording; calls which were definitely identified to belong to this species totalled 340 calls over the seven nights of recording (average 48.6 calls per night) and almost all calls (79%) were recorded at site 9. The activity of the threatened Southern Bent-wing Bat was much higher during this time of year compared with activity during both the early February 2010 and October 2009 surveys.

Calls of the uncommon Inland Broad-nosed Bat and Eastern False Pipistrelle were higher than in October 2009 and were at a level similar to other common species.

Table 10: Bat activity at Hawkesdale Wind farm during the period 16th – 23th February 2010 (period 3).

Species	No. calls at sites (7 nights)				Total calls	Average / night
	site 5D-20 m up	Site 7	Site 8	site 9		
Chocolate Wattle Bat	0	15	31	38	84	12.0
Southern Forest Bat	0	4	45	11	60	8.6
Large Forest Bat	0	16	223	22	261	37.3
Little Forest Bat	0	2	2	38	42	6.0
Southern Bent-wing Bat	1	25	46	268	340	48.6
Long-eared Bat	0	3	0	34	37	5.3
White-striped Freetail Bat	0	2	3	17	22	3.1
Gould's Wattle Bat	0	5	2	42	49	7.0
Southern Freetail Bat	0	2	9	28	39	5.6
Inland Broad-nosed Bat	0	2	0	8	10	1.4
Eastern False Pipistrelle	0	0	31	5	36	5.1
Total calls	1	76	390	511	978	139.7
Total files	4	253	1439	1168	2864	409.1

April 20th – 26th, 2010

The number of calls recorded over the seven nights of the survey varied between a total of 11 calls at site 5D (wind mast) to 93 calls at site 9 (table 11). Site 7 and 9 attracted most of the activity (43.8% and 50.2% of all calls, respectively) probably because of the presence of large trees that can provide shelter and roosting sites for bats compared with site 5B. Site 5B (wind mast) did not attract much bat activity, being in the middle of a grazing paddock without any trees.

The nine species recorded during this period varied in their relative activity as measured by the number of calls recorded. The Chocolate Wattle Bat was the most active bat on the wind farm site, with its calls constituting about 22.2% of all bat calls, followed by the White-striped Freetail Bat and Southern Freetail Bat, with calls from both constituting 17.3% each of all bat calls. The remaining species were less abundant and their total calls over the seven nights of recording varied between 3 and 27 calls (1.6–14.5%).

The number of the Southern Bent-wing Bat calls dropped significantly compared with the previous periods of recording. Calls which were definitely identified as belong to this species totalled 27 calls over the seven nights of recording (average 3.9 calls per night) and numbers of calls recorded were similar at sites 7 and 9. The calls of this species were recorded on three out of the seven nights of recording at site 5, four nights at site 7 and two nights at site 9.

Call numbers of the uncommon Inland broad-nosed Bat and Eastern False Pipistrelle were similar to the previous period and generally were at low levels compared with the more common bat species.

Table 11: Bat activity at Hawkesdale Wind farm during the period 20th – 27th April 2010 (period 4).

Species	No. calls at sites (7 nights)			Total Calls	Average / night
	site 5C-ground	site 7	site 9		
Chocolate Wattle Bat	1	30	10	41	5.9
Southern Forest Bat	0	0	0	0	0.0
Large Forest Bat	0	15	1	16	2.3
Little Forest Bat	0	0	0	0	0.0
Southern Bent-wing Bat	3	10	14	27	3.9
Long-eared Bat	3	4	8	15	2.1
White-striped Freetail Bat	4	1	27	32	4.6
Gould's Wattle Bat	0	10	2	12	1.7
Southern Freetail Bat	0	3	29	32	4.6
Inland Broad-nosed Bat	0	6	1	7	1.0
Eastern False Pipistrelle	0	2	1	3	0.4
Total calls	11	81	93	185	26.4
Total files	28	328	192	548	78.3

Height distribution of bats

The height distribution of bats was studied by placing the Anabat receivers at various heights utilising the 80 metre high wind mast for this purpose. Microphones were placed at the following heights:

- At 50 metres high with the microphone facing up;
- At 50 metres high with the microphone facing down;
- At 20 metres high with microphone facing up; and
- On the ground beneath the wind mast.

The first two heights and that on the ground were recorded concurrently during period 2 (9–16 February, 2010) and the 20 metre high recording was carried out in period 3 (16–23 February, 2010). Bat calls were again measured at ground level in period 4.

The results showed that of the eleven species utilising the wind farm site, the White-striped Freetail Bat was almost the only species flying at heights over 50 metres above ground-level (Table 9 & 10). Experience from other wind farms confirm that this species was also the species recorded at height (BL&A; unpubl. data).

The threatened Southern Bent-wing Bat was not recoded flying at heights above 50 metres; there was only one record of the bat from a height over 20 metres but lower than 50 metres. Bent-wing bats usually fly at tree canopy heights in treed areas and within six metres of ground in more open grassland areas (Churchill 2008).

5.3.3. Summary of findings

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).

Table 12 shows that bat activity in October (as measured by the number of calls) was much higher than activity in February. It was dominated by the Large Forest Bat (possible roost site near recording area) and the Southern Forest Bat. Both of these species and the remaining bats recorded were common and widespread species. In October few Southern Bent-wing Bat calls were recorded on the wind farm site.

Table 12: Summary of calls recorded at the nine sites of Hawkesdale Wind farm. Records made over seven nights for each of the four periods of recording.

Recording Sites	Period of recording	Total No. of Calls/site	Average / night	Total calls/ period	Average / night
Site 1	Period (1)	867	123.9	3128	446.9
Site 2		196	28.0		
Site 3		143	20.4		
Site 4		1922	274.6		
Site 5	Period (2)	22	3.1	248	35.4
Site 6		226	32.3		
Site 7	Period (3)	76	10.9	977	139.6
Site 8		390	55.7		
Site 9		511	73.0		
Site 5B	Period (4)	11	1.6	185	26.4
Site 7B		81	11.6		
Site 9B		93	13.3		

Recording periods: (1) 5–11 October 2009; (2) 9–16 February; (3) 16–23 February; (4) 20 – 27 April, 2010.
Note: Records were made from site 5 on both the second and third period of recording but period three was not included in table since only one call was recorded for site 5 (wind mast @ 20 m high).

In the February and April records, bat activity during the three periods was much lower than in the preceding October and originated from common and widespread species; however, an unexpected increase in activity of the Southern Bent-wing bat was recorded in February. This increase coincided with the time of the post-breeding migration of these bats from their maternity cave at Warrnambool (Starlight Cave) to their wintering caves at Byaduk,Mt Eccles and elsewhere in the region (for more details see below).

5.4. Summary of results for the Southern Bent-wing Bat

The Southern Bent-wing Bat occurs widely across western and south-western Victoria. Its local distribution is largely determined by the availability of caves, mine shafts or tunnels suitable as roosting sites. This bat 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. In Victoria, They usually forage over forested areas but also occur widely in lower densities on the sparsely-treed Volcanic Plain (Menkhorst 1995; Richards 2006).

In spring and summer, they congregate in "maternity caves" where the females give birth to and raise their young. In autumn and winter, after the young are weaned, these bats disperse over a large region of south-eastern Australia. Small numbers of this species have been found roosting during the day in inland and coastal cliff caves, as well as disused mine shafts (Duncan *et al*. 1999; Menkhorst 1995).

The nearest maternity cave of the Southern Bent-wing Bat to the Hawkesdale wind farm site is the Starlight Cave near Warrnambool (Vic.), approximately 34 kilometres to the south of the Hawkesdale wind farm site. In 2007, it was estimated that approximately 10,000 adult and 4000 young bats occupied the Starlight Cave (Richards 2007b). Bats recorded at the wind farm site most probably breed in these caves and visit the wind farm site for only short periods during spring and autumn migrations to and from their winter roosting caves at Byaduk, Mt Eccles and elsewhere in the region.

The Hawkesdale wind farm site lies to the north of the direct line of movements between the maternity and wintering caves of the Southern Bent-wing Bat. It is approximately 34 km from Starlight Cave and 30 km from Byaduk and Mt Eccles caves. It is not known whether the Hawkesdale Wind farm would be on a migration path. The recording of larger numbers of calls from this species during February suggests that more of this species may pass over the wind farm site at this time of year.

The Southern Bent-wing Bat usually moves to congregate at the maternity cave as early as August, and by October, almost all the regional population of the bat would be at the cave. Breeding takes place during October and November and in Starlight Cave in December. Bats remain at the maternity cave and start dispersing in late January and February (P. Gray, pers. comm., Richards 2007b) and continue through April;. Richards (2007b) also found that bats usually follow large patches of remnant vegetation in their movements. Bats did not migrate *en-masse* from the maternity cave, but dispersed gradually in small groups.

At Hawkesdale wind farm, the number of the Southern Bent-wing Bat calls fluctuated widely between the four periods of the survey (Figure 5). While numbers were very low in October 2009 (6 calls in seven nights of recording, or 0.9 calls/night; see Table 8), they increased to approximately 74 calls over the seven nights or 10.4 calls per night in early February (Table 9). The numbers further increased to a maximum of 340 calls or 48.6 calls per night in late February (table 10), and then dropped by April 2010 to 27 calls over the seven nights of recording or 3.9 calls per night (Table 11).

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.

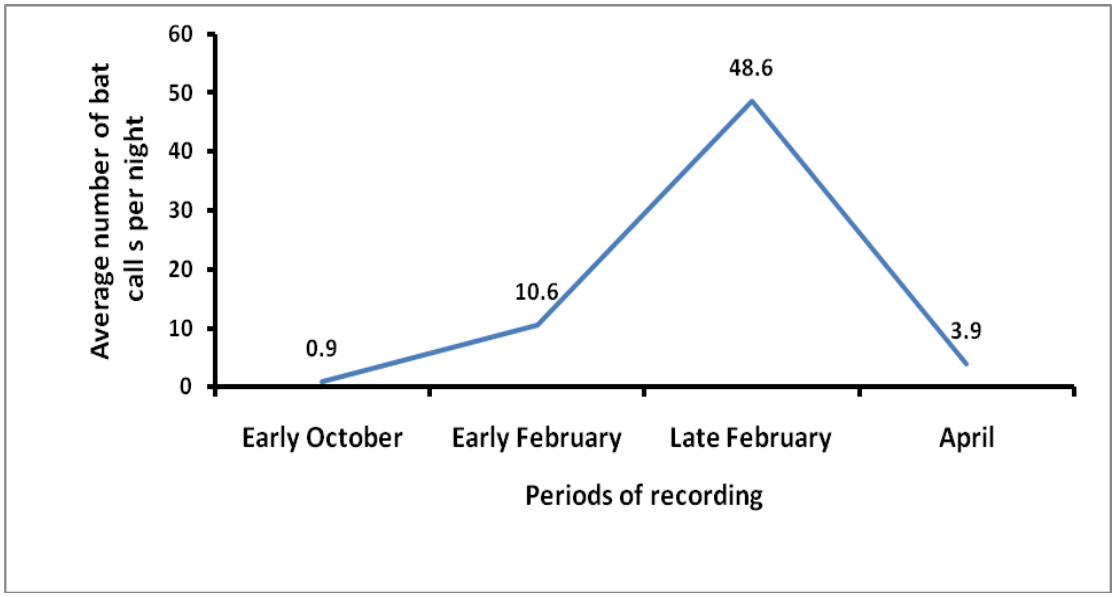
During the initial survey that took place between February 14th and 24th 2007, a recording time comparable to the late February records of 2010, the number of the Southern Bent-wing Bat was very low. A maximum of 22 calls were recorded from two sites within the wind farm. This low level of the activity 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.

During the increase in Southern Bent-wing Bat activity in February, the bulk of the calls were recorded from sites that contained old and mature trees, particularly old pines, and only few calls were recorded from open treeless sites such as Site 5. This patchiness in activity suggests a strong preference for areas of treed habitat, consistent with observations elsewhere (e.g. Richards 2006; 2007b).

For the return journey from the wintering sites towards the Starlight cave maternity cave, which takes place mostly during October, no increase in activity was noticed at the wind farm site. In fact, Southern Bent-wing Bat numbers were the lowest compared with the other recording periods (Figure 4).

The above findings indicated that the Southern Bent-wing Bat is likely to use the wind farm site during the autumn migration and that part of the bat population would continually forage in the wind farm site while passing through. The period of the most intensive activity by the species at the wind farm site is during late February

Figure 4: The relative abundance of bats during the four recording periods at Hawkesdale wind farm during October 2009 to April 2010.



6. REFERENCES

American Wind Energy Association and American Bird Conservancy, 2004, Proceedings of the Wind Energy and Birds/Bats Workshop: Understanding and Resolving Bird and Bat Impacts. Washington, DC May 18-19, 2004. RESOLVE, Inc.

Arnett, EB, *et al*. 2005, *Relationships between bats and wind turbines in Pennsylvania and West Virginia: an assessment of bat fatality search protocols, patterns of fatality, and behavioral interactions with wind turbines*. A final report submitted to the Bats and Wind Energy Cooperative. Bat Conservation International. Austin, Texas, USA.

Arnett, EB *et al*. 2008, 'Patterns of bat fatalities at Wind Energy Facilities in North America', *J. Wildlife Management*, 72 (1), 61–78.

Arnett, EB *et al*. 2009, *Effectiveness of changing wind turbine cut-in-speed to reduce bat fatalities at wind facilities*. An annual report submitted to the Bat and Wind Energy Cooperative, Bat Conservation International, Austin, Texas, USA.

Australian Wind Energy Association (AusWEA) 2005, *Wind farms and Birds: Interim Standards for Risk Assessment*, Report prepared by: Brett Lane and Associates and AIRA Professional Services, Report No. 2003.35(2.2), July 2005.

Baerwald, EF *et al*. 2008, 'Barotrauma is a significant cause of bat fatalities at wind turbines', *Current Biology*, 18 (16), 695–696.

Barclay, MR *et al.* 2007, 'Variation in bat and bird fatalities at wind energy facilities: assessing the effect of rotor size and tower height', *Canadian J. Zoology*, 85, 381–387.

Cryan, PM 2008, 'Mating Behaviour as a Possible Cause of bat Fatalities at Wind Turbines', *J. Wildlife Management*, 72 (3): 845–849.

Devereux, CL, Matthew JHD and Whittingham, MJ 2008, 'Minimal effects of wind turbines on the distribution of wintering farmland birds', *Journal of Applied Ecology* 45, 1689–1694.

Drewitt, AL and Langston, RHW 2006, 'Assessing the impacts of wind farms on birds', *Ibis* 148: 29–42.

DSE 2007, *Advisory List of Threatened Vertebrate Fauna in Victoria*. Department of Sustainability and Environment, Victoria, East Melbourne, Victoria.

Duncan, A, Baker, GB & Montgomery, N 1999, *The Action Plan for Australian Bats*. Environment Australia, Canberra.

Du Guesclin, P 2003, *Action Statement No 119. Brolga Grus rubicunda*. Department of Natural Resources and Environment, Victoria, Australia.

Durr, T and Bach L 2004, 'Bat deaths and wind turbines – A review of current knowledge and of the information available in the database for Germany', *Bremer Beiträge für Naturkunde und Naturschutz*, 7, 253-264.

Environmental Resources management Australia (ERM) Pty. Ltd. 2006, *Hawkesdale Wind farm Application for Planning Permit by Gamesa Energy Australia/TME Australia*. Consultants report to Gamesa Energy Australia/TME Australia.

Erickson, WP, Johnson, GD, Strickland, MD, Young, DP Jr, Sernka, KJ and Good, RE 2001, *Avian collisions with wind turbines: a summary of existing studies and comparisons to other sources of avian collision mortality in the United States*, Resource Document of the National Wind Coordinating Committee, Washington.

Everaert, J and Kuijken, E 2007, *Wind turbines and birds in Flanders (Belgium), Preliminary summary of the mortality research results*, Research Institute for Nature and Forest (INBO), Belgium.

Fiedler, JK *et al*. 2007, *results of bird and bat mortality monitoring at the expanded Buffalo Mountain wind farm*, Tennessee Valley Authority, Knoxville, USA.

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

Horn, JW *et al* 2008, 'Behavioural Responses of Bats to Operating Wind Turbines', *J. Wildlife Management*, 73 (1), 123–132.

Hötker, H, Thomsen, K-M. and H. Jeromin, H 2006, *Impacts on biodiversity of exploitation of renewable energy sources: the example of birds and bats - facts, gaps in knowledge, demands for further research, and ornithological guidelines for the development of renewable energy exploitation*. Michael-Otto-Institut im NABU, Bergenhusen.

Johnson, GD *et al*. 2003, 'Mortality of bats at a large-scale Wind Power Development at Buffalo Ridge, Minnesota', *The American Midland Naturalist*, 150 (2), 332–342.

Johnson, GD *et al* 2004, 'Bat activity, composition, and collision mortality at a large wind plant in Minnesota', *Wildlife Society Bulletin*, 32 (4), 1278–1288.

Kikuchi, R 2007, 'Adverse impacts of wind power generation on collision behaviour of birds and anti-predator behaviour of squirrels, *J. Nature Conservation*, 16, 44–55.

Kunz, TH 2004, *Wind Power: bats and Wind Turbines*, In, Wind Energy and Birds/Bats Workshop, Washington DC, May 18–19, 2004.

Kunz, TH *et al*. 2007 a, 'Assessing Impacts of Wind-Energy Development on Nocturnally Active Birds and Bats: A Guidance Document', *J. Wildlife Management*, 71 (8), 2449–2486.

Kunz, TH *et al.* 2007b, 'Ecological impacts of wind energy development on bats: questions, research need, and hypotheses', *Frontiers in Ecology and the Environment*, 5, 315–324.

Kuvlesky, WP *et al*. 2007, 'Wind Energy Development and Wildlife Conservation: Challenges and Opportunities', *Journal of Wildlife Management*, 78(1), 2487–2498.

Langston, RHW and Pullan, JD 2004, *Effects of Wind farms on Bird*, RSPB and BirdLife International, Convention on the4 conservation of European wildlife and habitats (Ben Convention), Council of Europe Publishing, Strasbourg.

Manuela de Lucas, Janss, GFE and Ferrer, M (Eds.) 2007, *Birds and Wind farms*, Risk Assessment and Mitigation, Quercus, Madrid.

Marchant, S & Higgins, PJ (Eds) 1990, *Handbook of Australian, New Zealand and Antarctic Birds,* Volume 1: Ratites to Ducks', Oxford University Press, Melbourne.

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

Menkhorst, P 1995, *Mammals of Victoria*. Oxford University Press, Melbourne

Naarding, JA 1983, *Latham's Snipe in Southern Australia, Wildlife Division*, Marchant, S & Technical Report 83/1, Tasmania National Parks and Wildlife Service.

National Research Council (NRC) 2007, *Environmental impacts of wind energy projects*, National Academy of Sciences, National Academies Press, Washington DC, USA.

National Wind Coordinating Committee (NWCC) 2004, *Wind turbine interaction with birds and bats: A summary of research results and remaining questions*, National Wind Coordinating Committee, Washington, DC.

National Wind Coordinating Committee (NWCC) 2007, *Mitigation Toolbox*, Compiled by: NWCC Mitigation Subgroup & Jennie Rectenwald, Consultant, National Wind Coordinating Committee, Washington, DC.

Ontario Ministry of Natural Resources (OMNR) 2006, *Wind power and bat ecology background information and literature review of impacts*. Fish and Wildlife Branch, Renewable energy section, Peterborough, Ontario, 61 pp.

Percival, SM 2003, *Birds and Wind farms in Ireland: A review of potential issues and impact assessment*, Consultant Report, Durham, UK.

Sovacool, BK 2009, 'Contextualizing avian mortality: A preliminary appraisal of bird and bat fatalities from wind, fossil-fuel, and nuclear electricity', *Energy Policy* 37, 2241–2248.

Richards G. 2006, *Ecology and conservation of the Southern Bent-wing Bat in relation to the proposed Ryan corner Wind farm, Victoria*, prepared for Gamesa Energy Australia Pty. Ltd., October 2006.

Richards, G 2007a, Expert Witness Statement of Dr Gregory Charles Richards, Expert retained by TME Australia, and presented to the Planning panels Victoria.

Richards, G 2007b, *An assessment of the bat fauna and patterns of regional migration in relation to the Ryan Corner Wind farm site, Victoria*. Report presented in collaboration with Brett Lane & Associates Pty Ltd to TME Australia Pty. Ltd., May 2007.

Appendix 1: Bird and bat species that occur or are likely to occur in the Hawkesdale Wind farm study area based on AVW records and field observations. A, birds recorded at the wind farm during the current field work; B, birds actually recorded during formal counts of the bird utilisation survey.

Common Name	*Scientific Name*	A	B
Birds			
Australasian Grebe	*Tachybaptus novaehollandiae*		
Australasian Pipit	*Anthus novaeseelandiae*	X	X
Australasian Shoveler	*Anas rhynchotis*		
Australian Magpie	*Gymnorhina tibicen*	X	X
Australian Raven	*Corvus coronoides*	X	X
Australian Shelduck	*Tadorna tadornoides*	X	X
Australian White Ibis	*Threskiornis molucca*		
Australian Wood Duck	*Chenonetta jubata*	X	X
Black Swan	*Cygnus atratus*	X	
Black-fronted Dotterel	*Elseyornis melanops*		
Black-tailed Native-hen	*Gallinula ventralis*	X	
Brolga	*Grus rubicunda*		
Brown Falcon	*Falco berigora*	X	X
Brown Goshawk	*Accipiter fasciatus*	X	X
Brown Songlark	*incloramphus cruralis*	X	X
Brown Thornbill	*Acanthiza pusilla*	X	X
Chestnut Teal	*Anas castanea*	X	
Common Blackbird	*Turdus merula*	*	
Common Starling	*Sturnus vulgaris*	* X	X
Crimson Rosella	*Platycercus elegans*	X	X
Dusky Moorhen	*Gallinula tenebrosa*	X	
Dusky Woodswallow	*Artamuscyanopterus*	x	X
Eastern Rosella	*Platycercus eximius*	X	X
European Goldfinch	*Carduelis carduelis*	* X	X
European Greenfinch	*Carduelis chloris*	*	
European Skylark	*Alauda arvensis*	* X	X
Galah	*Eolophus roseicapilla*	X	X
Grey Fantail	*Rhipidura albiscarpa*	X	X
Grey Teal	*Anas gracilis*	X	
Hardhead	*Aythya australis*		
Hoary-headed Grebe	*Poliocephalus poliocephalus*	X	
Horsfield's Bronze-Cuckoo	*Chrysococcyx basalis*		
House Sparrow	*Passer domesticus*	* X	
Laughing Kookaburra	*Dacelo novaeguineae*	X	
Little Pied Cormorant	*Microcarbo melanoleucos*		
Little Raven	*Corvus mellori*	X	X
Long-billed Corella	*Cacatua tenuirostris*	X	X
Magpie Goose	*Anseranas semipalmata*		

Common Name	*Scientific Name*	A	B
Magpie-lark	*Grallina cyanoleuca*	X	X
Masked Lapwing	*Vanellus miles*	X	X
Nankeen Kestrel	*Falco cenchroides*	X	X
Noisy Miner	*Manorina melanocephala*	X	X
Pacific Black Duck	*Anas superciliosa*	X	X
Pink-eared Duck	*Malacorhynchus membranaceus*		
Purple Swamphen	*Porphyrio porphyrio*	X	
Red Wattlebird	*Anthochaera carunculata*	X	X
Silvereye	*Zosterops lateralis*		
Straw-necked Ibis	*Threskiornis spinicollis*	X	X
Superb Fairy-wren	*Malurus cyaneus*	X	X
Welcome Swallow	*Hirundo neoxena*	X	X
Whiskered Tern	*Chlidonias hybridus*		
White-faced Heron	*Egretta novaehollandiae*	X	X
White-necked Heron	*Ardea pacifica*		
White-plumed Honeyeater	*Lichenostomus penicillatus*	X	X
Willie Wagtail	*Rhipidura leucophrys*	X	X
Yellow-billed Spoonbill	*Platalea flavipes*		
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	X	X
Yellow-tailed Black Cockatoo	*alyptorhynchus funereus*	X	X
White-winged Chough	*Corcorax melanorhamphos*	X	X
Yellow-faced Honeyeater	*Lichenostomus chrysops*	x	x
Grey-shrike Thrush	*Colluricinclaharmonica*	x	x
Mammals			
Common Brushtail Possum	*Trichosurus vulpecula*		
Eastern Grey Kangaroo	*Macropus giganteus*	* X	
European Hare	*Lepus europeaus*	* X	
European Rabbit	*Oryctolagus cuniculus*	* X	
House Mouse	*Mus musculus*		
White-striped Freetail Bat**	*Tadarida australis*		
Common Bent-wing Bat**	*Miniopterus dchreibersii*	X	
Large-footed Myotis**	*Myotis macropus*		
Southern Freetail Bat**	*Mormopterus* sp.		
Southern Forest Bat**	*Vespadelus regulus*		
Little Forest Bat**	*Vespadelus vulturnus*		
Longeared Bats**	*Nyctophilus* spp.		
Gould's Wattled Bat**	*Chalinolobus gouldii*		
Chocolate Wattled Bat**	*Chalinolobus morio*		
Eastern False Pipistrelle**	*Falsistrellus tasmaniensis*		

* Introduced species

** Bats recorded in an earlier survey on the wind farm site (Greg Richards & Brett Lane and Associates 2007).