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PLANNING · SURVEYING · ECOLOGY

# FLORA AND FAUNA ASSESSMENT

# BLACK SPRINGS

# WIND FARM

# OBERON SHIRE

*Job No: 23219*

**JULY 2006**

***Prepared for:***

**WIND CORPORATION AUSTRALIA**

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WINNER OF THE NSW EXCELLENCE IN SURVEYING AND MAPPING AWARD 2003

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| *PROJECT: FLORA AND FAUNA ASSESSMENT FOR BLACK SPRINGS WIND FARM* | |
| *CLIENT:* | *WIND CORPORATION AUSTRALIA* |
| *OUR REF:* | *23219* |
| *DATE:* | *JULY 2006* |
| *APPROVED BY:* | *TOBY LAMBERT* |
| *SIGNATURE:* | |
| *CHECKED BY:* | *MICK RODERICK* |
| *SIGNATURE:* | |

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# 1 INTRODUCTION

Harper Somers O'Sullivan Pty Ltd (HSO) has been commissioned by Wind Corporation Australia (WCA) to undertake a Flora and Fauna Assessment for a proposed wind farm development near the small village of Black Springs, in the Oberon Shire of New South Wales (NSW).

The report has been structured and conducted to fulfil the requirements of the *Environmental Planning and Assessment Act 1979* (EPA Act), the *Threatened Species Conservation Act 1995* (TSC Act) and the *Fisheries Management Act 1994* (FM Act). Assessment of the site under the requirements of State Environmental Planning Policy No. 44 (SEPP 44) – 'Koala Habitat Protection' is included. Consideration of the proposal has also been undertaken in relation to the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Director General's Requirements (DGRs) have been issued by the NSW Department of Planning (DoP) for the project. The DGRs identify certain requirements that must be incorporated into the flora and fauna assessment aspect of the project. These include consideration of *Draft NSW Wind Energy EIA Guidelines 2002,* outlining an adaptive management program, considering the AusWEA (2005) *Wind Farms and Birds: Interim Standards For Risk Assessment*, adhering to State *Draft Guidelines for Threatened Species Assessment* and having regard to the Department of Environment and Heritage's (DEH) *Cumulative Risk for Threatened and Migratory Species, March 2006.* These requirements (and the requirements of other relevant documentation such as EPBC Act Policy Statements) have been considered and are referred to throughout this assessment where appropriate.

## 1.1 Project Summary

The proposed Black Springs Wind Farm (BSWF) is to be located within the Shire of Oberon, west of the Blue Mountains on the Great Dividing Range. The site is west of the village of Black Springs and 25km southwest of Oberon. Figure 1-1 is a location map for the site.

Wind Corporation Australia proposes to develop an 18.9 megawatt (MW) generating wind farm on the site. The BSWF has the potential to offset 67,000 tonnes of $CO_2$ per year through the operation of the proposed nine (9) wind turbine generators (WTG's). It is estimated that the generation capacity of the BSWF would be able to power around 6,000 homes (e.g. whole Oberon/Black Springs/Burraga + timber mill in Oberon), using an average consumption of 7,900 kWh per household.

The WTG's will span two (2) privately owned rural allotments. The southern property is known as "Daisybank", while the northern property is known as "Acquatoria".

The subject site consists of cleared, open paddocks with scattered vegetation and remnant patches. Sheep and cattle grazing are the predominant land uses. The topography of the wind farm site is characterised by rolling hills and gently - steeply rising ridges separated by shallow valleys. Several minor creeks occur and within Daisybank these generally drain south into the Campbell's River, while within Acquatoria they generallty drain to the north into Racecourse Creek, which also eventually joins Campbell's Creek. WTG's are to be located on existing cleared knolls, ridgelines and elevated flats.

The WTG's proposed for the BSWF project will be comprised of Suzlon S88 units or equivalent turbine generators, each with a rated output of 2100 kW (2.1 MW), signifying a project capability of approximately 47,000,000 kWh annually. The hub height is 80m, with the rotor having three blades on a horizontal axis. The diameter of the rotor is 88m and covers a swept area of 6082 m². Automatic controls enable the turbines to face into the wind and to vary operation speed according to wind speed. An 800 – 1,000 ton crane (crawler or wheel based) will be used to erect the WTG's. An auxiliary 200-ton crane will also be used to assist the primary crane during construction.

The turbines will be connected through a 33kV underground cable network to a substation within the wind farm area. This proposed substation will then be connected to the Country Energy Oberon – Burraga 66 kV transmission line which passes directly north of the proposed substation location. The cable laying process involves a trenching machine digging a trench approximately 300mm wide by 0.8m-1.0m deep followed by a cable trailer feeding out cable. The trench is partly filled with sand after which optical fibre is laid and the trench is back filled. Control cables will also link the turbines to a facilities building which will house an office, electrical and computer equipment, storage, kitchen and amenities.

Access tracks required for the construction and maintenance of the wind farm are located on private land and typically follow the underground cable network and, if possible, existing farm tracks. Tracks will be graded and road base gravel applied to facilitate the high construction loads and will be returned to 4WD access tracks post construction depending on landholder requirements.

The main construction site will be the substation location where the operations and maintenance centre will also be based.

It is anticipated that BSWF will commence construction in the late 2006 / early 2007, with construction completion expected in mid to late 2007.

Figure 1-2 indicates the proposed location of the wind turbines and the surrounding area on an aerial photo.

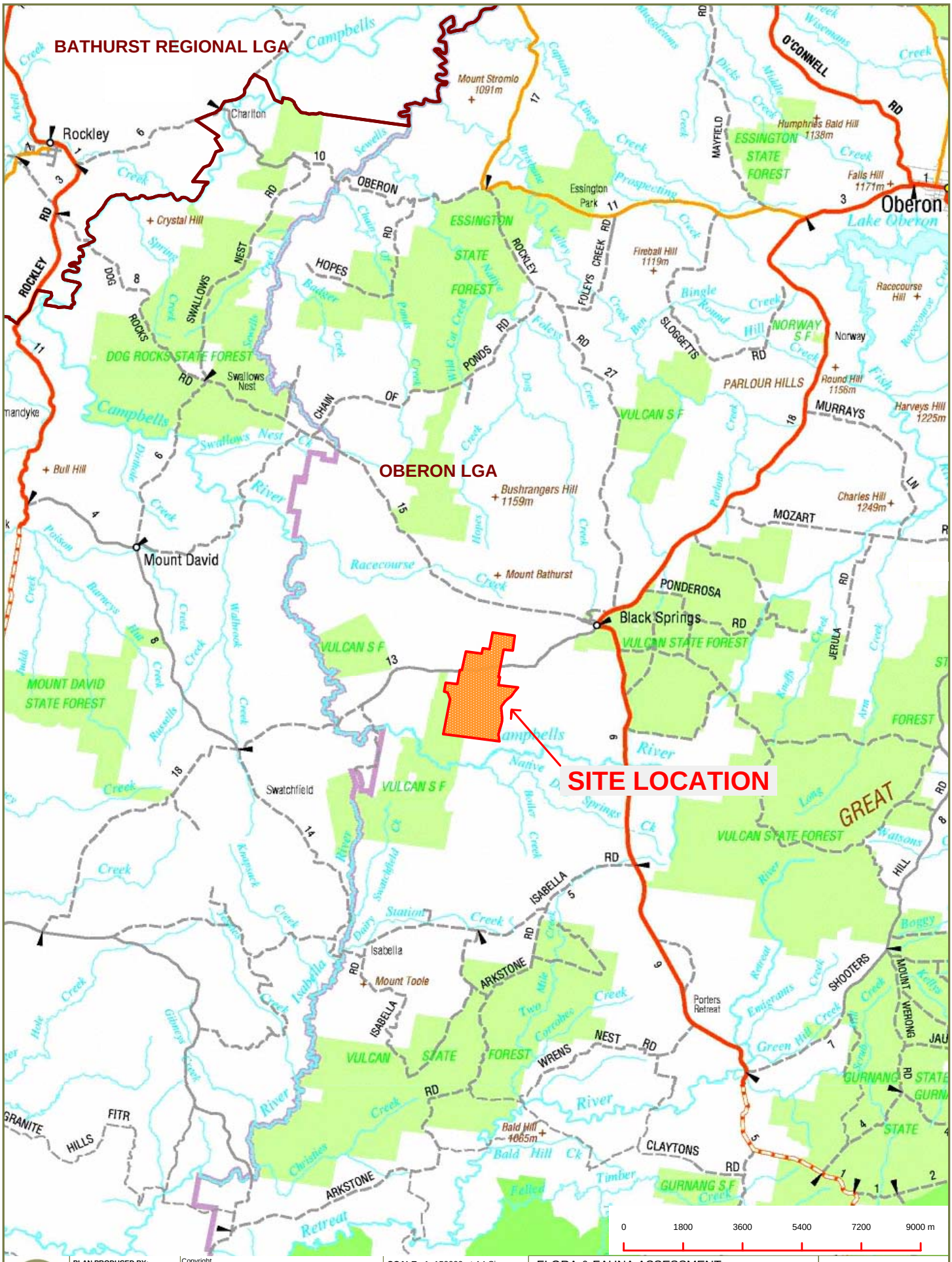
## 1.2 Purpose and Scope

The purpose of this flora and fauna assessment report is to:

- enable the presence or likely presence of components of biodiversity to be documented prior to the making of planning, land management and development decisions for the proposal;
- enable planning, land management and development decisions to be based on sound scientific information and advice;
- identify and document the known and potential ecological impacts of the proposal; and
- enable compliance with applicable assessment requirements contained within the EPA Act, TSC Act, FM Act, EPBC Act, and any other relevant state, regional and local environmental planning instruments.

## 1.3 Site Particulars

- **Locality** – Black Springs, Oberon Shire (see Figure 1-1).
- **LGA –** Oberon
- **Study Area –** 527 ha
- **Zoning –** Rural 1(a)
- **Current Land Use –** Cattle and sheep grazing, agricultural production, rural dwellings.
- **Topography –** The site lies on the Great Dividing Range (western Blue Mountains) with height ranges of 1120 - 1230 metres AHD.
- **Geology –** The study area is situated upon the Lachlan Fold Belt, which is of the Ordovician – Tertiary age. Kovac et al (1990) describes the geology as being a mixture of basalt caps on the ridges, grading into Rockley Volcanics and Triangle Group geological landscapes;
- **Soils –** Red earths, yellow earths and krasnozems on mid slopes and ridges and yellow soloths in valleys. Kovac et al (1990) shows three soil landscapes as occurring within the study area. These are Oberon Soil Landscape (northern boundary of the study area), Porters Retreat Soil Landscape (from the Daisybank trig hill to the northern boundary) and the Vulcan Soil Landscape (over a majority of the study area). The Oberon Soil Landscape consists predominantly of Red earths on mid-upper slopes and Yellow podzolics / Yellow earths on mid-lower slopes. Porters Retreat Landscape consists of krazonems on mid-upper slopes and chocolate soils on midslopes grading into red podzolics and yellow solodic soils on lower slopes. The Vulcan Soil Landscape is dominated by yellow earths on mid-upper slopes and yellow soloths in drainage depressions;
- **Vegetation –** Mainly cleared, although small remnant patches of woodlands composed of Narrow-leaved Peppermint, Mountain Gum and Snow Gum occur. Radiata Pine plantations are also locally common within Vulcan State Forest and windbreaks containing these pines are also present throughout the site.
- **Hydrology –** The site sits on the top of the Great Dividing Range and is characterised by first and second order streams. Several small farm dams occur throughout.





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**DATE:** 01/03/2006
**DATUM:** Longitude / Latitude (AGD 84)
**CONTOUR INTERVAL:**
**DESIGNED:** S. WATSON
**APPROVED:** T. LAMBERT

FLORA & FAUNA ASSESSMENT
BLACK SPRINGS WIND FARM, OBERON LGA

FIGURE 1-1

SITE LOCATION

**LAYOUT REF:**
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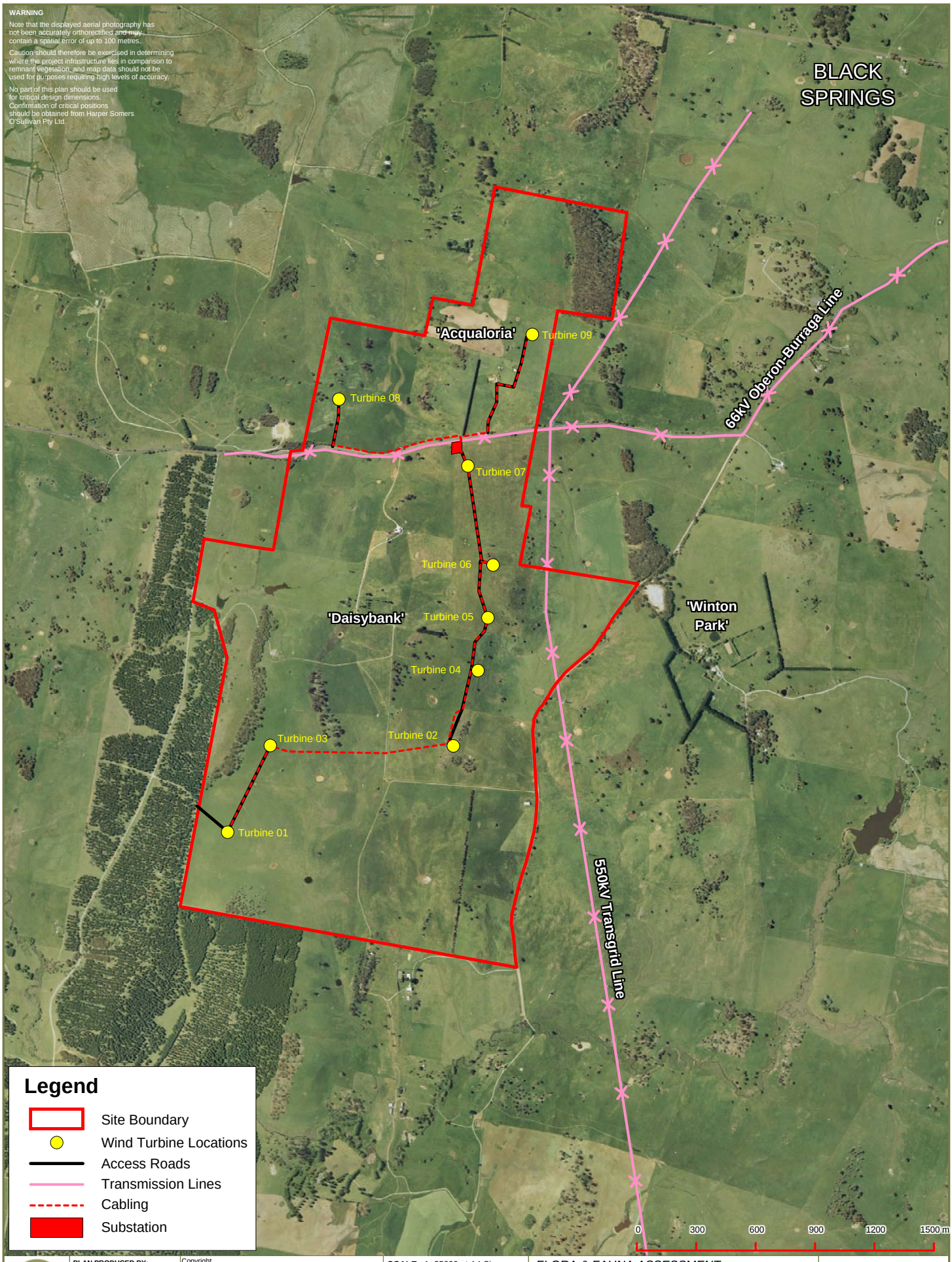


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**CONTOUR INTERVAL:**
**DESIGNED:** P. HILLIER
**APPROVED:** T. LAMBERT

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BLACK SPRINGS WIND FARM, OBERON LGA

FIGURE 1-2

PROJECT LAYOUT

**LAYOUT REF:** J:\JOBS\23k\23219 - Black Springs\Drafting\Mapinfo\23219-F&F FIG 1-2 PROJECT LAYOUT-B-A4

**JOB REF:** 23219

## 1.4 Qualifications, Licensing, and Certification

***Qualifications***

The report and the information from which it was collated, was undertaken by Toby Lambert (BEnvSc), Deborah Landenberger BSc (Hons) and Mick Roderick (BAppSc EAM) (HSO – see Appendix E for more detail).

***Licensing***

Research was conducted under the following licences:

- NSW National Parks and Wildlife Service Scientific Investigation Licence S10300 (Valid 30 October 2006);
- Animal Research Authority (Trim File No: 01/1142) issued by NSW Agriculture (Valid 12 March 2007);
- Animal Care and Ethics Committee Certificate of Approval (Trim File No: 01/1142) issued by NSW Agriculture (Valid 12 March 2007); and
- Certificate of Accreditation of a Corporation as an Animal Research Establishment (Trim No: 01/1522.) issued by NSW Agriculture (Valid 26 May 2008).

As the principle author, I, Toby Lambert make the following certification:

- The results presented in the report are, in the opinion of the principle author and certifier, a true and accurate account of the species recorded, or considered likely to occur within the study area;
- All research workers have complied with relevant laws and codes relating to the conduct of flora and fauna research, including the *Animal Research Act 1995, National Parks and Wildlife Act 1974* and the *Australian Code of Practice for the Care and Use of Animals for Scientific Purposes*.

Signature of Principle Author and Certifier:

**Toby Lambert**
**Senior Ecologist**
**BEnvSc MECA**

# 2 METHODOLOGY

Environmental Resources Management Pty Ltd (ERM) and sub-consultants undertook detailed ecological surveys for the project on 10th – 12th December 2004 (ERM) and in January / February 2005 (sub-consultants). Sub-consultants for ERM were Ekerlogic Consulting Services (ECS) (birds) and Fly By Night Bat Surveys (bats). These sub-consultants are specialist ornithologists and bat zoologists respectively. Follow-up surveys were undertaken by HSO on 17th – 22nd February and 28th – 29th June 2006.

As a consequence, the report herein represents a collation of the methods utilised and results obtained from all of these survey events. It should be noted that the previous surveys were undertaken for a proposed wind farm that consisted of approximately 30 WTG's. The follow-up surveys undertaken by HSO were limited to the site. However these previous studies provided information on the ecological characteristics of the surrounding environments (particularly to the north). Such surveys have been used in this assessment to comment as necessary on known records of relevant species within the locality.

The survey results obtained from ERM (2005) were used to supplement the results and impact assessment of the current project layout. As a consequence, the report herein represents a collation of the methods used and results obtained from all survey events.

During the ERM field studies the weather was not mentioned for all surveys, although it was stated as being 'generally warm and fine over the duration of both bat surveys, with some storm activity affecting the January bat survey'. Weather conditions during the HSO February surveys were generally mild with maximum daytime temperatures between 20° to 26°C and minimum night-time temperatures of approximately 10 to 15°C. During the HSO June surveys, conditions were cold with maximum daytime temperatures around 12°C and minimum night-time temperatures of approximately -7 to -3°C.

The DoP DGRs require consideration of the working draft of the *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities* (DEC 2004). However flora and fauna assessments for wind energy projects, particularly within rural landscapes, require a modified approach to the flora and fauna survey methods normally undertaken for development proposals, such as those required under these working draft guidelines.

The approach detailed herein has therefore also taken into consideration the more wind assessment specific *Best Practice Guidelines for Implementation of Wind Energy Projects in Australia* (AusWEA 2002) and the *Wind Farms and Birds: Interim Standards For Risk Assessment* (AusWEA 2005).

Although the wind power industry is relatively young in Australia, HSO has already prepared a number of impact assessments for wind farms of a range in size (HSO 2004; HSO 2005a-e) and is familiar with ecological issues associated with wind farms. While specific research in Australia is only recent, knowledge is improving with time as more wind farms are proposed and built. It is hoped that monitoring as advised by AusWEA (2002; 2005) will assist in increasing this knowledge.

Wind turbines by their very nature need to be located away from any remnant vegetation that may disrupt wind currents and velocities. Therefore the assessment

of potential impacts requires a shift in focus towards the identification of species at risk of collision with turbines, movement patterns of birds / bats, and key habitat areas and corridors in the vicinity of the turbines. The impacts associated with the infrastructure required to operate and service the turbines, including cabling, roads, and substation(s) also require investigation.

With regards to the current proposal, the majority of survey effort was given to bird / bat surveys (eg. identification of species at risk of collisions), vegetation mapping (eg. presence of endangered ecological communities), and habitat assessment (eg. identification of key habitats, potential movement corridors). Such an approach is consistent with the relevant requirements of DEH (2005), DEC (2004), AusWEA (2005), AusWEA (2002) and PlanningNSW (2002).

The flora and fauna survey methods, as detailed herein, provide sufficient baseline information to make an assessment of the potential use of the site by threatened species (as listed under the TSC Act and the EPBC Act) and to detail the known and potential ecological impacts of the proposal. They also provide baseline data to be used in future monitoring of the operating wind farm.

Names of plants used in this document follow Harden (2002; 2000; 1993; 1992) with updates from PlantNet (Royal Botanic Gardens 2003). Names of vertebrates follow the Census of Australian Vertebrates (CAVS) data maintained by the Department of Environment and Heritage (DEH) (2003).

## 2.1 Data Collation and Literature Review

A review of the information relating to the potential environmental impacts of wind turbines was undertaken. Biodiversity / threatened species data relevant to the site and the wider region was also obtained. Important information sources included:

- Atlas of NSW Wildlife (NSW National Parks & Wildlife Service). Accessed January 2006 including the Oberon 1:100 000 map sheet;
- Birds Australia “Bird Atlas”. Species lists for the 1-degree block covered by the study area. (http://www.abc.net.au/birds/). Accessed February 2006;
- DEC (2004) *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities – Working Draft*. November 2004.
- DEH (2006) *Wind farm collision risk for birds – Cumulative risks for threatened and migratory species.* Prepared by Biosis Research Pty Ltd.
- DEH (2005) *EPBC Act Policy Statements, Supplementary Significant Impact Guidelines 2.1.1 Wind Farm Industry Sector*
- DEH Environment Protection and Biodiversity Conservation Act Protected Matters Search Tool (http://www.deh.gov.au/erin/ert/epbc/index.html). Accessed February 2006;
- AusWEA (2005) *Wind Farms and Birds: Interim Standards For Risk Assessment*. Australian Wind Energy Association. July 2005.
- AusWEA (2004) *Fact Sheet 8: Wind Farms & Bird & Bat Impacts*. Australian Wind Energy Association.

- AusWEA (2002) *Best Practice Guidelines for Implementation of Wind Energy Projects in Australia*. Australian Wind Energy Association. March 2002;
- Planning NSW (2002) *Draft NSW Wind Energy EIA Guidelines*. June 2002.
- ERM (2005) *Draft Black Springs Windfarm Environmental Impact Assessment*. June 2005.
- Ekert, P. A. (2005) *The presence, distribution and movement of bird species at sites proposed for wind turbines at Black Springs, NSW.* Ekerlogic Consulting Services. Wallsend, NSW.
- Hoye, G. (2005a) *Results of the Survey for Bats at the proposed Black Springs Wind Farm, Oberon, New South Wales: A report to Environmental Resources Management Australia Pty. Ltd.* Fly By Night Bat Surveys Pty Ltd, Belmont, NSW.
- HSO flora and fauna reports undertaken previously for wind farms (HSO 2004; 2005a-e)

## 2.2 Flora Survey

Flora surveys were focused on the areas immediately surrounding proposed turbine locations and associated infrastructure (termed the 'development footprint'), such as cabling and access roads. Air photo interpretation and visual assessment and mapping of larger remnant patches was also undertaken to get an appreciation of the communities and habitats present in the wider locality. These survey methods were undertaken by both HSO and ERM.

***Flora Species***

Species of plants on site were assessed and recorded using the random meander technique (Cropper 1993). This technique involves walking in a random manner throughout the site and recording all species seen. The time spent in each vegetation community was generally proportional to the size of the community and its species richness.

***Vegetation Communities***

Delineation of vegetation communities present on the site was based on site observations. No regional vegetation mapping is known to cover the site that would otherwise provide a basis for comparison. The condition of larger remnant patches were visually assessed, mapped and rated according to condition, size, connectivity, etc.

***Rare and Significant Species***

Targeted searches were undertaken for potentially occurring threatened flora species in the vicinity of the proposed turbines and other infrastructure such as access roads, cabling locations and the substation. These searches were undertaken using a sub-metre accuracy GPS Trimble GeoXT to ensure the correct locations were examined.

## 2.3 Fauna Survey

Fauna species present on the site were recorded through observation methods such as point census bird surveys, incidental sightings, spotlighting, identifying bird and frog calls, searches for ground-dwelling reptile species under logs and leaf litter, and by sighting indirect evidence of species presence such as fauna scats, feathers, tracks and hair.

These techniques were conducted with reference to DEC (2004), and were used to derive an inventory of fauna species recorded and in the production of an Expected Fauna Species List for the study area (Appendix B). As previously mentioned, the focus was however shifted to surveying for birds and bats as these are the fauna groups most likely to be impacted by the proposal. In relation to bird surveys the AusWEA (2005) guidelines were also considered. However Ekert (2005) had already completed a comprehensive survey, which was considered to be consistent with these guidelines and sufficient for impact assessment purposes.

***Birds - Flight Activity and Behaviour***

To obtain baseline data on species diversity, abundance, and flight characteristics, formal diurnal bird census was previously undertaken. This was undertaken by Ekert (2005) in four locations at Daisybank, two locations to the north of Acqualoria and five locations at Winton Park (adjoining Daisybank to the east). Larger remnant forest patches away from proposed development areas were also subject to survey by HSO (as shown in Figure 2-1). The HSO methodology followed the 'sample plot counts' (see NPWS 1997), where a 20 minute search within a 1.0 ha area was conducted. All species heard or observed were recorded.

The flight characteristics of individual species were also recorded by Ekert (2005), with flight height ranges split into:

- 0-20m (well below tip of turbine blade);
- 20-40m (below tip of turbine blade);
- 40-120m (rotor swept area - potential collision zone);
- >120m (above tip of turbine blade).

Data collected was generally in accordance with the *Wind Farms and Birds: Interim Standards For Risk Assessment* (AusWEA 2005). The surveys were undertaken in various weather conditions and times during the day to determine levels of activity, behaviour and movement under these varying circumstances.

***Bat Call Detection and Harp Trapping***

Anabat bat detection was used to record and identify the echolocation calls of microchiropteran bats. HSO, ERM and Glenn Hoye all undertook surveys via this method. Refer to Figure 2-1 for their location.

The Anabat surveys previously completed by ERM and Glenn Hoye included, approximately 130 hours of Anabat detection, at various locations, including previously proposed turbine sites and remnant patches of woodland.

HSO also completed supplementary surveys and used a stationary Anabat II bat detector in two locations adjacent to large remnants of woodland within and adjoining

the current subject site, as shown in Figure 2-1. One night was undertaken in February and one night in June by HSO.

Calls recorded by all consultants were analysed by Glenn Hoye, a recognised expert in bat species call identification.

As a subconsultant for ERM, Glenn Hoye also completed surveys consisting of harp trapping in various areas throughout the locality. These surveys were undertaken during both January and February for a total of six nights, using four traps in January and three traps in February. They were undertaken at various locations within and outside of the current subject site, providing detailed information on the species of microchiropteran bats present within the locality.

***Call Playback***

Nocturnal animals were surveyed using call playback, whereby recordings of the vocalisations of animals are broadcast to elicit a response, either vocal or behavioural. Species calls used included Barking Owl, Masked Owl and Powerful Owl. At each site there was an initial 10 minute listening period followed by a five minute call broadcast and then a five minute listening and spotlighting period. For each additional species the two five minute periods would be repeated. A final listening period of 10 minutes would be included after call broadcasting was concluded. Calls were broadcast using a portable CD player and amplified through a megaphone. This was undertaken in two locations, as shown in Figure 2-1.

***Spotlighting***

Spotlighting was undertaken throughout the large forested remnants in the locality (as shown in Figure 2-1) on foot using handheld 100-w spotlights, with the approximate speed of survey being one kilometre an hour.

***Terrestrial and Arboreal Mammal Trapping***

No terrestrial or arboreal mammal trapping was undertaken, given that few or no impacts were expected to terrestrial and arboreal mammal species.

## 2.4 Habitat Assessment

An assessment of the relative value of the habitat(s) present on site was undertaken. Whilst this assessment focused primarily on the identification of specific habitat types / resources that are known to be favoured by threatened species recorded from the region, the assessment also considered the potential value of the site (and surrounds) for all major guilds of native flora and fauna.

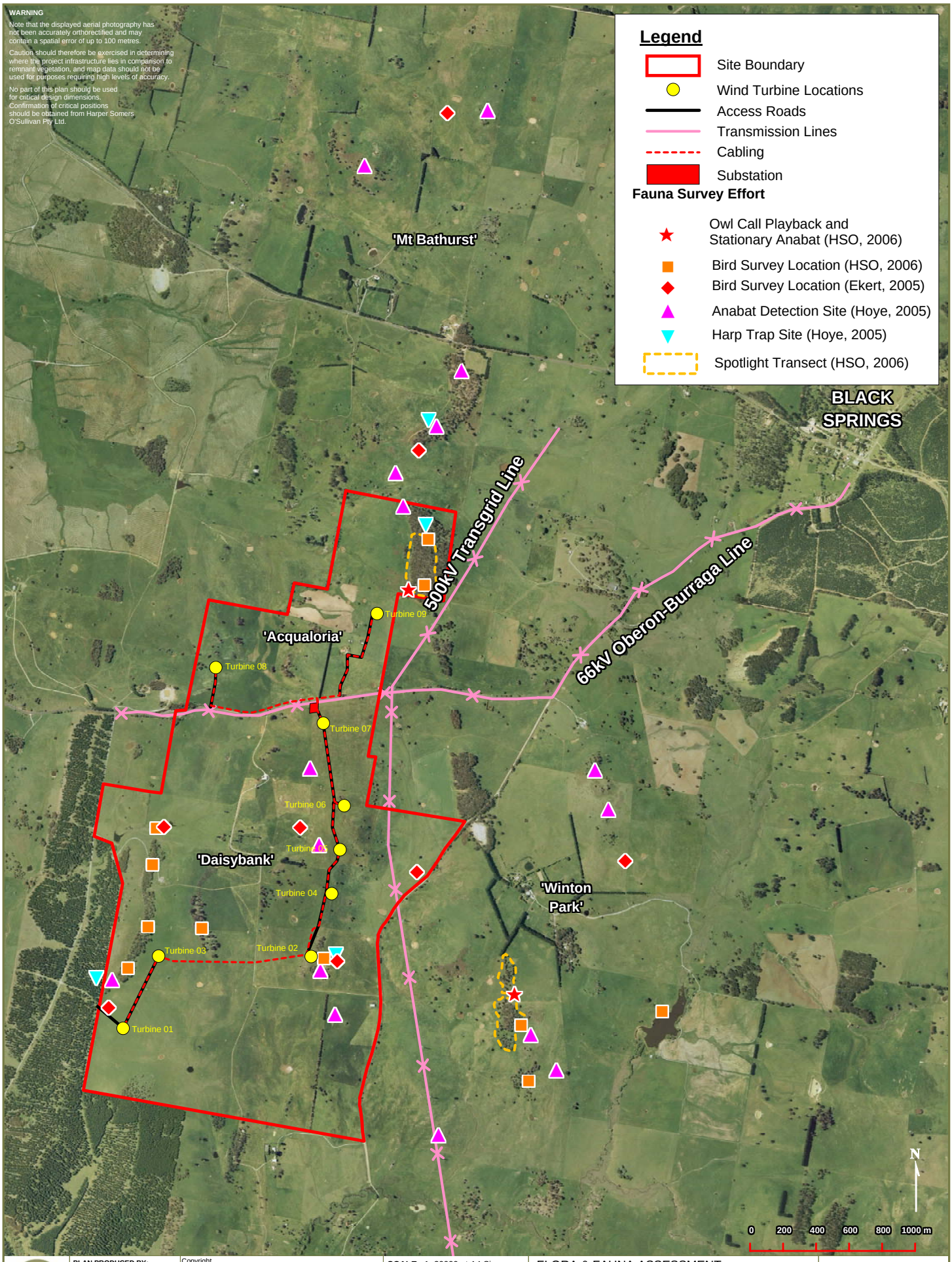
This assessment was based on the specific requirements of each species / guild in regards to home range, feeding, roosting, breeding, movement patterns and corridor requirements for fauna, and vegetation associations, topography, soil, light and hydrology for flora species and assemblages.

The flora, fauna, and habitat surveys provided an assessment of the potential use of the site by threatened species (such as listed under the TSC Act and the EPBC Act) identified from the vicinity of the site.

## 2.5 Limitations

Both HSO and ERM (including subconsultants) undertook flora and fauna surveys in February and June of 2006 and December / January / February 2004/5 respectively. These periods were favourable for surveying species active during warmer months, however a number of species may have been difficult to identify / detect during this period (eg. plants not in flower) or survey intensity was unlikely to detect the full range of species that are likely to use the site (eg. no mammal trapping was undertaken). A number of migratory species (both altitudinal and latitudinal) that may occur seasonally on the site may not have been present in the region during the survey periods. The June survey was also conducted during cold weather. Identification of plants was difficult at this time of year and fauna are known to be less active. However the surveys undertaken in the warmer months are considered likely to have overcome this issue.

Survey intensity was focused on areas in proximity to the development footprint, and large areas of the study area were not visited and/or subject to formal survey techniques. Where possible, these survey limitations have been taken into account with regards to the assessment of the ecological impacts of the proposed development, conduct of the Seven-Part Tests (Appendix A), and known and expected species lists (Appendix B).

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DESIGNED: S. WATSON
APPROVED: T. LAMBERT

FLORA & FAUNA ASSESSMENT
BLACK SPRINGS WIND FARM, OBERON LGA

FIGURE 2-1

# FAUNA SURVEY EFFORT

LAYOUT REF:
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# 3 RESULTS

## 3.1 Flora

The floristic composition of the vegetation can be broadly classified as open forests and woodlands dominated by, *Eucalyptus radiata* subsp. *radiata* (Narrow-leaved Peppermint), *Eucalyptus dalrympleana* subsp. *dalrympleana* (Mountain Gum) with co-dominant species *Eucalyptus dives* (Broad-leaved Peppermint). There are two small patches of *Eucalyptus pauciflora* subsp. *pauciflora* (Snow Gum) which are located on hills at higher elevations within the south eastern portion of the Daisybank property.

No rare or threatened flora species were recorded on-site during the current surveys. Records exist for seven (7) threatened species on the entire Atlas of NSW Wildlife Oberon 1:100,000 Map Sheet and EPBC Act Protected Matters Report. These include *Calotis glandulosa* (Mauve Burr-daisy)*, Lepidium hyssopifolium*, *Eucalyptus pulverulenta* (Silver-leaved Gum), *Diuris aequalis* (Buttercup Doubletail), *Persoonia acerosa, Boronia deanei, Euphrasia scabra* and *Thesium australe* (Austral Toadflax). These species have been assessed within Table 6-1.

Flora species recorded within the study area as part of this survey are shown in Appendix B.

The condition of the vegetation within the study area and wider locality is substantially degraded from over 100 years of European settlement and associated land management practices. Ongoing degradation regimes from cattle and sheep grazing, timber felling, weeds, erosion, and feral animals continue to impact upon the vegetation within the area.

### *3.1.1 Cleared Pasture with Scattered Trees*

This community is the dominant vegetation type over the study area. The vast majority of the study area has been historically utilised over approximately the last century for cattle and sheep grazing. These land uses have resulted in dominance of introduced pasture species and exotic grasses and the invasion of thistles, nettles and other numerous weeds.

In structure it is grassland, with some grasses growing up to 1 metre in height, including the introduced *Cynosurus echinatus* (Rough Dog's Tail Grass) and *Phalaris minor* (Lesser Canary Grass). *Poa sieberiana* var. *sieberiana* (Snow Grass) is also present as a dominant native grass within the pasture areas. Characteristic weeds include *Cirsium vulgare* (Spear Thistle), *Urtica urens* (Small Nettle), *Trifolium repens* (Clover), *Echium vulgare* (Viper's Bugloss), *Taraxacum officinale* (Dandelion), *Marrubium vulgare* (Horehound), *Persicaria* sp. (Smart Weed), *Rubus fruticosus* agg. (Blackberry) and *Verbena bonariensis* (Purpletop). Such species are characteristic of weed infested pastures in grazing country west of the Great Dividing Range.

Scattered trees consist mainly of a number of planted introduced trees and remnant trees of the two semi-natural vegetation communities on the site. Occasional trees of *Acacia dealbata* (Silver Wattle) and *Acacia implexa* (Hickory Wattle) were also present in small numbers. Mature rows of introduced pines (*Pinus radiata*) were located along fence lines within the Acqualoria and Daisybank properties.

### *3.1.2 Narrow-leaved Peppermint - Mountain Gum Open Forest*

This community is the most common treed vegetation type over the study area. While the dominance of each tree species varies in relation to site-specific conditions, these trees remain prevalent thoughout a majority of the remnants within the site.

Within the study area the majority of this community has been cleared for agricultural purposes, and its occurrence is characterised by small remnant patches.

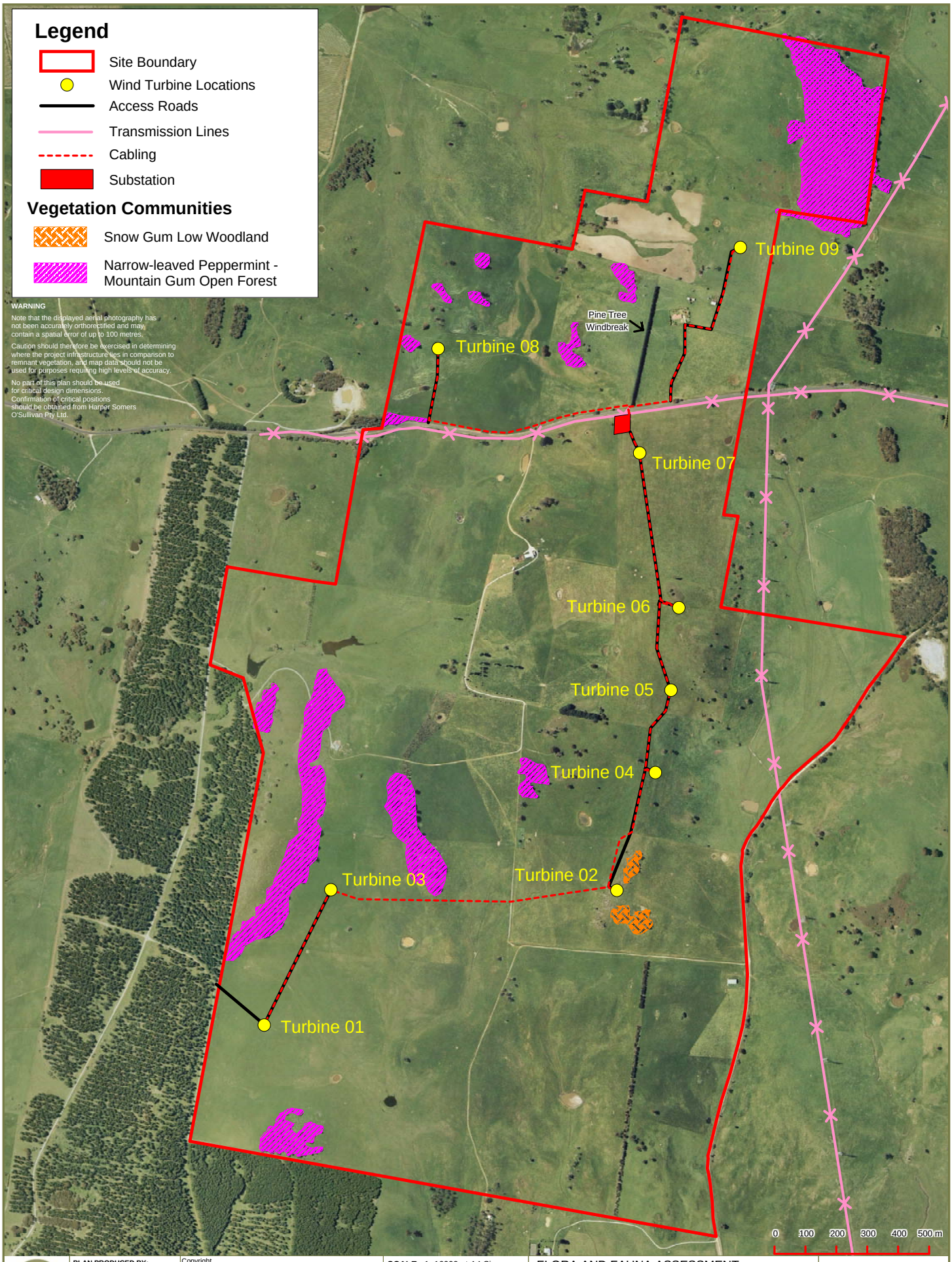
In structure it is an open forest with a height of 22 m with some trees emergent trees reaching 25 m and a canopy cover of between 40% and 50%. The canopy is dominated by *Eucalyptus radiata* subsp. *radiata* (Narrow-leaved Peppermint), and *Eucalyptus dalrympleana* subsp. *dalrympleana* (Mountain Gum) with *Eucalyptus dives* (Broad-leaved Peppermint) present as a sub-dominant species.

The understorey was mostly absent with the exception of the occasional *Acacia dealbata* (Silver Wattle) shrubs scattered throughout this vegetation community. The groundlayer is characterised by introduced grasses such as *Cynosurus echinatus* (Rough Dog's Tail Grass) and *Phalaris minor* (Lesser Canary Grass) where it adjoins the edges of the pasture, these grasses decrease in cover and *Poa sieberiana* var. *sieberiana* (Snow Grass) dominates the groundlayer with herbs such as *Einandia trigonos* subsp. *trigonos* (Fishweed) and *Gonocarpus tetragynus* (Poverty Raspwort). The dominant weeds within the groundlayer include *Acaena ovina* (Sheep's Burr), *Cirsium vulgare* (Spear Thistle), *Hypochloris radiata* (Flatweed), *Urtica urens* (Small Nettle) and *Trifolium repens* (Clover).

### *3.1.3 Snow Gum Low Woodland*

This community occurs in two small remnant patches near the most southerly proposed wind turbine in the Daisybank property. These two small remnants are situated upon a ridgeline that is very exposed and which eventaly rises to a trig station further to the north. Dominant within the canopy layer are *Eucalyptus pauciflora* (Snow Gum), which appear to have been stunted due to the low temperatures and high winds at this particular location.

In structure it is a Low Woodland, with trees being between 5 – 10 metres in height and the canopy cover being 10 – 30%. These remnants are highly disturbed and have been subject to continuing disturbance over a number of decades, such as irregular clearing, grazing and weed disturbance. The understorey was absent from all inspected remnants, while the groundlayer was characterised by introduced grasses such as *Cynosurus echinatus* (Rough Dog's Tail Grass) and *Phalaris minor* (Lesser Canary Grass) The prevalence of weeds at the groundlayer was noticeable, with common species being *Acaena ovina* (Sheep's Burr), *Cirsium vulgare* (Spear Thistle), *Chondrilla juncea* (Skeleton Weed), *Trifolium repens* (Clover) and *Hypochoeris radicata* (Catsear). While the exotics dominated the groundlayer within this vegetation community a small number of natives were also present. These included the native grasses *Poa sieberiana* var. *sieberiana* (Snow Grass), *Austrodanthonia caespitose* (Ringed Wallaby Grass) and the herb *Einandia trigonos* subsp. *trigonos* (Fishweed).

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| AMENDMENT | DATE | TYPE |
|---|---|---|
| A | | |
| B | | |
| C | | |
| D | | |

**SCALE:** 1: 16000 at A4 Size
**DATE:** 15/8/2006
**DATUM:** AMG Zone 55 (AGD 66)
**CONTOUR INTERVAL:**
**DESIGNED:** P. HILLIER
**APPROVED:** T. LAMBERT

FLORA AND FAUNA ASSESSMENT
BLACK SPRINGS WIND FARM, OBERON LGA

FIGURE 3-1

VEGETATION COMMUNITIES

**LAYOUT REF:** J:\JOBS\23k\23219 - Black Springs\Drafting\Mapinfo\23219-F&F FIG 3-1 VEGETATION COMMUNITIES-B-A4

**JOB REF:** 23219

**Figure 3-2 Cleared Pasture with Scattered Trees**

**Figure 3-3 Narrow-leaved Peppermint - Mountain Gum Open Forest**

**Figure 3-4 Snow Gum Low Woodland**

## 3.2 Fauna

A total of 110 vertebrate fauna species were recorded during formal and opportunistic surveys, including 103 native and 7 introduced species. The species recorded, and those that have the potential to occur are considered to be typical of the habitats present on the site and in the wider locality. Recorded and expected fauna species lists are detailed in Appendix B.

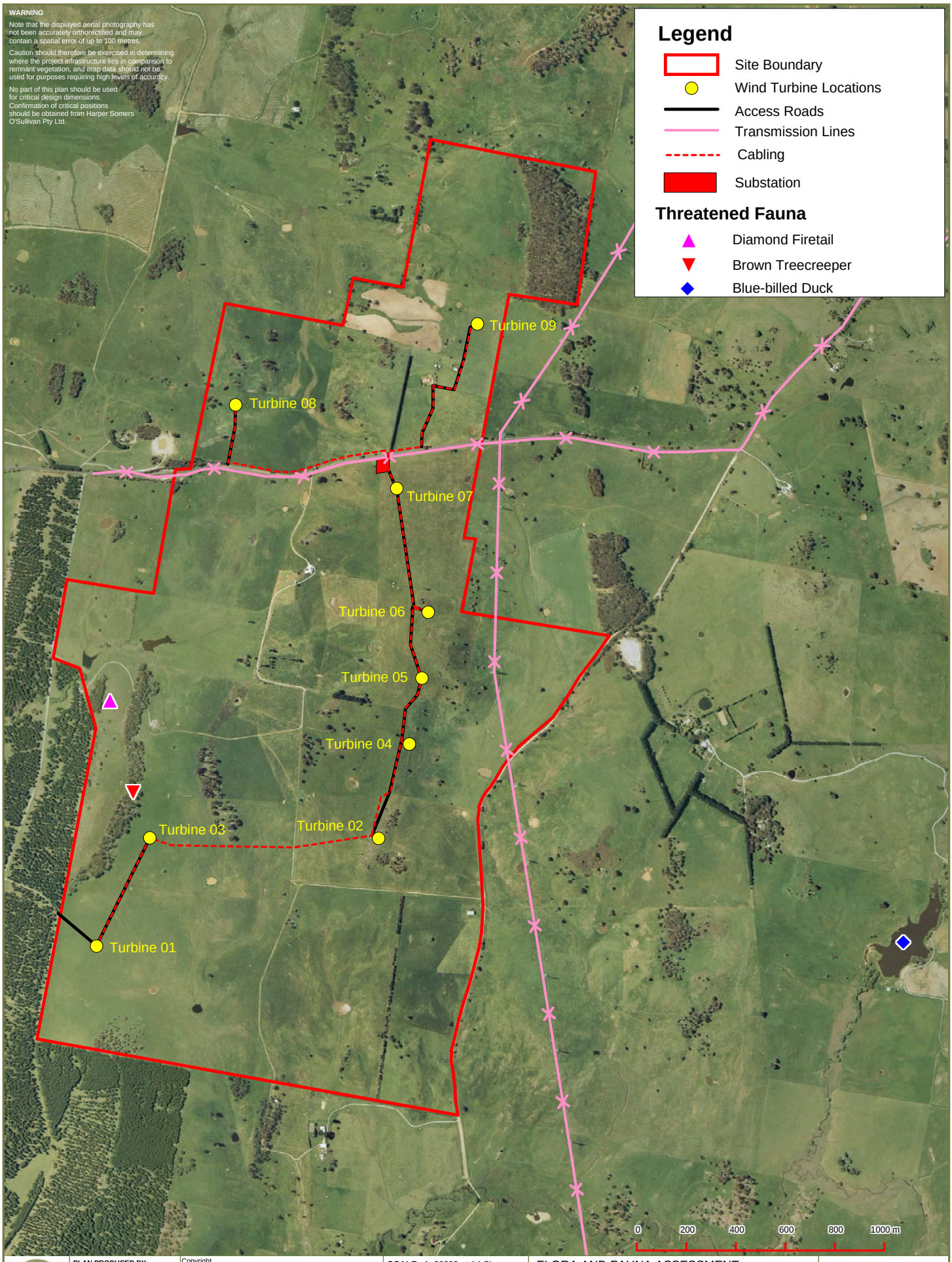
Five (5) threatened fauna species were recorded during the current and / or previous surveys, including *Oxyura australis* (Blue-billed Duck), *Miniopterus schreibersii* (Eastern Bent-wing Bat), *Falsistrellus tasmaniensis* (Eastern Falsistrelle), *Saccolaimus flaviventris* (Yellow-bellied Sheathtail Bat) and *Myotis adversus* (Large-footed Myotis). Both HSO and Ekert (2005) recorded the Blue-billed Duck in the large dam in the eastern part of Winton Park, which is now not part of the proposal. All threatened bat species were recorded at Mount Bathurst, with the latter two being only recorded there. The Eastern Bentwing Bat was also recorded at Daisybank, while the Eastern Falsistrelle was also recorded at both Winton Park and Daisybank. The Brown Treecreeper and Diamond Firetail have been recorded irregularly by the Daisybank landowner (G. Douglas) to the west of his dwelling in open forest and disturbed riparian habitat respectively. These species are assessed within Table 6-1.

All species are listed as 'Vulnerable' under the TSC Act.

Notable species recorded within the study area by ERM (2005) and HSO included:

- terrestrial mammals such as *Macropus giganteus* (Eastern Grey Kangaroo) *Vombatus ursinus* (Common Wombat) and *Tachyglossus aculeatus* (Short-beaked Echidna);
- arboreal mammals such as *Pseudocheirus peregrinus* (Common Ringtail Possum) and *Petaurus breviceps* (Sugar Glider) (anecdotal report);
- microchiropteran bats such as the threatened species aforementioned;
- birds such as the threatened *Oxyura australis* (Blue-billed Duck) as well as *Coturnix pectoralis* (Stubble Quail), *Elanus axillaris* (Black-shouldered Kite), *Aquila audax* (Wedge-tailed Eagle) and *Hirundapus caudacutus* (White-throated Needletail); and
- herpetofauna including anecdotal reports of *Austrelaps ramsayi* (Highlands Copperhead);

There was also a high noted occurrence of introduced pests such as rabbits, European hares, and foxes. Cattle and sheep (and some horses) were recorded in all habitats throughout the study area.

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| AMENDMENT | DATE | TYPE |
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| A | | |
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**SCALE:** 1: 20000 at A4 Size
**DATE:** 15/8/2006
**DATUM:** AMG Zone 55 (AGD 66)
**CONTOUR INTERVAL:**
**DESIGNED:** P. HILLIER
**APPROVED:** T. LAMBERT

FLORA AND FAUNA ASSESSMENT
BLACK SPRINGS WIND FARM, OBERON LGA

FIGURE 3-5

THREATENED SPECIES RECORDS

**LAYOUT REF: J:\JOBS\23k\23219 - Black Springs\Drafting\Mapinfo\23219-F&F FIG 3-5 THREATENED FAUNA-B-A4**

**JOB REF:** 23219

### *3.2.1 Key Observations from Bird Surveys*

Specific information was collated on avian diversity, activity, and behaviour. This was undertaken because birds are noted within the scientific literature as the fauna group (along with bats) most likely to be impacted upon through collisions with turbines, avoidance behaviour, and loss of habitat. Further information in this regard, including the potential impacts to fauna species is discussed in Chapter 4.

The results of the 13 bird census points undertaken by Ekert (2005) (including height ranges frequented, habitats, movements, and flight speed) undertaken in representative locations within the study area have been collated and are presented in Table 3-1. On the basis of these formal surveys and opportunistic sightings, which were undertaken during varying weather conditions and diurnal periods, the following key observations were made:

- there was a relatively low recorded diversity of bird species, especially in cleared areas (including at proposed turbine locations);
- there were relatively low numbers of individual birds recorded (including at proposed turbine locations);
- majority of observations were of localised movements within cleared areas and between forest patches;
- a number of species were recorded routinely flying at rotor height (40-120m) – see Table 3-1;
- one threatened bird species was recorded (Blue-billed Duck). Brown Treecreepers and Diamond Firetails were not observed;
- a higher diversity of species was recorded in the larger remnant forest patches and in areas containing smaller 'stepping-stone patches' and scattered trees between larger remnants;
- no specific areas were identified as being significant wildlife corridors, which is possibly due to the variegated nature of habitats across the wider landscape;
- the most prevalent species recorded included Australian Magpie, Pee-wee, Australian Raven, Sulphur-crested Cockatoo and Crimson Rosella;
- raptors including Wedge-tailed Eagle and Black-shouldered Kite were occasionally observed throughout the study area;
- most forest / woodland species such as honeyeaters, thornbills, fantails, treecreepers, and whistlers were restricted to their specific habitats (remnant forest patches); and
- populations of wetland / waterbirds were usually restricted to several individuals / small groups within or in close proximity to small farm dams.

## Table 3-1 Results of Formal and Opportunistic Bird Census

| Species | Height Ranges Frequented (metres) | | | | Habitat | Movements | Flight Speed |
|---|---|---|---|---|---|---|---|
| | 0-20 | 20-40 | 40-120 | 120+ | | | |
| Stubble Quail | | | | | Grassland/Woodland | Locally nomadic | Swift (but short) |
| Australian Wood Duck | | | | | Wetlands | Locally nomadic | Med |
| Pacific Black Duck | | | | | Wetlands | Nomadic | Swift |
| Grey Teal | | | | | Wetlands | Nomadic | Swift |
| Blue-billed Duck (V) | | | | | Wetlands | Regionally / seasonally nomadic | Swift |
| Australasian Grebe | | | | | Wetlands | Sedentary/dispersive | Medium |
| Great Cormorant | | | | | Grassland | Locally nomadic | Slow |
| White-faced Heron | | | | | Wetlands/Grassland | Locally nomadic | Slow |
| Black-shouldered Kite | | | | | Grassland/Woodland | Locally nomadic/dispersive | Medium |
| Brown Goshawk | | | | | Forest/Woodland | Sedentary (large territory) | Slow – Swift |
| Wedge-tailed Eagle | | | | | Forest/Woodland/ Grassland | Sedentary (large territory) | Slow – Swift |
| Nankeen Kestrel | | | | | Grassland/ Woodland edges | Sedentary/Dispersive | Slow – Swift |
| Eurasian Coot | | | | | Wetlands | Sedentary/Dispersive | Slow |
| Galah | | | | | Woodland/Grassland | Locally nomadic | Medium Flocks |
| Sulphur-crested Cockatoo | | | | | Forest/Woodland/Grassland | Locally nomadic | Medium Flocks |
| Crimson Rosella | | | | | Forest | Sedentary | Medium |
| Eastern Rosella | | | | | Forest/Woodland/Grassland | Sedentary | Medium |
| White-throated Needletail | | | | | Aerial | Nomadic Seasonal migrant | Swift |
| Laughing Kookaburra | | | | | Forest/Woodland | Sedentary | Slow |
| White-throated Treecreeper | | | | | Forest | Sedentary | Medium |
| Yellow-rumped Thornbill | | | | | Woodland/Grassland | Sedentary | Slow |
| Red Wattlebird | | | | | Forest/Woodland | Locally nomadic | Slow |
| Yellow-faced Honeyeater | | | | | Forest/Woodland | Locally nomadic/Seasonal migrant | Medium |
| Grey Shrike-thrush | | | | | Forest/Woodland | Sedentary | Medium |
| Willie Wagtail | | | | | Woodland/Grassland | Sedentary | Slow |
| Grey Fantail | | | | | Forest | Sedentary/Seasonal Migrant | Slow |
| Black-faced Cuckoo-shrike | | | | | Forest/Woodland | Locally nomadic | Medium |
| Grey Butcherbird | | | | | Forest/Woodland | Sedentary | Medium |
| Magpie-lark | | | | | Forest/Woodland/Grassland | Sedentary | Slow - Medium |
| Australian Magpie | | | | | Forest/Woodland/Grassland | Sedentary | Medium - Swift |
| Pied Currawong | | | | | Forest/Woodland | Locally nomadic | Medium - Swift |
| Australian Raven | | | | | Forest/Woodland/Grassland | Locally nomadic | Medium |
| Richard's Pipit | | | | | Grassland | Aerial Breeding displays | Medium |
| Red-browed Finch | | | | | Grassy Forest/Woodland | Sedentary | Medium Flocks |
| Fairy Martin | | | | | Exotic Pest | Sedentary | Medium |
| House Sparrow | | | | | Exotic Pest | Sedentary | Medium |
| Silvereye | | | | | Forest | Seasonal nomad | Medium Flocks |
| Common Starling | | | | | Exotic Pest | Locally nomadic | Swift Flocks |

*Key:* *= Species commonly recorded at this height range*
*= Species occasionally recorded at this height range*
*= Species rarely recorded at this height range*

## 3.3 Habitat Attributes

Quantitative data is not available on the anthropogenic impact of clearing activities on the local environment, as no vegetation mapping is readily available for the Oberon LGA (Oberon Council 2005). However, it is common knowledge that the Oberon area and surrounding districts has been subjected to historical and ongoing large-scale clearing of native vegetation. In many cases this cleared native vegetation has been replaced with introduced pine plantations and the Oberon area is particularly well known for the occurrence of such forests.

The study area is also typical of the wider bioregion with approximately 95% of native vegetation cleared and all properties within it are managed as active cattle and sheep farms. Flora and fauna habitats primarily consist of three broad habitat types: open forest / woodland; creeklines, soaks and dams; and cleared areas.

Many of the native flora and fauna species recorded or considered likely to occur on the site are those tolerant of a fragmented landscape. A number of other species that have specific habitat requirements (including many threatened species) are no longer present within the locality.

In the majority of areas, including most of the larger remnants, the understorey is absent due to livestock grazing and trampling.

The forested areas offer potential habitat for a variety of native fauna. A variety of bird species may use the forested habitats, particularly during flowering periods. Nesting habitat also exists for many bird species, including for larger cavity-dependant species such as owls and parrots. Potential habitat for terrestrial, arboreal, and flying mammals also exists, including nesting / roosting habitat in the form of tree hollows of various sizes. Caves that provide roosting habitat for cave-dwelling microchiropteran bats may occur in the locality, however the closest known maternity roost site occurs at Drum Cave, Bungonia (Hoye 2005a) (near Goulburn 140 km south).

Elsewhere, isolated paddock trees or small remnant patches of less than 1ha occur in otherwise cleared areas (see Figure 1-2). Whilst larger remnants provide most ecological attributes, scattered trees are also considered likely to play an important role in ecosystem functioning and productivity, and have been shown to be an important habitat feature for fauna, including foraging insectivorous bats (Lumsden & Bennett 2000). A number of bird species were noted foraging and nesting in scattered trees. Dieback, senescence, and lack of recruitment due to grazing threatened the longer-term viability of scattered farm trees and hence this habitat resource within the study area.

Historical clearing and selective tree lopping have substantially reduced the density of tree hollows throughout forested areas. It can be inferred that the demand for hollows is likely to exceed that which is currently available and the availability of hollows is likely to be a limiting factor for the size and distribution of hollow dependent fauna populations.

The large farm dam in the eastern part of Winton Park (outside of the study area) supports the Blue-billed Duck. The numerous small farm dams throughout the area provide habitat for wetland / water birds and frogs. Creeklines are generally degraded through clearing, erosion, sedimentation, and pollution from cattle and sheep dung.

In forested areas where a grassy understorey occurs and/or in cleared areas, habitat for macropods exists and where present leaf litter may be used by reptiles and small mammals. The cleared areas provide little habitat for native species aside from potential foraging habitat for macropods or granivorous birds.

Exposed rocks, which are common throughout the study area, also provide habitat for reptiles and small mammals. Exposed rocks and other ground debris are considered to be significant for the retention of terrestrial faunal diversity in a modified landscape (Michael, Lunt & Robinson 2004).

Ongoing patterns of degradation from weeds, erosion, grazing, and feral animals continue to impact upon the above mentioned habitat attributes such that the current biological diversity of the study area has been significantly reduced.

Of the numerous exotic species within the study area, two are considered to be 'problem weeds', namely *Rubus fruticosis* agg. (Blackberry) and *Cirsium vulgare* (Spear Thistle). Both species are prevalent in both cleared and forested areas and require ongoing management from landowners to keep them under control.

Feral animals including foxes, goats, rabbits, European hares, as well as cattle, sheep and horses impact on habitat attributes in a number of ways, including reduction in native fauna populations, simplification of understorey and pollution of waterbodies. Grazing in particular has lead to a depletion of the understorey, decline of native grass and forb species, and lack of regeneration of trees.

## 3.4 Significant Habitats within the Locality

The wider region (Oberon, Lithgow, Mulwaree and Crookwell LGA's) supports a number of ecologically significant areas. No major known bird migratory wetlands are located within close proximity to the site, although other reserves include:

- Abercrombie River National Park –forest with habitat for a number of threatened flora and fauna species. Located approximately 16 km south of the project site;
- Blue Mountains and Kanangra-Boyd National Parks – World Heritage conservation reserves located approximately 25 km east of the project site;
- Copperhannia and Razorback Nature Reserves – Important conservations reserves located approximately 45km to the west; and
- Evans Crown and Wambool Nature Reserves - Important conservations reserves located approximately 45km to the north.

It can be seen from the above information that much of the conserved habitats within the broader region are located substantial distances from the site. A major reason for this is the ongoing land uses within the region for forestry and agriculture.

## 3.5 Key Habitats and Corridors

### *3.5.1 Background*

The NSW National Parks and Wildlife Service (now Department of Environment and Conservation) and Local Councils have undertaken various habitat and corridor mapping programs throughout NSW. However, at this stage, no corridor mapping is known to have occurred within Oberon LGA.

### *3.5.2 Key Habitats and Corridors at Black Springs*

In terms of forested habitats, the wider locality is occupied primarily by monotypic stands of commercial pine plantations in areas such as Vulcan State Forest, Mount David State Forest, Dog Rocks State Forest, Essington State Forest and Norway State Forest. The site is centrally located within a predominantly cleared landscape, which is surrounded by these State Forests. The distance between State Forests in the locality is on average approximately 5km.

These forests are likely to provide shelter and general connectivity for some native fauna species within the locality, although they are of poor value in terms of providing foraging habitats or nesting hollows / microhabitat components. However in some areas, native forests have been retained within these State Forests, mostly as 'islands'. These areas of forests with native trees contain important habitats within the broader context of an otherwise predominantly cleared landscape.

Outside of the State Forests, the landscape is primarily pasture with scattered trees. Creeklines contain little native vegetation in many areas, limiting their value in terms of providing habitat or connectivity. Some boundaries have been planted with exotic pines, while others support stands of native trees. These contribute to the limited connectivity within the locality.

Some remnant patches have been retained and these range in size from a few trees to approximately 10ha. The larger of these remnants provide important habitat in their own right, while all of these remnants are likely to function as important 'stepping stones' for mobile fauna such as birds and bats.

# 4 ECOLOGICAL IMPACTS OF THE PROPOSAL

The known and potential impacts of the proposal were determined by both site-specific surveys (eg. areas of potential vegetation removal from project infrastructure were surveyed by GPS if necessary to quantify impacts) and by a review / interpretation of the existing scientific literature and data collated from the site.

Given the size and scale of the project, the ecological impacts of the proposal are expected to be comparatively minimal. This is due to the following factors:

- Wind turbines are a non-polluting renewable energy source and reduce greenhouse gas emissions from other sources of power generation by significantly displacing generation from coal and gas fired power plants (thereby addressing the problem of climate change).
- The area is predominantly cleared of native vegetation with the majority of properties used for cattle, sheep and horse grazing.
- Design phase siting of turbines and associated infrastructure away from vegetated areas.
- There will be minimal removal of trees (if any) and few or no impacts to remnant native vegetation.
- The area does not occur as part of any significant habitat resource for threatened flora and fauna species.
- No significant bird / bat migration corridors were identified or considered likely to occur within the site or within the immediate locality.
- Implementation of a number of recommendations, as specified in Chapter 8.

## 4.1 Vegetation

### *4.1.1 Overview*

The construction of the BSWF may potentially cause some destruction or disturbance to native vegetation through construction of access tracks, cabling and construction of foundations and other associated infrastructure. Soil disturbance and the construction of access tracks may also facilitate the spread of weeds and cause localised erosion / sedimentation or waterway pollution. Wind Corporation Australia will seek to minimise these impacts through effective weed-control and careful construction methods avoiding erosion and waterway pollution.

### *4.1.2 Known and Potential Impacts*

Careful sighting of the turbines and associated infrastructure in cleared areas and along existing access tracks has ensured no native vegetation will be removed or directly impacted upon as a consequence of the proposal. This represents the least possible impact to native habitats on site and native vegetation in general as a consequence of the proposal.

All wind turbines have been located away from remnant stands of native vegetation as far as practicable and no vegetation or individuals trees will be removed as a consequence of the construction and on-going operation of the turbines.

No threatened flora species were recorded in the immediate vicinity of the proposed works. Threatened flora is unlikely to be impacted upon.

Whilst there may be some increased levels of soil disturbance during construction and potential for the spread of weeds, weeds are already dominant within the landscape and these issues will be addressed by the implementation of an Environmental Management Plan (EMP) and / or a Construction Management Plan (CMP) for the project. Weeds will therefore be subject to a higher level of management than is currently the case.

## 4.2 Birds

### *4.2.1 Overview*

Research undertaken both overseas and in Australia has demonstrated two types of impacts to birds: 1) direct mortality from collisions, and 2) indirect impacts from avoidance, habitat disruption and displacement (NWCC 2004; AusWEA 2005).

There are a number of important factors that influence avian mortality. The location of wind farms is seen as a major factor, with those sited near wetlands, critical habitat areas, or along migratory flight paths having greatest impacts. The rates of collisions can be influenced by adverse weather conditions and poor visibility, flight characteristics of birds (eg. fast flying, flocking, and nocturnal flyers may be more prone to collisions) and an individual species' ecology (eg. migratory species may be less familiar with the area).

Turbulence created by the rotors (as a specific consideration) is also likely to affect species and result in a low level of mortality. This aspect of wind turbine impacts has been subject to little available research. Such effects are particularly likely for smaller birds and bats, which would be less able to divert course away from the blades / strong turbulence, once caught in the turbulence zone.

No specific calculations are available to accurately determine the turbulence zone size, although the turbulence zone has been assumed to be likely to be at least 100m in either direction of the rotor blades. Occasional deaths may be likely attributable to birds and bats being caught in such a turbulence zone generated by the proposed wind turbines, however numbers are unlikely to be significant, either due to this specific impact, or to blade-strike in general. This is particularly due to the locations of the turbines being in existing cleared areas.

The probability of adverse bird interactions appears to be both site-specific and species specific. The most important step that can be taken to avoid adverse bird interactions is to locate facilities based on careful siting studies and away from critical habitat (Colson and Associates 1995).

#### *International Examples*

Impacts to birds have been shown to vary among sites and are considered likely to depend on several factors including the amount of bird use, vegetation, and biological characteristics of the specific wind plant and surrounding area (NWCC 2004).

The most quoted international examples of turbines killing large numbers of birds are from poorly situated wind farms at Altamont Pass (California, USA) and Tarifa (Spain). In both cases the wind farms were located along bird migration routes and in critical habitats for endangered species. The Altamont pass wind farm, containing 5,400 smaller turbines with high rotating speeds densely laid on a bird migration route and staging area has killed over 22,000 birds in 20 years of operation, although management practices such as rodent control are thought to have worsened the problem (Rae 2005). Studies conducted at a number of other wind farm sites in the USA and Scotland have recorded minimal to no fatalities, including sites frequented by raptors (Rae 2005).

Based on a review of 12 comprehensive bird-monitoring studies in the USA, fatality rates have averaged 2.3 individuals per turbine per year (NWCC 2004). The impact of wind turbine collisions has been estimated to be less than 0.02 percent of the staggering 200 – 500 million collision related deaths in the USA from other structures such as vehicles (60 – 80 million), buildings and windows (98 – 980 million), and communication towers (4 – 50 million) (AusWEA 2004).

***Australian Examples***

In Australia, collision rates are generally around one to two birds per turbine per year (AusWEA 2004). The most susceptible Australian birds are likely to include:

- birds of prey and owls, particularly soaring species such as eagles and kites;
- nocturnal migrating songbirds;
- locally-breeding high-flying songbirds such as Magpie-larks;
- waterbirds such as Straw-necked Ibis and Black Swans;
- ducks;
- shorebirds, including migratory waders; and
- *Neophema* Parrots (*source:* AusWEA 2002).

Within Australia most wind farm development has been along coastal areas in Western Australia, South Australia and Victoria. In Tasmania, the first two stages of the Woolnorth wind farm have been the subject of a bird and bat strike-monitoring program. There has been some evidence for a slightly decreased usage of the site by birds post-construction and several species have been reportedly hit by turbines including Wedge-tailed Eagles, seabirds such as Petrels, Common Skylark, Grey Fantail, Black Currawong and Banded Lapwing (Rae 2005).

Studies conducted at Stanwell's Toora wind farm in South Gippsland found no evidence of significant levels of bird mortality with any impacts confirmed to localised indirect effects on common farmland birds. Species such as Wedge-tailed Eagles were regularly observed before and after operations began, but avoided the turbines by flying around or between them (AusWEA 2004).

As the Australian industry develops, more information is coming to light that the mortality rates at Australian wind farms are lower than in the northern hemisphere, which appears to be due primarily to the lack of large numbers of night-migrating songbirds in Australia (AusWEA 2004).

### *4.2.2 Known and Potential Impacts*

As the proposal will remove negligible native vegetation, the main potential impacts to birds are likely to be as a result of collisions with turbines and/or avoidance behaviour.

From the results obtained during field surveys, including flight activity and behaviour monitoring, and the collation of available literature, it was possible to assess the collision potential of birds seen or expected to occur within the study area, as shown in Table 4-1. Whilst risk potentials were classified into high / medium / low risks, it should be noted that the overall collision potentials of birds with the wind turbines is considered to remain relatively low, however it was necessary to determine which birds have a greater risk of collision.

Generally, the results indicated that the non-passerines, birds of the Orders Anseriformes (swans, ducks); Ciconiformes (herons, egrets, ibises); Falconiformes (hawks, kites, eagles, falcons); and Psittaciformes (cockatoos, parrots, lorikeets) have greater risk potentials, than the passerines (wrens, warblers, fantails, honeyeaters, whistlers, finches, swallows). The non-passerines generally have flight characteristics that make them more prone to collisions with wind turbines. They are usually larger and less mobile than the passerines and many occur in flocks and in more open areas.

With specific regard to the species noted within the study area, it is considered that raptors (eg. Nankeen Kestrel, Brown Falcon, Swamp Harrier, Black-shouldered Kite, Wedge-tailed Eagle and Peregrine Falcon), wetland / waterbirds (eg. Wood Duck, Straw-necked Ibis), and other common local resident birds (eg. Magpie, Crimson Rosella, Australian Raven) would be most likely to be prone to turbine collisions. Some minor changes to the local distribution and abundance of these species may be expected as a consequence of the ongoing operation of the turbines, although these impacts are not expected to be significant.

The regionally and seasonally nomadic species *Oxyura australis* (Blue-billed Duck) was recorded by both HSO and previously by Ekert (2005) in the large farm dam located in the eastern section of the adjoining Winton Park to the east. Unlike a number of the other recorded wetland / waterbirds, which were recorded in the smaller dams throughout the site, this species has only been recorded in that larger dam by HSO and Ekert (2005). This species remained on the water the entire time it was observed.

NPWS (1999) states that the species favours deep, permanent, well vegetated freshwater swamps, especially those with beds of Cumbungi (*Typha*) species and that daylight hours are spent alone in small, concealed bays within vegetation or communally in large exposed rafts far from shore. It is unlikely that the habitats of the large dam would support breeding habitat for the Blue-billed Duck, given the lack of extensive reed beds and fringing vegetation that would be suitable for the species.

It is known that young birds migrate each year from the natal swamps of inland NSW to non-breeding areas on the Murray River system and coastal lakes of Victoria and South Australia where they moult (NPWS 1999). Experienced dominant breeders tend not to migrate. Breeding occurs in secluded, densely vegetated situations with the nest constructed in Cumbungi beds or other vegetation, generally over water (NPWS 1999).

Movements of this species would be most likely to occur on an annual basis when moving between breeding and foraging areas. It is considered that if the species regularly utilises the large dam on the site, the vast majority of the time would be spent on the water as this is where it would forage and nest. The occasional movements in and out of the dam on an annual basis are considered unlikely to significantly impact this species, particularly given that the nearest proposed wind turbines are located approximately 2km metres to the north west of the dam. The topography of this distance rises relatively steeply. It is considered likely that the birds would fly around the spur to the south, rather than taking off and flying immediately up a steep incline for over half a kilometre. The overall collision potential for this species is considered to be low.

The study area is not located between or close to any significant conservation areas, upland wetlands within the region or potential flight paths between these areas. The regional distribution of bird habitats is also considered to be somewhat limited. Furthermore, no evidence was found to indicate that the locality is used as a corridor between conservation reserves.

Brown Treecreepers and Diamond Firetails generally do not persist in remnants less than 200ha in area. These species have been recorded irregularly by the landowner (G. Douglas) to the west of his dwelling in open forest and disturbed riparian habitat respectively. These species were not observed by either HSO or Ekert (2005), which would seem to indicate an intermittent occurrence within the study area.

Numbers of woodland birds such as robins, treecreepers and many small honeyeaters have declined in the bioregion (Australian Terrestrial Biodiversity Assessment 2002). Although threatened woodland birds such as Brown Treecreepers and Diamond Firetails have been recorded, it is considered that the fragmentation of habitat and other degradation regimes have considerably impacted upon the avian diversity, distribution, and abundance within the locality.

Whilst the proposal may remove a small number of trees, no tree hollows are likely to be removed (potential nesting habitat for Brown Treecreepers), therefore the main impacts to these species would be as a result of collisions with turbines and/or avoidance behaviour.

All turbines are located as far as practicable away from forested areas. These species are unlikely to fly at the height of the rotor blades and when in the study area are likely to remain within the woodlands where previously observed by the landowner, in the west of the study area.

This information suggests that impacts are likely to be mainly restricted to localised indirect effects on common farmland birds, as has been noted elsewhere within Australia (AusWEA 2004). In consideration of the above-mentioned factors, potential impacts to birds are expected to be relatively minimal and inline with stated AusWEA (2002) collision rates of around one to two birds per turbine per year.

Sufficient baseline data has been collected and presented herein, from which a post-construction monitoring program can be established to further assess the impacts of the project on bird species and populations.

**Table 4-1 Collision Potential of Selected Birds Seen or Expected to Occur within the Study Area**

| Birds | Risk Potential | Reasons | Risk Period |
|---|---|---|---|
| ***Non - Passerines*** | | | |
| ***Order: Anseriformes*** Black Swan | Medium / High | Size, low manoeuvrability, occurs in flocks, night flyer, preferred habitat close by. *Waterfowl common collision victim in overseas studies (primarily transmission lines).* | All year |
| Ducks (Chestnut Teal, Pacific Black, Australian Wood Duck) | Medium / High | Occur in flocks (flocks may lack spontaneous manoeuvrability), habitat close by. | All year |
| ***Order: Podicipediformes*** Grebes (Australasian Grebe, Hoary-headed Grebe) | Medium / High | Sedentary during breeding, but nocturnal nomadic movements occur outside of the breeding season. Direct flyer with low manoeuvrability. | Winter |
| ***Order: Pelecaniformes*** Cormorants (Little Pied, Little Black, Great, & Pied) | Medium / High | Highly mobile due to movements between foraging sites. Lower manoeuvrability after feeding. Some species flock reducing the spontaneous manoeuvrability of individuals. | All year |
| ***Order: Ciconiiformes*** Egrets and Herons (Cattle, & Great Egrets, White-faced and White-necked Herons ) | Medium / High | Order of mobile species due to movements between foraging sites. Slow flying and limited manoeuvrability. | All year |
| Ibises (White & Straw-necked) | Medium / High | Fly in 'V' flocks (although usually a great heights), highly gregarious, prefer grasslands. | All year |
| ***Order: Falconiformes*** Falcons (Australian Hobby, Peregrine & Brown Falcons & Australian Kestrel) | High | Flight height, aerial feeding. *Falcons are a common collision victim overseas (wind turbines & transmission lines).* | All year |
| Eagles (Wedge-tailed and Little) | High | Size, lower manoeuvrability in the case of the Wedge-tailed (may carry food on claw) and concentrated prey scanning of Little. There are a number of records of Wedge-tailed Eagle collisions with wind turbines. | All year |
| Kites, Goshawks and Baza (Whistling & Black-shouldered Kites; Brown & Grey Goshawks, Collared Sparrowhawk, Pacific Baza) | High | A group of raptors encompassing open habitat species and those that forage above and within the canopy of forests and woodlands. Most species relatively manoeuvrable in flight, though preoccupation with scanning for prey predisposes them to collision risks. | All year |
| ***Order Gruifomes****:* Crakes, Rails & Gullinules (Eurasian Coot, Dusky Moorhen, Purple Swamphen) | Low | Low frequency of nocturnal movements between wetlands. | All year |
| ***Order: Charadriiformes*** Migratory Waders (Painted and Latham's Snipe) | Low / Medium | Migratory (Snipe Species) tendency to unfamiliarity with surroundings and often move during the night. | Oct – Mar |
| Resident Waders (Dotterels, Plovers & Lapwings) | Medium / High | Most resident species at least nomadic between foraging sites or dispersive in response to rainfall constraints on foraging habitat. Lapwings sedentary with frequent territorial flights. | All year |
| ***Order: Columbiformes*** Pigeons (Crested) | High | Forages in loose groups and exhibits explosive takeoff fights in response to predator threats | All year |
| ***Order: Psittaciformes*** Cockatoos (Galah, Yellow-tailed Black, Glossy, Sulphur-crested and Corellas) | Medium / High | Most occur in flocks and move daily between roosts and feeding areas. Medium manoeuvrability. | All year |
| Parrots (Crimson & Eastern Rosellas and King Parrots). | High | Flocking species exhibiting swift and direct flight. | All year |
| Grass Parrots (Turquoise Parrot) | Medium | Swift flying but more reliant on cover than other parrot species. | All year |
| Lorikeets and Swift Parrot (Rainbow, Scaly-breasted, Musk & Little and Swift Parrot) | High | Highly nomadic swift flying species that tend to move in flocks and small groups in response to the distribution of blossom. Highly manoeuvrable, but speed limits their ability to change direction quickly | All year |

| Birds | Risk Potential | Reasons | Risk Period |
|---|---|---|---|
| | | | |
| ***Order Cuculiformes:*** Cuckoos (Pallid, Fan-tailed, Channel-billed & Koel). | Medium | Most latitudinal or altitudinal migrants. Locally nomadic during breeding season. | Aug – Feb |
| ***Order Strigiformes:*** Owls (Boobook, Masked & Barn). | High | Nocturnal and highly mobile in response to foraging and breeding habits. | All year |
| ***Order Caprimulgiformes*:** Frogmouthes (Tawny Frogmouth) | Medium | Nocturnal movements between habitats. | All year |
| ***Order Apodiformes*** Swifts (White-throated Needletail) | Medium | Swift flying nomad usually at high altitudes. Swift flight direct flight with low manoeuvrability. | Summer |
| ***Order Coraciformes:*** Kingfishers (Sacred, Laughing Kookaburra) | Medium | Movements between foraging and breeding territories. | Spring / Summer |
| ***Passerines*** | | | |
| ***Order: Passeriformes*** Welcome Swallow & Fairy Martin | Medium | Small & able to change direction rapidly. Aerial feeding and flight heights increase risks. | Aug – Apr |
| Richard's Pipit | Medium | High flight heights during breeding cycle. | Spring / Summer |
| Dollarbird | Medium | Aerial forager for flying insects. | Sep – Feb |
| Treecreepers (White-throated) | Low | Forest associations. | All year |
| Sittellas | Medium | Nomadic canopy forager that moves in family groups. | All year |
| Fantails (Willy Wagtail, & Grey) | Low | Low flight heights & foraging behaviour. | All year |
| Wrens (Superb Blue & Variegated) | Low | Low flight heights & foraging behaviour. | All year |
| Pardalotes (Striated and Spotted) and Mistletoe Bird. | Medium | Nomadic canopy foragers. | All year |
| Thornbills (Yellow, Yellow-rumped, Brown and Striated). | Medium | Generally low flying although movements between forest and woodland habitats can be at a reasonable height. | All year |
| Scrubwrens (White-browed). | Low | Understorey species. | All year |
| Honeyeaters (White-eared, White-naped, Yellow-faced, Noisy Miner, Red Wattlebird, Noisy Friarbird & Eastern Spinebill) | Medium / High | Small species are agile flyers but all are locally and seasonally nomadic in response to blossom distribution. Species such as the eastern spinebill feed closer to ground than most honeyeaters. Night migration. | All year |
| Whistlers (Rufous, Golden & Grey Shrike-thrush). | Low | Forest and woodland inhabitants. | All year |
| Cuckoo-shrikes (Little, Black-faced & Cicadabird) | Medium / High | Locally nomadic. | All year |
| Australian Magpie, Butcherbirds (Pied & Grey and Pied Currawong) | Medium / High | Foraging and perching behaviour (in close proximity to blades), flight height. Sedentary nature reduces risk although Currawongs are seasonally nomadic. | All year |
| Raven (Australian & Little) | Medium / High | Perching behaviour, flight heights, nomadic. | All year |

### *4.2.3 Cumulative Impacts*

Cumulative risks of increasing numbers of wind farms has recently been identified as being of concern for particular species of birds and bats in Australia by DEH. This aspect of concern in relation to wind farms has been investigated by Biosis for DEH, with the results contained in a report entitled *Wind farm collision risk for birds – Cumulative risks for threatened and migratory species* (DEH 2006). The report is a collation of six individual reports, with those being:

- An overview of the modelling of cumulative risks posed by multiple wind farms;
- Modelled cumulative impacts on the Orange-bellied Parrot;
- Modelled cumulative impacts on the Tasmanian Wedge-tailed Eagle;
- Modelled cumulative impacts on the Swift Parrot;
- Modelled cumulative impacts on the White-bellied Sea-eagle; and
- Risk level to select species listed under the EPBC Act of collision at wind farms in Gippsland, Victoria.

Of most relevance to the BSWF is the overview of the modelling of cumulative risks posed by multiple wind farms and the risk level investigation of select species at Gippsland. The Swift Parrot report has also been considered, although there are no known records in the locality of this species.

The risk of collision with the rotor blades was identified as being the focus of the cumulative impact investigation for multiple wind farms.

The model requires a high level of data, including the following:

- The numbers of flights each bird species may make below rotor height, and for which just the lower portion of the turbine towers present a collision risk.
- The numbers of bird flights that may occur at heights within the zone swept by the turbine rotors, and for which the moving rotor blades present a collision risk.
- The numbers of movements-at-risk of collision.
- The mean area ($m^2$ per turbine) of the tower, nacelle and stationary rotor blades of a wind generator that present a risk to birds.
- The additional area ($m^2$ per turbine) presented by the movement of rotors during the potential flight of a bird through a turbine.
- A calculation, based on the layout and total number of turbines proposed for a wind farm, of the number of turbines likely to be encountered by a bird in any one flight. This differs according to whether turbines are aligned in a linear or a clustered array on the landscape.
- The known or estimated entire population of the species

This data is then used in the model to assess the likelihood of individual birds being hit (and dying) as a result of flights through the wind farm area. This can be done for either sedentary or migratory species. Each wind farm within the likely movement area of each species is assessed and the likelihood of a bird being hit increases with an increase in wind farms / turbine numbers.

Such data is available, or can be readily predicted for, species such as the Orange-bellied Parrot, Tasmanian Wedge-tailed Eagle, Swift Parrot and White-bellied Sea-eagle. These species have been subject to intensive surveys due to their

conservation status. However, the studies indicate that the general availability of sufficient data for individual species is rare, even for threatened species. At this stage even monitoring data in Australian conditions is rare. No comprehensive investigation of bird or bat avoidance behaviour having been undertaken within any wind farm in Australia, aside from a single short investigation at one wind farm. This is stated as being a significant constraint to predictive cumulative monitoring, which can only be overcome by the accumulation of data from well-designed investigations at operational wind farms.

In terms of cumulative impacts relative to BSWF the closest other known existing or proposed wind farms are located at:

- Blayney Wind Farm, approximately 65km north west, 15 turbines, 9.9 MW, operational;
- Hampton Wind Farm, approximately 40km north east, 2 turbines, 1.2MW, operational;
- Paling Yard Wind Farm (north of Taralga), approximately 30-40km south, 30-50 turbines, 60-100MW, proposed; and
- Taralga Wind Farm, approximately 70km south, 69 turbines, 103 - 109MW, proposed.

No nationally listed threatened bird species were recorded within the project area.

The modelled cumulative impacts of wind farms on the Swift Parrot part of the DEH (2006) report considered the cumulative impacts of all of the listed wind farms above. This is despite Paling Yard and Taralga wind farms not being constructed, although each has been approved by DEH following referrals. This species has not been recorded on the site, however the cumulative assessment is relevant as the distribution of the Swift Parrot is mapped as including the listed wind farms locations and the Black Springs area (although the map is very general). The impact assessment identified that the cumulative impact of the 39 modelled wind farms within the mapped distribution of the Swift Parrot is likely to result in slightly more or less than a single parrot killed every ten years. As such it is considered unlikely that the current small proposal at Black Springs would significantly change the cumulative impact of wind farms on this species.

The three State-listed threatened bird species recorded were Blue-billed Duck, Brown Treecreepers and Diamond Firetails. No data is available that would make a cumulative modelling impact assessment practical for this project, nor is it considered warranted, given the low likelihood of impact upon populations of these species (refer to section 4.2.2 for explanation). Monitoring is proposed and where issues are identified mitigative measures will be implemented.

The Gippsland investigations by DEH indicated that the majority of EPBC Act species investigated would be subject to negligible impacts. Of the species identified at BSWF, the migratory species *Hirundapus caudacutus* (White-throated Needletail) was considered to be at Low risk. The report stated that this species was one of the highest priority species for investigation at Gippsland, although it qualified such a statement by indicating that this priority ranking was only relevant for that study as the potential risk of collision posed by such wind farms was considered to be low overall.

# 4.3 Bats

## *4.3.1 Overview*

There is little information on the impact of wind turbines on bats, although recent information from the US has suggested that bats suffer collision fatality at some level, particularly during migratory periods (NWCC 2004). Bats fly at night, and like other migrating bird species, may be subject to higher collision rates than many other birds. There is also some evidence that higher-flying species such as *Tadarida australis* may be vulnerable to collisions (AusWEA 2002).

To address the growing concern among researchers and the potential for significant impacts to bat populations, the issue of bats and wind farms has been the subject of cooperative research efforts to understand and deter bat mortality.

The issue was the subject of a workshop / presentation at the Australasian Bat Society Conference in Melbourne (Glenn Hoye pers. comm.). The outcomes of the workshop included:

- potential threats to bats from wind farms include blade strike, disruption to populations from noise, and by clearance of vegetation removing roosts and foraging resources;

- the issue of resident and migrating or nomadic bat species was highlighted including the identification of significant maternity roosts (such as for *Miniopterus schreibersii*) and the presence of important forest remnants within the locality during pre-development assessments;

- results achieved to date include: bats have been observed flying through rotor swept area with occasional collisions; bats appear to investigate both stationary and moving blades; and the ratio of avoidance behaviour to contact with blades is high; and

- discussion included potential mitigation efforts, post development monitoring programs and required future research.

## *4.3.2 Known and Potential Impacts*

A number of microchiropteran bat species are known to occur in the area or have the potential to occur, including the threatened *Miniopterus schreibersii* (Eastern Bent-wing Bat), *Falsistrellus tasmaniensis* (Eastern Falsistrelle), *Saccolaimus flaviventris* (Yellow-bellied Sheathtail Bat) and *Myotis adversus* (Large-footed Myotis). All threatened bat species were recorded at Mount Bathurst, with the latter two being only recorded there. The Eastern Bentwing Bat was also recorded at Daisybank, while the Eastern Falsistrelle was also recorded at both Winton Park and Daisybank.

These species occur in a variety of habitats including woodlands and open grasslands (Churchill 1998).

The proposal is unlikely to remove any native trees and no tree hollows are likely to be removed (potential roosting habitat), therefore the main impacts to these species would be as a result of collisions with turbines and/or avoidance behaviour.

Wind turbines have been located as far as practicable away from the remnant patches. In the majority of cases, this means that they are located 100 – 700 metres from these remnants in cleared areas. The most southern wind turbine on the Daisybank property is located in between two small remnant patches of Snow Gum Low Woodland. The height of the trees within the vegetation community is up to 10 metres. This tree canopy height is less likely than woodlands or forests to direct flying fauna towards the wind turbines (the blades of which are located another 30 metres higher). Individuals foraging in cleared grassland areas, scattered trees, and/or flying between patches of forested habitat may be considered to be at some minor potential risk.

Whilst it is acknowledged that there may be a potential loss of an unknown number of individuals due to turbine strikes, it is considered unlikely that this will place any local population(s) of these species at risk of extinction given that their key habitat features including forested areas, caves and tree hollows will remained unaffected.

Although the threatened *Pteropus poliocephalus* (Grey-headed Flying-fox) is likely to occasionally occur during the flowering of eucalypts in the region, no NPWS Atlas of NSW Wildlife records exist within the area, suggesting the locality is not significant to the species, and accordingly few or no impacts are expected. The Grey-headed Flying Fox has not been recorded foraging or flying over the site during either the previous survey by Hoye (2005a) or during the recent summer surveys. Although these surveys were at particular points in time, it could be reasonably expected that were the site part of a regular nightly foraging range or migratory route, some individuals would have been likely to be observed. However, by its very nature, such patterns of movement are unlikely to be regular and so on occasion the species may utilise the site during its nomadic movements. No camps are known to be located in close proximity to the site. It is expected that, were fatalities to occur as a result of impacts with the turbines, these would be minor in relation to deaths occurring via other permitted activities such as culling near fruit farms. Regular monitoring will ensure that this is the case and where required, contingency plans are in place (as likely to be identified in the recommended EMP).

A study by Hoye (2005b) for a proposed windfarm at Crookwell identified that turbines situated in open pasture away from forest remnants are likely to suffer relatively low levels of bat strike although the bat species stated as being of most risk was the White-striped Mastiff Bat. Hoye (2005b) indicated that activity levels of this species were proportionately higher in pasture as against forest remnants when compared to other species and that Hall & Richards (1972) had identified this species as being known to suffer mortality from “Dunlite” wind generators.

It is considered that, while this species occurs on the site, it would also be very common in the immediate vicinity of the site, and is common throughout the locality and region. Although it is likely to be the bat species most susceptible to being injured or killed by the rotating blades, it is considered that the risk of this occurring is still relatively low, given the situation of the blades away from the forested areas. It is considered that if this species is affected, the small number of proposed turbines is unlikely to result in the mortality of a significant proportion of the local population.

Nevertheless, relevant studies of wind farms in Australia and their corresponding impacts on species such as the White-striped Mastiff Bat are few. It is considered appropriate that ongoing monitoring of the turbines occurs to ensure that assumptions made during the assessment process are not flawed due to a lack of available scientific literature. Such monitoring would inform and provide rigorous scientific information that could assist in determining and implementing appropriate

contingency plans for this project, while also assisting in assessing the impacts of future proposed wind farms in other areas.

A post-construction monitoring program has been recommended to further assess the known and potential impacts to bat populations.

### *4.3.3 Cumulative Impacts*

Refer to section 4.2.3 for a detailed explanation of the DEH (2006) report, which applies to bats as it does to birds. The difference is that even less data exists on avoidance behaviour of bats, and monitoring data in general, than it does for birds. No bat species have been modelled, a main reason being likely to be a lack of suitable data. Few bat species are listed under the EPBC Act, which is also likely to be a reason for this lack of cumulative assessment.

The State-listed *Miniopterus schreibersii* (Eastern Bent-wing Bat), *Falsistrellus tasmaniensis* (Eastern Falsistrelle), *Saccolaimus flaviventris* (Yellow-bellied Sheathtail Bat) and *Myotis adversus* (Large-footed Myotis) are known to occur in the locality. It is considered that bat death attributable to the BSWF in addition to the surrounding operating and approved wind farms is unlikely to be significant on populations of any of these species (refer to section 4.3.2 for explanation). Monitoring will ensure that this is the case and mitigative measures will be implemented where necessary.

The Gippsland investigations by DEH indicated that the majority of EPBC Act species investigated would be subject to negligible impacts. Of the species identified at BSWF, the migratory species *Pteropus poliocephalus* (Grey-headed Flying-fox) was considered to be at Low risk. The report stated that this species was one of the highest priority species for investigation at Gippsland, although it qualified such a statement by indicating that this priority ranking was only relevant for that study as the potential risk of collision posed by such wind farms was considered to be low overall.

## 4.4 Other Fauna

### *4.4.1 Overview*

There is little or no published data on the impacts of wind turbines on ground based fauna, although some minor localised changes in the distribution and abundance of species may occur. There is no evidence that domesticated animals or grazing stock are negatively influenced and it is typical for stock to graze up to the base of wind turbines on farmland (AusWEA 2002).

### *4.4.2 Known and Potential Impacts*

Only minor impacts would be expected to terrestrial and arboreal fauna. The removal of several small trees would be unlikely to result in the reduction / alteration of fauna populations within the locality. No tree hollows will be removed, therefore the impacts to hollow dependent bird, mammal, and reptile species will be negligible.

Some minor alterations may occur to species movement patterns on a local basis especially during construction and through turbine noise. There may be some increased potential for collisions with vehicles to terrestrial fauna such as kangaroos.

Removal of exposed rocks for the construction purposes may also have some minor impacts to terrestrial fauna such as reptiles and small mammals.

## 4.5 Key Habitats and Corridors

Loss and fragmentation of habitat across the landscape are primary threats to the conservation of biodiversity, ecological processes and natural systems.

The project area does not contain habitat areas or habitat corridors that would be significantly affected by the proposal. All turbines and infrastructure are located as far as practicable away from habitat areas and corridors. On the basis of these factors it is considered that no impacts would be expected to key habitats and corridors. Whilst there is some potential for bird / bat strikes this would be highly unlikely to sever any potential wildlife corridors through the area.

## 4.6 Creeks and Aquatic Habitats

Inappropriately located wind turbine infrastructure works may potentially cause erosion, sedimentation, pollution, and alteration of flow regimes to creeks and other aquatic habitats (such as dams and wetlands), leading to further impacts to native flora and fauna species.

No major impacts are expected, as the majority of the project infrastructure (turbines, cables, & access roads) is located on ridge-tops. Existing drainage lines are highly disturbed and contain no native riparian vegetation. It is considered that provided appropriate measures are implemented, there should be no decrease in water quality or quantity as a result of the proposal.

Whilst there may be some potential for oil spills and other accidents during construction, an Environmental Management Plan (EMP) and a Construction Management Plan (CMP) will be established to minimise the impacts of any such potential occurrences or of potential erosion issues.

No impacts are expected to significant wetland areas. The project area is not located within the immediate catchment area of any such sites, nor is it located between or close to any significant conservation areas within the region and potential habitat corridors between such areas.

# 5 ADAPTIVE MANAGEMENT PROGRAM

## 5.1 Proposed Management Measures

Adaptive management is a principle that encourages an exploratory, experimental approach to management problems, and emphasises the value of continuous monitoring and periodic adjustment of management regimes.

Within Australia, there is a recognised lack of research on the behaviour of Australian species and resultant impacts in relation to wind farms. This can only be overcome by monitoring the behaviour of species at operating wind farms and by monitoring mortality of individual species.

An adaptive management program will be used at BSWF. This will ensure that the low-level impacts predicted in this assessment eventuate. It will provide a mechanism whereby issues will be identified, monitored, assessed and addressed as necessary. In regards to flora and fauna this will occur via two reporting avenues:

- An Environmental Management Plan (EMP) and Construction Management Plan (CMP); and
- A Bird and Bat Monitoring Program.

These are described in more detail below.

### *5.1.1 Management Planning*

Constructional and operational phases of the development should be inline with the Best Practice Guidelines for Wind Energy Projects (AusWEA 2002), including the implementation of an Environmental Management Plan (EMP) and / or a Construction Management Plan (CMP).

In accordance with the guidelines the EMP and / or CMP will involve:

- Identifications of risks
- Identification of mitigation processes
- Identification of monitoring processes

This would include management of issues such as erosion, dust and sediment control, storage of hazardous materials, weed control, rehabilitation and waste management. Regular reporting of monitoring results (at such frequencies as required by consenting authorities) would be undertaken. While not specifically for flora and fauna, such a management plan would provide for the protection of the environment in general (including habitats) and by default flora and fauna. The monitoring phase will ensure that where any issues are identified the EMP / CMP can

be updated to reflect the need for appropriate management. These issues would be reported to the consent authorities, including demonstration of how each specific issue was dealt with.

### *5.1.2 Bird and Bat Monitoring*

A post-construction bird and bat monitoring program will be established to determine the impacts of the project on bird / bat populations. This will be undertaken for a period of up to five years of the initial operation. Such data may prove invaluable for assessing the impacts of future wind farms within the South Eastern Highlands and elsewhere within Australia. The bird and bat monitoring program would be designed and undertaken in accordance with guidelines prepared by NWCC (1999) and AusWEA (2005).

The Before – After – Control – Impact (BACI) experimental design process should be used during ongoing monitoring of windfarm operation (AusWEA 2005). This involves monitoring the existing situation, monitoring any changes in bird behaviour or injuries / deaths and devising methods (or implementing previously proposed ameliorative measures) to ensure any impacts above a certain acceptable level are controlled.

AusWEA (2005) identifies that during the operational phase, direct impacts should be assessed via bird utilisation and roaming surveys, population assessment, population viability analysis and dead bird searches. Indirect impacts should be assessed via bird utilisation and roaming surveys, gradient studies, population assessment, population viability analysis, avoidance studies and indirect disturbance impact assessments.

The proposed bird and bat monitoring will include:

- Dead bird and bat searches
- Indirect disturbance impact assessments
- Avoidance studies

The monitoring of the above factors will generally occur in accordance with the methods outlined in AusWEA (2005) at regular intervals. Reports will be provided to consent authorities at required frequencies and mitigation measures will be implemented and reported as necessary.

# 6 ENVIRONMENTAL LEGISLATION ASSESSMENT

## 6.1 Threatened Species Assessment

Outlined below in Table 6-1 is a list of those threatened flora / fauna species, endangered populations and endangered ecological communities (as listed under the NSW *Threatened Species Conservation Act 1995* (TSC Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), which have been recorded from within the locality, on the Atlas of Wildlife Oberon 1:100,000 Map Sheet or have the potential to occur on the site. Information on the habitat requirements, chance of occurrence on the site, and level of potential impacts for each of these species / communities is contained within Table 6-1.

No threatened flora species have been previously recorded within 10km of the site, although seven have been recorded on the Oberon mapsheet and / or were listed on the EPBC Act Protected Matters Report. These include *Calotis glandulosa* (Mauve Burr-daisy), *Lepidium hyssopifolium*, *Eucalyptus pulverulenta* (Silver-leaved Gum), *Diuris aequalis* (Buttercup Doubletail), *Persoonia acerosa, Boronia deanei, Euphrasia scabra* and *Thesium australe* (Austral Toadflax).

Five (5) threatened fauna species were recorded during the current and / or previous surveys, including *Oxyura australis* (Blue-billed Duck), *Miniopterus schreibersii* (Eastern Bent-wing Bat), *Falsistrellus tasmaniensis* (Eastern Falsistrelle), *Saccolaimus flaviventris* (Yellow-bellied Sheathtail Bat) and *Myotis adversus* (Large-footed Myotis). Anecdotal records also exist for Brown Treecreeper and Diamond Firetail. Both HSO and Ekert (2005) recorded the Blue-billed Duck in the large dam in the eastern part of Winton Park (to the east of the subject site). All threatened bat species were recorded at Mount Bathurst, with the latter two being only recorded there. The Eastern Bentwing Bat was also recorded at Daisybank, while the Eastern Falsistrelle was also recorded at both Winton Park and Daisybank. A number of other threatened species have also been recorded on the Oberon Map Sheet, and these are commented on in the table.

No Endangered Ecological Communities were observed on the site.

## Table 6-1 Threatened Species Considered for the Study Area and Assessment of Potential Impacts

| Species | Habitat Description / Comment | Chance of Occurrence on the site | Level of Potential Impacts from the Proposal |
|---|---|---|---|
| **Plants** | | | |
| *Calotis glandulosa*<br>Mauve Burr-daisy (V, V*) | Erect or ascending branched herb with white to blue flowers, flowering in December – February. Grows in grasslands and sclerophyll forests at high altitude, from Eden to Dubbo (Harden 1992). One record from 1935, 30km to the north east. | Low | LOW. Not recorded on site although some minor potential habitat within the Narrow-leaved Peppermint – Mountain Gum vegetation communities and pasture areas of the site (although mainly consisting of introduced grasses and weeds) may be affected during the construction phases of the project. While minor potential habitat is present there have been no records since 1935. The current survey was undertaken outside the flowering period of this species but ERM undertook surveys within the flowering period and did not detect this species within the subject site. |
| *Lepidium hyssopifolium*<br>Basalt Pepper-cress (E, E*) | Perennial herb to 50cm high, recorded in few locations from Bathurst and near the Qld border. Doubtful specimen also recorded near Cooma (Harden 2000). One record from 1992, 45km to the north west. | Low | LOW. It is considered highly unlikely that the proposal would significantly impact upon any potentially occurring population(s) within the locality. |
| *Diuris aequalis*<br>Buttercup Doubletail (E, V*) | Terrestrial orchid with golden-yellow – orange flowers, flowering October to December. Grows among grass in sclerophyll forest, mainly in the ranges and tablelands, chiefly from Braidwood to Kanangra and Liverpool. One record in 1973, 31km to the east. | Low | LOW. ERM undertook surveys in December 2004 and this species was not observed. It is considered highly unlikely that the proposal would significantly impact upon any potentially occurring population(s) within the locality. |
| *Persoonia acerosa*<br>(V, V*) | Erect shrub with yellow flowers. Grows in heath or dry sclerophyll forest on sandstone, central Blue Mountains south to Hill Top (Harden 2002). One record in 1899, 30km to the east. | Low | LOW. Habitats typical to where this species occurs do not occur within the study area and therefore no potential habitat will be impacted upon. |
| *Eucalyptus pulverulenta*<br>Silver-leaved Gum (V, V*) | Tree or mallee to 10m high, bark smooth, grey or bronze. Rare and scattered, in small stands almost in the understorey of grassy woodland on relatively poor soil, from Bathurst to Bombala. Numerous records 35km km to the north. | Low | LOW. All areas of potential habitat removal were inspected and no individuals of this species will be removed nor will potential habitat will be impacted upon. |
| *Boronia deanei*<br>Deane's Boronia (V, V*) | Erect shrub, white to bright pink flowers, grows in wet heath from Lithgow to near Victorian border (Harden 2002). One record in 1973, 31km to the east. | Low | LOW. Habitats typical to where this species occurs do not occur within the study area and therefore no potential habitat will be impacted upon. |
| *Thesium australe*<br>Austral Toadflax (V, V*) | A small straggling herb to 40cm tall. Occurs in grassland or grassy eucalypt woodland, including roadsides and along railway lines. Uncommon but widespread in eastern Australia from south-east Qld to Vic (NPWS 2003). Often found in damp sites in association with Kangaroo Grass (*Themeda australis*). A root parasite that takes water and some nutrient from other plants, especially Kangaroo Grass. | Low | LOW. Some potential grassland habitat and areas of native vegetation such as along road reserves (although mainly consisting of introduced grasses and weeds) may be affected during the construction phases of the project. No *Themeda* was observed, particularly in areas to be affected by cabling / roads / turbines etc. |
| **Herpetofauna** | | | |
| *Litoria aurea*<br>Green and Golden Bell Frog (E, V*) | Inhabits swamps, lagoons, streams and ponds as well as dams, drains and storm water basins. Thought to be displaced from more established sites by other frog species, thus explaining its existence on disturbed sites. | Low | LOW. No impacts are expected to any areas of potential habitat such as dams (which are marginal in any case). |
| *Litoria booroolongensis*<br>Booroolong Frog (E) | Usually found on or under boulders and debris in and beside the rocky beds of mountain streams. | Low | LOW. No impacts are expected to areas of mountain streams, particularly as existing creeks are in poor condition and have been significantly altered by agriculture and stock. |

| Species | Habitat Description / Comment | Chance of Occurrence on the site | Level of Potential Impacts from the Proposal |
|---|---|---|---|
| **Birds** | | | |
| ***Oxyura australis*** **Blue-billed Duck (V)** | Wetland bird preferring deep permanent open waterbodies. Occasional records from Little Llangothlin Nature Reserve. Dams on the site may provide some minor supplementary habitat (during movements) for this species. | Low – although recorded within adjoining Winton Park | **MODERATE**. No potential habitat to be affected by the proposal. Site is not located within any known / potential flight paths or areas of significant habitat for this species, however still a possibility that turbines could affect individual birds. |
| *Calyptorhynchus lathami* Glossy Black-Cockatoo (V) | Species requires large hollows for nesting, and forages predominantly on *Allocasuarina* cones. Some minor potential habitat present on site. | Low | LOW. No potential habitat to be affected by the proposal. Site is not located within any known / potential flight paths or areas of significant habitat for this species. |
| ***Ninox strenua*** **Powerful Owl (V)** | Requires large hollows for nesting, hollows or thick vegetation for roosting, and forests for hunting. Some potential roosting, nesting and hunting habitat in the study area. NPWS (2003) state that the species is known from the eastern edge of the New England Tablelands including Warra NP and around Armidale. This species is currently subject to a draft recovery plan by the DEC (2005). | Moderate | **LOW / MODERATE**. Not recorded despite targeted surveys, although some potential habitat present. Considered to be a potential turbine strike victim. |
| ***Ninox connivens*** **Barking Owl (V)** | Occurs mainly in dry sclerophyll woodland. Nests in large Eucalypt hollows, and roosts in hollows or thick vegetation. Territories range from 30 to over 1000ha. NPWS (2003) state that the species is widespread but rare on the New England Tablelands. Previous records west and south of the study area. | Moderate | **LOW / MODERATE**. Not recorded despite targeted surveys, although some potential habitat present. Considered to be a potential turbine strike victim. |
| ***Tyto novaehollandiae*** **Masked Owl (V)** | Occupies dry eucalypt forest and woodlands. They require large hollows for nesting, roosts in tree hollows or thick foliage. Preys largely on terrestrial mammals, though some arboreal prey also taken. Predominantly occurs in coastal and near-coastal regions. This species is currently subject to a draft recovery plan by the DEC (2005). | Low / Moderate | **LOW / MODERATE**. Not recorded despite targeted surveys. More likely to occur along the eastern edge of the New England tablelands. Considered to be a potential turbine strike victim. |
| *Chthonicola sagittata* Speckled Warbler (V) | Occupies Eucalypt and cypress woodlands on the western slopes of the Great Dividing Range, and in drier coastal areas. Appears to be extinct in districts where no fragments larger than 100ha remain. Records from further west such as around Inverell and Kings Plains NP. | Low / Moderate | LOW. Not recorded in the area due possibly to cleared / fragmented nature of the habitats and not considered to be a likely turbine strike victim. |
| ***Climacteris picumnus*** **Brown Treecreeper (V)** | Occupies Eucalypt woodland. Nests in tree hollows. Does not occur in remnants less than 200ha. Not recorded on site during formal and opportunistic fauna species. Isolated records from the wider region including Warra NP. | **High – Anecdotal records in western part of site** | **LOW / MODERATE**. Recorded anecdotally on occasional basis by landowner near western boundary of study area (G. Douglas pers comm.). Not considered to be a likely turbine strike victim as unlikely to fly at height of turbine blades. |
| *Melanodryas cucullata* Hooded Robin (V) | Occupies drier eucalypt forests, woodlands, scrubs, mallee, mulga, cleared paddocks with stumps, banksia – dominated coastal scrubs. | Low | LOW. Not recorded in the area due possibly to cleared / fragmented nature of the habitats and not considered to be a likely turbine strike victim. |
| ***Stagonopleura guttata*** **Diamond Firetail (V)** | Small finch occupying open woodlands / forests and associated habitats with grassy understorey. Generally found west of the Divide or in drier coastal areas such as the Hunter Valley. Appears unable to persist in remnants less than 200ha. Records from further west such as around Lake Copeton and Kings Plains NP. | **High – Anecdotal records in western part of site** | **LOW / MODERATE**. Recorded anecdotally on occasional basis by landowner near western boundary of study area (G. Douglas pers comm.). Not considered to be a likely turbine strike victim as unlikely to fly at height of turbine blades. |
| *Grantiella picta* Painted Honeyeater (V) | Occupies dry open forest and woodlands with box / ironbarks and mistletoe. Individuals wonder widely and generally move north during winter. Isolated records from the region. | Low / Moderate | LOW. Not recorded on site and no preferred or significant habitat (box-ironbark with mistletoe) on site. |
| *Xanthomyza phrygia* Regent Honeyeater (E, E*) | Nomadic honeyeater that breeds west of the divide disperses to areas including the coast in winter, where winter flowering trees are sought. | Low / Moderate | LOW. Not recorded on site and no preferred or significant habitat (box-ironbark) on site. |

| Species | Habitat Description / Comment | Chance of Occurrence on the site | Level of Potential Impacts from the Proposal |
|---|---|---|---|
| **Mammals** | | | |
| *Phascolarctos cinereus* Koala (V) | Widespread but scattered records from the wider locality. Number of records approximately 15km to the north of site. | Moderate / High | LOW. No areas of significant habitat or potential corridors for this species will be impacted upon. |
| *Pteropus poliocephalus* Grey-headed Flying-fox (V, V*) | Forages over a large area for nectar / fruits etc. Roosts in communal base camps. | Low / Moderate | LOW. No confirmed records within the locality, but may utilise the forested portions of the site for foraging on a seasonal basis. |
| *Dasyurus maculatus* Spotted-tailed Quoll (V, E*) | Found in a variety of forested habitats. Den in fallen hollow logs or among rocky outcrops. Some potential habitat present in the study area, albeit high recorded incidence of introduced predators and degraded environs. | Low / Moderate | LOW. No areas of significant habitat or potential corridors for this species will be impacted upon. |
| *Petaurus australis* Yellow-bellied Glider (V) | Inhabits tall mature Eucalypt forest. Nest in large tree hollows. One record 25km to south east. | Low / Moderate | LOW. No areas of significant habitat or potential corridors for this species will be impacted upon. |
| ***Miniopterus schreibersii* Eastern Bentwing-bat (V)** | Cave dwelling species foraging above forest and woodland communities. Recorded on-site by Anabat detection (Hoye 2005a). Potential foraging habitat throughout the study area. | **High – Recorded in Daisybank property.** | **MODERATE / HIGH**. Records from within close vicinity to turbines and a potential strike victim (identified as a species of concern by the recent ABS workshop on bats and wind farms). |
| ***Saccolaimus flaviventris* Yellow-bellied Sheathtail-bat (V)** | Hollow dwelling species recorded from a wide range of habitats. Recorded to north of site by Hoye (2005a). Potential roosting and foraging habitat within the study area. | **High – Recorded at Mount Bathurst to north.** | **MODERATE**. Records from the site and potential turbine strike victim. |
| ***Falsistrellus tasmaniensis* Eastern Falsistrelle (V)** | Hollow dwelling species found in a variety of forest types. Some potential roosting and foraging habitat on site. Recorded on-site by Anabat detection (Hoye 2005a). | **High – Recorded in Daisybank property.** | **LOW / MODERATE**. Habitat present on site and potential turbine strike victim. |
| ***Myotis adversus* Large-footed Myotis (V)** | Usually found near bodies of water, including estuaries, lakes, reservoirs, rivers and large streams, often in close proximity to their roost site. Although usually recorded foraging over wet areas, it also utilises a variety of wooded habitats adjacent to such areas including rainforest, wet and dry sclerophyll forest, woodland, and swamp forest. Roosts in small colonies of between 15 and several hundred individuals in caves, mines and disused railway tunnels. | **High – Recorded at Mount Bathurst to north.** | **LOW / MODERATE.** Potential habitat present on site and potential turbine strike victim. |
| **Invertebrates** | | | |
| *Paralucia spinifera* Bathurst Copper Butterfly (E, V*) | *Paralucia spinifera* is known only from a small number of sites east of Bathurst. *Paralucia spinifera* is believed to be restricted to locations above 900m elevation, requires a specific host plant, *Bursaria spinosa* and is dependent on the ant *Anonychomyrma itinerans*. During, the egg phase, the attendant ants, *Anonychomyrma itinerans,* constantly search the host plant, *Bursaria spinosa,* seeking newly hatched larvae. | Low | LOW. No areas of significant habitat or potential corridors for this species will be impacted upon. No areas of *Bursaria spinosa* observed on the site, a specific requirement for this species. |

| Species | Habitat Description / Comment | Chance of Occurrence on the site | Level of Potential Impacts from the Proposal |
|---|---|---|---|
| **Endangered Ecological Communities** | | | |
| Montane Peatlands and Swamps (EEC) | This community is associated with accumulated peaty or organic-mineral sediments on poorly drained flats in the headwaters of streams. It occurs on undulating tablelands and plateaus, above 400-500 m elevation, generally in catchments with basic volcanic or fine-grained sedimentary substrates or, occasionally, granite. | Low | LOW. Not recorded on-site. Areas of potential habitat removal and/or areas subject to indirect impacts do not form part of this community. |
| White Box – Yellow Box – Blakely's Red Gum Woodland / Grassy White Box Woodlands (EEC, TEC*) | A formally widespread community within NSW, which has been extensively cleared and fragmented by agricultural practices (NPWS 2003). | Low | LOW. No species characteristic of this community have been recorded on site. Areas of potential habitat removal and/or areas subject to indirect impacts do not form part of this community. |

*Key:* ***(V)*** *= Vulnerable Species listed under Threatened Species Conservation Act 1995 (TSC Act).* ***(E)*** *= Endangered Species listed under TSC Act.* ***(V*)*** *= Vulnerable Species listed under Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).* ***(E*)*** *= Endangered Species listed under EPBC Act.* ***(EEC)*** *= Endangered Ecological Community listed under the TSC Act.* ***(TEC*)*** *= Threatened Ecological Community listed under the EPBC Act.* ***(EP^)*** *= Endangered Population listed under the Fisheries Management Act 1997 (FM Act).* ***(V^)*** *= Vulnerable Species listed under the FM Act. Species highlighted in* ***bold*** *have been subject to a 'seven part test' assessment.*

## 6.2 Section 5A of the EPA Act (Seven Part Test) Considerations

Given that a number of the factors regarding the ecological impacts of wind turbines are poorly understood, a precautionary approach will be taken for the threatened species assessment. Accordingly those species considered to have at least a low / moderate level of potential impact (refer to Table 6-1) have been subject to a Seven Part Test under the provisions of Section 5A of the EPA Act (as detailed in Appendix A).

The species subject to Seven Part Tests include:

**Threatened Fauna**

- *Oxyura australis* Blue-billed Duck
- *Tyto novaehollandiae* Masked Owl
- *Ninox strenua* Powerful Owl
- *Ninox connivens* Barking Owl
- *Climacteris picumnus* Brown Treecreeper
- *Stagonopleura guttata* Diamond Firetail
- *Falsistrellus tasmaniensis* Eastern Falsistrelle
- *Miniopterus schreibersii* Eastern Bentwing-bat
- *Saccolaimus flaviventris* Yellow-bellied Sheathtail Bat
- *Myotis adversus* Large-footed Myotis

**Conclusion**

Application of Section 5A of the EPA Act has been afforded to these species (refer to Appendix A).

## 6.3 Assessment under the EPBC Act

In considering whether the proposal is likely to have a significant impact upon a matter of National Environmental Significance (NES), a number of factors should be considered. Matters of NES are provided below, with comment made on the relevance of each NES.

**Matters of National Environmental Significance (NES)**

- *World Heritage areas:*

The site is not a World Heritage area or located in close proximity to a World Heritage Area. While World Heritage Areas are located in the region (such as Blue Mountains National Park and Kanangra-Boyd National Park), these are located approximately 25km away.

- *Wetlands protected by international treaty (the Ramsar convention):*

The site is not part of any Ramsar Wetland area or located within close proximity to any Ramsar wetland. No evidence was found to indicate that the study area would be part of a regular migratory route to any Ramsar wetland.

- *Nationally listed threatened species and ecological communities:*

Several nationally listed threatened species have been recorded from the vicinity and may have some potential to occur on the site including *Calotis glandulosa* (Mauve Burr-daisy), *Lepidium hyssopifolium* (Basalt Pepper-cress), *Diuris aequalis* (Buttercup Doubletail), *Eucalyptus pulverulenta* (Silver-leaved Gum), *Thesium australe* (Austral Toadflax) and *Litoria aurea* (Green and Golden Bell Frog). Few or no impacts are expected to these species. The project area was historically cleared of most native vegetation and the proposed turbines are not located along any known migratory bird flight paths or in close proximity to any areas that would be potentially identified as critical habitat. No nationally threatened ecological communities occur on the site.

- *Nationally listed migratory species:*

One migratory species has been recorded within the study area, being *Hirundapus caudacutus* (White-throated Needletail). Other listed species may have some potential to occur. Whilst some listed migratory species may utilise this area on an irregular / seasonal / nomadic basis, it considered highly unlikely that activity on the site would significantly affect populations or habitat availability for any listed migratory species, nor upset established migratory patterns.

- *All nuclear actions:*

No type of nuclear activity is proposed for the site.

- *The environment of Commonwealth marine areas:*

The proposed activity on the site will not have a significantly adverse effect on any Commonwealth marine area.

No significant impacts are expected to nationally listed threatened / migratory species and threatened ecological communities or other Matters of NES.

## 6.4 Assessment under SEPP 44 – 'Koala Habitat Protection'

**First Consideration – Is the Land 'Potential Koala Habitat'?**

Oberon Local Government Area (LGA) is listed in Schedule 1 of SEPP 44, therefore this policy is applicable to the site. The project area is mainly cleared of native vegetation and no listed Koala feed trees occur on the property.

Therefore the site does not qualify as 'Potential Koala Habitat', and no further provisions of the policy apply.

**Second Consideration – Is the Land 'Core Koala Habitat'?**

Searches were made for any secondary indications of Koalas on the site within those areas determined to be 'Potential Koala Habitat'. Such searches targeted features such as scats or distinctive scratch marks on the trunks of trees. Searches for direct observations of Koalas were also conducted during diurnal and nocturnal surveys. No animals were noted on site and no secondary evidence of the presence of Koalas

could be found. It should also be noted that there are only a handful of isolated records of Koalas from the locality.

Therefore the site does not qualify as 'Core Koala Habitat' and no further provisions of this policy apply.

# 7 CONCLUSION

From the information presented herein, it is asserted that the flora and fauna issues identified within the Draft NSW Wind Energy EIA Guidelines (Planning NSW 2002) and the Best Practice Guidelines for Implementation of Wind Energy Projects in Australia (AusWEA 2002) have been adequately addressed. Other guidelines (DEH 2004; AusWEA 2005; DEH 2006) referred to in this assessment have also been adequately considered.

Given the size and scale of the project, the ecological impacts of the proposal are expected to be comparatively minimal. This is due to the following factors:

- Wind turbines are a non-polluting renewable energy source and reduce greenhouse gas emissions from other sources of power generation by significantly displacing generation from coal and gas fired power plants (thereby addressing the problem of climate change).
- The area is predominantly cleared of native vegetation with the majority of properties used for cattle, sheep and horse grazing.
- Design phase siting of turbines and associated infrastructure away from vegetated areas.
- There will be minimal removal of trees (if any) and few or no impacts to remnant native vegetation.
- The area does not occur as part of any significant habitat resource for threatened flora and fauna species.
- No significant bird / bat migration corridors were identified or considered likely to occur within the site or within the immediate locality.
- Implementation of a number of recommendations, as specified in Chapter 8.

Application of Section 5A of the EPA Act (refer to Appendix A) indicated that no significant impacts to threatened species or endangered ecological communities are likely as a consequence of the proposal. Likewise, no significant impacts are expected to threatened flora and fauna species listed under the *Fisheries Management Act 1997* (FM Act).

No significant impacts are expected to any matters of National Environmental Significance (NES), as listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). It is considered that no further assessment / approval is required under the EPBC Act, although it may be advisable for the project to be referred to DEH for confirmation of this.

As a positive environmental consequence, the project addresses (in-part) the key threatening processes of “human-caused climate change” (as listed under the TSC Act), and “loss of climatic habitat caused by anthropogenic emissions of greenhouse gases” (as listed under the EPBC Act).

Some minor impacts to birds and bats may be expected due to turbine collisions. These are likely to be in line with stated AusWEA (2004) collision rates of several individuals per turbine per year. Some minor changes to the local distribution and

abundance of locally occurring common species may also be expected as a consequence of the ongoing operation of the turbines. However, these impacts are not expected to be significant with few or no impacts on population(s) sizes or surrounding habitats. Sufficient baseline data has been collected and presented herein from which a post-construction monitoring program can be developed.

Whilst some minor impacts to individual birds and bats may be expected as a consequence of the project, these impacts should be viewed in light of the growing body of scientific evidence which highlights the potentially drastic environmental consequences (including loss of species and ecosystems) from a continued dependence on traditional energy sources that produce greenhouse gas emissions, such as coal-fired power stations (eg. AGO 2003). Wind energy's ability to generate electricity without many of the environmental impacts associated with other energy sources (eg. air and water pollution and greenhouse gas emissions) can significantly benefit birds, bats, and many other flora and fauna species (NWCC 2004), including those species / communities on the South Eastern Highlands bioregion that are currently threatened by climate change.

From the data presented herein, there appears to be no significant ecological constraints to the development of wind farms within this locality of the South Eastern Highlands. This is based on the premise that appropriate baseline studies are undertaken, potential ecological impacts are minimised through appropriate siting of turbines and associated infrastructure, and further mitigation measures are dealt within the Environmental / Construction Management Plans, as demonstrated herein.

# 8 RECOMMENDATIONS AND MITIGATION

The following recommendations should be adhered to / implemented to minimise and monitor any likely and potential ecological impacts of the proposal:

- All vegetation removal should be restricted to the actual development footprint. Careful micro-siting of roads and cabling should be undertaken to minimise potential impacts.

- Access roads and cabling should be aligned along existing tracks wherever possible to minimise vegetation removal, number of easements, and the spread of weeds.

- Powerlines between turbines should be constructed underground and along road infrastructure to minimise number of easements through the property and further incidents of potential avian collisions (including the creation of perching locations in the vicinity of turbines).

- A post-construction bird and bat monitoring program, such as that described by NWCC (1999) and AusWEA (2005) should be established to determine the impacts of the project on bird / bat populations. Such data may prove invaluable for assessing the impacts of future wind farms within the South Eastern Highlands and elsewhere within Australia.

- Constructional and operational phases of the development should be inline with the Best Practice Guidelines for Wind Energy Projects (AusWEA 2002), including the implementation of an Environmental Management Plan (EMP) and a Construction Management Plan (CMP).

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# APPENDIX A: SEVEN PART TESTS

# CONSIDERATION UNDER SECTION 5A OF THE *EP&A ACT 1979*

Considerations of the effects of the proposed development under the guidelines of Section 5A of the *EP&A Act* for the concerned threatened species/populations/ecological communities are given below.

The majority of information used for the assessment has been sourced from NSW NPWS Threatened Species Information and Environmental Impact Assessment Guidelines, NPWS Atlas of NSW Wildlife and other published or widely available literature sources such as scientific journals and reports.

A seven-part test for the following species has been undertaken under the guidelines of Section 5A of the *EP&A Act*.

**Threatened Fauna**

- *Oxyura australis* Blue-billed Duck
- *Tyto novaehollandiae* Masked Owl
- *Ninox strenua* Powerful Owl
- *Ninox connivens* Barking Owl
- *Climacteris picumnus* Brown Treecreeper
- *Stagonopleura guttata* Diamond Firetail
- *Falsistrellus tasmaniensis* Eastern Falsistrelle
- *Miniopterus schreibersii* Eastern Bentwing-bat
- *Saccolaimus flaviventris* Yellow-bellied Sheathtail Bat
- *Myotis adversus* Large-footed Myotis

For the purposes of the *Environmental Planning and Assessment Act 1979* and, in particular, in the administration of Sections 78, 79 and 112, the following factors have been taken into account in deciding whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats:

***a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;***

***Oxyura australis* (Blue-billed Duck)**

The regionally and seasonally nomadic species *Oxyura australis* (Blue-billed Duck) was recorded by both HSO and previously by Ekert (2005) in the large farm dam located in the eastern section of Winton Park, which occurs to the east of the subject site. Unlike a number of the other recorded wetland / waterbirds, which were recorded in the smaller dams throughout the site, this species has only been recorded in that larger dam by HSO and Ekert (2005). This species remained on the water the entire time it was observed.

NPWS (1999) states that the species favours deep, permanent, well-vegetated freshwater swamps, especially those with beds of Cumbungi *Typha* species and that daylight hours are spent alone in small, concealed bays within vegetation or communally in large exposed rafts far from shore. It is unlikely that the habitats of the large dam would support breeding habitat for the Blue-billed Duck, given the lack of extensive reed beds and fringing vegetation that would be suitable for the species.

It is known that young birds migrate each year from the natal swamps of inland NSW to non-breeding areas on the Murray River system and coastal lakes of Victoria and South Australia where they moult (NPWS 1999). Experienced dominant breeders tend not to migrate. Breeding occurs in secluded, densely vegetated situations with the nest constructed in Cumbungi beds or other vegetation, generally over water (NPWS 1999).

Movements of this species would be most likely to occur on an annual basis when moving between breeding and foraging areas. It is considered that if the species regularly utilises the large dam on the site, the vast majority of the time would be spent on the water as this is where it would forage and nest. The occasional movements in and out of the dam on an annual basis are considered unlikely to significantly impact this species, particularly given that the nearest proposed wind turbines are located approximately 600 metres to the west of the dam. The topography of this distance rises relatively steeply. It is considered likely that the birds would fly around the spur to the south, rather than taking off and flying immediately up an incline for over half a kilometre. The overall collision potential for this species is considered to be low.

The study area is not located between or close to any significant conservation areas and upland wetlands within the region and potential flight paths between these areas. The regional distribution of bird habitats is also considered to be somewhat limited. Furthermore, no evidence was found to indicate that the locality is used as a corridor between conservation reserves.

It is considered highly unlikely that the proposal would place any populations of the Blue-billed Duck at risk of extinction.

**Woodland / Forest Owls - *Ninox strenua* (Powerful Owl), *Tyto novaehollandiae* (Masked Owl), and *Ninox connivens* (Barking Owl)**

Powerful Owls are sedentary within home ranges of about 1000ha in open Eucalypt, *Casuarina* or *Callitris* pine forests and woodlands. Principal prey are medium-sized mammals, particularly possums and gliders, but birds, flying foxes, rats and insects are also taken. They nest in mature Eucalypts containing large tree hollows (Garnett & Crowley 2000).

Masked Owls occupy home ranges of 5 –10km$^2$ within a diverse range of wooded habitats that provide large hollow bearing trees for roosting and nesting and nearby open areas for foraging. Prey is principally terrestrial mammals although possums, gliders, bats, birds, lizards and rabbits may be taken opportunistically (Garnett & Crowley 2000).

Barking Owls occupy home ranges from 30 – 1000ha in dry sclerophyll woodland, open forest, swamp woodlands and timbered watercourses. Nesting is in large hollows in live eucalypts. They feed on a variety of prey including birds, invertebrates and mammals (NPWS 2003).

Despite targeted surveys for these species, including call broadcast and spotlighting, no observations / records were obtained. The Atlas of NSW Wildlife (2006) indicates that, of these species, there is only one record for the Powerful Owl on the entire Oberon 1:100000 Map Sheet.

It is considered possible that some individuals of these species may occur within the study area. Owls have been identified as species susceptible to collisions with turbines by AusWEA (2004).

Whilst the proposal may remove a small number of trees, no tree hollows are likely to be removed (potential nesting / roosting habitat), therefore the main potential impacts to these species would be as a result of collisions with turbines and/or avoidance behaviour. Given these factors and the paucity of records from the vicinity it is considered highly unlikely that the proposal would place any populations of the Powerful Owl, Masked Owl, and Barking Owl (if extant) at risk of extinction.

**Micro-bats - *Falsistrellus tasmaniensis* (Eastern Falsistrelle), *Miniopterus schreibersii* (Eastern Bentwing-Bat), *Saccolaimus flaviventris* (Yellow-bellied Sheathtail Bat), and *Myotis adversus* (Large-footed Myotis)**

These micro-bats share similar foraging habitat requirements in that they forage in Eucalypt woodlands and forests, although the Large-footed Myotis predominantly forages over open water. The Eastern Falsistrelle, Yellow-bellied Sheathtail Bat, and Large-footed Myotis roost in tree hollows. The Eastern Bentwing-Bat roosts in caves, mines and other man made structures, and occasionally in tree hollows.

The Eastern Falsistrelle and Eastern Bentwing-Bat have been recorded on-site via Anabat detection by Hoye (2005a). The Yellow-bellied Sheathtail Bat and Large-footed Myotis were recorded at Mount Bathurst, to the north of the study area. Eastern Bentwing-Bats are a migrating / nomadic species that were identified as a species of potential concern for turbine strikes at a recent Australasian Bat Society (ABS) workshop on bats and wind farms.

In relation to the Yellow-bellied Sheathtail Bat, NPWS (2003) state that when foraging they fly high and fast over forest canopy but come lower in more open country. There is also some speculation that they migrate to southern Australia in late summer and autumn.

Whilst the proposal may remove a small number of trees, no tree hollows are likely to be removed (potential roosting habitat), therefore the main impacts to these species would be as a result of collisions with turbines and/or avoidance behaviour.

All turbines are located as far as practicable away from forested areas, although individuals foraging in cleared pasture areas and/or flying between patches of forested habitat may be considered to be at potential risk.

Whilst it is acknowledged that there may be a potential loss of an unknown number of individuals due to turbine strikes, it is considered unlikely that this will place any local population(s) of these species at further risk of extinction given that their key habitat features including forested areas, caves and tree hollows will remained unaffected.

Additionally it is recommended that a post-construction survey and monitoring of bats be undertaken to assess the project's impact on local bat fauna.

**Woodland Birds - *Climacteris picumnus victoriae* (Brown Treecreeper), *Stagonopleura guttata* (Diamond Firetail)**

The Brown Treecreeper is a medium-sized insectivorous bird that occupies Eucalypt woodlands, particularly open woodland lacking a dense understorey. It is sedentary and nests in tree hollows within permanent territories, breeding in pairs or communally in small groups. Birds forage on tree trunks and on the ground amongst leaf litter and on fallen logs for ants, beetles and larvae.

The Diamond Firetail is found in grassy eucalypt woodlands, including Box-Gum Woodlands and Snow Gum *Eucalyptus pauciflora* Woodlands. Often found in riparian areas (rivers and creeks), and sometimes in lightly wooded farmland. Feeds exclusively on the ground, on ripe and partly-ripe grass and herb seeds and green leaves, and on insects (especially in the breeding season). Nests are globular structures built either in the shrubby understorey, or higher up, especially under hawk's or raven's nests. Appears to be sedentary, though some populations move locally, especially those in the south.

Brown Treecreepers and Diamond Firetails generally do not persist in remnants less than 200ha in area. These species have been recorded irregularly by the landowner (G. Douglas) to the west of his dwelling in open forest and disturbed riparian habitat respectively. HSO and Ekert (2005) did not record either species during targeted surveys.

Whilst the proposal may remove a small number of trees, no tree hollows are likely to be removed (potential nesting habitat for Brown Treecreepers), therefore the main impacts to these species would be as a result of collisions with turbines and/or avoidance behaviour.

All turbines are located as far as practicable away from forested areas. These species are unlikely to fly at the height of the rotor blades and when in the study area are likely to remain within the woodlands where observed, in the west of the study area. The WTG's are located approximately 1km from the area in which these species were observed.

Whilst it is acknowledged that there may be a potential loss of an unknown number of individuals due to turbine strikes, it is considered unlikely that this will place any local population(s) of these species at further risk of extinction given that their key habitat features including forested areas, caves and tree hollows will remained unaffected.

Additionally it is recommended that a post-construction survey and monitoring of birds be undertaken to assess the project's impact on local bird fauna.

***b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;***

No populations of any of the species considered for this assessment (that are relevant to this locality) have been identified under Part 2 of Schedule 1 of the *TSC Act*.

***c) In the case of a critically endangered or endangered ecological community, whether the action proposed:***

***(i) Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction; or***

**(ii)** ***Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;***

No endangered ecological communities were identified as occurring within the study area and all remnant patches of forest are to remain completely intact post-development.

***d) In relation to the habitat of a threatened species, population or ecological community:***

***(i) The extent to which habitat is likely to be removed or modified as a result of the action proposed, and***
***(ii) Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and***
***(iii) The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;***

***Oxyura australis* (Blue-billed Duck)**

*(i) The extent to which habitat is likely to be removed or modified as a result of the action proposed:*

The existing known habitat of the Blue-billed Duck is located approximately 2km to the east of the nearest WTG. It comprises a large dam that contains limited fringing vegetation. This known habitat will not be affected in any way whatsoever. Modification of potential movement habitat will occur (i.e. the airspace in which the bird could potentially fly). This modification will be via the introduction of WTG's. The hub height is of these WTG's is 80m, with the rotor having three blades on a horizontal axis. The diameter of the rotor is 88m and covers a swept area of 6082 m². In addition to the actual swept area, a turbulence zone of an estimated 100m diameter around the blades may also result from the operation of the WTG's.

*(ii) Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action:*

The current proposal will not fragment or isolate an area of habitat for this species from other areas of potential habitat. However, the occurrence of the WTG's may result in the movement patterns of this species changing in order to avoid blade strike. This change in behaviour is unlikely to substantially affect connectivity for this species in the locality or region, as it is highly mobile.

*(iii) The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality:*

The locations of the WTG's will occupy a negligible proportion of the potential movement habitat (airspace) within the locality. As has been previously mentioned, where this species initiates its seasonal nomadic movements, it is unlikely that it would fly directly up an extended hillside immediately after taking off from the dam. It is more likely that the species will fly around the elevated areas upon initiation of its flight. The habitat (airspace) to be modified can therefore be considered as not important to the long-term survival of the species in the locality.

**Woodland / Forest Owls - *Ninox strenua* (Powerful Owl), *Tyto novaehollandiae* (Masked Owl), and *Ninox connivens* (Barking Owl)**

*(i) The extent to which habitat is likely to be removed or modified as a result of the action proposed:*

These species are not known to occur within the study area. No vegetated habitat (i.e. woodland or forest) will be affected as a result of the proposal, and grasslands will remain in abundance within the locality. Modification of potential movement habitat (i.e. the airspace in which the owls could potentially fly) will occur. This modification will be via the introduction of WTG's. The hub height is of these WTG's is 80m, with the rotor having three blades on a horizontal axis. The diameter of the rotor is 88m and covers a swept area of 6082 m². In addition to the actual swept area, a turbulence zone of an estimated 100m diameter around the blades may also result from the operation of the WTG's.

*(ii) Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action:*

The current proposal will not fragment or isolate an area of habitat for these species from other areas of potential habitat. However, the occurrence of the WTG's may result in the movement patterns of these species changing in order to avoid blade

strike. This change in behaviour is unlikely to substantially affect connectivity for these species in the locality or region, as they are highly mobile.

*(iii) The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality:*

The locations of the WTG's will occupy a negligible proportion of the potential movement habitat (airspace) within the locality. These species are highly sensitive to their environment and it is expected that such sensitivity will allow for these species to avoid the small number of WTG's proposed on the site. The habitat (airspace) to be modified can therefore be considered as not important to the long-term survival of the species in the locality.

**Micro-bats - *Falsistrellus tasmaniensis* (Eastern Falsistrelle), *Miniopterus schreibersii* (Eastern Bentwing-Bat), *Saccolaimus flaviventris* (Yellow-bellied Sheathtail Bat), and *Myotis adversus* (Large-footed Myotis)**

*(i) The extent to which habitat is likely to be removed or modified as a result of the action proposed:*

These species are known to occur within the study area and surrounds. No vegetated habitat (i.e. woodland or forest) will be affected as a result of the proposal, and grasslands will remain in abundance within the locality. Modification of potential movement habitat (i.e. the airspace in which the bats could potentially fly) will occur. This modification will be via the introduction of WTG's. The hub height is of these WTG's is 80m, with the rotor having three blades on a horizontal axis. The diameter of the rotor is 88m and covers a swept area of 6082 $m^2$. In addition to the actual swept area, a turbulence zone of an estimated 100m diameter around the blades may also result from the operation of the WTG's.

*(ii) Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action:*

The current proposal will not fragment or isolate an area of habitat for these species from other areas of potential habitat. However, the occurrence of the WTG's may result in the movement patterns of these species changing in order to avoid blade strike. This change in behaviour is unlikely to substantially affect connectivity for these species in the locality or region, as they are highly mobile.

*(iii) The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality:*

The locations of the WTG's will occupy a negligible proportion of the potential movement habitat (airspace) within the locality. These species are highly sensitive to their environment and it is expected that such sensitivity will allow for these species to avoid the small number of WTG's proposed on the site. The habitat (airspace) to be modified can therefore be considered as not important to the long-term survival of the species in the locality.

**Woodland Birds - *Climacteris picumnus victoriae* (Brown Treecreeper), *Stagonopleura guttata* (Diamond Firetail)**

*(i) The extent to which habitat is likely to be removed or modified as a result of the action proposed:*

The existing known habitat of the Brown Treecreeper and Diamond Firetail is located approximately 1 km to the west of the nearest WTG. It comprises remnant open forest. This known habitat will not be affected in any way whatsoever. Modification of potential movement habitat may occur (i.e. the airspace in which the bird could potentially, but would be unlikely to, fly). This modification will be via the introduction of WTG's. The hub height is of these WTG's is 80m, with the rotor having three blades on a horizontal axis. The diameter of the rotor is 88m and covers a swept area of 6082 m². In addition to the actual swept area, a turbulence zone of an estimated 100m diameter around the blades may also result from the operation of the WTG's. It must be stressed that it is unlikely that either of these species would fly into the rotor swept area.

*(ii) Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action:*

The current proposal will not fragment or isolate an area of habitat for these species from other areas of potential habitat any further that the current situation. However, the occurrence of the WTG's may result in the movement patterns of these species changing in order to avoid the WTG's. This change in behaviour is unlikely to substantially affect connectivity for these species in the locality or region.

*(iii) The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality:*

The locations of the WTG's will occupy a negligible proportion of the potential movement habitat (airspace) within the locality. It is unlikely that these species would fly directly up into the turbulence zone. The habitat (airspace) to be modified can therefore be considered as not important to the long-term survival of these species in the locality.

***e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);***

None of the site has been designated 'critical habitat' under Part 3 of the *TSC Act.*

***f) Whether the proposed action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan;***

**Recovery Plan** ***Oxyura australis* (Blue-billed Duck)**

No Recovery Plan exists for this species.

**Recovery Plan** **Forest Owls - *Tyto novaehollandiae* (Masked Owl) and *Ninox strenua* (Powerful Owl)**

1. *To minimise further loss and fragmentation of habitat outside conservation reserves and State Forests by protection and management of significant owl habitat (including protection of individual nest sites).*

No significant owl habitat exists within the study area. No potential nest sites will be removed. All forested habitats will be retained.

2. *To minimise the impacts of development activities on large forest owls and their habitats outside conservation reserves and State Forests.*

The WTG's have been located as far as practicable from remnant vegetation to minimise the likelihood of blade strike. Otherwise, all forested / wooded habitats are to be retained.

3. *To assess the distribution and amount of high quality habitat for each owl species across public and private lands to get an estimate of the number and proportion of occupied territories of each species that are, and are not protected.*

The entire Oberon 1:100,000 Map sheet contains one record for the Powerful Owl. No additional efforts, other than survey for this project, have been made to assess these factors as it is considered outside the scope of this assessment.

4. *To monitor trends in population parameters (number, distribution, territory fidelity and breeding success) across the range of the species and across different land tenures and disturbance history.*

No detailed monitoring studies identifying trends in population parameters have been conducted as part of the proposal.

5. *To assess the implementation and effectiveness for forest management prescriptions designed to mitigate the impact of timber-harvesting operations on the owl species and, (if necessary), to use this information to refine the prescriptions so that forestry activities in State Forests are not resulting in adverse changes in species abundance and breeding success.*

This objective is not relevant to the current proposal.

6. *To improve the recovery and management of the large forest owls based on an improved understanding of key areas of their biology and ecology.*

Whilst the potential forested habitat for these species has been reserved within the study area, the current proposal cannot be regarded as improving the recovery and management of the Powerful Owl or Masked Owl.

7. *To raise awareness of the conservation requirements of the three large forest owls amongst the broader community, to involve the community in owl conservation efforts and in so doing increase the information base owl habitats and biology.*

No schemes, in relation to this proposal, have been put in place that are considered to raise awareness of the conservation requirements of these owl species or involve the community in owl conservation efforts.

8. *To coordinate the implementation of the recovery plan and continually seek to integrate actions in this plan with actions in other recovery plans or conservation initiatives.*

The DEC co-ordinates the implementations of the actions in this recovery plan and carry out a review of the plan in its final year.

**Recovery Plan** ***Ninox connivens*** **(Barking Owl)**

1. *Increase understanding of the biology, ecology and management of the Barking Owl*

No Barking Owls are known to occur on the site and it is considered that the likely occurrence of this species in the locality is not well known. Given the small scale of the proposal, it is considered outside the scope of works to undertake such studies.

2. *Increase education and awareness of and involvement in the conservation of the Barking Owl and its habitat in NSW*

It is considered unnecessary to be involved in increasing public awareness of this issue, particularly given this species has not been recorded.

3. *Undertake threat abatement and mitigation*

The WTG's have been located as far as practicable from forest patches. In terms of mitigation, monitoring will occur post development to ensure that owls are not being significantly adversely affected.

4. *Gain efficiencies through links with other conservation plans and conservation groups*

Not relevant to this project.

5. *Provide organisational support*

Not relevant to this project.

**Recovery Plan** **Woodland Birds - *Climacteris picumnus victoriae* (Brown Treecreeper), *Stagonopleura guttata* (Diamond Firetail)**

No Recovery Plan exists for these species.

**Recovery Plan** **Micro-bats - *Falsistrellus tasmaniensis* (Eastern Falsistrelle), *Miniopterus schreibersii* (Eastern Bentwing-Bat), *Saccolaimus flaviventris* (Yellow-bellied Sheathtail Bat), and *Myotis adversus* (Large-footed Myotis)**

No Recovery Plan exists for these species.

**Threat Abatement Plan** **Predation by the Red Fox (*Vulpes vulpes*)**

1. *Ensure that fox control programmes undertaken for conservation purposes in New South Wales focus on those threatened species which are most likely to be impacted by fox predation.*

None of the 'priority threatened species' as listed in Table 5.1 of the Threat Abatement Plan have been recorded on site and the site is not listed in Table 5.2 as a priority site for fox control.

2. *Ensure that fox control programmes are effective in minimising the impacts of fox predation.*

No specific investigations into the effects of fox predation on the native species of the study area have been, or are proposed to be undertaken.

3. *Provide an experimental basis for validating the priority species for fox control and for measuring the effectiveness of control programmes.*

No known experiments to quantify the impact of fox predation on prey populations is known to have been undertaken in relation to the site.

4. *Provide support for the implementation of the plan.*

Fox control is likely to occur on an as-need basis on the study area by the landowners.

***g)*** **Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.**

KTP's are listed in Schedule 3 of the *TSC Act*. Those most applicable to the current proposal (both directly and indirectly) would appear to be:

- 'Clearing of Native Vegetation';
- 'Bushrock Removal';
- 'Removal of dead wood and dead trees'; and
- 'Invasion of native plant communities by exotic perennial grasses'.

**Clearing of Native Vegetation**

The impacts of this KTP are expected to be negligible as a result of the proposal.

**Bushrock Removal**

Whilst some bushrock does occur within the study area, and some rock is likely to require displacement for construction of WTG's and associated infrastructure, the rock will not be removed from the site and it is expected that rock habitat will still remain stable post-development.

Any removal of bushrock would be minimal in extent, and isolated in occurrence. No threatened species recorded on the site are known to be detrimentally affected by bushrock removal. Similarly, none of the flora & fauna species recorded on the site are listed within the Final Determination of this process by the NSW Scientific Committee.

**Removal of dead wood and dead trees**

Negligible removal of dead wood and dead trees will be required as a result of the proposal.

**Invasion of native plant communities by exotic perennial grasses**

The study area is already dominated by exotic grasses. The proposal may provide for some limited control within the areas to be affected by the proposal.

# APPENDIX B: FLORA AND FAUNA SPECIES LISTS

# Recorded Plant Species List

Appendix Key: * = introduced species
? = species not confirmed beyond doubt
R = Planted Species for rehabilitation
(E) = listed as Endangered in NSW.
(V) = listed as Vulnerable in NSW.

*A number of introduced taxa particularly around gardens and homesteads have not been included within this species list.

| Family Name | Scientific Name | Common Name |
|---|---|---|
| Anthericaceae | *Laxmannia gracilis* | Slender Wire-lily |
| | | |
| Apiaceae | *Centella asiatica* | - |
| | *Hydrocotyle pendularis* | - |
| | | |
| Asteraceae | **Bidens pilosa* | Farmers Friend |
| | **Carduus nutans* ssp. *nutans* | Nodding Thistle |
| | **Carthamus lanatus* | Saffron Thistle |
| | **Chondrilla juncea* | Skeleton Weed |
| | **Cirsium vulgare* | Spear Thistle |
| | **Conyza albida* | Fleabane |
| | **Hypochaeris radicata* | Flatweed |
| | **Silybum marianum* | Variegated Thistle |
| | **Taraxacum officinale* | Dandelion |
| | | |
| Boraginaceae | **Echium plantagineum* | Paterson's Curse |
| | **Echium vulgare* | Viper's Bugloss |
| | | |
| Campanulaceae | *Wahlenbergia stricta* | Austral Bluebell |
| | | |
| Caryophyllaceae | **Cerastium glomeratum* | Mouse Ear Chickweed |
| | | |
| Casuarinaceae | *Allocasuarina verticillata* [R] | Drooping She Oak |
| | | |
| Chenopodiaceae | *Einadia trigonos* | Berry Saltbush |
| | | |
| Convolvulaceae | *Dichondra repens* | Kidney Weed |
| | | |
| Cyperaceae | *Carex appressa* | - |
| | | |
| Dennstaedtiaceae | *Pteridium esculentum* | Bracken |
| | | |
| Dilleniaceae | *Hibbertia* sp. | - |
| | | |
| Epacridaceae | *Monotoca scoparia* | - |
| | | |
| Fabaceae (Faboideae) | *Glycine tabacina* | Love Creeper |
| | *Hardenbergia violacea* | False Sarsaparilla |
| | **Trifolium arvense* | Haresfoot Clover |
| | **Trifolium repens* | White Clover |
| | | |
| Fabaceae (Mimosoideae) | *Acacia elongata* [R] | - |
| | *Acacia dealbata* | Silver Wattle |
| | *Acacia falcata* [R] | Sickle Wattle |
| | *Acacia implexa* | Hickory Wattle |
| | *Acacia longifolia* [R] | Sydney Golden Wattle |
| | *Acacia melanoxylon* | Blackwood |

| Family Name | Scientific Name | Common Name |
|---|---|---|
| Geraniaceae | *Geranium solanderi* | Native Geranium |
| | *Pelargonium inodorum* | Wild Geranium |
| | | |
| Haloragaceae | *Gonocarpus tetragynus* | Poverty Raspwort |
| | | |
| Juncaceae | *Juncus sp.* | - |
| | | |
| Lamiaceae | **Marrubium vulgare* | Horehound |
| | | |
| Lomandraceae | *Lomandra filiformis* ssp. *coriacea* | Mat Rush |
| | | |
| Myrtaceae | *Eucalyptus dalrympleana* subsp. *dalrympleana* | Ribbon Gum/ Mountain Gum |
| | *Eucalyptus dives* | Broad-leaved Peppermint |
| | *Eucalyptus pauciflora* subsp. *pauciflora* | Snow Gum |
| | *Eucalyptus radiata* subsp. *radiata* | Narrow-leaved Peppermint |
| | *Eucalyptus stellulata* | Black Sally |
| | *Leptosperumum sp.* | - |
| | | |
| Plantaginaceae | **Plantago lanceolata* | Ribwort |
| | | |
| Poaceae | *Austrodanthonia caespitosa* | Ringed Wallaby Grass |
| | *Austrostipa sp.* | - |
| | **Briza minor* | Shivery Grass |
| | **Bromus catharticus* | Prairie Grass |
| | *Cynodon dactylon* | Common Couch |
| | **Cynosurus echinatus* | Rough Dog's Tail Grass |
| | **Dactylis glomerata* | Cocksfood |
| | **Digitaria* sp. | - |
| | *Eragostis* sp. | - |
| | **Lolium perenne* | Rye Grass |
| | *Panicum simile* | Two Colour Panic |
| | **Pennisetum clandestinum* | Kikuyu |
| | **Phalaris minor* | Lesser Canary Grass |
| | **Poa annua* | Winter Grass |
| | *Poa sieberiana* var. *sieberiana* | Snow Grass |
| | *Sporobolus* sp. | - |
| | | |
| Proteaceae | *Banksia marginata* [R] | Silver Banksia |
| | *Grevillea* (Cultivar) [R] | - |
| | | |
| Polygonaceae | *Persicaria* sp. | Smart Weed |
| | *Rumex brownii* | Swamp Dock |
| | | |
| Rosaceae | **Acaena ovina* | Sheep's Burr |
| | **Rubus fruticosus* | Blackberry complex |
| | | |
| Rubiaceae | *Galium propinquum* | - |
| | *Pomax umbellata* | Pomax |
| | | |
| Scrophulariaceae | *Veronica plebeia* | Speedwell |
| | | |
| Urticaceae | **Urtica urens* | Small Nettle |
| | | |
| Verbenaceae | **Verbena bonariensis* | Purple Top |

# Known and Expected Fauna Lists

Below is a list of fauna species that could be *reasonably* expected to be found within the study area at some occurrence. Such an approach has been taken given the unlikelihood to record *all* potentially occurring species within an area during formal fauna surveys (due to seasonality, climatic limitations, crypticism etc).

Family sequencing and taxonomy follow for each fauna class:

Birds – Christidis and Boles (1994).

Herpetofauna - Cogger (1996).

Mammals - Strahan (ed) (1995) and Churchill (1998).

# - Species observed or indicated by scats, tracks etc. on site during this investigation.

* - Indicates an introduced species

# Known and Expected Bird List

**Appendix Key:** ✓ = Species Detected
# = introduced species
**(E)** = listed as Endangered in NSW.
**(V)** = listed as Vulnerable in NSW.
**(EV)** = Species listed under the Commonwealth EPBC Act as Vulnerable
**(EE)** = Species listed under the Commonwealth EPBC Act as Endangered
**(EM)** = Species listed under the Commonwealth EPBC Act as Migratory
Species indicated in **BOLD** font are those threatened species known from the entire Oberon 1:100,000 map sheet (NPWS, 2006)

**Data Source:** **1** = Species recorded during this survey **(HSO, 2006)**
**2** = Species previously recorded **(Ekert, 2005)**
**3** = Species previously recorded **(G. Douglas (landowner) records)**

| Family Name | *Scientific Name* | Common Name | Daisy Bank | | | Winton Park | | Acqualoria | Mt Bathurst |
|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 1 | 2 | 1 | 2 |
| Casuariidae (Emu) | *Dromaius novaehollandiae* | Emu | | | | | | | |
| Phasianidae (True Quails, Pheasants and Fowls) | *Coturnix pectoralis* | Stubble Quail | ✓ | | ✓ | | | | |
| | *Coturnix ypsilophora* | Brown Quail | | | | | | | |
| Anatidae (Swans, Geese and Ducks) | *Anas castanea* | Chestnut Teal | | | | | | | |
| | *Anas gracilis* | Grey Teal | | ✓ | | | | | |
| | *Anas platyrhynchos* | *Mallard | | | | | | | |
| | *Anas rhynchotis* | Australasian Shoveler | | ✓ | | | | | |
| | *Anas superciliosa* | Pacific Black Duck | ✓ | ✓ | ✓ | | | | |
| | *Aytha australis* | Hardhead | | ✓ | ✓ | | | | |
| | *Biziura lobata* | Musk Duck | | | | | | | |
| | *Chenonetta jubata* | Australian Wood Duck | ✓ | ✓ | ✓ | | | | |
| | *Cygnus atratus* | Black Swan | | | | | | | |
| | *Malacorhynchus membranaceus* | Pink-eared Duck | | | | | | | |
| | ***Oxyura australis*** | **Blue-billed Duck (V)** | | | | ✓ | ✓ | | |
| Podicipedidae (Grebes) | *Tachybaptus novaehollandiae* | Australasian Grebe | ✓ | ✓ | ✓ | | | | |
| | *Podiceps cristatus* | Great Crested Grebe | | | | | | | |
| | *Poliocephalus poliocephalus* | Hoary-headed Grebe | | | | | | | |
| Anhingidae (Darters) | *Anhinga melanogaster* | Darter | ✓ | | ✓ | | | | |
| Phalacrocoracidae (Cormorants) | *Phalacrocorax carbo* | Great Cormorant | ✓ | ✓ | ✓ | | | | |
| | *Phalacrocorax melanoleucos* | Little Pied Cormorant | | | ✓ | | | | |
| | *Phalacrocorax* | Little Black | | | | | | | |

| Family Name | *Scientific Name* | Common Name | Daisy Bank | | | Winton Park | | Acqualoria | Mt Bathurst |
|---|---|---|---|---|---|---|---|---|---|
| | *sulcirostris* | Cormorant | | | | | | | |
| | *Phalacrocorax varius* | Pied Cormorant | | | | | | | |
| Pelecanide (Pelicans) | *Pelecanus conspicillatus* | Australian Pelican | | | | | | | |
| Ardeidae (Herons, Bitterns and Egrets) | *Ardea alba* | Great Egret | | | | | | | |
| | *Ardea ibis* | Cattle Egret | | | | | | | |
| | *Ardea intermedia* | Intermediate Egret | | | | | | | |
| | *Ardea pacifica* | White-necked Heron | | | | | | | |
| | *Egretta garzetta* | Little Egret | | | | | | | |
| | *Egretta novaehollandiae* | White-faced Heron | ✓ | | ✓ | ✓ | | | |
| | *Ixobrychus minutus* | Little Bittern | | | | | | | |
| | *Nycticorax caledonicus* | Nankeen Night Heron | | | | | | | |
| Threskiornithidae (Ibises and Spoonbills) | *Platalea flavipes* | Yellow-billed Spoonbill | | | ✓ | | | | |
| | *Platalea regia* | Royal Spoonbill | | | | | | | |
| | *Plegadis falcinellus* | Glossy Ibis | | | | | | | |
| | *Threskiornis molucca* | Australian White Ibis | ✓ | | ✓ | ✓ | | | |
| | *Threskiornis spinicollis* | Straw-necked Ibis | | | | | | | |
| Accipitridae (Hawks, Kites and Eagles) | *Accipiter fasciatus* | Brown Goshawk | | | | | | | ✓ |
| | *Accipiter cirrhocephalus* | Collared Sparrowhawk | | | | | | | |
| | *Accipiter novaehollandiae* | Grey Goshawk | | | | | | | |
| | *Aquila audax* | Wedge-tailed Eagle | ✓ | | ✓ | | | | |
| | *Circus approximans* | Swamp Harrier | | | ✓ | | | | |
| | *Circus assimilis* | Spotted Harrier | | | | | | | |
| | *Elanus axillaris* | Black-shouldered Kite | ✓ | | ✓ | | | | |
| | *Haliaeetus leucogaster* | White-bellied Sea-Eagle | | | | | | | |
| | *Haliastur sphenurus* | Whistling Kite | | | | | | | |
| | *Hieraaetus morphnoides* | Little Eagle | | | | | | | |
| | *Milvus migrans* | Black Kite | | | | | | | |
| Falconidae (Falcons) | *Falco berigora* | Brown Falcon | | | ✓ | | | | |
| | *Falco cenchroides* | Nankeen Kestrel | | ✓ | ✓ | | | | |
| | *Falco longipennis* | Australian Hobby | | | | | | | |
| | *Falco peregrinus* | Peregrine | | | ✓ | | | | |

| Family Name | *Scientific Name* | Common Name | Daisy Bank | | | Winton Park | | Acqualoria | Mt Bathurst |
|---|---|---|---|---|---|---|---|---|---|
| | | Falcon | | | | | | | |
| | *Falco subniger* | Black Falcon | | | | | | | |
| Rallidae (Crakes, Rails and Gallinules) | *Fulica atra* | Eurasian Coot | ✓ | ✓ | ✓ | ✓ | | ✓ | |
| | *Gallinula philippensis* | Buff-banded Rail | | | | | | | |
| | *Gallinula tenebrosa* | Dusky Moorhen | | | | | | | |
| | *Porphyrio porphyrio* | Purple Swamphen | | | | | | | |
| | *Porzana fluminea* | Australian Spotted Crake | | | | | | | |
| | *Porzana pusilla* | Baillon's Crake | | | | | | | |
| | *Porzana tabuensis* | Spotless Crake | | | | | | | |
| | *Rallus pectoralis* | Lewin's Rail | | | | | | | |
| Turnicidae (Button-Quails) | *Turnix varia* | Painted Button-quail | | | | | | | |
| | *Turnix velox* | Little Button-quail | | | | | | | |
| Charadriidae (Lapwings, Plovers and Dottrels) | *Charadrius bicinctus* | Double-banded Plover | | | | | | | |
| | *Vanellus miles* | Masked Lapwing | ✓ | | ✓ | | | | |
| | *Vanellus tricolor* | Banded Lapwing | | | | | | | |
| Haematopodidae (Oystercatchers) | *Erythrogonys cinctus* | Red-kneed Dotterel | | | | | | | |
| | *Elseyornis melanops* | Black-fronted Dotterel | | | | | | | |
| Laridae (Gulls and Terns) | *Chlidonias hybrida* | Whiskered Tern | | | | | | | |
| | *Larus novaehollandiae* | Silver Gull | | | | | | | |
| Columbidae (Pigeons and Doves) | *Columba livia* | Rock Dove # | | | | | | | |
| | *Columba leucomela* | White-headed Pigeon | | | | | | | |
| | *Geopelia humeralis* | Bar-shouldered Dove | | | | | | | |
| | *Geopelia striata* | Peaceful Dove | | | | | | | |
| | *Leucosarcia melanoleuca* | Wonga Pigeon | | | | | | | |
| | *Macropygia amboinensis* | Brown Cuckoo-Dove | | | | | | | |
| | *Ocyphaps lophotes* | Crested Pigeon | ✓ | | ✓ | | | | |
| | *Phaps chalcoptera* | Common Bronzewing | | | | | | | |
| | *Streptopelia chinensis* | Spotted Turtle-Dove # | | | | | | | |
| Cacatuidae (Cockatoos) | *Calyptrohynchus funereus* | Yellow-tailed Black-Cockatoo | | | ✓ | | | | |
| | *Cacatua roseicapilla* | Galah | | ✓ | ✓ | | | | ✓ |
| | *Cacatua* | Long-billed | | | | | | | |

| Family Name | *Scientific Name* | Common Name | Daisy Bank | | | Winton Park | | Acqualoria | Mt Bathurst |
|---|---|---|---|---|---|---|---|---|---|
| | *tenuirostris* | Corella | | | | | | | |
| | *Cacatua sanguinea* | Little Corella | | | | | | | |
| | *Cacatua galerita* | Sulphur-crested Cockatoo | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| | *Callocephalon fimbriatum* | Gang-gang Cockatoo | | | | | | | |
| Psittacidae (Parrots) | *Alisterus scapularis* | Australian King Parrot | | | | | | | |
| | *Glassopsitta pusilla* | Little Lorikeet | | | | | | | |
| | *Nymphicus hollandicus* | Cockatiel | | | | | | | |
| | *Platycercus elegans* | Crimson Rosella | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | *Platycercus eximius* | Eastern Rosella | | ✓ | ✓ | ✓ | ✓ | | ✓ |
| | *Psephotus haematonotus* | Red-rumped Parrot | | | ✓ | | | | |
| | *Trichoglossus chlorolepidotus* | Scaly-breasted Lorikeet | | | | | | | |
| | *Trichoglossus concina* | Musk Lorikeet | | | | | | | |
| | *Trichoglossus haematodus* | Rainbow Lorikeet | | | | | | | |
| Cuculidae (Old World Cuckoos) | *Cuculus saturatus* | Oriental Cuckoo (EM) | | | | | | | |
| | *Cacomantis flabelliformis* | Fan-tailed Cuckoo | | | ✓ | | | | |
| | *Cacomantis variolosus* | Brush Cuckoo | | | | | | | |
| | *Chrysococcyx basalis* | Horsfield's Bronze-Cuckoo | | | | | | | |
| | *Chrysococcyx lucidus* | Shining Bronze-Cuckoo | | | | | | | |
| | *Chalcites osculans* | Black-eared Cuckoo | | | | | | | |
| | *Cuculus pallidus* | Pallid Cuckoo | | | | | | | |
| | *Eudynamys orientalis* | Common Koel | | | | | | | |
| | *Scythrops novaehollandiae* | Channel-billed Cuckoo | | | | | | | |
| Centropodidae (Coucals) | *Centropus phasianinus* | Pheasant Coucal | | | | | | | |
| Strigidae (Hawk Owls) | ***Ninox strenua*** | **Powerful Owl (V)** | | | | | | | |
| | ***Ninox connivens*** | **Barking Owl (V)** | | | | | | | |
| | *Ninox boobook* | Southern Boobook | | | | | | | |
| Tytonidae (Barn Owls) | *Tyto alba* | Barn Owl | | | | | | | |
| Podargidae (Frogmouths) | *Podargus strigoides* | Tawny Frogmouth | | | ✓ | | | | |

| Family Name | *Scientific Name* | Common Name | Daisy Bank | | | Winton Park | | Acqualoria | Mt Bathurst |
|---|---|---|---|---|---|---|---|---|---|
| Caprimulgidae (Nightjars) | *Eurostopodus mystacalis* | White-throated Nightjar | | | | | | | |
| Aegothelidae (Owlet-nightjars) | *Aegotheles cristatus* | Australian Owlet-nightjar | | | | | | | |
| Apodidae (Typical Swifts) | *Hirundapus caudacutus* | White-throated Needletail (EM) | | | ✓ | | | | |
| | *Apus pacificus* | Fork-tailed Swift (EM) | | | | | | | |
| Alcedinidae (True Kingfishers) | *Alcedo azurea* | Azure Kingfisher | | | | | | | |
| Halcyonidae (Kingfishers and Kookaburras) | *Dacelo novaeguineae* | Laughing Kookaburra | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ |
| | *Todiramphus sanctus* | Sacred Kingfisher | | | | | | | |
| | *Todiramphus macleayii* | Forest Kingfisher | | | | | | | |
| Meropidae (Bee-eaters) | *Merops ornatus* | Rainbow Bee-eater (EM) | | | | | | | |
| Coraciidae (Typical Rollers) | *Eurystomus orientalis* | Dollarbird | | | ✓ | | | | |
| Climacteridae (Australo-Papuan Treecreepers) | *Cormobates leucophaeus* | White-throated Treecreeper | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ |
| | *Climacteris erythrops* | Red-browed Treecreeper | | | | | | | |
| | ***Climacteris picumnus*** | **Brown Treecreeper (V)** | | | ✓ | | | | |
| Maluridae (Fairy-Wrens and Emu-Wrens) | *Malurus cyaneus* | Superb Fairy-wren | ✓ | ✓ | ✓ | | ✓ | | ✓ |
| | *Malurus lamberti* | Variegated Fairy-wren | | | | | | | |
| Pardalotidae (Pardalotes, Scrubwrens, Thornbills, Whitefaces) | *Pardalotus punctatus* | Spotted Pardalote | | | | | | | |
| | *Paradalotus striatus* | Striated Pardalote | ✓ | | ✓ | | ✓ | | ✓ |
| | *Sericornis frontalis* | White-browed Scrubwren | | | ✓ | | ✓ | | ✓ |
| | ***Chthonicola sagittata*** | **Speckled Warbler (V)** | | | | | | | |
| | *Gerygone fusca* | Western Gerygone | | | | | | | |
| | *Gerygone mouki* | Brown Gerygone | | | | | | | |
| | *Gerygone olivacea* | White-throated Gerygone | | | | | | | |
| | *Acanthiza apicalis* | Inland Thornbill | | | | | | | |
| | *Acanthiza pusilla* | Brown Thornbill | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| | *Acanthiza reguloides* | Buff-rumped Thornbill | ✓ | ✓ | | | | | |

| Family Name | *Scientific Name* | Common Name | Daisy Bank | | | Winton Park | | Acqualoria | Mt Bathurst |
|---|---|---|---|---|---|---|---|---|---|
| | *Acanthiza chrysorrhoa* | Yellow-rumped Thornbill | | ✓ | | | ✓ | | ✓ |
| | *Acanthiza nana* | Yellow Thornbill | | | | | | | |
| | *Acanthiza lineata* | Striated Thornbill | | ✓ | | | ✓ | | ✓ |
| | *Smicrornis brevirostris* | Weebill | | | | | | | |
| | *Aphelocephala leucopsis* | Southern Whiteface | | | | | | | |
| Meliphagidae (Honeyeaters) | *Anthochaera carunculata* | Red Wattlebird | | ✓ | ✓ | ✓ | ✓ | | ✓ |
| | *Plectrhyncha lanceolata* | Striped Honeyeater | | | | | | | |
| | *Anthochaera chrysoptera* | Brush Wattlebird | | | | | | | |
| | *Philemon corniculatus* | Noisy Friarbird | | | | | | | |
| | *Philemon citerogularis* | Little Friarbird | | | | | | | |
| | ***Xanthomyza phrygia*** | **Regent Honeyeater (E, EE)** | | | | | | | |
| | *Manorina flavigula* | Yellow-throated Miner | | | | | | | |
| | *Manorina melanophrys* | Bell Miner | | | | | | | |
| | *Manorina melanocephala* | Noisy Miner | | | | | | | |
| | *Acanthagenys rufogularis* | Spiny-cheeked Honeyeater | | | | | | | |
| | *Meliphaga lewinii* | Lewin's Honeyeater | | | | | | | |
| | *Lichenostomus chrysops* | Yellow-faced Honeyeater | | | | | ✓ | | ✓ |
| | *Lichenostomus fuscus* | Fuscous Honeyeater | | | | | | | |
| | *Lichenostomus leucotis* | White-eared Honeyeater | | | | | | | |
| | *Lichenostomus melanops* | Yellow-tufted Honeyeater | | | | | | | |
| | *Lichenostomus penicillatus* | White-plumed Honeyeater | | ✓ | | | | | ✓ |
| | *Melithreptus brevirostris* | Brown-headed Honeyeater | | | | | | | |
| | *Melithreptus lunatus* | White-naped Honeyeater | | | | | | | |
| | *Entomyzon cyanotis* | Blue-faced Honeyeater | | | | | | | |
| | *Lichmera indistincta* | Brown Honeyeater | | | | | | | |
| | *Phylidonyris novaehollandiae* | New Holland Honeyeater | | | | | | | |
| | *Phylidonyris nigra* | White-cheeked Honeyeater | | | | | | | |
| | *Acanthorhynchus tenuirostris* | Eastern Spinebill | | | | | | | |
| | *Myzomela sanguinolenta* | Scarlet Honeyeater | | | | | | | |

| Family Name | *Scientific Name* | Common Name | Daisy Bank | | | Winton Park | | Acqualoria | Mt Bathurst |
|---|---|---|---|---|---|---|---|---|---|
| | *Epthianura albifrons* | White-fronted Chat | | | | | | | |
| Eopsaltriidae (Robins) | *Microeca fascinans* | Jacky Winter | | | | | | | ✓ |
| | *Petroica multicolor* | Scarlet Robin | | | | | ✓ | | |
| | *Petroica goodenovii* | Red-capped Robin | | | | | | | |
| | *Petroica phoenicea* | Flame Robin | | | ✓ | | ✓ | | |
| | *Petroica rosea* | Rose Robin | | | | | | | |
| | *Eopsaltria australis* | Eastern Yellow Robin | | | | | | | |
| | ***Melanodryas cucullata*** | **Hooded Robin (V)** | | | | | | | |
| Cinclosomidae (Quail-thrushes and allies) | *Psophodes olivaceus* | Eastern Whipbird | | | | | | | |
| | *Cinclosoma punctatum* | Spotted Quail-thrush | | | | | | | |
| Neosittidae (Sittellas) | *Daphoenositta chrysoptera* | Varied Sittella | | | | | | | |
| Pachycephalidae (Whistlers, Shrike-tit, Shrike-thrushes) | *Falcunculus frontatus* | Crested Shrike-tit | | | | | | | |
| | *Pachycephala pectoralis* | Golden Whistler | | | | | | | |
| | *Pachycephala rufiventris* | Rufous Whistler | | | | | ✓ | | |
| | *Colluricincla harmonica* | Grey Shrike-thrush | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Dicruridae (Monarchs, Fantails and Drongo) | *Monarcha melanopsis* | Black-faced Monarch | | | | | | | |
| | *Myiagra cyanoleuca* | Satin Flycatcher | | | | | | | |
| | *Myiagra rubecula* | Leaden Flycatcher | | | | | | | ✓ |
| | *Myiagra inquieta* | Restless Flycatcher | | | | | | | |
| | *Grallina cyanoleuca* | Magpie-lark | ✓ | | ✓ | ✓ | | | |
| | *Rhipidura rufifrons* | Rufous Fantail | | | | | | | |
| | *Rhipidura fuliginosa* | Grey Fantail | ✓ | | ✓ | | ✓ | | ✓ |
| | *Rhipidura leucophyrs* | Willie Wagtail | | ✓ | ✓ | ✓ | ✓ | | ✓ |
| Campephagidae (Cuckoo-shrikes and Trillers) | *Coracina maxima* | Ground Cuckoo-shrike | | | | | | | |
| | *Coracina novaehollandiae* | Black-faced Cuckoo-shrike | | | ✓ | | ✓ | | ✓ |
| | *Coracina papuensis* | White-bellied Cuckoo-shrike | | | | | | | |
| | *Coracina tenuirostris* | Cicadabird (EM) | | | | | | | |
| | *Lalage sueurii* | White-winged Triller | | | | | | | |
| Oriolidae (Orioles and Figbird) | *Oriolus sagittatus* | Olive-backed | | | | | | | |

| Family Name | *Scientific Name* | Common Name | Daisy Bank | | | Winton Park | | Acqualoria | Mt Bathurst |
|---|---|---|---|---|---|---|---|---|---|
| | | Oriole | | | | | | | |
| Artamidae (Woodswallows, Butcherbirds,Currawongs) | *Artamus cinereus* | Black-faced Woodswallow | | | | | | | |
| | *Artamus cyanopterus* | Dusky Woodswallow | | | ✓ | | | | |
| | *Artamus personatus* | Masked Woodswallow | | | | | | | |
| | *Artamus superciliosus* | White-browed Woodswallow | | | ✓ | | | | |
| | *Cracticus torquatus* | Grey Butcherbird | ✓ | | ✓ | ✓ | ✓ | | |
| | *Cracticus nigrogularis* | Pied Butcherbird | | | | | | | |
| | *Gymnorhina tibicen* | Australian Magpie | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| | *Strepera graculina* | Pied Currawong | | ✓ | ✓ | ✓ | ✓ | | ✓ |
| | *Strepera versicolor* | Grey Currawong | | | ✓ | | ✓ | | |
| Corvidae (Crows and allies) | *Corvus coronoides* | Australian Raven | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| | *Corvus mellori* | Little Raven | | | | | | | |
| Cororacidae (Mud-nesters) | *Corcorax melanorhamphos* | White-winged Chough | | ✓ | ✓ | | | | |
| | *Struthidea cinerea* | Apostlebird | | | | | | | |
| Alaudidae (Larks) | *Mirafra javanica* | Singing Bushlark | | | ✓ | | | | |
| Motacillidae (Old World Wagtails,Pipits) | *Anthus australis* | Australian Pipit (previously Richard's Pipit) | | ✓ | ✓ | | ✓ | | ✓ |
| Passeridae (Sparrows, Weaverbirds, Waxbills) | *Passer domesticus* | House Sparrow # | ✓ | | ✓ | | | ✓ | |
| | *Carduelis carduelis* | European Goldfinch | | ✓ | ✓ | | ✓ | | ✓ |
| | *Taeniopygia guttata* | Zebra Finch | | | | | | | |
| | *Taeniopygia bichenovii* | Double-barred Finch | | | | | | | |
| | *Neochmia modesta* | Plum-headed Finch | | | | | | | |
| | *Neochmia temporalis* | Red-browed Finch | | | | | | | |
| | *Lonchura castaneothorax* | Chestnut-breasted Mannikin | | | | | | | |
| | ***Stagonopleura guttata*** | **Diamond Firetail (V)** | | | ✓ | | | | |
| Dicaeidae (Flowerpeckers) | *Dicaeum hirundinaceum* | Mistletoebird | | | | | | | |
| Hirundinidae (Swallows and Martins) | *Hirundo neoxena* | Welcome Swallow | | ✓ | ✓ | | | | |
| | *Hirundo nigricans* | Tree Martin | | | ✓ | | | | |
| | *Hirundo ariel* | Fairy Martin | | ✓ | | | | | |

| Family Name | *Scientific Name* | Common Name | Daisy Bank | | | Winton Park | | Acqualoria | Mt Bathurst |
|---|---|---|---|---|---|---|---|---|---|
| Sylviidae (Old World Warblers) | *Acrocephalus stentoreus* | Clamorous Reed Warbler | | ✓ | | | | | |
| | *Cincloramphus mathewsi* | Rufous Songlark | | | | | | | |
| | *Cincloramphus cruralis* | Brown Songlark | | | ✓ | | | | |
| | *Cisticola exilis* | Golden-headed Cisticola | | ✓ | | | | | |
| | *Megalurus gramineus* | Little Grassbird | | | | | | | |
| | *Megalurus timorensis* | Tawny Grassbird | | | | | | | |
| Zosteropidae (White-eyes) | *Zosterops lateralis* | Silvereye | | | | | ✓ | | ✓ |
| Muscicapidae (Thrushes) | *Turdus merula* | Eurasian Blackbird | | | ✓ | | | | ✓ |
| | *Zoothera lunulata* | Bassian Thrush | | | | | | | |
| | *Zoothera heinei* | Russet-tailed Thrush | | | | | | | |
| Sturnidae (Starlings and allies) | *Sturnus vulgaris* | Common Starling # | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | *Acridotheres tristis* | Common Myna # | | | | | | | |

# Known and Expected Mammal List

**Appendix Key:** ✓ = Species Detected
# = introduced species
**(E)** = listed as Endangered in NSW.
**(V)** = listed as Vulnerable in NSW.
**(EV)** = Species listed under the Commonwealth EPBC Act as Vulnerable
**(EE)** = Species listed under the Commonwealth EPBC Act as Endangered
Species indicated in **BOLD** font are those threatened species known from the entire Oberon 1:100,000 map sheet (NPWS, 2006)

**Data Source:**
**1** = Species recorded during this survey **(HSO, 2006)**
**2** = Species previously recorded **(Hoye, 2005a)**

| **Family Name** | ***Scientific Name*** | **Common Name** | **Winton Park** | | **Daisy Bank** | | **Acqualoria** | **Mt Bathurst** |
|---|---|---|---|---|---|---|---|---|
| | | | **1** | **2** | **1** | **2** | **1** | **2** |
| Tachyglossidae (Echidnas) | *Tachyglossus aculeatus* | Short-beaked Echidna | | | | ✓ | | |
| Family Ornithorhynchidae (Platypus) | *Ornythorhynchus anatinus* | Platypus | | | | | | |
| Dasyuridae (Dasyurids) | *Antechinus flavipes* | Yellow-footed Antechinus | | | | | | |
| | *Antechinus stuartii* | Brown Antechinus | | | | | | |
| | *Sminthopsis crassicaudata* | Fat-tailed Dunnart | | | | | | |
| | *Sminthopsis murina* | Common Dunnart | | | | | | |
| | *Sminthopsis sp.* | Dunnart | | | | | | |
| Phascolarctidae (Koala) | ***Phascolarctos cinereus*** | **Koala (V)** | | | | | | |
| Vombatidae (Wombats) | *Vombatus ursinus* | Common Wombat | ✓ | | ✓ | | ✓ | |
| Petauridae (Wrist-winged Gliders) | *Petaurus breviceps* | Sugar Glider | | | | ✓ | | |
| | ***Petaurus australis*** | **Yellow-bellied Glider (V)** | | | | | | |
| Pseudocheiridae (Ringtail Possums, Greater Glider) | *Petauroides volans* | Greater Glider | | | | | | |
| | *Pseudocheirus peregrinus* | Common Ringtail Possum | ✓ | | | | | |
| Acrobatidae (Feathertail Glider) | *Acrobates pygmaeus* | Feathertail Glider | | | | | | |
| Phalangeridae (Brushtail Possums and Cuscuses) | *Trichosurus caninus* | Mountain Brushtail Possum | | | | | | |
| | *Trichosurus vulpecula* | Common Brushtail Possum | | | | | | |
| Macropodidae (Wallabies and Kangaroos) | *Macropus giganteus* | Eastern Grey Kangaroo | ✓ | | ✓ | | ✓ | |
| | *Macropus robustus* | Common Wallaroo | | | | | | |

| Family Name | *Scientific Name* | Common Name | Winton Park | | Daisy Bank | | Acqualoria | Mt Bathurst |
|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 1 | 2 | 1 | 2 |
| | *Macropus rufogriseus* | Red-necked Wallaby | | | | | | |
| | *Wallabia bicolor* | Swamp Wallaby | | | | | | |
| Pteropodidae (Flying-foxes, Blossom-bats) | *Pteropus scapulatus* | Little Red Flying-fox | | | | | | |
| Rhinolophidae (Horseshoe-bats) | *Rhinolophus megaphyllus* | Eastern Horseshoe-bat | | | | | | |
| Emballonuridae (Sheathtail-bats) | ***Saccolaimus flaviventris*** | **Yellow-bellied Sheathtail-bat (V)** | | | | | | ✓ |
| Molossidae (Freetail-bats) | *Mormopterus* sp.1 | Little Freetail-bat | | | | ✓ | | ✓ |
| | *Mormopterus planiceps* | Southern Freetail bat | | | | | | ✓ |
| | *Tadarida australis* | White-striped Freetail-bat | | ✓ | | ✓ | | ✓ |
| Vespertilionidae (Vespertilionid Bats) | ***Miniopterus schreibersii*** | **Eastern Bentwing-bat (V)** | | | | ✓ | | ✓ |
| | *Nyctophilus geoffroyi* | Lesser Long-eared Bat | | | | ✓ | | ✓ |
| | *Nyctophilus* sp. | Unidentified Long-eared Bat | | ✓ | | | | ✓ |
| | ***Myotis adversus*** | **Large-footed Myotis (V)** | | | | | | ✓ |
| | *Chalinolobus gouldii* | Gould's Wattled Bat | | ✓ | | ✓ | | ✓ |
| | *Chalinolobus morio* | Chocolate Wattled Bat | | ✓ | | ✓ | | ✓ |
| | ***Falsistrellus tasmaniensis*** | **Eastern Falsistrelle (V)** | | ✓ | | ✓ | | ✓ |
| | *Scotorepens orion* | Eastern Broad-nosed Bat | | ✓ | | ✓ | | ✓ |
| | *Vespadelus darlingtoni* | Large Forest Bat | | ✓ | | ✓ | | ✓ |
| | *Vespadelus regulus* | Southern Forest Bat | | ✓ | | ✓ | | ✓ |
| | *Vespadelus vulturnus* | Little Forest Bat | | | | | | ✓ |
| Muridae (Murids) | *Hydromys chrysogaster* | Water Rat | | | | | | |
| | *Mus musculus* | House Mouse# | | | | | | |
| | *Rattus fuscipes* | Bush Rat | | | | | | |
| | *Rattus norvegicus* | Brown Rat# | | | | | | |
| | *Rattus rattus* | Black Rat# | | | | | | |
| Canidae (Dogs) | *Canis familiaris* | Dog # | | | | | | |
| | *Canis familiaris dingo* | Dingo | | | | | | |
| | *Vulpes vulpes* | Red Fox# | ✓ | | | | | |
| Felidae (Cats) | *Felis catus* | Feral Cat# | | | | | | |
| Leporidae (Rabbit and Hare) | *Oryctolagus cuniculus* | European Rabbit# | | | ✓ | | | |
| | *Lepus capensis* | Brown Hare# | ✓ | | | ✓ | | |

| Family Name | *Scientific Name* | Common Name | Winton Park | | Daisy Bank | | Acqualoria | Mt Bathurst |
|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 1 | 2 | 1 | 2 |
| Equidae (Horse and Donkey) | *Equus caballus* | Horse# | ✓ | | | | | |
| Suidae (Pigs) | *Sus scrofa* | Pig# | | | | | | |
| Bovidae (Horned Ruminants) | *Bos taurus* | Cow# | ✓ | | | ✓ | | |
| | *Capra hircus* | Goat# | | | | | | |
| | *Ovis aries* | Sheep # | ✓ | | | ✓ | | |
| Cervidae (Deer) | *Cervus timorensis* | Rusa Deer # | | | | | | |

# Known and Expected Reptile List

Appendix Key: ✓ = Species recorded within the study area.

| Family Name | *Scientific Name* | Common Name | Recorded |
|---|---|---|---|
| Chelidae (Tortoises) | *Chelodina longicollis* | Long-necked Tortoise | |
| Gekkonidae (Geckoes) | *Diplodactylus vittatus* | Wood Gecko | |
| | *Oedura lesueurii* | Lesueur's Velvet Gecko | |
| | *Oedura tryoni* | Southern Spotted Velvet Gecko | |
| Agamidae (Dragons) | *Amphibolurus muricatus* | Jacky Lizard | |
| | *Physignathus lesuerii* | Eastern Water Dragon | |
| | *Pogona barbata* | Eastern Bearded Dragon | |
| Pygopodidae (Legless Lizards) | *Lialis burtonis* | Burton's Snake Lizard | |
| | *Pygopus lepidopus* | Common Scaly-foot | |
| | *Delma plebeia* | Leaden Delma | |
| Varanidae (Monitors) | *Varanus varius* | Lace Monitor | |
| Scincidae (Skinks) | *Anomalopus leuckartii* | Two-clawed Worm-skink | |
| | *Anomalopus verreauxii* | Three-clawed Worm-skink | |
| | *Bassiana platynota* | Red-throated Cool-skink | |
| | *Calyptotis ruficauda* | Red-tailed Calyptotis | |
| | *Calyptotis scutirostrum* | Scute-snouted Calyptotis | |
| | *Carlia tetradactyla* | Southern Rainbow-skink | |
| | *Carlia vivax* | Tussock Rainbow-skink | |
| | *Cryptoblepharus virgatus* | Wall Lizard | |
| | *Ctenotus taeniolatus* | Copper-tailed Skink | |
| | *Ctenotus robustus* | Striped Skink | |
| | *Cyclodomorphus casuarinae* | She-oak Skink | |
| | *Egernia cunninghamii* | Cunningham's Skink | |
| | *Egernia major* | Land Mullet | |
| | *Egernia modesta* | | |
| | *Egernia striolata* | Tree-crevice Skink | |
| | *Egernia saxatilis* | Black Rock Skink | |
| | *Egernia whitii* | White's Skink | |
| | *Eulamprus quoyii* | Eastern Water Skink | |
| | *Eulamprus tenuis* | Barred-sided Skink | |
| | *Lampropholis delicata* | Grass Skink | ✓ |
| | *Lampropholis guichenoti* | Garden Skink | |
| | *Lygisaurus foliorum* | Tree-base Litter-skink | |

| Family Name | *Scientific Name* | Common Name | Recorded |
|---|---|---|---|
| | *Morethia boulengeri* | South-eastern Morethia | |
| | *Pseudomoia platynota* | Red-throated Skink | |
| | *Saiphos equalis* | | |
| | *Saproscincus mustelinus* | Weasel Skink | |
| | *Tiliqua scincoides* | Eastern Blue-tongued Lizard | |
| Typhlopidae (Blind Snakes) | *Ramphotyphlops bituberculatus* | Prong-snouted Blind Snake | |
| | *Ramphotyphlops weidii* | Brown-snouted Blind Snake | |
| | *Ramphotyphlops nigrescens* | Black Blind Snake | |
| | *Ramphotyphlops wiedii* | Brown-snouted Blind Snake | |
| Elapidae (Venomous Snakes) | *Austrelaps ramsayi* | Highlands Copperhead | ✓ |
| | *Cacophis squamulosus* | Golden Crowned Snake | |
| | *Drysdalia coronoides* | White-lipped Snake | |
| | *Furina diadema* | Red-naped Snake | |
| | *Pseudechis porphyriacus* | Red-bellied Black Snake | |
| | *Suta spectabilis* | Spectacled Hooded Snake | |
| | *Suta spectabilis dwyeri* | Variable Black-naped Snake | |

# Known and Expected Frog List

Appendix Key: (E) = listed as Endangered in NSW. (V) = listed as Vulnerable in NSW.
(EV) = Species listed under the Commonwealth EPBC Act as Vulnerable

Data Source: ✓ = Species recorded within the study area.

| Family Name | *Scientific Name* | Common Name | Recorded |
|---|---|---|---|
| Hylidae (Tree Frogs) | *Litoria aurea* | Green and Golden Bell Frog | |
| | *Litoria caerulea* | Green Tree Frog | |
| | *Litoria dentata* | Keferstein's Tree Frog | |
| | *Litoria fallax* | Eastern Dwarf Tree Frog | |
| | *Litoria latopalmata* | Broad-palmed Frog | |
| | *Litoria lesueuri* | Lesueur's Frog | |
| | *Litoria peronii* | Peron's Tree Frog | ✓ |
| | *Litoria verreauxii* | Verreaux's Tree Frog | |
| Myobatrachidae (Ground Frogs) | *Crinia parinsignifera* | Eastern Sign-bearing Froglet | |
| | *Crinia signifera* | Common Eastern Froglet | ✓ |
| | *Limnodynastes dumerilii* | Bullfrog | |
| | *Limnodynastes fletcheri* | Long-thumbed Frog | |
| | *Limnodynastes ornatus* | Ornate Burrowing Frog | |
| | *Limnodynastes peronii* | Striped Marsh Frog | ✓ |
| | *Limnodynastes tasmaniensis* | Spotted Marsh Frog | ✓ |
| | *Neobatrachus sudelli* | Painted Burrowing Frog | |
| | *Pseudophryne bibronii* | Bibron's Toadlet | |
| | *Pseudophryne coriacea* | Red-backed Toadlet | |
| | *Uperoleia laevigata* | Smooth Toadlet | ✓ |
| | *Uperoleia marmorata* | Marbled Toadlet | |
| | *Uperoleia* sp. | | |

# APPENDIX C: CURRICULUM VITAE'S OF HSO PERSONNEL

# TOBY LAMBERT BENVSC

## Senior Ecologist

| | |
|---|---|
| **Date of Birth** | 7th March 1975 |
| **Qualifications** | B.Env.Sc.<br>University of Newcastle, New South Wales (1996) |
| **Fields of Special Competence** | Environmental Impact Assessment and mediation<br>Flora, fauna and habitat survey method, design and identification<br>Detailed understanding of legislation and threatened species issues<br>Terrestrial fauna surveys<br>Project management |
| **Professional Affiliations** | Ecological Consultants Association of NSW – Council Member<br>Royal Zoological Society of NSW<br>Frog and Tadpole Study Group |
| **Credentials** | NSW Driver's Licence: Car (Class "C")<br>4WD Course Certificate (NSW Rural Fire Service, Wyong)<br>NSW NPWS Scientific Investigation Licence (S10300) |

### *EMPLOYMENT HISTORY*

| | |
|---|---|
| **Dec 2005 - current** | Senior Ecologist<br>Harper Somers O'Sullivan, Broadmeadow, NSW |
| **Mar 2005 - Nov 2005** | Senior Project Manager<br>Cumberland Ecology, Epping, NSW |
| **Mar 2004 - Mar 2005** | Principal Consultant – Co-founder<br>Keystone Ecological, Kariong, NSW |
| **Jan 1998 - Jan 2004** | Ecologist / Senior Ecologist<br>Conacher Travers Environmental Consultants, Somersby, NSW |
| **June 1997 - Dec 1997** | Environmental Scientist<br>Australian Defence Industries (ADI), St Mary's, NSW |
| **Early 1997** | Field Assistant<br>Anne Clements and Associates, North Sydney, NSW |
| **1996** | Research Assistant<br>University of Newcastle, Callaghan, NSW |

# MICHAEL RODERICK BAPPSC(EAM)

## Senior Ecologist

**Date of Birth** 26th December 1972

**Qualifications** B.App.Sc. (Environmental Assessment and Management) University of Newcastle, New South Wales (1994).

**Fields of Special Competence**
Environmental Impact Assessment and mediation
Flora, fauna and habitat survey method, design and identification
Threatened species plans of management
Detailed understanding of legislation and threatened species issues
Threatened and migratory wildlife monitoring
Project management
Volunteer co-ordination and training

**Professional and Other Affiliations**
Hunter Bird Observers Club (HBOC)
Australasian Wader Study Group (AWSG)
Birds Australia (BA)

**Credentials**
NSW NPWS Scientific Investigation Licence (No. A2428) RFS / PIA NSW Consulting Planners Bushfire Training Course
Occupational Health and Safety Induction Training
NSW Driver's Licence: Car (Class "C")

### *EMPLOYMENT HISTORY*

**Nov 2002 – current** Ecologist / Senior Ecologist
Harper Somers O'Sullivan, Broadmeadow, NSW

**Dec 2002 – Nov 2003** Senior Project Officer
Ekerlogic Consulting Services, Wallsend, NSW

**Jan 2003 - current** Leader - Coastcare Summer Festival Walks / Gosford City Council
The Wetlands Centre, Kooragang NR / Empire Bay, Brisbane Water NP

**Mar 2002** Field Assistant (mistnetting avifauna - 'Wings of America' project)
Podocarpus National Park, Ecuador

**Jan – Mar 2002** Ecologist (compiling avifauna and amphibian inventories)
Cotacachi Cloud Forest and Cerro Seco Rainforest Reserves, Ecuador

**Mar 1998 - Oct 2001** Ecologist / Senior Ecologist
Wildthing Environmental Consultants, Salt Ash, NSW

**June - July 2001** Contract Ornithologist
Connell Wagner Pty Ltd

**Dec 2000 – Sept 2001** Part-time Ecologist Shortland Wetlands Consultancy, Shortland, NSW

# DEBORAH LANDENBERGER BSC (HONS)

## Botanist

**Date of Birth** 14th April 1965

**Qualifications** B.Sc (Hons)
University of Newcastle, New South Wales (2004)

**Fields of Special Competence** Conducting Field Surveys for Flora, Fauna and Habitat Identification
Flora identification and targeted threatened flora species searches
Geographical Information Systems project design and mapping
Report Preparation including Threatened Species Assessment, Endangered Ecological Communities assessment, and Vegetation Management Plans
Detailed understanding of environmental legislation and threatened flora species issues

**Professional Affiliations** Australian Ecological Society

**Credentials** NSW Driver's Licence: Car (Class 'C')
NSW NPWS Scientific Investigation Licence (S10300)

***EMPLOYMENT HISTORY***

**June 2006 – current** Botanist
Harper Somers O'Sullivan, Broadmeadow, NSW

**Mar 2005 – Jun 2006** Botanist
Conacher Travers, Gosford, NSW

**Dec 2004 – Mar 2005** Research Assistant
University of Newcastle, Newcastle, NSW