Appendix 3.2 Biodiversity Assessment Marilba Hills

EPURON
POWER FOR PORTFOLIOS

Biodiversity Assessment

MARILBA HILLS PRECINCT WIND FARM

JULY 2009

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1 INTRODUCTION

1.1 ABOUT THIS REPORT

This Biodiversity Assessment examines biodiversity values and likely impacts associated with a proposed wind farm in the Marilba Hills area west of Yass on the Southern Tablelands, New South Wales. The assessment has been undertaken by **ngh**environmental to support the Environmental Assessment (EA) report prepared on behalf of the proponent Epuron Pty Ltd.

The Biodiversity Assessment:

- provides a summary description of the proposed works;
- outlines the regional context of the study area in terms of biodiversity values;
- identifies, describes and maps the biodiversity values of the subject site;
- classifies and maps the constraints to development associated with biodiversity values;
- identifies species and communities of conservation significance which are present or have potential to be present at the subject site;
- identifies and assesses the significance of the potential impacts and risks associated with the proposed works in relation to biodiversity values;
- specifically assesses the risks from bladestrike and habitat impacts to bird and micro bat species, in conjunction with the bird and bat impact risk assessment (Appendix D) and specialist reports attached to the Yass Wind Farms Environmental Assessment report (**ngh**environmental 2009); and
- provides a series of recommended mitigation measures designed to reduce risks and minimise the impacts of the development on flora, fauna and ecological communities.

This Biodiversity Assessment is one of three assessments being undertaken concurrently as part of an overarching wind farm proposal encompassing sites located west of Yass at Carroll's Ridge, Marilba Hills and Coppabella Hills.

The Biodiversity Assessment is intended to meet the assessment requirements under Part 3A of the *Environmental Planning and Assessment Act 1979,* the *Threatened Species Conservation Act 1995* and the Commonwealth *Environmental Protection Biodiversity Conservation Act 1999.*

Further background information relating to the site and the proposal is contained in the Environmental Assessment report prepared for the wind farm proposal (**ngh**environmental 2009).

1.2 KEY ISSUES IN THE ASSESSMENT

Significant biodiversity values at the subject site include:

- stands of the Box Gum Woodland Endangered Ecological Community (EEC), in a range of condition classes
- colonies of the threatened Yass Daisy and potential habitat for a further four threatened flora species
- the potential presence of 25 threatened or migratory fauna species, including 1 waterbird, 2 raptors, 11 woodland birds and 3 microbat species

- 3 threatened woodland bird species were recorded at the subject site during the survey – Superb Parrot, Diamond Firetail and Speckled Warbler
- one threatened microbat – the Eastern Bentwing Bat – was recorded at the site. A further two threatened species – the Large-footed Myotis and Yellow-bellied Sheathtail-bat – were possible call records. Further assessment is to be undertaken in relation to microbat species.

Potential risks to these biodiversity values associated with the wind farm project include:

- bladestrike and habitat impacts to birds, particularly vulnerable groups such as raptors, waterbirds, migratory species and threatened woodland species
- bladestrike, pulmonary barotrauma and habitat impacts to microbats, particularly threatened and migratory species such as the Eastern Bentwing Bat
- loss and fragmentation of Box Gum Woodland Endangered Ecological Community, and associated threatened Yass Daisy and woodland bird habitats.

The Biodiversity Assessment examines the scale, nature and significance of the risks, and concludes that the proposal would not be likely to have a significant impact on these values. A combination of avoidance, mitigation and impact offsetting would be used to ensure that the proposal meets the objective of improving or maintaining environmental outcomes.

2 ASSESSMENT APPROACH

2.1 TERMINOLOGY

2.1.1 Subject site and study area

The 'subject site' refers to all areas directly affected by the proposal. 'Direct impacts' are those that directly affect flora and fauna values, and may include trampling, pollution, vegetation clearing and soil disturbance. The term 'study area' includes the subject site and any additional areas which are likely to be affected by the proposal, either directly or indirectly. The study area extends as far as is necessary to take all potential impacts into account. The use of these terms is consistent with the threatened species assessment guidelines issued by the NSW Department of Environment and Climate Change (DECC 2007b).

2.1.2 Development envelope

For a range of practical and commercial reasons, the proposed locations of the wind turbines, powerlines and access roads were not able to be precisely defined at the time of the biodiversity assessment.

The assessment has therefore been broadened to cover all parts of the site which have potential to carry this infrastructure. This 'development envelope' encompasses ridge and upper slope areas which are potentially suitable for turbine development, powerline access corridors 100 metres wide, proposed new turbine road access route corridors 50 metres wide and existing road access corridors 20 metres wide. The development envelope for the proposed Marilba Hills Precinct Wind Farm is 4140 hectares in area, and is shown on Figure 3.2.

Where relevant, the biodiversity assessment covers the range of possible impacts within the development envelope, including worst case impact scenarios. This approach is an effective precautionary response to the uncertainty regarding the positioning of wind farm infrastructure. The development envelope approach also allows finescale development planning and siting decisions to be informed by the findings of the assessment.

2.2 DESKTOP RESEARCH AND CONSULTATIONS

Information was sourced on threatened species, populations, and communities having potential to be present at the subject site and in the wider study area. Current reference books, research papers, conference papers, wind farm assessments and web search tools, databases and publications were sourced, focusing on relevant species and the study area. Several experts with local and specialist knowledge have been contacted in relation to threatened flora and fauna in the Yass district for earlier studies (**ngh**environmental 2006), and these consultations are equally relevant to the current proposal. These references are cited in relevant sections of the Biodiversity Assessment. In addition, government representatives and landholders provided relevant local information.

2.3 FIELDWORK

Site fieldwork was carried out on 16-19 September 2008, and 7 November 2008. A reconnaissance visit was undertaken on 1-3 September to obtain site information necessary to plan and design the field survey, including broad distribution of vegetation types, key physical features, potential threatened species habitats and access arrangements. Fieldwork sought to describe and measure key biodiversity attributes, assess the presence and condition of significant values and determine the nature and extent of impacts likely to result from the proposal. Field activities included general broadscale surveys as well as targeted surveys for threatened species and communities known to be present, or with potential to be present at the site. Specific methodologies are described in relevant sections of the assessment.

2.4 ANALYSIS, ASSESSMENT AND REPORT COMPILATION

Data collected during fieldwork was analysed to determine threatened species habitat suitability, representation of vegetation types and the significance of biodiversity values present at the proposal site. Dedicated assessments of impact significance are presented for threatened species and communities, consistent with State and Commonwealth legislative requirements. In view of the potential for wind farms to impact on bird populations, a specific risk assessment for birds has also been undertaken, focusing on significant and vulnerable species. Potential impacts to microchiropteran bats are also given specific attention. A series of recommended mitigation measures to avoid and reduce impacts to flora and fauna at the site has been developed, based on identified values and potential impacts.

3 DESCRIPTION OF THE PROPOSAL

3.1 SITE DESCRIPTION

The Marilba Hills Precinct Wind Farm proposal site is located on private farmland north and south of the Hume Highway, near Conroys Gap, approximately 17 kilometres west of Yass, and 6 kilometres southeast of the village of Binalong in New South Wales (Figure 3.1). The site extends along a number of north-south oriented ridgelines over a distance of 9 kilometres in a north-south direction and eight kilometres east-west.

The wider study area is characterised by undulating to hilly terrain, mostly on volcanic geology. The proposed wind farm site is situated in the upper catchment of Jugiong Creek, which drains to the Murrumbidgee River and the Murray River.

The subject site lies within the Yass Valley Council Local Government Area, and is currently used for commercial agriculture (sheep and cattle grazing). The 15 turbine Conroys Gap Wind Farm site approved in May 2007 is located immediately south of the Marilba Hills Precinct.

3.2 PROPOSED WORKS

The proposal would involve the construction, operation and eventual decommissioning of:

- up to 66 wind turbines, each approximately 5 metres in diameter at the base, with three blades up to 56 metres long mounted on a tubular steel tower up to 100 metres high [with an overall maximum tip height of 150m;
- 33kV reticulation cabling and powerlines between wind turbines, between the turbine clusters and the Marilba Hills substation, and between this substation and the Carroll's Ridge substation;
- a substation located adjacent to the existing 132 kV transmission system;
- access tracks to the turbines for construction, operation and maintenance;
- onsite control room and maintenance facilities.

The wind farm would have a generating capacity of around 165 megawatts and an operational life of up to 30 years.

Figure 3.2 shows the location of the wind farm proposal elements and the survey area. For referencing purposes in this assessment, each of the seven discrete turbine clusters have been numbered from 1 to 7, ordered west to east.

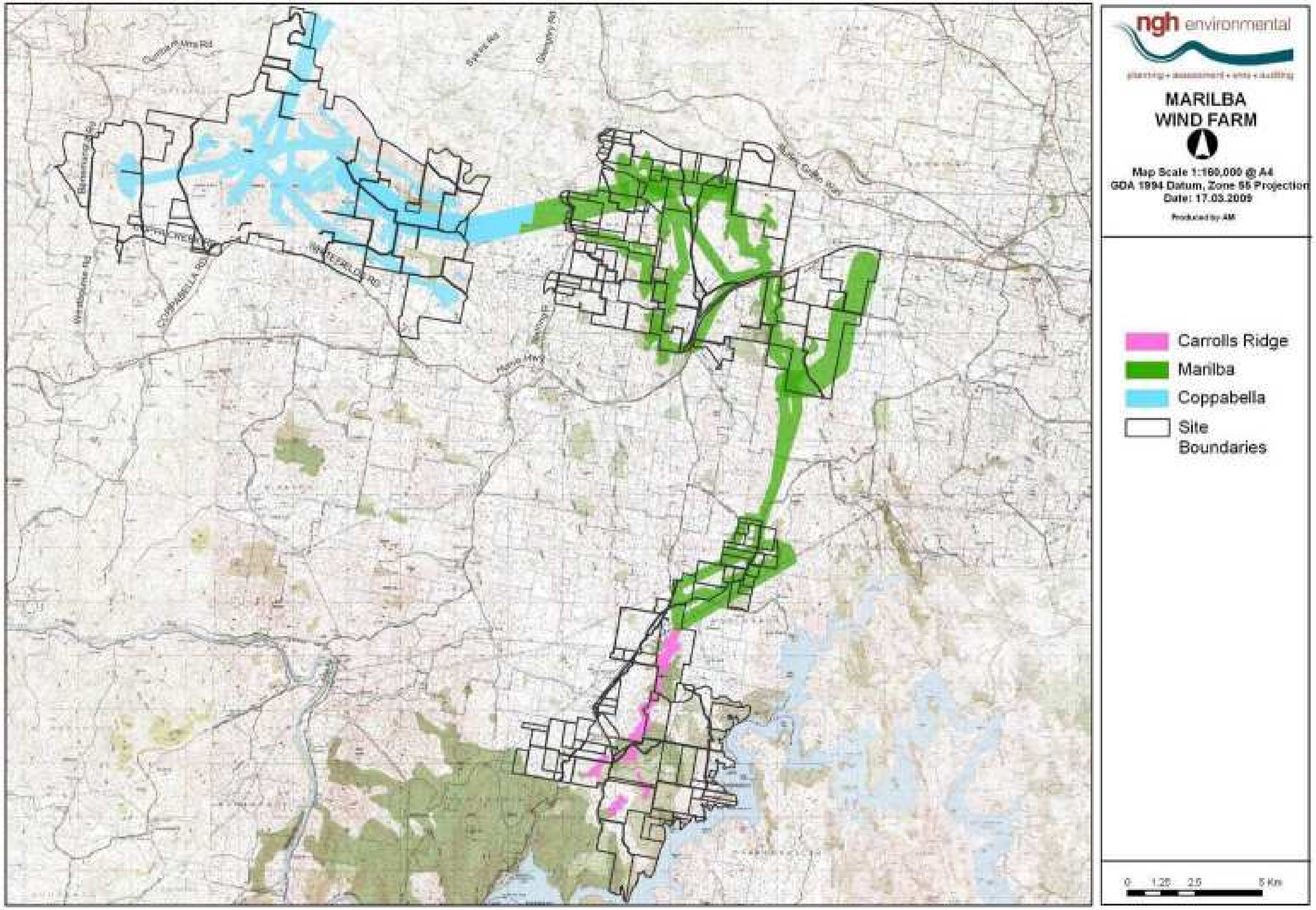


Figure 3.1 Location of the subject site

Development envelopes and site boundaries of the Marilba Hill Preceint (green), showing nearby Coppabella Hills Precinct (top left in blue) and Carrolls Ridge (pink).

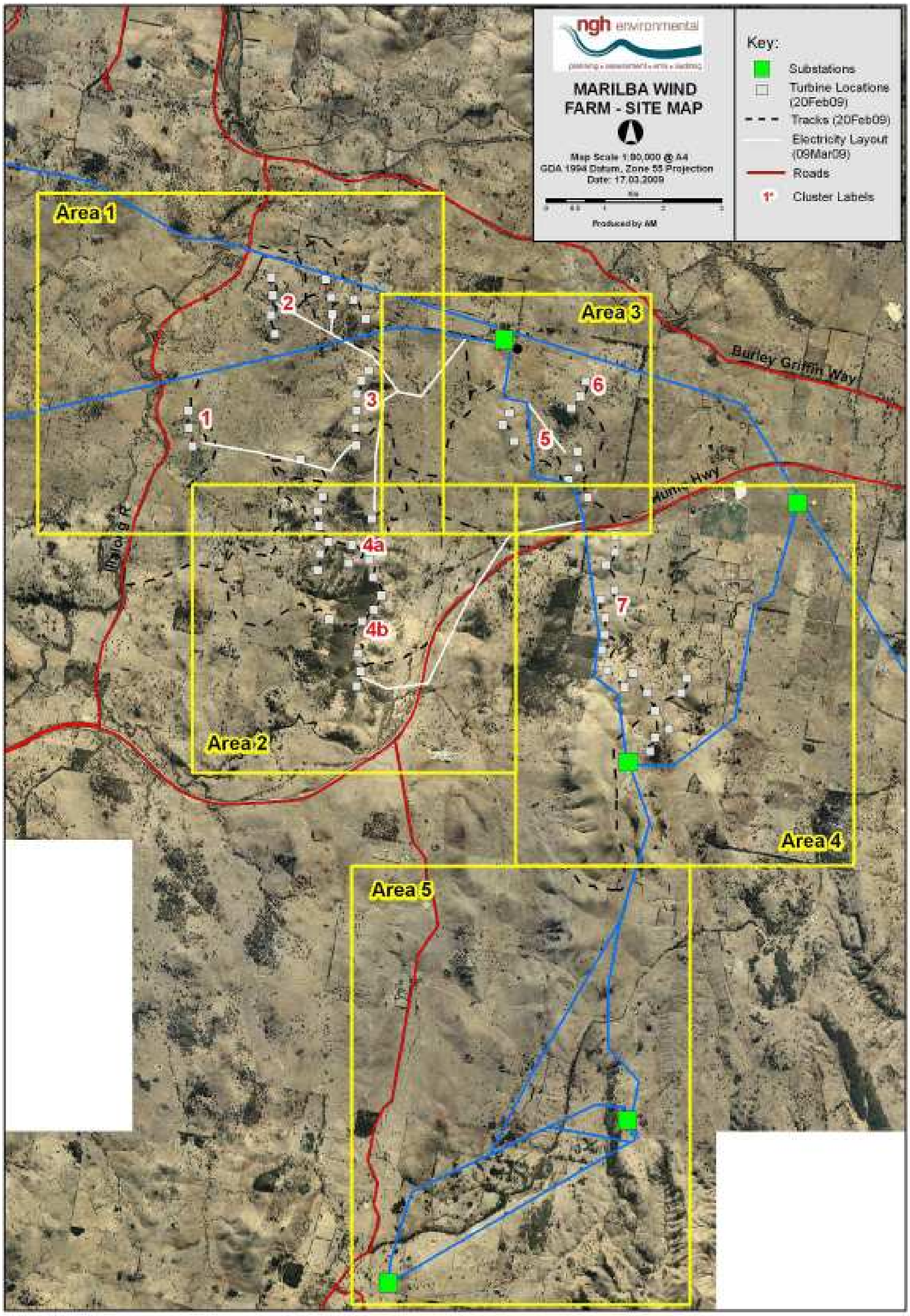


Figure 3.2 Wind farm development envelope and indicative locations of wind farm infrastructure

3.3 GENERAL ENVIRONMENTAL IMPACTS

3.3.1 Wind farm installation impacts

Vegetation clearing

Vegetation clearing would be required to construct the wind farm infrastructure – indicative land areas affected by the various elements of the proposal are provided in Table 3.1 below.

In general, underground cabling would be used to connect turbines on ridgelines, and overhead cabling would be used to transport power from clusters of turbines back to the substation. Cable trenches would, where possible, be dug within or adjacent to tracks to minimise ground disturbance. Trenches would be 1–1.5 metres deep and 0.5–1 metres wide.

The impacts on specific vegetation types, including Endangered Ecological Communities, are addressed in section 5 of the Biodiversity Assessment.

Because the turbine sites are largely situated on cleared farmland, it is assumed that clearing to provide materials and equipment laydown space would be minimal. Some branch lopping along access tracks and public roads is likely to be necessary to allow large vehicles to access the site. The significance of these losses in terms of conservation and fauna habitat values has been evaluated in sections 6 and 7 of this Biodiversity Assessment.

Water impacts

Increased sedimentation or nutrients that find their way to drainage lines can create ongoing offsite impacts. It has been assumed that large and heavy vehicles and turbine placement would not be required in close proximity to gullies and water bodies, with the exception of constructed dams located near proposed works. Some dams may need to be filled to reduce the attractiveness of the site to vulnerable bat and bird species. With this exception, water impacts are expected to be temporary, assuming the application of best practice construction and environmental protection methods.

Soils

The proposal would require upgrades to roads onsite and potentially to public roads accessing the site. This would involve some clearing as well as cut and fill and the laying of road base. Excavation would be required to establish turbine and power pole footings and to construct the substation and control buildings.

Construction facilities

A concrete batching plant and/or rock-breaking equipment would be established during the construction period to facilitate the construction of turbine footings, hard stand areas and roads. Water would be sourced offsite.

Indirect construction impacts

Noise, dust and vehicle emissions would be generated during installation activities. Appropriately managed, these impacts are expected to be temporary, confined to the 12-24 month construction period.

Table 3-1 Wind farm infrastructure components and scale of impact

This table calculates the uppermost areas of direct impact as a percentage of the development envelope (DE). Calculations are based on the indicative infrastructure layout provided by the Proponent.

Marilba Hills Precinct				
Infrastructure	**Width (m)**	**Length (m)**	**Area (ha)**	**Width (m)**
Turbine footing [a]	66.00	25.00	25.00	**4.13**
Crane hardstand [c]	66.00	22.00	40.00	**5.81**
Crane operation area (includes footing and hardstand) [c]	66.00	50.00	50.00	**16.50**
Tracks [a]	1.00	8.00	63834.46	**51.15**
Underground powerlines onsite [c]	1.00	2.00	18330.43	**3.67**
Overhead powerline cabling / easement [b]	1.00	20.00	40031.00	**80.06**
Overhead power pole footings [a]	400.31	1.00	1.00	**0.04**
Substation and control bldg [a]	5.00	150.00	85.00	**6.38**
Concrete batch plant [c]	1.00	75.00	100.00	**0.75**
Construction compound, staging and storage [c]	1.00	300.00	100.00	**3.00**
Development envelope (DE)				**4140.00**
Percentage of DE permanently removed				**1.81**
Breakdown by impact type:				
a Permanent habitat loss (includes all footings and tracks)				**74.93**
b Habitat modification (transmission easement maintenance)				**96.56**
c Temporary habitat loss (areas that can be rehabilitated post construction)				**19.79**

3.3.2 Wind farm operation impacts

The operation of the turbine would entail risks to local fauna, particularly birds and bats, in terms of collision, wind and air pressure impacts, habitat alienation, shadow flicker (when the sun is low on the horizon) and noise (including subaural or low frequency noise). Maintenance activities and vehicle access would have potential to impact soils and waterways, increase risks of weed introduction and spread and increase traffic hazards for fauna.

3.3.3 Wind farm decommissioning impacts

Decommissioning impacts are difficult to accurately determine, given that over the next 30 years, construction techniques and machinery are likely to change. In general, impacts are expected to include the following:

- removal of all above ground infrastructure, including limited excavation (concrete slabs and underground cabling would remain in situ);
- vegetation clearing/branch lopping may be required to enable access by large vehicles and for equipment/materials laydown.
- indirect construction impacts (noise, dust and vehicle emissions) confined to the decommissioning period.

4 REGIONAL CONTEXT

Regional context is important in the consideration of rarity and conservation significance, interactions between the subject site and surrounding habitats, and potential wind farm impacts which may have repercussions beyond the immediate study area.

A review of biodiversity features has been undertaken at two scales:

- region scale
  - using data compiled for established regionalisations (South-Eastern Highlands Bioregion, Southern Tablelands). Key regional attributes include the abundance, distribution and conservation status of communities and species and the presence of threats and disturbance regimes.
- district scale
  - examining an area around the proposal site over a radius of up to 30 kilometres. Species and habitat interactions within this area include foraging and breeding ranges, dispersal patterns and migration routes for fauna, and dispersal and genetic exchange opportunities for flora species.

4.1 REGION SCALE

4.1.1 Regionalisations

Interim Bioregionalisation of Australia (IBRA 5.1)

IBRA bioregions are a landscape-scale approach to land classification using a range of environmental data (Thackway and Cresswell, Environment Australia 2000). There are 17 bioregions across NSW. The study area is located close to the boundary between two IBRA bioregions; the South West Slopes Bioregion and the South Eastern Highlands Bioregion. Both bioregions capture a wide range of geophysical and biological variation.

Catchment Management Authority (CMA) regions and sub-regions

There are thirteen CMA regions in NSW, established by the State Government to manage natural resources on a catchment basis. The study area lies within the Murrumbidgee Catchment, which extends from the Great Dividing Range in the east to the confluence of the Murrumbidgee and Murray Rivers in the west near Balranald. The catchment contains a large variety of landforms and vegetation types, including alpine, montane, tableland and slopes and western plains environments. While many vegetation types in the far eastern parts of the catchment are well represented in conservation reserves, vegetation elsewhere in the region is poorly conserved (DECC 2008a). Box-Gum Woodland and Native Grassland in particular have been extensively cleared and degraded.

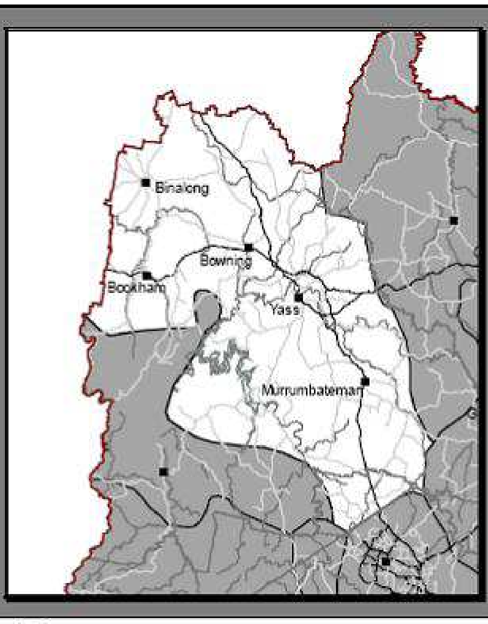
CMA sub-regions are based on a simplified overlay of CMA region boundaries with the draft sub-IBRA (V6) boundaries under the IBRA framework (DECC 2008a). The study area is located close to the boundary between two sub-regions; Upper Slopes to the west and Murrumbateman to the east. Upper Slopes sub-region features include Ordovician to Devonian geology, large areas of intrusive granites, steep, hilly and undulating ranges, texture contrast loams and clays grading from red subsoils on upper slopes to yellow subsoils on lower slopes, and shallow stony soils on steep slopes. Vegetation is generally open forests and woodlands (Morgan 2001 in NPWS 2003).

The Murrumbateman sub-region features fine-grained Palaeozoic sedimentary and metasedimentary rocks, with minor areas of coarse acid volcanics, undulating plateaus with rounded hills and peaks, entrenched meandering streams with chain of ponds tributaries. Soils include mottled yellow and brown texture contrast soils with strongly bleached topsoils, dark organic loams and clay loams on valley floors and saline patches. Vegetation is typically box gum woodland on lower slopes, and red stringybark, bundy and white gum on ridges (Morgan 2001 in NPWS 2003).

Threatened species, populations and communities known or predicted to occur within the Bondo, Upper Slopes and Murrumbateman sub-regions of the Murrumbidgee CMA region are listed in Appendix C.

Planning Framework for Natural Ecosystems of the ACT and NSW Southern Tablelands

The proposal site also occurs within the Southern Tablelands region, which has been defined by the NSW and ACT Governments for the purposes of biodiversity protection and conservation planning (Fallding 2002). Within this region, the proposal site lies in the Yass Landscape Unit. Key features of the Unit are summarised in the extract in Figure 4.1. The Yass Unit is characterised by undulating country largely carrying box gum woodlands. The major land uses are cropping, grazing, rural subdivisions and urban uses, with two major transport links and water-based recreation on Lake Burrinjuck (Fallding 2002).



1. Yass Landscape Unit

Planning and management guidelines

These guidelines summarise important biodiversity information for land within this landscape unit.

The information can be used to assist in:

- **Deciding where and how to develop land**
- **Assessing development proposals**
- **Guiding management of land**

Note: Information for each unit will be updated over time

Description	**Land uses**
Undulating country fringed to the east by the low Mundoonan Range and in the south-west by the Murrumbidgee valley, including the Burrinjuck Reservoir. Largely occupied by extensive Box-Gum Woodlands, areas of Grassland-Woodland Mosaic and areas of Grasslands, the unit is fringed to the east and south-west by Dry Forest on the low ranges. Riparian Forests of River Red Gum and River Oak occur along the Murrumbidgee River.	Cropping, grazing, a town and several small villages, rural subdivisions, two major transport links, lake-based recreation, one medium-sized and one very small nature reserve (Mundoonan NR, Hatton's Corner NR).
Vegetation status	**Endemic features**
Dry Forests on the fringing hills remain relatively intact in the east, though are largely cleared and fragmented in the south-west. The Box-Gum Woodlands have been severely cleared or modified throughout. The Grasslands are extremely highly cleared, modified and fragmented. The Riparian Forests are similarly fragmented. Burrinjuck Dam has replaced a large area of vegetation. There are: • Several samples of Box-Gum Woodlands and Grasslands of considerable diversity, including Nanima, Coolalie, Eedy's New and Wargeila TSRs, a reserve at Yass Gorge, and Bookham and Bowning Cemeteries.	This unit contains: • The region's core nesting habitat for Superb Parrot • The region's only population of Grey-crowned Babbler • Records of vagrant Major Mitchell's Cockatoos • Records of Striped Legless Lizard and Pink-tailed Worm-lizard • The centre of distribution of Yass Daisy • A minor karst landscape within Hatton's Corner NR.
Known threatened and important species and endangered ecological communities	**Planning and management issues**
Plants: Yass Daisy, Silky Swainson-pea, Tarengo Leek Orchid (an introduced population), Australian Anchor-plant **Mammals:** Koala, Eastern Pygmy-possum, Spotted-tailed Quoll, Eastern Quoll (an old record), Eastern Bent-wing Bat, Little Pied Bat **Birds:** Blue-billed Duck, Freckled Duck, Square-tailed Kite, Australasian Bustard (an old record), Major Mitchell's Cockatoo (vagrants), Superb Parrot, Powerful Owl, Grass Owl (a vagrant), Brown Treecreeper, Grey-crowned Babbler, Hooded Robin, Speckled Warbler, Regent Honeyeater, Diamond Firetail **Reptiles and frogs:** Striped Legless Lizard, Pink-tailed Worm Lizard, Booroolong Frog **Invertebrates:** Golden Sun Moth **Vegetation communities:** Natural Temperate Grassland, White Box - Yellow Box - Blakely's Red Gum Woodland	In this unit there are: • Small areas secure within nature reserves • Major pressures from rural subdivisions around Yass and Murrumbateman • Substantial areas developed as vineyards • Major areas showing signs of former severe clearing • Substantial areas of dryland salinity • Minor areas of tree dieback • Minor infestations of Chilean Needle-grass in low areas Consists primarily of planning setting D (See Part 5 of report).

Figure 4.1 Yass Landscape Unit profile

4.1.2 Vegetation

A diverse range of vegetation communities occur across the South West Slopes and South Eastern Highlands Bioregions, varying according to topography, soils and micro-climate.

The hill country in the east of the South West Slopes bioregion typically carries Red Stringybark (*Eucalyptus macrorhyncha*) and other species on higher slopes, with White Box (*Eucalyptus albens*), Yellow Box (*Eucalyptus melliodora*) and Blakely's Red Gum (*Eucalyptus blakelyi*) woodland occupying the lower slopes. River Red Gum (*Eucalyptus camaldulensis*) lines the larger central and western streams (NPWS 2003). There are 36 threatened flora species listed in the schedules of the TSC Act in the bioregion. Of these, 13 are endangered, 22 are listed as vulnerable and one species, *Euphrasia arguta*, is considered extinct in the bioregion (NPWS 2003).

The Southeastern Highlands has a diverse range of vegetation communities, including Yellow Box (*Eucalyptus melliodora*), Red Box (*Eucalyptus polyanthemos*) and Blakely's Red Gum (*Eucalyptus blakelyi*), with areas of white box (Eucalyptus albens) occupying lower areas. Red Stringybark (*Eucalyptus macrorhyncha*), Broad-leaved Peppermint (*Eucalyptus dives*) and White Gum (*Eucalyptus rossii*) associations dominate hills in the west of the bioregion. There are 88 species listed in the schedules of the TSC Act in the bioregion; 36 are listed as endangered, 50 are listed as vulnerable, and 2 species, *Stemmacantha australis* and *Galium australe*, are considered extinct (NPWS 2003).

In both bioregions, the box gum woodlands and natural temperate grasslands have been heavily cleared and fragmented by agricultural activities, and are listed as Endangered Ecological Communities.

Of the remnant vegetation that remains in the Southern Tablelands region (Fallding 2002), 1% is grassland, 3% is grassland-woodland mosaic, 9% is Box-Gum Woodland, 21% is dry forest, 12 % is wet forest and 0.5% is riparian forest. Box gum woodlands occupied around 23% of the region prior to European settlement. 9% of the region currently carries this community, in varying condition. Over 1200 flora species occur in the Southern Tablelands region.

4.1.3 Fauna

Sixty-seven threatened fauna species are found in the South Western Slopes Bioregion; 13 are listed as endangered and 54 are listed as vulnerable (NPWS 2003). Widespread vegetation clearing has caused a decline in woodland-dependent bird, reptile and insect populations.

Eighty-eight threatened fauna species occur in the South Eastern Highlands; 25 are listed as endangered and 63 are listed as vulnerable. Woodland bird species such as the endangered Regent Honeyeater (*Anthochaera phrygia*) have noticeably declined (Australian Terrestrial Biodiversity Assessment 2002 in NPWS 2003) as a result of landscape fragmentation. A decline in groundfeeding insectivores was recently observed in the bioregion (Australian Terrestrial Biodiversity Assessment 2002 in NPWS 2003). Protection and enhancement of woodland fragments is necessary to prevent continued loss of woodland birds. Some bird species such as the Noisy Miner (*Manorina melanocephala*), Australian Magpie (*Gymnorhina tibicen*) and Grey Butcherbird (*Cracticus torquatus*) have substantially increased, consistent with the effects of long term fragmentation (NPWS 2003).

54 mammal, 279 bird, 25 frog and 58 reptile species have been recorded in the Southern Tablelands region (Fallding 2002). The vegetation and fauna habitats over much of the region are heavily fragmented and dysfunctional. There are 54 fauna species listed as threatened in the region, including 17 mammals, 24 birds, 6 frogs and 5 reptiles. 13 fauna species have become extinct due to land use or habitat changes. There are 98 fauna species of regional conservation importance (Fallding 2002).

Waterbirds are likely to move between large waterbodies and wetland habitats at the region scale. Lake George (c. 70 kilometres south-east of the subject site), Lake Burley Griffin and associated wetlands (65 kilometres to the south), Lake Burrinjuck (12 kilometres to the south) and major rivers in the region are likely to form part of the foraging range for several mobile waterbird species.

Seasonal wetland and swamp habitats have declined throughout the region due to increasing irrigation and water extraction from rivers, increased small dams and increased use of deep-rooted perennial pastures resulting in reduced runoff. Most wetland bird species in the region show signs of long-term decline (Reid *et al.* 2004).

4.1.4 Conservation and environmental management

About 726,530 hectares or 14.86 per cent of the South Eastern Highlands Bioregion is managed in conservation tenures. A large proportion of grassland and woodland remnants are on private lands (DEC 2005a).

The box gum woodlands and natural temperate grasslands in the Bioregion have been heavily cleared and fragmented by agricultural activities, are poorly represented in reserves and are listed as Endangered Ecological Communities. Lower elevation wetlands and riparian forests are also extensively depleted. Sites with high biodiversity value are rare, isolated and fragmented.

Key environmental management issues in the Yass Landscape Unit include dryland salinity, rural subdivision pressures around Yass and major areas showing signs of former severe clearing (Fallding 2002). The Unit consists primarily of areas likely to have limited conservation values. Roadside remnants are an important conservation resource (Fallding 2002).

The study area is located in the upper catchment of the Murrumbidgee River. It is estimated that over half of the catchment has been completely cleared of native vegetation. Some of the areas where native vegetation remains are in severely degraded condition (MCMA 2005).

4.2 DISTRICT SCALE

A district-scale review of habitats in the area was conducted with reference to aerial photography and topographic maps, vehicle-based survey results and contacts with local landholders and authorities. In particular, the locations of important wetland, woodland and forest habitat areas, and potential connectivity with the subject site were considered. The assessment was limited by air photograph quality, road access and the inability to ground-truth, but does give a broad indication of district-level habitat quality and the relative significance of habitat at the subject site.

For the purposes of this report, the district occupies an area surrounding the proposal site over a radius of 30 kilometres. Confirmed key conservation values include:

- the district forms part of the core breeding area for the Superb Parrot;
- the district is the centre of distribution for the threatened Yass Daisy;
- the district contains remnant box gum woodlands (EEC, CEEC).

4.2.1 District habitat features

Watercourses and wetlands

The permanent Illalong Creek and Jugiong Creek are located to the west of the subject site, each with sections carrying substantial tree cover. The subject site itself contains lower order drainage lines, generally with little natural vegetation cover.

The Yass River is a major watercourse running east-west and impounded by Burrinjuck Dam around 12 kilometres south of the site. The Yass River corridor and Lake Burrinjuck are likely to provide locally important habitat for waterbirds, with connectivity to the Murrumbidgee system and more significant wetlands below the dam. The north-south oriented ridgelines and valleys provide intermittent connectivity between the subject site and Lake Burrinjuck.

Farmland surrounding the subject site is dotted with small farm dams, which provide ephemeral habitat for mobile waterbirds, but possibly at the expense of river flows and river-dependent species (Reid *et al*. 2005).

Grassland, woodland and forest remnants

No natural grassland areas were recorded at the subject site, or observed in surrounding areas during the survey. Natural grassland has been recorded at Hattons Corner Nature Reserve, near Yass.

The subject site is one of the most heavily cleared areas in the district, with the general loss of all indigenous eucalypts over large parts of the properties. Woodland remnants are largely restricted to areas with tree cover but depauperate or exotic understorey in farm paddocks. There are some highly restricted and fragmented examples of woodland understorey without tree cover in paddocks, and areas with tree cover and relatively intact understorey along watercourses (Illalong Creek, Jugiong Creek), roadsides (Black Range Road, Illalong Road, Hume Highway, Graces Flat Road) and in cemeteries (Bowning, Bookham, Galong) and Travelling Stock Reserves (such as Black Range Road to the east of the site).

Woodland remnants in the district, particularly those with tree cover, are used by a range of woodland bird species, including the threatened Superb Parrot and potentially several other threatened woodland bird species. Threatened and regionally significant plant species are also known to occur in woodland remnants in the district.

The subject site contains several small patches of remnant dry shrub forest dominated by Bundy (*Eucalyptus goniocalyx*). Remnant forest in the district is commonly associated with steep slopes and rock outcrops. In view of the general loss of native vegetation in the district, structurally and floristically intact forest remnants have at least regional conservation value. The closest large area of intact forest is Burrinjuck Nature Reserve, Burrinjuck Waters State Park and adjoining private land, which carry tableland dry sclerophyll and montane wet sclerophyll forest types.

4.2.2 Conservation reserves

The Yass Landscape Unit (Fallding 2002) contains one medium sized nature reserve (Mundoonen NR) and one very small nature reserve (Hattons Corner NR). The medium-sized Burrinjuck NR lies southwest of the unit. There are few large areas of remnant woodland or forest within 50 kilometres of the study area. Areas of montane and tableland forest are located to the south west, the closest being Burrinjuck Nature Reserve.

Burrinjuck Nature Reserve and Burrinjuck Waters State Park

Burrinjuck Nature Reserve occupies 5,250 hectares and is located 12 kilometres south-west of the study area. The reserve is contiguous with Burrinjuck Waters State Park, on the shores on Lake Burrinjuck, which has a strong recreational management focus. The dam was constructed in 1927, and raised in 1957, to supply water to the Murrumbidgee Irrigation Area. It impounds the Murrumbidgee River and the lower sections of the Yass and Goodradigbee Rivers. The area of stored water is 5,600 hectares and the shoreline is 645 kilometres in length (Yass Valley Council 2005).

Hattons Corner Nature Reserve

This small (4 hectare) karst reserve is located beside the Yass River, around three kilometres west of Yass, and fourteen kilometres east of the subject site. It is reserved principally for its geological values, but does contain an area of remnant grassland, and several ROTAP and regionally uncommon plant species (DEC 2005b).

Mundoonen Nature Reserve

Mundoonen Nature Reserve is located midway between Yass and Gunning, approximately 30 kilometres east of the study area. The reserve occupies 1,485 hectares, and together with adjoining private land forms part of a

3,000 hectare area of forests and woodland. Vegetation in the reserve is largely dry sclerophyll forest, with a small pocket of box gum woodland. Fauna of conservation significance recorded in the reserve include the Koala and Powerful Owl.

Wee Jasper Nature Reserve

Wee Jasper Nature Reserve is a 700 hectare reserve located around 30 kilometres south of the study area. Significant fauna recorded in the reserve includes the Regent Honeyeater, Gang-gang Cockatoo, White-throated Needle-tail and Eastern Bent-wing Bat.

Black Andrew Nature Reserve

This is a 1,559 hectare reserve located south of Burrinjuck, around 25 kilometres south-west of the study area. The reserve, with the Brindabella National Park and State Conservation Area, and reserves to the south, forms an almost continuous belt of forest extending to the Australian Alps. The reserve supports several dry and wet sclerophyll forest types. Disused mine shafts are used for roosting by dispersing juvenile bats, including the Eastern Bent-wing Bat. Other threatened fauna recorded in the reserve include the Yellow-bellied Glider, Powerful Owl, Barking Owl, Brown Treecreeper and the Booroolong Frog.

Brindabella National Park and State Conservation Area

The 18,472 ha National Park and recently declared 2,880 ha State Conservation Area adjoin the ACT boundary, around 40 kilometres south of the study area. The reserves carry tableland and montane forest and subalpine woodland communities. Threatened species recorded in the park include the Powerful Owl, Pink Robin, Brown Treecreeper, Gang-gang Cockatoo, Olive Whistler, Northern Corroboree Frog, Eastern Bent-wing Bat, Yellow-bellied Glider and Tiger Quoll.

Small reserves and woodland remnants

Small box gum woodland remnants are scattered throughout the Yass district, particularly along roadsides (including Black Range and Illlalong Roads), cemeteries (Bookham and Bowning Cemeteries) and Travelling Stock Reserves (Nanima, Bedulluck, Merryville, Coolalie, Eedy's, New and Wargeila TSRs) and a small reserve at Yass Gorge (Fallding 2002, Rainer Rehwinkel DECC pers. comm.). Lowland paddocks are also likely to carry remnant woodland; paddock tree density varies throughout the district and is generally low in the vicinity of the study area.

4.2.3 Corridors

Much of the sub-catchment has been cleared of woodland vegetation. Remaining remnants of substantial size (greater than 100-200 ha) are moderately rare in the landscape and linkages between these are limited to intermittent road-side and riparian corridors and smaller ‘stepping-stone’ woodland patches. Larger patches of remnant vegetation tend to occur on the steep slopes, with flats and ridges cleared for more intensive land use. The largest continuous area of forest and woodland vegetation within the district occurs to the south around Burrinjuck and Black Andrew Nature Reserve and within Bungongo, Wee Jasper, Red Hill and Bondo State Forests.

Large water bodies in the district include Lake Burrinjuck, Lake Bethungra and Lake George. The Murrumbidgee river system connects district wetland habitats including the Yass River and Lake Burrinjuck to wetlands on the slopes and inland of the Great Dividing Range. Nomadic and migratory water birds are likely to pass over the site when moving between large wetland systems.

4.3 THREATENED SPECIES AND COMMUNITIES

4.3.1 *Threatened Species Conservation Act 1995*

The DECC Threatened Species web-based search tool was used to identify threatened species, populations and communities listed under the NSW *Threatened Species Conservation Act 1995* which are known or predicted to occur within the Bondo, Upper Slopes and Murrumbateman sub-regions of the Murrumbidgee CMA region. The likelihood of the presence of these species, populations and communities at the subject site is evaluated in Appendix C and summarised in sections 6 and 7.

4.3.2 *Environment Protection and Biodiversity Conservation Act 1999*

The EPBC Matters of National Environmental Significance reporting tool was used to identify significant species, populations and communities listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999,* within a 50 kilometre radius of the development envelope. The likelihood of the presence of these species, populations and communities at the subject site is evaluated in Appendix C and summarised in sections 6 and 7. The full search report (biodiversity components) is provided in Appendix G.

5 FLORA AND ECOLOGICAL COMMUNITIES

5.1 METHODS

5.1.1 Preliminary assessments

The survey fieldwork was preceded by a desktop assessment to identify species and communities of conservation significance which may be present in the study area. Topographic maps, air photographs, previous research and surveys and records contained in national and state databases were consulted to identify known and potential values. Predictive vegetation mapping (Fallding 2002, Thomas *et al.* 2000) was used to assess the potential for the occurrence of threatened species and communities at the site. Key web-based databases used included the Commonwealth Protected Matters search tool using a 50 kilometre buffer, Bionet and the DECC Wildlife Atlas (based on the Murrumbidgee Catchment Management Area - Upper Slopes, Murrumbateman and Bondo sub-regions).

The Planning Framework for Natural Ecosystems of the ACT and NSW Southern Tablelands (Fallding 2002) was also consulted for threatened species and community records in the study area and analogous habitats within the region. Habitat potential for threatened species which have been recorded in the wider Southern Tablelands region was assessed using past records and known ecological relationships.

A preliminary scoping visit was undertaken on 1-3 September 2008 to obtain site information necessary to plan and design the field survey, including broad distribution of vegetation types, key physical features, potential threatened species habitats and access arrangements.

5.1.2 Field survey and mapping

The proposed turbine development zone and some sections of the grid connection powerline route were surveyed for flora values on 16-22 September 2008. Additional areas identified as having potential threatened species habitat were surveyed on 7 November 2008. Cluster 7 was surveyed in March 2007.

Additional survey work was undertaken on 10-11 March 2009 to assess proposed powerline routes between the Coppabella and Marilba substations, and Marilba and Carroll's Ridge substations. Woodland vegetation close to Black Range Road on the Carroll's Ridge – Marilba powerline route was assessed. The Coppabella – Marilba powerline sections were assessed as follows:

- Mylora property only at two points where the route intersects farm tracks,
- At Jugiong Creek/Illalong Road crossing point
- Myrana property, where tracks intersect the route, mostly in the eastern half of the property
- Weilora property, full distance of this property was walked, to a windbreak planting on the eastern side (on the adjoining property boundary)
- The final one kilometre section at the eastern end was not assessed
- The southern section of the route on the Ryalla property was driven, from where it crosses Graces Flat Road as far as the point where it begins its ascent of the ridge to the turbine cluster.

A total of 64 person hours was spent on the vegetation component of the survey.

Survey area

The development envelope survey area totals 4140 hectares and comprises:

- ridge crests and upper slopes of 7 discrete ridges where turbine clusters are proposed for construction. These turbine clusters are numbered 1 to 7, ordered from west to east;
- proposed powerline corridors between turbine ridges, where these intersected with access routes, or crossed areas of native vegetation (as determined from aerial photography).

The survey area is shown in Map Set 1. The area included all parts of the development envelope that would potentially be directly or indirectly affected by the proposal. In addition, the periphery of existing roads and tracks at the site which may be used during construction was examined for significant or sensitive vegetation features which may be impacted by increased traffic load or road improvement works.

Stratification

Following a preliminary scoping visit to the subject site and using aerial photographs, the survey area was stratified based on individual turbine clusters, vegetation type and vegetation condition. Within the development envelope, several representative survey sites were selected in each vegetation type which sampled the range of internal variation in each type.

The survey area was stratified into the following broad vegetation types:

- box gum woodland
    - overstorey including *Eucalyptus melliodora, E. albens, E. blakelyi*
- box gum woodland derived grassland
    - diverse secondary grassland likely to be derived from box gum woodland
- Long-leaved Box dry grass forest
    - overstorey dominated by *Eucalyptus goniocalyx*
- Brittle Gum – Broad-leaved Peppermint dry grass forest
    - overstorey dominated by *Eucalyptus dives* and *E. mannifera*
- native pasture
    - low diversity grassland derived from box gum woodland and dry grass forest, with a variable exotic component.

Survey methods

A three-tiered approach incorporating plot-based, traverse and general inspection methods was used to ensure that vegetation could be characterised in detail, while providing the areal coverage required for a project of this scale. Points at the centre of the survey sites are shown in Map Set 1, and the results summarised in Table 5.1 and Appendix A. The survey methods and outputs are intended to meet the requirements of the Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (DECC 2004).

Quadrats

In each vegetation type, a 0.04ha standard quadrat (generally 20 metres x 20 metres) was used to survey vegetation structure and floristics, and site physical values. Examples of representative quadrat data for a range of vegetation types are presented in Appendix A.

Random meanders

Formal random meanders (after Cropper 1993) within relatively homogeneous vegetation of up to 30 minutes duration and covering up to 1 hectare were undertaken at a number of sites in each vegetation type, recording floristics, with structural and physical data. This method complements the quadrat data by improving comprehensiveness in terms of species and variation within types, and improves opportunities for detecting significant or sparsely distributed plant species.

Inspections and targeted searches

In addition to the traverse and plot-based survey sites, the majority of the subject site was inspected on foot or by vehicle during the September survey to confirm vegetation types, map the distribution of Endangered Ecological Communities (EECs) and search for threatened species. EECs and areas of natural vegetation in better condition were given particular attention. Dedicated searches in specific habitat areas were undertaken for threatened species which were assessed as having at least a moderate potential to be present at the site (refer Appendix C). A return visit on 7 November targeted areas with greatest potential to support threatened species which may not have been detectable during the September survey.

Candidate areas of heavily disturbed habitats or areas carrying mainly exotic species, such as improved pasture and cultivated paddocks, were surveyed to record species composition. Because of their low likely conservation significance, not all of these highly modified areas were inspected in detail.

Understorey condition assessment

Vegetation surveyed using quadrat, random meander and inspection techniques was rated according to a five-point condition class scale, focusing on floristic integrity in the understorey:

Poor	groundlayer dominated by exotics
Poor-moderate	groundlayer dominated by one or two native grass species, very few native forbs
Moderate	groundlayer dominated by several native grasses, native forbs present but low diversity
Moderate-good	groundlayer dominated by several native grasses with a range of native forbs
Good	high groundlayer diversity, including significant forb species.

The understorey condition classes for each survey site are presented in Appendix A and shown in Map Set 2. These classes are most relevant for vegetation types with a grassy groundcover, such as box gum woodland.

Threatened species and communities

Threatened species and communities declared under the *Threatened Species Conservation Act 1995* or the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* were specifically targeted in the assessment. Threatened species or communities recorded in the study area, or with potential to occur there, were identified using previous survey records and a DECC Wildlife Atlas search based on the Upper Slopes, Bondo and Murrumbateman sub-regions of the Murrumbidgee Catchment Management Area. The Commonwealth online Protected Matters search tool was used to identify flora and other values in the study area listed under the EPBC Act.

The identification of the White Box, Yellow Box, Blakely's Red Gum Woodland Endangered Ecological Community (EEC) ('box gum woodland') draws on the definition provided in the Final Determination and the DECC identification guidelines for the EEC (NPWS undated). Verbal advice was sought from DECC staff (A. Treweek, R. Rehwinkel) where matters of EEC definition were problematic. A precautionary approach has been adopted where distribution and habitat information is incomplete or uncertain.

General

The identification of specific vegetation types is based on the classification developed for the Southern Region Comprehensive Regional Assessment by Thomas *et al.* (2000), updated by Gellie (2005). Botanical nomenclature follows Harden (1990-2001), except where recent taxonomic changes have occurred. Noxious weeds identified are those declared for the Southern Slopes County Council control area under the *Noxious Weeds Act 1993*. Map references locating significant vegetation features, vegetation type boundaries and noxious weeds were obtained using a hand-held 12 channel GPS unit, and are based on the GDA (new) datum. The study area is covered by the Binalong and Bookham 1:25,000 topographic map sheets (AGD datum). GDA map references can be converted to AGD datum by subtracting 113 metres from the eastings and 184 metres from the northings.

5.1.3 Survey limitations

The development envelope survey area covers around 4140 hectares, dispersed over 7 ridgelines, and powerline corridors totalling 120 kilometres in length. The envelope includes substantial buffer areas to allow for the finescale planning and flexible siting of proposal elements. While attempts were made to survey the range of environmental variation at each cluster, not every part of each cluster was able to be surveyed in detail.

Closer attention was paid to areas supporting predominantly native box gum woodland understorey and remnant forest. These areas were subjected to targeted searches for threatened species, generally in representative areas rather than the full extent of such communities. Candidate areas of pasture dominated by exotics were surveyed to record general species composition.

Specific areas that would be affected by road construction, realignment, widening or other improvement works were not well defined at the time of survey and were not surveyed in detail. Observations of EEC presence along access tracks or road verges in the general vicinity of the site were recorded but searches for threatened flora species were not made in these areas because they were generally observed to be in poor condition with very little habitat potential.

The cluster 7 site was surveyed in autumn 2007, following a dry summer and an extended drought period. Similarly, the additional survey work on 10-11 March 2009 to assess proposed powerline routes between the Coppabella and Marilba substations, and Marilba and Carroll’s Ridge substations was undertaken during very dry conditions. This is likely to have depressed the frequency and visibility of drought-sensitive species and summer-flowering species such as some grasses. Many spring flowering species, including a range of terrestrial orchids and grassland lilies and daisies may also have been unrecordable during the survey period. An inspection of this cluster undertaken in spring 2008 primarily to ascertain the distribution of the Yass Daisy at the site also provided an opportunity to supplement records with spring-flowering species.

Grass seed heads were still reasonably abundant despite the dry conditions during the March surveys, so it was generally possible to determine the nature of the understorey (whether predominantly native or exotic). However, some species are certain to have been overlooked, so the assessment of vegetation condition class could be out by one condition class. That is, areas assessed as poor-moderate condition could have been moderate in some areas, but insufficient native species were detectable to be able to make this distinction.

The vegetation survey for clusters 1-6 was undertaken in early spring, following good rains about a month previously. This is likely to have introduced a strong bias toward fast-growing annual and perennial species, particularly exotic weed and pasture species. This may have masked the ‘normal’ representation of native perennial grasses and forbs at the site. Most grasses were not identifiable with certainty at this time, other than by dried remains of the previous season’s fruiting stems, so the proportion of the cover provided by the various grass species could not be estimated with accuracy. A brief return visit to cluster 4 in November 2008 allowed some grass species and their relative abundance to be identified at this site.

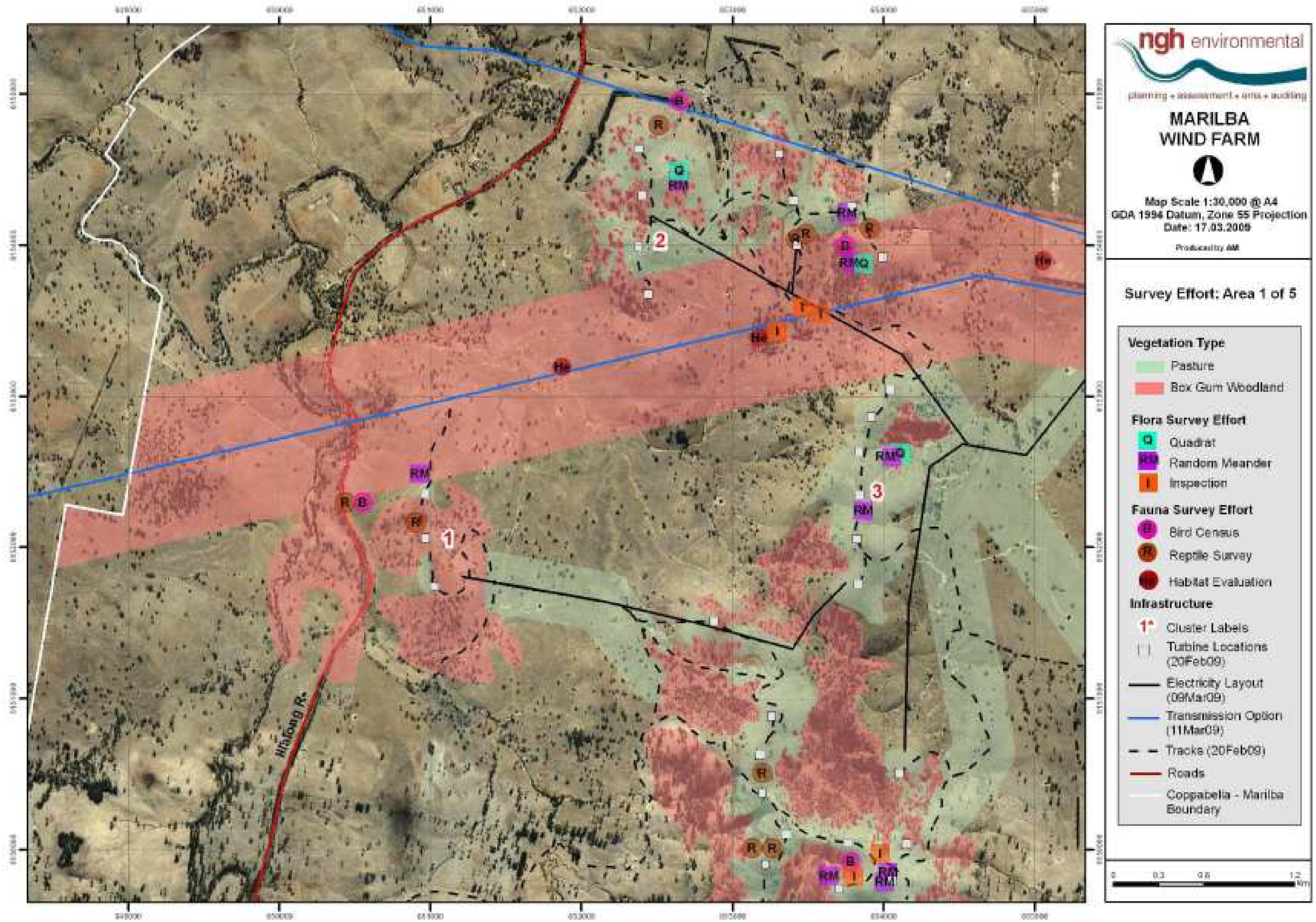
Some geophytic species (such as terrestrial orchids and lilies) which flower outside the survey periods will not have been recorded, and some species could be identified only to genus, due to lack of fertile material. Conversely, some species which are only apparent at the time of survey (e.g. *Wurmbea* spp) were abundant during the survey period but would not have been detected by a later survey. Ephemeral species which flower in response to irregular disturbance events such as fire will also have gone unrecorded. The probability of species of conservation significance having been omitted due to seasonal factors is further addressed in Appendix C.

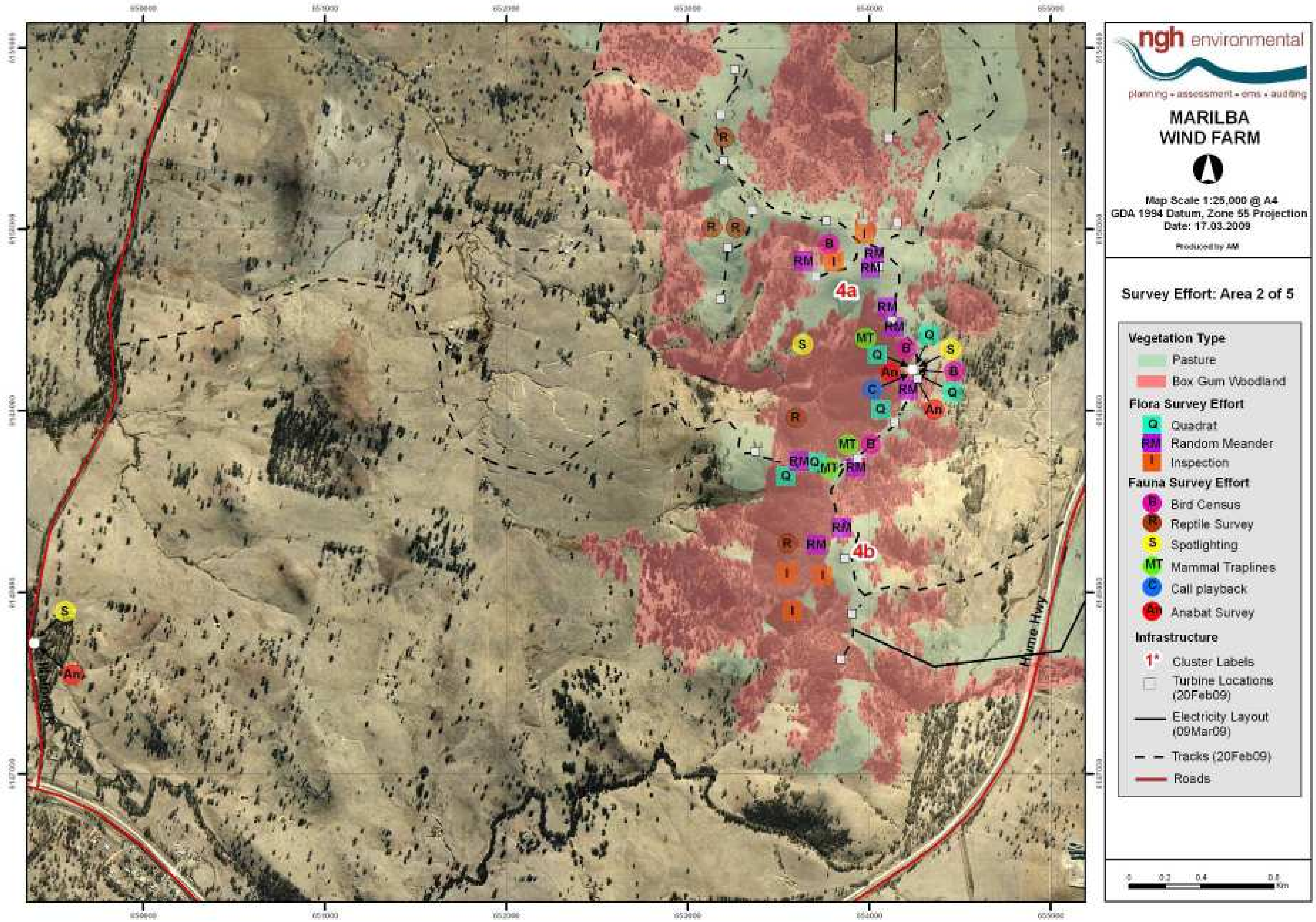
The survey of the powerline routes between substations undertaken in March 2009 was hampered by access problems due to fence and gate locations relative to the route. The proposed route was assessed at accessible locations (to which a vehicle could be driven) and some sections were walked if vehicle access was not feasible and vegetation appeared likely to be of conservation significance.

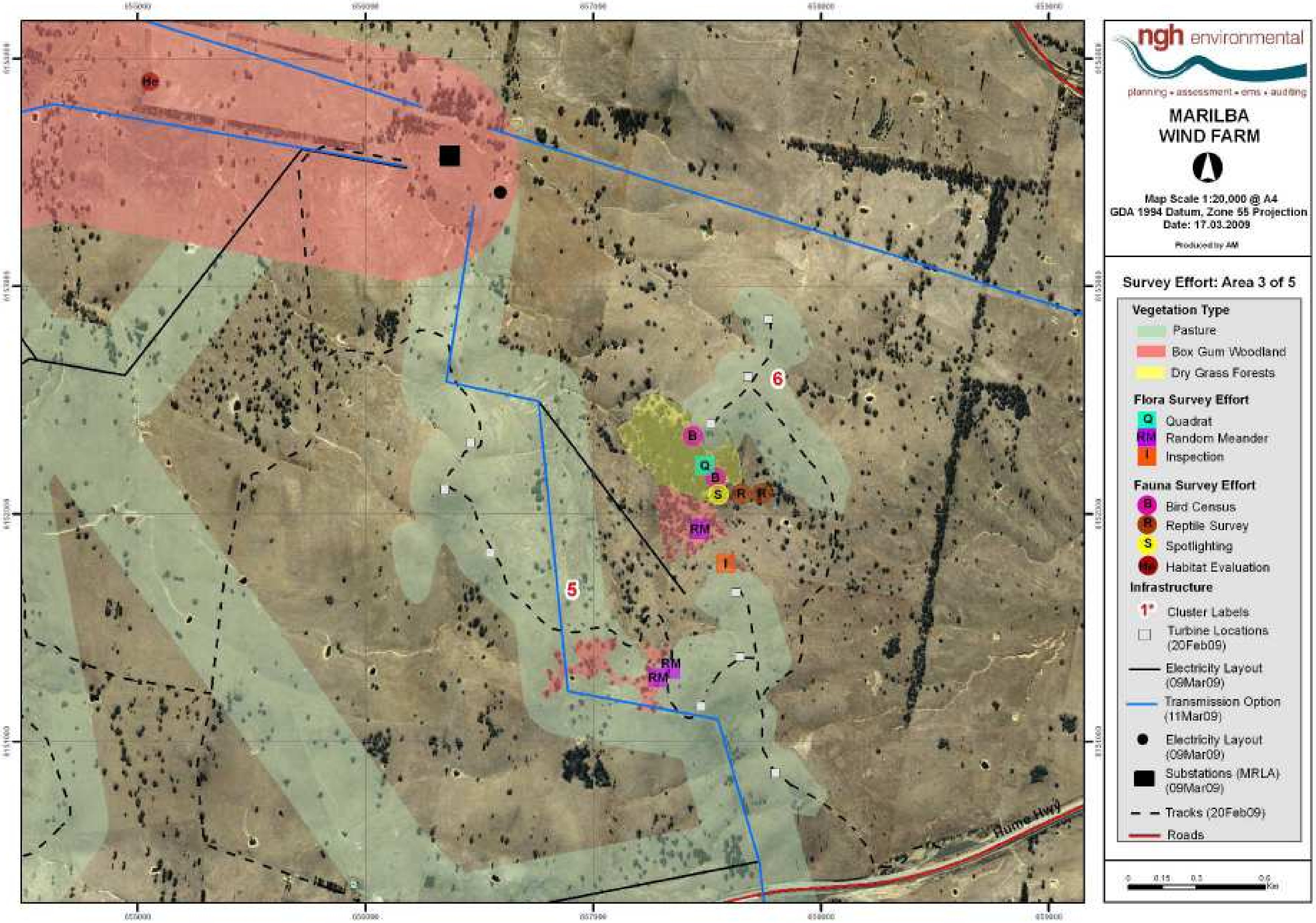
At the time of survey most of the subject site was being grazed by sheep or cattle, and this may have affected the recording of some taller or grazing-sensitive species, particularly grasses. However, the most heavily grazed areas were clearly largely composed of exotic plant species (either all exotic, or exotic forbs among native grasses), while the impact of current grazing on the steeper side slopes where the bulk of the native vegetation occurs appeared low at the time of the survey. Grazing impacts are therefore not likely to have significantly affected species detection.

In view of the known habitat requirements and distribution of threatened species which have been recorded in the region, and the degree of habitat degradation due to grazing over most of the site, it is considered unlikely that any threatened species will have been overlooked. Where some potential for unrecorded threatened species exists, this possibility is acknowledged and precautions incorporated into the impact assessment and mitigation measures.

Map Set 1 – Flora and fauna survey sites (5 maps in total)




ngh environmental
planning • assessment • ems • auditing
MARILBA
WIND FARM
Map Scale 1:25,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
Produced by AM
Survey Effort: Area 2 of 5
Vegetation Type
Pasture
Box Gum Woodland
Flora Survey Effort
Quadrat
Random Meander
Inspection
Fauna Survey Effort
Bird Census
Reptile Survey
Spotlighting
Mammal Traplines
Call playback
Anabat Survey
Infrastructure
Cluster Labels
Turbine Locations (20Feb09)
Electricity Layout (09Mar09)
Tracks (20Feb09)
Roads
4a
4b
Hume Hwy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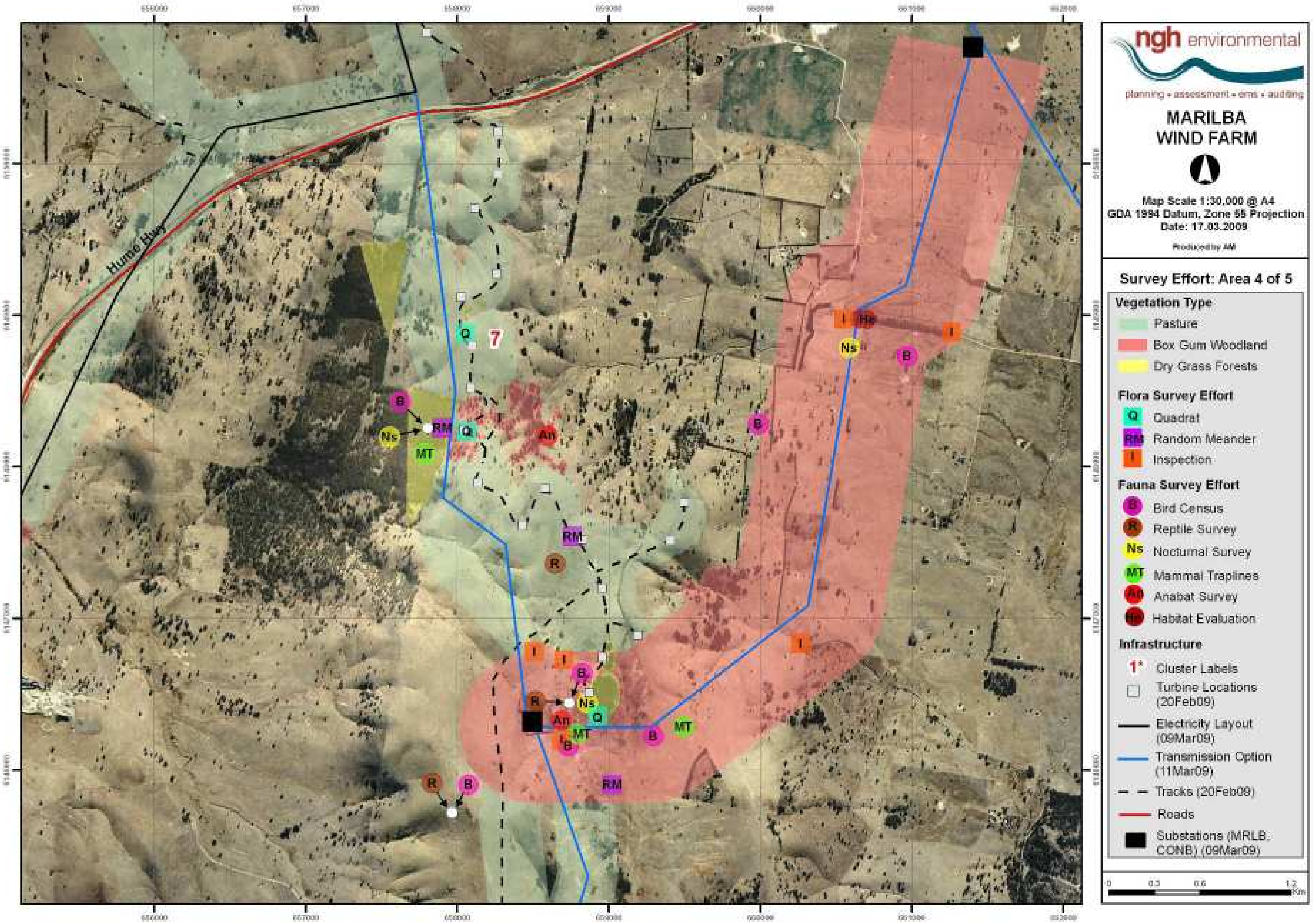
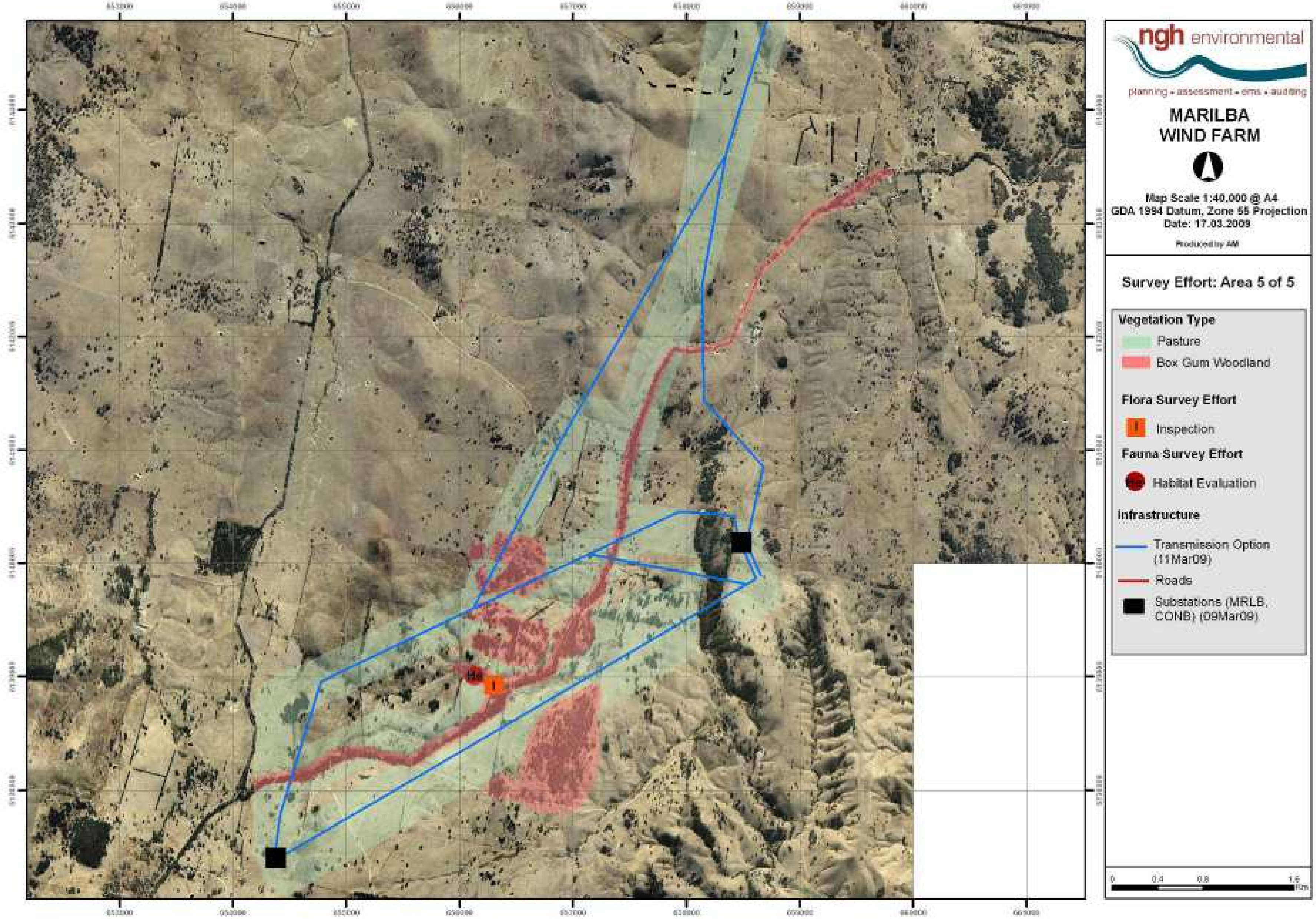
planning • assessment • ems • auditing
MARILBA WIND FARM
Map Scale 1:20,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
Produced by AM
Survey Effort: Area 3 of 5
Vegetation Type
Pasture
Box Gum Woodland
Dry Grass Forests
Flora Survey Effort
Quadrat
Random Meander
Inspection
Fauna Survey Effort
Bird Census
Reptile Survey
Spotlighting
Habitat Evaluation
Infrastructure
Cluster Labels
Turbine Locations (20Feb09)
Electricity Layout (09Mar09)
Transmission Option (11Mar09)
Electricity Layout (09Mar09)
Substations (MRLA) (09Mar09)
Tracks (20Feb09)
Roads
Hume Hwy
5
6



Hume Hwy
7
ngh environmental
planning • assessment • ems • auditing
MARILBA
WIND FARM
Map Scale 1:30,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
Produced by AM
Survey Effort: Area 4 of 5
Vegetation Type
Pasture
Box Gum Woodland
Dry Grass Forests
Flora Survey Effort
Quadrat
Random Meander
Inspection
Fauna Survey Effort
Bird Census
Reptile Survey
Nocturnal Survey
Mammal Traplines
Anabat Survey
Habitat Evaluation
Infrastructure
Cluster Labels
Turbine Locations (20Feb09)
Electricity Layout (09Mar09)
Transmission Option (11Mar09)
Tracks (20Feb09)
Roads
Substations (MRLB, CONB) (09Mar09)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planning • assessment • ems • auditing
MARILBA
WIND FARM
Map Scale 1:40,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
Produced by AM
Survey Effort: Area 5 of 5
Vegetation Type
Pasture
Box Gum Woodland
Flora Survey Effort
Inspection
Fauna Survey Effort
Habitat Evaluation
Infrastructure
Transmission Option (11Mar09)
Roads
Substations (MRLB, CONB) (09Mar09)
0 0.4 0.8 1.6 Km

5.2 SURVEY AND ASSESSMENT RESULTS

5.2.1 Vegetation communities

The majority of the study area is farmland that has been cleared and grazed for many decades. These areas generally lack sufficient integrity to enable confident attribution to the Southern Region vegetation types defined by Thomas *et al.* (2000) and Gellie (2005), which are based primarily on vascular plant structure and composition. There appears to be remnant native vegetation derived from two Southern Region dry shrub/grass forest types and several box gum woodland types present in the study area. The vegetation types which most closely correspond to remnants in the study area at the site are described below. The types, their local distribution, condition range and significance are summarised in Table 5.1. The indicative distribution of these types in the survey area is shown in Map Set 2. Full diagnostic species lists and habitat information for the Southern Region CRA vegetation types mentioned are contained in Thomas *et al*. (2000) and Gellie (2005). Species recorded in the vegetation types in the survey zones, with their cover/abundance scores, are listed in Appendix A, with examples of representative quadrat results.

Box gum woodland

Vegetation was conservatively assigned to box gum woodland if Yellow Box (*Eucalyptus melliodora*), White Box *(E. albens*) or Blakely's Red Gum (*E. blakelyi)* was present, even as a minority or sub-dominant component. Vegetation dominated by Long-leaved Box (*E. goniocalyx*) was also included, since this species usually occurs in association with the box gum woodland tree species at the subject site, and has an identical grassy understorey.

Box gum woodland remnants, in varying condition are present at all cluster sites, and is the dominant vegetation on most of the ridge crests, saddles and upper slopes in the survey area. Unlike many tableland areas where this community occupies lower slopes and valley floors and is replaced by a different assemblage (usually including *E. dives* and *E. mannifera* forest) on more exposed ridge tops, at the Marilba Hills Precinct this community also occurs on ridgelines. This is possibly a result of the volcanic geology and relatively deep, fertile soils on ridges over most of the Marilba Hills study area.

The community is dominated by White Box on more exposed crests and upper slopes in the north and west of the survey area (clusters 1, 2, 3 and 4). Yellow Box is dominant on more sheltered saddles and crests, usually on sites with gentler gradients (particularly clusters 4a and 7). Blakely's Red Gum is widespread as a dominant and sub-dominant, favouring moister slopes (eg clusters 2 and 7) and is dominant in post-grazing regeneration on ridgelines in clusters 4a and 4b. Some variants are locally dominated by Red Box (*E. polyanthemos*) (cluster 4a), Red Stringybark (*E. macrorhyncha)* (cluster 4b) and Long-leaved Box (*E. goniocalyx*) (clusters 3, 4a, 5). The small tree *Allocasuarina verticillata* is dominant over much of the large remnant on the western side of cluster 4a and 4b, possibly a result of past eucalypt clearing or thinning. Dense scrubs of Burgan (*Kunzea ericoides*) occupy some moist slopes in the south of cluster 4b.

The condition of box gum woodland samples ranges from good in areas with no or low grazing pressure (cluster 4) where a range of forb species are present in the understorey, including threatened and regionally significant species, to poor on crests at sheep camps, where virtually no native understorey species remain. In these latter nutrient enriched locations, thistles, Paterson's Curse (**Echium plantagineum*) and European nettle (**Urtica urens*) tend to dominate.

Most stands however are in poor-moderate or moderate condition, with the understorey dominated by native grasses (*Austrodanthonia* spp*, Microlaena stipoides, Austrostipa scabra* ssp *falcata, Bothriochloa macra, Aristida ramosa*) with relatively low diversity of native forb species (usually including *Rumex brownii* and *Oxalis perennans*, with *Dichondra repens, Hydrocotyle laxiflora* and *Cheilanthes* spp. persisting in small numbers beneath logs and rock outcrops). *Hypoxis vaginatus, Drosera peltata, Wurmbea* spp and *Diuris chryseopsis* are present in seepage areas. Woodland trees are generally mature, and regeneration is limited to areas with light grazing pressure (mainly cluster 4).

Small areas in moderate-good condition occur at cluster 3 and between clusters 5 and 6, and larger moderate-good areas occur at clusters 4a and 4b. Cluster 4b has an ungrazed stand in good condition (MGA 653629 6148696) comprising regenerating Blakely's Red Gum with a diverse understorey including the shrub *Pimelea treyvaudii*, the grass *Themeda triandra,* the herbs *Solenogyne dominii, Desmodium varians, Convolvulus angustissimus, Linum marginale,* the lilies *Tricoryne elatior, Dichopogon fimbriatus, Arthropodium minus* and *A. milleflorum,* the daisies *Ammobium craspedioides, Triptilodiscus pygmaeus, Vittadinia muelleri, V. cuneata, Leptorhynchos squamatus* ssp A, and the orchid *Microtis unifolia.*

Much of the native pasture in the study area is derived from the box gum woodland community, usually in depauperate form with low native forb diversity. The diverse secondary grassland near the substation site at cluster 7 is also likely to be derived from this community, although no diagnostic tree species remain at or near the site (refer below). This area is grazed as pasture but has retained considerable native species diversity.

Box gum woodland remnants are present outside the impact zone, beside Whitefields and Illalong Roads and on private property to the west, which may be available as offsets for the wind farm project. The road verge sites have a depauperate groundcover, but frequently include large old trees which provide potential threatened fauna habitat. Road woodland remnants occur on routes that may be needed to access the site for the construction and operation of the wind farm. Illalong Road has linear remnants with apparently little floristic integrity but mature trees which provide habitat and a movement corridor for local bird, bat and mammal species. The threatened Superb Parrot was observed along this road on several occasions during the survey period.

Some parts of the site may have some recovery potential if grazing pressure were reduced. Some areas, generally in saddles where native groundcover species tend to dominate more, may be capable of producing some tree regeneration and improved native groundcover diversity. Other areas, mostly heavily grazed or sheep camp areas on the highest points, seem likely to be incapable of recovery. In some dieback affected areas, trees may be too stressed to produce seed, and if grazing pressure were reduced exotic groundcovers would simply become more dominant.

There are several closely related box gum woodland vegetation types in the Thomas *et al.* (2000)/Gellie (2005) classification; Vegetation Group (VG) 116 (*E. macrorhyncha-E. blakelyi*), VG117 (E*. albens-E. blakelyi*), VG120 (*E. macrorhyncha-E. albens*), VG160 (*E. blakelyi-E. melliodora*), VG161 (*E. melliodora*) and VG163 (*E. blakelyi-E. polyanthemos*). These types share many common positive fidelity indicator species and they can be difficult to distinguish in disturbed and depauperate samples. Further, at least in the case of the box gum woodlands, the Southern Region classification is likely to be based on samples from disturbed sites and any variation in species composition may reflect past management rather than any inherent community differences. Given these identification difficulties, and since all of the types have similar conservation status, they have not been treated individually in this assessment.

Box gum woodland derived grassland

This diverse grassland community was recorded from a single site to the south-west of cluster 7, over an upper valley and low saddle area containing potential substation sites. No trees and few shrubs are present, and the groundlayer is variably dominated by the grasses *Austrodanthonia* spp*, Themeda triandra* and *Microlaena stipoides* and, in moister seepage areas, the forbs *Isotoma fluviatilis* and *Hydrocotyle peduncularis*. A wide range of native forbs are present including the threatened Yass Daisy (*Ammobium craspedioides*) and several woodland species which may be declining with woodland habitat in the region (such as *Desmodium varians, Leptorhynchos squamatus, Craspedia variabilis* and *Brachyscome* spp.). Although no box gum woodland tree species are present at the site, it is likely that the site once carried this community, given the topography and groundcover composition.

Native pasture

Most cleared parts of the study area carry a low diversity native pasture used for grazing sheep and cattle dominated by native grasses (variously *Microlaena stipoides*, *Austrodanthonia* spp., *Austrostipa* spp., *Bothriochloa macra*, *Aristida ramosa*). The diversity of grass species and native forbs varies depending on grazing intensity and disturbance history. Forbs are generally dominated by exotic weed and pasture species. A small suite of hardy native forbs persist in most areas including *Rumex brownii*, *Acaena* spp. and *Oxalis perennans.* Other native species are largely confined to rock outcrops in pasture, such as *Crassula sieberiana, Cheilanthes* spp, *Hydrocotyle laxiflora, Geranium solanderi* and *Dichondra repens*. On less disturbed moister slopes, *Drosera peltata, Hypoxis vaginata, Wurmbea* spp and *Solenogyne dominii* are present in native pasture (clusters 4a, 4b and 6). Higher diversity areas also carry *Ammobium craspedioides, Convolvulus angustissimus* and *Desmodium varians* (cluster 4a*), Leptorhynchos squamatus* ssp A (clusters 4a and 4b), *Erodium crinitum* (clusters 3 and 4a) and the orchid *Diuris chryseopsis* (cluster 6). Most native pastures appear to be derived from box gum woodland, which is the most widespread community in the study area. Some restricted areas on ridge crests are used as sheep camps and are wholly dominated by exotic forbs and grass species, including a range of agricultural weeds (refer section 5.2.6 below).

Dry grass forest types

Discrete dry grass forest remnants dominated by Long-leaved Box occur on sheltered slopes on volcanic substrates at the southern end of cluster 7. The understorey has been heavily modified by past grazing and clearing, particularly in the depletion of the shrub layer. The ground layer is dominated by a range of native grasses (*Microlaena stipoides*, *Austrodanthonia* spp., *Austrostipa* spp.) with generally low forb diversity. An exception is the remnant on the south-west side of cluster 6, which carries a relatively diverse groundcover, including the threatened Yass Daisy.

This community corresponds most closely to Vegetation Group 118: Western Slopes Dry Grass Forest in the Southern Region classification (Gellie 2005), though a number of very similar communities are described; VG 119 Western Tablelands Dry Shrub/Grass Forest, VG 121 Northern Tablelands and Slopes Dry Shrub/Grass Forest and VG 122 Northern Tablelands and Slopes Dry Shrub/Grass Forest. All of these types include several positive indicator species found on Marilba Hills sites. The conservation status of each of these types is identified in Table 5.2 below.

Key diagnostic species for VG 118 present at Marilba Hills include the trees *Eucalyptus goniocalyx, E. macrorhyncha* and occasionally *E. blakelyi* or *Allocasuarina verticillata,* the shrub *Hibbertia obtusifolia,* the forbs *Gonocarpus tetragynus, Wurmbea dioica, Senecio tenuiflorus* and *Hydrocotyle laxiflora* and the grasses *Microlaena stipoides, Elymus scaber* and *Austrodanthonia* spp. All these species are also typical of box-gum woodland, with which dry shrub/grass forest intergrades at the subject site. Examples of VG 118 which have a diverse grassy understorey may be included in the box gum woodland EEC/CEEC.

Another more distinctive dry shrub/grass forest assemblage occurs mainly as a single stand on sedimentary geology in the far south of cluster 7. This community is dominated by Brittle Gum (*E. mannifera*) and Broad-leaved Peppermint (*E. dives*) with a minimal shrub layer (scattered *Hibbertia obtusifolia*), grassy groundlayer dominated by *Joycea pallida, Poa sieberiana* and *Aristida ramosa* and forbs including *Stellaria pungens*. This community belongs to Vegetation Group 109 Widespread Tablelands Dry Shrub/Tussock Grass Forest (*E dives - E. mannifera*). Key positive indicator and diagnostic species present at the site include the trees *Eucalyptus mannifera, E. dives* and *E. macrorhyncha*, the shrubs *Hibbertia obtusifolia*, the forbs *Senecio tenuiflorus*, *Gonocarpus tetragynus* and *Hydrocotyle laxiflora*, the grasses *Joycea pallida* and *Poa sieberiana* and the graminoid *Lomandra filiformis* ssp *coriacea*.

Dry forest vegetation on a low granitic escarpment within the Carroll's Ridge – Marilba powerline envelope is attributed to a related vegetation type; Vegetation Group 14: Tablelands Dry Shrub/Tussock Grass Forest (*E. goniocalyx*). This area was surveyed for the Conroys Gap Wind Farm proposal in 2006 (**ngh**environmental 2006).

Lowland box gum woodland, riparian woodland and exotic pasture

The vegetation occupying the lowlands surrounding the clusters, and over much of the proposed powerline routes, is derived from a box gum woodland dominated by Yellow Box and Blakely's Red Gum. Modified remnants are present along roadsides (eg Grace's Flat Road, Illalong Road) and watercourses and in the form of remnant mature paddock trees. In many arable lowland paddocks, soils have been cultivated and fertilised and the understorey has been replaced with exotic pasture, fodder and weed species. Mature trees in paddocks may have high fauna conservation value, particularly those providing hollows for nesting birds and bats.

A riparian community dominated by River Red Gum (*E. camaldulensis*) with occasional Apple Box (*E. bridgesiana*) is present along Illalong Creek to the west. It could be impacted by powerlines or, in areas where creeks cross or run close to access roads, tree-lopping during the construction period to allow large components such as turbine blades to be transported to the sites. Because of its inherent fertility, and impacts arising from clearing, grazing, erosion, sedimentation, and disruption to flow regimes, the riparian habitat has been extensively colonised by exotic pasture grasses and weeds. This community falls within a single vegetation type VG 43 Western Slopes Riparian Moist Sedge Forest/Woodland. It occurs in Travelling Stock Reserve No. 38 on Illalong Road, west of the Marilba Hills Precinct, and various points along Illalong Road where the creek closely approaches the road.

Table 5-1 Summary of vegetation types, survey effort and results

Vegetation Group (VG) (Gellie 2005)	Overstorey dominants	Turbine clusters	Landforms	Survey effort	Condition class range		
					Class	Survey sites	Area[1] within envelope (ha)
Box gum woodland							
Several closely related types likely to be present: VG 116 (*E. macrorhyncha-E. blakelyi*), VG 117 (E. *albens-E. blakelyi*), VG 120 (*E. macrorhyncha-E. albens*), VG 160 (*E. blakelyi-E. melliodora*), VG 161 (*E. melliodora*) and VG 163 (*E. blakelyi-E. polyanthemos*).	Variably *Eucalyptus melliodora, E. albens, E. blakelyi, E. goniocalyx , E. polyanthemos, E. macrorhyncha* and *Allocasuarina verticillata.*	1, 2, 3, 4, 5, 7 Also dominant in adjacent lowland areas, generally in a more highly modified condition	Ridge crests, saddles, gentler slopes and valleys, on volcanics and sediments, all elevations	Quadrats: 10 Random meanders: 14 Inspections: 6	Poor Poor-moderate Moderate Moderate-good Good	6 sites 1 site 11 sites 10 sites 2 sites	497.68 777.31 286.29 232.01 9.09
Box gum woodland derived grassland							
Likely to be derived from one of the box gum woodland types.	*Austrodanthonia* spp, *Themeda triandra*	7	Upper valley and saddle (near substation site)	Quadrats: 0 Random meanders: 1 Inspections: 2	Poor Poor-moderate Moderate Moderate-good Good	- - - - 3 sites	- - - - 21.13
Native pasture							
Mostly derived from box gum woodland types (refer above), some limited areas from dry shrub/grass forest types (VG 122, VG 109)	*Austrodanthonia* spp, *Microlaena stipoides, Austrostipa scabra* ssp *falcata, Aristida ramosa* Exotic component variable – dominant in limited sheep camp areas on ridge crests.	Widespread at all clusters	The dominant type on cleared ridges, saddles and slopes. Also dominant in valley areas with no cultivation history.	Quadrats: 0 Random meanders: 6 Inspections: 1	Poor Poor-moderate Moderate Moderate-good Good	- 4 sites 2 sites 1 site -	2182.74
Long-leaved Box dry grass forest							
VG 118 (*E macrorhyncha - E. goniocalyx* –) on steeper slopes on volcanic soils	*E. goniocalyx*	clusters 4, 6 and 7	Steeper sideslopes, particularly sheltered aspects	Quadrats: 1 Random meanders: 1 Inspections: 0	Poor Poor-moderate Moderate Moderate-good Good	- - 1 site 1 site -	- - 14.72 2.05 -
Broad-leaved Peppermint – Brittle Gum dry grass forest							
VG 109 (*E dives - E. mannifera*) on metasediments in the far south of the site.	*E. mannifera – E- dives*	cluster 7	Rocky ridge crest and upper slope	Quadrats: 2 Random meanders: 0 Inspections: 0	Poor Poor-moderate Moderate Moderate-good Good	- 1 site 1 site - -	- 0.81 8.10 - -

[1] estimates based on air photo interpretation and extrapolation from field survey

5.2.2 Species recorded at the subject site

A full list of species recorded in the four vegetation types present at the subject site, and their cover/abundance, is provided in Appendix A. This list is not exhaustive due to the extensive nature of the survey area, and the omission of some species which flower or are only recordable outside the survey periods.

5.2.3 Disturbance and weeds

Forests and woodlands in the study area have been progressively ring-barked and felled over the past century to provide pasture. Many lowland areas have been repeatedly ploughed, seeded and fertilised to provide improved pasture. Clearing and agriculture has produced a range of direct and indirect impacts to flora habitats, including altered microclimate, loss of pollinator and dispersal fauna, sheet erosion of soils, watercourse bed incision and damming, localised sedimentation, elevated soil nutrients and rising saline groundwater. Gully erosion in drainage lines is widespread and active in some parts of the subject site. Salinity-related tunnel erosion is active around cluster 2.

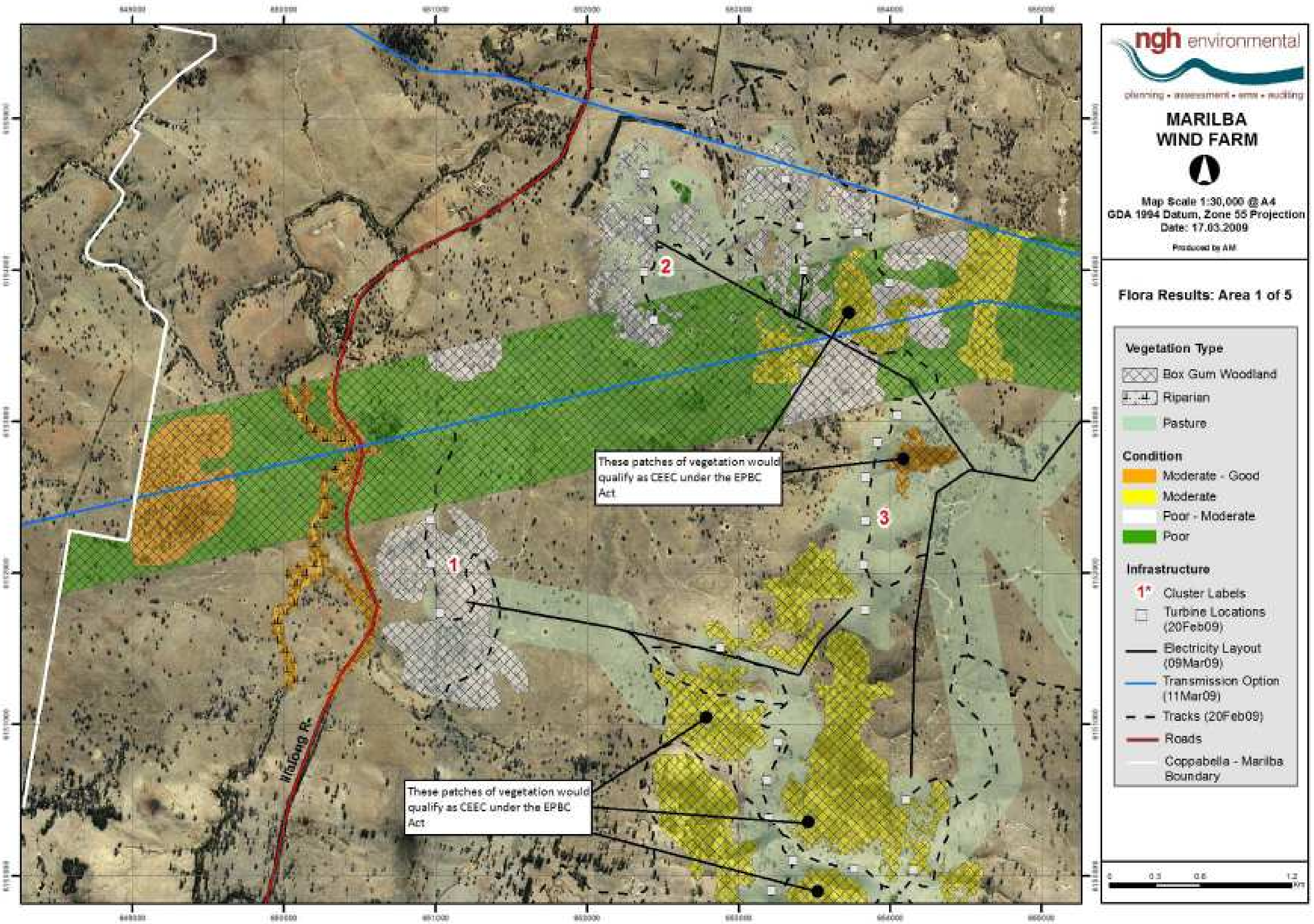
Agricultural activities have also resulted in the colonisation of a range of introduced plant species, with greatest displacement of natives occurring in moister, more fertile valley floor areas and areas subjected to pasture improvement and cultivation. In many areas, grazing is likely to have reduced or eliminated selectively grazed or grazing sensitive species, such as Kangaroo Grass (*Themeda triandra*), terrestrial orchids, wattles and pea shrubs.

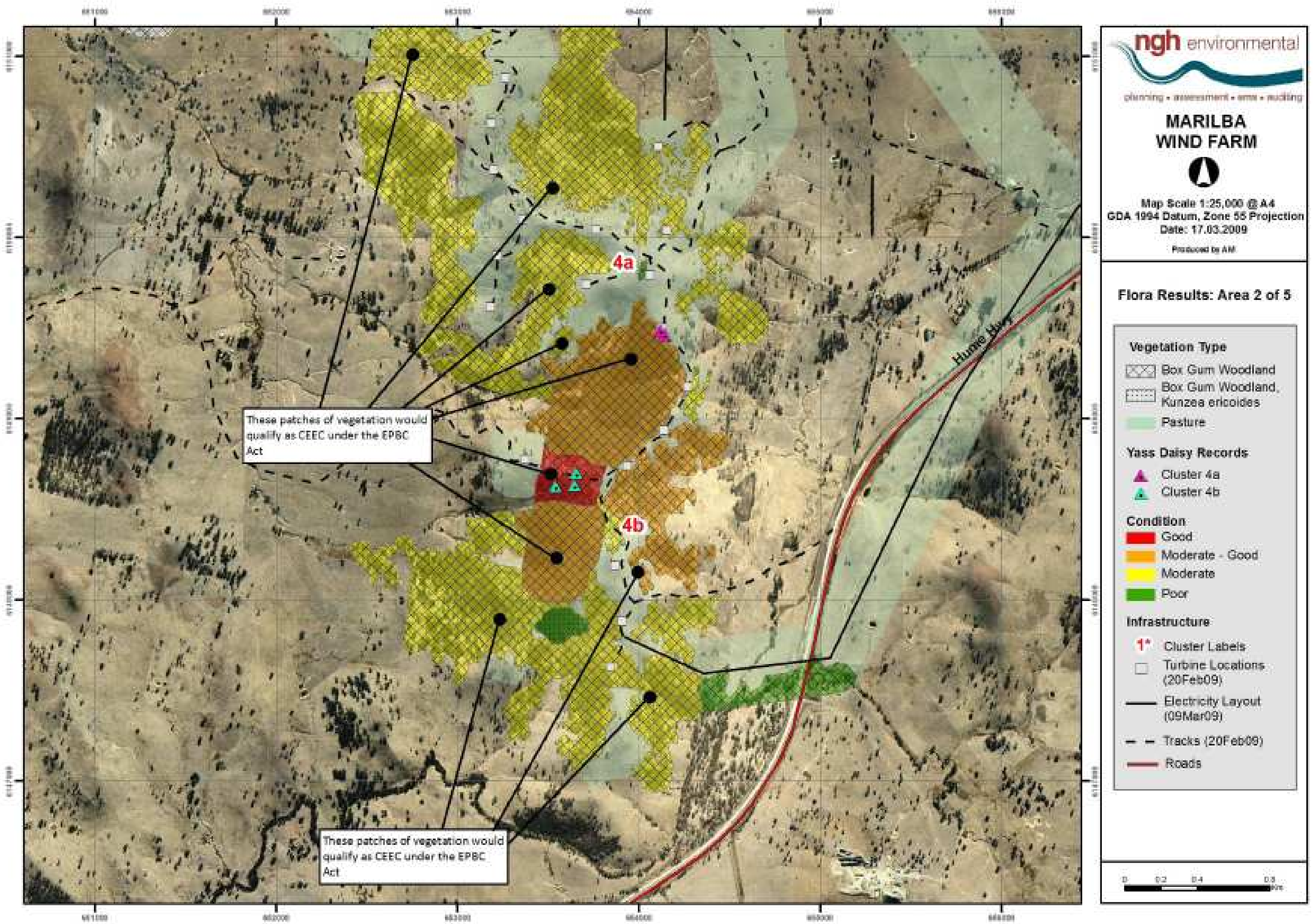
The study area carries a variable proportion of exotic weed and pasture species, ranging from less than one quarter of total herbaceous cover (especially parts of clusters 3, 4, 6 and 7) to almost total displacement of native species. The major exotic species are grasses (**Lolium perenne*, **Hordeum leporinum*), clovers (**Trifolium* spp), asteraceous weeds (Capeweed, thistles), Storksbills (**Erodium* spp), Paterson's Curse (**Echium plantagineum*) and Sheep Sorrel (**Acetosella vulgaris*). In heavily grazed and sheep camp areas on some ridge crests, asteraceous weeds such as Capeweed and thistles (*Carduus* spp, *Onopordum* spp, *Silybum marianum, Carthamus lanatus*), Paterson's Curse (*Echium plantagineum*) and European Nettle (*Urtica urens*) dominate. In less disturbed areas with a tree canopy the most common exotic species at the time of the survey were annuals, particularly Chickweed (**Stellaria media*) and Quaking Grass (**Briza maxima*). These areas would probably appear less weedy later in the season, when these species have seeded and disappeared.

Eight weeds listed as noxious for the Southern Slopes County Council control area under the *Noxious Weeds Act 1993* were recorded in the survey area; Paterson's Curse (*Echium plantagineum*), Horehound (*Marrubium vulgare*) – clusters 1, 2, 4a, 4b, 5, Scotch Thistle (*Onopordum acanthium*) – clusters 1, 2, 3, 4a, 6, St John's Wort (*Hypericum perforatum*) – cluster 4b, Serrated Tussock (*Nassella trichotoma*) – cluster 7, Sweet Briar (*Rosa rubiginosa*) – clusters 4a and 7, Blackberry (*Rubus fruticosus* sp. agg.) – cluster 7 and Yellow-flowered Devil's Claw (*Ibicella lutea*) – a single old fruit at cluster 4a. These records are drawn from vegetation survey site data and opportunistic sightings and are not likely to be exhaustive.

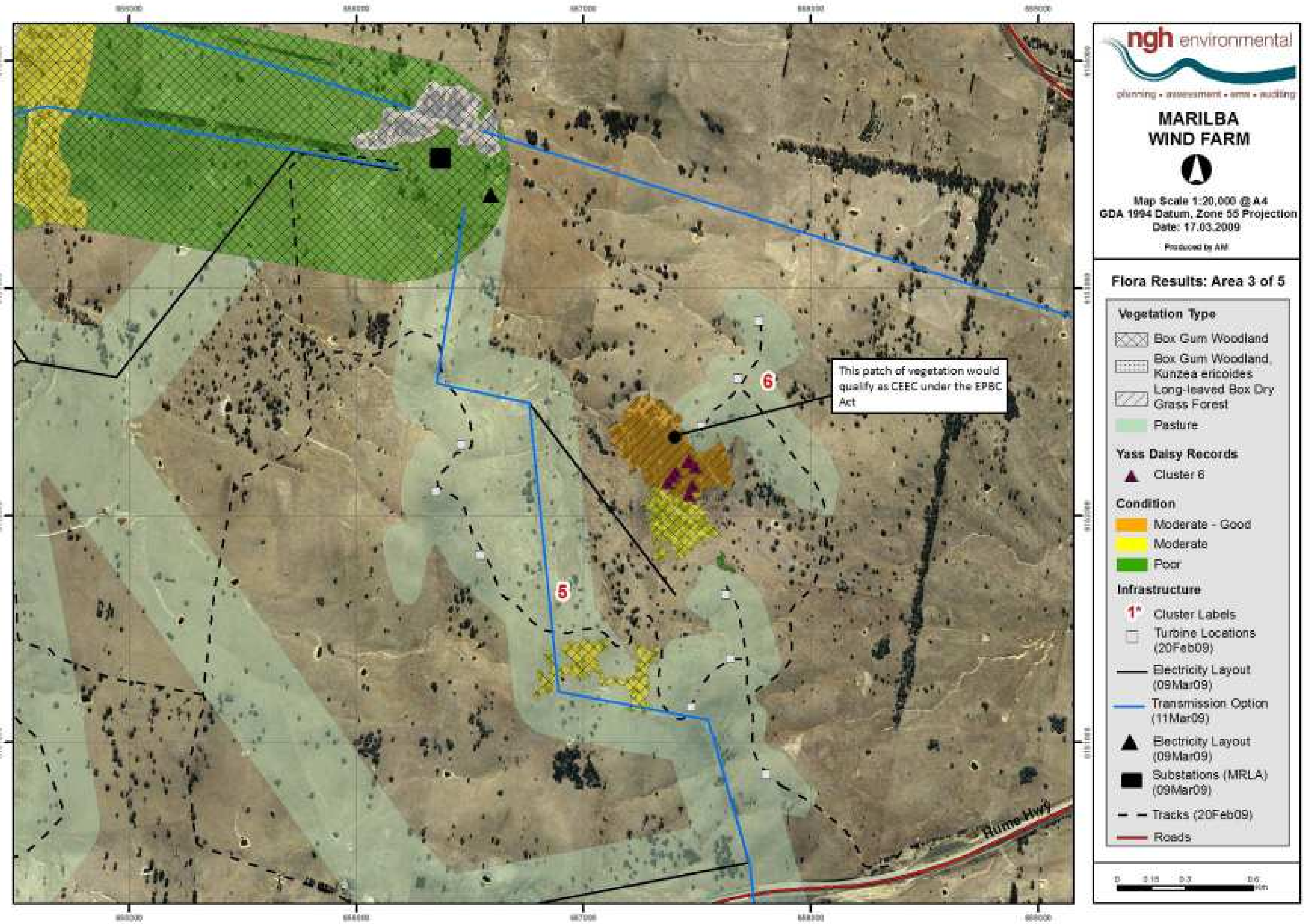
These noxious weed species are listed as Class 4 weeds. The control objective for Class 4 weeds is to minimise the negative impact of those plants on the economy, community or environment of New South Wales. The growth and spread of class 4 weeds must be controlled according to the measures specified in a management plan published by the local control authority.

Map Set 2 – Ecological communities, vegetation condition and significant flora features (5 maps in total)





ngh environmental
planning • assessment • ems • auditing
MARILBA
WIND FARM
Map Scale 1:25,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
Produced by AM
Flora Results: Area 2 of 5
Vegetation Type
Box Gum Woodland
Box Gum Woodland, Kunzea ericoides
Pasture
Yass Daisy Records
Cluster 4a
Cluster 4b
Condition
Good
Moderate - Good
Moderate
Poor
Infrastructure
Cluster Labels
Turbine Locations (20Feb09)
Electricity Layout (09Mar09)
Tracks (20Feb09)
Roads
4a
4b
Hume Hwy
These patches of vegetation would qualify as CEEC under the EPBC Act
These patches of vegetation would qualify as CEEC under the EPBC Act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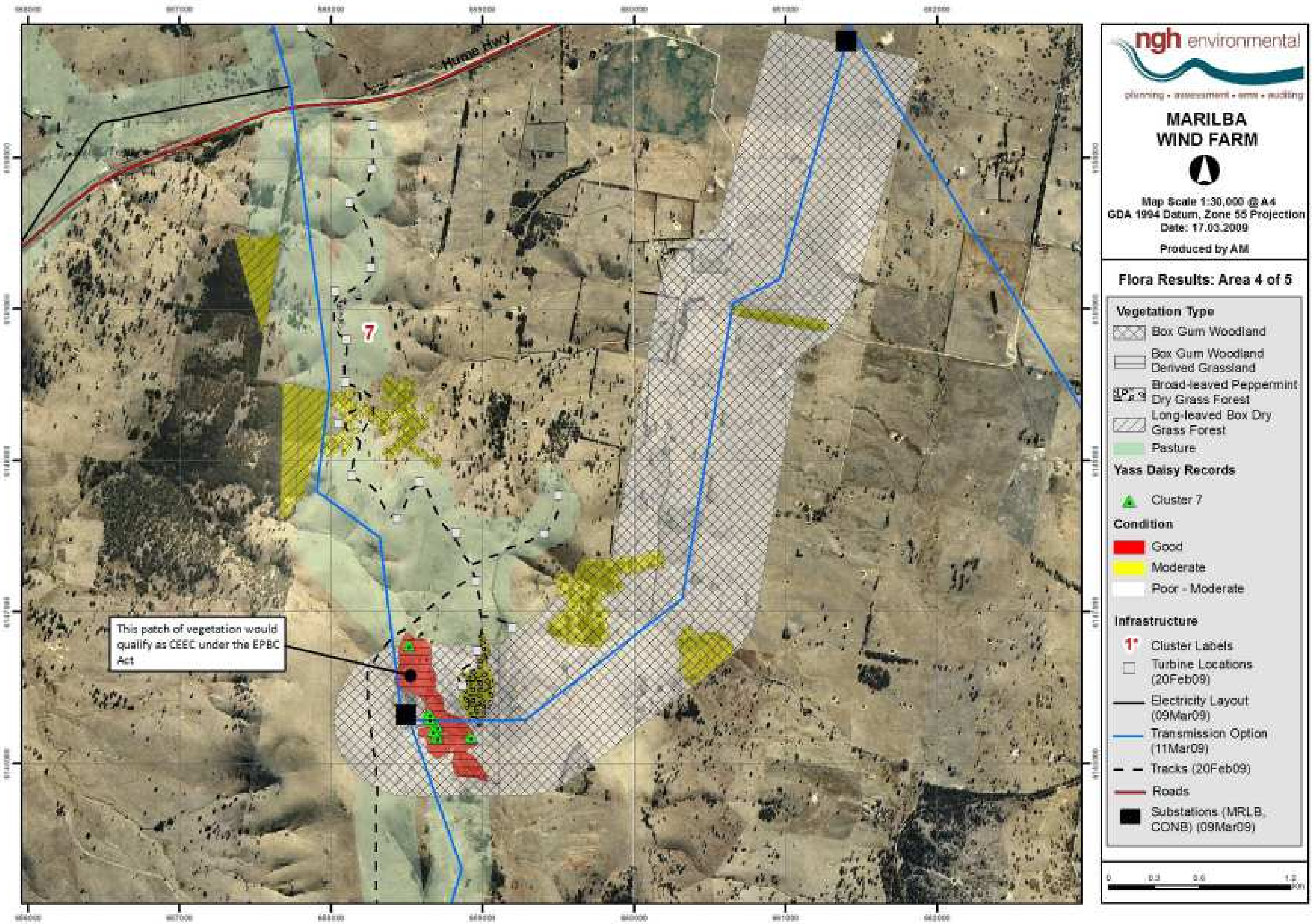
MARILBA
WIND FARM
Map Scale 1:20,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
Produced by AM
Flora Results: Area 3 of 5
Vegetation Type
Box Gum Woodland
Box Gum Woodland, Kunzea ericoides
Long-leaved Box Dry Grass Forest
Pasture
Yass Daisy Records
Cluster 6
Condition
Moderate - Good
Moderate
Poor
Infrastructure
Cluster Labels
Turbine Locations (20Feb09)
Electricity Layout (09Mar09)
Transmission Option (11Mar09)
Electricity Layout (09Mar09)
Substations (MRLA) (09Mar09)
Tracks (20Feb09)
Roads
This patch of vegetation would qualify as CEEC under the EPBC Act
6
5
Hume Hwy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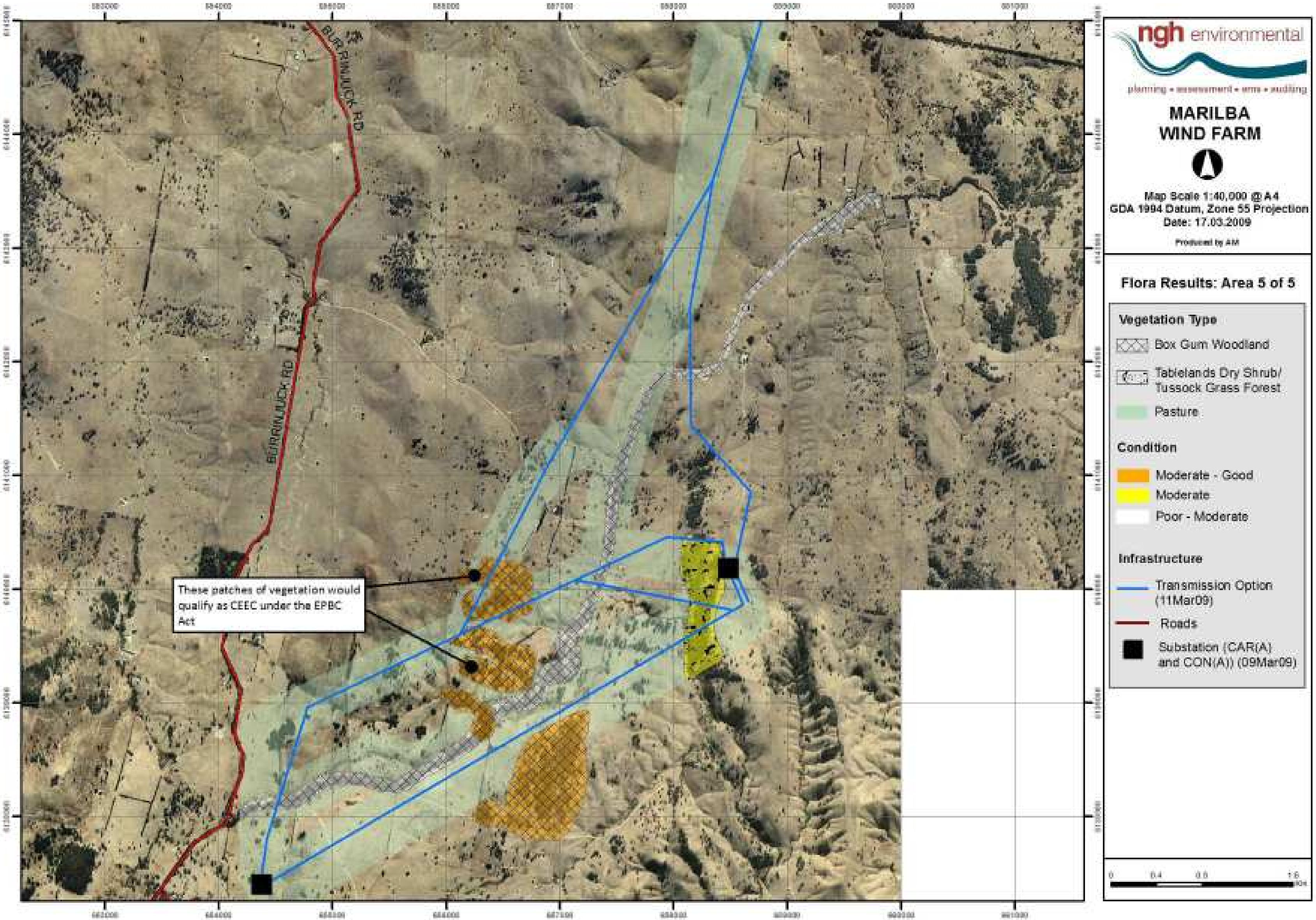
MARILBA
WIND FARM
Map Scale 1:30,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
Produced by AM
Flora Results: Area 4 of 5
Vegetation Type
Box Gum Woodland
Box Gum Woodland Derived Grassland
Broad-leaved Peppermint Dry Grass Forest
Long-leaved Box Dry Grass Forest
Pasture
Yass Daisy Records
Cluster 7
Condition
Good
Moderate
Poor - Moderate
Infrastructure
Cluster Labels
Turbine Locations (20Feb09)
Electricity Layout (09Mar09)
Transmission Option (11Mar09)
Tracks (20Feb09)
Roads
Substations (MRLB, CONB) (09Mar09)
Hume Hwy
7
This patch of vegetation would qualify as CEEC under the EPBC Act



BURRINJUCK RD
BURRINJUCK RD
These patches of vegetation would qualify as CEEC under the EPBC Act
ngh environmental
planning • assessment • ems • auditing
MARILBA
WIND FARM
Map Scale 1:40,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
Produced by AM
Flora Results: Area 5 of 5
Vegetation Type
Box Gum Woodland
Tablelands Dry Shrub/ Tussock Grass Forest
Pasture
Condition
Moderate - Good
Moderate
Poor - Moderate
Infrastructure
Transmission Option (11Mar09)
Roads
Substation (CAR(A) and CON(A)) (09Mar09)

5.3 SPECIES AND COMMUNITIES OF CONSERVATION SIGNIFICANCE

5.3.1 Online database searches

The TSC Act and EPBC Act online searches for threatened flora and communities known or with potential to occur in the region identified 15 threatened flora species and 3 threatened ecological communities:

Scientific name	Common name	TSC Act	EPBC Act
Pilularia novae-hollandiae	Austral Pillwort	E	-
Ammobium craspedioides	Yass Daisy	V	V
Senecio garlandii	Woolly Ragwort	V	V
Swainsona sericea	Silky Swainson-pea	V	-
Thesium australe	Austral Toadflax	V	V
Cullen parvum	Small Scurf-pea	E	-
Euphrasia collina ssp. *muelleri*	Mueller's Eyebright/ Purple Eyebright	E	E
Caladenia concolor/Caladenia sp. Burrinjuck	Burrinjuck Spider Orchid	V	V
Prasophyllum petilum	Tarengo Leek Orchid	E	E
Caladenia concolor	Crimson Spider Orchid	E	V
Diuris tricolor	Pine Donkey Orchid	V	V
Grevillea iaspicula	Wee Jasper Grevillea	E	E
Grevillea wilkinsonii	Tumut Grevillea	E	E
Pomaderris cotoneaster	Cotoneaster Pomaderris	E	E
Leucochrysum albicans var. *tricolor*	Hoary Sunray	-	E
Natural Temperate Grassland of the Southern Tablelands (NSW and ACT)	Natural Temperate Grassland of the Southern Tablelands (NSW and ACT)	-	E
White Box Yellow Box Blakely's Red Gum Woodland/ White Box Yellow Box Blakely's Red Gum Grassy Woodland and Derived Native Grasslands	Box-Gum Woodland	EEC	CE
Inland Grey Box Woodland in the Riverina; NSW South Western Slopes; Cobar Peneplain; Nandewar and Brigalow Belt South Bioregions	Inland Grey Box Woodland	EEC	-

The Threatened Species Evaluation Appendix C assesses the potential for threatened species and communities to be impacted by the proposed development, based on available habitat, known ecological requirements and local distribution records. Species and communities known to occur, or considered to have the potential to occur on the site are discussed below. Species and communities considered to have the potential to be impacted by the proposal (box gum woodland CEEC, *Ammobium craspedioides, Caladenia* sp Burrinjuck (syn *C. concolor* sens lat.) and *Thesium australe*) are assessed for significance of impacts in Appendices E and F.

5.3.2 Ecological communities

The conservation status of each of the natural vegetation types present as remnants in the study area is summarised in Table 5.2, based on data presented in Gellie (2005).

Table 5-2 Conservation status of vegetation types at the subject site

Vegetation type	Pre-1750 extent (ha)	Extant area (ha)	Reserved in CRA Southern Region (ha)
Box gum woodland types			
Vegetation Group 116: Western Slopes Herb/Grass Woodland	83,000	6,500 (8% of 1750 extent)	nil
Vegetation Group 117: Western Slopes White Box Dry Grass Woodland	107,200	8,400 (8% of 1750 extent)	nil
Vegetation Group 120: Western Slopes Shrub/Herb/Grass Dry Forest	131,300	20,200 (16% of 1750 extent)	2,500 (2% of 1750 extent)
Vegetation Group 160: Western Slopes Dry Grass Woodland	247,500	7,000 (3% of 1750 extent)	nil
Vegetation Group 161: Tablelands and Slopes Dry Herb/Grass Woodland	87,100	3,800 (4% of 1750 extent)	nil
Vegetation Group 163: Central North Slopes Dry Grass Woodland	7,400	260 (22% of 1750 extent)	nil
Long-leaved Box dry grass forest types			
Vegetation Group 118: Western Slopes Dry Grass Forest	6,900	3,100 (45% of 1750 extent)	500 (7% of 1750 extent)
Vegetation Group 119: Western Tablelands Dry Shrub/Grass Forest	121,800	23,000 (19% of 1750 extent)	1,300 (1% of 1750 extent)
Vegetation Group 121: Western Slopes Grass/Herb Dry Forest	90,800	56,400 (62% of 1750 extent)	16,900 (19% of 1750 extent)
Vegetation Group 122: Northern Tablelands and Slopes Dry Shrub/Grass Dry Forest	48,600	11,800 (24% of 1750 extent)	nil
Brittle Gum - Broad-leaved Peppermint dry grass forest			
Vegetation Group 109: Widespread Tablelands Dry Shrub/Tussock Grass Forest	158,000	70,600 (45% of 1750 extent)	16,200 (10% of 1750 extent)
Long-leaved Box dry shrub/tussock grass forest			
Vegetation Group 114: Tablelands Dry Shrub/Tussock Grass Forest	202,415	95,557 (47.2% of 1750 extent	11,681 (5.8% of 1750 extent)

Table 5.2 shows the high level of depletion and poor conservation status of the box gum woodland vegetation types which would have originally occupied much of the study area. Since box gum woodland habitat coincides with prime farmland, this community has been heavily impacted by clearing, grazing, cultivation and the introduction of weed and pasture species. The impact of this depletion is compounded by the severe fragmentation and continuing degradation of remaining stands. Box-Gum Woodland EEC remnants are threatened by a range of processes, including further clearing, firewood cutting, livestock grazing, weed invasion, inappropriate fire regimes, soil disturbance, increased nutrient loads, soil acidification and salinisation and loss of connectivity (NSW SC 2002).

Applying the general JANIS reservation target of 15% for each forest type (JANIS 1997), all of the box gum vegetation types and most of the dry grass forest types are under-represented in the conservation reserve system. Under JANIS criteria, 60% of the remaining stands of vulnerable types and 100% of endangered types should be reserved or otherwise protected.

Box gum woodland Endangered Ecological Community

Box gum woodland is listed as threatened under both the NSW TSC Act (as the White Box Yellow Box Blakely's Red Gum Woodland Endangered Ecological Community) and the Commonwealth EPBC Act (as Yellow Box – White Box- Blakely's Red Gum Grassy Woodland and Derived Native Grasslands). In relation to community condition, the identification criteria differ between the state and Commonwealth systems, with the Commonwealth community representing a higher quality subset of the NSW community.

NSW TSC Act

The EEC definition under the TSC Act is broad in terms of stand structure and condition. It encompasses woodlands and treeless formations dominated by native grasses, including examples in poor-moderate condition with low forb diversity. The EEC therefore covers a wide range of relative conservation significance. EEC status does not necessarily equate to high conservation value. For example, grazed native pastures derived from box gum woodland and dominated by native grasses but with very low native forbs diversity would form part of the EEC. However, this vegetation is locally very abundant, is likely to have low natural recovery potential and is considered to have relatively low conservation value. Condition, conservation value and impact significance are taken into account as part of the Assessment of Significance of impacts to the community (Appendix E).

Woodland examples

The box gum woodland EEC includes those woodlands where the characteristic tree species include one or more of the following species in varying proportions and combinations - *Eucalyptus albens* (White Box), *Eucalyptus melliodora* (Yellow Box) or *Eucalyptus blakelyi* (Blakely's Red Gum). Recent verbal advice from DECC staff (A. Treweek, R. Rehwinkel, pers. comm.) on interpretation of this EEC is that these three species need not be the dominant trees, but may be a small proportion of the total tree cover. Remnants with even a single tree of White Box, Yellow Box or Blakely's Red Gum present are regarded as belonging to the EEC. Whether remnants lacking any of those species are regarded as belonging to the EEC should be determined at the landscape scale, considering the presence of the box gum woodland trees in surrounding vegetation.

Consistent with DECC advice, vegetation dominated by Long-leaved Box (*E. goniocalyx*) was considered part of the EEC, since this species usually occurs in association with the box gum woodland tree species on the volcanic soils of the subject site. Long-leaved Box is among the tree species listed in the Determination as potentially occurring in the EEC. Long-leaved Box stands appear to occupy a discrete landscape position on sheltered slopes, although these stands have essentially the same grassy understorey as box gum woodland and share a similar function in the landscape (for example, as fauna habitat).

Under the EEC Determination, disturbed remnants form part of the EEC. Some remnants survive partly or wholly cleared of trees, or with the tree layer intact but with the understorey degraded or lost through grazing or pasture modification. The EEC includes '*remnants where the vegetation, either understorey, overstorey or both, would, under appropriate management, respond to assisted natural regeneration, such as where the natural soil and associated seed bank are still at least partially intact*', but does not specifically exclude stands with no natural understorey or with no assisted natural regeneration potential or soil seed bank (although the NPWS identification guidelines appear to do this). The EEC includes degraded remnants which have few, if any native species in the understorey (NPWS undated). So long as one or more of the diagnostic tree species are present in woodland formation, remnants form part of the EEC irrespective of the groundcover stratum (DECC 2008a).

Hence, all parts of the study area carrying Yellow Box, Blakely's Red Gum or White Box in a woodland formation would be considered part of the EEC, regardless of understorey condition. Box gum woodland with these species as dominants, or as minority species in association with *E. goniocalyx,* is the most common vegetation type in the study area, with stands present in varying condition at all of the clusters. The conservation value of degraded stands is influenced by stand condition, the presence of significant species, local levels of depletion, fauna habitat values, recovery potential and connectivity with other areas of natural vegetation. Condition in the study area ranges from sparse dieback-affected White Box over a heavily grazed exotic understorey (eg parts of clusters 1 and 2) to mature Blakely's Red Gum regrowth over a diverse natural grassy understorey with a range of significant species (eg parts of cluster 4b). In extreme cases examples of the former condition would have very little or no capacity for regeneration of even the tree layer, and none whatever of the understorey, even if grazing pressure was removed.

Nearly all of the vegetation within the Marilba Hills project area in the proposed powerline route envelopes between Coppabella and Marilba substations and Marilba and Carroll's Ridge substations route would fall within the TSC Act definition of box-gum woodland EEC, since at least scattered eucalypts are present throughout the route, with trees denser in some areas. The groundcover is predominantly native for most of the proposed route, with the exception of some paddocks in the eastern part of the Mylora property, and one on the Weilora property which have been cropped or converted to exotic pasture (Phalaris). However, since these paddocks include some Yellow Box or Blakely's Red Gum trees, and have some potential for tree regeneration, they would also fall within the EEC definition. Dominant groundcover species over most of the route are the grasses *Austrodanthonia* spp. and *Bothriochloa macra*, with patches of corkscrew grass (*Austrostipa falcata*) and Microlaena. Generally groundcover condition is poor-moderate, with one or two native grass species dominant and few or no native forbs.

There are areas of higher tree density where vegetation appears to fit the definition of the Critically Endangered box-gum woodland ecological community listed under the EPBC Act. Although it does not have the higher groundcover species diversity required by the EPBC Act definition, it satisfies the other criteria: patch size is >2 hectares, tree density appears to be >20 trees per hectare and/or tree regeneration is present. These areas are located across most of the width of the Weilora property, where the proposed route cuts across the southern end of the ridge with the northern-most turbine cluster on the Marilba site, close to where a small creek skirts the end of the ridge.

The Determination notes that native species within the EEC which do not appear to tolerate grazing by domestic stock include *Dianella revoluta, Diuris dendrobioides, Microseris lanceolata, Pimelea curviflora* and *Templetonia stenophylla* (Prober & Thiele 1995 in NSW SC 2002). These species were not recorded in grazed parts of the subject site. Suspected *Pimelea curviflora* seedlings were recorded in ungrazed woodland west of cluster 4.

Treeless examples – native pasture

The EEC determination also includes treeless areas with an 'intact understorey'. The key in the NPWS identification guidelines for the community includes treeless areas which would once have carried one of the box gum tree species and which are now 'predominantly grassy'. Subsequent DECC advice has also confirmed that secondary grassland derived from the past clearing of box gum woodland forms part of the EEC (DECC 2008a, A. Treweek, R. Rehwinkel pers. comm.).

The majority of pasture in the study area dominated by native grasses would therefore form part of the EEC. Some heavily grazed areas or sheep camps on ridge crests are dominated by exotic forbs and would be excluded from the EEC. The vast majority of native pasture in the study area, while dominated by native grasses, shows very low levels of native forb diversity (typically 1-4 species) and high levels of exotic forb cover (pasture and weed species). The relative cover of exotic annuals and native grasses varies between seasons.

Dominant pasture species typically change from *Themeda triandra* and *Poa* spp. to *Austrostipa falcata, Austrodanthonia* spp. and *Bothriochloa macra* as grazing intensity increases (Moore 1953a in NSW SC 2002). The native pasture in the study area is dominated by *Austrodanthonia* spp and *Austrostipa scabra* ssp *falcata* (syn. *A. falcata*), with occasional *Bothriochloa macra* and *Aristida ramosa,* on ridges, saddles and slopes*,* and with *Microlaena stipoides* in sheltered sites, indicating a long history of grazing. While derived from box gum woodland and technically part of the EEC, these pastures probably have limited natural recovery potential.

The 'diverse secondary grassland' recorded at potential substation sites to the west of cluster 7 may be derived from box gum woodland, although no box gum woodland trees are present at or near the site. The vegetation at this site is variably dominated by the grasses *Austrodanthonia* spp*, Themeda triandra* and *Microlaena stipoides* and, in moister seepage areas, the forbs *Isotoma fluviatilis* and *Hydrocotyle peduncularis*. The groundlayer is generally consistent with box gum woodland understorey. A 2005 survey of similar habitat on property immediately south of cluster 7 recorded species such as *Diuris* and *Thelymitra* orchids and *Bulbine bulbosa* and *Craspedia variabilis.* The ACT Lowland Woodland Conservation Strategy (ACT Government 2004) notes that these species are moderately to highly sensitive to disturbance. As well as *Craspedia variabilis,* the cluster 7 substation sites carry *Ammobium craspedioides*, which is also known to be sensitive to grazing pressure. The presence of these species in reasonable abundance at the site suggests that the soil seed bank may be intact and the site may have good understorey recovery potential. This site is considered to have high conservation value.

The indicative distribution of the EEC in the study area is illustrated in Map Set 2. An assessment of the significance of the impact of the proposal on the EEC is included in Appendix E.

Commonwealth EPBC Act

The identification criteria for the box gum woodland endangered ecological community are considerably more stringent under Commonwealth legislation. Vegetation forms part of the Critically Endangered Ecological Community (CEEC) if one of the most common overstorey species is/was Yellow Box, Blakely's Red Gum or White Box, the understorey is predominantly native, the patch is greater than 0.1 ha, and either:

a) there are 12 or more non-grass species in the understorey including at least one important species (based on a list issued by the Environment Department), or

b) the patch is greater than 2 ha with an average of 20 or more mature trees per hectare, or natural regeneration of the dominant overstorey eucalypts.

Under the diversity criterion (a), a remnant to the east of cluster 3 and much of the fenced portion on the western side of clusters 4a and 4b would be included in the listed community. A ridgeline carrying

Eucalyptus blakelyi regeneration at cluster 4a (MGA 653629 6148696) was surveyed by random meander and recorded 34 listed native non-grass species in the understorey, including 16 important species. Other survey sites within the large remnant on the western side of cluster 4 qualify as CEEC, including some stands which are now dominated in the midstorey by the small tree Allocasuarina verticillata.

The treeless diverse secondary grassland near cluster 7 supports at least 16 listed non-grass species (10 of which are important). Given its topographic position and groundlayer composition, this vegetation appears likely to be derived from box gum woodland although there are no remnant box gum woodland trees in the immediate vicinity. This site has recovery potential with the reinstatement of the tree stratum, stabilisation of soils and appropriate grazing management.

A remnant on the south-west side of cluster 6 carries similar understorey with more than 12 non-grass species including several important species, but is a regrowth stand now dominated by Eucalyptus goniocalyx (Yellow Box, Blakely's Red Gum and White Box are generally absent, but present in woodland south of the site). The understorey composition is however consistent with box gum woodland, and supports at least 22 listed non-grass species including at least 7 important species and the threatened Yass Daisy (refer Map Set 2 and quadrat data in Appendix A). Vegetation at this site may have supported box gum tree species prior to disturbance and has also been included in the Commonwealth CEEC on a precautionary basis.

Under the structural criteria (b), additional CEEC areas are present within the development envelope at cluster 4, cluster 2 and powerline routes between clusters. These woodland patches are more than 2 hectares in size and carry mature trees at a density greater than 20/hectare. The areas are grazed with generally depauperate groundcover and no regeneration.

The indicative distribution of the Commonwealth listed CEEC in the study area is illustrated in Map Set 2. An assessment of the significance of the impact of the proposal on the CEEC is included in Appendix E.

Dry grass/shrub forest types

Because of the generally high levels of native vegetation loss in the district, all dry forest remnants have at least moderate conservation value. Relatively intact samples of two dry grass/shrub forest types are present in the study area; Long-leaved Box forest on the south-west side of cluster 6 and northwest side of cluster 7, and Brittle Gum- Broad-leaved Peppermint forest in the far south of cluster 7.

The former community, VG 118 Western Slopes Dry Grass Forest under the Gellie (2005) system, intergrades strongly with box gum woodland and locally shares a similar understorey structure and floristics. Long-leaved Box is dominant on slopes at other clusters; some of these stands have been identified as box gum woodland because of this similarity in understorey and because one or more of the box gum tree species are present. VG 118 has been moderately depleted since European settlement (45% remains) and is poorly represented in the reserve system in the Southern Region. Woodland vegetation at the subject site has moderate-high conservation significance for fauna regardless of its EEC status, in view of the general depletion of grassy woodland vegetation in the region. However, the conservation value of remnants on the site is reduced by the loss of floristic and structural integrity.

The latter forest type, VG 109 Widespread Tablelands Dry Shrub/Tussock Grass Forest (Gellie 2005), is more clearly distinguished from box gum woodland on the basis of floristics. This community is present as a small stand in the south of cluster 7. The related VG 114 Tablelands Dry Shrub/Tussock Grass Forest is present as a single stand within the Marilba – Carroll's Ridge powerline envelope. Both communities have been moderately cleared but are under-represented in the reserve system, based on JANIS (1997) reservation targets.

5.3.3 Species of conservation significance

Threatened and nationally significant species

A number of threatened flora species have potential distribution ranges which include the study area. These species, their known distribution and habitat requirements and their likelihood of being present at the subject site are identified in the Threatened Species Evaluation in Appendix C. Eleven threatened species have some potential to be present at the subject site:

Yass Daisy	*Ammobium craspedioides*
Burrinjuck Spider Orchid	*Caladenia* sp Burrinjuck
Mauve Burr-daisy	*Calotis glandulosa*
Small Scurf-pea	*Cullen parvum*
Hoary Sunray	*Leucochrysum albicans*
Tarengo Leek Orchid	*Prasophyllum petilum*
Button Wrinklewort	*Rutidosis leptorhynchoides*
Woolly Ragwort	*Senecio garlandii*
Small Purple-pea	*Swainsona recta*
Silky Swainson-pea	*Swainsona sericea*
Austral Toadflax	*Thesium australe.*

Of these species, only *Ammobium craspedioides, Caladenia* sp Burrinjuck, *Swainsona sericea, Cullen parvum* and *Thesium australe* are considered to have at least moderate potential to be present at the subject site, considering site quality, disturbance history, distribution ranges and the results of the field surveys. These species have been included in the Assessment of Significance in Appendix E.

Yass Daisy (*Ammobium craspedioides*)

In surveys conducted in the Booroowa Shire to the north, all of the occurrences of this species were on land characterised by a light grazing regime (NPWS 2002). The species was recorded at clusters 4, 6 and 7 at the subject site. At each site, Yass Daisy colonies were sizeable (hundreds). The cluster 4 site is fenced and apparently ungrazed. Some Yass Daisy plants were recorded in grazed pasture at this site, but only in close proximity to colonies on ungrazed land. At clusters 4 and 6, and in the Coppabella Hills to the west, this species appears to favour sheltered south-facing slopes, although this may be the result of reduced grazing pressure on these aspects. The location of Yass Daisy records is shown in Map Set 2, and listed in Appendix A.

During an earlier survey undertaken in 2005, the Yass Daisy was also observed to be scattered in roadside remnants beside Black Range Road south of the subject site, east from GDA/MGA 661089 6143407. Some of these occurrences are recorded in the Wildlife Atlas and Bionet databases.

Burrinjuck Spider Orchid (*Caladenia* sp Burrinjuck)

This species has marginal potential habitat in dry shrub forest remnants dominated by *E. goniocalyx*, *E. dives* and *E. mannifera* at clusters 4, 6 and 7. This community is very broadly analogous to known habitats in Burrinjuck Nature Reserve to the south (NPWS 2003a), particularly the Broad-leaved

Peppermint – Brittle Gum community on sediments in the south of cluster 7. Forest remnants at the subject site north of cluster 7 occur on higher fertility volcanic substrates, rather than the infertile sediments at Burrinjuck, which may reduce habitat suitability for this species. A targeted search of the isolated cluster 7 remnant was undertaken as part of the September fieldwork. While the fieldwork was undertaken within the late August - October flowering period for this species, it may not have been flowering or recordable at the time of survey.

Silky Purple Pea (*Swainsona sericea*)

The Silky Purple Pea is an erect perennial to 10 centimetres high, flowering October-December. Potential habitat for this species exists in remnant grassy woodland understorey, particularly at clusters 4 and 7. As noted above, grazing at the subject site over many decades is likely to have resulted in a general reduction in the density of native legumes, and the loss of some grazing-sensitive species. Given the disturbance history of the site, and the failure to detect it during the survey, the chances of the species being present are probably low.

Small Scurf-pea *(Cullen parvum*)

The Small Scurf-pea is listed under the TSC Act as endangered in NSW. It is a small erect or trailing perennial pea with three elongated leaflets and purple-pink (or sometimes white) flowers usually also in threes, appearing in summer. Plants tend to die back over summer and resprout with rain in winter or spring; in dry years, plants apparently do not always produce shoots but survive below the ground. Flooding has been suggested as a mechanism for seed dispersal. The species is threatened by intensive grazing by stock, clearing of habitat and agricultural practices such as cropping (DECC 2008a).

Until recently the Small Scurf-pea was known in NSW from only two herbarium collections; one from Wagga Wagga in 1884 and the other from Jindera (near Albury) in 1967 (DECC 2007a). A small population was discovered in 2006 in a Box-Gum Woodland remnant at Galong, around 20 kilometres north of the proposal site (Douglas 2006). The species therefore has a potential distribution in the local area. However, the level of grazing pressure over most of the site site reduces this potential considerably. Native legumes were generally uncommon at the subject site, with low density records of *Desmodium varians* and *Glycine clandestina* from woodland and forest remnants, and rarely, native pasture. Pea shrubs are generally absent from the site. The long grazing history is the probable cause of this loss of native legumes, which are usually quite common in lightly grazed remnants of grassy woodland types.

The elevated nature of the cluster sites, the grazing history and the failure to detect it during the survey, probably makes it unlikely that this species occurs within the subject site.

Austral Toadflax (*Thesium australe*)

Thesium australe is a sprawling perennial herb growing in grassland and woodland. It is semi- parasitic on grasses, particularly Kangaroo Grass, and shows a preference for moist areas. It is found in small populations across eastern NSW, along the coast and from the Northern to Southern Tablelands. It has not been recorded in the region. The long history of grazing precludes the possibility of this species being present over the majority of the subject site. The ungrazed remnant on the western side of cluster 4 has sparse and scattered Kangaroo Grass and has some potential to support *Thesium australe*. Despite targeted searches, this species was not recorded during the field surveys.

Regionally significant species

There are a number of grassland and grassy woodland species which are of regional conservation significance due to the general depletion of these communities. These species include Zornia (*Zornia dyctiocarpa*), Australian Anchor Plant (*Discaria pubescens*), Emu-foot (*Cullen tenax*), Mountain Swainson-pea (*Swainsona monticola*), Wedge Diuris (*Diuris dendrobioides*), Purple Diuris (*D. punctata* var. *punctata*), Hairy Buttons (*Leptorhynchos elongatus*), Austral Trefoil (*Lotus australis*), Yam Daisy (*Microseris lanceolata*), *Picris* species, a milkwort (*Polygala japonica*) and Wild Sorghum (*Sorghum leiocladum*) (ACT Government 2004). These species may occur on less disturbed remnants in the Yass area, but none were recorded within the subject site.

Several grassy woodland species were recorded which may also be declining in the region along with grassy woodland habitat. These species were recorded in Box Gum Woodland remnants (cluster 4) and diverse secondary grassland (cluster 7) and include the Chocolate Lily (*Dichopogon fimbriatus*), Vanilla Lilies (*Arthropodium milleflorum* and *A. minus*), Milkmaids (*Burchardia umbellata*), Early Snake Orchid (*Diuris chryseopsis*), Onion Orchid (*Microtis unifolia*), Scaly Buttons (*Leptorhynchos squamatus*), Austral Sunray (*Triptilodiscus pygmaeus*), New Holland Daisy (*Vittadinia cuneata* and *V. muelleri*), Billy Buttons (*Craspedia variabilis*), Blue Heron's Bill (*Erodium crinitum*), Native Flax (*Linum marginale*), Tick Trefoil (*Desmodium varians*) and Australian Bindweed (*Convolvulus angustissimus*). Most of these species are listed as important species belonging to the box gum woodland community by the Commonwealth Environment Department (DEH undated).

6 FAUNA

6.1 METHODS

6.1.1 Preliminary assessments

A preliminary assessment of fauna habitat values and the likelihood of threatened fauna species being present was undertaken based on species distribution records and known habitat requirements. Online databases were interrogated and the results of previous fauna survey work in the region were reviewed for threatened fauna records (refer section 6.3.1).

6.1.2 Field survey

Survey timing

Following an initial reconnaissance on 1-3 September 2008, the main survey work was carried out for diurnal and nocturnal vertebrates and their habitats on 16-22 September 2008. The survey was undertaken by Jim Reside and Steve Coulson, fauna specialists engaged by **ngh**environmental. Follow-up visits occurred on 9 November (habitat assessment), in January 2009 (microbat and nocturnal survey – reported separately) and March 2009 (habitat assessment). Cluster 7 was surveyed as part of an earlier superseded proposal on 26-28 March 2007.

Survey methodologies and effort

Survey effort targeted habitats within and adjacent to the development envelopes of the proposed turbine ridges and associated electricity and road infrastructure. Within the development envelope, surveys were stratified by habitat and vegetation type (box gum woodland, Long-leaved Box forest, Brittle Gum – Broad-leaved Peppermint forest, native pasture and wetlands) and landscape position (ridges, slopes, flats, gullies) to ensure that the assessment covered the diversity of habitats that would be directly or indirectly impacted by the proposal.

All vertebrates and their habitats were surveyed, however priority was given to areas considered most likely to provide habitat for threatened fauna. Standard survey methods were employed including mammal trapping, nocturnal survey, bird, reptile and frog survey, Anabat recording and habitat assessment. Survey sites are indicated in Map Set 1.

Trapping

Trapping targeted small and medium-sized mammals, including the threatened Squirrel Glider and the Spotted-tailed Quoll. Trapping studies aim to provide information on the diversity of small mammals on the site, which reflects overall habitat quality and the availability of prey for larger carnivorous species such as forest owls and raptors. Mammal trapping was undertaken in large woodland remnants at cluster 4a and 4b, and in dry forest remnants and a cleared drainage line at cluster 7.

The trapping survey effort was biased toward larger, less disturbed woodland and forest remnants. Formal habitat evaluations were used to assess the potential for other parts of the subject site to support mammal fauna.

Bird census, reptile survey, frog censuses and habitat assessment

Bird censuses and general habitat assessments were undertaken at and near most clusters within representative areas of all vegetation, habitat and landform types. Reptile searches (rock and log rolling) were undertaken where suitable habitat (rocky outcrops and woodland) was present at clusters 1, 6 and 7, sampling a range of aspects. Reptile surveys targeted ridges and upper slopes within the nominated development envelope, and were also conducted opportunistically on lower slopes and valleys in suitable habitat. Reptile habitat assessments were conducted on rocky outcrops to assess their potential to support threatened reptile species.

Frog censuses and aquatic habitat assessments were undertaken in representative examples of riparian corridors, drainage lines and farm dams to identify the diversity of frog species present and the condition and quality of these habitats. Frogs species were also recorded during spotlighting surveys.

Habitat assessments considered vegetation composition and structure, disturbances, potential for threatened species habitat and fauna sign.

Nocturnal surveys

Nocturnal surveys targeted nocturnal bird and mammal species. The surveys commenced with call playback of the threatened Powerful Owl, Masked Owl, Barking Owl and Squirrel Glider and were followed by foot-based or vehicle-based spotlighting traverses. Microbat echolocation recording was conducted in two locations at cluster 7 during the March 2007 survey of this part of the subject site. Microbats were recorded at cluster 4, a lower slope east of cluster 4 and in a roadside lowland woodland remnant on Illalong Road during the September 2008 survey. Further microbat recording and trapping was conducted in January to ensure surveys coincide with microbat activity periods.

Opportunistic records

Searches for fauna, fauna sign and key habitat features were conducted opportunistically whilst conducting other surveys.

The overall survey effort is summarised in Table 6.1 and illustrated in Map Set 1. Fauna survey effort details, survey location and results data are presented in Appendix B.

Table 6-1 Summary of fauna survey effort

SURVEY TYPE	DESIGN	LOCATIONS	TOTAL SURVEY EFFORT	TARGET SPECIES
Ground Elliot trap (A)	March 07: 100 trap nights over 3 transects Sept 08: 116 trap nights over 3 transects Bait – rolled oats, peanut butter and pistachio essence	Cluster 7 – 2 forest remnants and cleared gully line Cluster 4 - woodland remnants	216 trap nights	Small mammals (Antechinus species and rodents) Target threatened species: diversity and abundance of prey for carnivorous species including Large forest owls, Spotted-tail Quoll and raptors (such as the Square-tailed Kite)
Cage trap transects	**March 07:** 24 trap nights over 3 transects Bait - peanut butter, rolled oats, cat food and honey	Cluster 7 – 2 forest remnants and cleared gully line	**Mar 07:** 24 trap nights	Medium sized animals (quolls, bandicoots and potoroos, reptiles) Target threatened species: Spot-tailed Quoll
Bird censuses	Species seen and heard were recorded. Surveys involved spot surveys and transects through representative habitats. The height of individuals was recorded when observed flying above 30m from the ground. If species were observed to be flocking, the number of individuals in each flock was recorded.	Surveys were undertaken in representative areas of all vegetation, habitat and landform types.	**Mar 07:** 8 transects of 30 minutes duration (total 4 person hours) **Sept 08:** 9 transects of 20 person minutes duration (total 3 person hours)	All avifauna. Surveys focused particularly on threatened and migratory birds, raptors, flocking species and wetland birds
Reptile searches	Rocks were rolled and the soil raked with a hand rake. A variety of slope aspects and disturbance regimes were surveyed.	Representative reptile habitat was surveyed. Searches focused on ridge and slopes with extensive rock outcropping, however woodland, leaf litter, hollow logs, tussocks, and sheets of metal were also searched.	**Mar 07:** 3 surveys of 30 minutes duration **Sept 08:** 14 surveys of 20-80 minutes: 465 person minutes	All reptile species. Particular focus was given to potential habitat for threatened reptiles *(Delmar impar, Aprasia parapulchella*)

SURVEY TYPE	DESIGN	LOCATIONS	TOTAL SURVEY EFFORT	TARGET SPECIES
Nocturnal survey (Frog census, spotlighting)	Riparian sites (creek lines and drainage lines) and dams were visited and frog species were identified by call. Spotlighting was preceded by playback of Powerful Owl, Masked Owl, Barking Owl and Squirrel Glider calls. Calls of each species were played for 2.5 - 5 minutes. Listening for responses was carried out for an additional ten minutes. Spotlighting was conducted from vehicle and on foot using hand-held 12v 50w spotlights. Foot-based transects were a minimum of two persons for 15 minutes in duration.	Ridge crest, drainage line and lowland woodland remnants and associated aquatic and riparian habitats. **Mar 07:** riparian and lowland woodland, ridge forest remnants **Sept 08:** riparian and lowland woodland, ridge crest and saddle woodland, riparian woodland below ridgeline	**Mar 07:** 4 surveys of 45-75 minutes duration (240 minutes) **Sept 08:** 4 surveys of 14-110 minutes duration (194 minutes)	Threatened nocturnal bird and arboreal mammal species (Powerful Owl, Masked Owl, Barking Owl and Squirrel Glider) All frog species.
Microbat echolocation call (Anabat)	The September Anabat survey timing was not optimal – follow-up surveys undertaken in January 2009 (reported separately).	**Mar 07:** ridge dam site, forest remnants and lowland woodland remnant **Sept 08:** saddle dam and lowland woodland sites	**Mar 07:** 3 nights (12 hrs/night) **Sept 08:** 3 nights (12 hrs/night)	Microbats, including threatened species.
General habitat assessment	A standard assessment form was used to record habitat and vegetation type; habitat structure, condition and disturbance; important habitat features and resources; and quality of habitat for threatened fauna species. Edited examples of habitat survey forms are is provided in Appendix B.	Habitat assessments were undertaken at all clusters in representative areas of all vegetation, habitat and landform types.	17 sites	All fauna species and their habitats
Opportunistic records	All opportunistic records of fauna were recorded. Searches for signs of fauna presence and use of the habitat were also carried out opportunistically in the course of other surveys.	Various, at all clusters	119 observations	All fauna species, with particular focus on vulnerable bird species.

6.1.3 Mapping

Fauna habitat types were identified from habitat assessments and vegetation surveys conducted in the study area. The spatial extent of these habitats was mapped using habitat point data collected using hand-held GPS receivers (GDA 94) which were projected onto aerial photographs of the site using ArcGIS. Habitat areas within and adjacent to the development envelope were then extrapolated using the aerial photographs and were based primarily on tree cover and the location of rocky outcrops and water features.

6.1.4 Threatened and significant species

Threatened and migratory fauna declared under the TSC Act and the EPBC Act recorded or predicted to occur from the region were identified using previous survey records and online database search tools. Following the field surveys, risk assessments were compiled to determine the potential for threatened and migratory species to be present at the subject site, and the risk to these fauna from the impacts of the wind farm proposal. Species either recorded during the surveys, with potential to be present and with potential to be impacted by the proposal have been included in the Assessments of Significance (Appendices E and F). Where relevant, specific mitigation measures have been developed to reduce impacts to these species (refer chapter 8).

6.1.5 Survey limitations

Survey extent

The surveys covered the proposed development envelope as well as key habitat areas in the wider study area. The large size of the subject site (nearly 3 hectares), together with access difficulties limited the comprehensiveness of the survey in terms of areal coverage. Nocturnal survey was particularly restricted by access across the site. However, all habitat types have been included in representative and replicated fauna survey sites, and the highest quality habitats have been included in the survey. It is therefore considered that fauna survey will have adequately sampled the full range of habitats and species at the subject site, within the practical limitations of the area, access and time.

Survey timing

The limited duration and intensity of the surveys may have resulted in the omission of some sparsely distributed, ephemeral or seasonal species. For example, some occasional wetland bird species which visit small dams and watercourses at the site are likely to have been omitted.

The autumn timing of the March 2007 fauna survey of the cluster 7 site, following a dry summer and extended period of drought is likely to have affected fauna distribution and abundance records. The survey is likely to have been too early for the winter immigrant species such as the Swift Parrot, and winter emigrants such as the Superb Parrot may have left the study area. The dry conditions are likely to have depressed food resources available from local eucalypts; many trees were seen to be dying back and coppicing during the survey. The restricted aquatic resources available from farm dams and watercourses will also have been further reduced by the drought.

The cool conditions during the September 2008 survey was not optimal for recording frogs, reptiles and microchiropteran bats which are generally less active in the cooler months. To address this limitation, additional surveys were conducted January 2009 and focused specifically on microbats and other nocturnal species. This survey coincided with the dispersal of cave-dwelling bats for known roost sites (including as the Eastern Bent-wing Bat).

Mapping

Fauna habitat mapping was conducted by field data extrapolation using aerial photographs. Given the scale of the site, not all areas could be ground-truthed or included in the field survey. The habitat mapping can therefore only be considered to be a general representation of the vegetation composition on the site. A precautionary approach has been used where classification of habitat types is uncertain.

Threatened species

Threatened species were assessed for their potential to occur based on the habitat available, known habitat requirements and known distribution records. A precautionary approach to the assessment of impacts to threatened species has been adopted, as these species are often cryptic, sparsely distributed and difficult to survey, and distribution and habitat information is frequently incomplete or uncertain.

6.2 ASSESSMENT AND SURVEY RESULTS

Survey weather conditions

The weather during the March 2007 survey was calm, cloudy and mild (to 22°C) during the day, and partly cloudy, cool (10-12°C), calm with a near-full moon at night. During the September 2008 survey, the weather was variable, ranging from very warm and sunny to cold days and nights. Wind speeds were also variable for the duration of the survey (refer Table 6-2).

Three nights were spent spotlighting for nocturnal fauna. The first two nights (17 and 18 September 2008) were cool (ranging from -1 to 15.8°C over the two days), although fine with light winds from the south-west. The third night was warmer (ranging from 6.3-24.5°C), conditions were calm and fine. On all survey nights the moon was bright (full moon on 15 September 2008).

Daytime conditions were generally fine, warm and sunny (maximum 24.5°C on 19 and 20 September), with moderate to fresh easterly winds developing on 19 and 20 September.

Recent rains had provided good local conditions for wetland birds and frogs; however conditions were not optimal for bat detection. The warm, sunny weather which prevailed over the early part of the survey was favourable for reptile observation.

Table 6-2 Weather conditions during September 2008 survey

Summarised information from the Yass (Linton Hostel) Bureau of Meteorology weather station

Date	Minimum temp. (°C)	Maximum temp. (°C)	Rainfall (mm)	9am			3pm		
				Cloud amount (oktas)	Wind direction	Wind speed (km/h)	Cloud amount (oktas)	Wind direction	Wind speed (km/h)
16/09/2008	4.8	11.1	2.2	6	W	33	6	WSW	37
17/09/2008	-1	15.8	0	2	SW	4	3	SW	4
18/09/2008	0.5	19.5	0	6	SW	4			
19/09/2008	6.3	24.5	0	0		Calm	1	NW	22
20/09/2008	8.5	24	0	3	E	22	0	E	37
21/09/2008	4.5	20	0	1	NW	20	1	W	26

6.2.1 Fauna habitats in the study area

The study area provides a variety of habitat resources to fauna. The type and quality of these resources present in any one location is related to variable factors such as the disturbance history (grazing, clearing and weed invasion), vegetation composition and structure, topography and seasonal and climatic variables.

Five broad fauna habitat types were identified across the study area:

1. box gum woodland and Long-leaved Box forest (variable age structure and condition)
2. dry grass forest
3. native pasture (variable diversity and exotic component)
4. wetland and riparian habitats (seepages, creeks, dams and drainage lines)
5. rock outcrops.

These habitats in the study area are shown in Map Set 3. Habitat evaluation data are provided in Appendix B. The area of habitat types within the development envelope is given in Table 6.1.

1. Box gum woodland and Long-leaved Box forest

Description and location

- Box gum woodland habitat is present at or near all of the clusters and along the proposed powerline routes. Remnant size varies from a few trees to around 150 hectares at cluster 4. As well as valleys, remnants occur on ridges and slopes, particularly southerly aspects. They are generally highly fragmented, and separated by cleared valley lowland pasture areas.
- Tree canopy cover ranges from 10% in disturbed stands, 20-30% in mature stands and over 50% in regrowth or regenerating stands. Tree age classes include sapling regeneration (uncommon, eg cluster 4b), even age young mature regrowth with few hollows (eg cluster 6), and scattered old growth paddock trees with medium and small hollows. These latter trees are usually dieback-affected (eg cluster 1).
- Groundcover in some discrete ridge crest areas are dominated by exotic weeds (sheep camps), but most sites have groundcover dominated by native grasses with few native forb species. Exceptions occur at clusters 3, 4 and 6 trees where a higher diversity native groundcover is present. At all sites, shrubs are either very sparse or totally absent.

Habitat values

- Most of the hollow-bearing trees occur in heavily disturbed ridge crest stand or as isolated paddock trees. Many of these isolated trees appear too stressed to reproduce and in many cases there is no evidence of flowering and fruiting.
- Regrowth stands have fewer hollows but higher crown cover, and higher floristic and structural diversity. The paucity of hollows and fragmentation of woodland at the subject site reduces the likelihood of less-mobile hollow-dependent species such as the threatened Squirrel Glider being present.
- The better quality stands provide habitat for woodland birds, including the threatened Speckled Warbler and Diamond Firetail and terrestrial fauna such as ground-dwelling mammals and reptiles. This habitat recorded the highest bird diversity at the subject site.

2. Dry grass forest

Description and location

- This habitat occurs mainly in a single remnant dry grass forest patch dominated by Brittle Gum and Broad-leaved Peppermint in the far south of cluster 7, on lower fertility sedimentary geology. This forest is young mature regrowth, with mid-dense crown cover (up to 50%), very few shrubs, and a low diversity groundlayer dominated by native tussock grasses (such as *Joycea pallida*). Older trees with hollows are scattered in the stand, but not common.
- This habitat type is rare at the subject site, and generally absent on the higher fertility volcanic soils at cluster sites north of the highway. The stand is fenced but has been grazed in the past.

Habitat values

- This dry forest patch is better suited to forest rather than woodland fauna. Woodland birds dependent on box nectar, open vegetation structure or diverse, productive groundcover are not likely to use this habitat. Forest canopy bird species and the Yellow-footed Antechinus were recorded in this habitat.

3. Native pasture and ridges

Description and location

- This is the most common habitat type within the development envelope. It encompasses all areas with no or low tree cover and is generally derived from box gum woodland (with the exception of southern parts of cluster 7).
- Most areas are dominated by native grasses, with forb component dominated by exotic weed and pasture species. Some restricted areas have higher native forb diversity, usually in proximity to better condition woodland. All pasture areas were affected by grazing at the time of the survey.

Habitat values

- Because of the level of grazing at the subject site, native pasture provides limited shelter value and nest site opportunities for most fauna. The native grasses and forbs (and some exotics) provide food resources for herbivorous mammals and seed-eating birds. Native pasture close to getter quality woodland remnants is likely to be used by woodland birds, including the threatened Diamond Firetail and Speckled Warbler.
- Many of the ridge crests carry dead trees, stumps and logs which provide potential nest sites and shelter for birds, reptiles and microbats, and vantage points for raptors and woodland birds. Anthropogenic habitat resources are present at the site, including old fence posts and building materials, which provide shelter habitat reptiles. Rocky outcrops are also generally located in native pasture (refer below).
- Open pasture areas also represent prime hunting areas for raptors such as the Wedge-tailed Eagle (which feed primarily on the rabbit populations which live and feed in pasture areas). The ridges produce updrafts and thermals used by raptors for soaring, hunting and courtship displays.
- Isolated paddock trees in pasture areas are often the oldest trees in the study area, with small to large hollows. These trees are likely to be used by hollow-nesting birds (including the threatened Superb Parrot) and microbats. They are generally located in lowland areas outside the development envelope.

4. Wetland areas, seepages, dams and watercourses

Location and description

- Numerous small dams are present at and around the subject site. There is generally little or no aquatic vegetation and water quality is poor. Dams in the lowland areas tend not to retain water for long periods (Keith Smith, 'Ryalla' manager, pers. comm.).
- There are no permanent watercourses at the subject site. An intermittent watercourse with pools and rock bars runs between clusters 5 and 6. Drainage lines in the study area are often incised and without riparian vegetation. Low gradient watercourse pools in lowland areas have reed and sedge vegetation.
- Illalong Creek, 3 kilometres to the west of the site, is a permanent watercourse supporting aquatic and riparian vegetation under an intermittent River Red Gum canopy.
- Some pasture slopes adjacent to the subject site are seasonally wet and carry a range of moisture-loving plant species (particularly south of cluster 6 and south of cluster 7).

Habitat values

- Waterbodies and watercourses at the subject site are small, degraded and mostly ephemeral, and are not likely to provide sustained habitat for waterbirds.
- Better quality aquatic habitat is present in lowland areas around the subject site, particularly creek pools. These habitats are likely to support a range of frog and reptile species, and provide nest sites for bird such as the Clamorous Reed Warbler and forage opportunities for waterbirds such as Herons and Ibises.
- Dams and creek pools also provide forage habitat for microbats, including the threatened species such as the Eastern Bent-wing Bat and Large-footed Myotis.

5. Rock outcrops

Description and location

- Surface rock is present at all of the clusters, generally on volcanic geology. In most areas, rock is either massive and deeply embedded or scattered small surface rock. Some sites (notably cluster 2 and 4) have areas of surface rock fragments in a range of sizes.
- Most sites, outcrops occur on ridge crests and slopes in pasture, in both exotic and native groundcover. At cluster 4, outcrops occur in remnant woodland.

Habitat values

- These outcrops provide shelter and basking habitat for reptile species in particular. Threatened species such as the Striped Legless Lizard and the Pink-tailed Legless Lizard use rock outcrop microhabitats; however, these species were not recorded at the subject site, the site provides only very marginal habitat and the proposal presents a low risk for these threatened reptiles.
- Reptile habitat assessments and reptile searches targeted this habitat type.
- Crest areas dominated by exotic forbs such as thistles and nettles are less likely to support reptile species because of the dense shade at ground level.

Rare or limiting habitat features

Large and intact areas of box gum woodland

Woodland habitats have been extensively cleared and modified for agriculture throughout the region. Box-gum woodland remnants occur at or near all cluster sites, usually with heavily degraded understorey. A few sites – notably clusters 4 and 6 –have regrowth stands in reasonably good condition, with a diverse grassy understorey. Some sedentary and poorly dispersing woodland bird species require large remnants to sustain a viable population. Woodland is generally heavily fragmented in the study area and large remnants are very rare. The cluster 4 remnant, around 140 ha in area, is relatively large and consequently of high conservation value. Stands combining large area, old age class trees and intact understorey are extremely rare in the region and are not present at the subject site.

Hollow-bearing trees

Mature trees with hollows provide essential habitat resource for many arboreal mammals (such as gliders, possums and bats) and birds (Gibbons and Lindenmayer, 2002). Large hollow-bearing trees have been depleted by clearing for agriculture throughout the district and are now a limiting habitat resource for dependent species.

Mature trees are generally rare across the study area and tend to occur only in disturbed lowland woodland remnants or as isolated paddock trees in lowland areas. Many of these lowland stands and trees are dieback affected, with no regeneration. Trees in larger remnant woodland and forest patches on slopes and ridge crests at the subject site are generally mature regrowth yet to reach hollow-forming age. Hollow-dependent fauna populations may be significantly stressed if the lowland trees are lost before these younger woodland remnants develop hollows.

6.2.2 Species recorded at the site

In total, 107 introduced and native vertebrate species were recorded during the surveys. This comprises 62 birds, 11 terrestrial and arboreal mammals, 12 microbats, 17 reptiles and 5 frog species. The highest fauna species richness was recorded from woodland habitats. Most species were recorded in multiple habitat types. Fauna survey and habitat evaluation data are provided in Appendix B.

Birds

Bird species recorded in the habitats at the subject included:

- Woodland patches on ridge crests and slopes: whistlers, thornbills, pardalotes, robins, fantails, cuckoos, choughs, honeyeaters, parrots, gerygones, silvereye, superb fairy wren, treecreepers and currawong. Raptors recorded in this habitat included the Brown Goshawk, Wedge-tailed Eagle and Nankeen Kestrel.
- Pasture with scattered trees on flats: open country species including raptors, pipits, parrots, crested pigeon, red wattlebird, noisy friarbird, honeyeaters, welcome swallow, tree martin, willy wagtail, weebill, kookaburra, magpie and starling.

Greatest bird richness was recorded in woodland habitats, including threatened and declining bird species (Superb Parrot, Speckled Warbler, Diamond Firetail). Two migratory bird species listed under the EPBC Act - the Rainbow Bee-eater and Satin Flycatcher- were observed in woodland at the site.

Many of the woodland bird species recorded are specialist species and were not recorded in other habitats. Woodland bird species that have been identified as declining in the wheat-sheep belt region of NSW that were recorded on the site include the Red-Capped Robin and Dusky Woodswallow, recorded in woodland habitat (Reid 1999).

On other, more disturbed sites, surveys showed that habitats were dominated by only a few generalist or aggressive species. For example, in scattered trees and small remnants the Crimson Rosella, Common Starling and Australian Magpie were more abundant than any other species, and the Galah and Sulphur Crested Cockatoo were common in cleared pasture areas over the entire site.

Raptors recorded from pasture and ridge areas at the subject site include the Brown Falcon, Nankeen Kestrel, Black-shouldered Kite, Little Eagle and Wedge-tailed Eagle. Nocturnal birds recorded include the Tawny Frogmouth and Australian Owlet-nightjar.

Waterbirds and waterbird habitats were rare at the site. The White-face Heron and Australian Wood Duck were observed in a valley in the south of the site.

Mammals

Mammals habitats at the subject site have been heavily modified by clearing, grazing and weed invasion. Woodland and forest patches are mostly young-mature regrowth and highly fragmented. Connectivity is commonly limited to scattered paddock trees and eroded drainage lines.

The mammal survey targeted microbats, and ground-dwelling and arboreal mammals in and near remnant woodland patches and creeklines. Brushtail and Ringtail Possums were the only arboreal mammals recorded during spotlighting, in lowland woodland (beside Illalong Creek and east of cluster 7), and mid-upper slope woodland (cluster 4). The Yellow-footed Antechinus was the only small ground-dwelling mammal recorded. This species was trapped in both forest remnants at cluster 7, and in 2 of 3 traplines set in the large woodland remnant at cluster 4.

The scarcity of hollows and other shelter habitat and low connectivity in many parts of the subject site is likely to be limiting the abundance of arboreal mammals. Fragmentation and grazing are known to reduce the capacity of the landscape to support small mammals (Bennett, 1990; Lindenmayer et al., 2000), and this is likely to have consequences for larger fauna (owls, quolls, foxes) that prey on these species.

Several macropod species were observed at the subject site; Eastern Grey Kangaroo, Eastern Wallaroo, Red-necked Wallaby and Swamp Wallaby. Only the Eastern Grey Kangaroo was observed in pasture habitats. Introduced fauna recorded at the site included the European Rabbit, Brown Hare, Red Fox and House Mouse, as well as grazing stock (sheep, cattle).

Local fox numbers are kept low by biannual cooperative baiting programs undertaken by farmers in the district using baits supplied by the Rural Lands Protection Board (James Payne, local landholder pers. comm.). The European Rabbit and Brown Hare are likely to be principal food sources for local Wedge-tailed Eagles.

Microchiropteran bats

12 microbat species were recorded at the subject site, with additional two species as possible records (refer Appendix B and Table 7.3). These species were identified beside dams and woodland and forest patches at clusters 4 and 7.

Many microbats forage in the forest canopy and use large hollow-bearing trees for roosting (Pennay and Freeman 2005). Many species also use multiple roosts to avoid predation and reduce parasite loads (Kunz and Lumsden 2003 in Rhodes 2006). Hollow-bearing paddock trees have been shown to provide critical roosting and nesting resources for microbats (Gibbons and Boak, 2002; Manning *et al.*, 2006).

One threatened species was identified with confidence: the Eastern Bent-wing Bat, listed as vulnerable under the TSC Act and Conservation Dependent under the EPBC Act. The threatened Large-footed Myotis and Yellow-bellied Sheathtail Bat were possible records from the cluster 4 site.

Anabat microbat call detection equipment was placed near ridgetop forest, saddle dam and remnant valley woodland habitats. The recorded habitat and call identification confidence for each species is presented in Table 7.3. The recorded diversity of microbat species may have been increased by the position of the site in an area where the ranges of coastal and western species overlap.

Calls analysis was undertaken using the latest guide to call identification (Pennay *et al*. 2004). All identified calls were ranked using a confidence rating (confident, probable, possible) (DEC 2004; Pennay et al. 2004). Where the call analysis indicates the possiblity of a threatened species, the species was assumed present in accordance with DEC guidelines (DEC 2004). Suspected threatened species calls were confirmed by Glenn Hoye and Ecotone Environmental Consultants. The threatened Eastern Bentwing Bat was recorded at the cluster 7 site to at least a 'probable' level of confidence, and at the cluster 4 site at confidence levels 1-3.

Table 6-3 Microbat call detection results

March 2007 survey – cluster 7

Species	Common name	Ridgetop forest	Saddle dam	Woodland
Chalinolobus gouldii	Goulds Wattled Bat	positive	possible	possible
Chalinolobus morio	Chocolate Wattled Bat	probable	positive	possible
Miniopterus schreibersii	Eastern Bentwing Bat	probable	possible	-
Mormopterus sp. no.4 lpf		positive	positive	positive
Mormopterus sp. no.3 spf		probable	possible	probable
Nyctophilus geoffroyi/gouldi complex	Long-eared Bat	positive	positive	positive
Scotorepens balstoni	Inland Broad-nosed Bat	positive	positive	-
Scotorepens greyii	Little Broad-nosed Bat	positive	positive	possible
Vespadelus darlingtoni	Large Forest Bat	positive	positive	-
Vespadelus regulus	Southern Forest Bat	positive	positive	-
Vespadelus vulternus	Little Forest Bat	positive	prob	-
Tadarida australis	White striped Freetail bat	-	-	positive

September 2008 survey – cluster 4 and TSR west of site

Species	Common name	ID confidence	No. records
17.9.08 – cluster 4 saddle adjacent to woodland/scrubland on upper slope, adjacent to farm dam			
Miniopterus schreibersii	Eastern Bentwing Bat	1	2
Miniopterus schreibersii	Eastern Bentwing Bat	2	16
Miniopterus schreibersii	Eastern Bentwing Bat	3	2
Chalinolobus morio	Chocolate Wattled Bat	1	1
Chalinolobus morio	Chocolate Wattled Bat	2	1
Chalinolobus morio	Chocolate Wattled Bat	3	1
Vespadelus vulternus	Little Forest Bat	2	3
Vespadelus sp.	Little Forest Bat	2	2
Nyctophilus sp. or *Myotis macropus*	Long-eared Bat	2	1
18.9.08 - Travelling Stock Reserve beside Illalong Road, on creekline flat under woodland			
Miniopterus schreibersii	Eastern Bentwing Bat	1	1
Miniopterus schreibersii	Eastern Bentwing Bat	2	3
Vespadelus regulus	Southern Forest Bat	2	1
Vespadelus vulternus	Little Forest Bat	2	3
Vespadelus sp.	Little Forest Bat	2	5

Species	Common name	ID confidence	No. records
Vespadelus sp. or Miniopterus schreibersii	Little Forest Bat	1	1
Mormopterus sp. no.4		2	1
Mormopterus sp. no.3 or 4		2	2
Mormopterus sp. no.3 or 4 or Saccolaimus flaviventris	Yellow-bellied Sheathtail Bat	1	2
Nyctophilus sp.	Long-eared Bat	2	1
Nyctophilus sp. or Myotis macropus	Long-eared Bat	1	5

Further surveys were undertaken to support a more detailed assessment of the potential impacts of the wind farm on microbat species. This assessment will be included in a specialist microbat report attached to the Yass Wind Farms Environmental Assessment (**ngh**environmental 2009).

Reptiles

Fifteen reptile species were recorded during the survey, comprising 9 skinks, 1 legless lizard, 1 gecko, 1 dragon and 3 elapid snakes. Reptile habitats present at the site include rock outcrops and woody ground debris in both pasture and woodland communities. The most commonly recorded species were the Three–toed Skink, Garden Skink, Southern Rainbow Skink and Copper-tailed Skink, recorded in both woodland and cleared habitats. Boulenger's Skink, the Marbled Gecko and the Olive Legless Lizard were recorded under rocks on ridge crests at cluster 2.

Outcropping rock and surface rock in particular is relatively common on ridge crests and upper slopes at the subject site. The quality of these habitats for reptiles is related to the extent of exotic grass and forb cover and grazing pressure. These factors have been shown to be negatively correlated with reptile diversity on rock outcrops (Fischer *et al*., 2004; Michael et al., 2008). Ridge crests were frequently the areas most heavily impacted by grazing, nutrient loading, soil erosion and weeds.

Frogs

Four frog species were recorded during the nocturnal survey at the subject site: Plains Froglet (*Crinia parinsignifera),* Common Eastern Froglet (*Crinia signifera),* Southern Banjo Frog or Pobblebonk *(Limnodynastes dumerilii)* and Spotted Marsh Frog *(Limnodynastes tasmaniensis*), in drainage line and dam habitats. These species are likely to be common and widely distributed in the region.

6.2.3 Profile of potential bird usage

The recorded abundance and diversity of birds on the cleared ridgetops of the subject site was generally low. The most commonly recorded species in these habitats were Magpies, Crimson Rosellas, Richards Pipits and Wedge-tailed Eagles. Single Wedge-tailed Eagles were observed at the site on each day of the survey, ranging 10-100 metres above the ground. During the March 2007 survey two birds were observed exhibiting possible courtship behaviour clasping talons and tumbling. During earlier surveys conducted immediately south of cluster 7, a group of five eagles were observed.

Remnant forest and woodland patches provide habitat for a wider range of species. Larger remnants, such as at cluster 4, provide habitat for species intolerant of habitat disturbance and fragmentation. Waterbodies and watercourses at the subject site are small and ephemeral, and are not likely to provide a sustained habitat for large numbers of waterbirds.

Survey data on species recorded, numbers of individuals and relevant behaviours are provided in Appendix B, and these findings are used in the risk and impact assessments.

Ramsar wetland and migratory wetland species

There are no Ramsar wetlands close to the subject site, and no large concentrations of migratory wetland species are expected to occur in the local area. Local waterbodies are small and largely ephemeral, and degraded by clearing, siltation, weeds and drought. The closest large waterbodies include Lake Burrinjuck (9km to the south), Lake Bethungra (60km to the west) and Lake George (70km south-east).

Migratory species and migration corridors

Seasonally migratory species recorded at the site include the threatened Superb Parrot, the EPBC Act–listed Rainbow Bee-eater, and woodland species such as Silvereyes and honeyeaters. Several other migratory or nomadic species also potentially use woodland and wetland habitats in the study area. Precise migratory routes are largely unknown.

Waterbirds

Daily and seasonal migration corridors for waterbirds in the study area are not known. Nomadic and migratory water birds may pass over the site during dispersal, migration between breeding and foraging grounds, or in response to seasonal availability of resources.

The subject site is not located between significant habitat areas and bird movements across the site may be diffuse and irregular, rather than concentrated and seasonal. Potential long-distance migration paths that intercept the site include east-west movements from larger wetland systems in the west to wetlands on the coast, and north-south movements between Lake Burrinjuck and Lake Cowal, Lachlan River and Lake Wyangala.

No congregations of waterbirds were recorded at the subject site during the survey, and, given the habitat scale and quality, none would be expected to occur there. The Australian Wood Duck and White-faced Heron were the only waterbirds recorded at the site during the survey.

Under suitable conditions, waterbird species such the White Ibis, White-faced Heron and ducks, would be expected to disperse to forage in farmland north of Lake Burrinjuck, including the study area. However, rather than crossing the turbine ridges, waterbirds are likely to more frequently move through valley areas between lowland dams and pools, or along watercourses such as Illalong Creek. Dams constructed in these lowland areas do not tend to hold water for long periods (Keith Smith, Manager, 'Ryalda' pers. comm.), waterbird use of these habitats is likely to be seasonal and dependent on rainfall.

White Ibises used Lake Burrinjuck, south of the subject site, for breeding until the recent drought (C. Davey CSIRO, retired, pers. comm.). With the breaking of the drought, breeding would be expected to resume and Ibis numbers in the study area may increase. Ibis and other waterbirds may travel between Lake Burrinjuck and the large waterbodies in Canberra, to the south.

Waterbirds travelling long distances from and to Lake Burrinjuck, located nine kilometres to the south of the subject site, are likely to have attained a travelling altitude greater than the turbine height. No waterbirds or migratory wetland species were assessed as being at moderate or high risk of bladestrike or habitat impacts at the Marilba Hills site (refer bird and bat impact risk assessment Appendix D).

Woodland birds

Daily and seasonal migration corridors for woodland birds and other species in the study area are not known. Most woodland passerines in the study area are likely to use habitat with at least some tree cover. Many threatened woodland species, such as the Diamond Firetail and Speckled Warbler, are poor dispersers and are unlikely to venture far from remnant woodland patches.

Superb Parrots use woodland remnants as corridors, and they avoid open areas on foraging flights (DNRE 1992), and rarely cross extensive open ground (Webster 1988, Davidson and Chamber 1992, Webster and Ahern 1992, Higgins 1999, Garnett and Crowley 2000). Research in grazing landscapes in southern NSW showed a pronounced trend for nectarivores to move along densely vegetated areas, and use the same route for return journeys (Fischer and Lindenmayer 2002a).

Woodland remnants with tree cover are present at the subject site in the form of small degraded and fragmented stands on ridges and sideslopes, separated by cleared valley areas. Woodland birds are likely to move between woodland patches in close proximity to forage and disperse, although movement ranges are likely to be limited given the extent of fragmentation.

The principal long distance flight paths for woodland species are likely to follow riparian and roadside remnant corridors, such as Illalong Road and Illalong Creek to the west, and Black Range Road to the south. Birds moving at tree canopy height through these remnants are unlikely to be affected by the wind turbines located on the cleared ridge crests.

Woodland habitat loss and fragmentation has been linked to the decline of many woodland birds, particularly species with low fecundity, poor dispersal or those that require specialised habitat resources such as hollow-bearing trees.

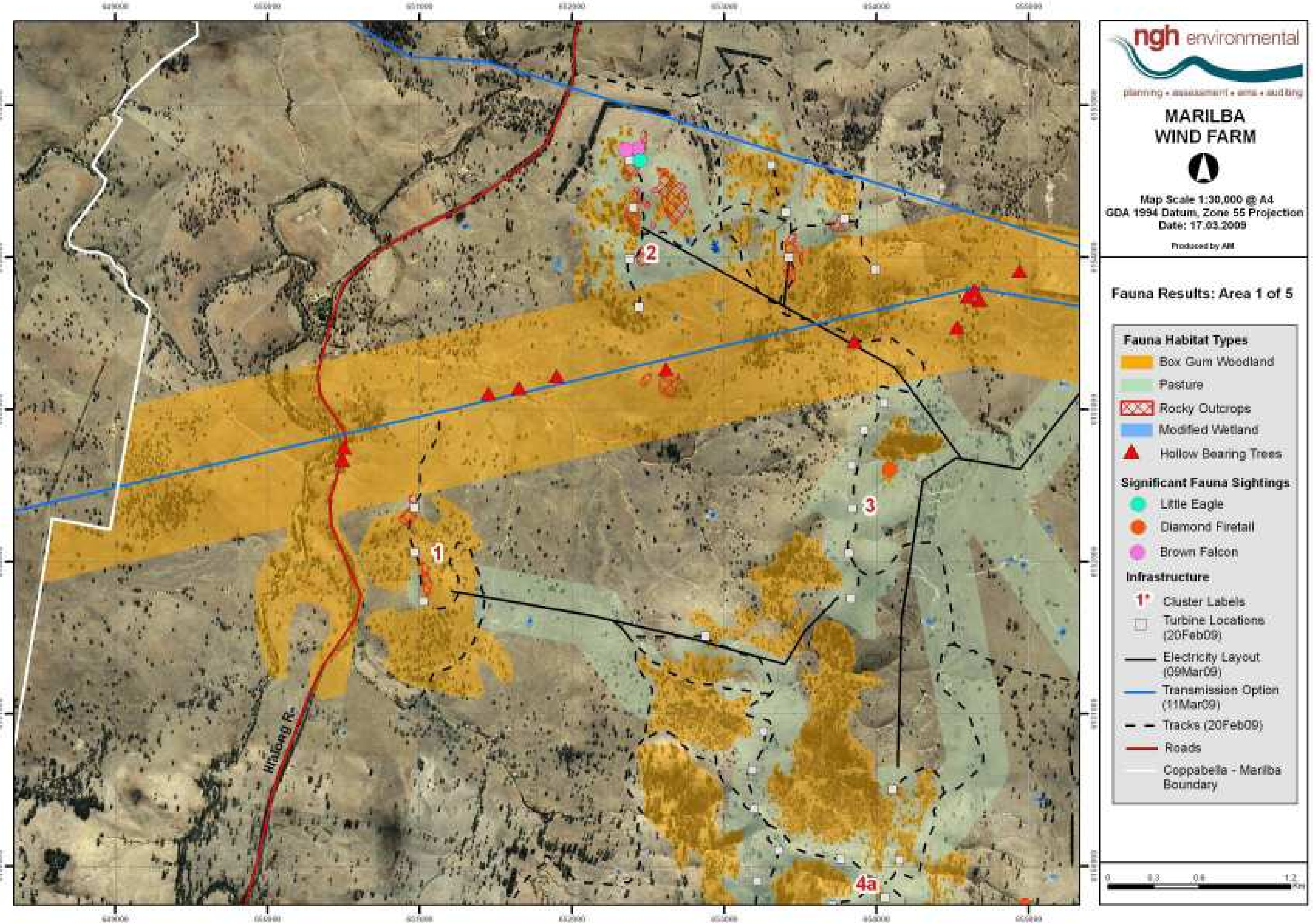
Geographical features that concentrate bird movements

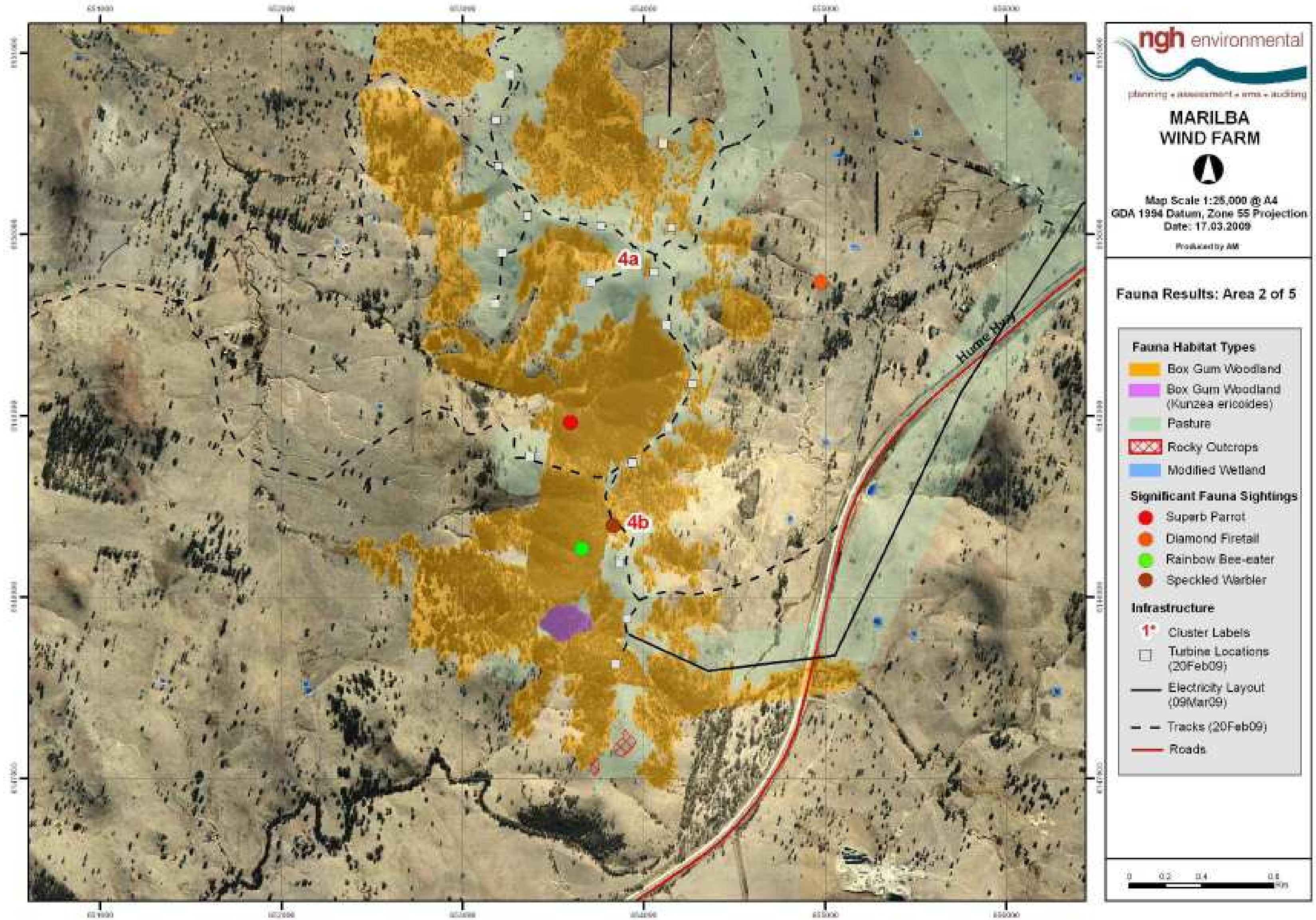
The proposal is located on a series of valleys and ridgelines oriented roughly north-south. These features may concentrate hunting and foraging behaviour for some species (particularly raptors) and dispersal movements for waterbirds.

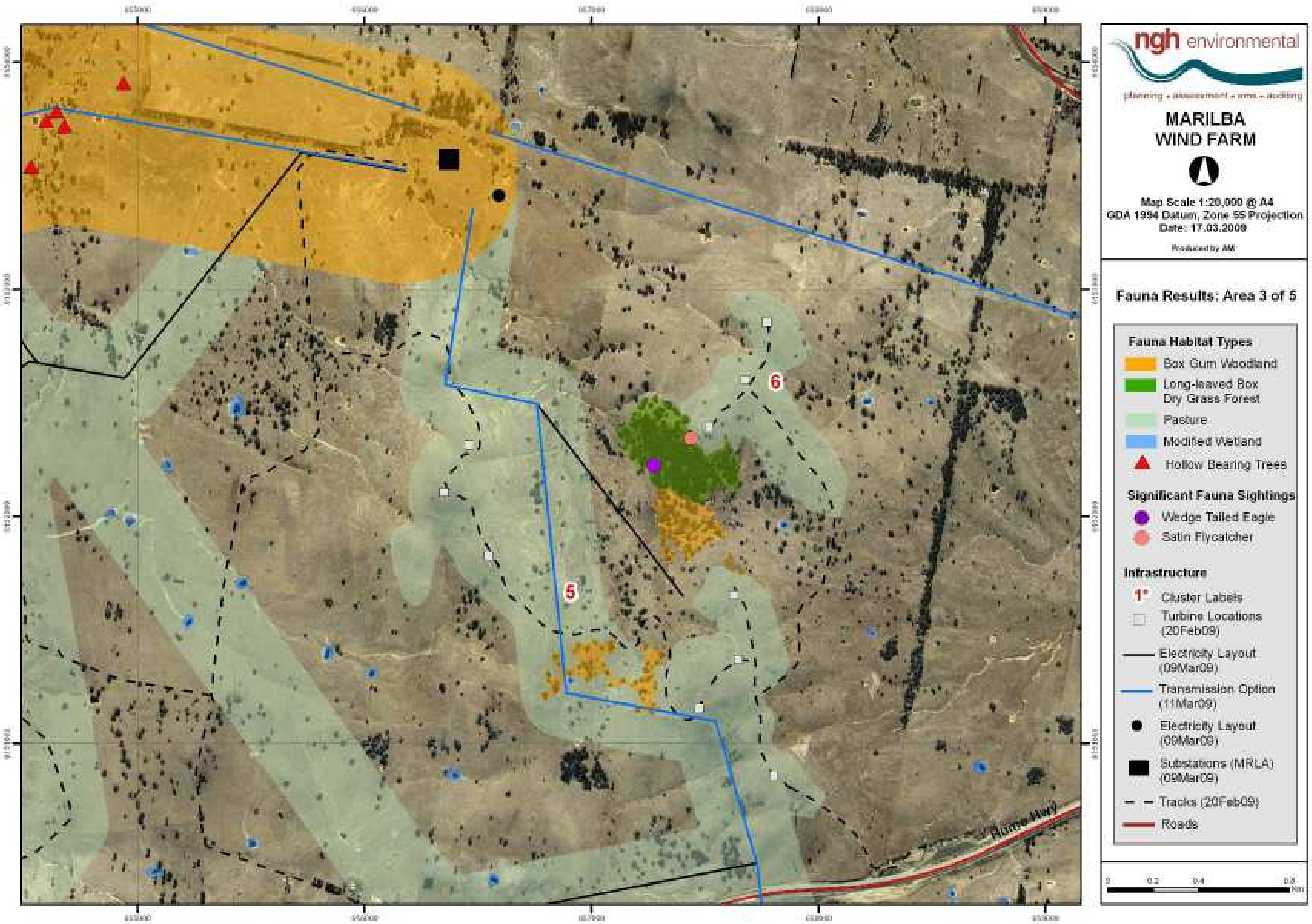
Raptors

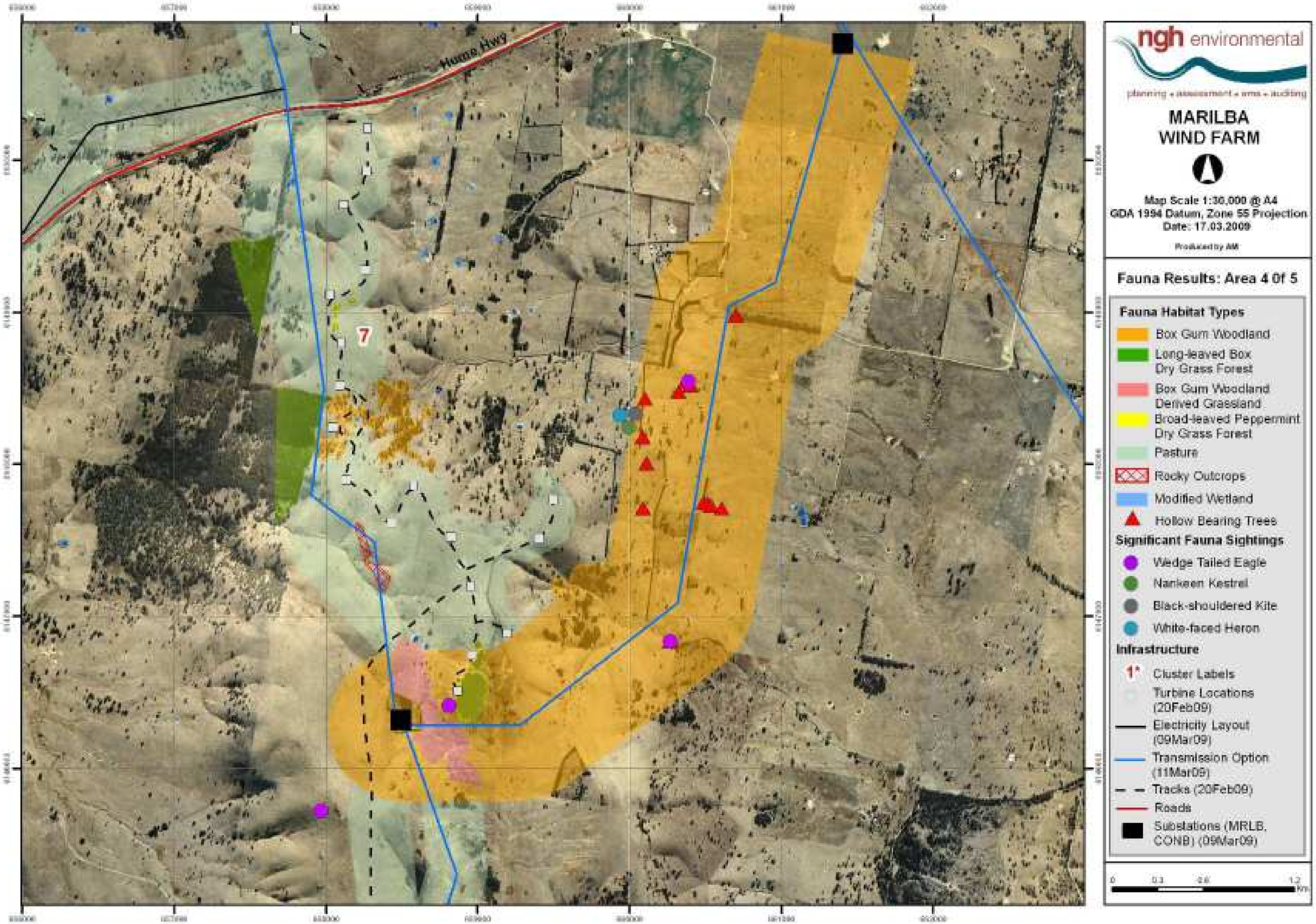
Five raptor species were recorded at the subject site – the Brown Falcon, Nankeen Kestrel, Black-shouldered Kite, Little Eagle and Wedge-tailed Eagle. These species are likely to breed locally and use open woodland/pasture areas and ridge updrafts for hunting. Rabbits are likely to provide a prime food source for larger raptor species. No confirmed raptor nests were observed at the subject site, although several stick nests were recorded (eg at cluster 7 MGA 659579 6146357) which may be used by Currawongs, Magpies or smaller raptors.

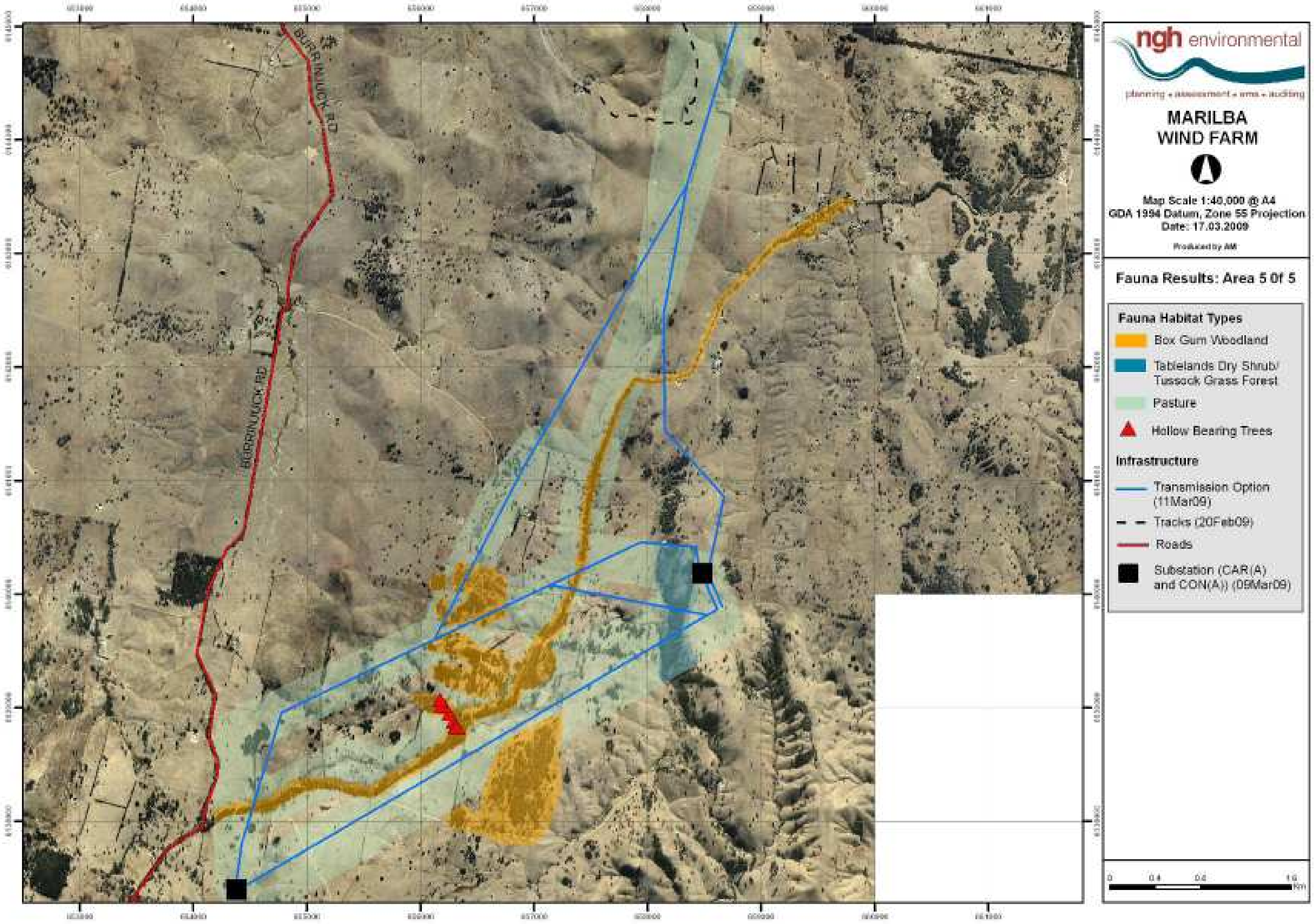
Map Set 3 – Fauna habitat and significant fauna features (5 maps in total)




ngh environmental
planning • assessment • ems • auditing
MARILBA
WIND FARM
Map Scale 1:25,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
Fauna Results: Area 2 of 5
Fauna Habitat Types
Box Gum Woodland
Box Gum Woodland (Kunzea ericoides)
Pasture
Rocky Outcrops
Modified Wetland
Significant Fauna Sightings
Superb Parrot
Diamond Firetail
Rainbow Bee-eater
Speckled Warbler
Infrastructure
Cluster Labels
Turbine Locations (20Feb09)
Electricity Layout (09Mar09)
Tracks (20Feb09)
Roads
4a
4b
Hume Hwy
0
0.2
0.4
0.8


ngh environmental
planning • assessment • ems • auditing
MARILBA
WIND FARM
Map Scale 1:20,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
Produced by AM
Fauna Results: Area 3 of 5
Fauna Habitat Types
Box Gum Woodland
Long-leaved Box Dry Grass Forest
Pasture
Modified Wetland
Hollow Bearing Trees
Significant Fauna Sightings
Wedge Tailed Eagle
Satin Flycatcher
Infrastructure
Cluster Labels
Turbine Locations (20Feb09)
Electricity Layout (09Mar09)
Transmission Option (11Mar09)
Electricity Layout (09Mar09)
Substations (MRLA) (09Mar09)
Tracks (20Feb09)
Roads
Hume Hwy
5
6


Hume Hwy
7
ngh environmental
planning • assessment • ems • auditing
MARILBA
WIND FARM
Map Scale 1:30,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
Produced by AM
Fauna Results: Area 4 Of 5
Fauna Habitat Types
Box Gum Woodland
Long-leaved Box Dry Grass Forest
Box Gum Woodland Derived Grassland
Broad-leaved Peppermint Dry Grass Forest
Pasture
Rocky Outcrops
Modified Wetland
Hollow Bearing Trees
Significant Fauna Sightings
Wedge Tailed Eagle
Nankeen Kestrel
Black-shouldered Kite
White-faced Heron
Infrastructure
Cluster Labels
Turbine Locations (20Feb09)
Electricity Layout (09Mar09)
Transmission Option (11Mar09)
Tracks (20Feb09)
Roads
Substations (MRLB, CONB) (09Mar09)
0 0.3 0.6 1.2
Km


BURRINJUCK RD
ngh environmental
planning • assessment • ems • auditing
MARILBA
WIND FARM
Map Scale 1:40,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
Fauna Results: Area 5 Of 5
Fauna Habitat Types
Box Gum Woodland
Tablelands Dry Shrub/ Tussock Grass Forest
Pasture
Hollow Bearing Trees
Infrastructure
Transmission Option (11Mar09)
Tracks (20Feb09)
Roads
Substation (CAR(A) and CON(A)) (09Mar09)

6.3 SPECIES OF CONSERVATION SIGNIFICANCE

6.3.1 Online database searches

The Commonwealth EPBC Act Matters of National Environmental Significance Reporting Tool (using a 50 km radius) and NSW DECC Wildlife Atlas database (using relevant CMA sub-regions) were used to identify threatened or otherwise significant species with potential to occur at the subject site. The results of the searches are presented in Appendix C and the Commonwealth Matters of National Environmental Significance search report is provided at Appendix G.

6.3.2 Threatened species evaluation and risk assessment

The Threatened Species Evaluation in Appendix C assesses the potential for threatened species to be present at the proposal site, based on available habitat, known ecological requirements, local distribution records and the results of online database searches. The evaluation indicates that 25 threatened or migratory fauna species have potential to be present at the subject site:

Waterbirds		
Blue-billed Duck	*Oxyura australis*	V
Raptors		
Square-tailed Kite	*Lophoictinia isura*	V
Barking Owl	*Ninox connivens*	V
Woodland Birds		
Speckled Warbler	*Pyrrholaemus saggitatus*	V
Brown Treecreeper	*Climacteris picumnus Victoriae*	V
Diamond Firetail	*Stagonopleura guttata*	V
Black-chinned Honeyeater	*Melithreptus brevirostris*	V
Painted Honeyeater	*Grantiella picta*	V
Regent Honeyeater	*Anthochaera phrygia*	E
Hooded Robin	*Melanodryas cucullata cucullata*	V
Swift Parrot	*Lathamus discolour*	E
Turquoise Parrot	*Neophema pulchella*	V
Superb Parrot	*Polytelis swainsonii*	V
Gang-gang Cockatoo	*Callocephalon fimbriatum*	V
Satin Flycatcher	*Myiagra cyanoleuca*	M (EPBC)
White-throated Needle-tail	*Hirundapus caudacutus*	M (EPBC)
Rainbow Bee-eater	*Merops ornatus*	M (EPBC)
Cattle Egret	*Ardea ibis*	M (EPBC)
Microbats		
Eastern Bentwing-bat	*Miniopteris schriebersii*	V
Large-footed Myotis	*Myotis macropus*	V
Yellow-belied Sheathtail-bat	*Saccolaimus flaviventris*	V
Arboreal mammals		
Squirrel Glider	*Petaurus norfolcensis*	V
Koala	*Phascolarctos cinereus*	V
Reptiles		
Pink-tailed Legless or Worm Lizard	*Aprasia parapulchella*	V
Striped Legless Lizard	*Delma impar*	V

These species include 15 threatened bird species - 1 waterbird, 2 raptors and 11 woodland species – and 3 microbat species. These species have been included in a preliminary risk assessment (refer bird and bat impact risk assessment Appendix D) and those species determined to be at risk from the wind farm proposal have been included in the Assessment of Significance presented in Appendix E. Three threatened woodland bird species were recorded in and near the site – Superb Parrot, Diamond Firetail and Speckled Warbler. The locations of these records are shown in Map Set 3.

7 BIODIVERSITY CONSTRAINTS ANALYSIS

7.1 APPROACH AND METHODS

An environmental constraint, for the purposes of the assessment, is an environmental condition that reduces the capability of a site to accommodate development.

The biodiversity constraints operating at the Marilba Hills subject site have been classified and mapped using a 'traffic light' model to display areas of high, moderate and low constraint.

The constraint class maps consolidate a range of significant biodiversity values to enable project planners to avoid and minimise impacts. Suggested planning responses to the three constraint classes are indicated in Table 7.1 below.

Table 7-1 'Traffic light' constraint classes and recommended planning responses

Level of constraint	Colour	Recommended response
High constraint	Red	Impacts to these areas and habitat resources are difficult to offset and should be avoided
Moderate constraint	Orange	Impacts to these areas should be avoided or specific measures taken to mitigate impacts. Losses should be offset with similar or better condition examples
Low constraint	Green	No special mitigation measures required

7.2 APPLICATION TO THE PROPOSAL

A two-stage process was used to firstly identify and map key biodiversity constraints at the Marilba Hills site, and secondly modify the proposal in response to these constraints. The final proposal is the result of numerous minor and more significant modifications, including the relocation of proposed infrastructure such as tracks, powerlines, turbines and the substation.

7.2.1 Constraining values

Biodiversity values that constrain the suitability of the Marilba Hills site for wind farm development and which have been included in the constraints mapping include:

- box gum woodland Endangered Ecological Community
    - present in a range of condition classes; **poor and poor-moderate classes without tree cover represent low constraint**, poor and poor-moderate classes **with tree cover** represent moderate constraint, moderate and good condition classes represent high constraint.
- presence of threatened flora and fauna
    - three threatened bird species were recorded at the subject site - Speckled Warbler (cluster 4), Diamond Firetail (cluster 3 and 4); and Superb Parrot (cluster 4) and one threatened plant species was recorded - Yass Daisy (clusters 4, 6 and 7)

  - woodland habitat supporting threatened species is considered a high constraint
- rare, limiting, potential threatened species habitats
  - rock outcrops, hollow-bearing trees (including dead trees) and woodland are key habitats present at the site.

7.2.2 Constraint classes

The constraining biodiversity values have been classified into the three constraint classes. Table 7.2 identifies the key biodiversity values and respective constraint class within the development envelope.

Note that the classification scale is relative, and specific to the particular combination of project characteristics and biodiversity values.

Table 7-2 Key biodiversity constraints within the development envelope

Biodiversity feature	Extent within envelope	Location	Constraint class
Vegetation types			
Box gum woodland EEC in moderate, moderate-good and good condition	527 ha with tree cover, 21 ha of diverse grassland derived from woodland	All clusters except 1. Cluster 7 has a 20 ha patch of diverse grassland derived from box gum woodland.	**High**
Box gum woodland EEC (with tree cover) in poor and poor-moderate condition	1275 ha	Cluster 1, 2 and 4. Localised patches of poor condition woodland also occur on ridge crest sheep camps.	**Moderate**
Native pasture (derived from box-gum woodland)	Total pasture: 2182 ha	The majority of cleared pasture areas at all cluster sites. While this vegetation is derived from woodland and has EEC status, diversity, integrity and habitat values are relatively low and similar vegetation is locally abundant.	**Low**
Exotic pasture and croplands	Not mapped	Occupies some lowland areas which may be affected by the powerline and access routes.	**Low**
Habitat features			
Threatened species habitat	-	Woodland remnants at clusters 3, 4, 6 and 7.	**High**
Hollow-bearing trees and mature paddock trees	Not all mapped	Present in all remnant woodland areas and as isolated living or dead trees in native pastures on ridges and in valleys	**High**
Rocky outcrops	Not all mapped	All ridge tops and side slopes within the development envelope	**Moderate**

7.2.3 Biodiversity constraint mapping

The constraint classes have been mapped for the subject site, together with the wind farm infrastructure to show areas of potential impact. The biodiversity constraint class maps are provided in Map Set 4. Constraint areas based on vegetation type and condition class have been extrapolated from survey plot data and air photographs.

7.3 PLANNING AND MODIFYING THE PROPOSAL

The constraint class maps provide a simple visual representation of areas key biodiversity values which may be impacted by the proposal. The maps also allow for the selection of alternative less constrained sites for development works.

Map Set 4 shows the main modifications to the proposal that have resulted from the constraints analysis and mapping process. Specific modifications that the proponent has made to the proposal in response to the analysis include:

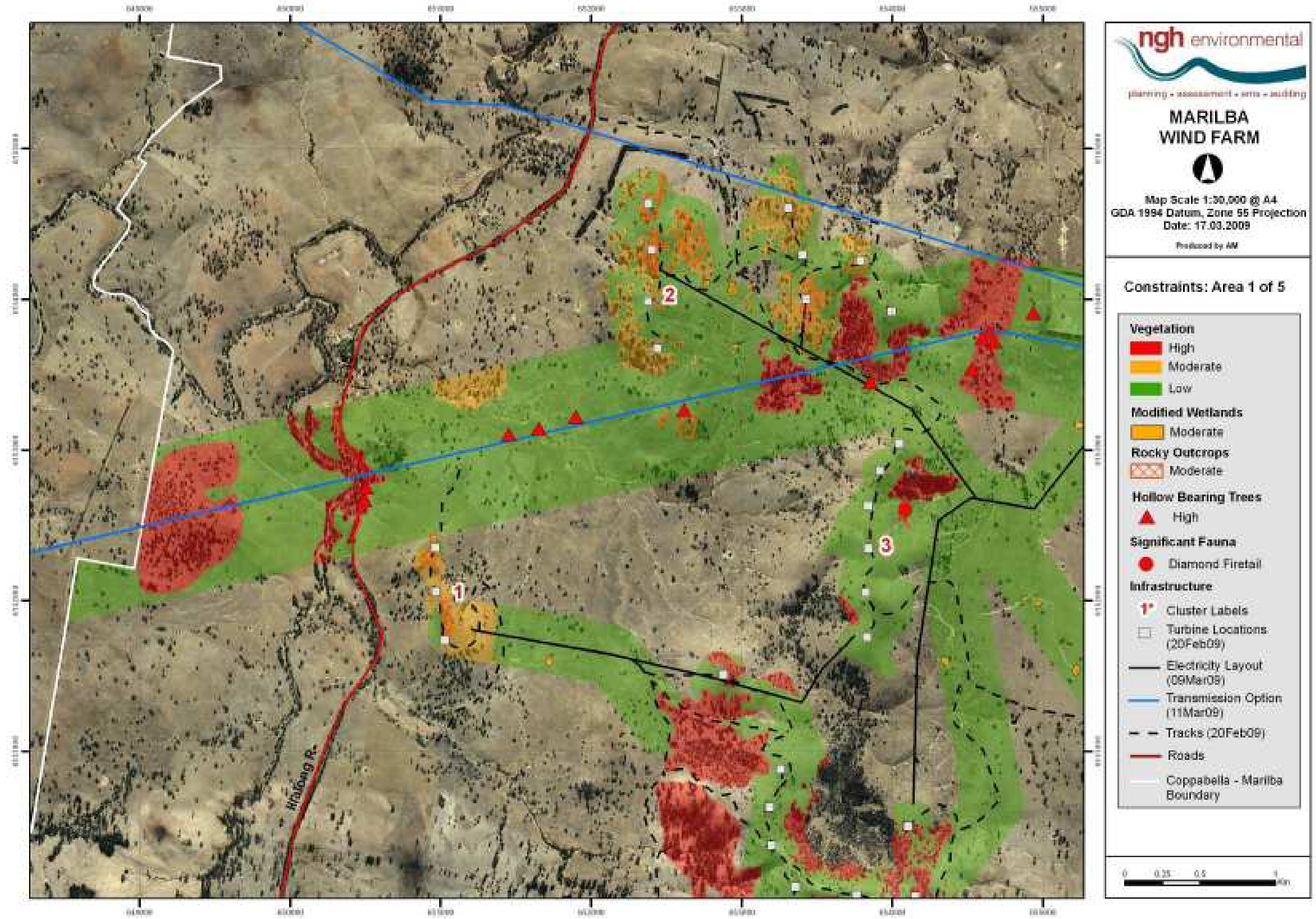
- locating the substation in cluster 7 within a disturbed treelot (low constraint) area to avoid a high constraint area (secondary grassland derived from box gum woodland, and Yass Daisy habitat)
- relocating access track routes to avoid moderate condition woodland at cluster 4a
- minimising the area of impact of turbine infrastructure at the cluster 6 site to avoid a high constraint area (box gum woodland and Yass Daisy habitat)
- modifying design and construction methods to minimise impacts to box gum woodland woodland in good condition in cluster 4b, including reducing the track width, siting to avoid the need for road battering, using the natural soil and vegetation surface, low impact clearing and trenching methods and rehabilitation with native grass species following the works
- routing the Coppabella – Marilba and Marilba – Carroll's Ridge powerline routes to avoid potential CEEC box gum woodland areas of large patch size, high tree density or with large mature or hollow-bearing trees. On the Weilora property, the route would be shifted 200-250 metres to the south to avoid CEEC areas if practicable.

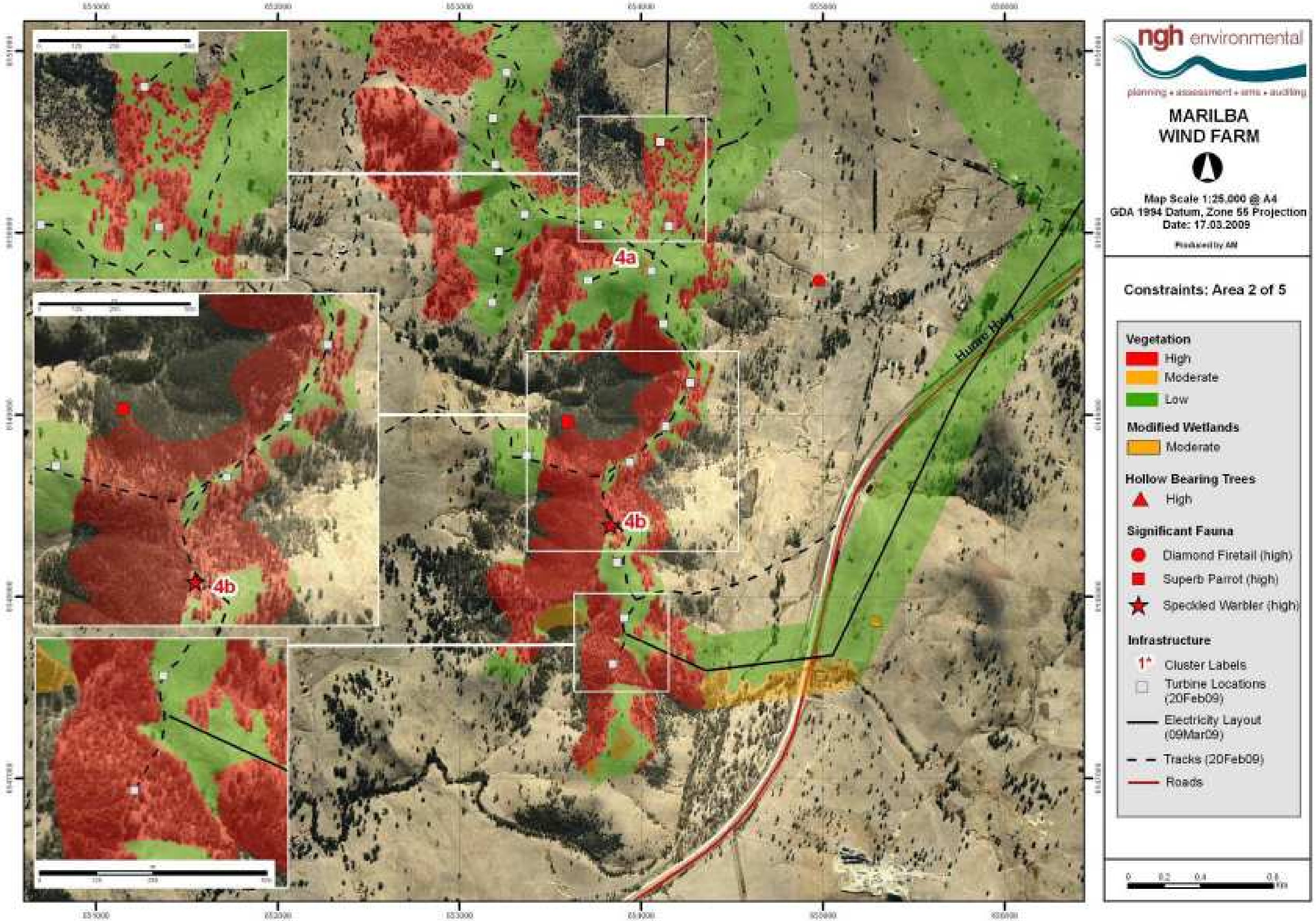
The process also highlights areas where project infrastructure would be sited close to constrained areas. These areas are indicated Map Set 4 and include:

- turbine and access track locations at clusters 4a, 4b and 7
- substation access track at near cluster 7.

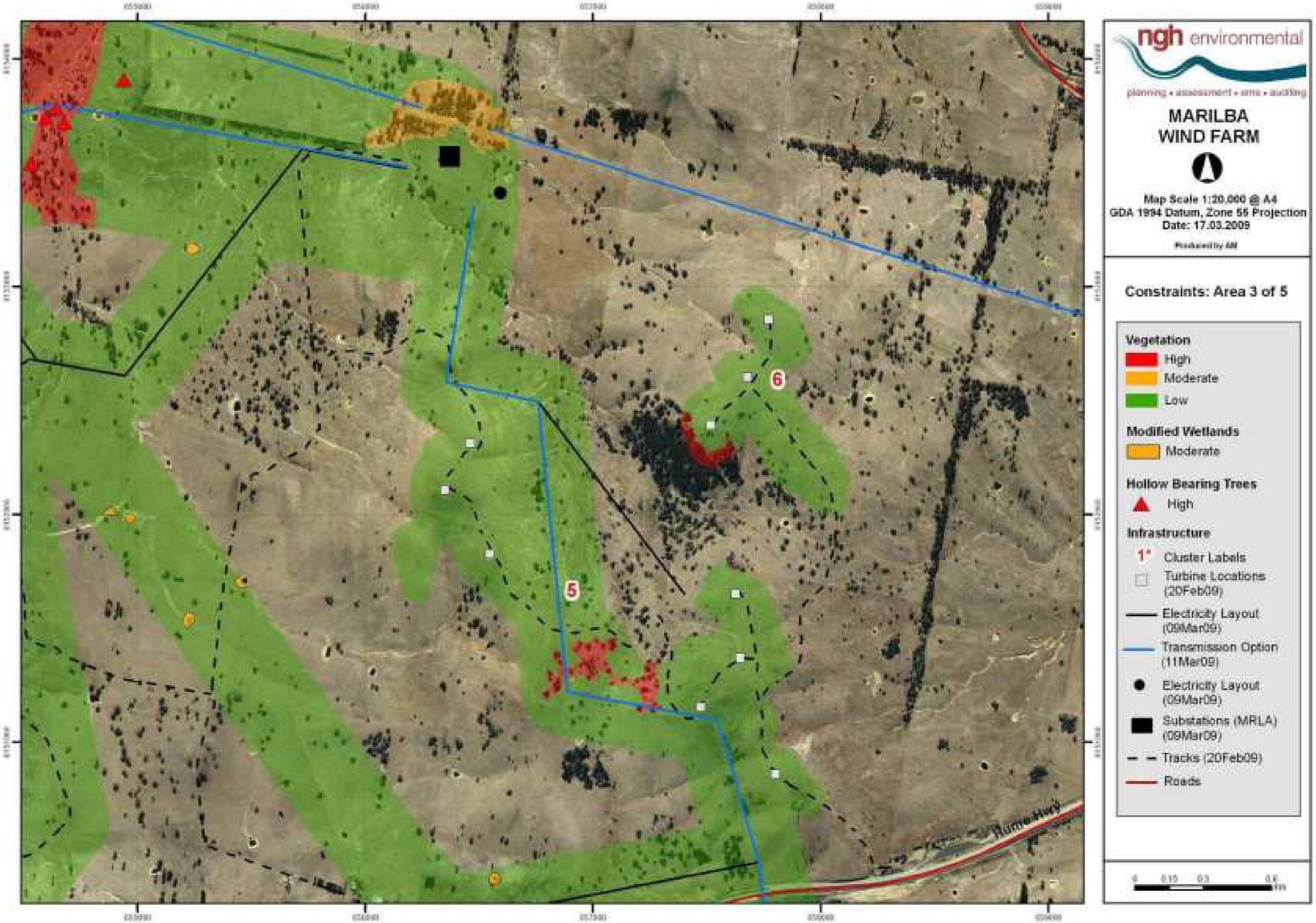
Track widths would be reduced to 4.5 metres in these areas (topography and turning requirements permitting), and an ecologist would be used in the finescale planning of the location of infrastructure (refer also section 8 mitigation measures).

Map Set 4 - Biodiversity constraint classes and project modifications (5 maps in total)





ngh environmental
planning • assessment • ems • auditing
MARILBA
WIND FARM
Map Scale 1:25,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
Constraints: Area 2 of 5
Vegetation
High
Moderate
Low
Modified Wetlands
Moderate
Hollow Bearing Trees
High
Significant Fauna
Diamond Firetail (high)
Superb Parrot (high)
Speckled Warbler (high)
Infrastructure
Cluster Labels
Turbine Locations (20Feb09)
Electricity Layout (09Mar09)
Tracks (20Feb09)
Roads
4a
4b
4b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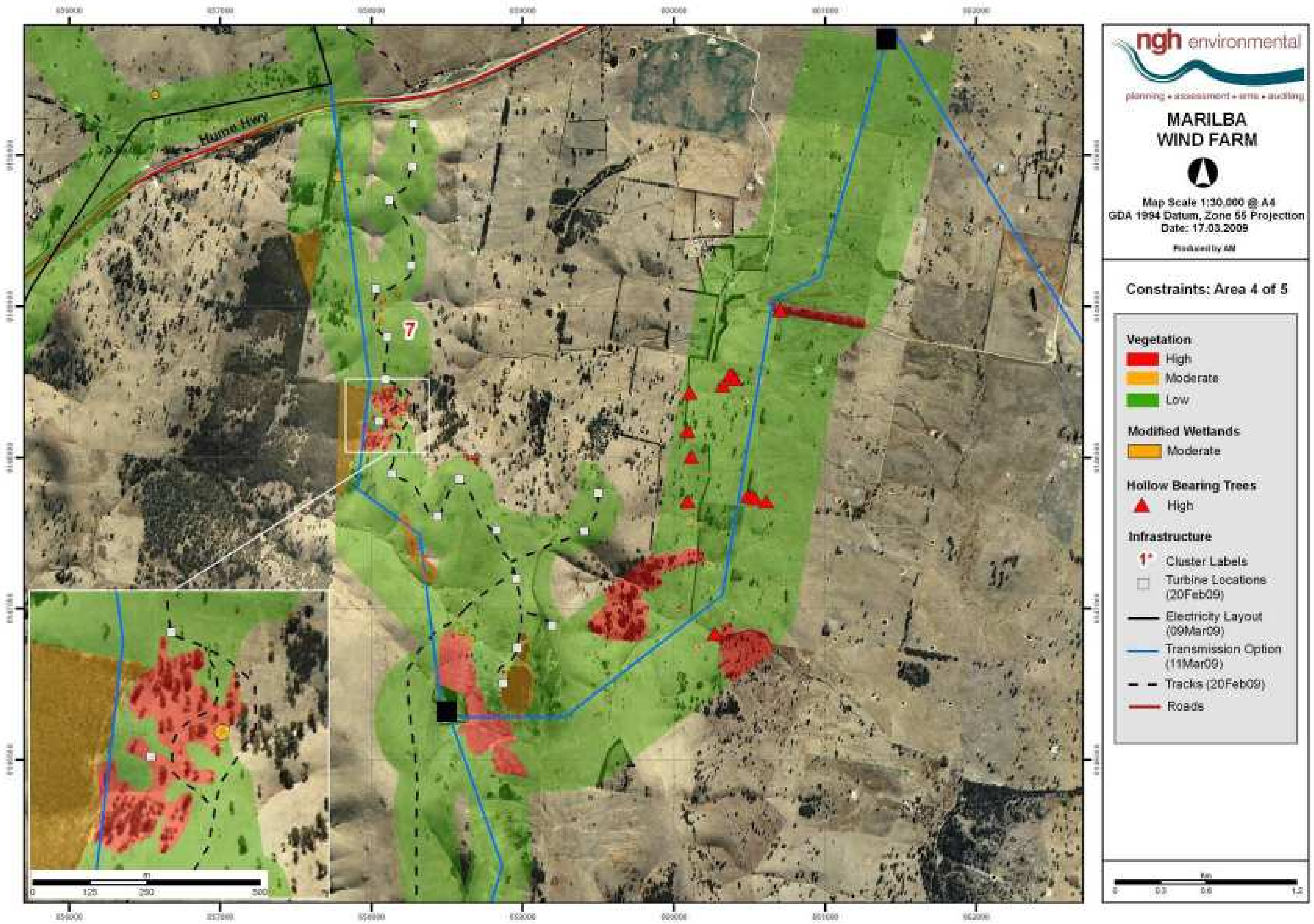
MARILBA
WIND FARM
Map Scale 1:20,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
Constraints: Area 3 of 5
Vegetation
High
Moderate
Low
Modified Wetlands
Moderate
Hollow Bearing Trees
High
Infrastructure
Cluster Labels
Turbine Locations (20Feb09)
Electricity Layout (09Mar09)
Transmission Option (11Mar09)
Electricity Layout (09Mar09)
Substations (MRLA) (09Mar09)
Tracks (20Feb09)
Roads
Hume Hwy
5
6



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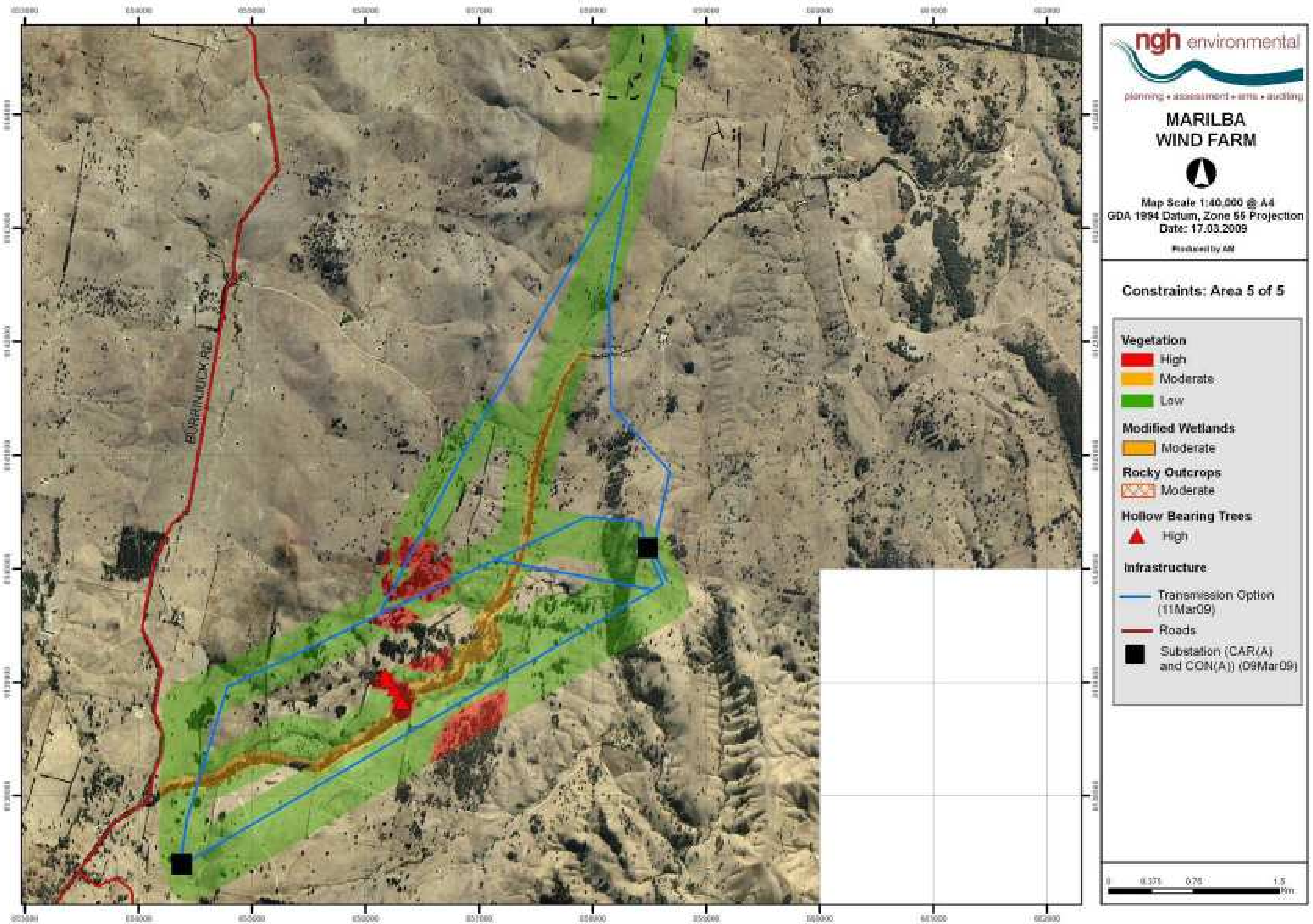
MARILBA
WIND FARM
Map Scale 1:30,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
Constraints: Area 4 of 5
Vegetation
High
Moderate
Low
Modified Wetlands
Moderate
Hollow Bearing Trees
High
Infrastructure
Cluster Labels
Turbine Locations (20Feb09)
Electricity Layout (09Mar09)
Transmission Option (11Mar09)
Tracks (20Feb09)
Roads
Hume Hwy
7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MARILBA
WIND FARM
Map Scale 1:40,000 @ A4
GDA 1994 Datum, Zone 55 Projection
Date: 17.03.2009
Constraints: Area 5 of 5
Vegetation
High
Moderate
Low
Modified Wetlands
Moderate
Rocky Outcrops
Moderate
Hollow Bearing Trees
High
Infrastructure
Transmission Option (11Mar09)
Roads
Substation (CAR(A) and CON(A)) (09Mar09)
BURRINJUCK RD
Km

8 IMPACT ASSESSMENT AND MITIGATION

8.1 CONSTRUCTION IMPACTS

8.1.1 Flora and ecological communities

Direct impacts

The proposal would result in the removal of vegetation under the development footprint, including the turbine towers and surrounding hardstand areas, control building, substation, new and widened access tracks and powerline poles. This vegetation would be removed for the life of the wind farm (up to 30 years).

Underground cabling between turbines on the ridgelines would generally follow access tracks constructed to and between the wind turbines and other facilities. The route for the main onsite construction access track was not precisely determined at the time of assessment, but is assumed to be generally contained within the potential powerline survey corridors surveyed between the turbines and the potential substation sites. The actual track routes may move outside the powerline corridors in places to achieve design requirements.

The powerline between the substation and turbines would be constructed as an overhead cable on single wood or concrete poles approximately 17-22 metres high, spaced approximately 100–200 metres apart. Some temporary disturbance to vegetation would occur during construction of the powerline, and the poles would permanently displace a small area of groundlayer vegetation at their base. The powerline would require a cleared easement of 20 metres and would be located to minimise clearing of trees. Where possible, the powerline route would avoid remnant box gum woodland, particularly large paddock trees and linear remnants beside roads and watercourses.

Grass cover may be able to be restored over much of the permanent access routes running between the turbines to assist track stability and reduce runoff. It is proposed that a concrete batch plant would be located on an existing hardstand area at the Bogo Quarry on Paynes Road.

Estimates of permanent and temporary vegetation loss for each of the affected vegetation types are presented in Tables 8.1.

Table 8-1 Impact areas per vegetation community

Marilba Hills Precinct										
Infrastructure	**Quantity**	**Width (m)**	**Length (m)**	**Area (ha)**	**P**	**BGW**	**BGBPF**	**DSTF**	**LBDGF**	**BGWke**
Turbine footing [a]	66.00	25.00	25.00	**4.13**	3.25	0.82	0.06	0.00	0.00	0.00
Crane hardstand [c]	66.00	22.00	40.00	**5.81**	4.58	1.14	0.09	0.00	0.00	0.00
Crane operation area (includes footing and hardstand) [c]	66.00	50.00	50.00	**16.50**	13.00	3.25	0.25	0.00	0.00	0.00
Tracks [a]	1.00	8.00	63834.46	**51.15**	43.80	7.35	0.00	0.00	0.00	0.00
Underground powerlines onsite [c]	1.00	2.00	18330.43	**3.67**	2.92	0.75	0.00	0.00	0.00	0.00
Overhead powerline cabling / easement [b]	1.00	20.00	40031.00	**80.06**	40.52	37.89	0.21	1.44	0.00	0.00
Overhead power pole footings [a]	400.31	1.00	1.00	**0.04**	0.02	0.02	0.00	0.00	0.00	0.00
Substation and control bldg [a]	5.00	150.00	85.00	**6.38**	2.55	3.83	0.00	0.00	0.00	0.00
Concrete batch plant [c]	1.00	75.00	100.00	**0.75**	0.75	0.00	0.00	0.00	0.00	0.00
Construction compound, staging and storage [c]	1.00	300.00	100.00	**3.00**	3.00	0.00	0.00	0.00	0.00	0.00
Development envelope (DE)				**4140.00**						
Percentage of DE permanently removed				**1.81**						
Breakdown by impact type:										
a Permanent habitat loss (includes all footings and tracks)				**61.70**	49.62	12.01	0.06	0.00	0.00	0.00
b Habitat modification (transmission easement maintenance)				**80.06**	40.52	37.89	0.21	1.44	0.00	0.00
c Temporary habitat loss (areas that can be rehabilitated post construction)				**19.79**	16.42	3.18	0.19	0.00	0.00	0.00

P: Pasture, BGW: Box Gum Woodland, BGBPF: Brittle Gum – Broad-leaved Peppermint Forest, DSTF: Dry Shrub – Tussock Grass Forest, LBDGF: Long-leaved Box Dry Grass Forest, BGWke: Box-Gum Woodland – *Kunzea ericoides*

Based on these estimates, the proposed works would permanently remove up to 12 ha of box gum woodland; the areas impacted within each condition class are indicated in Table 8-2. Up to 1.47 ha of box gum woodland in good, moderate-good or moderate condition would be affected. Around 38 ha would be required to be maintained as transmission easement and 3.18 ha would be rehabilitated following construction. Woodland vegetation would be avoided using micrositing adjustments and route modifications where possible.

In addition, up to 50 ha of pasture would be permanently removed during construction of the turbines, access tracks and substation. The majority of this is likely to be native pasture in generally poor-moderate condition derived from box gum woodland vegetation types. Native pasture dominated by native grasses and derived from box gum woodland belongs to the box gum woodland EEC listed under the TSC Act (but not the EEC listed under the Commonwealth EPBC Act). Around 16.42 ha of pasture would be reinstated following removal of the construction facilities.

This vegetation belongs to the box gum woodland EEC listed under the TSC Act. The majority would not qualify as EEC under the Commonwealth EPBC Act. The proposal would involve the clearing of a small area of woodland in good condition in cluster 4b would form part of the Commonwealth EEC (refer Map Set 2). 0.25 ha would be cleared to provide a construction access track 4.5 metres wide and to install underground cabling in a 0-5-1 metre wide trench. Box gum woodland in good condition is very rare in the region and usually restricted to public reserves such as cemeteries, travelling stock reserves and roadsides with a light grazing history. Specific measures to minimise impacts to this area are included in section 8.1.5 *Impact avoidance and mitigation*. These include minimising track width, siting to avoid the need for road battering, using the natural soil and vegetation surface for the track, low impact clearing and trenching methods and rehabilitation with native grass species following the works.

Less than 1 ha of Brittle Gum - Broad-leaved Peppermint dry forest would be impacted by the construction of turbine, powerlines and tracks.

Some of the powerline routes will overlap with tracks, reducing the overall area of disturbance. In addition, low gradient sections of the inter-turbine access tracks may be reinstated with native grass cover following the works to reduce runoff and improve long term stability. Some powerline and access track routes have been modified to reduce the extent of impact on woodland vegetation (refer section 7).

Parts of the cluster 7 ridge, particularly areas on sedimentary geology, are derived from dry grass forest types (non-EEC). Some flatter lowland areas traversed by tracks and powerlines are likely to be dominated by exotic crop and pasture species.

Table 8-2 Maximum impact areas on Box Gum Woodland EEC[1] vegetation based on condition class and constraint level

Calculations are based on the indicative infrastructure layout provided by the Proponent.

Marilba Hills Precinct						
EEC	**Permanent habitat loss a within each condition class**					
	Good	**Moderate / good**	**Moderate**	**Poor / moderate**	**Poor**	**Total**
Box Gum Woodland	0.29	0.00	1.18	7.84	2.69	12.00

Marilba Hills Precinct			
EEC	**Permanent habitat loss [a] within each class**		
	High constraint EEC	**Moderate constraint EEC**	**Low constraint EEC**
Box Gum Woodland EEC	1.47	7.84	
Total area within the DE	527.00	1275.00	2182.00

[1] Box-Gum Woodland EEC includes both box-gum woodland and long-leaved box dry grass forest remnants. In general terms, poor and poor-moderate condition class EEC without tree cover (native pasture) represent low constraint, poor and poor-moderate classes with tree cover represent moderate constraint, moderate and good condition classes represent high constraint (refer Section 7). Condition classes are defined in section 5.1.2 of the Marilba Hills Precinct Biodiversity Assessment, Appendix 3.2.

Indirect and peripheral impacts

Vegetation surrounding the development footprint would be affected by vehicle access and parking, materials laydown and spoil deposition and retrieval. Peripheral impacts may include soil compaction, soil erosion and sedimentation. The works have the potential to introduce and spread weed species. The concrete batch plant and associated flush pit, if used, would alter local subsoil conditions over the medium term.

Pollution risks are associated with the use of concrete, fuels and lubricants and construction chemicals. With appropriate safeguards and practices (refer Environmental Assessment), these risks to native vegetation are expected to be low. Similarly, the increased bushfire risks to vegetation caused by construction activities are expected to be manageable and acceptable. Dust would be generated from the excavation and building activities at the construction sites, and by traffic using unsealed access routes, over the 6-9 month construction period. The limited duration of dust deposition is not expected to significantly affect soils and vegetation at the site.

Impacts on threatened species and communities

The impacts of the proposal on the threatened Yass Daisy (*Ammobium craspedioides*) and the Box-Gum Woodland Endangered Ecological Community are discussed in the Assessments of Significance presented in Appendices E and F.

Yass Daisy populations are located close to proposed works areas in the following locations:

- in remnant woodland on the western side of cluster 4a/4b
- in remnant woodland on the south-western side of cluster 6
- in secondary grassland west of cluster 7 (near potential substation sites).

Yass Daisy records in these habitat areas are shown in Map Set 2. The proposal has been modified so that turbine construction works would avoid impacts to these habitats (refer section 7). In particular, the proposed substation site beside cluster 7 has been relocated to a less sensitive site outside the Yass Daisy population. Special measures would be implemented to minimise impacts to good condition box gum woodland adjacent to the Yass Daisy colony in cluster 4b (refer section 8.1.5).

Sensitive areas adjacent to works would be clearly marked and protected from direct and indirect impacts during the construction phase. Where necessary, finescale development area boundaries would be identified with the assistance of an ecologist.

The Assessment of Significance also concludes that the proposal would not significantly impact on other threatened species which have potential to be present at the subject site, subject to mitigation measures and precautions to account for uncertainty identified below.

The majority of vegetation at the subject site falls within the Box-Gum Woodland EEC listed under the TSC Act. This includes:

- woodland and forest with relatively intact native understorey,
- woodland trees with depauperate understorey dominated by native grasses and with few native forb species and
- native pasture derived from box gum woodland.

The indicative distribution of these forms of box gum woodland at the subject site is shown in Map Set 2. The proposal would avoid disturbance to woodland and forest with intact native understorey and impacts to this vegetation are expected to be minor. Approximately 12 ha of degraded woodland in generally poor, poor-moderate and moderate condition and up to 50 of pasture derived from box gum woodland would be permanently removed by the proposal. The Assessment of Significance (Appendix E) concludes that, in view of the condition of this vegetation, and the limited scale of the clearing, this impact is not expected to be significant.

The survey recorded four areas of box gum woodland have sufficiently high diversity or patch size to qualify as part of the Critically Endangered Ecological Community (CEEC) listed under the Commonwealth EPBC Act (at clusters 3, 4, 6 and 7). Woodland on the slopes beside cluster 3 is outside the area of impact and would be protected from indirect impacts or associated impacts such as access track construction. Treeless secondary grassland which is likely to be derived from box gum woodland near cluster 7 would be excluded from the proposal and protected during the works (refer Map Set 2).

Some areas within the Coppabella – Marilba powerline envelope also appear to belong to the Commonwealth CEEC, based on patch size (> 2 ha), tree density (>20 trees per hectare) and presence of regeneration. These areas are located across most of the width of the Weilora property, where the proposed route cuts across the southern end of the ridge with the northern-most turbine cluster on the Marilba site, close to where a small creek skirts the end of the ridge. A more southerly route would avoid most, if not all, such vegetation.

Since the groundcover is of low native species diversity even in areas which fit the CEEC definition, the main issue of concern is tree removal, particularly of large old trees with hollows, or of an age to begin forming hollows soon. Trees in better health would also be of greater conservation significance than trees severely affected by dieback, and Yellow Box or Blakely's Red Gum trees of greater significance than Long-leaved Box or Red Stringybark trees. Some CEEC may have to be traversed at the eastern-most gully crossing on the Weilora property, and the route of least tree density should be chosen. This constraint applies also to areas of the route which were not inspected, such as the western part of the Myrana property.

A small area of CEEC woodland with intact understorey and a regenerating Blakely's Red Gum tree layer in cluster 4b would be affected by construction vehicle access and the installation of underground cabling (refer Map Set 2). 0.25 ha would be cleared to provide a construction access track and 0.5-1 metre wide cable trench. Specific measures to minimise impacts to this area are included in section 8.1.5 *Impact avoidance and mitigation* below. These include minimising track width, siting to avoid the need for road battering, using the natural soil and vegetation surface for the track, low impact clearing and trenching methods and rehabilitation with native grass species following the works. It should be possible to install this infrastructure while maintaining the conservation values of the remnant. Impacts to the Commonwealth CEEC in this area are therefore not expected to be significant.

Conclusion

In view of the local abundance and degraded nature of vegetation affected by the proposal, the results of the threatened species evaluation and flora survey and the conclusions of the Assessments of Significance regarding impacts to threatened species and communities, the construction phase of the proposal is not expected to significantly affect flora and ecological community values.

Under the Commonwealth EPBC Act, an action is considered likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will reduce the extent of a community. The proposed clearing would reduce the extent of the box gum woodland CEEC at the subject site, and a referral to the Commonwealth Environment Minister will be made on this basis.

8.1.2 Fauna

Vegetation clearing

Based on the infrastructure layout in Figure 3.2, the proposed wind farm would permanently remove approximately 12 ha of box gum woodland habitat with tree cover in poor, poor-moderate and moderate condition. Additionally, around 38 ha of woodland would be affected by powerline easement maintainance.

Around 50 ha of pasture would be cleared during construction of the turbines, access tracks and substation. The majority of this is likely to be grazed native pasture in generally poor-moderate condition derived from box gum woodland vegetation types. Some of the powerline routes will overlap with tracks, reducing the overall area of disturbance. Some powerline and access track routes have been modified to reduce the extent of impact on woodland vegetation (refer section 7). Track widths would be reduced to 4.5 metres in constrained areas, where contours and turning requirements allow.

The cleared ridgetop habitats most affected by turbine construction are used by reptiles, birds, macropods, rabbits and microbats. This habitat is generally not high quality and is abundant throughout the district. The minor areal losses are not expected to significantly affect any local fauna population. The proposed wind farm is not expected to result in the loss of substantial microbat roosting habitat at the site, or substantially alter flyways or prey sources. This conclusion is provisional, subject to the findings of a more detailed specialist assessment that will form an attachment to the Yass Wind Farms Environmental Assessment (**ngh**environmental 2009).

The size and integrity of larger remnants at the subject site are critical to the persistence of some woodland species, including the threatened Speckled Warbler. The works would avoid impacts to the large remnant on the western side of cluster 4, where two threatened woodland bird species and areas of woodland in good condition were recorded.

A small area of woodland with intact understorey and a regenerating Blakely's Red Gum tree layer in cluster 4b would be affected by construction vehicle access and the installation of underground cabling (refer Map Set 2). 0.15 ha would be cleared to provide a 350 metre long and 4.5 metre wide access track and 0.5-1 metre wide cable trench. Specific measures to minimise impacts to this area are included in section 8.1.5 *Impact avoidance and mitigation* below. These include minimising track width, siting to avoid the need for road battering, using the natural soil and vegetation surface for the track, low impact clearing and trenching methods and rehabilitation with native grass species following the works.

The relatively narrow disturbance corridors of clearing required for the proposal is not likely to significantly add to existing habitat fragmentation at the subject site.

As far as possible, the powerline routes would be sited to avoid mature woodland eucalypts on the lowland sections, and larger forest remnants on sideslopes. Isolated hollow-bearing trees in particular may be important and uncommon habitat resources in modified landscapes.

Removal or degradation of offsite roadside habitats

Some sections of roads accessing the site (such as Illalong Road) may require lopping or pruning of roadside trees to accommodate large construction vehicles. Roadside remnants frequently contain old hollow-bearing trees and provide movement corridors for woodland species. Illalong Road carries some heavy vehicle traffic and may not require extensive clearing. A traffic study would be completed for the wind farm which would identify trees requiring pruning. Graces Flat Road would not be used for construction access to cluster 7 to avoid impacts to roadside box gum woodland habitats.

Following the construction period, any branches removed would be allowed to regrow. The branch pruning impacts required for the wind farm is not expected to be significant. Where hollows are required to be removed, these should be replaced by nest boxes of similar size in nearby trees.

A final site inspection should be carried out after road and electricity easements are finalised, to ensure that threatened species habitat and EEC vegetation has been avoided and identify any required mitigation measures.

Wetland and riparian habitats

Wetland and riparian areas at the subject site generally provide poor quality fauna habitat. These sites do however contribute to habitat diversity and provide water sources for a range of species. If dams are removed during site development works, alternative watering points should be established to compensate for their loss.

Dust, noise, vibration, visual disturbances and vehicle collision risks

The dust, noise, vibration and activity associated with the 6-9 month construction phase at the construction sites and along the access routes may affect the foraging behaviour of local fauna species, particularly birds and macropods. Given the local abundance of similar habitat, this temporary effect on habitat utilisation is not likely to significantly affect local populations of these generally highly mobile species. Since construction would occur principally during daylight hours, nocturnal and crepuscular species are unlikely to be affected by construction activity. Standardised access routes, low speeds (max. 40km/hr) and temporary destocking of paddocks would reduce the risk of vehicles colliding with stock or native fauna during the construction period.

The threatened Superb Parrot has been shown to be particularly vulnerable to vehicle collisions after feeding on roadside grain spills (Sydney Morning Herald 4 January 2009). Several Superb Parrot sightings were recorded along Illalong Road during the survey, a sealed road located west of the subject site. Contractors and staff would be made aware of this issue and would limit driving speed on Illalong Road and Burley Griffin Way to 80 kph and report any grain spills to DECC.

Pollution risks

The construction activities using concrete and the storage and use of fuels, lubricants and construction chemicals carry a pollution risk for aquatic habitats. These risks are considered acceptable and manageable using appropriate safeguards and practices (refer Environmental Assessment).

8.1.3 Cumulative impacts

The Marilba Hills Wind Farm project forms part of a wider proposal including wind farm sites at Coppabella Hills to the west and Carroll's Ridge to the south. Together, the Coppabella Hills and Marilba Hills wind farms involve:

- the construction of up to 152 turbines, approximately 130 kilometres of access tracks and 54 kilometres of powerlines
- the permanent removal of up to 23.33 ha of box gum woodland with tree cover (generally in poor, poor-moderate and moderate condition).

In the context of the wider study area, this level of habitat loss in not considered significant in areal terms.

8.1.4 Offsetting

In order to meet the 'maintain or improve' test for biodiversity values, the proposal may be required to provide for the long term protection of areas of native vegetation as offsets for the clearing required by the works. Offsetting would be subject to a further process of assessment and planning.

A Habitat Restoration Plan covering the study area would be useful in determining priority areas and actions for recovering threatened species and communities. One aim for selecting offset areas should be to improve the size, integrity and connectivity of existing high value remnants, such as the cluster 4 remnant.

8.1.5 Impact avoidance and mitigation

Further pre-works survey and assessment

- If the dry forest remnant in the far south of cluster 7 would be impacted by the proposed works, another targeted survey for the Burrinjuck Spider Orchid would be undertaken in mid-October. If found to be present at the site, works would be re-sited to avoid impacting this species.
- If the secondary grassland on the south-western side of cluster 7 would be substantially impacted, such as by the construction of an access track, powerline or substation, a spring survey would be undertaken targeting threatened grassy woodland species.
- A final site inspection should be carried out after road and electricity easements are finalised, to ensure that threatened species habitat and EEC vegetation has been avoided and identify any required mitigation measures.
- A referral to the Commonwealth Environment Minister will be made to obtain approval for clearing within the area of box gum woodland CEEC at the cluster 4b site.

Microscale site selection

- An ecologist will assist with the finescale siting of the development in sensitive areas such as around the substation site at cluster 7 and the cluster 4 remnant to avoid and minimise impacts to the significant biodiversity values associated with these sites.
- The access track through the small area of good condition box gum woodland in cluster 4b (refer Map Set 2) would be sited on the level part of the ridge crest to avoid the need for road battering. The track would coincide with the powerline route through this vegetation.
- Approach routes to the subject site should be selected to minimise the need to clear or trim remnant eucalypts along local roads such as Illalong Road and Grace's Flat Road, since most of this vegetation falls within the Box-Gum Woodland EEC definition and is likely to be significant for threatened fauna species such as Superb Parrot.
- Powerline and access track routes, and turbine sites should be selected to avoid forest and woodland remnants and individual mature and hollow-bearing trees (refer Map Set 3), which provide habitat for threatened fauna and potential seed sources for future site rehabilitation.
- The Coppabella – Marilba and Marilba – Carroll's Ridge powerline routes should also be selected to avoid potential CEEC box gum woodland areas of large patch size, high tree density or with large mature or hollow-bearing trees wherever possible (refer Map Set 4). On the Weilora property, the route should be relocated to the south to avoid CEEC areas. If areas of box gum woodland of large patch size and/or high tree density would be impacted by powerline clearing, a further approval from the Commonwealth to impact the box gum woodland CEEC may be required under the EPBC Act.
- Powerlines would be routed to avoid the moderate-good condition box gum woodland remnant and Diamond Firetail habitat near cluster 3 (refer Map Sets 2 and 3).
- All proposed works would be sited outside known Yass Daisy population areas and Commonwealth-listed CEEC areas, with the exception of the cluster 4b remnant.
- The cluster 4 woodland remnant would be protected from peripheral and indirect impacts and would not be used for site access or materials/equipment laydown. Contractors and staff will be made aware of the significance and sensitivity of the remnant.

Design and construction

- The identified Yass Daisy populations located close to the proposed works areas

  - in remnant woodland on the western side of cluster 4a/4b
  - in remnant woodland on the south-western side of cluster 6
  - in secondary grassland west of cluster 7 (near potential substation sites)

  would be clearly marked during construction and protected from the direct and indirect impacts of the proposal (refer Map Set 2). Contractors and staff will be made aware of the significance and sensitivity of these areas.

- Work sites adjacent to the Yass Daisy colonies would be revegetated with native tussock grasses to provide continuing potential habitat for this species.
- Track construction and powerline corridor impacts in the small area of good condition box gum woodland in cluster 4b would be minimised by:
  - siting the track on the level part of the ridge crest to avoid the need for road battering
  - minimising the track width (to 4.5 metres)
  - retaining the natural vegetation and soil as the driving surface (the track would not be bulldozed)
  - removing young trees and shrubs from the driving surface and powerline corridor using a chainsaw, and treating cut stumps with glyphosate herbicide (using a brush or applicator)
  - installing the powerline as an underground cable. Topsoil and subsoil removed from the trench would be placed on either side of the trench on geotextile fabric. The trench would be revegetated with locally native grasses following the works (such as Weeping Grass, Wallaby Grasses and Kangaroo Grass).
- The other recorded areas of box gum woodland forming part of the Critically Endangered Ecological Community listed under the Commonwealth EPBC Act (beside clusters 3, 4, 6 and 7 – refer Map Set 2) would be clearly marked during construction and protected from the direct and indirect impacts of the proposal. Contractors and staff will be made aware of the significance and sensitivity of these areas.
- In areas dominated by exotic groundcover species, exposed soils in the excavation corridor will be lightly mulched with chipped vegetation or sterile hay, and sown with a cover crop such as oats or millet, depending on season and seed availability, or an appropriate pasture seed mix (in consultation with landowners).
- In areas dominated by native grasses, exposed soils will be lightly mulched with chipped native vegetation or sterile hay, and sown with Weeping Grass (*Microlaena stipoides*) and/or Wallaby Grass (*Austrodanthonia* spp), or a cover crop such as oats or millet, depending on season and seed availability. In such areas, seed-bearing native pasture hay could be used for mulching, depending on availability.
- Fertiliser will not be used to promote revegetation in native grass-dominated areas of the site to reduce weed pressures.
- The development sites will be inspected for weeds prior to the commencement of works, in consultation with the Southern Slopes County Council. Noxious weeds in the vicinity of the works site will be treated prior to the commencement of works, subject to seasonal factors.
- Contractors and staff would be made aware of the potential risk of vehicle collision to the threatened Superb Parrot feeding on spilt grain beside local roads, particularly Illalong Road and Burley Griffin Way. Staff and constractors would limit driving speed on Illalong Road to 80 kph and report any grain spills to DECC.
- Where cement is included in cable trench backfill, at least 20 centimetres of cement-free topsoil will be replaced as the top layer in the backfill.
- Where practicable, grass surfaces will be retained or restored on infrequently used vehicle routes.

- Site stabilisation, rehabilitation and revegetation will be undertaken without delay, following the rehabilitation guidelines in the EA.
- Works will avoid impacts to mature eucalypts wherever possible. Wherever practicable, excavations and vehicle/machinery movements will occur outside the canopy dripline of large eucalypts.
- As a general rule, disturbed areas will be used for vehicle and machinery access, materials laydown, stockpiling of cleared vegetation and the deposition and retrieval of spoil whenever practicable.
- Works will be avoided during, and immediately following heavy rainfall events to protect soils and vegetation at the site.
- Any compaction of soil resulting from vehicle access and laying of materials, particularly during saturated soil conditions, will be avoided and remediated as necessary.
- Excavated topsoil, subsoil and weathered rock will be stored separately and replaced in a manner that approximates the original profile as closely as possible.
- Where practicable, whole sods will be removed with an excavator where these areas are well-vegetated with dense root systems. Sods will be stored in moist, shaded conditions and replaced following the works. Sod storage time will be minimised and sods will be replaced in a manner that maximises the chances of re-establishment.
- Appropriate fire fighting equipment will be held on site when the fire danger is high to extreme, and a minimum of one person on site will be trained in its use.
- Machinery and vehicles used in construction works will be washed before and after site access to reduce the introduction and spread of weeds and pathogens.
- Laydown sites for excavated spoil, equipment and construction materials will be weed-free or treated for weeds wherever practicable.
- Weed monitoring will be carried out at all sites after the completion of construction works and ongoing weed control will occur where noxious or invasive species are recorded. In particular, monitoring will be undertaken during the following late spring/early summer, and remedial action taken as required.
- Only certified weed free hay bales will be used for sediment control, if available.
- Imported materials such as sand and gravel will be sourced from sites which do not show evidence of noxious weeds or *Phytophthora* infection.
- Where tree hollows are required to be removed, these should be replaced by nest boxes of similar size in nearby trees.
- If dams are removed during site development works, alternative watering points should be established to compensate for their loss.

8.2 OPERATIONAL IMPACTS

8.2.1 Flora and ecological communities

The operational impacts of the proposal may include alteration to the prevailing grazing regime at the turbine sites, and some alteration to native fauna use of the sites.

Inspection, maintenance and monitoring visits would be required, although existing farm and construction tracks would be used and impact on vegetation is expected to be minimal. Access tracks would be maintained to minimise ongoing erosion and sedimentation impacts. The maintenance program would also include regular inspections for weed and rabbits, and control as required.

The impacts of major repairs would be similar in nature to construction impacts, but more limited in extent. The proposal would produce an ongoing pollution risk from the oil-cooled substation; design measures have been incorporated to ensure that any spill would be contained by bunding and treated expeditiously.

The operational impacts of the proposal on vegetation are not expected to significantly affect flora and ecological community values.

8.2.2 Fauna

General

The key operational impacts of the proposal relate to the operation of the wind turbines. The potential bladeswept area of the turbines would range from 34 to 150 metres above the ground. Generally the turbines begin rotation when the wind speed reaches 4 metres/second and shut down at 25 metres/second (or around 90km/h). The impacts of the wind farm would be most acutely felt by those species utilising aerial habitat within the bladeswept zone. At the Marilba Hills subject site, this fauna belongs to two groups; birds and microchiropteran bats.

Terrestrial fauna may be affected by turbine noise and blade flicker, although, given the low terrestrial fauna diversity and abundance at the site, these impacts are not likely to be significant.

A review of research literature and monitoring data relating to bird and bat impacts of wind farms and a discussion of monitoring and impact management options is presented in a specialist microbat report attached to the Yass Wind Farms Environmental Assessment (**ngh**environmental 2009). The Biodiversity Assessment draws on this study where relevant.

Birds

Impact risk assessment

Impact risk assessments have been undertaken for bird species from vulnerable groups - raptors, waterbirds, migratory and threatened species - recorded at the subject site, or with potential to use habitat at the site. The risk assessment is provided in Appendix D.

The bird impact risk assessment identifies and evaluates risks posed by the proposed wind farm development at the subject site in terms of:

- collision with wind turbines, or ‘bladestrike’. For these purposes, ‘bladestrike’ refers to mortality caused by direct collision with turbine blades and by birds being swept down by the wake behind a turbine blade; and
- habitat loss or avoidance caused by the presence of the turbines and associated infrastructure.

The risk assessment incorporates all species listed as threatened or migratory under the NSW *Threatened Species Conservation Act 1995* or the Commonwealth *Environmental Protection Biodiversity Conservation Act 1999* which have been recorded in the relevant CMA sub-regions or are included on the EPBC Act Matters of National Environmental Significance search report.

A preliminary risk matrix has been used to identify threatened species which are at particular risk from operational impacts of the wind farm. An impact risk rating is allocated to each species, derived from the cumulative scores of eight risk factors, including likelihood of presence at the subject site and behavioural traits. Threatened species with high cumulative risk scores are included in the relevant Assessments of Significance of the potential impacts in Appendices E and F.

Species from vulnerable bird groups are included in a qualitative assessment of risk (refer Appendix D); the results of this assessment are summarised in Table 8.4 below. Assessments of likelihood and consequence are combined to produce an overall risk assessment of low, moderate or high risk for selected species. Likelihood incorporates biological, behavioural and environmental risk factors. Consequence includes the significance of habitat loss and bladestrike in terms of habitat rarity and importance, population impacts, recovery potential and species conservation status. A distinction is drawn between the significance of impacts to individual birds at the site and impacts to the wider population.

The risk assessment is based on the proposed works described in section 4 and the expected vegetation and habitat loss quantified in sections 8.1.1 and 8.1.2. Importantly, the assessment assumes the adoption of measures to avoid and protect the sensitive habitats at clusters 3, 4, 6 and 7 identified in section 8.1.5.

The assessment draws on the Interim Standards for Risk Assessment relating to birds and wind farms (Brett Lane and Associates 2005) and the Australian Standards for Risk Assessment (AS/NZS 4360) and Environmental Risk Management (HB203:2000).

Table 8-3 Overall impact risk for vulnerable bird groups (bladestrike and habitat impacts)

Species	Risk to individuals at site	Risk to population
Raptors		
Wedge-tailed Eagle (*Aquila audax)*	Moderate	Moderate-high
Little Eagle (*Hieraaetus morphnoides*)	Moderate	Moderate
White-bellied Sea-eagle (*Haliaeetus leucogaster)*	Low	Low
Australian Kestrel (*Falco cenchroides)*	Low-moderate	Low
Square-tailed Kite (*Lophoictinia isura*)	Low-moderate	Low-moderate
Brown Falcon (*Falco berigora*)	Moderate	Low-moderate
Peregrine Falcon (*Falco peregrinus*)	Low-moderate	Low
Australian Hobby, Little Falcon (*Falco longipennis*)	Low-moderate	Low
Spotted Harrier (*Circus assimilis)*	Moderate	Low
Barking Owl (*Ninox connivens*), Barn Owl (*Tyto alba)* and other owl species	Low-moderate	Low-moderate
Tawny Frogmouth (*Podargus strigoides)*	Low	Low
Threatened species (passerines and parrots)		
Diamond Firetail (*Emblema guttata)*	Low	Low
Speckled Warbler	Low	Low-moderate
Regent Honeyeater (*Xanthomyxa phrygia*)	Low-moderate	Low-moderate
Superb Parrot (*Polytelis swainsonii)*	Low-moderate	Low-moderate
Swift Parrot (*Lathamus discolor)*	Low-moderate	Low-moderate
Gang-gang Cockatoo (*Callocephalon fimbriatum)*	Low-moderate	Low-moderate
Waterbirds and migratory species		
Painted Snipe (*Rostratula benghalensis*)	Low	Low
Latham's Snipe, Japanese Snipe (*Gallinago hardwickii*)	Low	Low
White Ibis (*Threskiornis molucca*)	Low-moderate	Low
Australian Wood Duck (*Checonetta jubata)*	Low-moderate	Low
White-faced Heron (*Ardea novaehollandiae)*	Low-moderate	Low
White-throated Needle-tail, Spine-tailed Swift (*Hirundapus caudacutus*)	Low-moderate	Low
Satin Flycatcher (*Myiagra cyanoleuca*)	Low-moderate	Low

Raptors

Six raptor species were considered to be at moderate or moderate-high risk at the individual level; Wedge-tailed eagle, Little Eagle, Australian Kestrel, Brown Falcon, Australian Hobby and the Spotted Harrier. Two species were assessed to be at moderate or moderate-high risk at the population impact level; Wedge-tailed Eagle and the Little Eagle. These raptor species typically construct stick nests in eucalypts, and soar over open country at turbine blade height. Both are likely to be dependent on rabbits as a local food source. These raptor species are frequently recorded close to human development, and are likely to be able to habituate to the proposed wind farm over time. A Californian study shows a similar number of raptor nests before and after wind plant construction (Howell and Noone 1992 in Strickland 2004). Raptor populations have also been found to co-exist with turbines at Australian wind farms, including at Codrington (Biosis Research Pty Ltd 2002, Wonthaggi EES Panel 2003), Toora (Brett Lane and Associates 2005), Crookwell (URS 2004) and Woolnorth (Hydro Tasmania 2003).

Compared to larger raptors with extensive breeding territories, such as the Wedge-tailed Eagle, the Brown Falcon, Australian Hobby and Spotted Harrier have higher reproductive rates and are more abundantly distributed. Risks to the Wedge-tailed Eagle at the site are discussed in the case study in Box 8.2. Given the low frequency of recorded collisions at existing Australian wind farms, it is unlikely that the bladestrike impacts of the proposed wind farm would create a continuing population sink for the regional Wedge-tailed Eagle population. However, the alienation of ridgetop hunting resources may have more pervasive consequences for this species.

For most species, the proposal area is unlikely to provide limiting, uncommon or significant habitat. In view of the substantial buffer distances involved, the wind turbines are not expected to alter habitat utilisation rates on neighbouring farmland, remnant woodland and wetlands.

In the case of the Wedge-tailed Eagle (refer Box 8.2) and possibly the Little Eagle, the high ridge habitat may provide an important updraft hunting resource and food supply (rabbits). The loss of this habitat may not affect existing birds but, if the area forms part of a breeding territory, it may affect breeding success over the longer term. The precise impact of habitat alienation on the local eagle population is difficult to predict. Further pre-works investigations are required to determine if nests are located near the subject site, and operation-phase monitoring will be required to record bladestrike mortality, habitat avoidance and impact on breeding success.

Waterbirds

No waterbirds or migratory wetland species were assessed as being at moderate or high risk at either the individual or population level (refer bird and bat impact risk assessment Appendix D). Of the waterbirds, species which fly at night, fly at blade height or which form large circling flocks are likely to be at greatest risk of bladestrike.

Overseas studies have shown that some waterbird species are able to perceive and avoid turbines, both during the day and at night (Erickson *et al*. 2001). At Crookwell, property owners noted that waterbirds have habituated to large man-made structures such as powerlines and demonstrate collision avoidance tactics in their flight patterns (URS 2004). Because of this capacity to avoid turbines, the US National Wind Coordinating Committee (2000) considers waterbirds to be at lower risk from bladestrike than some other groups.

In studies of bird mortalities from colliding with powerlines in the Hunter Valley, the species most at risk were found to be those with large bodies and awkward flight characteristics, species which fly in tight and/or fast-moving flocks and night-flying species (Hunter Wetlands Research 1996 in URS 2004). In this case, powerlines were located close to a major roosting/nesting site, and 12-42 metres above the ground. Pelicans, White Ibis and Swans were most affected.

The subject site is not located between significant habitat areas and bird movements across the site may be diffuse and irregular, rather than concentrated and seasonal. Ibis and other waterbirds may travel between Lake Burrinjuck and the large waterbodies in Canberra. Some species, including White Ibis, White-faced Heron and ducks, would also be expected to disperse to forage in farmland north of Lake Burrinjuck, including the study area.

Few waterbirds were recorded at the site during the survey owing to poor habitat quality and the continuing drought. Short-range foraging journeys by waterbirds from core habitat areas may follow chains of small seasonally available wetland habitats scattered over the lowland areas of the district. However, the highly ephemeral nature of lowland dam resources in the study area (Keith Smith, 'Ryalda' pers. comm.) limits their ability to support aquatic and riparian vegetation and hence their food resource value for waterbirds.

Major migration routes for these species are not known. Longer range migrations may involve crossing high ridges at blade height or higher, but the frequency of this occurring at the subject site is likely to be low. Most Australian species are classified as only partial migrants (Dingle 2005), which vary their routes according to ephemerally available resources. Blade collisions are therefore expected to be rare. The proposal is not considered likely to significantly affect waterbird species at the population level.

While the seasonal and diurnal migration routes for bird species at the site are not known, the subject site is not expected to present a significant migration corridor for waterbirds and woodland species. The site does not appear to lie between significant and localised habitat areas where large numbers of birds congregate. Migration patterns of waterbirds and other species over the site are likely to be diffuse, reducing the risk of catastrophic or frequent collision events. Risks to local bird populations from altered migration patterns are assessed as low.

Terrestrial migratory and woodland birds

No migratory or threatened woodland bird species were assessed as being at moderate or high risk at either the individual or population level (refer bird and bat impact risk assessment Appendix D). Three threatened woodland species were recorded at and near the subject site; the Superb Parrot, Speckled Warbler and the Diamond Firetail. These species may use habitat in and around the development envelope for nesting and foraging. However, foraging and nesting behaviour and migration movements are likely to be concentrated well below the bladeswept area, and more frequent in woodland remnants and lowland areas located outside the area of impact.

Birds moving at tree canopy height through roadside woodland corridors and between other lowland remnants are unlikely to be affected by the wind turbines located on adjacent ridges. These species are considered to be at low and low-moderate risk from the construction and operation of the wind farm.

Bird bladestrike impacts

The proposed wind turbines have the potential to cause mortalities in local bird populations due to collision with turbine blades or being swept down by the wake behind a turbine blade.

Biological, environmental and design factors which may affect risk by contributing to either the likelihood of bladestrike, or the significance of the consequence of bladestrike are discussed in Box 8.1, below.

Cumulative bladestrike risk modelling

Biosis Research Pty Ltd, on behalf of the Commonwealth Department of Environment and Heritage, recently completed an assessment of the cumulative wind farm collision risk for threatened and migratory birds (Biosis Research 2006). The study involved cumulative risk modelling for four threatened species (the Orange-bellied Parrot, Tasmanian Wedge-tailed Eagle, Swift Parrot and White-bellied Sea-eagle) and a preliminary risk assessment for 34 bird species with potential to occur at wind farm sites in Gippsland, Victoria. 39 operating and planned wind farms in south-east Australia were used in the assessment, including Crookwell, Gunning and Taralga on the Southern Tablelands.

The modelling took into account turbine number and size, local population size and density, duration of residency and the ability of birds to actively avoid collision with turbines. Avoidance rates are expressed as a percentage of flights made by a bird in which the bird takes no evasive action to avoid collision. Directly observed avoidance rates have been documented as 100% for a range of species at Codrington, Victoria, including the Wedge-tailed Eagle, Brown Goshawk, Nankeen Kestrel, Swamp Harrier, Brown Falcon, Richards Pipit, Magpie-lark, Magpie, Raven, Straw-necked Ibis, White Ibis, Egret spp. and White-faced Heron (Meredith *et al.* 2002). Calculated avoidance rates at Codrington – taking recorded mortalities into account – showed a reduced rate for the Magpie (99%) and Brown Falcon (>95%) (Meredith *et al.* 2002). The cumulative risk modelling applies three collision avoidance rates; 95%, 98% and 99%.

Swift Parrot

Wind farms are generally sited in cleared areas which would not provide quality habitat for the Swift Parrot. This highly mobile species may however traverse wind farm sites moving between habitat areas. It is considered that a bird species with the flight characteristics of the Swift Parrot would be likely to have an actual avoidance rate of around 99% (Biosis Research 2006). While collision risks would increase during very windy or foggy weather, this species is unlikely to be active during these conditions.

The model assumed 10 annual movements of birds per annum through the Crookwell, Gunning and Taralga wind farms, and assumed a population size of 10 birds for Gunning and Taralga, and 2 for Crookwell. 25% of flights were conservatively assumed to be within the bladeswept zone. The modelled average annual number of deaths due to turbine collision at these wind farms is less than 0.01452 all cases. The cumulative total of deaths for all of the 39 wind farms modelled is small; between 0.08 and 0.13 birds per annum. This equates to slightly more or less than a single parrot being killed every ten years.

Tasmanian Wedge-tailed Eagle

The cumulative bladestrike collision risk of eight wind farms on the Tasmanian Wedge-tailed Eagle were modelled by Biosis Research (2006) for each of the three given avoidance rates. For the 95% avoidance rate, the predicted annual cumulative mortality rate is 0.1898. This would increase the mortalities of the entire Tasmanian population by 2.5 birds per annum. For 98% avoidance rate, mortalities would increase by 1.4 birds per annum. At 99% avoidance rate, mortalities would increase by approximately 1 bird per annum. The actual avoidance rate is considered to be 99% or higher, and hence the cumulative effects of the wind farms is likely to be one bird per annum (Biosis Research 2006).

The assessment concluded that while the cumulative impacts of collision would be negative, the impacts would be very small and it is highly likely that these effects would be masked by normal fluctuations in the population due to natural variables. A population viability analysis also found that a significant increase in extinction risk would only occur if impacts were five times the predicted level. Refer also *Australian experiences*, below.

Gippsland species preliminary risk assessment

A preliminary assessment of risk to 34 EPBC Act listed species with potential to occur in the vicinity of five operating or planned Gippsland wind farms was recently undertaken by Biosis Research (2006). Species assessed included migratory wetland species, including Lathams Snipe, and the White-throated Needletail. The assessment concludes that collision impacts are likely to be low or negligible for all of these species. It is considered that a very small proportion of the Australian population of these species would ever move through a wind farm site and that, if they do enter a wind farm, they would be likely to actively avoid collisions or fly outside the bladeswept zone (Biosis Research 2006).

Box 8.1 Bladestrike risk factors for birds

A number of factors may operate which affect risk by contributing to either the likelihood of collision with blades, or the significance of the consequences of bladestrike. These factors may be related to particular species, sites or development designs.

Behavioural traits and biology/physiology

Aspects of bird biology and behaviour which may add to bladestrike risk include:

- foraging, courting or migration behaviour at potential bladeswept area height;
- flying during periods of reduced visibility, such as during fog or low cloud or dusk/night travel;
- flocking behaviour, particularly large and/or tight flocking patterns;
- period of residency;
- an inability to see moving blades ('motion smear').

The capacity of birds to 'habituate' to turbines may vary between species. Some species groups appear disproportionately vulnerable to bladestrike. Northern hemisphere studies point to three groups which are most vulnerable to bladestrike; gulls, raptors and migrant songbirds (Airiola 1987 in Canada Bird Studies 2001).

Population factors and conservation status

Species which are rare or declining, or which are naturally distributed at low density (such as top order raptors) may be at greater risk because, while collision rates may be low, each mortality has high significance. Similarly, species with low reproductive rates, or poor capacity to disperse and recolonise habitats may be at greater risk of significant impacts from blade collisions at the population scale. Species which are very abundant may have a higher frequency of bladestrike, but this impact as a proportion of the total population may not be significant and risk therefore would be considered low.

Local weather patterns

Many studies have shown that poor weather conditions increase the occurrence of turbine collisions (Canada Bird Studies 2001). Weather conditions which reduce the ability of birds to perceive the turbine blades or avoid collisions (such as fog and strong gusty winds) add to risks for susceptible species. Hence, sites which experience these conditions at higher frequency may be correspondingly riskier for these species.

Relative location of habitat and prey sources

The relative location of key habitat areas (such as updraft zones, prey populations, wetlands and nesting sites) and natural diurnal and seasonal migration routes also affects risks to birds.

Development structural factors

Structural characteristics of the development, such as the presence of guy lines (Erickson *et al.* 2001), aerial cabling and perching opportunities (especially lattice structures) may also be critical factors affecting the frequency of bird collision. Warning lights on towers may attract night migrating birds (Cochran and Graber 1958 in Canada Bird Studies 2001) and insect prey. US studies suggest that red flashing lights on wind turbines do not attract night migrants (Kerlinger and Kerns 2003), and would not attract insects, which are generally not sensitive to the red end of the spectrum.

Experiences at existing wind farms

Wind farm impacts are usually site-specific and species-specific. Nonetheless, there are a growing number of studies and monitoring programs in Australia and overseas which provide some insight into the nature and scale of potential risks to birds from wind farms.

Overseas experiences

A recent review of overseas wind farms showed low mortality rates for most wind farms (Langston and Pullen 2002). On average for all birds, new generation projects in the US (outside California) have recorded three fatalities per megawatt per year (Erikson *et al*. 2001). A review of 32 wind farms in North America produced an average of 1.4 birds per turbine per year, with a range of zero to 4.3 (Barclay *et al.* 2007). A review of European and North American wind farms indicates that most wind farms in agricultural settings affect between 2 and 4 birds per turbine per year (Lane and Associates 2004). However, the most commonly recorded bird group to collide with European and North American turbines were night-migrating songbirds, of which there are comparatively few in Australia.

Looking at wind farms in Europe, Winkelman (1994) produced an estimated average of 0.04 to 0.09 mortalities per turbine per day. 43% of these were killed by being swept down by the wake behind a blade, 36% flew directly into a blade, and for 21% the cause of death was unknown. At Altamont Pass in the United States, 55% of raptors were killed by striking a blade, 8% from electrocution, 11% from wire collision and 26% from unknown causes (Orloff and Flannery 1992 in Canada Bird Studies 2001). Winkelman concluded that the number of birds killed per unit of energy produced is low compared to other human-related causes of bird death.

Research conducted on farmland around two wind farms in the East Anglian fens in the United Kingdom found the turbines had no effect on the distribution of seed-eating birds, corvids (the crow family), gamebirds and Eurasian skylarks (Devereux *et al*. 2008). There was only one bird whose distribution was affected by the turbines – the common pheasant – the largest and least manoeuvrable species encountered. The researchers cite this as evidence that the present and future location of large numbers of wind turbines on European farmland is unlikely to have detrimental effects on farmland birds.

Australian experiences

There are relatively few published bird mortality studies at Australian wind farms, and most are of short duration. The studies do however suggest a generally low rate of blade collision, and that species at most risk are locally common birds which are active at the bladeswept height, including some raptors, skylarks, magpies and some seabirds (Meredith 2003, Hydro Tasmania 2004).

Monitoring research at the three operational wind farms in Victoria has recorded no rare, threatened or endangered birds killed by wind turbines to date. Searches conducted by Biosis Research for dead birds around seven turbines at the Codrington Wind farm (Victoria) showed three bird deaths attributable to impact with wind generators. The species concerned were the introduced skylark (1), Richard's pipit (1) and Australian magpie (1). Incidental carcass finds showed a further adult brown falcon death. The estimated total number of deaths likely from Codrington's 14 turbines over one year is 18 to 38 birds, or 1.2 to 2.7 birds per turbine per year (Brett Lane and Associates 2005).

At the Toora Wind Farm in Victoria, no bird carcasses were found during a year of monitoring or during informal inspections. Wedge-tailed eagles were regularly observed before and after operations began at this site. Eagles were observed to avoid the turbines by flying around or between them, not into them (Brett Lane and Associates 2005). A study at Codrington also found that all birds approaching the turbines were observed to take avoidance action, by flying over, around or under the rotating turbine blades (Biosis Research Pty Ltd 2002).

The 140 MW Woolnorth Wind Farm project in north-west Tasmania was progressively developed between 2002 and 2007. The rate of bird collisions for stage 1 of the project is estimated at 14 native birds per year or 2.3 birds/turbine/year (Hydro Tasmania 2004). Monitoring recorded 18 bird collisions in 2003, 7 of which were the introduced Skylark. One of these collisions was a Wedge-tailed Eagle. Eagles have been observed living near the turbines for more than 12 months and the collision occurred during a period of limited visibility (Hydro Tasmania 2003).

Woolnorth's owners Roaring 40s report that 11 Wedge-tailed Eagles (*Aquila audax fleayi*), an endemic and threatened Tasmanian sub-species, have been killed by collision with rotors since operations commenced.

Roaring 40s have managed risks to eagles by reducing food resources around turbines, studying eagle behaviour and breeding success in the local population and protecting nest sites elsewhere in Tasmania (Roaring 40s website 2008).

Bladestrike risks to birds at the subject site

The risk assessment focuses particularly on bird groups which have been shown to be at greater risk in studies at other wind farms (raptors, waterbirds, migratory species), and rare, threatened or protected species which have potential to be present in the study area.

The subject site is located in a heavily cleared agricultural setting with generally small, degraded and fragmented woodland remnants on steeper ridge slopes and along larger watercourses and roadsides. The majority of the site is cleared with low diversity and low abundance of bird fauna.

Important bird habitats at the site include larger woodland remnants (such as cluster 4) and ridgeline updraft and hunting habitat for raptors such as the Black-shouldered Kite, Nankeen Kestrel, Brown Falcon, Little Eagle and Wedge-tailed Eagle. Five raptor species are considered to be at moderate or moderate-high risk; Wedge-tailed eagle, Little Eagle, Brown Falcon, Australian Hobby and the Spotted Harrier. Experience elsewhere in Australia suggests that Wedge-tailed Eagle mortality is a possibility, although there are examples of this species habituating to, and co-existing with wind turbines.

Waterbirds and wetland habitats were uncommon at the subject site. No migratory or wetland bird species or waterbirds were considered to be at moderate or high risk. Three threatened woodland species were recorded at and near the subject site; the Superb Parrot, Speckled Warbler and the Diamond Firetail. The activity of these woodland-dependent species is likely to be concentrated in woodland remnants and lowland areas at heights well below the bladeswept zone. These species are considered to be at low and low-moderate risk from the operation of the wind farm.

There are several bladestrike risk factors operating at the subject site:

- local populations of threatened and vulnerable bird species are present, including declining species and species which are sparsely distributed in the landscape;
- the turbines would be located in high topographic positions and will therefore be more affected by low cloud cover, reducing visibility at times. The subject site may experience winter fog cover, but such occurrences are not common, and are considerably more frequent in lower country east of the site toward Yass (James Payne, local landholder, pers. comm., Cathy Kaveney, local landholder, pers. comm.). In the case of very strong winds (>90 km/hr), turbines would automatically shut down, reducing collision risk.
- while the proposed turbine towers would not have guy wires and would not provide perching opportunities, wind monitoring towers located near the turbines would be supported by guy wires and have a 300mm face width lattice construction that may provide limited perching opportunities for birds.

Some structural and design characteristics of the proposal serve to reduce collision risks, including widely spaced turbines, high turbines and tubular towers without perch opportunities.

These assessments are based on available information. The knowledge base is imperfect in several areas, including in relation to the migration behaviour and routes of local bird species, the importance of raptor habitat at the turbine sites to breeding success and the short and long term responses to the wind turbines.

Bird habitat and habitat utilisation impacts

The operational phase of wind farm developments has the potential to affect bird habitats and habitat utilisation patterns by:

- degrading off-site habitats (for example, from polluted runoff or weed introductions);
- alienating and fragmenting breeding or foraging habitat;
- altering migration behaviour.

Off-site degradation resulting from the construction and operational phases of the project are readily avoided and controlled using standard best-practice mitigation methods. Risks to local bird populations from off-site habitat degradation are assessed as low.

In Europe, the effects of wind farms on habitat utilisation are considered to have a greater impact on birds than collision mortality (Strickland 2004). European studies suggest that most habitat displacement involves migrating, resting and foraging birds. Studies have reported displacement effects ranging from 75 metres to as far as 800 metres away from turbines (Strickland 2004). Winkelman (1994) found that resident birds avoided turbines at distances of 250-500 metres. This is likely to reduce the risk of bird mortality, but may affect populations where the alienated habitat is particularly important or limiting.

Box 8.2 Wedge-tailed Eagle impacts

Biology and behaviour

Wedge-tailed Eagles are sedentary and widely distributed in a range of habitats. They are monogamous and apparently mate for life. If one bird of a pair is killed, the survivor will find a new mate. Established pairs defend breeding territories around their nest sites from other Wedge-tailed Eagles. Nest density varies with food supply but nests are usually 2.5-4 kilometres apart (Australian Museum 2003a). Home ranges around the breeding territories may be shared by two or more breeding pairs and by non-breeding birds (Australian Museum 2003a).

Wedge-tailed Eagles have a relatively slow reproductive rate, mating at an advanced age, raising few chicks and having long incubation (42-45 days) and chick dependency periods (12 weeks-1 year). Eagles begin breeding at 5 years, have a usual lifespan is 20-25 years and a reproductive lifetime of 15-20 years. A clutch usually consists of two eggs. A breeding pair usually rears only one young per clutch, although in a good year, two chicks may fledge (Australian Museum 2003a). During drought periods, eagles may not breed at all for several years. Monitoring of breeding pairs at Lake Burrendong (Central West NSW) in a post-calicivirus environment showed an annual productivity of 1 chick per territory, with fledging success at 76% (Davey and Pech 2001).

Wedge-tailed Eagles feed on a range of small to medium sized fauna. In many areas, native prey, particularly kangaroo pouch young, have declined and eagles have become reliant on rabbits and carrion. They have been observed feeding after dark on a roadkill carcasse (Wren 2002).

Conservation status

Birds Australia surveys indicate that, Australia-wide, the Wedge-tailed Eagle has declined by 28% since the 1980s (Davey 2003). Some regions may produce regular eagle population surpluses (‘population sources’) which disperse to less productive regions (‘population sinks’) (Davey 2003). The Marilba Hills locality may form part of a population source upon which flatter, lower rainfall population sink areas to the west are dependent (C. Davey CSIRO, retired, pers. comm.). The significance of the site to regional eagle populations hinges on whether the site forms part of a breeding territory, and hence contributes to the population source.

The Marilba Hills site

At the subject site eagles were observed singly and in a pair displaying courtship behaviour, at 10-80 metres above ground level. The eagles were observed using ridgeline updrafts for soaring. The local rabbit population provides a likely food source. Eagles also occasionally take lambs (J. Payne pers. comm.) and are likely to scavenge paddock carcasses and roadkill. No nests were observed at the site.

Possible response scenarios

There are a range of possible scenarios regarding the response of local Wedge-tailed Eagles to the proposed wind turbines including:

1. Local birds habituate to the turbines and are able to continue to use local habitat with a low collision rate. **Bladestrike and habitat impacts are low**.
2. Local birds avoid the area of the wind turbines but continue to use surrounding habitat within their territory or home range. Habitat dependence at the site is low and breeding success is not significantly affected. **Bladestrike impacts are low, but habitat impacts are moderate**.
3. Local birds avoid the area of the wind turbines but continue to use surrounding habitat within their territory or home range. Habitat dependence at the site is high and breeding success is significantly affected. **Bladestrike impacts are low, but habitat impacts are high**.
4. Local birds experience high collision rates, retaining local a presence but negating the source population function. **Bladestrike impacts are high, habitat impacts may be low**.
5. Local birds experience very high collision rates, exceeding the reproductive rate of the local population and producing a continuing population sink and possibly regional species decline. **Bladestrike impacts are very high, habitat impacts may be low**.

Bladestrike risks

Raptors appear to have no difficulty avoiding turbines when simply flying or soaring (Canada Bird Studies 2001), but when hunting may focus intensely on prey beyond the turbine without perceiving the rotor blades (Thelander *et al.* 2003). Raptor eyes do however have two foveal regions allowing focusing on the horizon as well as downwards (Hodos *et al*. 2001 in Canada Bird Studies 2001).

Available data from existing wind farms in south-eastern Australia show that large raptors have the capacity to avoid wind turbines, and have a relatively low frequency of collision. However, Wedge-tailed Eagle mortalities at the Starfish Hill Wind Farm in South Australia and Woolnorth (Tasmania) indicate that collision is possible. Risks may be higher during the period immediately following the installation of the turbines, before local birds have habituated. Risks may also be higher for inexperienced, juvenile birds, and during periods of heavy rain, fog or low cloud.

Experiences at other wind farms suggest that local Wedge-tailed Eagles would become habituated to the Marilba Hills Wind Farm over time. Resident Wedge-tailed Eagles have been observed to fly among turbines at wind farms at Codrington (Biosis Research Pty Ltd 2002, Wonthaggi EES Panel 2003) and Toora (Brett Lane and Associates 2005). A range of raptors continue to be present within one kilometre of the Crookwell I turbines (URS 2004). Wedge-tailed Eagles are also resident near the Woolnorth Wind Farm and 11 mortalities due to bladestrike have been reported since commencement in 2002 (SMH, 3 Jan 2008).

At Codrington, Wedge-tailed Eagles were observed to avoid turbines by flying horizontally around them and turning and not entering the turbine area (Biosis Research 2002). Directly observed collision avoidance rates at this site have been documented as 100% (Meredith *et al.* 2002). The collision avoidance rate for the Tasmanian Wedge-tailed Eagle has been estimated to be 99% or higher (Biosis Research 2006).

Assuming breeding productivity of 1 chick/year and a conservative fledging success of 50% (accounting for drought years), a breeding pair of eagles at Marilba Hills would produce an average of one additional bird every two years. Based on the low frequency of collision at these existing wind farm sites, it is considered unlikely that the Marilba Hills Wind Farm would result in bladestrike impacts that would significantly affect the local or regional eagle population, or reduce the value of the region as an eagle population source.

Habitat impacts

In studies at Burrendong Dam, a typical eagle territory was found to consist of a high ridge sweeping down to a flat plain terminating in the waters of the dam (C. Davey CSIRO, retired, pers. comm.). Nests would typically be found on the upper slope usually in a gully but with a dominant view of the countryside. The birds would spend most of their time soaring along the ridgeline making use of the updraft. Based on the time spent soaring along the ridgeline, this part of their territory must have been extremely important to them (C. Davey CSIRO, retired, pers. comm.).

The Marilba Hills ridgelines, particularly the higher central ridge on the Linbrook property, support rabbit populations and provide updrafts used by eagles. Marilba Hills may be a population source area for the Wedge-tailed Eagle and, if so, the ridge-tops would be a critical part of their territory (C. Davey CSIRO, retired, pers. comm.). The extent to which local eagles are dependent on these resources, and the abundance of similar resources on surrounding lands, are not known. The presence of the wind turbines may reduce the availability of both the rabbit and updraft resources at the Marilba Hills site, and may possibly reduce the reproductive success of a local breeding pair, if present (C. Davey CSIRO, retired, pers. comm.).

These breeding success impacts would not be evidenced by any decline in local eagle numbers in the short term, but may change the area from being a population source to being a population sink. This may have ramifications for areas to the west which are dependent on the southern tablelands source populations. Survey and monitoring is required to determine the presence of breeding eagles and the extent of habitat impacts.

Microchiropteran bat impacts

Impact risk assessments have been undertaken for microbat species recorded at the subject site, or with potential to use habitat at the site. The full risk assessment is provided in Appendix D.

This assessment examines relevant background information and evaluates the risk of significant impact posed by the proposed wind farm in terms of:

- collision with wind turbines
- physical damage caused by sudden decompression (pulmonary barotrauma)
- behaviour modification, including habitat avoidance.

The risk assessment incorporates all species listed as threatened or migratory under the NSW *Threatened Species Conservation Act 1995* or the Commonwealth *Environmental Protection Biodiversity Conservation Act 1999* which have been recorded in the relevant CMA sub-regions or are included on the EPBC Act Matters of National Environmental Significance search report.

A preliminary risk matrix is used to identify threatened species which are at particular risk from operational impacts of the wind farm. Threatened species with high cumulative risk scores are included in the relevant Assessments of Significance of the potential impacts in Appendices E and F.

Species from vulnerable bird groups are included in a qualitative assessment of risk (refer Appendix D); the results of this assessment are summarised in Table 9.4 below. The risk assessment is based on the proposed works described in section 4 and the expected vegetation and habitat loss quantified in section 8.1. Importantly, the assessment assumes the adoption of measures to avoid and protect the sensitive habitats at clusters 3, 4, 6 and 7 identified in section 8.2.4 below**.**

Pulmonary barotrauma

Pulmonary barotrauma, or decompression, has been identified as a significant cause of mortality for microbats. Rapid or excessive air-pressure change can result in fatal haemorrhaging in the lungs as bats pass near moving turbine blades. Moving turbine blades can cause a drop in air pressure by 5 to 10 kPa (Horn *et al.* 2008; G. Richards 2008 pers. comm). Mammals are thought to be more susceptible to barotrauma than birds (Baerwald *et al.* 2008). A recent Canadian study, Baerwald *et al.* (2008) found evidence of barotrauma in 90% of 75 microbats that had been killed at wind turbines, while only 50% of these had had direct contact with turbine blades.

Barotrauma potentially poses significant risks to microbats at wind farms as microbats are unable to detect rapid pressure reductions, even though echolocation may allow microbats to detect and avoid turbine blades. It is possible that some mortalities which have in previous studies been attributed to collision or blade wind may have in fact been caused by barotrauma.

Bladestrike and decompression impacts

12 bat species were recorded at the subject site with reasonable confidence using the Anabat call detection system, including the threatened (vulnerable) Eastern Bentwing Bat. In addition, the threatened Large-footed Myotis and Yellow-bellied Sheathtail Bat were possible records from the cluster 4 site. The proposed wind turbines have the potential to cause mortalities in local bat populations due to bladestrike. The risk of collision is influenced by the behavioural and possibly morphological characteristics of particular bat species, as well as site environmental factors. Relevant notes on the ecology of these species and the identification confidence of the survey records are presented in Appendix D.

Species risk factors

A range of hypotheses have been advanced to explain bat collisions, including echolocation failure, migration along linear corridors, the inability to perceive moving blades ('motion smear'), attraction to lights, attraction to the towers as potential roost sites, attraction to noises emitted by the turbine, curiousity about the blade movement, insect concentrations caused by insect attraction to turbines, and attraction to insect concentrations in rising warm air above ridgetops (Kunz *et al*. in prep. in Arnett 2005). There does not appear to be any published work which demonstrates the veracity or otherwise of any of these hypotheses.

Horn *et al*. (2008) observed that many microbats actively investigated turbine structures when blades were both moving and stationary at a wind farm in West Virginia USA.

Microbats are long-lived and have exceptionally low reproductive rates (Kunz 1982 in Arnett 2005). Most species produce only 1 young per year (Law 1996). Population growth is slow and the ability to recover from population crashes is limited (Racey and Entwhistle 2003 in Arnett 2005). Species characteristics which may affect collision risk include reproductive potential, migration behaviour, echolocation ability, flying manoeuvrability, foraging or flocking responses to weather or resource pulses, foraging height, long-distance flying height, reaction to the new infrastructure and dispersal and recolonising ability.

The relative vulnerability of the various bat species in Australia to bladestrike is not well known. Bats niche partition within their foraging habitat; some forage low in the canopy, some within or just above the canopy and others hundreds of metres above the canopy. Wing morphology reflects the difference in manoeuvrability required in these different environments. Bats that fly rapidly but are not very manoeuvrable are suggested to be less able to avoid collisions with wind farms (Erickson *et al.* 2002). United States studies show that higher flying 'tree bats' were disproportionately affected by bladestrike (AusWEA 2004).

Vision, as well as manoeuvrability, affects the risk of collision. Erickson *et al*. (2002) suggest that individuals most at risk appear to be migrating bats; migrating bats may navigate without use of echolocation, depending on vision, rather than echolocation. During migration, microbats may cease the use of echolocation to conserve energy (Keeley *et al.* 2001 in Sterner *et al.* 2007). Migratory bats comprise the majority of mortalities in all wind farm studies to date (Erickson *et al* 2002, Arnett 2005).

Echolocation has been assessed as functional only over small distances of c.20 metres (Grindal and Bringham 1998). The functional range of echolocation in North American bats is typically 3-5 metres, giving a bat flying at 5 metres/second less than a second to respond to a wind turbine (Kunz *et al*. in prep. in Arnett 2005).

Bat collision with wind turbines was first documented in Australia when 22 White-striped Freetail or White-striped Mastiff Bats (*Nyctinomus australis* syn *Tadarida australis*) collided with wind turbines over a 4-year period (Hall and Richards 1972, in Erickson *et al.* 2002.). This species may be uniquely vulnerable to wind turbine collisions due to its high flight and a low rate of echolocation call emission (Herr and Klomp 1997, in Rhodes

2001). White-striped Mastiff/Freetail Bats were recorded at the subject site. Other high-flying species may also occur at the site and be at risk of bladestrike.

Long distance migration behaviour and foraging within the bladeswept zone are likely to represent important factors that may differentiate risk between species. In Australia, long-distance migrating microbats include the Eastern Bentwing-bat and Yellow-bellied Sheath-tailed Bat; both of these species have been recorded at or near the subject site. Species which fly along the edges or above the canopy during foraging are likely to be most at risk from turbine impacts, compared to those that forage close to the ground or below the forest canopy. The Eastern Bentwing-bat, Yellow-bellied Sheath-tailed Bat and also Gould's Wattled Bat are included among these species. Species which utilise open areas and forage above the canopy may also have limited manoeuvrability, which may further increase turbine impact risks (Van Dyck and Strahan 2008). Examples include the Yellow-bellied Sheathtail-bat, Eastern Free-tailed Bat and Gould's Wattled Bat.

Environmental risk factors

Environmental factors which may affect the potential for collision or barotrauma include wind speeds and weather, proximity to foraging and roosting resources, linear vegetation features which may influence migration behaviour and proximity to other landscape features which may affect bat movements.

Monitoring in the USA has revealed that large numbers of microbats are killed in windfarms situated in forested, ridge top areas as opposed to agricultural areas (Kunz *et al.* 2007). Whilst most microbat species do not utilise open paddocks for foraging, isolated paddock trees are often used as much as forested areas (Lumsden and Bennett 2003).

German studies have shown higher collision rates from turbines located near hedgerows (Australian Bat Society 2005). Many species use linear vegetation or topographic features while commuting (Limpens and Kapteyn 1991, in Erickson *et al.* 2002) and migrating (Humphrey and Cope 1976, Timm 1989, in Erickson *et al*. 2002). The Marilba Hills subject site is located in heavily cleared farmland with generally small remnant woodland patches on steeper sideslopes. The nearest linear vegetation features are located some distance from the turbine ridges woodland remnants beside Illalong Road and Illalong Creek to the west, and Graces Flat and Black Range Roads to the south-east and south. Large forest and woodland remnants are present west of cluster 7 and on the western side of cluster 4. These remnants, as well as isolated paddock trees, may provide roost sites and insect food sources.

Although the association between man-made structures and bats is not well understood, evidence suggests that most bat collisions with structures occur during migration and that these are normally associated with inclement weather (Erickson *et al.* 2002). A feature of wind turbines is that in high wind speeds they shut down to protect themselves from damage, thereby also mitigating collision risks. Lights on turbines may increase the probability of bat collisions, as insect abundance is higher under lights (Erickson *et al*. 2002). This can also be mitigated by avoiding or reducing the use of lights on or near turbine towers, or by using red flashing lights that would be less likely to attract insects, which are generally not sensitive to the red end of the light spectrum.

Experiences at existing wind farms

Overseas experiences

Migratory microbats comprise the majority of mortalities in all wind farm studies to date (Erickson et al. 2002, Arnett 2005). Microbat fatalities at USA wind-energy facilities range from 53.3 bats/MW/year at the Buffalo Mountain Wind Energy Centre for small Vestas V47 turbines producing 0.66-MW and 38.7 bats/MW/year for larger Vestas V80 turbines producing 1.8MW (Kunz *et al*. 2007). More turbines equates to more impact, with the Mountaineer Wind Energy Centre in West Virginia accounting for 4000 microbat deaths in the autumn of 2004.

Many microchiropteran bat species hibernate or aestivate during cold periods to reduce their energy requirements when resources are low. In a compilation of survey results for wind farms in the United States, most bat mortality documented occurred in late summer and autumn (nearly 90% from mid-July through mid-

September) with most fatalities attributed to migratory tree bats with no pattern in distribution to suggest the victims were local bats commuting from roosting to foraging areas (Erickson *et al.* 2002). Resource abundance at this time would be expected to be high and bats requiring fat stores for aestivation would need to take advantage of the resource pulse and may migrate in order to do so.

North American research has shown that most bat collisions have involved adult bats, hence collisions were not thought to be attributed to dispersing juveniles (ABS 2005).

Erickson *et al.* (2002) in a North American study, state that based on available data bat collisions during the breeding season are virtually non-existent. Many of the scientific programs in the USA designed to test impacts of wind farms have been hampered by operational requirements (Kunz *et al*. 2007).

US studies show that bats tend to be killed on low wind nights, when blade speeds were at or close to full operational speed (17 rpm) (Arnett 2005). Fatalities tended to increase just before and just after the passage of storm fronts, when microbat activity would increase in response to insect abundance. This study also found that bat activity was greatest during the first two hours after sunset, which may also be a relatively high risk time for collisions. This study showed similar mortality rates at sites lit by aircraft lighting and sites which had no lights.

A review of 32 North American wind farm monitoring studies suggests that bat mortality increases with increased turbine height. The review shows an average of 5.9 bat fatalities per turbine per year, ranging from zero to 42.7. The maximum mortality rate occurred when turbines were at or greater than 65 metres in height (Barclay *et al*. 2007).

Australian experiences

There has been little research into collision or avoidance risks to bats in Australia, and no long term Before and After Controlled Impact (BACI) studies. The limited and disparate survey effort generally completed for impact assessment prior to project developments is inadequate to answer broader research questions such as the locations and importance of migration paths, which species are most vulnerable and what deterrent options are available (ABS 2005). Monitoring of wind farms to date has shown that bats investigate the blades and blade area of turbines and that while collisions do occur, they are able to avoid the blades on most occasions (ABS 2005).

Monitoring at Woolnorth recorded 11 bat collisions in 2003 (Hydro Tasmania 2003). Monitoring research at the three operational wind farms in Victoria has recorded no rare, threatened or endangered birds or bats killed by wind turbines to date. Searches conducted by Biosis Research for dead birds around seven turbines at Victoria's Codrington Wind farm (Victoria) showed one bat death (a White-striped Mastiff Bat) attributable to impact with turbines during the 2001-2003 monitoring period (AusWEA 2004). Incidental carcass finds showed a further White-striped Mastiff Bat death. Six bat mortalities were recorded at the Toora wind farm between 2002 and 2003; this impact was not considered to be of conservation significance (AusWEA 2004).

Bladestrike impact potential and significance

The Anabat survey recorded relatively high species diversity at the subject site, possibly reflecting the ecotonal position of the site between coastal/tableland and inland ecosystems. Some environmental risk factors such as ridgetop location of turbine cannot realistically be avoided. Impact risk may be reduced by:

- siting turbines away from woodland and forest remnants (including canopy edges)
- reducing the attractiveness of turbine structures and habitat areas to microbats
- regular or periodic shutdown of the turbines (such as during seasonal migration periods, peak foraging activity times or poor weather conditions).

An assessment of the potential for impact to microchiropteran bat species which were recorded or have at least moderate potential to be present at the subject site is presented in Table 8.4, based on survey data and existing information.

No species is assessed as having moderate or high potential to be impacted at the population level, although further field assessment is required on this matter, particularly in relation to colonial and migratory species such as the Eastern Bentwing Bat. Additional studies and assessment findings have been presented in a specialist bat survey report attached to the Yass Wind Farm Environmental Assessment (**ngh**environmental 2009).

Two threatened microbat species have at least moderate potential to be impacted by bladestrike or decompression at the individual level; the Eastern Bentwing Bat and the Yellow-bellied Sheathtail-bat. In these cases, risk was affected by behaviour (foraging height, agility, colonial roosting, migration), the quality, nature and extent of local habitats (remnant forest, farm dams) and local and regional abundance.

The surveys at the subject site also detected the high-flying White-striped Mastiff Bat. Based on known behaviour and mortalities at other wind farm sites, some level of mortality of this species caused by turbine collision is possible at the site. The presence of farm dams contributes to the attractiveness of the site for water-dependent species such as the Little Pied Bat, Large-footed Myotis and Broad-nosed Bat. The removal of dams close to the turbines should reduce collision risk for these species if mortalities are found to occur, although habitat impacts would then increase.

While considerable uncertainty remains regarding the responses of particular species, the relatively low level of recorded mortalities at existing wind farms in south-east Australia, the absence of recorded significant species mortalities, the degraded and fragmented condition of forest and woodland remnants over most of the subject site and the presence of similar habitat throughout the district combine to suggest that the proposal would not be likely to significantly affect local populations of microbats. This conclusion is subject to the findings of further assessments to be undertaken reported in an attached to the Yass Wind Farm Environmental Assessment (**ngh**environmental 2009). The uncertainty and risk would also need to be managed using operational monitoring and adaptive management.

Table 8-4 Impact potential for microbat species

Species	Potential for impact	
Goulds Wattled Bat (*Chalinolobus gouldii)*	Individual Population	Low Low
Chocolate Wattled Bat (*Chalinolobus morio)*	Individual Population	Low-moderate Low
Little Pied Bat (*Chalinolobus picatus)*	Individual Population	Low Low
Eastern Bentwing Bat (*Miniopterus schreibersii)*	Individual Population	Moderate Requires further assessment
Mormopterus sp.no.4	Individual Population	Moderate Low
Mormopterus sp.no.3	Individual Population	Moderate Low
Eastern Freetail Bat (*Mormopterus norfolkensis)*	Individual Population	Moderate Low
Large-footed Myotis (*Myotis macropus)*	Individual Population	Low Low
Long-eared Bat (*Nyctophilus geoffroyi/gouldi* complex)	Individual Population	Low Low
Inland Broad-nosed Bat (*Scotorepens balstoni)* Little Broad-nosed Bat (*Scotorepens grayii)*	Individual Population	Low Low
Yellow bellied Sheathtail Bat *(Saccolaimus flaviventris)*	Individual Population	Moderate Requires further assessment
White-striped Freetail bat (*Tadarida australis)* (*syn. Nyctinomus australis*)	Individual Population	Moderate Low-moderate
Large Forest Bat (*Vespadelus darlingtoni)*	Individual Population	Low Low
Southern Forest Bat (*Vespadelus regulus)*	Individual Population	Low Low
Little Forest Bat (*Vespadelus vulternus)*	Individual	Low

Species	Potential for impact	
	Population	Low
Eastern False Pipistrelle or Great Pipistrelle *(Falsistrellus tasmaniensis)*	Individual	Low
	Population	Low

Bat habitat and habitat utilisation impacts

The subject site provides potential foraging and roosting habitat for microbat species. During an earlier (spring) survey south of the subject site (**ngh**environmental 2006), abundant insect activity was observed, possibly related to warm updrafts, which would provide foraging resources for microbats. Microbats are also known to forage over cleared paddocks with isolated paddock trees and this may have benefits in terms of regulating herbivorous insects on these trees (Lumsden and Bennett 2004).

Most of the site offers marginal roosting habitat because of the scarcity of tree or cave habitat. Paddock trees are present as individual trees and small copses. Forest and woodland remnants are present, consisting largely of regrowth trees of pre-hollow forming age. The tree clearing or branch trimming that would result from the proposal is not expected to significantly affect available roost habitat, flyways, water sources or prey sources at the subject site. Rock outcrops do not provide suitable roosting habitat for cave-dwelling species. Habitat loss impacts are therefore not expected to significantly affect bat behaviour at the site.

The presence of operating turbines may affect foraging behaviour through habitat avoidance or collision with rotor blades or powerlines. However, similar foraging habitat is locally and regionally abundant. Some degree of localised habitat avoidance may in fact be desirable to reduce collision risks.

Given the extent of habitat loss in the district, habitat utilisation could be expected to be broadly dispersed through the locality, with some focus on the larger forest/woodland remnants and better condition aquatic habitats. The proposed turbines are unlikely to alienate these potential foraging and nesting habitat areas.

Because of the close proximity of large numbers of breeding and foraging individuals, risks to the Eastern Bentwing Bat may be higher than current information suggests. Additional anabat survey work is required to confirm the presence and distribution of the Eastern Bentwing Bat, Large-footed Myotis and Yellow-bellied Sheathtail Bat over the subject site. This work is scheduled for January 2009 and the assessment will be presented in the bat survey report included in the Yass Wind Farm Environmental Assessment (**ngh**environmental 2009). This report will include more detailed assessment potential impacts to threatened microbats.

Operational monitoring will be critical to the ongoing assessment of wind farm impacts to this species. Monitoring techniques and management options are addressed in the Bird and Bat Risk Addendum, included with the Yass Wind Farms Environmental Assessment report (**ngh**environmental 2009). If operational monitoring indicates mortality of the Eastern Freetail Bat or the Large-footed Myotis, local habitat could be modified by removing farm dams at the site to reduce feeding activity close to turbines. However, this habitat removal would have ramifications for a range of other species and would be viewed as a last resort. Replacement dams could be constructed at safer distances from the turbines (more than 200 metres) to preserve site habitat and agricultural values. Similar farm dam habitat is likely to be relatively abundant in the surrounding district, including within commuting distance of the subject site.

The impacts on habitat or habitat utilisation are not expected to significantly affect local populations of microbats. However, monitoring and an adaptive management approach would be required to account for the lack of information about these species.

8.2.3 Cumulative impacts

The Marilba Hills Wind Farm project forms part of a wider proposal involving two other project sites; Coppabella Hills 5 kilometres to the west and Carroll's Ridge 10 kilometres to the south. Together, these three projects total up to 185 turbines, 115.5 kilometres of powerlines and 140.5 kilometres of access tracks. The impacts associated with these projects have been assessed in separate Biodiversity Assessments prepared by **ngh**environmental.

The 15 turbine Conroys Gap Wind Farm, located between the Marilba Hills and Carroll's Ridge Precincts, was approved in May 2007.

There are several other wind farms proposed and operating in the region. Most of these are well to the east of the subject site. Figure 8.1 shows the relative location of these wind farm projects.

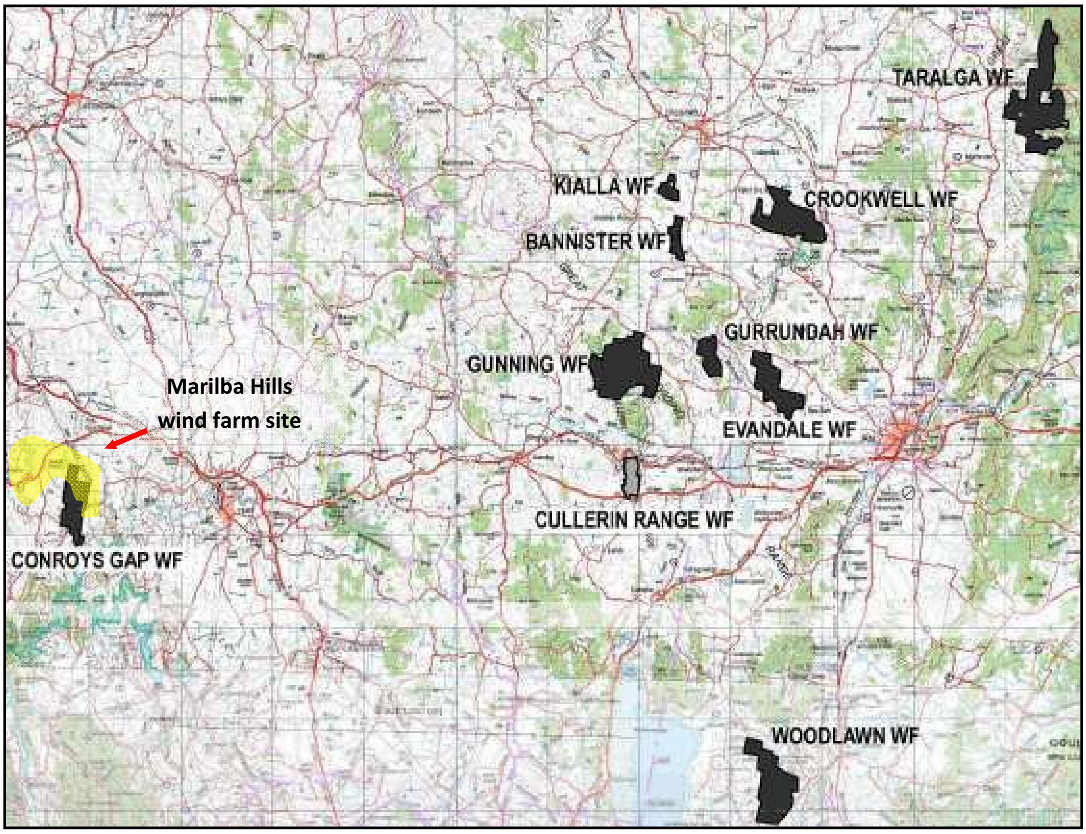

Figure 8.1 Operating and proposed wind farms in the region

There is considerable electrical infrastructure present in the locality, including major transmission lines and electrical substation and powerline infrastructure south of Yass. The construction of a substation and single pole powerlines associated with the wind farm proposal is not considered likely to significantly add to the impacts of existing electrical infrastructure in terms of scale or type of impact.

The construction of the wind turbines would introduce a new and distinctive suite of environmental impacts. Biological impacts can be far-reaching, because of the mobility of migratory, nomadic and territorial fauna species such as bats and birds. The operational and proposed wind farm localities in the district may involve overlapping raptor territories and bird and bat migration routes.

Based on habitat in the local area and elsewhere in the district, and known bat and bird movements, the subject site is not likely to be located on a major migratory route for wetland birds, seasonally migrating birds or microchiropteran bats. Visits from migratory or nomadic species are expected to be infrequent and sporadic. The wind farm is not likely to significantly add to risks to these species.

Other wind farms in the region are located well outside local raptor breeding territories and foraging ranges. The risks of the wind farm to raptors are addressed in Appendix D. Continuing losses of some raptor species with low reproductive rates (such as Wedge-tailed Eagles) could represent a 'mortality sink'. This could have the potential to affect region-level populations, although the likelihood of this is considered low. The subject site provides foraging resources for a range of raptor species. Mortalities are possible, but, given the low rate of bladestrike recorded at other Australian wind farms, are not expected to affect local or regional populations by outstripping the reproductive capacity of any species. For this reason, the proposal is not expected to significantly add to the collective impacts of wind farms in the region. The ongoing monitoring and assessment of the operational impacts of all wind farms operating in the region should however be consistent, centrally analysed and published to ensure cumulative impacts remain within acceptable limits.

The impacts of the wind farm on biodiversity values would combine with existing impacts resulting from land clearing, agricultural activities, weeds and hazards. It is important to recognise that the district has experienced extensive losses to ecosystem integrity and stability. Woodland and grassland communities in particular, which coincide with prime agricultural land, and riparian and wetland communities have been heavily simplified and destabilised. It is likely that many woodland flora and fauna species have become locally extinct, and many are in continuing decline.

There is a time lag, or 'extinction debt', operating which may mean that decline and extinction will continue for many species for decades to come, regardless of management responses. Further impacts on lowland environments are expected from soil and water salinisation, soil erosion and sedimentation, weed invasion and spread, disruption to river hydrology due to farm dam construction and water extractions and habitat fragmentation and clearing resulting from residential sub-division and building.

The offsetting of vegetation losses with the long term protection of similar vegetation in the study area will reduce the cumulative effects of the proposal (refer section 8.1.3).

When the cumulative impacts of all disturbances are considered, it is clear that any significant addition to stresses experienced by flora and fauna in the region need to be avoided. The location of the proposed wind farm turbines on largely cleared ridgetop sites, and avoiding impacts to natural woodland communities and habitats, should restrict the potential to affect declining woodland or wetland species.

The presence of the turbines and powerline would provide additional obstacles and hazards to birds and bats. Existing hazards include electricity transmission lines, and air, rail and road traffic. These hazards at this site are not known to produce significant or unusual impacts on local fauna.

The proposal is not expected to significantly affect waterbirds, migratory species, local raptor populations or threatened species. The project therefore is considered unlikely to produce significant cumulative impacts, in combination with existing obstacles and hazards. An adaptive monitoring and management program would be implemented to ensure that any unforeseen impact on these species are detected and addressed in a timely manner.

A monitoring program should include a combination of techniques to measure impact – monitoring components identified below should form only part of the overall monitoring effort. Monitoring techniques and management options are further addressed in the Bird and bat Impact Addendum attached to the Yass Wind Farms Environmental Assessment report (**ngh**environmental 2009).

8.2.4 Impact avoidance and mitigation

Further survey and monitoring work

- Pre-operational monitoring of habitat utilisation by birds and microbats should be undertaken in order to acquire baseline data, accurately assess risk and calculate potential mortality rates (refer **ngh**environmental 2009a, **ngh**environmental 2009b, Brett Lane and Associates 2005).
- Additional anabat survey work was undertaken during January 2009 to confirm the presence and distribution of the Eastern Bentwing Bat, Large-footed Myotis and Yellow-bellied Sheathtail Bat and other significant microbat species over the subject site. The results of this survey and further assessment of potential impacts to threatened microbats will be presented in the specialist bat survey report included in the Yass Wind Farm Environmental Assessment (**ngh**environmental 2009). No further bat work is proposed.
- Prior to the commencement of works, timbered areas within 2 kilometres of the turbines will be surveyed for the presence of Wedge-tailed Eagle nests, access permitting. Active nests will be monitored and breeding success recorded over the forthcoming breeding season (July-January). Both breeding success and habitat use behaviour at the subject site will be recorded to provide a baseline for operational monitoring.
- In conjunction with the above survey, the local abundance of ridgetop hunting habitat (exposed ridges with rabbit populations) will be reviewed to determine the importance of the subject site to the eagle population.

Microscale site selection

- Where practicable, the turbines will be sited centrally on the ridgeline, away from the ends and edges of linear ridges, to minimise disturbance to raptors using updrafts and microbats using ridgelines as navigational aids.
- Where possible, the turbine sites should avoid corridors between microbat and bird habitat areas, and turbines should be sited as far as practicable from the edge of woodland and forest remnants.

Design and construction measures

- The turbine towers will be as widely spaced as possible to reduce bird collision risks.
- To protect aquatic habitats, silt fences will be used around all excavation works, the duration of works will be minimised, and any drainage line and creek crossings will be stabilised (consistent with Fisheries NSW guidelines).
- Where practicable, power poles and overhead powerlines will be bird-safe using flags or marker balls, large wire size and wire and conductor spacing.
- If lights are required to be fitted to the towers (eg for aircraft safety), they should be red flashing lights to reduce attractiveness to insects and possibly night-flying birds (subject to CASA requirements). For similar reasons, turbine paint should be non-reflective if practicable.
- Guy lines will not be fitted to turbine towers. Any guy lines which need to be used on associated structures will be indicated with marker balls or flags.
- The turbine towers and associated structures will minimise perching opportunities.
- Rock and log habitat removed during the construction phase will be reinstated following the works.

- Any trench sections left open for greater than a day would be inspected daily, early in the morning and any trapped fauna removed.

Operational measures

Site modification and management

- It is suggested that Epuron advise landowners that sheep may be preferable to cattle as grazing stock on the turbine ridges (farm operational requirements permitting) to reduce the incidence of insects, which could provide prey for smaller raptors, owls, insectivorous passerines and bats. Restricting lambing on ridges with turbines may be required to reduce the collision risk to raptors. It is recognized this may be sugject to landowner agreement.
- Vegetation at the turbine sites should be kept low to allow a high level of carcass detectability. The use of dogs to find carcasses could improve search efficiency.
- If operational monitoring indicates mortality of the Little Pied Bat, Eastern Freetail Bat and/or the Large-footed Myotis, local habitat could, as a last resort, be modified by removing farm dams at the site to reduce feeding activity close to turbines. Replacement dams could be constructed at safer distances from the turbines (more than 200 metres) to preserve site habitat and agricultural values.

Operation phase monitoring

- The OEMP would contain details of a three-tiered monitoring program for bird and bat mortalities and habitat utilisation impacts. The design of the monitoring program would draw on the Australian Wind Energy Association's *Wind Farms and Birds: Interim standards for Risk Assessment* (Brett Lane and Associates 2005) and the *Wind Farm Risks to Birds and Microbats* study (**ngh**environmental 2009a) (Appendix K). The program would use a range of techniques including the following components:

  1. First six months of operation

  - a more intensive period of monitoring because birds and bats are in the process of habituating to the new development, and sensitive species may experience higher levels of mortality during this period.
  - during this period all turbine sites will be surveyed to determine variation in impact over the study area. Surveys will include regular dead bird and bat searches (with scavenging trials), bird utilisation surveys, observation of bird avoidance/diversion behaviour and targeted surveys for species of concern.
  - if practicable, a reference site located between 500 metres and 1,500 metres from the turbines should also be surveyed.

  2. First three years of operation

  - an extended period of monitoring to assess mortality rates and trends over successive seasons and longer term changes to local species abundance, habitat use patterns and possibly breeding success.
  - the survey may be limited to representative or higher risk turbine sites, based on the results of the first six months of monitoring.
  - surveys will include regular dead bird and bat searches, bird utilisation surveys, observation of bird avoidance/diversion behaviour and targeted surveys for species of concern.
  - dead bird and bat searches may be extended beyond three years if thresholds are exceeded and adaptive management responses are required to be implemented.

- if any active Wedge-tailed Eagle nest sites are located within 2 kilometres of the turbines, these nests will be monitored during breeding seasons (July-January) for **at least 5 years** following the commencement of operations to determine any impacts on breeding success caused by bladestrike mortality or habitat alienation. Ideally, breeding success at a comparable reference nest site not affected by the wind farm should also be monitored concurrently.

3. Ongoing monitoring

- mortality inspection and reporting will be continued for the life of the wind farm. The inspection regime would be linked to turbine inspection and maintenance cycles. Mortalities of any significant species (including threatened species and Wedge-tailed Eagles) will be reported to DECC.
- monitoring methods and data standards for dead bird searches, indirect disturbance impact assessment and habitat avoidance studies will be based on protocols in the Interim Standards for Assessing the Risks to Birds from Wind Farms in Australia (Brett Lane and Associates 2005).

- Given the concentration of operational and proposed wind farms in the Southern Tablelands region, monitoring of bird and bat impacts should ideally be coordinated and consistent with monitoring programs conducted at other wind farms, and the results of monitoring collected and published by AusWEA or government.

Adaptive Management

Adaptive management allows the initiation of a project in the absence of complete knowledge by providing a framework to incorporate new information to adapt management strategies (Johnson 1999). Mortality and habitat avoidance thresholds will be developed and used to trigger specific management responses to mitigate impacts.

Thresholds for mortality rates and habitat impacts for threatened or sensitive bird and bat species will be determined for each of the three monitoring periods during the development of the monitoring program, having regard to species reproductive potential, conservation status and experiences at other Australian wind farms.

Management responses to monitoring threshold exceedances would be dependant on the cause and the impact, but could include further research, detailed risk modelling and population assessments, adjustments or enhancements to turbine and associated infrastructure, the installation of flight diversion or deterrent structures, acoustic deterrents, blade painting (refer Hodos *et al.* 2001), fitting cowls to shield lights, removing local food sources or insect attracting light sources, removal of farm dams near turbines, compensatory off-site habitat protection or enhancement, nest site protection, and the periodic shutdown of one or more turbines (on a daily or seasonal basis or irregularly in response to weather conditions).

8.3 DECOMMISSIONING IMPACTS

Decommissioning impacts would be similar to, but less extensive than, construction impacts. The area of impact would be reduced because all below-ground structures (footings, concrete slabs, underground cabling) would remain in situ. The control building may also be retained on the site. Access tracks would be upgraded as required, and appropriate weed hygiene and rehabilitation measures would be implemented. The decommissioning phase of the proposal is not expected to significantly affect local flora values.

The decommissioning phase of the proposal may temporarily affect the use of habitat at the site by fauna, but is not expected to significantly affect local fauna populations in the medium-long term.

Relevant mitigation measures implemented during the construction phase would also apply to decommissioning works.

A biodiversity assessment would be required prior to decommissioning, to update the knowledge of site attributes and evaluate specific impact types. New measures to avoid and mitigate impacts may be required depending on the results of the assessment.

9 CONCLUSION

9.1 CONSTRUCTION

The construction phase of the proposal is not likely to have a significant impact on flora and fauna values at the subject site.

The proposal would remove 12 ha of box gum woodland, including up to 1.47 ha that would qualify as EEC in good, moderate-good or moderate condition. Clearing areas would be reduced by avoiding individual trees and woodland stands at the finescale site planning stage wherever practicable. Larger remnants in better condition and threatened flora habitats at the subject site would generally be excluded from the development area and protected during construction. A small area of woodland (0.14 ha) of woodland in good condition in cluster 4b would be cleared to provide an access track and cable trench. Special measures would be used to minimise impacts in this area.

Given the local abundance of degraded box gum woodland, the proposed vegetation clearing would not add appreciably to the existing level of habitat depletion and fragmentation, and would not significantly affect threatened species.

9.2 OPERATION

The operation phase of the proposal is not likely to have a significant impact on flora and fauna values at the subject site.

The key operational impacts of the proposal relate to the potential impacts to birds and microbats from collision with turbine blades, decompression and habitat avoidance. Impact risk assessments have been undertaken for bird species from vulnerable bird groups - raptors, waterbirds, migratory and threatened species - and bat species recorded at the subject site, or with potential to use habitat at the site. These assessments are provisional, and based on available information.

Five raptor species are considered to be at moderate or moderate-high risk. Experience elsewhere in Australia suggests that raptor mortality is a possibility, although there are examples of these species co-existing with wind turbines. Waterbirds and wetland habitats are uncommon at the subject site. No migratory or wetland bird species or waterbirds were considered to be at moderate or high risk. Three threatened woodland species were recorded at and near the subject site. The activity of these woodland-dependent species is likely to be concentrated in woodland remnants and lowland areas at heights well below the bladeswept zone. These species are considered to be at low and low-moderate risk from the operation of the wind farm.

Two threatened microbat species have at least moderate potential to be impacted by bladestrike or decompression at the individual level. No microbat species is assessed as having moderate or high potential to be impacted at the population level, although further assessment is required on this matter, particularly in relation to colonial and migratory species such as the Eastern Bentwing Bat. Additional studies and assessment findings are presented in a specialist bat survey report attached to the Yass Wind Farm Environmental Assessment (**ngh**environmental 2009).

The uncertainty and risk in relation to birds and bats would also need to be managed using operational monitoring and adaptive management. Several components of a monitoring program for the project are included with the mitigation measures in the Biodiversity Assessment. Monitoring techniques and management options are also further addressed in the Bird and Bat Risk Addendum, included with the Yass Wind Farms Environmental Assessment report (**ngh**environmental 2009).

9.3 IMPACT AVOIDANCE AND MITIGATION

Avoidance and mitigation measures have been developed for the planning/design and construction phases of the project. These include general best practice measures applicable to a wide range of projects, and specific measures tailored to the environmental context and nature of the Marilba Hills Wind Farm proposal. The measures form part of the proponent's Statement of Commitments in the Part 3A development application, and would be implemented through an Environmental Management Plan (EMP) developed for the project.

10 ASSESSMENT PERSONNEL

Personnel	Role	Qualifications	Expertise and experience
Paul McPherson nghenvironmental	Flora survey Report writing and research	Bachelor of Applied Science (Natural Resources)	With nghenvironmental since 1996 undertaking flora and fauna survey, planning assessment and environmental impact assessment for a wide range of projects, environments and clients.
Jackie Miles	Flora survey	Bachelor of Science Honours	Jackie specialises in botanical and zoological surveys. Jackie has worked on a number of large assignments including extensive fauna surveys for the Comprehensive Regional Assessment program, and botanical surveys including CRA full floristic surveys, field validation for the Parks & Wildlife Division - Dept. of Environment and Conservation (formerly NPWS)
Jim Reside	Fauna survey	Associate Diploma in Applied Science Resource Management	Jim is the director of Wildlife Unlimited, a consultancy established in 1996. WU have worked on several projects with nghenvironmental as lead field ecologists.
Steve Coulson	Fauna survey		Steve, from Wildlife Unlimited, has worked on several projects with nghenvironmental as a lead field ecologist. Steve's specialist area is herpetology. For WU, Steve has undertaken a wide range of survey projects.
Joshua Wellington	Technical assistant	B.Sc. (Environmental)	Josh's skills include bush/riparian restoration, fauna handling, field sampling of soils, water, and biological transects. With nghenvironmental Josh has prepared several REFs for roadworks.
Nick Graham-Higgs Principal nghenvironmental	Editorial review	Bachelor of Applied Science	An environmental consultant specialising in environmental impact assessment and natural resource management since 1992. Much of the work undertaken has been within sensitive areas, including major infrastructure development works.

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Appendix A **FLORA SURVEY RESULTS**

A1. Composite species lists for each vegetation type

A2. Representative quadrat results for vegetation types and type variants

A3. Vegetation survey sites locations, methods and results summary

A4. Yass Daisy (*Ammobium craspedioides*) records

The flora survey area included all areas within the development envelope that would potentially be directly or indirectly affected by the proposal, with an appropriate buffer to account for off-site impacts (refer Map Set 1). The survey area was stratified into 4 relatively homogeneous survey zones based on broad consolidated vegetation types:

BGW Box gum woodland (*Eucalyptus albens, E. melliodora, E.blakelyi*)
DGF Dry grass forest (*E. goniocalyx, E. mannifera, E. dives*)
DG Diverse secondary grassland
NP Native pasture, variable exotic component.

Species lists for these vegetation types are presented in Table A1, derived from random meanders (up to 1 ha) undertaken in each type (refer Map Set 1). Representative quadrat data for each type is presented in Tables A2.1-A2.8. Note that these types frequently intergrade at the subject site and transitional stands are common.

Where White Box, Blakely's Red Gum or Yellow Box is present, the vegetation has been assigned to Box-Gum Woodland. The condition, conservation value and relationship between these types and vegetation communities defined by Gellie (2005) are discussed in section 5.

Survey methods are also detailed in section 5. All native and introduced vascular plant species occurring at the random meander and quadrat sites, and their relative abundances, were recorded. Cover/abundance assessments are based on visual estimates of foliage cover (after Carnahan 1997), scored using a modified Braun-Blanquet 6-point scale:

1 1 to a few individuals present, less than 5% cover
2 many individuals present, but still less than 5% cover
3 5 - <20% cover
4 20 - <50% cover
5 50 - <75% cover
6 75 - 100% cover.

Where the cover/abundance of a particular species varies markedly over the random meander survey area, a range of values is provided. In these cases, abundance is based on a standard 20 metre x 20 metre quadrat scale.

Species of conservation significance are bolded. Introduced species are denoted by an asterisk. Noxious weeds declared for the Southern Slopes County Council control area under the *Noxious Weeds Act 1993* are indicated with a 'Δ' symbol.

Where uncertainty exists due to the unavailability of mature reproductive material, the taxon is preceded by a question mark, or plants are identified to genus level only. Botanical nomenclature follows G.J. Harden (ed) (1990-2002) Flora of New South Wales, UNSW Press, except where recent changes have occurred.

A1. Composite species lists for each vegetation type

BGW Box gum woodland (*Eucalyptus albens, E. melliodora, E.blakelyi*)

DG Box gum woodland derived grassland

DGFL Long-leaved Box dry grass forest (*E. goniocalyx*)

DGFB Brittle Gum – Broad-leaved Peppermint dry grass forest (*E. mannifera, E. dives*)

NP Native pasture, variable exotic component.

Scientific name	Common name	Family	Abundance				
			BGW	DG	DGFL	DGFB	NP
TREES							
Acacia implexa	lightwood or hickory	Fabaceae	0-1			2	0-3
Allocasuarina verticillata	dryland drooping sheoak	Casuarinaceae	0-4				0-1
Brachychiton populneus	kurrajong	Sterculiaceae	0-1				0-1
Eucalyptus albens	white box	Myrtaceae	0-3				0-1
Eucalyptus blakelyi	Blakely's red gum	Myrtaceae	0-3				
Eucalyptus bridgesiana	apple box	Myrtaceae	0-1				
Eucalyptus dives	broad-leaved peppermint	Myrtaceae				0-3	0-1
Eucalyptus goniocalyx	bundy, long-leaved box	Myrtaceae	0-3		3	0-2	
Eucalyptus macrorhyncha	red stringybark	Myrtaceae	0-3				0-1
Eucalyptus mannifera	brittle or red spotted gum	Myrtaceae				0-3	0-1
Eucalyptus melliodora	yellow box	Myrtaceae	0-3				
Eucalyptus polyanthemos ssp *polyanthemos*	red box	Myrtaceae	0-3				
Exocarpos cupressiformis	native cherry	Santalaceae				1	
SHRUBS, SUB-SHRUBS							
Acacia dealbata	silver wattle	Fabaceae	0-1				
Acacia verniciflua	varnish wattle	Fabaceae		0-1			
Amyema miquellii	box mistletoe	Loranthaceae	0-1				
Amyema pendulum	a mistletoe	Loranthaceae	0-1				
Bossiaea prostrata		Fabaceae	0-1				
Dillwynia sericea	hairy parrot-pea	Fabaceae	0-1				
Dodonaea viscosa ssp *angustissima*	hop bush	Sapindaceae	0-1				0-1
Hibbertia obtusifolia	guineaflower	Dilleniaceae	0-2	1	2	1	0-2
Hovea heterophylla	variable hovea	Fabaceae			0-1		
Kunzea ericoides	burgan	Myrtaceae	0-5	0-1			
Leptospermum myrtifolium	swamp teatree	Myrtaceae		0-1			
Leucopogon virgatus	beard heath	Ericaceae	0-1				
Lissanthe strigosa	peach heath	Ericaceae	0-1				
Melichrus urceolatus		Ericaceae		0-1			
Muellerina eucalyptoides	a mistletoe	Loranthaceae	0-1				
?*Pimelea curviflora* var *sericea* (seedlings)	curved rice flower	Thymeleaceae	0-1				
Pimelea treyvaudii		Thymeleaceae	0-1				
Pomaderris angustifolia		Rhamnaceae	0-3		0-1		
Pultenaea foliolosa		Fabaceae	0-1				
Δ**Rosa rubiginosa*	briar rose, sweet briar	Rosaceae					0-2
Δ**Rubus fruticosus* sp. agg.	blackberry	Rosaceae					0-1
VINES AND TWINERS							
Clematis microphylla		Ranunculaceae				1	
Convolvulus angustissimus	Australian bindweed	Convolvulaceae	0-2				0-2

Scientific name	Common name	Family	Abundance				
			BGW	DG	DGFL	DGFB	NP
Glycine clandestina	twining glycine	Fabaceae	0-1		0-1		
FORBS							
Acaena echinata		Rosaceae	0-2	1	2		0-1
Acaena novae-zelandiae	bidgee-widgee	Rosaceae	0-1	1			
Acaena ?ovina		Rosaceae	0-2				
*Acetosella vulgaris	sheep sorrel	Polygonaceae	0-2	0-2		0-1	1-3
Ammobium craspedioides	**Yass daisy**	**Asteraceae**	0-2	0-2	0-2		
*Amsinckia calycina	fiddleneck	Boraginaceae	0-1				
*Anagallis arvensis	scarlet pimpernel	Myrsinaceae	0-2				
*Arctotheca calendula	capeweed	Asteraceae	2			0-2	0-4
Arthopodium milleflorum	pale vanilla lily	Anthericaceae	0-2				
Arthopodium minus	small vanilla lily	Anthericaceae	0-1				
Asperula conferta	common woodruff	Rubiaceae	0-2			1	
Brachyscome ptychocarpa		Asteraceae		0-2			
Bulbine bulbosa	bulbine lily	Asphodelaceae	0-2		0-1		
Burchardia umbellata	milkmaids	Colchicaceae	0-1				
*Capsella bursa-pastoris	shepherd's purse	Brassicaceae	0-1				
*Carduus pycnocephalus	slender thistle	Asteraceae	0-1				
*Carduus tenuiflorus	winged slender thistle	Asteraceae	0-2				
*Carthamus lanatus	saffron thistle	Asteraceae	0-2				0-2
*Centaurea sp.	cockspur thistle	Asteraceae	0-1				
*Centaurium erythraea	centaury	Gentianaceae	0-2	1			
Centipeda minima	sneezeweed	Asteraceae		0-2			
*Cerastium glomeratum	Mouse-ear Chickweed	Caryophyllaceae	0-1			1	
Chamaescyce drummondii	caustic weed	Euphorbiaceae					0-1
Chenopodium pumilio	crumbweed	Chenopodiaceae	0-2				
*Chondrilla juncea	skeleton weed	Asteraceae					0-1
*Cirsium vulgare	black or spear thistle	Asteraceae	1	1		1	0-2
Cotula australis	carrot weed	Apiaceae	1-2				
Craspedia variabilis	billy buttons	Asteraceae		0-2			
Crassula decumbens		Crassulaceae	0-2				
Crassula sieberiana	Australian stonecrop	Crassulaceae	0-1				0-1
*Cucumis myriocarpus	paddy melon	Cucurbitaceae	0-1				
Cymbonotus sp.	bear's ear	Asteraceae	0-1		1		0-1
Cynoglossum suaveolens	hound's tongue	Boraginaceae	0-2				
Daucus glochidiatus	native carrot	Apiaceae	0-1				
Desmodium varians	slender tick trefoil	Fabaceae	0-1		0-1		0-1
Dianella longifolia	blue flax lily	Phormiaceae			0-1		
Dichondra repens	kidney weed	Convolvulaceae	1				0-1
Dichopogon fimbratum	chocolate lily	Anthericaceae	0-2				
Diuris chryseopsis	early snake orchid	Orchidaceae			0-2		
Drosera peltata ssp peltata	sundew	Droseraceae	2		0-1		
Δ_*Echium plantagineum_	Paterson's curse	Boraginaceae	0-4		0-2		1-4
Epilobium billardierianum ssp _cinereum_	willow herb	Onagraceae	0-1				
*Erodium brachycarpum	heronsbill	Geraniaceae	0-2				0-2
*Erodium cicutarium	common storksbill	Geraniaceae	1			0-2	1-4
Erodium crinitum	blue storksbill	Geraniaceae	0-1				0-1
*Erodium moschatum	musky storksbill	Geraniaceae	0-2				
Euchiton gymnocephalus	slender cudweed	Asteraceae		0-2	0-1		
*Galium murale	annual bedstraw	Rubiaceae	0-1				
Galium gaudichaudii	rough bedstraw	Rubiaceae	0-1				
Galium sp.		Rubiaceae	0-1				
*Geranium molle		Geraniaceae	1-2				
Geranium potentilloides		Geraniaceae	0-2				
Geranium solanderi var. _solanderi_		Geraniaceae	1-2		1	1	0-1
Gonocarpus elatus	tall raspwort	Haloragaceae	0-4				

Scientific name	Common name	Family	Abundance				
			BGW	DG	DGFL	DGFB	NP
Gonocarpus tetragynus	raspwort	Haloragaceae	1-2	0-2	2	2	0-1
Goodenia hederacea	ivy-leaved goodenia	Goodeniaceae	1				0-1
Goodenia ?paniculata		Goodeniaceae	0-1				
Haloragis heterophylla		Haloragaceae		0-2			
Hydrocotyle laxiflora	stinking pennywort	Apiaceae	2	0-2	2	1	
Hydrocotyle peduncularis	shining pennywort	Apiaceae		0-3			
Hypericum gramineum	native St Johns wort	Clusiaceae	0-1	1			0-1
Hypericum japonicum	small St John's wort	Clusiaceae	0-1	0-2			
Δ*Hypericum perforatum*	St John's wort	Clusiaceae	0-1				
**Hypochaeris glabra*		Asteraceae	0-2				0-2
**Hypochaeris radicata*	cat's ear, flatweed	Asteraceae	1-3	1-2	2	1	0-2
Hypoxis vaginata var. *brevistigmata*	yellow star	Hypoxidaceae	0-2	0-2	0-2		0-1
Hypoxis vaginata var. *vaginata*	yellow star	Hypoxidaceae	0-2				
Δ*Ibicella lutea*	yellow-flowered devil's claw	Martyniaceae	0-1				
Isotoma fluviatilis	swamp isotome	Lobeliaceae		0-4			
**Lactuca serriola*	prickly lettuce	Asteraceae		1			
Leptorhynchos squamatus ssp A	scaly buttons	Asteraceae	0-2	0-2	0-1		
Linum marginale	native flax	Linaceae	0-1				
Lythrum hyssopifolia	hyssop loosestrife	Lythraceae		0-2			
**Malva parviflora*	small-flowered mallow	Malvaceae	0-2				
Δ*Marrubium vulgare*	horehound	Lamiaceae	0-1				0-1
**Medicago arabica*	spotted burr-medic	Fabaceae	0-2				0-2
Microtis unifolia	onion orchid	Orchidaceae	0-2				
**Moenchia erecta*	erect chickweed	Caryophyllaceae	0-1				
Myriophyllum sp.	water milfoil	Haloragaceae	0-2				
Δ*Onopordum acanthium*	Scotch thistle	Asteraceae	0-1		0-1		
Δ*Onopordum ?illyricum*	Illyrian thistle	Asteraceae	0-1				
Oreomyrrhis eriopoda	Australian carraway	Apiaceae	0-1				
**Orobanche minor*	broomrape	Scrophulariaceae	0-2				
Oxalis ?perennans	oxalis	Oxalidaceae	1-2	1-2	2	2	0-2
**Papaver ?hybridum*	rough poppy	Papaveraceae	0-1				
Parietaria debilis	native pellitory	Urticaceae					0-1
**Petrorhagia nanteuilii*	proliferous pink	Caryophyllaceae	0-1	0-2			0-2
Poranthera microphylla		Euphorbiaceae	1-2		2	2	
?Prasophyllum/Microtis sp. (leaf)	leek/onion orchid	Orchidaceae	0-1				
Pterostylis curta	blunt greenhood	Orchidaceae	0-1				
Ranunculus lappaceus	common buttercup	Ranunculaceae	0-1				
**Romelea rosea*	onion weed	Iridaceae	0-2				0-1
Rumex brownii	native dock	Polygonaceae	0-2	0-1			0-1
Scleranthus fasciculatus		Caryophyllaceae		1			
Scutellaria humilis	dwarf skullcap	Scrophulariaceae	0-2				
Senecio prenanthoides		Asteraceae	0-1				
Senecio tenuiflorus		Asteraceae	0-1			1	
**Sherardia arvensis*	field madder	Rubiaceae	0-1				
**Silene gallica*	French catchfly	Caryophyllaceae	0-2				
Siloxerus multiflorus	small wrinklewort	Asteraceae	0-1				
**Silybum marianum*	variegated thistle	Asteraceae	0-1				1
**Sisymbrium officinale*	hedge mustard	Brassicaceae	0-2				
Solanum cinereum	Narrawa burr	Solanaceae	0-1				
**Solanum nigrum*	black nightshade	Solanaceae	0-1				
Solenogyne dominii	smooth solenogyne	Asteraceae	0-1	2	0-1		0-2
Solenogyne gunnii	hairy solenogyne	Asteraceae	0-1	1		1	0-1
**Sonchus asper*	prickly sow thistle	Asteraceae	0-1	1			
**Sonchus oleraceus*	sow thistle	Asteraceae	0-1				
Stackhousia monogyna	creamy candles	Stackhousiaceae	0-1				
**Stellaria media*	common chickweed	Caryophyllaceae	0-2			1-3	0-2

Scientific name	Common name	Family	Abundance				
			BGW	DG	DGFL	DGFB	NP
Stellaria pungens	prickly starwort	Caryophyllaceae				2	
Stuartina muelleri	Spoon Cudweed	Asteraceae	0-2				
Stypandra glauca	nodding blue lily	Phormiaceae	0-3				
**Taraxacum officinale*	dandelion	Asteraceae	0-1	1			0-1
Thysanotus patersonii	twining fringe-lily	Anthericaceae			0-1		
Thysanotus tuberosus	fringe-lily	Anthericaceae	0-1		0-1		
**Tolpis umbellata*	yellow hawkweed	Asteraceae	0-2				
**Tragopogon porrifolius*	salsify	Asteraceae					0-1
Tricoryne elatior	yellow autumn lily	Anthericaceae	0-1				
**Trifolium angustifolium*	narrow-leaved clover	Fabaceae	0-1				
**Trifolium arvense*	hare's foot clover	Fabaceae	0-2				
**Trifolium campestre*	hop clover	Fabaceae	0-2				0-2
**Trifolium dubium*	yellow suckling clover	Fabaceae	0-2	0-1			
**Trifolium repens*	white clover	Fabaceae				0-2	0-3
**Trifolium subterraneum*	sub clover	Fabaceae	0-1				0-2
**Trifolium* sp.	clover	Fabaceae	1-3			0-2	2-5
Triptilodiscus pygmaeus	austral sunray	Asteraceae	0-2				
**Urtica urens*	stinging nettle	Urticaceae	0-4				
**Veronica anagallis-aquatica*	water speedwell	Plantaginaceae		0-2			
Veronica calycina	hairy speedwell	Plantaginaceae	0-1				
Veronica plebeia	common speedwell	Plantaginaceae	0-2				
Viola betonicifolia	narrow-leaved violet	Violaceae			0-1		0-1
Vittadinia cuneata var cuneata	New Holland daisy	Asteraceae	0-2				
Vittadinia muelleri		Asteraceae	0-2				
Wahlenbergia communis	tufted bluebell	Campanulaceae	0-1				0-1
Wahlenbergia gracilis	sprawling bluebell	Campanulaceae					0-1
Wahlenbergia stricta	tall bluebell	Campanulaceae	0-2		0-1		
Wurmbea dioica	early nancy	Colchicaceae	0-2	0-1	0-2		0-1
Wurmbea latifolia	early nancy	Colchicaceae	0-1		0-2		
GRASSES							
**Aira caryophyllea*	hair grass	Poaceae	0-2				0-1
**Anthoxanthum odoratum*	sweet vernal grass	Poaceae	0-2				
Aristida ramosa var. *ramosa*	wiregrass	Poaceae	0-4	0-2	0-1	0-2	1-4
Austrodanthonia auriculata	wallaby grass	Poaceae	0-2				0-3
Austrodanthonia carphoides	wallaby grass	Poaceae	0-3				
Austrodanthonia eriantha	wallaby grass	Poaceae	0-3				
Austrodanthonia monticola	wallaby grass	Poaceae	0-1				
Austrodanthonia pilosa	wallaby grass	Poaceae	0-2	2			
Austrodanthonia racemosa var. *racemosa*	wallaby grass	Poaceae	0-3	1-4			
Austrodanthonia sp.	wallaby grass	Poaceae	2		2		3
Austrostipa bigeniculata		Poaceae	0-1				
Austrostipa densiflora		Poaceae	0-2		0-1		
Austrostipa scabra ssp falcata	corkscrew grass	Poaceae	0-4		0-2		0-3
**Avena* sp.	wild oats	Poaceae	0-3				
Bothriochloa macra	red-stem grass	Poaceae	1-4	0-1			0-3
**Briza maxima*	quaking grass	Poaceae	1-4		2	2	0-2
**Briza minor*	shivery grass	Poaceae	0-2	0-1			0-1
**Bromus racemosus*	soft brome	Poaceae	0-2				
**Bromus rubens*	red brome	Poaceae	0-2				
**Bromus sterilis*	sterile brome	Poaceae	0-2				
Chloris truncata	windmill grass	Poaceae	0-1				
Cymbopogon refractus	barbed wire grass	Poaceae	0-2				
Cynodon dactylon	couch	Poaceae		0-3			
**Cynosurus echinatus*	dog's tail grass	Poaceae	1-4		0-1		
Elymus scaber	common wheat grass	Poaceae	1-2		2		
**Holcus lanatus*	Yorkshire fog	Poaceae	0-1				

Scientific name	Common name	Family	Abundance				
			BGW	DG	DGFL	DGFB	NP
**Hordeum leporinum*	barley grass	Poaceae	0-4				
Joycea pallida	robust wallaby grass	Poaceae	0-1	0-2		1-4	0-3
Lachnagrostis filiformis	blown grass	Poaceae		1			
**Lolium perenne*	perennial ryegrass	Poaceae	0-5				
Microlaena stipoides	weeping grass	Poaceae	0-6	1-3	2-3	1-2	0-4
Δ**Nassella trichotoma*	serrated tussock	Poaceae					0-1
Panicum effusum	hairy panic	Poaceae	1-3		0-2		0-2
**Phalaris aquatica*	phalaris	Poaceae	0-6				
**Poa annua*	winter grass	Poaceae	0-2				0-1
Poa labillardieri	silver tussock	Poaceae					0-2
Poa ?meionectes		Poaceae					
Poa sieberiana var. *sieberiana*		Poaceae	0-2	0-2		0-2	
Poa sieberiana var. *cyanophylla*		Poaceae	0-2			0-2	
Themeda triandra	kangaroo grass	Poaceae	0-5	1-4			
**Vulpia bromoides*	squirrel-tail fescue	Poaceae	0-2				
GRAMINOIDS							
Cyperus sanguinolentus		Cyperaceae		0-2			
Isolepis sp.		Cyperaceae		0-1			
**Juncus articulatus*	jointed rush	Juncaceae		0-3			
Juncus filicaulis	pinrush	Juncaceae	1	1			
Juncus sp.		Juncaceae		0-2			
Lepidosperma laterale	Sword Sedge	Cyperaceae			0-1		
Lomandra filiformis ssp coriacea	Wattle Mat-rush	Lomandraceae	1-3		2		0-2
Lomandra filiformis ssp filiformis	Wattle Mat-rush	Lomandraceae	0-2				0-1
Lomandra longifolia	spiny matrush	Lomandraceae				1	
Lomandra multiflora	many-flowered matrush	Lomandraceae					0-1
Luzula sp.	woodrush	Juncaceae		0-1	1	1	
Schoenus apogon	bog sedge	Cyperaceae	0-3	0-2			
Typha orientalis	cumbungi, bullrush	Typhaceae		0-2			
FERNS							
Asplenium flabellifolium	necklace fern	Aspleniaceae	0-1				0-1
Cheilanthes austrotenuifolia		Sinopteridaceae	0-4		0-2		0-2
Cheilanthes distans	bristly cloak fern	Sinopteridaceae	0-1				
Cheilanthes sieberi ssp sieberi	rock or mulga fern	Sinopteridaceae	0-3	1	0-1	0-1	0-2
Pellaea sp.	Sickle Fern	Sinopteridaceae	0-1				
Pteridium esculentum	bracken	Dennstaedtiaceae					0-2

A2. Representative quadrat results for vegetation types and type variants

Condition classes:

Poor	groundlayer dominated by exotics
Poor-moderate	groundlayer dominated by one or two native grass species, very few native forbs
Moderate	groundlayer dominated by several native grasses, native forbs present but low diversity
Moderate-good	groundlayer dominated by several native grasses with a range of native forbs
Good	high groundlayer diversity, including significant forb species

A2.1 Box gum woodland – *Eucalyptus albens* on ridgetop

Condition: Poor (heavily grazed by sheep)

Location				
Property	**Turbine cluster**	**GDA map reference (centre of quadrat)**		**Quadrat size**
'Weilora'	2	MGA 652648 6154493	**Zone:** 55	20m x 20m
Physical environment				
Topographic position	**Geology**	**Elevation (m AHD)**	**Slope**	**Aspect**
Upper slope	Granitic **% surface rock:** 50	562	10°	NE

Vegetation structure and dominants					
Stratum	**Height**	**Cover**[1]	**Dominant 1**	**Dominant 2**	**Dominant 3**
Tree	10m	20%	*Eucalyptus albens*		
Small tree	-	-			
Shrub	-	-			
Groundcover	0-0.4m	20%	Unidentified grasses	**Stellaria media*	**Urtica urens*

[1] non-opaque, foliage and branches

Scientific name	Common name	Family	Cover/abundance
TREES			
Eucalyptus albens	White Box	Myrtaceae	3
FORBS			
**Arctotheca calendula*	capeweed	Asteraceae	2
**Carduus tenuiflorus*	winged slender thistle	Asteraceae	1
**Carthamus lanatus*	saffron thistle	Asteraceae	1
**Cirsium vulgare*	black thistle	Asteraceae	1
Cotula australis	Carrot Weed	Apiaceae	2
Crassula sieberiana	Australian stonecrop	Crassulaceae	1
**Erodium moschatum*	musky storksbill	Geraniaceae	2
**Geranium molle*		Geraniaceae	2
**Marrubium vulgare*	Horehound	Lamiaceae	1
**Onopordum acanthium*	Scotch thistle	Asteraceae	1
Oxalis ?perennans	oxalis	Oxalidaceae	1
Rumex brownii	native dock	Polygonaceae	2
**Silybum marianum*	Variegated Thistle	Asteraceae	1
**Stellaria media*	common chickweed	Caryophyllaceae	2
**Trifolium* sp.	clover	Fabaceae	2

Scientific name	Common name	Family	Cover/abundance
**Urtica urens*	Stinging nettle	Urticaceae	2
GRASSES			
Austrodanthonia sp.	wallaby grass	Poaceae	1
Austrostipa scabra ssp falcata	corkscrew grass	Poaceae	2
Unidentified grasses		Poaceae	2
Microlaena stipoides	weeping grass	Poaceae	1

A2.2 Box gum woodland – *Eucalyptus melliodora* on saddle

Condition: Moderate

Location					
Property	**Turbine cluster**	**GDA map reference (centre of quadrat)**			**Quadrat size**
'Marilba'	4a	MGA 654284 6149179		**Zone:** 55	20m x 20m
Physical environment					
Topographic position	**Geology**	**Elevation (m AHD)**	**Slope**		**Aspect**
Rounded saddle	Granitic **% surface rock:** <5	620	<5°		-

Vegetation structure and dominants					
Stratum	**Height**	**Cover[1]**	**Dominant 1**	**Dominant 2**	**Dominant 3**
Tree	12m	10%	*Eucalyptus melliodora*		
Small tree	-	-			
Shrub	-	-			
Groundcover	0-0.3m	80%	*Microlaena stipoides*	*Austrostipa scabra ssp falcata*	**Erodium brachycarpum*

[1] non-opaque, foliage and branches

Scientific name	Common name	Family	Cover/abundance
TREES			
Eucalyptus blakelyi	Blakely's Red Gum	Myrtaceae	1
Eucalyptus melliodora	Yellow Box	Myrtaceae	3
FORBS			
**Acetosella vulgaris*	Sheep Sorrel	Polygonaceae	1
**Arctotheca calendula*	Capeweed	Asteraceae	2
**Carthamus lanatus*	Saffron Thistle	Asteraceae	2
**Cirsium vulgare*	Black Thistle	Asteraceae	1
Crassula sieberiana	Australian Stonecrop	Crassulaceae	1
**Echium plantagineum*	Paterson's Curse	Boraginaceae	2
**Erodium brachycarpum*	Heronsbill	Geraniaceae	2
**Erodium cicutarium*	Common Storksbill	Geraniaceae	1
Erodium crinitum	Blue Storksbill	Geraniaceae	**1**
Geranium solanderi	Native Geranium	Geraniaceae	1
Hydrocotyle laxiflora	Stinking Pennywort	Apiaceae	2
**Hypochaeris radicata*	Cat's Ear, Flatweed	Asteraceae	1
**Marrubium vulgare*	Horehound	Lamiaceae	1
**Onopordum acanthium*	Scotch Thistle	Asteraceae	1
Oxalis ?perennans	Oxalis	Oxalidaceae	2
Rumex brownii	Native Dock	Polygonaceae	1
Scutellaria humilis	Dwarf Skullcap	Scrophulariaceae	1
Solenogyne dominii	Smooth Solenogyne	Asteraceae	1
**Trifolium subterraneum*	Sub Clover	Fabaceae	1
**Trifolium* sp.	Clover	Fabaceae	2
GRASSES			
Austrodanthonia sp.	Wallaby Grass	Poaceae	1

Scientific name	Common name	Family	Cover/abundance
Austrostipa scabra ssp falcata	Corkscrew Grass	Poaceae	2
Bothriochloa macra	Red-stem Grass	Poaceae	1
**Cynosurus echinatus*	Dogstail Grass	Poaceae	2
Microlaena stipoides	Weeping Grass	Poaceae	5
Panicum effusum	Hairy Panic	Poaceae	2

A2.3 Box gum woodland – *Eucalyptus blakelyi* regeneration (10-30cm dbh) on ridge crest, ungrazed

Condition: Moderate - good

Location				
Property	**Turbine cluster**	**GDA map reference (centre of quadrat)**		**Quadrat size**
'Marilba'	4b	MGA 653710 6148717	**Zone:** 55	20m x 20m
Physical environment				
Topographic position	**Geology**	**Elevation (m AHD)**	**Slope**	**Aspect**
Rounded ridge crest and upper slope	Granitic **% surface rock:** 20	653	0-10°	NNE

Vegetation structure and dominants					
Stratum	**Height**	**Cover[1]**	**Dominant 1**	**Dominant 2**	**Dominant 3**
Tree	8m	20%	*Eucalyptus blakelyi*		
Small tree	-	-			
Shrub	-	-			
Groundcover	0-1m	70%	*Themeda triandra*	*Stypandra glauca*	*Cheilanthes austrotenuifolia*

[1] non-opaque, foliage and branches

Scientific name	Common name	Family	Cover/abundance
TREES			
Allocasuarina verticillata	Dryland Drooping She-oak	Myrtaceae	1
Eucalyptus blakelyi	Blakely's Red Gum	Myrtaceae	3
FORBS			
Acaena echinata	Sheep's Burr	Rosaceae	1
**Carthamus lanatus*	Saffron Thistle	Asteraceae	1
Cynoglossum australe	Hound's Tongue	Boraginaceae	2
Geranium solanderi	Native Geranium	Geraniaceae	2
Gonocarpus elatus	Tall Raspwort	Haloragaceae	1
Hydrocotyle laxiflora	Stinking Pennywort	Apiaceae	2
Oxalis ?perennans	Oxalis	Oxalidaceae	1
Scutellaria humilis	Dwarf Skullcap	Scrophulariaceae	2
Stypandra glauca	Nodding Blue Lily	Phormiaceae	3
Wurmbea dioica	Early Nancy	Colchicaceae	1
GRASSES			
Aristida ramosa var. *ramosa*	Wiregrass	Poaceae	1
Austrodanthonia sp.	Wallaby Grass	Poaceae	2
Austrostipa ?densiflora		Poaceae	1
**Briza maxima*	Quaking Grass	Poaceae	1
**Cynosurus echinatus*	Dogstail Grass	Poaceae	2
Microlaena stipoides	Weeping Grass	Poaceae	3
Themeda triandra	Kangaroo Grass	Poaceae	3
FERNS			
Cheilanthes austrotenuifolia		Sinopteridaceae	2

A2.4 Box gum woodland – *Eucalyptus macrorhyncha* dominant on upper slope, ungrazed

Condition: Good

Location					
Property	**Turbine cluster**	**GDA map reference (centre of quadrat)**			**Quadrat size**
'Marilba'	4b	MGA 653542 6148641		**Zone:** 55	20m x 20m
Physical environment					
Topographic position	**Geology**	**Elevation (m AHD)**	**Slope**		**Aspect**
Upper slope	Granitic **% surface rock:** 5	630	15°		S

Vegetation structure and dominants					
Stratum	**Height**	**Cover**[1]	**Dominant 1**	**Dominant 2**	**Dominant 3**
Tree	8m	20%	*Eucalyptus macrorhyncha*		
Small tree	-	-			
Shrub	1-2	10	*Pomaderris angustifolia*		
Groundcover	0-1m	50%	*Gonocarpus elatus*	*Stypandra glauca*	*Microlaena stipoides*

[1] non-opaque, foliage and branches

Scientific name	Common name	Family	Cover/abundance
TREES			
Allocasuarina verticillata	Dryland Drooping She-oak	Myrtaceae	1
Eucalyptus blakelyi	Blakely's Red Gum	Myrtaceae	1
Eucalyptus goniocalyx	Long-leaved Box	Myrtaceae	1
Eucalyptus macrorhyncha	Red Stringybark	Myrtaceae	3
SHRUBS			
Pomaderris angustifolia		Myrtaceae	3
FORBS			
Acaena sp.		Rosaceae	1
Ammobium craspedioides	Yass Daisy	Asteraceae	2
**Anagallis arvensis*	Scarlet Pimpernel	Myrsinaceae	1
Bulbine bulbosa	Bulbine Lily	Asphodelaceae	1
**Centaurium erythraea*	Centaury	Gentianaceae	1
Drosera peltata	Sundew	Droseraceae	1
Geranium solanderi	Native Geranium	Geraniaceae	2
Gonocarpus elatus	Tall Raspwort	Haloragaceae	3
Gonocarpus tetragynus	Raspwort	Haloragaceae	1
Hydrocotyle laxiflora	Stinking Pennywort	Apiaceae	2
**Hypochaeris radicata*	Cat'sear, Flatweed	Asteraceae	2
Hypoxis vaginata var *brevistigmata*		Hypoxidaceae	2
Oxalis ?perennans	Oxalis	Oxalidaceae	1
Poranthera microphylla		Euphorbiaceae	2
Ranunculus lappaceus	Common Buttercup	Ranunculaceae	1
Senecio tenuiflorus		Asteraceae	1
Stackhousia monogyna	Scented Candles	Stackhousiaceae	1
Stypandra glauca	Nodding Blue Lily	Phormiaceae	3
Wurmbea dioica	Early Nancy	Colchicaceae	1
GRASSES			
Austrodanthonia sp.	Wallaby Grass	Poaceae	2
**Briza maxima*	Quaking Grass	Poaceae	1
**Cynosurus echinatus*	Dogstail Grass	Poaceae	1
Elymus scaber	Wheat Grass	Poaceae	1
Microlaena stipoides	Weeping Grass	Poaceae	3
GRAMINOIDS			
Lomandra filiformis var *coriacea*	Mat Rush	Lomandraceae	2

FERNS			
Cheilanthes austrotenuifolia		Sinopteridaceae	2

A2.5 Box gum woodland – *Allocasuarina verticillata* dominant on upper slope, ungrazed

Condition: Moderate - good

Location				
Property	**Turbine cluster**	**GDA map reference (centre of quadrat)**		**Quadrat size**
'Marilba'	4a	MGA 654065 6149009	**Zone:** 55	20m x 20m
Physical environment				
Topographic position	**Geology**	**Elevation (m AHD)**	**Slope**	**Aspect**
Upper slope	Granitic **% surface rock:** 5	600	5°	W

Vegetation structure and dominants					
Stratum	**Height**	**Cover**[1]	**Dominant 1**	**Dominant 2**	**Dominant 3**
Tree	5-7m	5%	*Allocasuarina verticillata*		
Small tree	1-4	10	*Allocasuarina verticillata*	*E. melliodora*	
Shrub	-	-			
Groundcover	0-0.4m	80%	*Gonocarpus elatus*	*Cheilanthes austrotenuifolia*	*Austrostipa scabra ssp falcata*

[1] non-opaque, foliage and branches

Scientific name	Common name	Family	Cover/abundance
TREES			
Allocasuarina verticillata	Dryland Drooping She-oak	Myrtaceae	3
Eucalyptus melliodora	Blakely's Red Gum	Myrtaceae	1
FORBS			
**Anagallis arvensis*	Scarlet Pimpernel	Myrsinaceae	1
**Arctotheca calendula*	Capeweed	Asteraceae	1
Bulbine bulbosa	Bulbine Lily	Asphodelaceae	1
Drosera peltata	Sundew	Droseraceae	2
**Echium plantagineum*	Paterson's Curse	Boraginaceae	2
Erodium sp.	Blue Storksbill	Geraniaceae	1
Geranium solanderi	Native Geranium	Geraniaceae	2
Gonocarpus elatus	Tall Raspwort	Haloragaceae	4
Gonocarpus tetragynus	Raspwort	Haloragaceae	1
Hydrocotyle laxiflora	Stinking Pennywort	Apiaceae	1
**Hypochaeris glabra*		Asteraceae	2
Hypoxis vaginata var *brevistigmata*		Hypoxidaceae	1
Leptorhynchos squamatus ssp A	Scaly Buttons	Asteraceae	1
Poranthera microphylla		Euphorbiaceae	1
**Sonchus oleracea*	Sow Thistle	Asteraceae	1
Stypandra glauca	Nodding Blue Lily	Phormiaceae	2
**Trifolium* sp.	Clover	Fabaceae	1
GRASSES			
Aristida ramosa var. *ramosa*	Wiregrass	Poaceae	2
Austrodanthonia sp.	Wallaby Grass	Poaceae	1
Austrostipa densiflora		Poaceae	2
Austrostipa scabra ssp *falcata*	Corkscrew Grass	Poaceae	3
**Briza maxima*	Quaking Grass	Poaceae	2
Elymus scaber	Wheat Grass	Poaceae	1
GRAMINOIDS			
Lomandra filiformis var *coriacea*	Mat Rush	Lomandraceae	2
FERNS			
Cheilanthes austrotenuifolia		Sinopteridaceae	4

Cheilanthes austrotenuifolia	Poison Rock Fern	Sinopteridaceae	1

A2.6 Native pasture on ridge crest

Condition: Moderate

Location					
Property	**Turbine cluster**	**GDA map reference (centre of quadrat)**			**Quadrat size**
'Marilba'	5	MGA 657321 6151295		**Zone:** 55	20m x 20m
Physical environment					
Topographic position	**Geology**	**Elevation (m AHD)**		**Slope**	**Aspect**
Upper saddle slope	Volcanic **% surface rock:** 5	682		10°	NW

Vegetation structure and dominants					
Stratum	**Height**	**Cover[1]**	**Dominant 1**	**Dominant 2**	**Dominant 3**
Tree	-	-			
Small tree	-	-			
Shrub	-	-			
Groundcover	0-0.6m	75%	*Austrodanthonia* sp.	*Bothriochloa macra*	

[1] non-opaque, foliage and branches

Scientific name	Common name	Family	Cover/abundance
FORBS			
**Acetosella vulgaris*	Sheep Sorrel	Polygonaceae	1
**Arctotheca calendula*	Capeweed	Asteraceae	1
**Carthamus lanatus*	Saffron Thistle	Asteraceae	2
Dichondra repens	Kidney Weed	Convolvulaceae	1
**Echium plantagineum*	Paterson's Curse	Boraginaceae	1
**Erodium brachycarpum*	Heronsbill	Geraniaceae	2
**Erodium cicutarium*	Common Storksbill	Geraniaceae	1
**Hypochaeris radicata*	Cat's Ear, Flatweed	Asteraceae	2
Hypoxis vaginata var. *brevistigmata*	Yellow Star	Hypoxidaceae	1
**Marrubium vulgare*	Horehound	Lamiaceae	1
Oxalis ?perennans	Oxalis	Oxalidaceae	2
**Romulea rosea*	Onion Weed	Iridaceae	1
**Trifolium* sp.	Clover	Fabaceae	2
Wurmbea dioica	Early Nancy	Colchicaceae	1
GRASSES			
Aristida ramosa var. *ramosa*	Wiregrass	Poaceae	1
Austrodanthonia sp.	Wallaby Grass	Poaceae	3
Austrostipa scabra ssp *falcata*	Corkscrew Grass	Poaceae	2
Bothriochloa macra	Red-stem Grass	Poaceae	3
Microlaena stipoides	Weeping Grass	Poaceae	2
Panicum effusum	Hairy Panic	Poaceae	2
FERNS			
Cheilanthes austrotenuifolia		Sinopteridaceae	1

A2.7 Long –leaved Box dry grass forest (*Eucalyptus goniocalyx*), regrowth 10-30cm dbh

Condition: Moderate – good

Location				
Property	**Turbine cluster**	**GDA map reference (centre of quadrat)**		**Quadrat size**
'Marilba'	6	MGA 657491 6152213	**Zone:** 55	20m x 20m

Physical environment				
Topographic position	**Geology**	**Elevation (m AHD)**	**Slope**	**Aspect**
Upper slope	Volcanic **% surface rock:** 5	617	10°	SW

Vegetation structure and dominants					
Stratum	**Height**	**Cover[1]**	**Dominant 1**	**Dominant 2**	**Dominant 3**
Tree	7	25%	*Eucalyptus goniocalyx*		
Small tree	-	-			
Shrub	-	-			
Groundcover	0-0.3m	50%	*Microlaena stipoides*	**Briza maxima*	

[1] non-opaque, foliage and branches

Scientific name	Common name	Family	Cover/abundance
TREES			
Eucalyptus goniocalyx	Bundy, Long-leaved Box	Myrtaceae	3
SHRUBS, SUB-SHRUBS			
Hibbertia obtusifolia	Guinea Flower	Dilleniaceae	1
Hovea heterophylla	Variable Hovea	Fabaceae	1
FORBS			
Acaena echinata	Sheep's Burr	Rosaceae	2
Bulbine bulbosa	Bulbine Lily	Asphodelaceae	1
Cymbonotus sp.	Bear's Ear	Asteraceae	1
Drosera peltata	Sundew	Droseraceae	1
Euchiton gymnocephalus	Creeping Cudweed	Asteraceae	1
Geranium solanderi	Native Geranium	Geraniaceae	1
Gonocarpus tetragynus	Raspwort	Haloragaceae	2
Hydrocotyle laxiflora	Stinking Pennywort	Apiaceae	2
**Hypochaeris radicata*	Cat's Ear, Flatweed	Asteraceae	2
Hypoxis vaginata var. *brevistigmata*	Yellow Star	Hypoxidaceae	2
Leptorhynchos squamatus ssp A	Scaly Buttons	Asteraceae	1
**Onopordum acanthium*	Scotch Thistle	Asteraceae	1
Oxalis ?perennans	Oxalis	Oxalidaceae	2
Poranthera microphylla		Euphorbiaceae	2
Solenogyne dominii	Smooth Solenogyne	Asteraceae	1
Thysanotus patersonii	Twining Fringe-lily	Anthericaceae	1
Viola betonicifolia	Swamp Violet	Violaceae	1
Wahlenbergia stricta	Tall Bluebell	Campanulaceae	1
Wurmbea latifolia	Early Nancy	Colchicaceae	2
GRASSES			
Aristida ramosa var. *ramosa*	Wiregrass	Poaceae	1
Austrodanthonia sp.	Wallaby Grass	Poaceae	2
Austrostipa ?densiflora		Poaceae	1
**Briza maxima*	Quaking Grass	Poaceae	2
**Cynosurus echinatus*	Dogstail Grass	Poaceae	1
Elymus scaber	Wheat Grass	Poaceae	2
Microlaena stipoides	Weeping Grass	Poaceae	3
GRAMINOIDS			
Lepidosperma laterale	Sword Sedge	Cyperaceae	1
Lomandra filiformis ssp *coriacea*	Wattle Mat-rush	Lomandraceae	2

A2.8 Brittle Gum – Broad-leaved Peppermint dry grass forest remnant (*Eucalyptus dives – E. mannifera*), ungrazed

Condition: Moderate

Location					
Property	**Turbine cluster**	**GDA map reference (centre of quadrat)**			**Quadrat size**
'Ryalla'	7	MGA 658927 6146356		**Zone:** 55	20m x 20m
Physical environment					
Topographic position	**Geology**	**Elevation (m AHD)**	**Slope**		**Aspect**
Ridge upper slope and crest	Quartzite? **% surface rock:** 5	750	10°		S

Vegetation structure and dominants

Stratum	Height	Cover[1]	Dominant 1	Dominant 2	Dominant 3
Tree	10m	30%	*Eucalyptus dives*	*Eucalyptus mannifera*	
Small tree	4m	5%	*Acacia implexa*		
Shrub	0.5m	<5%	*Hibbertia obtusifolia*		
Groundcover	0-0.5m	50%	*Joycea pallida*	*Poa sieberiana*	

[1] non-opaque, foliage and branches

Scientific name	Common name	Family	Cover/abundance
TREES			
Acacia implexa	Hickory, Lightwood	Fabaceae	2
Eucalyptus dives	Broad-leaved Peppermint	Myrtaceae	3
Eucalyptus goniocalyx	Bundy, Long-leaved Box	Myrtaceae	1
Eucalyptus mannifera	Red Spotted or Brittle Gum	Myrtaceae	3
Exocarpus cupressiformis	Native Cherry	Santalaceae	1
SHRUBS, SUBSHRUBS			
Hibbertia obtusifolia	Guinea Flower	Dilleniaceae	2
FORBS			
Asperula conferta	Woodruff	Rubiaceae	1
**Cerastium* sp.	Mouse-ear Chickweed	Caryophyllaceae	1
Gonocarpus tetragynus	Raspwort	Haloragaceae	2
Hydrocotyle laxiflora	Stinking Pennywort	Apiaceae	1
**Hypochaeris radicata*	Cat's Ear, Flatweed	Asteraceae	1
Poranthera microphylla		Euphorbiaceae	2
Senecio tenuiflorus		Asteraceae	1
Solenogyne dominii	Smooth Solenogyne	Asteraceae	1
**Stellaria media*	Common Chickweed	Caryophyllaceae	3
Stellaria pungens	Prickly Starwort	Caryophyllaceae	1
GRASSES			
**Briza maxima*	Quaking Grass	Poaceae	2
Joycea pallida	Robust Wallaby Grass	Poaceae	1-4
Microlaena stipoides	Weeping Grass	Poaceae	1
Poa sieberiana var *cyanophylla*		Poaceae	2
GRAMINOIDS			
Lomandra longifolia	Spiny Mat-rush	Lomandraceae	1
Luzula sp.	Woodrush	Juncaceae	1
FERNS			
Cheilanthes sieberi ssp sieberi	Rock or Mulga Fern	Sinopteridaceae	1

A3. Vegetation survey sites locations, methods and results summary

Key

Survey methods:

Q	Quadrat (20m x 20m or areal equivalent)
RM	Random meander (in homogeneous vegetation up to 1 ha)
I	Inspection

Consolidated vegetation types:

BGW	Box gum woodland (*Eucalyptus albens, E. melliodora, E.blakelyi*)
DG	Box gum woodland derived grassland
DGFL	Long-leaved Box dry grass forest (*E. goniocalyx*)
DGFB	Brittle Gum – Broad-leaved Peppermint dry grass forest (*E. mannifera, E. dives*)
NP	Native pasture, variable exotic component.

Understorey condition classes:

Poor	groundlayer dominated by exotics
Poor-moderate	groundlayer dominated by one or two native grass species, very few native forbs
Moderate	groundlayer dominated by several native grasses, native forbs present but low diversity
Moderate-good	groundlayer dominated by several native grasses with a range of native forbs
Good	high groundlayer diversity, including significant forb species

Significance:

EPBC	vegetation belonging to the White Box Yellow Box Blakely's Red Gum Woodland and Derived Native Grasslands Ecological Community listed as Critically Endangered under the Commonwealth EPBC Act (based on understorey diversity criteria)
TSC	vegetation belonging to the White Box Yellow Box Blakely's Red Gum Woodland Endangered Ecological Community listed under the NSW TSC Act

Cluster	Easting	Northing	Survey method	Type	Overstorey dominants	Understorey condition	Significance
1	650932	6152488	RM	BGW	*E. albens*	poor	TSC
2	652643	6154425	RM	BGW	*E. albens*	poor-mod	TSC
2	653760	6154215	RM	NP	*Microlaena stipoides, Bothriochloa macra, Austrodanthonia spp. (E. albens nearby)*	poor-mod	TSC
2	653800	6153883	RM	BGW	*E. blakelyi, Allocasuarina verticillata*	mod	TSC
2	652648	6154493	Q	BGW	*E. albens*	poor	TSC
2	653871	6153878	Q	BGW	*E. blakelyi*	mod	TSC
3	654112	6152623	Q	BGW	*E. albens, Allocasuarina verticillata*	mod-good	TSC EPBC
3	653868	6152243	RM	NP	*Austrodanthonia spp. (E. albens* nearby)	poor-mod	TSC
3	654056	6152600	RM	BGW	*E. goniocalyx, Allocasuarina verticillata (with E. blakelyi)*	mod-good	TSC EPBC
4a	654284	6149179	Q	BGW	*E. melliodora*	mod	TSC
4a	654030	6149850	RM	BGW	*E. melliodora*	poor	TSC
4a	653639	6149825	RM	BGW	*E. melliodora, E. blakelyi*	mod	TSC
4a	654026	6149814	RM	BGW	*E. melliodora*	poor	TSC
4a	654101	6149572	RM	NP	*Austrodanthonia auriculata (E. albens, E. melliodora, E goniocalyx* nearby)	mod	TSC

Cluster	Easting	Northing	Survey method	Type	Overstorey dominants	Understorey condition	Significance
4a	653805	6149842	I	BGW	*E. blakelyi*	mod	TSC
4a	653977	6149973	I	BGW	*E. blakelyi*	mod	TSC
4a	654230	6149146	RM	BGW	*Allocasuarina verticillata, E. blakelyi*	mod-good	TSC EPBC
4a	654065	6149009	Q	BGW	*Allocasuarina verticillata* (with *E. melliodora)*	mod-good	TSC EPBC
4a	654255	6149226	Q	BGW	*E. blakelyi, Allocasuarina verticillata*	mod-good	TSC EPBC
4a	654220	6149280	Q	BGW	*E. goniocalyx, Allocasuarina verticillata*	mod-good	TSC EPBC
4a	654140	6149463	RM	NP	*Kunzea ericoides, Aristida ramosa*	mod-good	TSC
4b	653848	6148356	RM	BGW	*E. blakelyi, E. albens*	mod	TSC
4b	653542	6148641	Q	BGW	*E. macrorhyncha* (with *E. blakelyi)*	good	TSC EPBC
4b	653710	6148717	Q	BGW	*E. blakelyi*	mod-good	TSC EPBC
4b	653577	6147898	I	BGW	*Kunzea ericoides thicket*	poor	TSC
4b	653710	6148263	RM	BGW	*Allocasuarina verticillata, E blakelyi*	mod-good	TSC EPBC
4b	653629	6148696	RM	BGW	*E. blakelyi*	good	TSC EPBC
4b	653549	6148105	I	BGW	*Allocasuarina verticillata, E blakelyi*	mod-good	TSC
4b	653928	6148689	RM	BGW	*E. melliodora, E. goniocalyx*	mod-good	TSC EPBC
4b	653746	6148094	I	BGW	*E. albens, E. goniocalyx*	mod	TSC
5	657583	6151782	I	BGW	*E. albens*	poor	TSC
5	657321	6151295	RM	NP	*Austrodanthonia spp., Bothriochloa macra (E. goniocalyx and E. melliodora nearby)*	poor-mod	TSC
5	657285	6151281	RM	BGW	*E. goniocalyx* (with *E. melliodora)*	mod	TSC
5-6	657470	6151933	RM	BGW	*E. mannifera, E. goniocalyx* (with *E. albens*)	mod -good	TSC
6	657491	6152213	Q	DGFL	*E. goniocalyx*	mod -good	TSC EPBC
7	658763	6147540	RM	NP	*Microlaena stipoides, Aristida ramosa, Austrodanthonia spp.*	poor-mod	-
7	658692	6146200	I	DG	*Austrodanthonia spp, Themeda triandra*	good	TSC EPBC
7	658511	6146780	I	DG	*Themeda triandra, Austrodanthonia spp*	good	TSC EPBC
7	658705	6146729	I	NP	*Aristida ramosa*	mod	-
7	658927	6146356	Q	DGFB	*E dives, E mannifera*	mod	-
7	658057	6148879	Q	DGFB	*E mannifera, E. goniocalyx*	poor-mod	-
7	657901	6148256	RM	DGFL	*E. goniocalyx*	mod	TSC
7	658063	6148234	Q	BGW	*E. melliodora, E. goniocalyx*	mod	TSC
7	659023	6145904	RM	DG	*Austrodanthonia spp, Themeda triandra*	good	TSC EPBC
Powerline	651873	6153194	I	BGW		Poor-moderate	TSC
Powerline	653176	6153386	I	BGW		Poor-moderate	TSC
Powerline	660655	6148976	I	BGW		Poor-moderate	TSC
Powerline	656253	6138942	I	BGW		Poor-	TSC

Cluster	Easting	Northing	Survey method	Type	Overstorey dominants	Understorey condition	Significance
Powerline	656322	6138824	I	BGW		moderate Poor-moderate	TSC

March 2009 additional inspection sites

Eastings	Northings	ID
660662	6148984	2
661264	6148891	17
660268	6146834	16
653176	6153389	25
653585	6153544	26
653465	6153588	38
656304	6138926	

A4. Yass Daisy (*Ammobium craspedioides*) records

Cluster	Easting	Northing
4a	654140	6149463
4a	654118	6149485
4b	653538	6148624
4b	653654	6148697
4b	653643	6148630
6	657463	6152090
6	657371	6152144
6	657391	6152173
6	657406	6152193
6	657460	6152234
6	657465	6152245
6	657480	6152130
6	657491	6152213
7	658917	6146173
7	658698	6146240
7	658692	6146200
7	658698	6146170
7	658671	6146215
7	658649	6146291
7	658648	6146324
7	658511	6146780

Appendix B FAUNA SURVEY RESULTS

1. Fauna species list

Common Name	Scientific Name
Mammals	
Brown Hare	*Lepus capensis*
Common Brushtail possum	*Trichosurus vulpecula*
Common Ringtail Possum	*Pseudocheirus peregrinus*
Common Wombat	*Vombatus ursinus*
Eastern Grey Kangaroo	*Macropus giganteus*
Eastern Wallaroo	*Macropus robustus robustus*
European Red Fox	*Canis vulpes*
House Mouse	*Mus musculus*
Short-beaked Echidna	*Tachyglossus aculeatus*
Swamp Wallaby	*Wallabia bicolor*
Yellow-footed Antechinus	*Antechinus flavipes*
Microbats	
Goulds Wattled Bat	*Chalinolobus gouldii*
Chocolate Wattled Bat	*Chalinolobus morio*
Eastern Bentwing Bat	*Miniopterus schreibersii*
	Mormopterus sp.no.4
	Mormopterus sp.no.3
Long-eared Bat	*Nyctophilus geoffroyi/gouldi complex*
Inland Broad-nosed Bat	*Scotorepens balstoni*
Little Broad-nosed Bat	*Scotorepens greyii*
White-striped Freetail bat	*Tadarida australis* (*syn. Nyctinomus australis*)
Large Forest Bat	*Vespadelus darlingtoni*
Southern Forest Bat	*Vespadelus regulus*
Little Forest Bat	*Vespadelus vulternus*
Large-footed Myotis (possible)	*Myotis macropus*
Yellow-bellied Sheathtail Bat (possible)	*Saccolaimus flaviventris*
Birds	
Australasian Grebe	*Podiceps ruficollis*
Australian Magpie	*Gymnorhina tibicen*
Australian Owlet-nightjar	*Aegotheles cristatus*
Australian Raven	*Corvus coronoides*
Black faced Cuckoo Shrike	*Coracina novaehollandiae*
Brown Falcon	*Falco berigora*
Brown Goshawk	*Accipiter fasciatus*
Brown Songlark	*Cincloramphus cruralis*
Common Starling	*Sturnus vulgaris*
Crested Pigeon	*Ocyphaps lophotes*
Crimson Rosella	*Platycercus elegans*
Diamond Firetail	*Stagonopleura guttata*
Double-barred Finch	*Poephila bichenovii*
Dusky Woodswallow	*Artamus cyanopterus*
Eastern Rosella	*Platycercus eximius*
Fan-tailed Cuckoo	*Cacomantis flabelliformis*
Galah	*Cacatua roseicapilla*
Golden Whistler	*Pachycephala pectoralis*
Grey Butcherbird	*Cracticus torquatus*
Grey Fantail	*Rhipidura fuliginosa*
Horsefield's Bronze cuckoo	*Chrysococcyx basalis*
Laughing Kookaburra	*Dacelo novaeguineae*
Little Eagle	*Hieraaetus morphnoides*
Little Pied Cormorant	*Phalacrocorax melanoleucos*
Little Wattlebird	*Anthochaera chrysoptera*
Magpie Lark	*Grallina cyanoleuca*
Masked Lapwing	*Vanellus miles*

Common Name	Scientific Name
Mistletoebird	*Dicaeum hirundinaceum*
Nankeen Kestrel	*Falco cenchroides*
Noisy Friarbird	*Philemon corniculatus*
Noisy Miner	*Manorina melanocephala*
Olive-backed Oriole	*Oriolus sagittatus*
Painted Button-quail	*Turnix varia*
Pied Currawong	*Strepera graculina*
Rainbow Bee-eater	*Merops ornatus*
Red Wattlebird	*Anthochaera carunculata*
Red-capped Robin	*Petroica goodenovii*
Red-browed Finch	*Neochmia temporalis*
Red-rumped Parrot	*Psephotus haematonotus*
Restless Flycatcher	*Myiagra iniquieta*
Richards Pipit	*Anthus novaeseelandiae*
Rufous Whistler	*Pachycephala rufiventris*
Satin Flycatcher	*Myiagra cyanoleuca*
Scarlet Robin	*Petroica multicolor*
Silvereye	*Zosterops lateralis*
Speckled Warbler	*Chthonicola sagittata*
Splendid Fairy-wren	*Malurus splendens*
Spotted Pardalote	*Pardalotus punctatus*
Striated Pardalote	*Pardalotus striatus*
Striated Thornbill	*Acanthiza lineata*
Sulfur-crested Cockatoo	*Cacatua galerita*
Superb Fairywren	*Malurus cyaneus*
Superb Parrot	*Polytelis swainsonii*
Tawny Frogmouth	*Podargus strigoides*
Wedgetail Eagle	*Aquila audax*
Weebill	*Smicrornis brevirostris*
Welcome Swallow	*Hirundo neoxena*
White-faced Heron	*Egretta novaehollandiae*
White-throated Gerygone	*Gerygone olivacea*
White plumed Honeyeater	*Lichenostomus penicillatus*
White-throated Treecreeper	*Cormobates leucophaeus*
White-winged Chough *s*	*Corcorax melanorhampho*
Willie Wagtail	*Rhipidura leucophrys*
Yellow faced honeyeater	*Lichenostomus chrysops*
Yellow thornbill	*Acanthiza nana*
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*
Reptiles	
Bearded Dragon (eastern)	*Pogona barbata*
Boulenger's Skink	*Morethia boulengeri*
Common Blue-tongued Lizard	*Tiliqua scincoides*
Copperhead Snake	*Austrelaps superbus*
Delicate Skink	*Lampropholis delicata*
Cunningham's Skink	*Egernia cunninghami*
Dwyer's Snake	*Suta spectabilis dwyeri*
Copper-tailed Skink	*Ctenotus taeniolatus*
Garden Skink	*Lampropholis guichenoti*
Marbled Gecko	*Christinus marmoratus*
Olive Legless Lizard	*Delma inornata*
Red-bellied Black Snake	*Pseudechis porphyriacus*
Shingle Back Lizard	*Tiliqua scincoides*
Southern Rainbow Skink	*Carlia tetradactyla*
Southern Rainbow Skink	*Carlia tetradactyla*
Three toed Skink	*Hemiergis decresiensis*
Tree Skink	*Egernia striolata*
	Gehyra variegata
Frogs	
Common Froglet	*Crinia signifera*
Plains Froglet	*Crinia parinsignifera*
Smooth Toadlet	*Uperoleia laevigata*
Southern Bullfrog	*Limnodynastes dumerilii*
Spotted Marsh Frog	*Limnodynastes tasmaniensis*

2. Fauna survey data summary

September 2008 survey site locations and effort (GDA datum)

Survey type	Date	start E	start N	end E	end N	Location	Person hours
trap line 1	19/09/2008	653779	6148685	653753	6148695	Upper slope 4a-4b, open woodland yellow box and red gum, native grasses	8 trap nights
trap line 2	17/09/2008	653751	6148819	653628	6148918	cluster 4a/4b	72 trap nights
trap line 3	17/09/2008	654188	6149265	654006	6149363	cluster 4a/4b	36 Trap nights
bird census 1	22/09/2008	650671	6152297	650904	6152163	Top of rocky ridge with sparse scattered mature eucalypts	20 min
bird census 2	21/09/2008	657438	6152343	657595	6151733	Lower slope Open woodland	
bird census 3	21/09/2008	657538	6152137	657438	6152343	Lower slope Open woodland	20min
bird census 4	20/09/2008	653781	6149920	653544	6149936	Mid slope just above gully in open woodland	20min
bird census 5	19/09/2008	652649	6154954	652405	6154984	Mid slope adjacent to windbreak of direct seeded native trees	20min
bird census 6	18/09/2008	653750	6153996			Lower slope Open woodland Sparse-Nil Groundcover	20min
bird census 7	18/09/2008	654188	6149265	654006	6149363	Trapline TL2 Site 4a/4b Upper slope under allocasuarina and Eucalypt	20min
bird census 8	18/09/2008	653751	6148819	653595	61489631	Midslope with rocky ground under Allocasuarina and Eucalypt Site 4a/4b	20min
bird census 9	17/09/2008	654306	6149248			Upper slope amongst Allocasuarina Site 4a/4b	20min
reptile census 1	18/09/2008	653595	6148963			Cluster 4a/4b, upper slope, small rock outcrop with Allocasuarina woodland, north aspect	40min
reptile census 2	18/09/2008	6533378	6148859			Large rock outcrop in grassland, cluster 4a/4b. North aspect	80min
reptile census 3	18/09/2008	653422	6154040			Rock outcrop in pasture, cluster 2. NW aspect	20min
reptile census 4	18/09/2008	653463	6154052			Rock outcrop in pasture , cluster 2. NW aspect	30min
reptile census 5	18/09/2008	653908	6154112			Sparse rock outcrop in heavily grazed paddock, cluster 2, NE aspect	20min
reptile census 6	19/09/2008	653549	6148269			Rock outcrop, lower pasture, Allocasuarina woodland, N aspect	40min
reptile census 7	19/09/2008	652513	6154795			Cluster 2, rock outcrop in pasture, NE aspect	30min
reptile census 8	20/09/2008	653394	6150004			Rock outcrop, hill crest in pasture, NE aspect	40min
reptile census 9	20/09/2008	653199	6150506			Rock outcrop, hillcrest in pasture, cluster 4a	40min
reptile census 10	20/09/2008	653394	6150004			Cluster 4a, open saddle, dead trees and logs in pasture	20min

Survey type	Date	start	start	end	end	Location	Person hours
reptile census 11	22/09/2008	657549	6152086	657218	6152255	Clusters 5 and 6, transect along small creek lined with rocky outcrops and sedges	45min
reptile census 12	21/09/2008	657549	6152086			Clusters 5 and 6, midslope with rock outcrop and dead wood in grassland	20min
reptile census 13	22/09/2008	650671	6152297			Cluster 1, rock outcrop on upper slope in pasture, many thistles, most rock embedded, NW aspect	20min
reptile census 14	22/09/2008	650904	6152163			Cluster 1, rock outcrop on rocky hill in pasture, some embedded roack, some loose, NW aspect	20min
anabat survey 1	17/09/2008	654165	6149239			Saddle adjacent to woodland/scrubland on upper slope - anabat place on dam	12hrs
anabat survey 2	18/09/2008	649352	6147730			Travelling stock route along Illalong Road, adjacent to creekline flat under woodland	11 hrs 45mins
anabat survey 3	20/09/2008	654306	6149248			To of saddle adjacent to woodland on upper slope (Cluster 4a-4b)	12hrs
nocturnal survey 1	17/09/2008	654306	614248	654006	6149363	Ridgetop	14min
nocturnal survey 2	18/09/2008	649359	6147722			Illalong Road - Travelling Stock Route, River Flat Woodland (50m from creek in mature trees)	20min
nocturnal survey 3	19/09/2008	654306	6149248	653779	614685	Saddle adjacent to upper slope woodland	110min
nocturnal survey 4	21/09/2008	657549	6152086	657218	6152255	Clusters 5 and 6. Riparian vegetation (small creek open woodland)	50min

Bird census transects

Cluster 7 survey, 26-28 March 2007 (AGD datum)

Date	Observer	Transect	Scientific name	Common name	Easting	Northing	Height - metres (if applicable)	Comments
27.3.07	KG	**B1**		Australian Mapgpie	659405	6146407	10	Sth section of powerline route
27.3.07	KG	**B1**		Wombat	659405	6146407		scat
27.3.07	KG	**B1**		Copperhead Snake	659405	6146407		
27.3.07	KG	**B2**		Black-faced Cuckoo Shrike	658924	6146597	1	
27.3.07	KG	**B2**		Silvereye	658924	6146597	5	
27.3.07	KG	**B2**		Australian Mapgpie	658924	6146597	5	
27.3.07	KG	**B2**		Crimson Rosella	658924	6146597	5	
27.3.07	KG	**B2**		Thornbill sp.	658924	6146597	5	
27.3.07	KG	**B2**		Superb Fairywren	658924	6146597	0	

Date	Observer	Transect	Scientific name	Common name	Easting	Northing	Height - metres (if applicable)	Comments
27.3.07	KG	**B2**		Willie Wagtail	658924	6146597	0	
27.3.07	KG	**B2**		**Wedgetail Eagle**	658924	6146597	10	single low to ground
27.3.07	KG	**B2**		Red-browed Finch	658924	6146597	5	
27.3.07	KG	**B2**		Richards Pipit	658924	6146597	0	
27.3.07	KG	**B2**		Swamp Wallaby	658924	6146597		
27.3.07	KG	**B2**		Eastern Grey Kangaroo	658924	6146597		
27.3.07	KG	**B3**		Australian Mapgpie	657926	6148436	10	
27.3.07	KG	**B3**		Striated Pardalote	657926	6148436	10	
27.3.07	KG	**B3**		Grey Fantail	657926	6148436	5	
27.3.07	KG	**B3**		Galah	657926	6148436	10	
27.3.07	KG	**B3**		Golden Whistler	657926	6148436	5	
27.3.07	KG	**B3**		Crimson Rosella	657926	6148436	5	
27.3.07	KG	**B3**		Grey Butcherbird	657926	6148436	0	
27.3.07	KG	**B3**		Pied Currawong	657926	6148436	5	
27.3.07	KG	**B3**		Brown Thornbill	657926	6148436	10	
27.3.07	KG	**B3**		Red Wattlebird	657926	6148436		
27.3.07	KG	**B3**		Willie Wagtail	657926	6148436	0	
27.3.07	KG	**B3**		Welcome Swallow	657926	6148436	10	
27.3.07	KG	**B3**		Spotted Pardalote	657926	6148436	5	
27.3.07	KG	**B3**		Eastern Grey Kangaroo	657926	6148436		
27.3.07	KG	**B3**		Fox	657926	6148436		
27.3.07	KG	**B3**		Swamp Wallaby	657926	6148436		
27.3.07	KG	**B3**		Wombat	657926	6148436		
27.3.07	KG	**B3**		skink	657926	6148436		
28.3.07	KG	**B4**		**Wedgetail Eagle**	658081	6145903	60	
28.3.07	KG	**B4**		Crimson Rosella	658081	6145903		
28.3.07	KG	**B4**		Yellow-rumped Thornbill	658081	6145903	0	
28.3.07	KG	**B4**		Striated Thorbill	658081	6145903	5	
28.3.07	KG	**B4**		Richards Pipit	658081	6145903	0	
28.3.07	KG	**B4**		Australian Mapgpie	658081	6145903		
28.3.07	KG	**B4**		**Wedgetail Eagle**	658081	6145903	80	very high on thermals
28.3.07	KG	**B5**		Crimson Rosella	658873	6146366	5	
28.3.07	KG	**B5**		Silvereye	658873	6146366	5	
28.3.07	KG	**B5**		Willie Wagtail	658873	6146366	0	
28.3.07	KG	**B5**		Grey Fantail	658873	6146366	5	

Date	Observer	Transect	Scientific name	Common name	Easting	Northing	Height - metres (if applicable)	Comments
28.3.07	KG	**B5**		Pied Currawong	658873	6146366		
28.3.07	KG	**B5**		White-throated Treecreeper	658873	6146366	5	
28.3.07	KG	**B5**		Striated Pardalote	658873	6146366	5	
28.3.07	KG	**B5**		Eastern Rosella	658873	6146366	5	
28.3.07	KG	**B5**		Crested Pigeon	658873	6146366	5	
28.3.07	KG	**B5**		Striated Thornbill	658873	6146366	5	
28.3.07	KG	**B5**		Galah	658873	6146366	10	
28.3.07	KG	**B5**		Masked Lapwing	658873	6146366	0	
28.3.07	KG	**B5**		Australian Mapgpie	658873	6146366	0	
28.3.07	KG	**B5**		Swamp Wallaby	658873	6146366		
28.3.07	KG	**B5**		Eastern Grey Kangaroo	658873	6146366		
28.3.07	KG	**B5**		Common Wombat	658873	6146366		
28.3.07	KG	**B5**		Brown Thornbill	658873	6146366	5	
28.3.07	KG	**B5**		Welcome Swallow	658873	6146366	10	
29.3.07	KG	**B6**		Australian Raven	662901	6150662		
29.3.07	KG	**B6**		Willie Wagtail	662901	6150662		
29.3.07	KG	**B6**		Thornbill sp.	662901	6150662		
29.3.07	KG	**B6**		**Australian Mapgpie**	662901	6150662		
29.3.07	KG	**B6**		Grey Fantail	662901	6150662		
29.3.07	KG	**B6**		Red-browed Finch	662901	6150662		
29.3.07	KG	**B6**		**Superb Fairywren**	662901	6150662		
29.3.07	KG	**B6**		Magpie Lark	662901	6150662		
29.3.07	KG	**B7**		Australian Mapgpie	661082	6148915		
29.3.07	KG	**B7**		Crimson Rosella	661082	6148915		
29.3.07	KG	**B7**		Galah	661082	6148915		
29.3.07	KG	**B7**		Noisy Miner?	661082	6148915		
29.3.07	KG	**B7**		Willie Wagtail	661082	6148915		
29.3.07	KG	**B7**		Eastern Rosella	661082	6148915		
29.3.07	KG	**B8**		Australian Mapgpie	660099	6148467	5	
29.3.07	KG	**B8**		Galah	660099	6148467	5	
29.3.07	**KG**	**B8**		**White-faced Heron**	**660099**	**6148467**	**10**	
29.3.07	KG	**B8**		Striated Thornbill	660099	6148467	5	
29.3.07	KG	**B8**		Crested Pigeon	660099	6148467	5	
29.3.07	KG	**B8**		Willie Wagtail	660099	6148467	0	
29.3.07	KG	**B8**		Crimson Rosella	660099	6148467	5	

Date	Observer	Transect	Scientific name	Common name	Easting	Northing	Height - metres (if applicable)	Comments
29.3.07	KG	**B8**		Little Wattlebird	660099	6148467	5	
29.3.07	KG	**B8**		Superb Fairywren	660099	6148467	0	
29.3.07	KG	**B8**		Sulfur-crested Cockatoo	660099	6148467	10	
29.3.07	KG	**B8**		Eastern Rosella	660099	6148467	20	
29.3.07	KG	**B8**		Australian Raven	660099	6148467		
29.3.07	KG	**B8**		Pied Currawong	660099	6148467	15	
29.3.07	KG	**B8**		White-winged Chough	660099	6148467	5	
29.3.07	KG	**B8**		Fox	660099	6148467	0	
29.3.07	KG	**B8**		Common Starling	660099	6148467	0	
29.3.07	**KG**	**B8**		**Australian Wooduck**	**660099**	**6148467**	**0**	
29.3.07	**KG**	**B8**		**Black-shouldered Kite**	**660099**	**6148467**	**30**	
29.3.07	**KG**	**B8**		**Nankeen Kestrel**	**660099**	**6148467**	**20**	
29.3.07	KG	**B8**		Yellow-rumped Thornbill	660099	6148467	0	
29.3.07	KG	**B8**		Common Bronzewing	660099	6148467	0	

September 2008 survey (GDA datum)

ID	Common Name	Scientific Name	Date of sighting	Location		No. recorded	Height above ground (m)
				Easting	Northing		
b1	Australian Magpie	*Gymnorhina tibicen*	22/09/2008	650671	6152297	2	10-20m
b1	Sulphur crested cockatoo	*Cacatua galerita*	22/09/2008	650671	6152297	19	0
b1	Brown Songlark	*Cincloramphus cruralis*	22/09/2008	650671	6152297	1	N/A
b1	Galah	*Cacatua roseicapilla*	22/09/2008	650671	6152297	13	0
b1	Common Starling	*Sturnus vulgaris*	22/09/2008	650671	6152297	6	2-10m
b1	Striated Pardalote	*Pardalotus striatus*	22/09/2008	650671	6152297	1	N/A
b1	Noisy Friarbird	*Philemon corniculatus*	22/09/2008	650671	6152297	2	Upper Canopy
b1	Willie Wagtail	*Rhipidura leucophrys*	22/09/2008	650671	6152297	2	2m
b1	Laughing Kookaburra	*Dacelo novaeguineae*	22/09/2008	650671	6152297	1	N/A
b1	White plumed Honeyeater	*Lichenostomus penicillatus*	22/09/2008	650671	6152297	1	10m
b1	Crimson Rosella	*Platycercus elegans*	22/09/2008	650671	6152297	4	4-5m
b1	Weebill	*Smicrornis brevirostris*	22/09/2008	650671	6152297	2	N/A
b2	Galah	*Cacatua roseicapilla*	21/09/2008	657438	6152343	2	20m

	Common Name	Scientific Name	Date of sighting	Location			
b2	Crimson Rosella	*Platycercus elegans*	21/09/2008	657438	6152343	1	N/A
b2	Laughing Kookaburra	*Dacelo novaeguineae*	21/09/2008	657438	6152343	1	N/A
b2	Grey Fantail	*Rhipidura fuliginosa*	21/09/2008	657438	6152343	1	N/A
b2	Golden Whistler	*Pachycephala pectoralis*	21/09/2008	657438	6152343	1 (F)	2
b2	Satin Flycatcher	*Myiagra cyanoleuca*	21/09/2008	657438	6152343	1	3
b2	Brown Goshawk	*Accipiter fasciatus*	21/09/2008	657438	6152343	1	15-20m
b2	Pied Currawong	*Strepera graculina*	21/09/2008	657438	6152343	3	10-15m
b2	Sulphur crested cockatoo	*Cacatua galerita*	21/09/2008	657438	6152343	1	20m
b2	**Wedge tailed Eagle**	***Aquila audax***	**21/09/2008**	**657438**	**6152343**	**2**	**100+m**
b2	**Brown Falcon**	***Falco berigora***	**21/09/2008**	**657438**	**6152343**	**1**	**20**
b3	Red Wattlebird	*Anthochaera carunculata*	21/09/2008	657538	6152137	1	N/A
b3	Noisy Friarbird	*Philemon corniculatus*	21/09/2008	657538	6152137	5	N/A
b3	Eastern Rosella	*Platycercus eximius*	21/09/2008	657538	6152137	1	N/A
b3	Australian Raven	*Corvus coronoides*	21/09/2008	657538	6152137	1	N/A
b3	**Nankeen Kestrel**	***Falco cenchroides***	**21/09/2008**	**657538**	**6152137**	**2**	**20m**
b3	Yellow rumped thornbill	*Acanthiza chrysorrhoa*	21/09/2008	657538	6152137	2	N/A
b3	Black faced Cuckoo Shrike	*Coracina novaehollandiae*	21/09/2008	657538	6152137	1	N/A
b3	Australian Magpie	*Gymnorhina tibicen*	21/09/2008	657538	6152137	1	N/A
b3	Magpie Lark	*Grallina cyanoleuca*	21/09/2008	657538	6152137	1	N/A
b3	Striated Pardalote	*Pardalotus striatus*	21/09/2008	657538	6152137	1	N/A
b3	Buff-rumped Thornbill	*Acanthiza reguloides*	21/09/2008	657538	6152137	6	0-3m
b3	Spotted Pardalote	*Pardalotus punctatus*	21/09/2008	657538	6152137	3	3
b3	White Throated Treecreeper	*Cormobates leucophaeus*	21/09/2008	657538	6152137	1	N/A
b3	Weebill	*Smicrornis brevirostris*	21/09/2008	657538	6152137	1	20m
b4	Eastern Rosella	*Platycercus eximius*	20/09/2008	653781	6149920	1	5m
b4	White Throated Treecreeper	*Cormobates leucophaeus*	20/09/2008	653781	6149920	1	N/A
b4	Striated Thornbill	*Acanthiza lineata*	20/09/2008	653781	6149920	2	2-4m
b4	Buff-rumped Thornbill	*Acanthiza reguloides*	20/09/2008	653781	6149920	6	0-3m
b4	Australian Raven	*Corvus coronoides*	20/09/2008	653781	6149920	1	N/A
b4	Australian Magpie	*Gymnorhina tibicen*	20/09/2008	653781	6149920	1	N/A
b4	Grey Fantail	*Rhipidura fuliginosa*	20/09/2008	653781	6149920	1	2m
b4	Yellow rumped thornbill	*Acanthiza chrysorrhoa*	20/09/2008	653781	6149920	1	2m
b4	Spotted Pardalote	*Pardalotus punctatus*	20/09/2008	653781	6149920	1	3m
b4	Red-capped Robin	*Petroica goodenovii*	20/09/2008	653781	6149920	1	3m
b4	Scarlet Robin	*Petroica multicolor*	20/09/2008	653781	6149920	1	1m
b4	Rufous Whistler	*Pachycephala rufiventris*	20/09/2008	653781	6149920	1	N/A

	Common Name	Scientific Name	Date of sighting	Location			
b5	Brown Songlark	*Cincloramphus cruralis*	19/09/2008	652649	6154954	1	N/A
b5	Crested Pigeon	*Ocyphaps lophotes*	19/09/2008	652649	6154954	2	0-2m
b5	White plumed Honeyeater	*Lichenostomus penicillatus*	19/09/2008	652649	6154954	2	2-3m
b5	Willie Wagtail	*Rhipidura leucophrys*	19/09/2008	652649	6154954	2	2-3m
b5	Rufous Whistler	*Pachycephala rufiventris*	19/09/2008	652649	6154954	1	N/A
b5	Australian Magpie	*Gymnorhina tibicen*	19/09/2008	652649	6154954	2	4m
b5	Crimson Rosella	*Platycercus elegans*	19/09/2008	652649	6154954	2	1.5m
b5	Grey Shrike-thrush	*Colluricincla harmonica*	19/09/2008	652649	6154954	1	1m
b5	Superb Fairy wren	*Malurus cyaneus*	19/09/2008	652649	6154954	3	0-1m
b5	Bronzewing Pigeon	*Phaps chalcoptera*	19/09/2008	652649	6154954	1	0-1m
b5	Magpie Lark	*Grallina cyanoleuca*	19/09/2008	652649	6154954	1	N/A
b5	Striated Thornbill	*Acanthiza lineata*	19/09/2008	652649	6154954	1	N/A
b5	Sulphur crested cockatoo	*Cacatua galerita*	19/09/2008	652649	6154954	20	0m
b5	Grey Fantail	*Rhipidura fuliginosa*	19/09/2008	652649	6154954	1	2m
b5	Black faced Cuckoo Shrike	*Coracina novaehollandiae*	19/09/2008	652649	6154954	1	N/A
b5	Common Starling	*Sturnus vulgaris*	19/09/2008	652649	6154954	1	10m
b5	Galah	*Cacatua roseicapilla*	19/09/2008	652649	6154954	2	N/A
b5	Yellow rumped thornbill	*Acanthiza chrysorrhoa*	19/09/2008	652649	6154954	1	0-1m
b5	**Brown Goshawk**	***Accipiter fasciatus***	**19/09/2008**	**652649**	**6154954**	**1**	**20m**
b5	Welcome Swallow	*Hirundo neoxena*	19/09/2008	652649	6154954	1	20m
b6	Australian Magpie	*Gymnorhina tibicen*	18/09/2008	653750	6153996	2	
b6	Galah	*Cacatua roseicapilla*	18/09/2008	653750	6153996	2	
b6	Horsefield's Bronze cuckoo	*Chrysococcyx basalis*	18/09/2008	653750	6153996	1	
b6	Red Wattlebird	*Anthochaera carunculata*	18/09/2008	653750	6153996	1	
b6	Pallid cuckoo	*Cuculus pallidus*	18/09/2008	653750	6153996	2	
b6	**Wedge tailed Eagle**	***Aquila audax***	**18/09/2008**	**653750**	**6153996**	**N/A**	
b6	Crimson Rosella	*Platycercus elegans*	18/09/2008	653750	6153996	1	
b6	Sulphur crested cockatoo	*Cacatua galerita*	18/09/2008	653750	6153996	1	
b6	Grey Fantail	*Rhipidura fuliginosa*	18/09/2008	653750	6153996	2	
b6	White Throated Treecreeper	*Cormobates leucophaeus*	18/09/2008	653750	6153996	N/A	
b6	Striated Thornbill	*Acanthiza lineata*	18/09/2008	653750	6153996	N/A	
b6	Red capped robin	*Petroica goodenovii*	18/09/2008	653750	6153996	1 (M)	
b6	**Nankeen Kestrel**	***Falco cenchroides***	**18/09/2008**	**653750**	**6153996**	**6**	
b6	Rufous Whistler	*Pachycephala rufiventris*	18/09/2008	653750	6153996	N/A	
b6	Yellow rumped thornbill	*Acanthiza chrysorrhoa*	18/09/2008	653750	6153996		
b6	Striated Pardalote	*Pardalotus striatus*	18/09/2008	653750	6153996		

	Common Name	Scientific Name	Date of sighting	Location			
b6	Silvereye	*Zosterops lateralis*	18/09/2008	654188	6149265	N/A	N/A
b6	Australian Raven	*Corvus coronoides*	18/09/2008	654188	6149265	1	N/A
b6	Yellow faced honeyeater	*Lichenostomus chrysops*	18/09/2008	654188	6149265	1	N/A
b6	Rufous Whistler	*Pachycephala rufiventris*	18/09/2008	654188	6149265	1	N/A
b6	Striated Pardalote	*Pardalotus striatus*	18/09/2008	654188	6149265	N/A	N/A
b6	Striated Thornbill	*Acanthiza lineata*	18/09/2008	654188	6149265	N/A	N/A
b6	White winged Chough	*Corcorax melanorhamphos*	18/09/2008	654188	6149265	N/A	N/A
b6	Superb Fairy wren	*Malurus cyaneus*	18/09/2008	654188	6149265	2	1.5m
b6	Red Wattlebird	*Anthochaera carunculata*	18/09/2008	654188	6149265	1	N/A
b6	White Throated Treecreeper	*Cormobates leucophaeus*	18/09/2008	654188	6149265	1	N/A
b6	Grey Shrike-thrush	*Colluricincla harmonica*	18/09/2008	654188	6149265	1	N/A
b6	Scarlet Robin	*Petroica multicolor*	18/09/2008	654188	6149265	1	N/A
b6	Australian Magpie	*Gymnorhina tibicen*	18/09/2008	654188	6149265	3	5-6m
b6	Grey Fantail	*Rhipidura fuliginosa*	18/09/2008	654188	6149265	1	3m
b6	Crimson Rosella	*Platycercus elegans*	18/09/2008	654188	6149265	N/A	N/A
b6	Yellow thornbill	*Acanthiza nana*	18/09/2008	654188	6149265	N/A	N/A
b6	Laughing Kookaburra	*Dacelo novaeguineae*	18/09/2008	654188	6149265	1	N/A
b6	Golden Whistler	*Pachycephala pectoralis*	18/09/2008	654188	6149265	1 (F)	3m
b8	Red capped robin	*Petroica goodenovii*	18/09/2008	653751	6148819	2	2m
b8	Striated Thornbill	*Acanthiza lineata*	18/09/2008	653751	6148819	N/A	N/A
b8	Striated Pardalote	*Pardalotus striatus*	18/09/2008	653751	6148819	N/A	N/A
b8	Yellow faced honeyeater	*Lichenostomus chrysops*	18/09/2008	653751	6148819	2	4-5m
b8	Australian Magpie	*Gymnorhina tibicen*	18/09/2008	653751	6148819	N/A	N/A
b8	**Speckled Warbler**	***Chthonicola sagittata***	**18/09/2008**	**653751**	**6148819**	**1**	**0-2m**
b8	**Brown Goshawk**	***Accipiter fasciatus***	**18/09/2008**	**653751**	**6148819**	**1**	**3m**
b8	Yellow thornbill	*Acanthiza nana*	18/09/2008	653751	6148819	2	2m
b8	Grey Fantail	*Rhipidura fuliginosa*	18/09/2008	653751	6148819	2	2-4m
b8	White winged Chough	*Corcorax melanorhamphos*	18/09/2008	653751	6148819	N/A	N/A
b8	Golden Whistler	*Pachycephala pectoralis*	18/09/2008	653751	6148819	1 (F)	2-3m
b8	Spotted Pardalote	*Pardalotus punctatus*	18/09/2008	653751	6148819	5	2
b8	Pied Currawong	*Strepera graculina*	18/09/2008	653751	6148819	N/A	N/A
b8	Grey Fantail	*Rhipidura fuliginosa*	17/09/2008	654306	6149248	4	2-m
b8	Crimson Rosella	*Platycercus elegans*	17/09/2008	654306	6149248	8	0-4m
b8	Striated Thornbill	*Acanthiza lineata*	17/09/2008	654306	6149248	2	3-4m
b8	Australian Magpie	*Gymnorhina tibicen*					2
b8	Golden Whistler	*Pachycephala pectoralis*	17/09/2008	654306	6149248	1 (F)	4m

	Common Name	Scientific Name	Date of sighting	Location			
b8	Yellow rumped thornbill	*Acanthiza chrysorrhoa*	17/09/2008	654306	6149248	6	0-4m
b8	Yellow thornbill	*Acanthiza nana*	17/09/2008	654306	6149248	2	2-4m
b8	Yellow faced honeyeater	*Lichenostomus chrysops*	17/09/2008	654306	6149248	2	4m
b8	White winged Chough	*Corcorax melanorhamphos*	17/09/2008	654306	6149248	6	4-5m

Reptile search transects

Cluster 7 survey, 26-28 March 2007 (AGD datum)

Date	Observer	Transect	Scientific name	Common name	Easting	Northing
27.3.07	KG	**R1**	*Carlia tetradactyla*		658924	6146597
28.3.07	KG	**R2**	*Pogona barbata*	Bearded Dragon (eastern)	658757	6147547
28.3.07	KG	**R2**	*Tiliqua scincoides*	Shingle Back Lizard	658757	6147547
28.3.07	KG	**R2**	*Hemiergis decresciensis*	Four Toed Skink	658757	6147547
28.3.07	KG	**R3**	*Lampropholis guichenoti*	Garden Skink	658081	6145903
28.3.07	KG	**R3**	*Tiliqua scincoides*	Shingle Back Lizard	658081	6145903

September 2008 survey (GDA datum)

ID	Common Name	Scientific Name	Location		No. observed
			Easting	Northing	
H1	Red-bellied Black Snake	*Pseudechis porphyriacus*	653595	6148963	1
	Cunningham's Skink	*Egernia cunninghami*	653595	6148963	1
	Copper-tailed Skink	*Ctenotus taeniolatus*	653595	6148963	1
H2	Southern Rainbow Skink	*Carlia tetradactyla*	653378	6148859	
	Copper-tailed Skink	*Ctenotus taeniolatus*	653378	6148859	
	Three-toed Skink	*Hemiergis decresiensis*	653378	6148859	
	Cunningham's Skink	*Egernia cunninghami*	653378	6148859	
	Boulenger's Skink	*Morethia boulengeri*	653378	6148859	
	Unidentified Skink		653378	6148859	4
H4	Olive Legless Lizard	*Delma inornata*	653463	6154052	

	Common Name	Scientific Name	Location		No. observed
	Boulenger's Skink	*Morethia boulengeri*	653463	6154052	
	Southern Rainbow Skink	*Carlia tetradactyla*	653463	6154052	
	Marbled Gecko	*Christinus marmoratus*	653463	6154052	
H6	Copper-tailed Skink	*Ctenotus taeniolatus*	653549	6148269	
	Southern Rainbow Skink	*Carlia tetradactyla*	653549	6148269	
	Dwyer's Snake	*Suta spectabilis dwyeri*	653549	6148269	
	Unidentified Skink		653549	6148269	2
H7	Boulenger's Skink	*Morethia boulengeri*	652513	6154795	
H8	Tree Skink	*Egernia striolata*	653394	6150004	1
H10	Olive Legless Lizard	*Delma inornata*	653394	6150004	
	Southern Rainbow Skink	*Carlia tetradactyla*	653394	6150004	
H11	Common Froglet	*Crinia signifera*	657549	6152086	
	Plains Froglet	*Crinia parinsignifera*	657549	6152086	
	Spotted Marsh Frog	*Limnodynastes tasmaniensis*	657549	6152086	
	Unidentified tadpoles		657549	6152086	1
H12	Olive Legless Lizard	*Delma inornata*	650671	6152297	
		Lampropholis spp.	650671	6152297	
H14	Cunningham's Skink	*Egernia cunninghami*	650904	6152163	

Spotlighting transects

Cluster 7 survey, 26-28 March 2007 (AGD datum)

Date	Observer	Transect	Scientific name	Common name	Easting	Northing	Count
27.3.07	KG PM	**S1**	*Lepus capensis*	Brown Hare	662678	6149704	
28.3.07	KG PM	**S2**		Microbat sp.	657926	6148436	
28.3.07	KG PM	**S2**		Australian Mapgpie	657926	6148436	
28.3.07	KG PM	**S2**		Eastern Grey Kangaroo	657926	6148436	
27.3.07	KG	**S3**		Brush-tail Possum	660698	6148969	2
27.3.07	KG PM	**S4**		Microbat sp.	658972	6146624	
27.3.07	KG PM	**S4**		Eastern Grey Kangaroo	658972	6146624	
27.3.07	KG PM	**S4**		Swamp Wallaby	658972	6146624	
27.3.07	KG PM	**S4**		Wombat	658972	6146624	
27.3.07	KG PM	**S4**		Australian Wooduck	658972	6146624	

Date	Observer	Transect	Scientific name	Common name	Easting	Northing	Count
27.3.07	KG PM	**S4**		Australian Mapgpie	658972	6146624	

September 2008 survey (GDA datum)

ID	Common Name	Scientific Name	Date of sighting	Location	
				Easting	Northing
SL1	Tawny Frogmouth	*Podargus strigoides*	17/09/2008	654306	6149248
SL1	Common Froglet	*Crinia signifera*	17/09/2008	654306	6149248
SL1	Plains Froglet	*Crinia parinsignifera*	17/09/2008	654306	6149248
SL1	Common Ringtail Possum	*Pseudocheirus peregrinus*	17/09/2008	654306	6149248
SL1	Spotted Marsh Frog	*Limnodynastes tasmaniensis*	17/09/2008	654306	6149248
SL1	White-striped Mastiff Bat	*Tadarida australis*	17/09/2008	654306	6149248
SL1	Red Fox	*Vulpes vulpes*	17/09/2008	654306	6149248
SL1	Common Brushtail Possum	*Trichosurus vulpecula*	17/09/2008	654306	6149248
SL2	Common Ringtail Possum	*Pseudocheirus peregrinus*	18/09/2008	649359	6147722
SL2	Common Brushtail Possum	*Trichosurus vulpecula*	18/09/2008	649359	6147722
SL3	Common Ringtail Possum	*Pseudocheirus peregrinus*	19/09/2008		654306
SL3	Common Brushtail Possum	*Trichosurus vulpecula*	19/09/2008		654306
SL3	White-striped Mastiff Bat	*Tadarida australis*	19/09/2008	654306	6149248
SL3	Australian Owlet-nightjar	*Aegotheles cristatus*	19/09/2008	654306	6149248
SL3	Spotted Marsh Frog	*Limnodynastes tasmaniensis*	19/09/2008	654306	6149248
SL3	Southern Bullfrog	*Limnodynastes dumerilii*	19/09/2008	654306	6149248
SL3	Smooth Toadlet	*Uperoleia laevigata*	19/09/2008	654306	6149248
SL3	Plains Froglet	*Crinia parinsignifera*	19/09/2008	654306	6149248
SL3	Common Froglet	*Crinia signifera*	19/09/2008	654306	6149248
SL4	Common Froglet	*Crinia signifera*			
SL4	Plains Froglet	*Crinia parinsignifera*			
SL4	Spotted Marsh Frog	*Limnodynastes tasmaniensis*			
SL4	Australian Owlet-nightjar	*Aegotheles cristatus*			
SL4	White-striped Mastiff Bat	*Tadarida australis*			

Trapping transects

Cluster 7 survey, 26-28 March 2007 (AGD datum)

Date	Observer	Transect	Scientific name	Common name	Sex	Easting	Northing	Comments
28.3.07	KG PM	**T1**	*Antechinus flavipes*	Yellow-footed Antechinus	F	658897	6146422	
28.3.07	KG PM	**T1**	*Antechinus flavipes*	Yellow-footed Antechinus	F	658897	6146422	
27.3.07	KG PM	**T2**	*Antechinus flavipes*	Yellow-footed Antechinus	M	657900	6148270	male with enlarged testes
27.3.07	KG PM	**T3**				659603	6146469	
27.3.07	KG PM	**T3**				659603	6146469	
27.3.07	KG PM	**T3**				659603	6146469	
27.3.07	KG PM	**T3**				659603	6146469	
27.3.07	KG PM	**T3**				659603	6146469	

September 2008 survey (GDA datum)

Date	Observer	Transect	Result
20/09/2008	JR SC	TL3 of 3	Nil captures
18/09/2008	JR SC	TL1 of 3	Yellow-footed Antechinus (*Antechinus flavipes*)
19/09/2008	JR SC	TL1 of 3	Yellow-footed Antechinus (*Antechinus flavipes*)
20/09/2008	JR SC	TL1 of 3	Yellow-footed Antechinus (*Antechinus flavipes*)
18/09/2008	JR SC	TL2 of 3	Nil captures
19/09/2008	JR SC	TL2 of 3	Yellow-footed Antechinus (*Antechinus flavipes*)
20/09/2008	JR SC	TL2 of 3	Yellow-footed Antechinus (*Antechinus flavipes*)

Opportunistic observations

Cluster 7 survey, 26-28 March 2007 (AGD datum)

Date	Observer	Scientific name	Common name	Height - metres (if applicable)	Comments
26.3.07	KG		Crimson Rosella		
	KG		Australian Mapgpie		
	KG		Magpie Lark		

Date	Observer	Scientific name	Common name	Height - metres (if applicable)	Comments
	KG		Grey Fantail		
	KG		White-throated Treecreeper		
	KG		**Wedgetail Eagle**		
27.3.07	KG		Australian Mapgpie		
	KG		Crimson Rosella		
	KG		Common Starling		flock of approx. 20-30, approx 10m high
	KG		Richards Pipit		
	KG		Pied Currawong		
	KG		Currawong/magpie nest? (659466 6146173)		large stick nest, not big enough for wteagle but perhaps raptor or raven/magpie, grace flat road
	KG		**Brown Falcon**	**30**	**central west area**
	KG		Brown Thornbill	5	
	KG		Yellow-rumped Thornbill		
	KG		Scarlet Robin		
	KG		**Wedgetail Eagle**	50+	Munns property, two observed clasping and tumbling, possible courtship behaviour
	KG		**Wedgetail Eagle**	50	single bird observed, lighter colours (juvenile/young?) ridgetop in Waldrens
28.3.07	**KG**		**White-faced Heron**	**20**	
	KG		Sulfur-crested Cockatoo	20	
	KG		Red-rumped Parrot	10	
	KG	*Hemiergis decresciensis*	Three toed Skink		
	KG		White-winged Chough	0	approx. 6 on ground
	KG		**Wedgetail Eagle**	0-10	flushed from ground, possibly feeding, in southern part of site
	KG	*Crinia parinsignifera*	Plains Froglet		drainage line

September 2008 survey (GDA datum)

Common Name	Scientific Name	Location	
		Easting	Northing
European Rabbit	*Oryctolagus cuniculus*	653931	6148902
Common Brushtail Possum	*Trichosurus vulpecula*	653931	6148902
Black Wallaby	*Wallabia bicolor*	653931	6148902
Red-bellied Black Snake	*Pseudechis porphyriacus*	653601	6148949

Common Name	Scientific Name	Location	
Common Blue-tongued Lizard	*Tiliqua scincoides*	653672	6149050
Common Froglet	*Crinia signifera*	653672	6149050
Plains Froglet	*Crinia parinsignifera*	653672	6149050
Fan-tailed Cuckoo	*Cacomantis flabelliformis*	653601	6148949
Pied Currawong	*Strepera graculina*	653601	6148949
Noisy Friarbird	*Philemon corniculatus*	653601	6148949
Spotted Pardalote	*Pardalotus punctatus*	653601	6148949
Splendid Fairy-wren	*Malurus splendens*	653601	6148949
Red Wattlebird	*Anthochaera carunculata*	653601	6148949
Scarlet Robin	*Petroica multicolor*	653601	6148949
Sulphur-crested Cockatoo	*Cacatua galerita*	653601	6148949
Short-beaked Echidna	*Tachyglossus aculeatus*	653601	6148949
Laughing Kookaburra	*Dacelo novaeguineae*	653601	6148949
White-throated Treecreeper	*Cormobates leucophaeus*	653601	6148949
Rufous Whistler	*Pachycephala rufiventris*	654006	6149363
Brown Hare	*Lepus capensis*	654165	6149239
Yellow-footed Antechinus	*Antechinus flavipes*	653014	6148857
Dusky Woodswallow	*Artamus cyanopterus*	654978	6149737
Diamond Firetail	***Stagonopleura guttata***	**654978**	**6149737**
Diamond Firetail	***Stagonopleura guttata***	**654089**	**6152602**
White-plumed Honeyeater	*Lichenostomus penicillatus*	654978	6149737
Crested Pigeon	*Ocyphaps lophotes*	654978	6149737
Shingle-back	*Trachydosaurus rugosus*	654076	6148889
Olive-backed Oriole	*Oriolus sagittatus*	653651	6148888
Delicate Skink	*Lampropholis delicata*	653552	6148382
Short-beaked Echidna	*Tachyglossus aculeatus*	653552	6148382
Brown Thornbill	*Acanthiza pusilla*	653552	6148382
Marbled Gecko	*Christinus marmoratus*	653552	6148382
Southern Rainbow Skink	*Carlia tetradactyla*	653659	6148267
Rainbow Bee-eater	***Merops ornatus***	**653659**	**6148267**
Speckled Warbler	***Chthonicola sagittata***	**653832**	**6148393**
Brown Falcon	***Falco berigora***	**652394**	**6154657**
Little Eagle	***Hieraaetus morphnoides***	**652394**	**6154657**
Superb Parrot	***Polytelis swainsonii***	**653595**	**6148963**
Eastern Wallaroo	*Macropus robustus robustus*	653229	6150484
House Mouse	*Mus musculus*	653229	6150484
Marbled Gecko	*Christinus marmoratus*	653229	6150484
Mistletoebird	*Dicaeum hirundinaceum*	654188	6149265
White-throated Gerygone	*Gerygone olivacea*	654188	6149265
Olive Legless Lizard	*Delma inornata*	653733	6148738
Wedge-tailed Eagle	*Aquila audax*	657275	6152225
Painted Button-quail	*Turnix varia*	654017	6149860

Common Name	Scientific Name	Location	
Garden Skink	*Lampropholis guichenoti*	644844	6149650
Eastern Bearded Dragon	*Pogona barbata*	644844	6149650
Short-beaked Echidna	*Tachyglossus aculeatus*	657438	615343
Black Wallaby	*Wallabia bicolor*	657438	615343
Eastern Grey Kangaroo	*Macropus giganteus*	657438	615343
Red Fox	*Canis vulpes*	657438	615343
Boulenger's Skink	*Morethia boulengeri*	650904	6152163

March 2009 survey (GDA datum)

Common Name	Scientific Name	Location	
		Easting	Northing
Wedge tailed Eagle	***Aquila audax***	660391	6148544
Wedge tailed Eagle	***Aquila audax***	660268	6146834
	Gehyra variegata	653176	6153386

Anabat results

Cluster 7 survey, 26-28 March 2007 (AGD datum)

Species	Common name	Poss	Prob	Positive	Totals
27.3.07: near southern ridgetop forest remnant					
Chalinolobus gouldii	Goulds Wattled Bat	0	2	1	3
Chalinolobus morio	Chocolate Wattled Bat	1	1	0	2
Mormopterus sp. no.4 lpf		1	2	2	5
Mormopterus sp. no.3 spf		0	1	0	1
Miniopterus schreibersii	Eastern Bentwing Bat	0	2	0	2
Nyctophilus geoffroyi/gouldi complex	Long-eared Bat	0	0	3	3
Scotorepens balstoni	Inland Broad-nosed Bat	0	0	1	1
Scotorepens greyii	Little Broad-nosed Bat	0	2	1	3
Vespadelus darlingtoni	Large Forest Bat	6	12	4	22
Vespadelus regulus	Southern Forest Bat	2	8	2	12
Vespadelus vulternus	Little Forest Bat	1	3	3	7
28.3.07: near northern saddle dam					

Species	Common name	Poss	Prob	Positive	Totals
Chalinolobus gouldii	Goulds Wattled Bat	2	0	0	2
Chalinolobus morio	Chocolate Wattled Bat	2	2	1	5
Miniopterus schreibersii	Eastern Bentwing Bat	1	0	0	1
Mormopterus sp. no.4 lpf		6	4	1	11
Mormopterus sp. no.3 spf		1	0	0	1
Nyctophilus geoffroyi/gouldi complex	Long-eared Bat	2	0	10	12
Scotorepens balstoni	Inland Broad-nosed Bat	3	4	3	10
Scotorepens greyii	Little Broad-nosed bat	3	3	3	9
Vespadelus darlingtoni	Large Forest bat	5	3	3	11
Vespadelus regulus	Southern Forest Bat	1	2	1	4
Vespadelus vulternus	Little Forest Bat	2	1	0	3
29.3.07: Linear roadside woodland remnant (Graces Flat Road)					
Chalinolobus gouldii	Goulds Wattled Bat	1	0	0	1
Chalinolobus morio	Chocolate Wattled Bat	1	0	0	1
Mormopterus sp. no.4 lpf		3	11	6	20
Mormopterus sp. no.3 spf		0	4	0	4
Nyctophilus geoffroyi/gouldi complex	Long-eared Bat	2	3	6	11
Scotorepens greyii	Little Broad-nosed bat	1	0	0	1
Tadarida australis	White striped Freetail bat	1	1	2	4

September 2008 survey (GDA datum)

Species	Common name	ID confidence	No. records
17.9.08			
Miniopterus schreibersii	Eastern Bentwing Bat	1	2
Miniopterus schreibersii	Eastern Bentwing Bat	2	16
Miniopterus schreibersii	Eastern Bentwing Bat	3	2
Chalinolobus morio	Chocolate Wattled Bat	1	1
Chalinolobus morio	Chocolate Wattled Bat	2	1
Chalinolobus morio	Chocolate Wattled Bat	3	1
Vespadelus vulternus	Little Forest Bat	2	3
Vespadelus sp.	Little Forest Bat	2	2
Nyctophilus sp. or *Myotis macropus*	Long-eared Bat	2	1
18.9.08			

Species	Common name	ID confidence	No. records
Miniopterus schreibersii	Eastern Bentwing Bat	1	1
Miniopterus schreibersii	Eastern Bentwing Bat	2	3
Vespadelus regulus	Southern Forest Bat	2	1
Vespadelus vulternus	Little Forest Bat	2	3
Vespadelus sp.	Little Forest Bat	2	5
Vespadelus sp. or Miniopterus schreibersii	Little Forest Bat	1	1
Mormopterus sp. no.4		2	1
Mormopterus sp. no.3 or 4		2	2
Mormopterus sp. no.3 or 4 or Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	1	2
Nyctophilus sp.	Long-eared Bat	2	1
Nyctophilus sp. or Myotis macropus	Long-eared Bat	1	5

September 2008 habitat evaluation (GDA datum)

Evaluation site location and description

Site no.	Cluster	Date	eastings	northings	General Description	Landscape Position	Habitat type	Disturbance level (0-3)	Size of remnant	% vegetation	% other	% bare ground	% rocks
1	**4A**	17/09/2008	654130	6149453	Cleared slope	Upper slope	Cleared	2, cattle grazing		95			5
2	**4A**	17/09/2008	654143	6149316	Eucalypt woodland	Mid slope	Woodland	2, cattle grazing	140ha	95	43		2
3	**4B**	17/09/2008	653860	6148767	Casuarina woodland	Upper slope	Woodland	2, cattle grazing, regrowth	140ha	95	5		
4	**4A**	17/09/2008	654137	6149085	Casuarina woodland	Upper slope	Woodland	2, cattle grazing, regrowth	140ha	90	8		2
5	**2**	17/09/2008	652644	6154428	Cleared with rock outcrops	Upper slope	Cleared/rock outcrop	3, sheep grazing	0	90			10
6	**2**	17/09/2008	652640	6154488	Cleared with rock outcrops	Upper slope	Cleared/rock outcrop	3, sheep grazing	$60m^2$	70		5	25
7	**2**	17/09/2008	653755	6154216	Cleared rocky ridge	Ridge	Cleared/rock outcrop	3, sheep grazing		70		10	20

Site no.	Cluster	Date	eastings	northings	General Description	Landscape Position	Habitat type	Disturbance level (0-3)	Size of remnant	% vegetation	% other	% bare ground	% rocks
8	**2**	17/09/2008	653789	6153935	Woodland	Mid slope	Woodland	2, sheep grazing	12.5ha	80		10	10
9	**1**	17/09/2008	650923	6152302	Cleared rocky ridge	Ridge	Cleared/rock outcrop	3, sheep grazing, weed infestation	0	70			30
10	**1**	17/09/2008	650951	6152422	Cleared rocky slope	Mid slope	Cleared/rock outcrop	3, sheep grazing, weed infestation		50		15	35
11	**7**	20/09/2008	658698	6146264	Cleared saddle	Lower slope	Cleared	3, sheep grazing		60		30	10
12	**6**	20/09/2008	657368	6152281	Eucalypt woodland	Mid slope	Forest	1, regrowth, sheep grazing	12.5ha	40	20	20	20
13	**6**	20/09/2008	657416	6152071	Drainage line	Gully	Forest	2, regrowth, sheep grazing	12.5ha	50			50
14	**5**	20/09/2008	657327	6151301	Cleared Slope	Mid slope	Woodland	3, sheep grazing	$400m^2$	90	5		5
15	**4**	22/09/2008	654000	6154057	Casuarina woodland in gully	Gully	Woodland	1, cattle grazing	140ha	80			20
16	**2**	17/09/2008	653843	6154057	Cleared Pasture	Upper slope	Cleared	3, sheep grazing		60		30	10
17	**2**	17/09/2008	653447	6154124	Rock Outcrop	Ridge	Rock outcrop	2, grazing	0	<5			95

Tree habitats

Site no.	Standing Dead Timber Y/N	Hollows or fissures Y/N	Feed trees and mistletoe Y/N	Hollows Y/N	Abundance	Size range	spouts Y/N	crevices/fissures	recruits Y/N	signs of use Y/N
1										
2	Y	Y	Y	Y	medium	5-15cm	Y (in dead standing timber	Y (in dead standing timber	Y	N

3	Y	Y	Y	Y	medium	5-15cm	Y (in dead standing timber	Y (in dead standing timber	Y	Y
4	Y	Y	Y	Y	medium	5-15cm	Y (in dead standing timber	Y (in dead standing timber	Y	Y
5	Y	Y	N	Y	medium	5-15cm	Y (in dead standing timber	Y (in dead standing timber	Y	N
6	Y	Y	N	Y	Abundant	5-15cm	Y (in dead standing timber	Y (in dead standing timber	Y	N
7										
8	Y	Y	Y	Y	Low	<10cm	N	N	Y	N
9	Y	Y	N	Y	Low	10cm	N	N	Y	N
10										
11										
12	Y	N	Y							
13	Y	N	Y							
14	Y	Y	N	Y	High	10-20cm	Y	Y	Y	N
15	Y	Y	Y	Y	rare	5-10cm	Y (in dead standing timber)	Y (in dead standing timber)	Y	N
16										
17	N	N	Y							

Rock and groundlayer habitats

Site no.	Rock outcrops Y/N	Size range of rocks	Size range of crevices	Black ants present Y/N	Refuge (tussocks, fallen timber)
1	N				
2	N				
3	Y	10cm-3m	N/A	N/A	Y
4	Y	10cm-3m	N/A	N/A	Y
5	Y	10cm-3m	2cm	N/A	Y
6	Y	10cm-3m	N/A	N	Y
7	Y	10cm-1m	2-8cm	N	N
8	N				
9	Y	10-30cm	N/A	Y	N
10	Y	10-1m	N/A	Y	Y

Site no.	Rock outcrops Y/N	Size range of rocks	Size range of crevices	Black ants present Y/N	Refuge (tussocks, fallen timber)
11	N				
12	N				
13	N				
14	N				
15	N				
16	Y	2-15cm	N/A	N	N
17	Y	10cm->5m	2cm->15cm	Y	Y

March 2009 Coppabella – Marilba and Marilba – Carroll's Ridge powerline habitat constraints assessment (GDA)

Northings	Eastings	Constraint level	Recommended response	Comments
6148977	660655	moderate	mitigate	box-gum woodland surrounded by cleared land with scattered trees. Grassy tussocks suitable for reptiles, HBTs with signs of use - may provide small area of habitat for possums, goannas, and variety of birds. Potential for threatened reptiles but unlikely threatened mammal.
6148974	660707	high	avoid	box-gum woodland linear remnant with 20-50% canopy with HBTs with signs of use. Sparse understorey with falls timber and refuse piles. Habitat provision as above. Quite isolated for forest dependent spp by surrounding paddocks.
6153194	651873	low	mitigate	pasture with scattered trees (box-gum woodland) disturbed by grazing and clearing. Hollow-bearing trees (high constraints) and small rocky outcrops scattered around. Fairly homogenous surrounding. Several dams nearby, habitat likely to be used by birds incl, hbt dependent and raptors. Mistletoe present. reptiles may be present although may be reduced by grazing.
6153386	653176	high	avoid	box-gum woodland remnant with sparse understorey (grazed) which covers hillside and saddle area above and within the gully. Features several hollows, incised banks for rainbow bee-eaters, feed shrub species, rocky areas suitable for reptiles (loose and buried rock) with scattered tussocks. Gehyra variegata egg found.
6153898	655056	low	mitigate	pasture with scattered trees (box-gum woodland) disturbed by grazing and clearing. Hollow-bearing trees (high constraints) scattered around. Fairly homogenous surrounding. Habitat likely to be used by birds
6138942	656253	high	avoid	Dry creek incised with fringing mature bgw trees and long native grasses and tussocks. Piles of bark and litter, hbts, likely to be CEEC, habitat suitable fore reptiles, birds and some mammals incl. arboreal.

Appendix C THREATENED SPECIES EVALUATION

An evaluation of threatened species known from the area from both the Environmental Reporting Tool (EPBC Act) and DECC Wildlife Atlas database (TSC Act) determined that several species have potential to occur at the subject site based on the known habitat requirements and their recorded distribution.

The EPBC Matters of National Environmental Significance Search Tool results are based on a 50km buffer around the approximate centre of the subject site (34° 46’ 37” S, 148° 42’ 12.62” E) (24.09.08). The NPWS Atlas search is based on 3 sub-regions from the Murrumbidgee CMA region; Murrumbateman (M), Upper Slopes (U) and Bondo (B). Marine and littoral fauna species have been excluded from this analysis due to the absence of suitable habitat.

The following definitions are used in this evaluation.

Presence of habitat	
Present	Potential or known foraging, roosting, nesting, refuge, movement corridor (including movement of genetic material) or other habitat is present within the study area
Absent	No potential foraging, roosting, nesting or other habitat is present within the study area
Likelihood of occurrence	
None	Species has a very low, or no, probability of occurrence
Vagrant	Species could occur on occasion as a vagrant or passing over/across the study area (usually applies to more mobile fauna species)
Possible	Species could occur and utilise resources in the study area
Present	Species was recorded during the field investigations
Possible impact	
No	The proposal would not impact this species or its habitats. No Seven-Part Test is necessary for this species.
Yes	The proposal could impact this species or its habitats. A Seven-Part Test for NSW threatened species or an EPBC Assessment of Significance has been undertaken for these species unless, in the case of easily recordable plant species, field survey has demonstrated that the species is absent from the site.

1. Threatened flora and ecological communities

Species and status*	Ecology and distribution	Vegetation community	Presence of habitat	CMA sub-region records and EPBC presence type	Likelihood of occurrence	Recorded during survey?	Potential to be impacted
SHRUBS							
Grevillea iaspicula Wee Jasper Grevillea TSC (E) EPBC (E)	Restricted to limestone outcrops in the Wee Jasper area and on the shores of Lake Burrinjuck c. 20km south of the site (DECC 2008a).	• Southern Tableland Dry Sclerophyll Forests • Southern Tableland Grassy Woodlands	Absent	Known M and B. EPBC search indicates likely to occur.	None	No	No
Grevillea wilkinsonii Tumut Grevillea TSC (E)	The Tumut Grevillea is found in two areas: one is a 4.5 km stretch of the Goobarragandra River, approximately 18 km south-east of Tumut; the other at a small site near Gundagai. Habitat is in dense riparian shrubland on steep rocky slopes or on alluvial terraces with sparse tree cover. Typical associated tree species are *E. blakelyi, E. macrorhyncha, E. bridgesiana* and *E. melliodora.*	• Southern Tableland Grassy Woodlands • Southern Tableland Wet Sclerophyll Forests	Absent	Known B and U.	None	No	No
Pomaderris cotoneaster Cotoneaster Pomaderris TSC (E)	This shrub grows in riparian and rocky areas, the latter often close to creeks. It is known from the Tumut area (Goobarragandra River), and Bungonia Gorge (J. Miles, pers. obs.), but not from near Yass.	• Southern Tableland Grassy Woodlands • Southern Tableland Wet Sclerophyll Forests	Absent	Known B, Predicted U.	None	No	No

Species and status*	Ecology and distribution	Vegetation community	Presence of habitat	CMA sub-region records and EPBC presence type	Likelihood of occurrence	Recorded during survey?	Potential to be impacted
FORBS							
Ammobium craspedioides Yass Daisy TSC (V) EPBC (V)	Perennial daisy growing in sclerophyll woodland, forest and roadsides, in Yass district and near Wagga Wagga. Numerous Atlas records in district including along Black Range Road, Burrinjuck Road and Hume Highway.	• Southern Tableland Dry Sclerophyll Forests • Southern Tableland Grassy Woodlands • Upper Riverina Dry Sclerophyll Forests • Western Slopes Dry Sclerophyll Forests • Western Slopes Grassy Woodlands	Present	Known from all 3 EPBC search indicates likely to occur.	Present	Yes	Yes
Calotis glandulosa Mauve Burr-daisy TSC (V) EPBC (V)	A low perennial forb which grows in montane or subalpine grassland or grassy woodland on the tablelands and slopes, including disturbed areas.	Not indicated in DECC CMA search or EPBC search.	Present	Not indicated	Possible	No	No
Cullen parvum Small Scurf-pea TSC (E)	A small erect or trailing perennial pea flowering in summer. Plants tend to die back over summer and resprout with rain in winter or spring; survives below-ground in dry years (DECC 2008a). Recorded in grassy woodland on the slopes/tablelands and in the Riverina.	Not indicated in DECC CMA search.	Present	Not indicated	Possible	No	Yes
Leucochrysum albicans ssp *albicans* var *tricolor* Hoary Sunray EPBC (E)	Perennial daisy growing in natural and secondary grasslands and grassy woodlands, often colonising disturbed sites such as road verges, but does not persist well in grazed situations Flowers spring-summer. May be locally common on the Southern Tablelands, and is not listed as threatened in NSW. Not recorded in the region.	Not indicated in DECC CMA search.	Present	EPBC search indicates likely to occur.	Possible	No	No

Species and status*	Ecology and distribution	Vegetation community	Presence of habitat	CMA sub-region records and EPBC presence type	Likelihood of occurrence	Recorded during survey?	Potential to be impacted
Rutidosis leptorhynchoides Button Wrinklewort TSC (E) EPBC (E)	A multi-stemmed perennial herb restricted to natural grassland and margins of grassy woodland. Recorded near Sutton, c. 30km SE of the site.	Not indicated in DECC CMA search or EPBC search.	Present	Not indicated	Possible	No	No
Senecio garlandii Woolly Ragwort TSC (V) EPBC (V)	Largely restricted to dry forests on western slopes of NSW, growing on rocky outcrops and exposed ridges. Main distribution is well west of the site, but a record exists near Burrinjuck Dam c. 25 km south-west of the site.	• Southern Tableland Dry Sclerophyll Forests • Southern Tableland Grassy Woodlands • Upper Riverina Dry Sclerophyll Forests • Western Slopes Dry Sclerophyll Forests • Western Slopes Grassy Woodlands	Present	Known from B and U, predicted M	Possible	No	No
Swainsona recta Small Purple Pea TSC (E) EPBC (E)	A small perennial pea recorded on the central and south west slopes and the ACT/Queanbeyan area. It occurs in grassy woodland on undulating terrain, often stony hillsides and flowers in spring (peaking Oct).	Not indicated in DECC CMA search or EPBC search.	Present	Not indicated	Possible	No	No

Species and status*	Ecology and distribution	Vegetation community	Presence of habitat	CMA sub-region records and EPBC presence type	Likelihood of occurrence	Recorded during survey?	Potential to be impacted
Swainsona sericea Silky Swainson-pea TSC (V)	Recorded in Natural Temperate Grassland, Snow Gum Woodland and Box-Gum Woodland on the Monaro, Northern Tablelands and Southern Tablelands, and inland on the slopes and plains. Not recorded in the region.	• Floodplain Transition Woodlands • Southern Tableland Dry Sclerophyll Forests • Southern Tableland Grassy Woodlands • Subalpine Woodlands • Tableland Clay Grassy Woodlands • Temperate Montane Grasslands • Upper Riverina Dry Sclerophyll Forests • Western Peneplain Woodlands • Western Slopes Dry Sclerophyll Forests • Western Slopes Grassy Woodlands	Present	Known M and U.	Possible	No	Yes
Thesium australe Austral Toadflax TSC (V) EPBC (V)	A sprawling perennial herb growing in grassland and woodland, semi- parasitic on grasses, particularly kangaroo grass. Found in small populations across eastern NSW, along the coast and from the Northern to Southern Tablelands. Shows a preference for moist areas. Not recorded in the region.	• Coast and Tableland Riverine Forests • Montane Bogs and Fens • Southern Escarpment Wet Sclerophyll Forests • Southern Tableland Dry Sclerophyll Forests • Southern Tableland Grassy Woodlands • Southern Tableland Wet Sclerophyll Forests • Subalpine Woodlands • Tableland Clay Grassy Woodlands • Temperate Montane Grasslands	Present (marginal)	Known from B, predicted M. EPBC search indicates likely to occur.	Possible	No	Yes

Species and status*	Ecology and distribution	Vegetation community	Presence of habitat	CMA sub-region records and EPBC presence type	Likelihood of occurrence	Recorded during survey?	Potential to be impacted
ORCHIDS							
Caladenia sp Burrinjuck Burrinjuck Spider Orchid (Formerly included in *Caladenia concolor sens. lat.*) TSC (V) EPBC (V)	An undescribed terrestrial orchid recorded growing in dry open forest (including *E. goniocalyx, E. dives, E. macrorhyncha, E, mannifera, E. rossii*) with a shrubby understorey, in Burrinjuck Waters State Park and Nature Reserve, c. 20 km south-west of the site. Flowers late August-October.	Not indicated in DECC CMA search or EPBC search. *Caladenia concolor* indicated for: • Upper Riverina Dry Sclerophyll Forests • Western Slopes Dry Sclerophyll Forests	Present	Known U and B, Predicted M EPBC search indicates likely to occur (*Caladenia concolor*).	Possible	No	Yes
Diuris pedunculata Small Snake Orchid TSC (E) EPBC (E)	Terrestrial orchid favouring grassland, often in stony soils on low ridges or moist flats. Recorded in south-east tablelands at higher elevations (>1000m ASL) at Adaminaby, Bago State Forest and Snowy Plains. Flowers August-September on the Northern Tablelands (Bishop 1996), but flowering in late November at Snowy Plains (J. Miles, pers. obs.).	Not indicated in DECC CMA search.	Absent	Not indicated	None	No	No
Diuris tricolor (syn. D. *sheaffiana*) Pine Donkey Orchid, Tricolour Diuris TSC (V) EPBC (V)	Sporadically distributed from Narrandera across the western slopes to northern NSW, usually in grassy *Callitris* woodland on sandy soils in flat country or on top of small hills. Not recorded in the region.	• Floodplain Transition Woodlands • Upper Riverina Dry Sclerophyll Forests • Western Peneplain Woodlands • Western Slopes Dry Sclerophyll Forests	Absent	Known from U. EPBC search indicates may occur.	None	No	No

Species and status*	Ecology and distribution	Vegetation community	Presence of habitat	CMA sub-region records and EPBC presence type	Likelihood of occurrence	Recorded during survey?	Potential to be impacted
Prasophyllum petilum Tarengo Leek Orchid TSC (E) EPBC (E)	Recorded from grassy woodland in Hall cemetery, c. 55km south-east of the site, Booroowa 45km north of the site and Captains Flat, in Natural Temperate Grassland, Box-Gum Woodland or moist grassy flats, with kangaroo grass or wallaby grasses (*Austrodanthonia* spp), in silty clay-loam. The Hall and Captains Flat populations occur in areas with high watertables. Flowers Oct-Nov.	• Southern Tableland Grassy Woodlands • Tableland Clay Grassy Woodlands • Temperate Montane Grasslands	Present	Predicted M and U.	Possible	No	No
FERNS AND FERN ALLIES							
Austral Pillwort *Pilularia novae-hollandiae* TSC (E)	Recorded from suburban Sydney, Khancoban, the Riverina between Albury and Urana in shallow swamps and waterways, often among grasses and sedges, in drying mud and in roadside table drains. Recorded in the ACT in a subalpine grassy plain. Not recorded in the region.	• Floodplain Transition Woodlands • Inland Riverine Forests	Absent	Predicted U	None	No	No
ECOLOGICAL COMMUNITIES							
Aquatic ecological community in the natural drainage system of the lower Murray River catchment (TSC)				Known all 3	None	No	No
Inland Grey Box Woodland in the Riverina; NSW South Western Slopes; Cobar Peneplain; Nandewar and Brigalow Belt South Bioregions (TSC)				Known U	None	No	No
Natural Temperate Grassland of the Southern Tablelands of NSW and the ACT (EPBC)				Known all three EPBC search indicates likely to occur.	None	No	No
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (EPBC, TSC)				Known M and U, predicted B EPBC search indicates likely to occur.	Present	Yes	Yes

Threatened flora evaluation summary

Based on the above analysis, eleven threatened species have some possibility to be present at the subject site, based on known distribution or habitat requirements:

Yass Daisy	*Ammobium craspedioides*
Burrinjuck Spider Orchid	*Caladenia* sp Burrinjuck
Mauve Burr-daisy	*Calotis glandulosa*
Small Scurf-pea	*Cullen parvum*
Hoary Sunray	*Leucochrysum albicans*
Tarengo Leek Orchid	*Prasophyllum petilum*
Button Wrinklewort	*Rutidosis leptorhynchoides*
Woolly Ragwort	*Senecio garlandii*
Small Purple-pea	*Swainsona recta*
Silky Swainson-pea	*Swainsona sericea*
Austral Toadflax	*Thesium australe*

Of these species, only *Ammobium craspedioides, Caladenia* sp Burrinjuck, *Cullen parvum, Swainsona sericea* and *Thesium australe* are considered to have a realistic potential to be present at the subject site, considering site quality, disturbance history, distribution ranges and the results of the field surveys.

Most of the species listed above inhabit box gum woodland communities. Targeted searches for threatened species were undertaken in the box gum woodland stands in best condition at the subject site in September and November. *Calotis glandulosa, Leucochrysum albicans, Rutidosis leptorhynchoides* and *Senecio garlandii* - are perennial and conspicuous and should have been readily recordable during field survey. *Swainsona recta* may be more difficult to detect when not flowering but its known highly restricted distribution pattern, the distance of records from the subject site, coupled with site habitat quality and disturbance history, makes the probability of its presence at the site very low.

Prasophyllum petilum is known only from ungrazed remnants of high native species diversity. At the Tarengo TSR, the Tarengo Leek Orchid grows in remnant *Themeda triandra-Bothriochloa macra* grassland (NPWS 2002). Potential habitat at the subject site was surveyed during the November flowering period for this species (it was flowering at Hall Cemetery during the survey period) and was not recorded. The potential for its presence elsewhere at the subject site is very low.

Caladenia sp Burrinjuck has moderate potential to be present in dry shrub/grass forest stands at the subject site, particularly the Broad-leaved Peppermint – Brittle Gum community in the south of cluster 7, and may not have been recordable during the survey period. The survey was conducted during the late August to October flowering period and the species was not detected, though it is unlikely to flower reliably every year, or could flower later than the survey period (16-21 September).

Three woodland species - *Swainsona sericea, Cullen parvum* and *Thesium australe* – have moderate potential to be present in less disturbed woodland at the subject site. *Ammobium craspedioides* was recorded at three of the turbine cluster ridges. *Ammobium craspedioides, Caladenia* sp Burrinjuck, *Cullen parvum, Swainsona sericea* and *Thesium australe* have been included in the Assessment of Significance (Appendix E).

2. Threatened fauna

The Threatened Species Evaluation assesses the potential for threatened species to be present at the proposal site, based on available habitat, known ecological requirements, local distribution records and the results of online database searches. The impact risk rating is derived from the cumulative scores of eight risk factors:

1. The species is known to occur within the region (weighted 2 units)
2. The species could breed onsite
3. Breeding habitat has the potential to be impacted
4. The species could forage onsite
5. Foraging habitat has the potential to be impacted
6. The species may fly at the height of the turbine blades (40m) and may therefore be at risk of collision or barotrauma
7. Given 4, the species is a flocking or colonial species (individuals cluster in groups)
8. The species is migratory or nomadic.

All factors were weighted equally, except for presence of local records as this was considered to be important to filter out species with known distribution ranges outside the study area. The risk assessment is based on the proposed works described in section 4 and the expected vegetation and habitat loss quantified in section 8. Importantly, the assessment assumes the adoption of measures to avoid and protect the sensitive habitats at clusters 3, 4, 6 and 7 identified in section 9.

SPECIES AND STATUS*	ECOLOGY	PRESENCE OF HABITAT	NEAREST RECORDS	LIKELIHOOD OF OCCURRENCE	POTENTIAL TO BE IMPACTED	IMPACT RISK
Amphibians						
Green and Golden Bell Frog *Litoria aurea* E TSC V EPBC	Formerly, had a wide distribution across most of NSW, although since 1990 recorded populations have become largely restricted to small, coastal or near coastal populations. This species has been recorded in a wide variety of natural and man-made waterbodies such as coastal swamps, marshes, lagoons, permanent farm dams and other excavations capable of capturing water (DEC 2005a). Habitats are generally permanent, still or slow-flowing, unpolluted waterbodies with a complexity of vegetation structure and abundance of refuge sites, although without heavy shading (DEC 2005a).	Marginal. Farm dams are accessible to stock, with little or no aquatic or fringing vegetation, and generally eroded	Has not been recorded within 20km of the site	Unlikely	Yes, farm dams near the turbines would be filled to prevent attracting birds and bats to the site, this would have impacts on amphibian species present on the site	**4**
Booroolong Frog *Litoria booroolongensis*	Occurs predominantly along the western-flowing streams of Great Dividing Range. It occurs in permanent rocky streams with fringing	Absent	This species has been recorded in	None	No	**2**

SPECIES AND STATUS*	ECOLOGY	PRESENCE OF HABITAT	NEAREST RECORDS	LIKELIHOOD OF OCCURRENCE	POTENTIAL TO BE IMPACTED	IMPACT RISK
E TSC E EPBC	vegetation cover such as ferns, sedges or grasses (DECC 2008a). Adults shelter under rocks adjacent to streams and lay their eggs under small in-stream rocks and rocky margins (Regan 2002). The majority of records are from the Tumut area.		the region, near Burrinjuck Dam.			
Yellow-spotted Bell Frog *Litoria castanea* E TSC E EPBC	Not recorded in the wild since the 1970s (DECC 2008a). It occurs in highland habitats and has only two known populations, in the New England Tableland and on the southern highland ranges from Lake George to Bombala. It occurs between 1000 and 1500 AHD in permanent ponds, wetlands and slowly moving streams with abundant emergent bulrushes and other vegetation (NPWS 2001).	Absent	Has not been recorded in the region	No	No	**0**
Southern Bell Frog *Litoria raniformis* *E TSC* V EPBC	Formerly distributed along the Murray and Murrumbidgee Rivers and their tributaries; however its current distribution is limited to isolated populations in the Coleambally Irrigations area, the Lowbidgee floodplain and around Lake Victoria (DECC 2008a). This species is found in permanent swamps or billabongs along floodplains and river valleys.	Absent	Has not been recorded in the region	None	No	**0**
Birds						
Speckled Warbler *Pyrrholaemus saggitatus* V TSC	Occurs in a wide range of eucalypt woodland communities in the hills and tablelands of the Great Dividing range. Habitats typically are structurally diverse with a grassy understorey, a sparse shrub layer and an open canopy (DECC 2008a; Watson et al. 2001). Declines have been linked to habitat fragmentation as the species appears to be locally extinct in districts where no habitat fragments larger than 100ha remain (Watson et al. 2001). Further, larger remnants (about 300ha) may be required for populations to be viable (Gardner 2002a). The species is sedentary and nests and forages on the ground. Nests are built directly on the ground amongst leaf litter and understorey vegetation and are vulnerable to predation by large birds such as Currawongs (Gardner 2002b).	Present	Recorded at subject site (cluster 4). Also recorded in Mundoonen Nature Reserve near Gunning.	Presence confirmed	Yes; the development would occur adjacent to remnant woodland habitats.	**6**
Square-tailed Kite *Lophoictinia isura* V TSC	Has a large and sparsely populated range throughout mainland Australia (Griffin and Clarke 2002) and is a breeding migrant to the south east from July to December. It occurs primarily in coastal and sub-coastal open forest, woodlands and mallee. It has been recorded inland along timbered watercourses and adjacent areas	Present	This species has been recorded in the region, in the Mundoonen Nature Reserve	Possible	Yes, this species may be impacted by removal of woodland habitat and blade-strike	**8**

SPECIES AND STATUS*	ECOLOGY	PRESENCE OF HABITAT	NEAREST RECORDS	LIKELIHOOD OF OCCURRENCE	POTENTIAL TO BE IMPACTED	IMPACT RISK
	(NPWS 1999e). The species hunts small passerines, especially honeyeaters in the tree canopy. Resident pairs have large hunting ranges of greater than 100 km² (DECC 2008a). Nests are a platform of sticks up to 90cm in diameter in a fork of a tall tree in forest or woodland (DEC 2004).		near Gunning.			
Blue Billed Duck *Oxyura australis* V TSC	Widespread in NSW although is most common in the southern Murray-Darling Basin area. During spring and summer birds travel up to 300km from non-breeding areas on the Murray River system and coastal lakes to breed in deep swamps of inland NSW (NPWS 1999b). They are often seen in coastal areas in summer and during drought (DECC 2008a). Feeding occurs in permanent freshwater wetlands and swamps with deep water and dense aquatic vegetation. Nesting occurs in Cumbungi over deep water or in dense wetland vegetation.	Not present, however species may fly between Lake Burrinjuck inland to breed	This species has been recorded in the region near the Murrumbidgee River, Bundarbo, c. 25km south west of the site.	Vagrant	Yes, habitat is not present, however the species has been recorded in the region and may be at risk of blade-strike	**5**
Freckled Duck *Stictonetta naevosa* V TSC	Occurs on wetlands of inland NSW. Large temporary swamps created by floods in the Bulloo and Lake Eyre basins and the Murray-Darling system, particularly along the Paroo and Lachlan Rivers, and other rivers within the Riverina are a breeding stronghold (DECC 2008a). The species is partially migratory and may move to coastal habitats during severe inland drought. The species inhabits a variety of plankton-rich wetland types, including swamps, lakes farm dams, sewerage ponds and floodwaters that are heavily vegetated with Cumbungi, Lignum, Canegrass or Tea-tree (DECC 2008a).	Absent, however may move across the site to Lake Burrinjuck during drier periods	Has been recorded from Lake George (c. 80km east of the site)	Vagrant	No, although there is potential for blade strike, the species has not been recorded in the region and is unlikely to pass over the site.	**3**
Australasian Bittern *Botaurus poiciloptilus* V TSC	Widespread although uncommon over south-eastern Australia (DECC 2008a). It favours permanent shallow freshwater or brackish wetlands and swamps with dense vegetation including rushes (particularly bulrushes Typha spp.), sedges and reeds (Garnett and Crowley 2000; NPWS 1999a). This species are mainly sedentary although sightings are occasionally irruptive (suddenly occurring in great numbers) after heavy rains.	Absent	Known from Lake George	Unlikely	No, habitat is not present and the species has not been recorded from the locality. Local movements would be more likely restricted to wet habitat corridors and wetlands which occur adjacent to the site.	**3**
Bush Stone-curlew	Has a broad distribution although has suffered severe declines	Present, however	Not recorded	Unlikely	No, this species is	**4**

SPECIES AND STATUS*	ECOLOGY	PRESENCE OF HABITAT	NEAREST RECORDS	LIKELIHOOD OF OCCURRENCE	POTENTIAL TO BE IMPACTED	IMPACT RISK
Burhinus grallarius E TSC	throughout its range, particularly in disturbed and fragmented areas and where foxes are common (DEC 2006a). In NSW, it is not found on the escarpments but on lower elevation grassy woodlands of the coast or west of the divide. The area bounded roughly by Albury, Wagga Wagga, Hay and Wentworth is regarded as the stronghold for the species in NSW (DEC 2006a). This species inhabits open forests and grassy woodlands where it builds nests directly on the ground (DECC 2008a). It requires logs, fallen trees and branches, course litter and some shrubs for shelter. Foraging may occur over a wide area within woodlands, paddocks, grasslands, residential gardens and saltmarsh (DEC 2006a). Breeding pairs are generally sedentary within home ranges estimated to be 250-600ha for foraging year round, with a core of 10-25ha during breeding. It is very vulnerable to predation by exotic predators, the clearing of native woodlands, habitat degradation and even trampling by stock.	no records from region	from the region. Records are from the coast or Wagga Wagga		sedentary and has not been recorded from the locality. Therefore it is unlikely to be impacted by the proposal	
Gang-gang Cockatoo *Callocephalon fimbriatum* V TSC	In NSW, distributed from the south-east coast to the Hunter region, and inland to the Central Tablelands and south-west slopes. It occurs regularly in the ACT. It feeds in pairs or small flocks on seeds of eucalypts and wattles, and occurs primarily in heavily timbered and mature wet forest, but occasionally in towns, farming areas (DECC 2008a). It is often a seasonal altitudinal migrant, moving to lower altitudes and more open forests and woodlands (particularly Box-Ironbark assemblages for winter. This species requires large hollows in which to breed (Gibbons and Lindenmayer 2000)	Present, however habitat is open	This species has been recorded in the region, south of Binalong, c. 9km east of the site.	Possible	Yes. Breeding (hollow-bearing trees) and foraging habitat is present within the development envelope. Potential for collision with turbine blades.	**9**
Brown Treecreeper (eastern subspecies) *Climacteris picumnus Victoriae* V TSC	Occurs in eucalypt woodlands, mallee and drier open forest on inland slopes and plains of the Great Dividing Range (DECC 2008a). Populations have declined over much of their range, particularly in fragments smaller than 300 hectares that have been isolated or fragmented for more than 50 years (Barrett et al. 1994; DECC 2008a). Declines in NSW have been attributed primarily to habitat fragmentation which limits dispersal and recruitment (Cooper and Walters, 2002; Walters et al. 1999). The species occurs in eucalypt woodlands dominated by stringybarks or other rough-barked eucalypts with an open canopy and sparse understorey and shrub layer (DECC 2008a). It is sedentary and gregarious and nests in tree	Present, however woodland habitats on the site are highly fragmented	This species has been recorded in the region near the Murrumbidgee River, Bundarbo; west of the Burrinjuck Dam.	Possible	Yes, Although continuous woodland habitat is not present within the development envelope, some collision risk	**5**

SPECIES AND STATUS*	ECOLOGY	PRESENCE OF HABITAT	NEAREST RECORDS	LIKELIHOOD OF OCCURRENCE	POTENTIAL TO BE IMPACTED	IMPACT RISK
	hollows. It forages for insects on tree trunks and on the ground amongst fallen timber and leaf litter.					
Diamond Firetail *Stagonopleura guttata* V TSC	Widely distributed in NSW, occurring predominantly west of the Great Dividing Range, although populations are known from drier coastal areas near Sydney, the Hunter Valley and the Bega Valley. Habitat is grassy eucalypt woodlands, including Box-Gum and Snow Gum assemblages (DECC 2008a). The species may also occur in open grassy forest, mallee, Natural Temperate Grassland, secondary grassland and lightly wooded farmland. The species is gregarious and primarily sedentary. It forages on the ground for grass seeds and other plant material and nests in shrubby understorey and will nest in mistletoe (Cooney and Watson 2005; DECC 2008a).	Present	Recorded at the Marilba Hills subject site (east of cluster 3 and east of cluster 4)	Presence confirmed	Yes, grassy woodland habitat is present within the development envelope.	**7**
Brolga *Grus rubicunda* E TSC	Formerly found across Australia, except for the south-east corner. It inhibits large open wetlands, grassy plains, coastal mudflats and irrigated croplands. Breeding and foraging habitat includes shallow (< 50 cm) wetlands, mudflats and margins of deeper waterbodies with emergent vegetation (e.g. canegrass, lignum or sedges) (DECC 2008a).	Absent	Has not been recorded from the region, records are clustered inland from Wagga Wagga and Forbes	None	No	**3**
Painted Honeyeater *Grantiella picta* V TSC	Primarily occurs on the inland slopes of the Great Dividing Range, although is nomadic and may occur in low densities in other parts of NSW in suitable habitat. It inhabits dry open forests and woodland including Boree, Brigalow and Box-Gum Woodlands and Box-Ironbark open forests, also paperbark and casuarinas (DECC 2008a; Pizzey et al. 2006). It is a specialist feeder on mistletoe, particularly of genus *Amyema*, and generally requires 5 or more mistletoes per hectare (DECC 2008a). Seasonal migrant, movements are linked to the fruiting of mistletoe.	Present	Closest records are from Cootamundra and north of Young, c. 55km west of the site.	Vagrant	Yes, woodland habitat is present within the development envelope. Potential for collision impacts.	**6**
Black-chinned Honeyeater (Eastern Subspecies) *Melithreptus gularis gularis* V TSC	Widespread west of the Great Dividing Range, although has declined throughout its range due to removal and fragmentation of habitat. It inhabits the upper levels of drier open forests or woodlands most often dominated by box and ironbark eucalypts, particularly Mugga Ironbark, White Box, Grey Box, Yellow Box and	Present, however may be marginal in view of woodland fragmentation	This species has been recorded in the region near Harden-Murrumburrah c.	Vagrant	No, although woodland habitat is present, this habitat has been fragmented and disturbed, which reduces	**5**

SPECIES AND STATUS*	ECOLOGY	PRESENCE OF HABITAT	NEAREST RECORDS	LIKELIHOOD OF OCCURRENCE	POTENTIAL TO BE IMPACTED	IMPACT RISK
	Forest Red Gum (DECC 2008a). A gregarious species usually seen in pairs and small groups of up to 12 birds and occupies large home ranges of at least 5 hectares. Local populations appear not to persist in remnants less than 200 ha in area (NSW Scientific Committee 2001).		35km west of the site (1992) Frogmore (60km north) and Goulburn.		the likelihood of this species occurring on the site.	
Regent Honeyeater *Anthochaera phrygia* E TSC E EPBC M EPBC	Formerly widely distributed across NSW, although has since greatly declined in numbers and range extension due to land clearing. There are now only a small number of known breeding sites in NSW, the most important of which are: Warrumbungles NP, Pilliga NR, Barraba district, central coast around Gosford, Hunter Valley, and Capertee Valley (NPWS 1999d). Most records are from box-ironbark eucalypt associations and it appears to prefer wetter fertile sites within these associations (Menkhorst et al. 1999). It is a generalist forager, which mainly feeds on the nectar from a wide range of eucalypts and mistletoes. Key eucalypt species include Mugga Ironbark, Yellow Box, Yellow Gum, Blakely's Red Gum and White Box (Menkhorst et al. 1999). It also occurs in riparian forests of River She-oak and wet lowland coastal forests dominated by Swamp Mahogany and Spotted Gum and (DECC 2008a; NPWS 1999d). The species can undertake large-scale nomadic movements in the order of hundreds of kilometres.	Foraging habitat present	This species has been recorded in the region, south of Binalong, c. 9km northwest of the site.	Possible	Yes, species is nomadic; potential for collision impacts. Feed tree species are present within and adjacent to the site	**9**
Gilbert's Whistler *Pachycephala inornata* V TSC	Sparsely distributed over much of the arid and semi-arid zone of inland southern Australia, west of the western slopes of NSW (DECC 2008a). There are only three separate populations left in NSW. Most of the eastern population occurs in an area enclosed by a line joining Gilgandra to Cobar, then south to Narrandera, east to Wagga Wagga, north to Wellington and back to Gilgandra. In NSW the species occurs mostly in mallee shrubland in association with Spinifex and low shrubs. It also occurs in box-ironbark woodlands, Cypress Pine and Belah woodlands and River Red Gum forests. In woodland habitats, the species requires a dense shrubby understorey (DECC 2008a).	Absent	No close records in region.	None	No	**1**
Hooded Robin (South eastern form)	Sparsely distributed throughout much of NSW, and is rarely found on the coast. It is sedentary and occurs in open eucalypt woodland	Present	This species has been recorded in	Possible	Yes, habitat is present within the development	**6**

SPECIES AND STATUS*	ECOLOGY	PRESENCE OF HABITAT	NEAREST RECORDS	LIKELIHOOD OF OCCURRENCE	POTENTIAL TO BE IMPACTED	IMPACT RISK
Melanodryas cucullata cucullata V TSC	and scrub, often in or near cleared areas (DECC 2008a). The species generally occurs in woodland remnants with high habitat complexity (Watson et al. 2001) and uses stumps, posts or fallen timber for nesting and locating prey on the ground. Territories range from 10 to 30ha (DECC 2008a).		the region, near Blakney Creek.		envelope and has been recorded from the region	
Grey-crowned Babbler (Eastern Subspecies) *Pomatostomus temporalis temporalis* V TSC	In NSW occurs west of the Great Dividing Range and on the coast near the Hunter Valley and several locations on the north coast of NSW. It prefers Box-Gum Woodlands although also inhabits open forests, scrub lands, even farmlands and suburbs (DECC 2008a; Pizzey et al. 2006). The species is gregarious and forage on the ground on invertebrates on tree trunks and branches and by foraging amongst litter and tussocks. Territories of family groups range from one to fifty hectares (DECC 2008a).	Present	This species has been recorded from Boorowa (2000); c. 45km north of the site. Most records are west of the line between Cowra and Albury.	Unlikely, given the lack of records from the region	No, species has not been recorded from the region, no potential for collision	**4**
Swift Parrot *Lathamus discolour* E TSC E EPBC	Breeds in Tasmania, migrating to south and eastern NSW in autumn/winter where it inhabits eucalypt forests and woodlands, particularly Box-Ironbark Forests of central Victoria and southern NSW (DECC 2008a; Smales 2005). Mostly occurs on the south-west slopes. It feeds on nectar flowers of eucalypts and lerp-insects, also soft fruits and berries sometimes foraging in grass (Pizzey et al 2006). Favoured feed trees include winter flowering species such as Swamp Mahogany, Spotted Gum, Red Bloodwood, Mugga Ironbark, and White Box (DECC 2008a).	Present, foraging only	This species has been recorded near McMahons Reef (1997, within 10km of the site)	Possible	Yes, foraging habitat is present within the development envelope, potential collision risks	**7**
Turquoise Parrot *Neophema pulchella* V TSC	In NSW, typically recorded west of the escarpment in the tablelands and on the western slopes, extending to the coastal districts through the Hunter Valley (NPWS, 1999f). It occurs in grassy woodland and open forest carrying a mixed assemblage of White Box, Yellow Box, Blakely's Red Gum, Red Box and Red Stringybark (NPWS 1999f). The species will also utilise the edges of woodland, timbered ridges and creeks in farmland and nests in tree hollows, logs or posts (DECC 2008a). The species lives in pairs or small groups and forages on the ground.	Present	Records are west of the line between Cowra and Albury (45km west of the site).	Possible, although records are from west of the site	Yes, although the species has not been recorded locally, woodland habitat is present within the development envelope, collisions risks may also apply	**6**
Superb Parrot *Polytelis swainsonii*	TFound throughout eastern inland NSW. On the South-western slopes the core breeding area is roughly bounded by Cowra and	Present	Recorded at the subject site (west	Present	Yes. The species was recorded on the site	**8**

SPECIES AND STATUS*	ECOLOGY	PRESENCE OF HABITAT	NEAREST RECORDS	LIKELIHOOD OF OCCURRENCE	POTENTIAL TO BE IMPACTED	IMPACT RISK
V TSC V EPBC	Yass in the east, and Grenfell, Cootamundra and Coolac in the west (DECC 2008a). It inhabits Box-Gum, Box-Cypress-pine and Boree Woodlands and River Red Gum Forest. The species nests in the hollows of large trees (dead or alive) in open Box-Gum Woodland or isolated paddock trees. Species known to be for used for nesting are Blakely's Red Gum, Yellow Box, Apple Box and Red Box (DECC 2008a). It forages on the ground in grassy woodland, also on fruit, seeds and blossoms of acacias, eucalypts and mistletoes (Pizzey et al 2006).		cluster 4b) and beside Illalong Road west of the site during surveys.		within habitat that occurs within the development envelope, collision risks also apply	
Barking Owl *Ninox connivens* V TSC	Found throughout Australia except for the central arid regions and Tasmania. It has declined across much of its range across NSW and is most frequently recorded on the western slopes and plains (DECC 2008a). It occurs in dry box-dominated forest and woodlands and roosts in dense foliage of *Acacia, Casuarina* or *Eucalyptus* species. It nests in large hollows (20-46 cm diameter) of large, old eucalypts including River Red Gum, White Box, Red Box and Blakely's Red Gum (DECC 2008; NPWS 2003d). Nest and roost sites are usually near watercourses or wetlands (NPWS 2003d). The species have also been recorded in remnants of forest and woodland and in clumps of trees at farms, towns and golf courses (NPWS 2003d). Have large territories of 30 to more than 200 hectares (DECC 2008a; NPWS 2003d).	Present	This species has been recorded in the region near Jugiong Reservoir and the Burrinjuck Nature Reserve.	Possible	Yes, woodland habitat and hollow-bearing trees and present within the development envelope, nocturnal collision risks may also apply	**7**
Powerful Owl *Ninox strenua* V TSC	Occurs primarily in tall, moist productive eucalypt forests of the eastern tableland edge and the mosaic of wet and dry sclerophyll forests occurring on undulating, gentle terrain nearer the coast (DEC 2006b). Only scattered, mainly historical records are from the western slopes and plains (DECC 2008a). The species requires old hollow eucalypts in unlogged, unburnt forests for nesting, and roosts in dense mid-canopy trees or tall shrubs (She-oaks, wattles or rainforest species). Nesting and roosting habitat occurs in sheltered gullies, or within 100m of streams, creekflats or minor drainage lines (DEC 2006b). Hollows greater than 45 cm diameter and greater than 100 cm deep are required. Breeding pairs of this species defend large (300-1500hectare), permanent territories. Optimal habitat includes a tall shrub layer with abundant hollows and	Absent	This species has been recorded in the region, near Burrinjuck Dam and Burrinjuck Nature Reserve.	Unlikely	No	**3**

SPECIES AND STATUS*	ECOLOGY	PRESENCE OF HABITAT	NEAREST RECORDS	LIKELIHOOD OF OCCURRENCE	POTENTIAL TO BE IMPACTED	IMPACT RISK
	supporting high densities of arboreal marsupials (DEC 2006b).					
Painted Snipe or Australian Painted Snipe *Rostratula benghalensis* E TSC V EPBC M EPBC CAMBA	In NSW, recorded at the Paroo wetlands, Lake Cowell, Macquarie Marshes and Hexham Swamp. It is most common in the Murray-Darling Basin (DECC 2008a). It inhabits inland and coastal ephemeral and permanent freshwater wetlands, especially where there is a cover of vegetation. It has been recorded on the margins of wetlands, dams and even sewage ponds, also found in wet pastures, marshy areas, irrigation systems, tea tree scrub and adjacent open woodlands (Pizzey and Knight 2003). The species is likely to be nomadic in response to suitable conditions, such as floods (NPWS 1999c).	Absent	This species has not been recorded in the region. Canberra (1964)	Unlikely/vagrant	No, habitat is not present and the species has not been recorded from the locality. Local movements would be more likely restricted to wet habitat corridors and wetlands which occur adjacent to the site.	**2**
White-bellied Sea-Eagle *Haliaeetus leucogaster* M EPBC CAMBA	Resident from India through southeast Asia to Australia. It occurs around coastal areas, islands and estuaries, but is also found in inland areas where there are from large rivers, wetlands and reservoirs (Pizzey et al 2006). This species is known from the area and is thought to use terrestrial as well as riparian corridors to access inland areas (R. Falconer pers. comm. 2005).	Absent	This species has been recorded along the Murrumbidgee River system near the site at Burrinjuck Dam and Yass.	Vagrant	Yes. If present at site, risks may be high, although the likelihood of presence is low.	**4**
Fork-tailed Swift *Apus pacificus* Marine overfly area M EPBC CAMBA JAMBA ROKAMBA	Breeds from central Siberia eastwards through Asia and winters south to Australia. Uncommon in eastern Australia. It spends most of its time in the air feeding on insects, occasionally roosting on cliffs or in large trees (Pizzey et al. 2006). It spends most of its life in the air feeding on insects. It occurs throughout mainland Australia, mostly west of the divide.	Present, although generally occur west of the divide	This species is uncommon in eastern Australia (Pizzey et al., 2006) Closest record is from Junee (100km west of the site, in 1980)	Vagrant	No, the site is outside this species migratory range and therefore it is highly unlikely to occur.	**4**
White-throated Needletail *Hirundapus caudacutus* M EPBC CAMBA JAMBA	Noted as one of the world's fastest birds, this species has been recorded in the airspace above woodlands, forests and farmlands (Pizzey et al 2006). It is a regular summer migrant to eastern Australia and returns to the northern hemisphere in mid-April to breed. It is often seen 'patrolling' favoured feeding grounds above ridges and hilltops. It feeds on flying insects and has been recorded	Present	This species has been recorded in the region in the Bungongo State Forest (c. 30km south of the site).	Possible	Yes, the species has been recorded locally and is at risk of collision with turbine blades	**6**

SPECIES AND STATUS*	ECOLOGY	PRESENCE OF HABITAT	NEAREST RECORDS	LIKELIHOOD OF OCCURRENCE	POTENTIAL TO BE IMPACTED	IMPACT RISK
	flying at c.1000-2000m ASL over the Australian Alps (Pizzey et al. 2006).					
Rainbow Bee-eater *Merops ornatus* M EPBC	Inhabits open woodlands with sandy, loamy soil (Pizzey et al 2006); also occurs in riverbanks, sandspits, road cuttings, beaches and golf courses. It builds a burrow in sandy ground or bank cuttings. The species is a summer breeding migrant (Sept-Apr) to south-eastern Australia, but winters in northern Australia, Solomon Islands, PNG and Indonesia, moving in large flocks.	Present	This species was observed on the site and has been recorded near Jugiong Creek.	Present	Yes, Although habitat would not be impacted, the species is migratory and is therefore at risk of collision	**7**
Satin Flycatcher *Myiagra cyanoleuca* M EPBC	Normally found in heavily vegetated gullies in tall forests, woodlands wherever a shrub layer is present (Pizzey et al 2006). During migration it is often found in coastal forests, woodlands and trees in open country. It breeds mostly in south-east Australia, nesting on a dead branch 5-25m high under live foliage (Pizzey et al 2006), regularly returning to the same locality to breed. The species moves northwards in winter to northern Queensland and Papua New Guinea, returning south to breed in spring.	Marginal foraging habitat. Breeding habitat unlikely.	Recorded at the site.	Possible	Yes but unlikely because breeding habitat and optimal habitat (dense gullies) are not present	**5**
Great Egret *Ardea alba* V EPBC M EPBC CAMBA, JAMBA	Occur throughout most of the world. They are common throughout Australia, with the exception of the most arid areas. They prefer shallow water in rivers, estuaries, tidal mudflats, freshwater wetlands, sewerage ponds, irrigation areas and larger dams etc (Pizzey et al., 2006). They nest in treetop canopy over water in swamp woodland or mangroves (Pizzey et al., 2006).	Absent	This species has not been recorded in the region.	Unlikely	No, habitat is not available onsite. Any long-distance movements would follow wetland corridors and thereby avoid the site.	**3**
Cattle Egret *Ardea ibis/Bubulcus ibis* M EPBC CAMBA JAMBA	Found in grasslands, woodlands and wetlands. It also utilises pasture lands, paddocks and croplands where drainage is poor, often in association with cattle and other stock; wetlands, tidal mudflats and drains (Pizzey et al., 2006). Nests in swamp woodlands in groups. Originally found in Africa, Europe and Asia, the Cattle Egret is now found on nearly every continent. Occurs on the north and east coast of Australia. Partially migratory.	Present	This species has been recorded near Murrumbidgee west of the site.	Possible, on lowland pasture and dams	Yes, minor impacts would occur in lowland areas. Removal of dams may impact this species. Collision risks also apply	**7**
Latham's Snipe *Gallinago hardwickii* M EPBC JAMBA	Breeds in northern Japan and migrate to eastern Australia in during the Australian summer. The species is generally coastal and sub-coastal, although also move inland through Murray-Darling regions (Pizzey et al., 2006). It usually inhabits open, freshwater wetlands with low, dense vegetation for shelter (e.g. swamps, flooded	Absent	This species has not been recorded in the Murrumbidgee CMA catchment.	Vagrant	No, habitat is not available onsite. Any long-distance movements would follow wetland corridors and thereby	**3**

SPECIES AND STATUS*	ECOLOGY	PRESENCE OF HABITAT	NEAREST RECORDS	LIKELIHOOD OF OCCURRENCE	POTENTIAL TO BE IMPACTED	IMPACT RISK
	grasslands or heathlands, around bogs and other water bodies) although can also occur in habitats with saline or brackish water, and in modified or artificial habitats including pasture, ploughed paddocks, irrigation channels and drainage ditches (DEWHA 2008). It requires areas of mud and some form of vegetative cover for feeding (DEWHA 2008).				avoid the site.	
Mammals - marsupials						
Eastern Pygmy-possum *Cercartetus nanus* V TSC	In NSW found from the coast inland as far as the Pillaga, Dubbo, Parkes and Wagga Wagga on the western slopes. It prefers woodland and heath although has been recorded in a broad range of habitats including rainforest and sclerophyll (including Box-Ironbark) forest (DECC, 2008). This species feeds largely on nectar and pollen from banksias or other proteaceous or myrtaceous shrubs incl. Melaleucas, Tea-trees and Callistemons (DECC 2008a). This species requires hollows, cracks or fissures > 2.0 cm diameter in trees, stumps or logs, bark or disused bird's nests for breeding (DECC 2008a).	Absent, woodland doesn't have shrubs	Closest record is from Mundoonen Nature Reserve near Gunning (1996).	None	No	**2**
Spotted-tailed Quoll *Dasyurus maculatus* V TSC E EPBC	Found in a variety of forest types such as rainforest, wet and dry sclerophyll forest, woodland, coastal heath and scrub, sometimes Red Gum forest along inland waterways (Menkhorst and Knight 2004). It utilises hollow-bearing trees, fallen logs, rock caves and crevices as denning and breeding sites (DECC 2008a). Mostly nocturnal it hunts mammals, birds and large arthropods. Females occupy home ranges up to about 750 hectares and males up to 3500 hectares; usually traverse their ranges along densely vegetated creeklines.	Absent	This species has been recorded in the region, near Burrinjuck Dam, and Burrinjuck Nature Reserve.	Unlikely, given absence of suitable habitat	No	**2**
Yellow-bellied Glider *Petaurus australis* V TSC	Found along the eastern coast to the western slopes of the Great Dividing Range (DECC 2008a). It occurs in tall mature wet and damp eucalypt forest with high rainfall and nutrient rich soils and feed primarily on plant and insect exudates, including nectar, sap, honeydew and manna with pollen and insects providing protein (DECC 2008a; Menkhorst and Knight, 2004). A large number of eucalypt species are used as sap trees throughout the range (NPWS 2003f). Have large home ranges between 20 to 85 ha to encompass	Absent	This species has been recorded in the region, near Burrinjuck Dam. Burrinjuck Nature Reserve.	None	No	**2**

SPECIES AND STATUS*	ECOLOGY	PRESENCE OF HABITAT	NEAREST RECORDS	LIKELIHOOD OF OCCURRENCE	POTENTIAL TO BE IMPACTED	IMPACT RISK
	dispersed and seasonally variable food resources. Trees with hollows >10 cm diameter are required for nesting in eucalypt forests.					
Squirrel Glider *Petaurus norfolcensis* V TSC	Inhabits mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest west of the Great Dividing Range and Blackbutt-Bloodwood forest with heath understorey in coastal areas (DECC 2008a). It prefers mixed species stands with a shrub or Acacia understorey although will occur in areas where no understorey if there is more than one species of Eucalypt. Feeds on insects, nectar and exudates from leaves and trees (*Eucalyptus* and *Acacia*) and requires abundant tree hollows greater than 5cm diameter. It can use patches less than 1 ha & isolated trees if within 75 m of other patches (DECC 2008a). Has a mean home range of 1.4–2.8 ha (Quin, 1995; Ree and Bennett 2003).	Present	This species has been recorded in the region, near Burrinjuck Dam. and Bungongo State Forest	Possible	Yes, potential woodland habitat is present within the development envelope	**6**
Brush-tailed Phascogale *Phascogale tapoatafa* V TSC	Found in a variety of forest types although prefers dry sclerophyll forest with a sparse groundcover (DECC, 2008a). It generally occurs in areas where the annual rainfall exceeds 500mm. Have large overlapping territories between 20 – 100 hectares. It requires tree hollows with openings 25-40mm wide for nesting and utilises multiple trees throughout its lifetime. Prefer large trees and are most abundant where there are more than 2 trees per ha greater than 60cm DBH. It requires remnants greater than 25ha in dry forests and ridges.	Present, although marginal due to fragmentation	No records from the Murrumbidgee CMA	Unlikely	No	**4**
Koala *Phascolarctos cinereus* V TSC	Was historically abundant in the south of NSW, although now occurs in sparse and possibly disjunct populations. It occurs in woodland communities, coastal forests, woodlands of the tablelands and western slopes and the riparian communities of the western plains (NPWS, 2003e). May also utilise isolated paddock trees (NPWS, 2003e). Primary feed tree species listed for the central and southern tablelands are Ribbon Gum and River Red Gum, secondary species include Candle Bark, Blakely's Red Gum, White Box, Yellow Box and Brittle Gum (NPWS 2003e).	Present	This species has been recorded c. 8km east of the site (2004)	Possible	Yes, secondary feed tree species are located within the development envelope	**6**
Mammals – micro bats						
Little Pied Bat	Though the species is recorded in a wide variety of habitats, they	Present, although	This species has	Unlikely	No, the species is not	**0**

SPECIES AND STATUS*	ECOLOGY	PRESENCE OF HABITAT	NEAREST RECORDS	LIKELIHOOD OF OCCURRENCE	POTENTIAL TO BE IMPACTED	IMPACT RISK
Chalinolobus picatus V TSC	are mainly found in arid inland areas. Prefers open, dry forests such as Mulga woodlands, chenopod shrublands or mallee with access to water sources (Churchill 1998,DECC 2005, DECC 2008a). It roosts in caves, rock outcrops, mine shafts, tunnels, tree hollows and buildings. It often forages along watercourses (Menkhorst and Knight 2003) where it feeds on moths and possibly other flying invertebrates. Foraging occurs within the canopy (or subcanopy), as with most of the Vespertilinidae in Australia. A sedentary species, little is known of home ranges for foraging but the species has been known to travel up to 34 kilometres to gain access to water in more arid environments (Queensland Murray Darling Basin Commission, 2008).	very marginal	been recorded in the region north of Yass.		likely to occur at the site.	
Eastern False Pipistrelle *Falsistrellus tasmaniensis* V TSC	Occurs on the south-east coast and ranges of NSW. It tends to prefer moist forests with tall trees. It roosts in tree hollows, under bark, or in buildings. The species hibernates in winter (DECC 2008a)	Marginal	Recorded at Carroll's Ridge to south, and Cuumbeun Nature Reserve, near Queanbeyan	Possible	Yes but low likelihood dur to marginal range and habitat.	**4**
Eastern Bent-wing Bat *Miniopterus schreibersii oceanensis* V TSC	A common although a vulnerable species that is likely to be widely distributed throughout the region. It roosts and raises its young in caves and mine tunnels (Strahan 1995). The species appears to forage above the forest canopy in a diverse range of forest types (Strahan 1995).	Foraging habitat is present on the site	**Recorded on the site.** Wee Jasper Caves is a known breeding site, c. 35km south of the site.	Present	Yes, collision and barotrauma risk is present. Foraging habitat is located within the development envelope	**7**
Greater Long-eared bat (south-eastern form)/ Eastern Long-eared Bat *Nyctophilus timoriensis* V TSC V EPBC	The species prefers more arid regions, the distribution of the south eastern form approximately coincides with the Murray Darling Basin with the Pilliga Scrub region being the distinct stronghold for this species. This species inhabits a variety of vegetation types, including mallee, bulloke but more commonly box/ironbark/cypress-pine communities that occurs in a north-south belt along the western slopes and plains of NSW and southern Queensland (DECC 2008a). It is a slow flying agile species and forages in the lower parts of the canopy, even amongst the shrub layers and on the ground (Menkhorst and Knight 2001) and often over water bodies. The	Present, although very marginal	This species has not been recorded in the region. Closest records are from south of Tumut, more than 70km from the site	Unlikely	No, the species is not likely to occur at the site.	**0**

SPECIES AND STATUS*	ECOLOGY	PRESENCE OF HABITAT	NEAREST RECORDS	LIKELIHOOD OF OCCURRENCE	POTENTIAL TO BE IMPACTED	IMPACT RISK
	species roosts in tree hollows, and under loose bark.					
Large-footed Myotis *Myotis macropus* V TSC	Found in the coastal band from the north-west of Australia, across the top-end and south to western Victoria. It is rarely found more than 100 km inland, except along major rivers (DECC 2008a). It forages on the surface of water bodies such as rivers, lakes and swamps. It roosts in small groups in caves, mine, tunnels and old buildings (Hall & Richards 1979).	Foraging habitat (dams and Jugiong Creek) is present on the site	**Possible record at site.** Most records of this species are from west of the dividing range although there is a single record from Wee Jasper c. 35km south of the site.	Vagrant, given that the site is more than 100km from the coast	Yes, potential foraging habitat (dams) would be impacted. Collision and barotrauma risk also exists.	**6**
Yellow-bellied Sheathtail-bat *Saccolaimus flaviventris* V TSC	A wide-ranging species across northern and eastern Australia. It roosts alone or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows (DECC 2008a). The species is sedentary and possibly territorial. Southern populations probably migrate northwards in winter (Strahan 1996). A fast flying species with low maneuverability, it favours a range of insect species, mainly beetles (Churchill 1996; Richards 2001). The species may favour habitat in large tracts that has extensive understorey flora (shrubs)(Richards 2005).	Present, although marginal	**Possible record at site.** Known from U Recorded at Carroll's Ridge to south	Possible	Possible	**9**
Mammals - rodents						
Smoky Mouse *Pseudomys fumeus* E TSC E EPBC	In NSW, there are 3 records from Kosciuszko National Park and 2 records adjacent to the park in Bondo and Ingbyra State Forests; the remainder are centred around Mt Poole, Nullica State Forest and the adjoining S. E. Forests National Park. The species has been recorded on heathy ridge tops and slopes within sclerophyll forests, heathland and open forest from the coast to sub-alpine regions (DECC 2008a). It forages o seeds and fruits from leguminous shrubs, some invertebrates and fungi.	Absent	Not recorded in the region	None	No	**0**
Reptiles						
Little Whip Snake *Suta flagellum* V TSC	Found within an area bounded by Crookwell in the north, Bombala in the south, Tumbarumba to the west and Braidwood to the east (DECC 2008a). It occurs in Natural Temperate Grasslands and grassy woodlands, including those dominated by Snow Gum or Yellow Box	Present	Not recorded in the region.	Unlikely, beyond the known distribution	Unlikely	**4**

SPECIES AND STATUS*	ECOLOGY	PRESENCE OF HABITAT	NEAREST RECORDS	LIKELIHOOD OF OCCURRENCE	POTENTIAL TO BE IMPACTED	IMPACT RISK
	as well as secondary grasslands derived from clearing of woodlands. It is commonly found on well-drained hillsides with loose scattered rocks.					
Pink-tailed Legless or Worm Lizard *Aprasia parapulchella* V TSC V EPBC	Known only from the Central and Southern Tablelands, and the South Western Slopes (Osborne and Jones 1995). This species inhabits sloping, open woodland areas with predominantly native grass groundlayers, particularly those dominated by Kangaroo Grass (*Themeda australis*). Typically these areas are well-drained, with rocky outcrops or scattered, partially-buried rocks. Commonly found beneath small, partially-embedded rocks in burrows below these rocks; the burrows usually have been constructed by and are often still inhabited by small black ants and termites (Osborne and Jones, 1995). This species feeds on the larvae and eggs of these ants (DECC 2008a).	Present, however most rocky habitat is heavily grazed	The closest record is from Boorowa (2001), c. 35km north of the site.	Possible	Yes, potential habitat (rock outcrops) is located within the turbine development envelope	**6**
Striped Legless Lizard *Delma impar* V TSC V EPBC	Populations are known in the Goulburn, Yass, Queanbeyan, Cooma and Tumut areas. It inhabits temperate lowland grasslands, secondary grasslands and occasionally in open Box-Gum Woodland. It has been recorded at sites dominated by introduced species (such as *Phalaris aquatica, Nasella trichotoma* and *Hypocharis radicata*) and sites with a history of grazing and pasture improvement (Smith and Robertson, 1999). Shelters in grass tussocks, thick ground cover, soil cracks, under rocks, spider burrows, and ground debris such as timber. The key to their survival in rural areas may be the availability of shelter during disturbance events (Smith and Robertson, 1999).	Present	This species has been recorded in the region near Yass (1997).	Possible	Yes, potential habitat (rock outcrops) is located within the turbine development envelope	**6**
Rosenberg's Goanna *Varanus rosenbergi* V TSC	Occurs on the Sydney Sandstone in Wollemi National Park to the north-west of Sydney, in the Goulburn and ACT regions and near Cooma in the south. It is found in heath, open forest and woodland. It is known to nest in termite mounds and feeds on carrion, birds, eggs, reptiles and small mammals. Individuals require large areas of habitat.	Absent	This species has not been recorded in the region	Unlikely	No	**0**
Grassland Earless Dragon *Tympanocryptis pinguicolla* E TSC	Historical range in NSW is from Bathurst to Cooma, although now the only known populations are in the ACT and at Queanbeyan, Cooma and Nimmitabel. Inhabits natural grassland dominated by	Present (marginal)	This species has not been recorded in the	Unlikely, beyond the known extant distribution	No	**4**

SPECIES AND STATUS*	ECOLOGY	PRESENCE OF HABITAT	NEAREST RECORDS	LIKELIHOOD OF OCCURRENCE	POTENTIAL TO BE IMPACTED	IMPACT RISK
E EPBC	*Austrodanthonia* spp, *Austrostipa* spp, *Poa sieberiana*, *Bothriochloa macra* and occasionally *Themeda triandra*, particularly open structured sires with bare patches. Has been captured in secondary grassland (DECC 2009). Feeds on invertebrates, shelters in spider holes and under rocks.		region			
Fish						
Macquarie Perch *Macquaria australasica* V TSC E EPBC	A riverine, schooling species. It prefers deep, rocky holes with considerable cover and a substrate of small boulders, pebbles and gravel. Occurs within rivers, dams and tributaries in Southern NSW (Ecology Lab 2003), but mainly in the upper reaches of rivers and streams where siltation levels are low. The species appears to prefer pools with cover.	Absent	Recorded from Yass	None	No	**0**
Murray Cod *Maccullochella peelii peelii* V EPBC	Occurs throughout most of the Murray-Darling system, mainly in slow-flowing turbid rivers often among submerged trees and flood debris (Allen 1989).	Absent	-	None	No	**0**
Invertebrates						
Golden Sun Moth *Synemon plana* E TSC CE EPBC	Distributed in an area of NSW between Queanbeyan, Gunning, Young and Tumut (DECC 2008a). It occurs in grassy Box-Gum woodlands and natural temperate grasslands, typically low, open and dominated by several wallaby grass species. Also may be associated with spear-grasses (*Austrostipa* spp.) or Kangaroo Grass (*Themeda australis*).	Present	Closest record is from Queanbeyan	Unlikely, site is beyond the known distribution of the species	No	**2**

Threatened fauna evaluation summary

The assessment presented in Table C2 has identified that 25 threatened or migratory fauna species have potential to be present at the subject site and score a risk rating of at least 5.

Waterbirds		
Blue-billed Duck	*Oxyura australis*	V
Raptors		
Square-tailed Kite	*Lophoictinia isura*	V
Barking Owl	*Ninox connivens*	V
Woodland Birds		
Speckled Warbler	*Pyrrholaemus saggitatus*	V
Brown Treecreeper	*Climacteris picumnus Victoriae*	V
Diamond Firetail	*Stagonopleura guttata*	V
Black-chinned Honeyeater	*Melithreptus brevirostris*	V
Painted Honeyeater	*Grantiella picta*	V
Regent Honeyeater	*Anthochaera phrygia*	E
Hooded Robin	*Melanodryas cucullata cucullata*	V
Swift Parrot	*Lathamus discolour*	E
Turquoise Parrot	*Neophema pulchella*	V
Superb Parrot	*Polytelis swainsonii*	V
Gang-gang Cockatoo	*Callocephalon fimbriatum*	V
Satin Flycatcher	*Myiagra cyanoleuca*	M (EPBC)
White-throated Needle-tail	*Hirundapus caudacutus*	M (EPBC)
Rainbow Bee-eater	*Merops ornatus*	M (EPBC)
Cattle Egret	*Ardea ibis*	M (EPBC)
Microbats		
Eastern Bentwing-bat	*Miniopteris schriebersii*	V
Large-footed Myotis	*Myotis macropus*	V
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*	V
Arboreal mammals		
Squirrel Glider	*Petaurus norfolcensis*	V
Koala	*Phascolarctos cinereus*	V
Reptiles		
Pink-tailed Legless or Worm Lizard	*Aprasia parapulchella*	V
Striped Legless Lizard	*Delma impar*	V

Species with an impact rating of 5 and above have been assessed for their potential to be significantly impacted by the proposal (Appendices E and F).

The potential impact of the proposal on these species is assessed in an Assessment of Significance presented in Appendix E.

Appendix D **BIRD AND BAT IMPACT RISK ASSESSMENT**

D.1. Threatened species risk potential matrix

This risk assessment incorporates all bird and bat species listed as threatened or migratory under the NSW *Threatened Species Conservation Act 1995* or the Commonwealth *Environmental Protection Biodiversity Conservation Act 1999* which have been recorded in the CMA sub-regions or are included on the EPBC Act Matters of National Environmental Significance search report. A number of non-threatened species have been added which are known from the area and considered to be potentially at risk.

The impact risk rating is derived from the cumulative scores of eight risk factors. Factors were weighted equally, except for presence of local records as this was considered to be important to filter out species with known distribution ranges outside the study area. Species with cumulative risk scores of 5 and above are included in the relevant Assessments of Significance in Appendices E and F.

The risk assessment is based on the proposed works described in section 3 and the expected vegetation and habitat loss quantified in section 7. The assessment assumes the adoption of measures to avoid and protect the sensitive habitats at clusters 3, 4, 6 and 7 (refer mitigation measures in section 8).

Threatened bird and bat species risk potential matrix

Species	Impact type	Risk factors: Occurs locally (2 points)	Breeding habitat present	Breeding habitat potentially impacted	Foraging habitat present	Foraging habitat potentially impacted	Use of turbine ridge airspace	Flocking or gregarious	Migratory or nomadic	Cumulative risk score
Gang-gang Cockatoo	Collision risk Habitat removal	2	1	1	1	1	1	1	1	**9**
Regent Honeyeater	Collision risk Habitat removal	2	1	1	1	1	1	1	1	**9**
Square-tailed Kite	Collision risk Habitat removal	2	1	1	1	1	1	0	1	**8**
Superb Parrot	Collision risk Habitat removal	2 Recorded at subject site	1	1	1	1	1	1	0	**8**
Diamond Firetail	Collision risk Habitat removal	2 Recorded at subject site	1	1	1	1	0	1	0	**7**
Black-chinned Honeyeater	Collision risk Habitat removal	0	1	1	1	1	1	1	1	**7**
Swift Parrot	Collision risk Habitat removal	2	0	0	1	1	1	1	1	**7**
Barking Owl	Collision risk Habitat removal	2	1	1	1	1	1	0	0	**7**
Rainbow Bee-eater	Collision risk	2	1	0	1	0	1	1	1	**7**
Cattle Egret	Collision risk	2	0	0	1	1	1	1	1	**7**
Speckled Warbler	Habitat removal	2 Recorded at subject site	1	1	1	1	0	0	0	**6**
Brown Treecreeper	Habitat removal	2	1	1	1	1	0	0	0	**6**
Painted Honeyeater	Collision risk Habitat removal	0	1	1	1	1	1	1	0	**6**
Hooded Robin	Habitat removal	2	1	1	1	1	0	0	0	**6**
Turquoise Parrot	Collision risk Habitat removal	0	1	1	1	1	1	1	0	**6**
White-throated Needletail	Collision risk	2	0	0	1	0	1	1	1	**6**
Blue-billed Duck	Collision risk	2	0	0	0	0	1	1	1	**5**
Bush Stone-curlew	Habitat removal	0	1	1	1	1	0	0	0	**4**
Grey-crowned Babbler	Habitat removal	0	1	1	1	1	0	0	0	**4**
White-bellied Sea-Eagle	Collision risk	2	0	0	0	0	1	0	1	**4**

Species	Impact type	Risk factors								Cumulative risk score
		Occurs locally (2 points)	Breeding habitat present	Breeding habitat potentially impacted	Foraging habitat present	Foraging habitat potentially impacted	Use of turbine ridge airspace	Flocking or gregarious	Migratory or nomadic	
Fork-tailed Swift	Collision risk	0	0	0	1	0	1	1	1	**4**
Satin Flycatcher	Collision risk	2	0	0	1	0	1	0	1	**5**
Freckled Duck	Collision risk	0	0	0	0	0	1	1	1	**3**
Australasian Bittern	Collision risk	0	0	0	0	0	1	1	1	**3**
Brolga	Collision risk	0	0	0	0	0	1	1	1	**3**
Powerful Owl	none	2	0	0	0	0	1	0	0	**3**
Great Egret	Collision risk	0	0	0	0	0	1	1	1	**3**
Latham's Snipe	Collision risk	0	0	0	0	0	1	1	1	**3**
Australian Painted Snipe	Collision risk	0	0	0	0	0	1	0	1	**2**
Gilbert's Whistler	none	0	0	0	0	0	1	0	0	**1**
Eastern False Pipistrelle	Collision risk Habitat removal	2	0	0	0	0	1	1	0	**4**
Large-footed Myotis	Collision/barotrauma risk	2	0	0	1	1	1	1	0	**6**
Yellow-bellied Sheathtail-bat	Collision/barotrauma risk Habitat removal	2	1	1	1	1	1	1	1	**9**
Eastern Long-eared Bat	Collision/barotrauma risk	0	1	1	1	1	1	0	0	**5**
Little Pied Bat	Collision/barotrauma risk Habitat removal	2 (unlikely at site)	1	1	1	1	1	1	0	**8**
Eastern Bentwing-bat	Collision/barotrauma risk	2	0	0	1	1	1	1	1	**7**

D.2. Vulnerable bird group risk assessment

This assessment focuses on vulnerable bird groups considered to be particularly vulnerable to wind farm developments; raptors, waterbirds and migratory species, and rare or threatened species. Threatened species potentially at significant risk have been identified in the matrix in section D.1 and the significance of potential impacts to these species is assessed in Appendix E.

The assessment identifies and evaluates risk of significant impact posed by the proposed wind farm development at Marilba Hills Precinct in terms of:

- collision with wind turbines, or 'bladestrike'. For these purposes, 'bladestrike' refers to mortality caused by direct collision with turbine blades and by birds being swept down by the wake behind a turbine blade; and
- habitat loss or avoidance caused by the presence of the turbines and associated infrastructure.

This risk assessment is qualitative, combining assessments of likelihood and consequence to produce a final risk assessment of low, moderate or high risk for selected species. Likelihood incorporates biological, behavioural and environmental risk factors. Consequence includes the significance of habitat loss and bladestrike in terms of habitat rarity and importance, population impacts, recovery potential and species conservation status. The risk rating assumes the implementation of relevant mitigation measures identified in section 8 of the Biodiversity Assessment.

The assessment draws on the Interim Standards for Risk Assessment relating to birds and wind farms (Brett Lane and Associates 2005) and the Australian Standards for Risk Assessment (AS/NZS 4360) and Environmental Risk Management (HB203:2000).

The impacts of the proposal on habitat and habitat utilisation are further addressed in chapter 7 of the Biodiversity Assessment. Chapter 7 also briefly reviews experiences at wind farms in Australia and overseas and identifies the bird fauna present and likely to be present at the subject site.

A number of factors may operate which affect risk by contributing to either the likelihood of collision with blades, or the significance of the consequence of bladestrike. These factors may be related to particular species, sites or development designs. Some biological/behavioural, population, environmental and development design risk factors are outlined in Box 8.1 in the Biodiversity Assessment.

RAPTORS, OWLS AND FROGMOUTHS

Wedge-tailed Eagle (*Aquila audax)*
Risk factors: Observed at site Forages in open country at blade height Large home range Male diving displays Prey source present at turbine sites Low reproductive rate Limited agility
Behaviour and ecology: Widely distributed in a range of forest and plain habitats, sedentary. Constructs large stick nests in trees. During the survey, observed singly and in a pair displaying courtship behaviour at 10-80 metres above ground level. Feeds on birds, rabbits, small mammals. Rabbits and lambs are local food sources. Rabbit warrens are present on the turbine ridges. Mortalities for the related Golden Eagle in US due to presence of prey around turbines (Thelander *et al.* 2003). Turbines with lower blade reaches were most deadly to Golden Eagles. Summer and winter had highest mortality rates (Thelander

et al. 2003). Wedge-tailed Eagles have collided with turbines in Tasmania, South Australia and Victoria. Raptors continue to be present within 1 km of the Crookwell I turbines (URS 2004). At Toora (Vic.), Wedge-tailed eagles were regularly observed before and after operations began at this site. Eagles were observed to avoid the turbines by flying around or between them, but not into them (Brett Lane and Associates 2005). During bird behaviour surveys at Codrington, Wedge-tailed eagles were observed to avoid turbines by flying horizontally around them (twice) and turning and not entering the turbine area (Biosis Research 2002). The species has also been observed flying safely between turbines at the Toora wind farm (Wonthaggi EES Panel 2003). Collisions are possible but are not expected to be frequent or in excess of the reproductive and dispersal capacity of the regional population.			
Likelihood of habitat avoidance: moderate		Habitat importance: moderate-high	
Collision likelihood: low		Collision consequence: moderate	
Overall risk levels	**Individuals**	**moderate**	
	Population	**moderate-high**	

Little Eagle (*Hieraaetus morphnoides*)		
Risk factors: Forages in open country at blade height Diving display flights Prey source present at turbine sites		
Behaviour and ecology: Inhabits plains, open woodlands, usually near water, timber along watercourses and lakes (Pizzey et al 2006). Soars in tight circles. Builds stick nests in trees. Uncommon but widespread. Diet includes carrion and small mammals. Like the Wedge-tailed Eagle, has become dependent on rabbits in many areas. Recorded at the subject site and observed south of the subject site soaring c. 10-80 metres above the ground (**ngh**environmental 2006).		
Likelihood of habitat avoidance: moderate		Habitat importance: moderate
Collision likelihood: low		Collision consequence: minor-moderate
Overall risk levels	**Individuals**	**moderate**
	Population	**moderate**

White-bellied Sea-eagle (*Haliaeetus leucogaster)*		
Risk factors: Forages at blade height		
Behaviour and ecology: Sedentary or nomadic. Soars in slow majestic circles, rests on prominent trees over rivers, lakes shores. Occurs singly, in pairs or family parties. Hovers low and drops to take fish and waterfowl (Pizzey et al 2006). Likely habitat occurs well south of the site on Lake Burrinjuck and Yass River. May visit site but frequency is expected to be low.		
Likelihood of habitat avoidance: low		Habitat importance: low
Collision likelihood: low		Collision consequence: low
Overall risk levels	**Individuals**	**low**
	Population	**low**

Square-tailed Kite (*Lophoictinia isura)*
Risk factors: Forages in open country at blade height Prey source present at turbine sites Large home range, sparse distribution
Behaviour and ecology:

Scattered records indicate that the species is a regular resident in the north, north-east and along the major west-flowing river systems in NSW. It is found in a variety of timbered habitats including dry woodlands and open forests, showing a particular preference for timbered watercourses. It is a specialist hunter of passerines, especially honeyeaters, and most particularly nestlings, and insects in the tree canopy, picking most prey items from the outer foliage. It appears to occupy large hunting ranges of more than 100km^2. Breeding is from July to February, with nest sites generally located along or near watercourses (DECC 2008a). The study area, nearby cleared lands, forest remnants and conservation reserves and lake to the south provide foraging and nesting habitat for this species. Habitat is marginal over most of the subject site because of the extent of clearing. The species is generally absent from cleared pastoral or agricultural lands (Pizzey 2006). Ridges at the subject site may provide thermals for hunting. Clusters 3, 4, 6 and 7 have remnant forest patches which could provide nesting habitat and prey species. The proposal would not result in the loss of a significant area of woodland or forest cover. Given the large range of the species, the marginal nature of habitat over most of the subject site and the presence of similar habitat in the district, the proposal is not expected to significantly affect this species at the individual or population levels.		
Likelihood of habitat avoidance: moderate		Habitat importance: low-moderate
Collision likelihood: low		Collision consequence: low-moderate
Overall risk levels	**Individuals**	**low-moderate**
	Population	**low-moderate**

Australian Kestrel (*Falco cenchroides)*		
Risk factors: Forages in open country at blade height Family parties play in air currents		
Behaviour and ecology: Sedentary or nomadic. Soars around city buildings and spires (Pizzey et al 2006). Nests in tree hollows; few hollow-bearing trees are present on the turbine properties, but are scattered in farmland and remnant patches in the district. Have been known to collide with aircraft when hunting at airports, but have a relatively rapid reproductive rate (URS 2004). The species is relatively common at the Woolnorth and Codrington wind farm sites and no collisions have been recorded at those sites. Should have the capacity to habituate to turbines over time.		
Likelihood of habitat avoidance: moderate		Habitat importance: low
Collision likelihood: low		Collision consequence: low
Overall risk levels	**Individuals**	**low-moderate**
	Population	**low**

Brown Falcon (*Falco berigora*)		
Risk factors: Performs tumbling and diving flight displays Soars on thermals		
Behaviour and ecology: Nests in nest of crow or hawk, makes own stick nest or uses tree hollows. Makes sloping descent to catch prey on ground (Pizzey et al 2006). This species appears able to adapt and habituate to human developments. A Brown Falcon mortality has been reported from the Codrington wind farm (Biosis Research 2002).		
Likelihood of habitat avoidance: moderate		Habitat importance: low
Collision likelihood: moderate		Collision consequence: low
Overall risk levels	**Individuals**	**moderate**
	Population	**low-moderate**

Peregrine Falcon (*Falco peregrinus*)		
Risk factors: Chases prey and dives at high speed		
Behaviour and ecology: Habitat most commonly gorges and timbered watercourses, generally near rivers and swamps. Nests on rock crevice, bare ledge, tree hollow or old corvid nest, also on spires and tall buildings (Pizzey et al 2006). This species appears able to adapt and habituate to human developments. Habitat at the site may be marginal for this species.		
Likelihood of habitat avoidance: low		Habitat importance: low
Collision likelihood: low		Collision consequence: low
Overall risk levels	**Individuals**	**low-moderate**
	Population	**low**

Australian Hobby, Little Falcon (*Falco longipennis*)		
Risk factors: Forages in open country at blade height Fast determined pursuit of flying birds and insects		
Behaviour and ecology: Range of open habitats, typically woodland with large trees and timbered watercourses. Often seen over cities (Pizzey et al 2006). Builds stick nest in top of tall trees. Hunts small and medium sized birds (including ducks and herons) and flying insects. Appears able to adapt and habituate to developed environments.		
Likelihood of habitat avoidance: moderate		Habitat importance: low
Collision likelihood: low		Collision consequence: low
Overall risk levels	**Individuals**	**low-moderate**
	Population	**low**

Spotted Harrier (*Circus assimilis)*		
Risk factors: Forages in open country at blade height		
Behaviour and ecology: Nomadic or migratory. Soars high and very low over open country. Constructs large stick nest in eucalypts. Observed at the subject site soaring c. 20-100 metres above the turbine ridges.		
Likelihood of habitat avoidance: moderate		Habitat importance: low
Collision likelihood: moderate		Collision consequence: low
Overall risk levels	**Individuals**	**moderate**
	Population	**low**

Barking Owl (*Ninox connivens*), Barn Owl (*Tyto alba)* and other owl species
Risk factors: Night-flying Forages in open country
Behaviour and ecology: The Barking owl is a top order predator with a varied diet and large home range. The species hunts for arboreal mammals and birds within the tree canopy and for rabbits and other prey on the ground (NPWS 2003c). Each pair occupies a 30-200 hectare territory, depending on habitat quality (Blakers et al. 1984), although this remains speculative (NPWS 2003c). Inhabits drier forest and woodland, and has been recorded persisting around human habitation. Requires

Barking Owl (*Ninox connivens*), Barn Owl (*Tyto alba)* and other owl species		
large tree hollows for nesting and an abundance of prey species. Declining in NSW (NPWS 2003c). Recorded in Black Andrew NR c.25km SW of the site. Not recorded at the site during call playback. The species may forage and nest in remnant forest on ridgetops at the subject site, although habitat is likely to be marginal for breeding because of a paucity of hollow-bearing trees. The Barn Owl inhabits open forests, woodlands and grasslands with stands of timber, including farmlands. Nests in tree hollows. Local populations fluctuate with mice and native rodent prey populations (Pizzey et al 2006). In the arid pastoral zone of north-eastern South Australia, the diet of the Barn Owl consisted of 82 per cent mammals (74% rodents), 8 per cent birds, 10 per cent lizards and less than 1 per cent insects by biomass. The introduced House Mouse was the predominant mammal, and only rodent, recorded (Debus et al 2004). Occasionally roosts or nests in buildings, forages in cities. Rodent populations on the turbine site are expected to be small, reflected in the survey trapping results. Barn owls are not expected to use the turbine ridges for foraging on a regular or frequent basis. Forest owls are generally confined to areas with tree cover, although dispersing juveniles may fly over open country. This is expected to be a rare event at the northern turbine sites, and infrequent at the southern turbine sites. There is some risk of bladestrike. Hunting flights are likely to be at ground and canopy level. The canopy height of forest and woodland remnants around the site range from 5 to 15 metres, well below the potential bladeswept zone of 34-126 metres. These species are unlikely to enter the bladeswept zone during hunting flights.		
Likelihood of habitat avoidance: low		Habitat importance: low
Collision likelihood: low		Collision consequence: moderate
Overall risk levels	**Individuals**	**low-moderate**
	Population	**low-moderate**

Tawny Frogmouth (*Podargus strigoides)*		
Risk factors: Night-flying		
Behaviour and ecology: Inhabits heavy forests to open woodlands, timber along watercourses in inland areas Nests in flimsy stick platforms on branches 5-10m high. Sedentary (Pizzey et al 2006). Active at dusk, takes prey from sitting position from ground surfaces such as roads. Feeding activities are more likely of the site in timbered lowlands, and would generally occur below blade height.		
Likelihood of habitat avoidance: low		Habitat importance: low
Collision likelihood: low		Collision consequence: low
Overall risk levels	**Individuals**	**low**
	Population	**low**

WATERBIRDS AND MIGRATORY SPECIES

Painted Snipe (*Rostratula benghalensis*)
Risk factors: Migratory Potential habitat adjacent to site
Behaviour and ecology: Little is known of the behaviour of this cryptic waterbird. Possibly nomadic; has been observed occupying ephemeral wetlands. Seeds and invertebrates are foraged for on the waters edge. Breeding is thought to occur in response to local conditions between September and December (Pringle 1987). A recent assessment of collision risk on 34 bird species present at five operational and planned wind farm sites in

Gippsland, Victoria, including migratory wetland species concluded that potential impacts are likely to be negligible or low for these species (Biosis Research 2006). Habitat is likely to be marginal at the site given the small and modified nature of local water sources. There are no local records. Local migration routes are not known. Flight paths between ephemeral habitats are likely to follow watercourses, drainage lines and lowland pastures. This species does not appear to congregate in large numbers and spends most of its time foraging on the water's edge. Hence, the risk of population level impacts from collision or resource avoidance impacts would not be expected to be high for this species.		
Likelihood of habitat avoidance: low		Habitat importance: low
Collision likelihood: low		Collision consequence: low
Overall risk levels	**Individuals**	**low**
	Population	**low**

Latham's Snipe, Japanese Snipe (*Gallinago hardwickii*)		
Risk factors: Migratory Potential habitat adjacent to site		
Behaviour and ecology: This species nests annually in northern Japan, where it congregates in large numbers on the shores of local lakes (Schodde & Tideman 1995). Favoured habitats during the non-breeding season include wet paddocks or shallow water with good covering of tussocks or other growth, seepage below dams, from sea level to 2000m (Pizzey et al 2006), where they probe for aquatic invertebrate and seed (Green & Osborne 1994). A recent assessment of collision risk on 34 bird species present at five operational and planned wind farm sites in Gippsland, Victoria, including migratory wetland species such as Lathams Snipe, concluded that potential impacts are likely to be negligible or low for these species (Biosis Research 2006). Habitat is likely to be marginal at the site given the small, modified and ephemeral nature of local water sources and the species is not expected to be a regular inhabitant. There are no local records. Local migration routes are not known. Flight paths between ephemeral habitats are likely to follow watercourses, drainage lines and lowland pastures.		
Likelihood of habitat avoidance: low		Habitat importance: low
Collision likelihood: low		Collision consequence: low
Overall risk levels	**Individuals**	**low**
	Population	**low**

White Ibis (*Threskiornis molucca*)
Risk factors: Nomadic or migratory Night-flying
Behaviour and ecology: Occurs singly or in large flocks, typically in pastures and swamps. Flies in lines or v formations with quick wing beats and glides. Nests over water in dense trees or swamp growth. Highly nomadic, migratory or dispersive (Pizzey et al 2006). Australian White Ibises and other waterbird species demonstrate crepuscular peaks of abundance (Hamilton et al. 2004). In the Hunter Valley, the White Ibis was found to be one of the species most at risk of colliding with powerlines at night (Hunter Wetlands Research 1996 in URS 2004). In daytime bird behavioural studies at Codrington Wind Farm, where Straw-necked Ibises are abundant, 517 Ibises were observed. 476 birds adopted avoidance strategies of weaving between the turbines and 39 flew in a straight line through the site in a path that kept them well away from the turbines. There were no observed Ibis collisions and no Ibis

carcasses have been found (Biosis Research 2002). A recent assessment of collision risk on 34 bird species present at five operational and planned wind farm sites in Gippsland, Victoria, including migratory wetland species concluded that potential impacts are likely to be negligible or low for these species (Biosis Research 2006). White Ibises used Lake Burrinjuck, south of the site, for breeding until the recent drought (pers. comm. C. Davey CSIRO, retired, 4/11/2005). With the breaking of the drought, breeding would be expected to resume and Ibis numbers in the study area may increase. Ibis and other waterbirds may travel between Lake Burrinjuck and the large waterbodies in Canberra. They would also be expected to disperse to forage in farmland north of Lake Burrinjuck, including the study area. Flight paths between ephemeral habitats are likely to follow watercourses, drainage lines and lowland pastures. Birds moving during the day are likely to use avoidance behaviours. Because of low local habitat utilisation rates, the distance of prime habitats, and the widespread and common status of the White Ibis, the risk of night collisions is considered low.		
Likelihood of habitat avoidance: low		Habitat importance: low
Collision likelihood: low		Collision consequence: low
Overall risk levels	**Individuals**	**low-moderate**
	Population	**low**

Australian Wood Duck (*Checonetta jubata)*		
Risk factors: Swift flight, possibly with poor manoeuvrability		
Behaviour and ecology: Typically in better-watered lightly timbered pastoral country with plentiful dams. Follows courses of creeks through timber. Nests in hollow of live tree (Pizzey et al 2006). Regionally abundant, recorded in dams near the turbine ridges. Local migration routes are not known. Flight paths between between dams are likely to follow watercourses, drainage lines and lowland pastures. Unlikely to pass through the bladeswept area with high frequency.		
Likelihood of habitat avoidance: rare		Habitat importance: minor
Collision likelihood: rare		Collision consequence: minor
Overall risk levels	**Individuals**	**low-moderate**
	Population	**low**

White-faced Heron (*Ardea novaehollandiae)*		
Risk factors: May form winter flocks Tendency to perch on high trees or posts		
Behaviour and ecology: Common, sedentary and nomadic, found almost wherever there is shallow water, including dams. Builds stick nest in tree (5-12 m above ground), usually near water or some distance away. May perch on dead trees and telephone posts (Pizzey et al 2006). Flight paths between between dams are likely to follow watercourses, drainage lines and lowland pastures. A recent assesssment of collision risk on 34 bird species present at five operational and planned wind farm sites in Gippsland, Victoria, including migratory and wetland species concluded that potential impacts are likely to be negligible or low for these species (Biosis Research 2006).		
Likelihood of habitat avoidance: low		Habitat importance: low
Collision likelihood: low		Collision consequence: low
Overall risk levels	**Individuals**	**low-moderate**
	Population	**low**

White-throated Needle-tail, Spine-tailed Swift (*Hirundapus caudacutus*)		
Risk factors: Migratory High-flying Vertical flight and diving displays May form large flocks		
Behaviour and ecology: Summer migrant to Australia from Asia, mid-October to mid-April. Feed on flying insects. Occurs over cities. Roosting habits not known. Risk is lessened by limited time spent at the site and capacity to habituate to humanised landscapes. Local migration routes are not known. Recorded in Wee Jasper Nature Reserve, 30 kilometres to the south. A recent assessment of collision risk on 34 bird species present at five operational and planned wind farm sites in Gippsland, Victoria, including migratory species such as the White-throated Needletail, concluded that potential impacts are likely to be negligible or low for these species (Biosis Research 2006).		
Likelihood of habitat avoidance: low-moderate		Habitat importance: low
Collision likelihood: low		Collision consequence: low-moderate
Overall risk levels	**Individuals**	**low-moderate**
	Population	**low**

Satin Flycatcher (*Myiagra cyanoleuca*)		
Risk factors: Migratory High-flying Vertical flight and diving displays May form large flocks		
Behaviour and ecology: Occurs singly or in pairs, usually in tops of taller trees. Breeds in SE Australia arriving from NG Aug-Oct, departing Feb-April. When breeding favours heavily vegetated gullies and taller woodlands. During migration, uses coastal forests, woodlands, scrubs, trees in open country (Pizzey et al 2006). Habitat is likely to be marginal over most of the site due to the extent of clearing. The Satin Flycatcher was recorded in Long-leaved Box woodland at the subject site (cluster 6).		
Likelihood of habitat avoidance: low		Habitat importance: low
Collision likelihood: low-moderate		Collision consequence: low
Overall risk levels	**Individuals**	**Low-moderate**
	Population	**low**

THREATENED SPECIES (PASSERINES AND PARROTS)

Diamond Firetail (*Emblema guttata)*
Risk factors: Seasonal flock aggregations Declining
Behaviour and ecology: Sedentary. Restricted largely to ungrazed or lightly grazed woodland remnants of grassy eucalypt woodlands and sometimes lightly wooded farmland. Feeds predominantly on the ground on grass seeds, in groups from 5 to 150 individuals (Schodde & Tidemann 1986), nesting in pairs or communally in shrubs and small trees. May form large flocks during winter and autumn. *Recorded c.14km NE of the site (Atlas) and Wee Jasper (Bionet). Recorded at the subject site on a midslope east of cluster 3) in moderate condition box gum woodland, and a lower slope east of cluster 4 in poor-*

moderate condition woodland. These areas are outside the development envelope and would not be impacted by the works. Research in grazing landscapes in southern NSW suggests that granivores prefer to move along densely vegetated areas (Fischer and Lindenmayer 2002a). Diamond Firetails are considered to have poor dispersal abilities and are likely to be less common away from tree cover. The cleared, exposed habitat over most of the turbine ridges is marginal.		
Likelihood of habitat avoidance: low		Habitat importance: moderate
Collision likelihood: low		Collision consequence: moderate
Overall risk levels	**Individuals**	**low**
	Population	**low**

Speckled Warbler (*Pyrrholaemus saggitatus)*		
Risk factors: Flocking behaviour Declining		
Behaviour and ecology: A sedentary, ground-dwelling bird inhabiting grassy communities including rocky ridges and gullies (DECC 2008a). Population declines exceed 40% in areas where remnants less than 100ha in size remain (Watson et al. 2001) – the species requires large, relatively undisturbed remnants (DECC 2008a). Larger remnants (about 300ha) may be required for populations to be viable (Gardner 2002a). Permanent breeding ranges occupy around 10 ha. The contiguous area of remnant woodland at cluster 4 at the subject site totals around 143 ha, in moderate and moderate-good condition. The typical habitat featuring scattered tussock grasses and sparse shrub layer, an open eucalypt canopy with some regrowth is a close match for cluster 4. The species was recorded in moderate condition woodland on an upper slope at cluster 4b. It may form mixed species feeding flocks in winter, with thornbill species. The Speckled Warbler feeds and nests on the ground, is non-migratory and is unlikely to use airspace within the turbine bladeswept zone. The proposed works would be largely confined to cleared paddock areas on the cluster 4 ridgeline and would not remove a significant area of habitat for this species at the cluster 4 site.		
Likelihood of habitat avoidance: low		Habitat importance: moderate
Collision likelihood: low		Collision consequence: moderate
Overall risk levels	**Individuals**	**low**
	Population	**low**

Regent Honeyeater (*Xanthomyxa phrygia*)	
Risk factors: Flocking Declining	
Behaviour and ecology: Forms breeding colonies or nomadic flocks of dozens (Pizzey et al 2006). Inhabits eucalypt forests and woodlands (Blakers et al. 1984), timber along watercourses, shelterbelts, gardens, mostly coastal and sub-coastal (Pizzey et al 2006). A generalist forager, feeding mainly on the nectar from a wide range of eucalypts (particularly prolifically flowering box and ironbark species) and mistletoes but also eats invertebrates and exotic fruits (Blakers et al. 1984). Key eucalypt species include Yellow Box and Blakely's Red Gum, Red Box and Red Stringybark, which occur locally. Nectar and fruit from *Amyema* mistletoes are also eaten during the breeding season. Potential habitat is present at the site, although confined to remnant woodland/forest areas. Recorded at Binalong, c.10km NW of the site *(Atlas) and east of Yass c.33km E of the site (Bionet).* Research in grazing landscapes in southern NSW showed a pronounced trend for nectarivores to move along densely vegetated areas, and using the same route for return journeys (Fischer and Lindenmayer 2002a).	
Likelihood of habitat avoidance: low	Habitat importance: low

Collision likelihood: low		Collision consequence: moderate
Overall risk levels	**Individuals**	**low-moderate**
	Population	**low-moderate**

Superb Parrot (*Polytelis swainsonii)*
Risk factors: Migratory (seasonal) Limited flocking Declining
Behaviour and ecology: Nesting habitat on SW Slopes is often open Box-Gum Woodland or isolated paddock trees. Species known to be used are Blakely's Red Gum, Yellow Box, Apple Box and Red Box. Nests in tree hollows September-January in small colonies, often with more than one nest in a single tree. Blakely's Red Gum is the main source of nesting hollows (Davey 1997). At the microscale, distribution and abundance is influenced by tree cover and species composition. Nest trees tended to be older, often affected by dieback with little regeneration (Manning 2004). A general dispersal north from Victoria after the breeding season (DNRE 1992). Migrates north in winter to the upper Namoi and Gwydir Rivers. Local migration routes are not known. If disturbed by human activity near the nest, the Superb Parrot may display agitation and avoid entering the nest hollow (Webster 1988). It is therefore important to avoid disturbance at known nest sites during the breeding season. Egg incubation appears to be highly synchronised amongst the population, suggesting that any disruption to breeding is unlikely to be compensated by the production of a second clutch. The species is faithful to traditional nest sites (Webster 1988). Superb Parrot nest trees tend to be close to watercourses (Webster 1988). West of Yass forms part of core breeding population in region. *Numerous Atlas and Bionet records exist around the subject site. The species was recorded at the subject site (on a midslope west of cluster 4b) and observed on numerous occasions beside Illalong Road 3 kilometres west of the site.* *In a* recent survey of road verges on the NSW south-western slopes, there were 2.5 possible nesting trees per kilometre whilst just prior to the start of the breeding season there were 0.62 birds per kilometre (Davey, C. and Purchase, D. 2004). The species feeds in trees and understorey shrubs and on the ground. Food items are mainly flowers, fruits and seeds. Forage species include Yellow Box (*E. melliodora*), Box Mistletoe (*Amyema miquelii*) and insect parasites such as lerps. Understorey food species include Common Wallaby-grass (*Austrodanthonia caespitosa*), numerous wattle species, and introduced plants including cereal grains, barley-grasses (DNRE 1992). Records of flocks of between 20 and 50 birds were made in the Yass region only three times during spring and early summer of 1998; most records were of single birds or pairs (ACT Government 1999). The total breeding population is estimated to be less than 5000 pairs. Loose nesting colonies are often found, and form around clusters of nest trees (ACT Government 1999). The species may forage up to 10 km from nesting sites (Webster 1988; Garnett1992a), although at some sites, including those north of Canberra, the nesting and foraging areas coincide and the birds move very little distance at all during breeding (Webster and Ahern 1992, Martin 1996, Davey 1997 in Act Government 1999). The Superb Parrot avoids open areas on foraging flights, hence simple fragmentation of the habitat can be devastating (DNRE 1992). While Superb Parrots use woodland remnants as corridors, they rarely cross extensive open ground (Webster 1988, Davidson and Chamber 1992, Webster and Ahern 1992, Higgins 1999). Because of the extent of clearing and fragmentation, the majority of the turbine sites are unlikely to provide quality foraging habitat for the Superb Parrot. Little is known about seasonal migration routes; it is assumed that they move west and then north after the breeding season (A. Manning, CRES ANU, pers. comm.). No flight height data is available for this species; a variety of other parrot species are known to fly at turbine blade height at times, although the great majority of recorded flights are from below that zone (Biosis Research 2006). Flights between roost/nest and foraging areas are likely to be at tree canopy level. Superb Parrots have been observed flying high over open areas in the South-West Slopes. However, they do tend to occur more in the lower elevation/relief parts of the landscape where the Box-

Gum Woodlands, including scattered paddock trees, are located - this is where nest trees and food is likely to occur (A. Manning, CRES ANU, pers. comm.). The frequency of parrots flying high over the turbine ridgetops is likely to be low. The absence of intact woodland vegetation with hollow-bearing trees and watercourses in close proximity to the turbines would mean that the risk of nest abandonment due to visual or noise disturbance would be low.		
Likelihood of habitat avoidance: low		Habitat importance: low
Collision likelihood: low		Collision consequence: moderate
Overall risk levels	**Individuals**	**low-moderate**
	Population	**low-moderate**

Swift Parrot (*Lathamus discolor)*		
Risk factors: Migratory (seasonal) Flocking Fast flying Declining		
Behaviour and ecology: Breeds in Tasmania and Furneaux Group islands, migrating to mainland in Feb-April, where it becomes nomadic in response to the availability of blossoms and other food (Pizzey et al 2006). Wintering flocks may remain in a district for weeks, returning as a flock to the same tree each night for roosting. A non-breeding winter migrant to southern and eastern NSW, where it inhabits eucalypt forests and woodlands (Blakers *et al* 1984). Feeds on eucalypt blossom and psyllids, particularly large prolifically flowering trees. Food sources and distribution varies year to year. Habitat is marginal over most of site due to clearing. Forest remnants provide potential habitat where the winter-flowering Long-leaved Box provides a potential food source. Recorded in Booroowa Shire to the north (NPWS 2002). The species may use habitat in the far south of the site, although Long-leaved Box stands are generally regrowth and heavily fragmented. Better habitat is likely to be present in timbered lowland areas. No flight height data is available for this species; a variety of other parrot species are known to fly at turbine blade height at times, although the great majority of recorded flights are from below that zone (Biosis Research 2006). Flights between roost and foraging areas are likely to be at tree canopy level. The frequency of flights over the turbine ridges is likely to be low. A recent cumulative assessment of 39 wind farms located in the distribution range of the Swift Parrot concluded that the combined bladestrike impact of all of these wind farms would not be significant (Biosis Research 2006).		
Likelihood of habitat avoidance: rare		Habitat importance: insignificant
Collision likelihood: rare		Collision consequence: moderate
Overall risk levels	**Individuals**	**low-moderate**
	Population	**low-moderate**

Gang-gang Cockatoo (*Callocephalon fimbriatum)*	
Risk factors: Declining	
Behaviour and ecology: Feeds in pairs or small flocks on seeds of eucalypts and wattles, primarily in forest, but occasionally towns and farming areas for artificial food resources such as berry-bearing exotic shrubs. It is a seasonal altitudinal migrant. Nesting is in large tree hollows. Marginal forage habitat is present in forest and woodland remnants in the study area, and nesting habitat may be present in surrounding areas. Recorded at Binalong, c. 10km NW of the site and Burrinjuck NR c.17km to the SW *(Atlas). Unlikely to use the turbine ridges for foraging due to scarcity of eucalypts. May pass over ridgelines at blade height on longer-distance flights. Frequency of visit to site likely to be low.*	
Likelihood of habitat avoidance: low	Habitat importance: low

Collision likelihood: low		Collision consequence: moderate
Overall risk levels	**Individuals**	**low-moderate**
	Population	**low-moderate**

D 3. Impact potential for microbat species at the subject site

This assessment focuses on microbat species which have some potential to be present at the subject site. Threatened microbat species which are potentially at significant risk have been identified in the matrix in section D.1 and the significance of potential impacts to these species is assessed in Appendix E.

Species	Ecology	Potential for impact	
Goulds Wattled Bat *Chalinolobus gouldii* ID confidence: positive Recorded habitats: forest	Abundant. Forages below the canopy for slow-flying insects, particularly along waterways, seldom more than 20 metres above the ground. Roosts in tree holes or buildings.	**Individual**	Low
		Population	Low
Chocolate Wattled Bat *Chalinolobus morio* ID confidence: positive Recorded habitats: forest, dam	Common. Highly agile, feeding mainly on small moths. Roosts in tree hollows. Colonies range from 20 to several hundred. Starts hibernation later than other species.	**Individual**	Low-moderate
		Population	Low
Little Pied Bat *Chalinolobus picatus* Not recorded at site	Primarily an arid and semi-arid species. Roosts in caves, rock outcrops, mine shafts, tunnels, tree hollows and buildings. Needs access to nearby open water. Feeds on moths and possibly other flying invertebrates. Unlikely to be present at site.	**Individual**	Low
		Population	Low
Eastern Bentwing Bat *Miniopterus schreibersii* ID confidence: probable Recorded habitats: ridgetop	Abundant. Range of habitats, typically well timbered habitats, feeding above the canopy. Constrained by requirement for caves for breeding. Each population uses a single maternity site. Other caves extending for several hundred kilometres from the maternity site are used the rest of the year (ABS 2000). Maternity caves located at Wee Jasper, 30km to the south (ABS 2000). Also *recorded south of Lake Burrinjuck, c.10km S of the site (Atlas)* and Booroowa Shire to the north (NPWS 2002). Refer Appendix E NSW Assessment of Significance for more discussion.	**Individual**	Moderate
		Population	Requires further assessment
Mormopterus sp.no.4 ID confidence: positive Recorded habitats[1]: forest, dam, woodland	Little known; presumed to be an agile, fast-flying predator feeding on flying insects above and beside the forest canopy and over water, roosting in hollows communally or singly.	**Individual**	Moderate
		Population	Low
Mormopterus sp.no.3 ID confidence: probable Recorded habitats[1]: forest, woodland	Little known; presumed to be an agile, fast-flying predator feeding on flying insects above and beside the forest canopy and over water, roosting in hollows communally or singly.	**Individual**	Moderate
		Population	Low
Eastern Freetail Bat *Mormopterus norfolkensis* Not recorded at site	Appears to be a fast-flying predator, hunting above and below the canopy and over water. Roosts singly or small colonies in tree holes, rock crevices or roofs.	**Individual**	Moderate
		Population	Low
Large-footed Myotis *Myotis macropus* Not recorded at site	Comparatively rare over limited range. Forages for aquatic invertebrates and small fish over water bodies. Roosts in small colonies in caves, mines, buildings and under bridges. May forage and migrate in groups. Also recorded near Wee Jasper, c.30km S of the site (Bionet). Refer Appendix D NSW	**Individual**	Low
		Population	Low

	Assessment of Significance for more discussion.		
Long-eared Bat *Nyctophilus geoffroyi/gouldi complex* ID confidence: positive Recorded habitats: forest, dam, woodland	Possibly the most wide-ranging bat in Australia, abundant throughout range, adapted to human presence, even inner city environments. Roosts in variety of locations such as under barks, roofs, hanging awnings. Short-range echo-location system and hunts very near to the ground. Maternity colonies form in spring of 10-100 individuals.	**Individual** **Population**	Low Low
Inland Broad-nosed Bat *Scotorepens balstoni* ID confidence: positive Recorded habitats: forest, dam	Common (*S. greyii*). Habits of both species similar. Inhabit open woodlands and plains; water holes and creeks are favoured feeding areas. Takes occasional drinks by skimming surface of still waters. Requires nightly access to drinking water. Roosts mainly in tree hollows or disused buildings. Colonies range in size from a pair to about 20 individuals.	**Individual**	Low
Little Broad-nosed Bat *Scotorepens greyii* ID confidence: positive Recorded habitats: forest, dam		**Population**	Low
Yellow bellied Sheathtail Bat *Saccolaimus flaviventris* Possible record at site	Rare in widespread habitat. Seldom trapped, presumed to forage high and fast above the tree canopy, lower in open country. A fast flying species with low maneuverability. Roosts in tree hollows, mammal burrows in treeless areas, usually solitary, occasionally in colonies of up to 10 individuals. Appears to defend an aerial territory. Southern populations probably migrate northwards in winter (Strahan 1996). Recorded in Booroowa Shire to the north (NPWS 2002) and a possible record during Marilba Hills survey.	**Individual** **Population**	Moderate Requires further assessment
White-striped Freetail bat *Tadarida australis* (*syn. Nyctinomus australis*) ID confidence: positive Recorded habitats: woodland	Common to uncommon in widespread habitat. Forages on the ground for terrestrial insects and above the canopy, particularly along waterways for flying insects, including high-flying moths. Roosts in tree holes.	**Individual** **Population**	Moderate Low-moderate
Large Forest Bat *Vespadelus darlingtoni* ID confidence: positive Recorded habitats: forest, dam	Inhabits alpine heaths to rainforests. Flies fast below the canopy. Roosts in tree holes and similar crevices, in colonies up to 50.	**Individual** **Population**	Low Low
Southern Forest Bat *Vespadelus regulus* ID confidence: positive Recorded habitats: forest, dam	Common, limited. Agile fast-flying bat feeding on flying insects (especially moths). Roost in tree holes, in colonies of up to 9 individuals, often with other species. Maternity colonies form in late spring.	**Individual** **Population**	Low Low
Little Forest Bat *Vespadelus vulternus* ID confidence: positive Recorded habitats: forest, dam	Common, limited in some areas. Agile, feeds on flying insects just under tree canopy to 2 metres above the ground. Roost in tree holes or old buildings, solitary or in colonies of up to 50.	**Individual** **Population**	Low Low
Eastern False Pipistrelle or Great Pipistrelle *Falsistrellus tasmaniensis* Not recorded at site	Widely distributed in eastern NSW on the Dividing Range and to the east (Parnaby 1992; Strahan 1992), in a range of habitats including dry and wet sclerophyll forest, appearing to prefer wet sclerophyll (Hall and Richards 1979). Roosts in large trees and occasionally caves and buildings. Apparently hibernates during winter months and probably forages mostly above the forest canopy, in open woodland or over water (Strahan et al. 1995). Range and habitat probably marginal at site. Recorded near forest at Carroll's Ridge to south.	**Individual** **Population**	Low Low

Appendix E ASSESSMENT OF SIGNIFICANCE (NSW)

Section 5A of the *Environmental Planning and Assessment Act 1979* (EP&A Act) specifies seven factors to be taken into account in deciding whether a development is likely to significantly affect threatened species, populations or ecological communities, or their habitats.

The following Assessment of Significance assesses the significance of the likely impacts associated with the Marilba Hills Precinct wind farm proposal on Endangered Ecological Communities and threatened flora and fauna species declared under the *Threatened Species Conservation Act 1995*..

Endangered ecological communities

The Endangered Ecological Community White Box Yellow Box Blakely's Red Gum Woodland (Box-Gum Woodland) was recorded in a range of condition classes at all of the clusters at the subject site (refer Map Set 2).

Threatened flora species

The threatened species evaluation presented in Appendix C concluded that *Ammobium craspedioides, Caladenia* sp Burrinjuck, *Cullen parvum, Swainsona sericea* and *Thesium australe* have a realistic potential to be present at the subject site, considering site quality, disturbance history, distribution ranges and the results of the field surveys.

Threatened fauna species

The threatened species evaluation in Appendix C and the Bird and Bat Impact Risk Assessment (Appendix D) have identified 21 threatened fauna species that have potential to be present at the subject site and that score a risk rating of at least 5. These species comprise 2 arboreal marsupials, 3 microchiropteran bats, 14 bird species and 2 reptiles. Ecological, distribution and habitat information for these species is summarised in Appendices C and D.

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

FLORA

Yass Daisy (*Ammobium craspedioides*)

The Yass Daisy is a rare perennial herb, 30-60 centimetres high, inhabiting sclerophyll woodland, forest and roadsides (Harden 1992). It bears yellow button-like flowers in spring, and early summer in wet years. The Yass district is the centre of distribution for this species (Fallding 2002), and most records are confined to the district. Other records exist from near Crookwell (DEC 2005a) and in Livingstone State Forest, 20 kilometres south of Wagga Wagga (Burrows 1999).

The species has been recorded in dry forest, Box-Gum Woodland and secondary grassland derived from clearing of these communities. Associated eucalypts include *Eucalyptus blakelyi*, *E. bridgesiana*, *E. dives*, *E. goniocalyx*, *E. macrorhyncha*, *E. mannifera*, *E. melliodora*, *E. polyanthemos* and *E. rubida.* It appears to be unaffected by light grazing, with some populations persisting in grazed sites (DEC 2005a). In surveys conducted in the Booroowa Shire to the north, all of the occurrences of this species were on land characterised by a light grazing regime (NPWS 2002).

Current threats to the species include agricultural developments, intensification of grazing regimes, invasion of weeds, road works (particularly widening or re-routing) and inappropriate mowing or slashing in cemetery sites (DEC 2005a). The principal recovery actions required involve:

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- the protection of known populations from changes to land use, road works, pasture modification, increased grazing pressures, weeds and inappropriate mowing regimes;
- marking sites and potential habitat onto maps used for farm, development and conservation planning and management; and
- searching for new populations in potential habitat (after DEC 2005a).

The species was recorded at clusters 4, 6 and 7 at the subject site. At each site, Yass Daisy colonies were sizeable (hundreds).

The cluster 4 site is fenced and apparently ungrazed. Some Yass Daisy plants were recorded in grazed pasture at this site, but only within 10 metres of colonies on ungrazed land. This suggests that the species has the capacity to colonise bare ground in grazed paddocks from a protected seed source, but may not be able to persist in the long term in heavily grazed open paddocks in the absence of such a seed source. Some plants occurring in native pasture in this area may be removed during the construction phase.

At clusters 4 and 6, and in the Coppabella Hills to the west, this species appears to favour sheltered south-facing slopes, although this may be the result of reduced clearing and grazing pressure on these aspects. The location of Yass Daisy records is shown in Map Set 2, and listed in Appendix A.

In contrast, the cluster 7 colony occurs in cleared secondary grassland on an upper valley floor and sideslopes. Several other grazing-sensitive species are present, suggesting a light grazing history.

The proposed turbine, substation, access track and powerline works would generally be sited to avoid direct and indirect impacts to the Yass Daisy colonies. A small area (0.14 ha) of woodland understorey habitat in good condition in cluster 4b (refer Map Set 2) would be cleared to provide a 350 metre long and 4.5 metre wide access track and cable trenching. The Yass Daisy colony at this site was centred some distance from the route of the proposed track (refer Map Set 2). Specific measures to minimise impacts to this area are included in section 8.1.5 *Impact avoidance and mitigation*. These include minimising track width, siting to avoid the need for road battering, using the natural soil and vegetation surface for the track, low impact clearing and trenching methods and rehabilitation with native grass species following the works.

The cluster 7 remnant would be excluded from the development envelope and protected from direct and indirect impacts during the works. The natural soil surface and groundcover would be retained and the track width reduced to 4.5 metres for the 350 metre long access track passing through the cluster 4b site.

Work sites adjacent to the Yass Daisy colonies would be revegetated with native tussock grasses to provide continuing potential habitat for this species. The works are not expected to adversely affect the life cycle of the Yass Daisy such that a viable local population of the species is likely to be placed at risk of extinction.

Burrinjuck Spider Orchid (*Caladenia* sp Burrinjuck)

This species has potential habitat in dry shrub forest remnants dominated by *E. goniocalyx*, *E. dives* and *E. mannifera* at clusters 4, 6 and 7. This community is very broadly analogous to known habitats in Burrinjuck Nature Reserve to the south (NPWS 2003a), particularly the Broad-leaved Peppermint – Brittle Gum community on sediments in the south of cluster 7. Forest remnants in the north of the subject site (north of the highway) occur on higher fertility volcanic substrates, rather than the infertile sediments at Burrinjuck, which may reduce habitat suitability for this species. The disturbance and grazing history further reduces the likelihood of its presence in many parts of the site.

A targeted search of the cluster 7 remnant was undertaken as part of the September fieldwork. While the fieldwork was undertaken within the late August - October flowering period for this species, it may not have been flowering or recordable at the time of survey. It is unlikely to flower reliably every year, or could flower later than the survey period (21 September). The isolation of the remnant, disturbance history, grazing pressures and highly restricted distribution of the species reduce the likelihood of its presence at the site.

If the cluster 7 remnant would be impacted by the proposed works, another targeted survey would be undertaken in mid-October. If found to be present at the site, works would be re-sited to avoid impacting this species. The works are not expected to adversely affect the life cycle of the Yass Daisy such that a viable local population of the species is likely to be placed at risk of extinction.

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Small Scurf-pea *(Cullen parvum*)

Silky Purple Pea (*Swainsona sericea*)

Austral Toadflax (*Thesium australe*)

These species are restricted to box gum woodland remnants in good condition, with no or very light grazing history. Box gum woodland in relatively good condition was recorded at cluster 7 (as grazed derived grassland) and cluster 4b (ungrazed intact understorey over regenerating Blakely's Red Gum woodland). While the threatened woodland species were not recorded during the survey and are unlikely to be present at the site, they may have been inconspicuous during the survey period.

The Small Scurf-pea is a small erect or trailing perennial pea with three elongated leaflets and purple-pink (or sometimes white) flowers usually also in threes, appearing in summer. Plants tend to die back over summer and resprout with rain in winter or spring; in dry years, plants apparently do not always produce shoots but survive below the ground. Flooding has been suggested as a mechanism for seed dispersal. The species is threatened by intensive grazing by stock, clearing of habitat and agricultural practices such as cropping (DECC 2008a).

Until recently the Small Scurf-pea was known in NSW from only two herbarium collections; one from Wagga Wagga in 1884 and the other from Jindera (near Albury) in 1967 (DECC 2007a). A small population was discovered last year in a box gum woodland remnant at Galong, around 20 kilometres north of the proposal site (Douglas 2006). The species therefore has a potential distribution in the study area. However, the level of historical or current grazing pressure over most of the site makes it very unlikely that this species would occur there. Native legumes were generally uncommon at the subject site, with low density records of *Desmodium varians* and *Glycine clandestina* from woodland and forest remnants, and rarely, native pasture. Pea shrubs are generally absent from the site. The long grazing history is the probable cause of this loss of native legumes, which are usually quite common in lightly grazed remnants of grassy woodland types.

The Silky Purple Pea is an erect perennial to 10 centimetres high, flowering October-December. As noted above, grazing at the subject site over many decades is likely to have resulted in a general reduction in the density of native legumes, and the loss of some grazing-sensitive species.

Thesium australe is a sprawling perennial herb growing in grassland and woodland. It is semi-parasitic on grasses, particularly Kangaroo Grass, and shows a preference for moist areas. It is found in small populations across eastern NSW, along the coast and from the Northern to Southern Tablelands, but has not been recorded in the region. The woodland remnants at the subject site (clusters 4b and 7) have a patchy sward of Kangaroo Grass and therefore some potential to support *Thesium australe*. This species was not detected at these sites despite targeted searches. The cluster 7 remnant would be excluded from the development envelope and protected from direct and indirect impacts during the works. The natural soil surface and groundcover would be retained and the track width reduced to 4.5 metres for the 350 metre long access track passing through the cluster 4b site. The works are not expected to adversely affect the life cycle of these species such that viable local populations are likely to be placed at risk of extinction.

FAUNA

Waterbirds

Blue-billed Duck

This species is at risk primarily because of migratory and flocking behaviour. The species disperses between ephemeral and/or permanent water bodies within the region. There are several large water bodies within a 200km radius, including Lake Burrinjuck to the south, and birds travelling between them may pass over the turbine ridges and risk blade-strike. Flocking birds are most at risk of population scale impacts. The Blue-billed Duck is known to travel great distances (>300km) between water bodies, has been recorded within 100km and travels in flocks. However, Wildlife Atlas records indicate the species is more likely to follow river systems than ridges between water bodies. The proposal is unlikely to place any viable local population at risk of extinction.

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Raptors

Square-tailed Kite, Barking Owl

The risks to these species relate to foraging behaviour and habitat. Neither of these species was detected in the study area. However, they have been recorded within potential home range distance of the study area and foraging habitat is present on site.

Square-tailed Kites occur at low densities over a very large area. The study area, nearby cleared lands, forest remnants and conservation reserves and lake to the south provide foraging and nesting habitat for this species. Habitat is marginal over most of the subject site because of the extent of clearing. The species is generally absent from cleared pastoral or agricultural lands (Pizzey 2006). Ridges at the subject site may provide thermals for hunting. Clusters 3, 4, 6 and 7 have remnant forest patches which could provide nesting habitat and prey species. The proposal would not result in the loss of a significant area of woodland or forest cover. Given the large range of the species, the marginal nature of habitat over most of the subject site and the presence of similar habitat in the district, the proposal is not expected to affect the life cycle of this species such that a viable local population would be placed at risk of extinction.

Barking Owls prey on mammals, birds and invertebrates, and prefer dense vegetation along watercourses. While generally confined to areas with tree cover, dispersing juveniles may fly over open country. This is expected to be an infrequent event at the subject site. The forest remnants located at and near the subject site provide foraging habitat, but are unlikely to support large numbers of arboreal prey species. Owls tend to use a perch and pounce method of foraging rather than soaring at height. Hunting flights are likely to be at ground and canopy level. The canopy height of forest and woodland remnants around the site range from 5 to 15 metres, well below the potential bladeswept zone of 34-126 metres. This species is unlikely to enter the bladeswept zone during hunting flights.

The proposal is not expected to affect the life cycle of this species such that a viable local population would be placed at risk of extinction.

Woodland Birds

Speckled Warbler, Diamond Firetail, Hooded Robin, Brown Treecreeper

The Speckled Warbler, Diamond Firetail and Hooded Robin forage for seeds and insects on the ground in *Eucalyptus* dominated communities with a grassy understorey and sparse shrub layer (Garnett & Crowley 2000; Hogendyk 2008; NSW Scientific Committee 2008). The Hooded Robin also utilises perches, while the Brown Treecreeper forages for invertebrates on tree trunks and on the ground amongst fallen timber and leaf litter (DECC, 2008; Hogendyk 2008). These species are sedentary and persist only in large woodland areas (100-300 ha) containing structurally diverse habitat (Barrett et al., 1994; Hogendyk 2008; NSW Scientific Committee 2008; TAMS 2005). All four species generally occur in low densities, although the Diamond Firetail and Brown Treecreeper are gregarious (Cooney & Watson 2005; DECC 2008a). The proposal would not significantly affect nesting or foraging habitat for these species. These species are unlikely to regularly or frequently use cleared, heavily grazed ridgetop habitat for foraging.

Diamond Firetails have been recorded travelling 5km during dispersal (Olsen et al. 2005). This species feeds predominantly on the ground on grass seeds, in groups from 5 to 150 individuals (Schodde & Tidemann 1986), nesting in pairs or communally in shrubs and small trees. They may form large flocks during winter and autumn. Research in grazing landscapes in southern NSW suggests that granivores prefer to move along densely vegetated areas (Fischer and Lindenmayer 2002a).

The Diamond Firetail (in moderate condition box gum woodland on a midslope east of cluster 3 and in poor-moderate condition woodland on a lower slope east of cluster 4) and the Speckled Warbler (in moderate condition woodland on an upper slope at cluster 4b) were recorded at the subject site. Habitat may be marginal for the other species which may require higher quality groundlayer habitat for invertebrate food sources.

While most time is spent foraging on or close to the ground, the tendency of the Diamond Firetail to flock when dispersing may place local populations at risk of collision with wind turbines. Winter-autumn would be the time of greatest risk when individuals tend to amalgamate and flocks are at their largest. Given the open nature of the

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proposed turbine ridges, the frequency of this species entering the bladeswept zone as a flock is likely to be very low.

The Speckled Warbler was recorded in moderate condition woodland on an upper slope at cluster 4b at the subject site. It is a sedentary species which feeds and nests on the ground, and is unlikely to use airspace within the turbine bladeswept zone. This species has declined more than 40% in areas where remnants less than 100ha in size remain (Watson et al. 2001). Larger remnants (about 300ha) may be required for populations to be viable (Gardner 2002a). Warblers appear to be averse to open canopy areas, and have poor dispersal ability between fragments (Garnett & Crowley 2000). The contiguous area of remnant woodland at cluster 4 totals around 143 ha, in moderate and moderate-good condition. The proposed works would be largely confined to cleared paddock areas on the cluster 4 ridgeline and would not remove a significant area of habitat for this species or significantly add to habitat fragmentation at the cluster 4 site. Special measures would be implemented to minimise the impacts of road and powerline construction at this cluster (refer section 8).

The proposal is not expected to affect the life cycle of these woodland bird species such that viable local populations would be placed at risk of extinction.

Black-chinned Honeyeater, Regent Honeyeater, Painted Honeyeater

These arboreal honeyeaters are found at low densities in eucalypt open forests or woodlands, particularly ironbark-box and box-gum assemblages. Nomadic movements are linked to flowering events of favoured feed species (Garnett & Crowley 2000; NSW Scientific Committee, 2008).

The Regent Honeyeater prefers wetter, more fertile sites along creek flats, broad river valleys and lower slopes. It forms breeding colonies or nomadic flocks of dozens (Pizzey 2006). Inhabits eucalypt forests and woodlands (Blakers et al. 1984), timber along watercourses, shelterbelts, gardens, mostly coastal and sub-coastal (Pizzey 1985). It is a generalist forager, feeding mainly on the nectar from a wide range of eucalypts (particularly prolifically flowering box and ironbark species) and mistletoes but also eats invertebrates and exotic fruits (Blakers et al. 1984). Key eucalypt species include Yellow Box and Blakely's Red Gum, Red Box and Red Stringybark, which occur locally. Regent honeyeaters are known to undertake irruptive nomadic movements hundreds of kilometres between coastal and inland resources (DECC 2008a). It has been recorded at Binalong, north of the site.

The Painted Honeyeater occupies open eucalypt forest and woodland, and timber along watercourses. Painted Honeyeaters feed almost exclusively on mistletoe, particularly of genus *Amyema*, and generally require 5 or more mistletoes per hectare (DECC 2008a; TAMS 2005b). *Amyema* mistletoes are scattered at the subject site, and may achieve densities greater than 5/ha in some parts of the site.

The Black-chinned Honeyeater occupies taller drier eucalypt woodlands and forests and timber along watercourses, often without understorey, typically in ironbark forests (Pizzey 2006). Black-chinned honeyeaters probe for insects and glean nectar (Lollback *et al.* 2008). They tend to occur in the largest woodland patches. Feeding territories are large (at least 5 hectares) making the species locally nomadic. Stands of suitable species growing on high quality sites where nectar production is copious and relatively predictable appear to be critical to the survival of the species (Menkhorst *et al.* 1999).

Despite their mobility, local populations of these species appear not to persist in small remnants (less than 200 ha) (Garnett & Crowley 2000; NSW Scientific Committee 2008). The largest remnant at the subject site (cluster 4) is around 140 ha. Habitat at the site may be suitable, but marginal given the level of clearing and fragmentation.

None of these species were recorded in the study area. The painted honeyeater is considered unlikely to be impacted by the proposal due to low abundance of *Amyema* species over the study area. The age of regrowth trees and levels of stress of box trees in many parts of the subject site will reduce the availability of nectar for the other two species.

Research in grazing landscapes in southern NSW showed a pronounced trend for nectarivores to move along densely vegetated areas, and using the same route for return journeys (Fischer and Lindenmayer 2002a).

The low quality and fragmentation of available habitat at the subject site and the low probability of these species passing through the bladeswept zone over the turbine ridges makes it unlikely that the proposal would affect the life cycle of these bird species such that viable local populations would be placed at risk of extinction.

Gang-gang Cockatoo, Swift Parrot, Superb Parrot, Turquoise Parrot

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These parrots occupy eucalypt forest and woodland and are long lived with low fecundity. The Turquoise Parrot appears to be non-migratory, while the other species undertake nomadic and seasonal movements for breeding and foraging (Garnett and Crowley 2000).

The Turquoise Parrot lives in small groups or pairs (DECC 2008a). Nesting sites are located within a few kilometres of foraging grounds usually in tree hollows, in forests within 100 m from cleared land and 250 m from surface water (Higgins 1999). The species forages mostly on the ground for seeds of grasses and herbaceous plants, or browses on vegetable matter (Garnett and Crowley 2000).

The Gang-gang Cockatoo moves between tall mature wet sclerophyll forest for breeding (summer) and dry open eucalypt forests (winter). It feeds mostly in the canopy on seeds of eucalypt trees and shrubs and may also eat invertebrates (Cameron 2007). It nests in large hollows (NSW Scientific Committee 2008) between October and January, usually in tall mature sclerophyll forests that have a dense understorey, and occasionally in coastal forests. Nests are most commonly recorded in eucalypt hollows in live trees close to water (Beruldsen 1980). Gang-gangs tend to travel in family groups rather than large flocks.

The Swift Parrot is an annual migrant to the southern mainland from Tasmania, where it breeds. It is a specialist nectar- and pollen-feeder. Flowering events of *E. globulus* may only be sufficient to support breeding in three years out of every ten (Garnett and Crowley 2000; Hingston et al. 2004). On the mainland, Swift Parrots inhabit eucalypt forests and woodlands, particularly box-ironbark forests, with a preference for sites along drainage lines (Higgins 1999). The Swift Parrot is a, particularly favouring *E. globulus*, and also eats psyllids and exotic fruits (Hingston et al 2004; Blakers et al. 1984, Emison et al. 1987).

Superb Parrots utilise box-woodland for foraging and breeding (summer), mostly nesting in dead trees (Manning et al. 2006; Webster 1988). In winter they move into woodlands to feed on lerp, mistletoe berries, eucalypt flowers and grass seed (Higgins, 1999). The superb parrot forages on the ground or in trees, feeding on lerp, mistletoe berries, eucalypt flowers and grass seed (Higgins 1999). Understorey food species include Common Wallaby-grass (*Austrodanthonia caespitosa*), numerous wattle species, and introduced plants including cereal grains, barley-grasses (DNRE 1992). A general dispersal north from Victoria occur after the breeding season (DNRE 1992), migrating along the upper Namoi and Gwydir Rivers. Little is known about seasonal migration routes; it is assumed that they move west and then north after the breeding season (A. Manning, CRES, pers. comm.). Local migration routes are not known. Records of flocks of between 20 and 50 birds were made in the Yass region only three times during spring and early summer of 1998; most records were of single birds or pairs (ACT Government 1999).

The total breeding population is estimated to be less than 5000 pairs. Nesting habitat on SW Slopes is often open Box-Gum Woodland or isolated paddock trees. Blakely's Red Gum is the main source of nesting hollows (Davey 1997), but Yellow Box, Apple Box and Red Box are also used. It nests September-January in small colonies, often with more than one nest in a single tree. Nest trees tended to be older, often affected by dieback with little regeneration (Manning 2004). Loose nesting colonies are often found, and form around clusters of nest trees (ACT Government 1999). The species is faithful to traditional nest sites (Webster 1988). Superb Parrot nest trees tend to be close to watercourses (Webster 1988). In a recent survey of road verges on the NSW south-western slopes, there were 2.5 possible nesting trees per kilometre whilst just prior to the start of the breeding season there were 0.62 birds per kilometre (Davey, C. and Purchase, D. 2004).

The species may forage up to 10 km from nesting sites (Webster 1988; Garnett 1992a), although at some sites, including those north of Canberra, the nesting and foraging areas coincide and the birds move very little distance at all during breeding (Webster and Ahern 1992, Martin 1996, Davey 1997 in Act Government 1999). The Superb Parrot avoids open areas on foraging flights, hence simple fragmentation of the habitat can be devastating (DNRE 1992). While Superb Parrots use woodland remnants as corridors, they rarely cross extensive open ground (Webster 1988, Davidson and Chamber 1992, Webster and Ahern 1992, Higgins 1999, Garnett and Crowley 2000).

If disturbed by human activity near the nest, the Superb Parrot may display agitation and avoid entering the nest hollow (Webster 1988). It is therefore important to avoid disturbance at known nest sites during the breeding season. Egg incubation appears to be highly synchronised amongst the population, suggesting that any disruption to breeding is unlikely to be compensated by the production of a second clutch.

West of Yass forms part of core breeding population in region. Numerous Atlas and Bionet records exist around the subject site. The species was recorded at the subject site (on a midslope west of cluster 4b) and observed on

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numerous occasions beside Illalong Road 3 kilometres west of the site.

Much of the proposal site is heavily cleared and provides low quality habitat for these species. Remnant forest patches are often composed of regrowth eucalypts with few hollows, and usually some distance from water. The subject site is unlikely to be frequently used for foraging or nesting, but the Swift Parrot, Gang-gang and Superb Parrot may fly over the turbine ridges during migrations or moving between habitat areas. No flight height data is available for these species. A variety of other parrot species are known to fly at turbine blade height at times, although the great majority of recorded flights are from below that level (Biosis Research 2006). Flights between roost/nest and foraging areas are likely to be at tree canopy level. Superb Parrots have been observed flying high over open areas in the South-West Slopes. However, they do tend to occur more in the lower elevation/relief parts of the landscape where the Box-Gum Woodlands, including scattered paddock trees, are located - this is where nest trees and food is likely to occur (A. Manning, CRES, pers. comm.). The frequency of parrots flying high over the turbine ridgetops is likely to be low.

The absence of intact woodland vegetation with hollow-bearing trees and watercourses in close proximity to the turbines would mean that the risk of nest abandonment due to visual or noise disturbance would be low.

The low quality of available habitat at the subject site, the distance from nest habitat, and the low probability of these species passing through the bladeswept zone over the turbine ridges makes it unlikely that the proposal would affect the life cycle of these bird species such that viable local populations would be placed at risk of extinction.

Marsupials

Koala, Squirrel Glider

Both these species occupy woodland and forest and appear able to occupy moderately disturbed environments although it is questionable whether these species can persist in fragmented habitats over time (Ahern; DECC 2008a; Gordon et al. 1988; McAlpine et al 2006; Wintle et al. 2008). Both species have been recorded in the local area.

Squirrel gliders have been found to travel over a large area to forage (up to 2.6km), while koalas are less able to travel between fragments due to their low energy diet (Ahern & van der Ree 2003; Menkhorst 2004). Important habitat parameters for Squirrel Gliders are the presence of Yellow Box, Long-leaved Box, and Red Stringybark species, mature hollow-bearing trees, and vegetated corridors if in a fragmented landscape (showing a preference for lowlands and gullies) (Ahern & van der Ree 2003; DECC 2008a). Squirrel Gliders feed on insects, nectar and exudates from leaves and trees (*Eucalyptus* and *Acacia*).

Koalas are specialised foragers and regionally utilise Ribbon Gum and River Red Gum as primary habitat and Candle Bark, Brittle Gum, White Box and Yellow Box as secondary habitat (NPWS, 2003e). Connectivity is important to koala persistence in an area. Secondary habitat has been found to be highly important, as it is more common and aids dispersal (McAlpine et al 2006). In Booroowa Shire to the north, koalas have been recorded at very low densities recorded in Scribbly Gum (*E. rossii*), Red Stringybark (*E. macrorhyncha*) and Bundy (*E. goniocalyx*) forest.

Potential habitat is present at the site, but very marginal due to scarcity of hollows and habitat fragmentation. The remnants with highest potential for these species at cluster 4 would be avoided and protected during the works. The loss of a relatively small area of remnant woodland within the development envelope would not be likely to affect the life cycle of these species such that viable local populations would be placed at risk of extinction.

Microbats

Eastern Bentwing-bat, Large-footed Myotis, Yellow-bellied Sheathtail-bat

The Eastern Bentwing-bat is a cave dependant species. Females migrate to specific cave sites in October-November each year to give birth in December and raise one young. Post weaning, females leave maternity sites in late February-March (Dwyer in Strahan 1983), with young dispersing from the sites approximately two weeks later (late March) (G. Richards pers.comm). The species utilize other structures for roosting such as mines, and occasionally buildings, when caves are in short supply. Four maternity caves are known in NSW- Willi Willi and Riverton in the north and Church Cave (at Wee Jasper) and Drum in southern NSW.

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Church Cave is c. 35 kilometres south-east of the subject site and the maternity colony size is estimated at 60,000 when juveniles are flying with mothers. This number may have been subject to more recent decline (Dimitri Young pers. comm., DECC). Each maternity cave often has an associated “staging” cave close by (Wee Jasper’s is Mt Fairy Cave situated in the triangle between Bungendore, Tarago and Doughboy). Dwyer (1968) suggests that the nursery colony at Church Cave was the maternity centre for the Murrumbidgee, Lachlan and Moruya drainages, plus some of those from the Shoalhaven drainage (Mt Fairy and Major’s Creek).

The exact migration route taken by females to reach or disperse from Church Cave is unknown, though supposed by Dwyer (1968) to be strongly related to topography- both waterways and divides, with the species flying along ridges or waterways, rather than over them, using them as navigation aides. Home ranges are not confined to river basin areas (Wilson 2003). In light of the fact that the species would migrate to and from coastal areas, impacts from the proposed Marilba Hills wind farm, located to the north-west of the maternity cave at Wee Jasper, are considered unlikely.

However, the presence of large numbers of females during the maternity season creates a potential risk to the population. Male movements do not often exceed distances of 160 kilometres (Dwyer 1968, Wilson 2003). Females would travel further to reach maternity caves, and may travel further afield than males in order to meet nutritional requirements of lactation. When not breeding however, most movements are local for foraging for both males and females. The 35km distance of the Marilba subject site from Wee Jasper would be well within the foraging distance of the species each night. Eastern Bentwing-bats require forested areas to forage in, flying above the canopy and to some height over the canopy to capture insects on the wing. The species will utilize “flyways”- tracks or roads- to forage also. There is no evidence that they have a strong affiliation with gradient, being recorded on ridges, midslopes and gullies. Dwyer (1964) found that the species emergence from roost sites correlates strongly with sunset, though re-entry was not so precise. The Eastern Bentwing Bat was recorded at the subject site during the survey.

The Large-footed Myotis is known to use tree hollows, caves, mines, under bridges and storm water drains for roosting. Foraging is dependent on water bodies, both riparian and artificial such as dams; the species gleans insects from the surface and just below, as well as aerial prey. The species may forage and migrate in groups. Only one record exists in the area at Wee Jasper.

The Yellow-bellied Sheathtail-bat ranges across northern and eastern Australia. It roosts alone or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows (DECC 2008a). The species is sedentary and possibly territorial. Southern populations probably migrate northwards in winter (Strahan 1996). It is a fast flying species with low maneuverability, feeding on insects, mainly beetles (Churchill 1996; Richards 2001). The species may favour habitat in large tracts that has extensive understorey flora (shrubs)(Richards 2005). It was recorded near intact forest at Carroll’s Ridge to the south.

Both the Large-footed Myotis and the Yellow-bellied Sheathtail-bat possible records at the Marilba subject site.

The subject site provides potential foraging habitat for all three species. The proposal would not involve the removal of maternity, over-wintering or roosting habitat for the Eastern Bentwing Bat, but would result in the loss of tree hollows and fissures which may provide roosting habitat for the other two species.

The proposal has the potential to introduce a threat from bladestrike and barotraumas for these species. It is also possible that the noise and turbulence around turbines may preclude the species from using adjacent areas or may interfere with the echolocation used to navigate.

Impacts to these species require further assessment – additional surveys were undertaken in January 2009 and have been used to support a more detailed assessment of impacts to microbats in a separate report attached to the Yass Wind Farms Environmental Assessment (nghenvironmental 2009). The report includes a specialist Assessment of Significance for microbats.

Reptiles

Pink-tailed Legless Lizard, Striped Legless Lizard

The Pink-tailed Known only from the Central and Southern Tablelands, and the South Western Slopes (Osborne and

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

Jones 1995), including Canberra in the ACT, and Tarcutta and Bathurst in NSW. This species inhabits sloping, open woodland areas with predominantly native grass groundlayers, particularly those dominated by Kangaroo Grass (*Themeda triandra*). Typically these areas are well-drained, with rocky outcrops or scattered, partially-buried rocks (Osborne and Jones 1995). The species is commonly found beneath small, partially-embedded rocks which are exposed to sunlight, in burrows usually constructed by and are often still inhabited by small black ants and termites (Osborne and Jones, 1995). This species feeds on the larvae and eggs of these ants (DECC 2008a). The species shows a preference for sunny aspects, avoiding south facing slopes (Barrer 1992). Most sites have relatively open vegetation (Osborne and McKergow 1993), including grassland sites supporting no native grasses.

Populations of the Striped Legless Lizard are known in the Goulburn, Yass, Queanbeyan, Cooma and Tumut areas. It inhabits temperate lowland grasslands, secondary grasslands and occasionally in open Box-Gum Woodland. It has been recorded at sites dominated by introduced species (such as *Phalaris aquatica, Nasella trichotoma* and *Hypocharis radicata*) and sites with a history of grazing and pasture improvement (Coulson 1995; Dorrough 1995, Smith and Robertson, 1999). The species feeds on arthropods, most commonly wolf spiders, jumping spiders, crickets, grasshoppers, Lepidopteran larvae and cockroaches (Smith and Robertson 1999). The key to their survival in rural areas may be the availability of shelter during disturbance events (Smith and Robertson 1999). It shelters in grass tussocks, thick ground cover, soil cracks, under rocks, spider burrows, and ground debris such as timber.

The majority of the site has either no surface rock or outcropping bedrock which would not provide suitable habitat. Some areas, notably crests at clusters 1 and 2, have surface rock and potential habitat with largely exotic forb vegetation cover. Some cluster 1 crests are dominated by large weeds such as Scotch Thistle and European Nettle which provides dense ground level shading and are unlikely to provide suitable habitat for these species. Neither species was detected during targeted searches in potential habitat during the survey. Given the marginal nature of habitat over most of the subject site, the absence of nearby records and the limited area affected by the proposal, the proposal is not expected to affect the life cycle of these species such that viable local populations would be placed at risk of extinction.

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 have been listed for the local area under Part 2 of Schedule 1 of the TSC Act or Part 2 of Schedule 4 of the FM Act.

c) in the case of an endangered ecological community or critically 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 the 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

Box gum woodland remnants are present at all cluster sites, and is the dominant vegetation on most of the ridge crests, saddles and upper slopes in the survey area. Condition ranges from good in areas with no or low grazing pressure where a range of forb species are present in the understorey, including threatened and regionally significant species, to poor on crests where sheep camp, where virtually no native understorey species remain. Small areas in moderate-good condition occur at cluster 3 and between clusters 5 and 6, and larger moderate-good and good condition areas occur on the western side of clusters 4a and 4b. Most stands however are in poor-moderate or moderate condition, with the understorey dominated by native grasses with relatively low diversity of native forb species. Woodland trees are generally mature, and regeneration is limited to areas with light grazing pressure (mainly cluster 4).

In addition, much of the native pasture in the study area is derived from the box gum woodland community, usually in depauperate form with low native forb diversity, and forms part of the EEC. The diverse secondary grassland at the

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

potential substation sites near cluster 7 is also likely to be derived from this community, although no diagnostic tree species remain at or near the site.

All box gum woodland remnants in moderate-good or good condition would be excluded from the development envelope and protected from direct and indirect impacts during the works. This includes the midslope stands at cluster 3, the large remnant on the western side of cluster 4, the small stand on the south-western side of cluster 6 and the derived grassland west of cluster 7.

Some parts of the site may have some recovery potential if grazing pressure were reduced. Some areas, generally in saddles where native groundcover species tend to be more dominant, may be capable of producing some tree regeneration and improved native groundcover diversity. Other areas, mostly heavily grazed or sheep camp areas on the highest points, seem likely to be incapable of recovery. Many native grassy understorey species do not appear to form a long term seed bank in the soil. This is supported by the results of experiments with daisy and lily species (Lunt 1990) and by the loss of species diversity which results from the absence of fire for periods greater than 7-10 years (Scarlett and Parsons 1990). In some dieback affected areas, trees may too be stressed to produce seed, and if grazing pressure were reduced exotic groundcovers would simply become more dominant.

Many of the lowland woodland areas on the potential powerline routes have scattered mature Yellow Box and Blakely's Red Gum trees and virtually no native understorey. Given the general absence of native species in the groundlayer and the long history of grazing and pasture improvement involving ploughing, sowing of exotic pasture and fodder crops and fertilising, it is considered that the potential for any native seed bank in these areas is exceedingly low.

The proposal would permanently remove up to 12.01 ha of box gum woodland, an endangered ecological community, including up to 1.47 ha in good, moderate-good or moderate condition. This vegetation is locally common and dominant on ridges and slopes and this loss would not be significant in terms of area. Some of the powerline routes will overlap with tracks, reducing the overall area of disturbance.

The proposal would also involve the clearing of a small area of woodland in good condition in cluster 4b (refer Map Set 2). A small area (0.14 ha) would be cleared for a 350 metre long and 4.5 metre wide access track and cable trenching. Specific measures to minimise impacts to this area are included in section 8.1.5 *Impact avoidance and mitigation*. These include minimising track width, siting to avoid the need for road battering, using the natural soil and vegetation surface for the track, low impact clearing and trenching methods and rehabilitation with native grass species following the works.

The proposal would not place the EEC at this location at risk of extinction, or modify the composition of remaining stands such that they are placed at risk of extinction. At worst it would result in the removal of some trees, within a landscape where woodland is already fragmented, and result in an increase in weed cover in limited areas of native pasture. The amount of tree removal cannot be precisely quantified at this stage, and some adjustment to the siting of infrastructure may be achievable to minimise it.

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

FLORA AND ECOLOGICAL COMMUNITIES

Yass Daisy habitat was recorded in box gum woodland remnants at clusters 4, 6 and 7 at the subject site. These sites also provide potential habitat to the Small Scurf-pea, Silky Purple Pea and Austral Toadflax. These remnant habitat areas would be excluded from the development envelope and protected from direct and indirect impacts during the

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

works. Some Yass Daisy plants were recorded in grazed pasture adjacent to the fenced cluster 4 remnant. Some of this native pasture habitat may be removed during the construction phase. These plants area restricted to within 10 metres of the core population in the fenced cluster 4 remnant, and are unlikely to be sustainable without ongoing dispersal from this source population. Impacts to this marginal pasture habitat would not threaten the core population at the site. While the Yass Daisy appears capable of colonising native pasture, the local population is fragmented by grazing pressures and exotic plant competition. The proposal is unlikely to significantly add to these fragmentation processes. Work sites adjacent to the Yass Daisy colonies would be revegetated with native tussock grasses to provide continuing potential habitat for this species.

The proposal would permanently remove up to 12.01 ha of box gum woodland, an endangered ecological community, including up to 1.47 ha in good, moderate-good or moderate condition. Track, powerline, turbine and substation locations have been modified to reduce impact on the EEC (refer Section 7). Up to 50 ha of pasture would be cleared during construction of the turbines, access tracks and substation. The majority of this is likely to be native pasture derived from box gum woodland (EEC) in generally poor-moderate condition. 16.42 ha of pasture would be reinstated following removal of the construction facilities.

This vegetation is locally common and dominant on ridges and slopes and this loss would not be significant in terms of area. With the exception of a small area of good condition woodland at cluster 4b (refer Map Set 2), all box gum woodland remnants in moderate-good or good condition would be excluded from the development envelope and protected from direct and indirect impacts during the works. Special measures would be implemented to minimise impacts to the woodland stand at cluster 4b (refer section 8.1.1). The proposal would not place the EEC at this location at risk of extinction, or significantly add to the existing high level of habitat fragmentation. Given the condition, use history and fragmented nature of the box gum woodland remnants that would be affected, the proposal would not be likely to significantly affect the extent, security or conservation value of the EEC at the subject site. Measures would be adopted to prevent indirect or peripheral impacts to higher conservation value stands.

A small dry forest remnant in the south of cluster 7 provides marginal potential habitat for the Burrinjuck Spider Orchid. The species was not recorded during a targeted search undertaken in September 2008. The isolation of the remnant, disturbance history, grazing pressures and highly restricted distribution of the species reduce the likelihood of its presence at the site.

If the cluster 7 remnant would be impacted by the proposed works, another targeted survey would be undertaken in mid-October. If found to be present at the site, works would be re-sited to avoid impacting this species. The works are not expected to adversely affect the life cycle of the Yass Daisy such that a viable local population of the species is likely to be placed at risk of extinction.

FAUNA

Key threatened fauna habitat features in the study area include woodland and forest remnants, pasture dominated by native grasses, rocky outcrops and modified wetland habitats. The proposal would not result in the removal of a significant area of these potential threatened fauna habitat features (refer section 8.1.1). Specific measures would be implemented to protect remnant forest and woodland vegetation and hollow-bearing trees present at the subject site.

The operation of the wind turbines has the potential to create a barrier between habitat areas, exacerbating existing levels of habitat fragmentation. The threatened woodland bird species which have potential to be present at the site are dependent on remnant woodland habitats, and are unlikely to frequently use the cleared high ridge habitats occupied by the turbines for foraging or dispersal. Precise bird and microbat migration routes in the study area are not known, but woodland species dependent on tree cover (such as the Diamond Firetail, Regent Honeyeater, Gang-gang Cockatoo and Superb Parrot) could be expected to use riparian corridors or scattered trees and patches in lowland areas as ‘stepping stones’. Similarly, waterbirds are likely to favour lowland routes when dispersing from large waterbodies such as Lake Burrinjuck; this assumption is supported by Atlas of NSW Wildlife records for these species. Given the very limited areas of native vegetation affected, the proposal is unlikely to significantly add to the existing levels of habitat fragmentation in the study area.

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

No areas of critical habitat have been declared within the district.

f) whether the action proposed is consistent with the objectives or action of a recovery plan or threat abatement plan

A draft recovery plan has been prepared for the Burrinjuck Spider Orchid (*Caladenia* sp Burrinjuck) (NPWS 2003a). Proposed recovery objectives and actions include the rehabilitation and protection of known populations, monitoring and researching known populations, and surveying for additional populations in the Burrinjuck reserves and adjacent private property. The proposal would not conflict with these objectives and actions.

A draft Recovery Plan has been prepared for the Barking Owl (DEC 2006; NPWS 2003b). The plan assumes that all cases or individual mortality and nest failure are significant for the population. Actions in the plan include survey and research, protecting the more productive, lower lying areas of the landscape from further clearing, protecting substantial-sized blocks of mature forest and woodland and smaller forest fragments within a few kilometres of such blocks, and nest site protection. The proposal, the assessment process and mitigation measures are consistent with the objectives and actions contained in this plan.

A national recovery plan has been prepared for the Swift Parrot (Swift Parrot Recovery Team 2001). Among other things, the plan aims to reduce the incidence of collisions with man-made structures. Collisions with chain-link fences, cars and windows are a significant cause of mortality during the breeding season (Swift Parrot Recovery Team 2001). These collisions occur mainly in urban areas where concentrated foraging occurs at native and introduced flowering eucalypts, particularly when natural food supplies are low because of drought or other factors. These conditions would not apply at the proposed wind farm site, where foraging would occur well below blade height and foraging resources would not be so concentrated. To date, no wind farms have been implicated in Swift Parrot collisions (Biosis Research 2006). The proposal would not conflict with this or other elements of the recovery plan.

The Recovery Plan for the Koala identifies clearing of native vegetation and loss of vegetation structure and composition as key threatening processes. The proposal would not significantly exacerbate these threatening processes in the study area.

The DECC Threatened Species Priorities Action Statement (PAS) outlines the broad strategies and detailed priority actions to be undertaken in NSW to promote the recovery of threatened species, population and ecological communities and manage key threatening processes. The proposal would not conflict with any of the priority actions identified for threatened species which have potential to be present at the subject site.

No current Threat Abatement Plans are relevant to the proposal.

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

Six listed Key Threatening Processes are relevant to this proposal:

1. **Bush Rock Removal.** Includes removal of rocky outcrops or rock within areas of native vegetation. Impacts of bush rock removal includes loss or disturbance of native flora and fauna species habitat, including those described (e.g. *Delma impar).* The subject site is unlikely to support threatened fauna dependent on bush rock (refer a) above) and similar habitat is likely to be widespread in the district. The loss of small areas of rocky outcrop at the subject site is not expected to significantly exacerbate bush rock removal as a threatening process in the study area.
2. **Clearing of native vegetation**. In the determination, the NSW Scientific Committee found that 'clearing of any area of native vegetation, including areas less than two hectares in extent, may have significant impacts on biological diversity'. Clearing can lead to direct habitat loss, habitat fragmentation and associated genetic impacts, habitat degradation, loss of the leaf litter layer increased habitat for invasive species and off-site impacts such as downstream sedimentation. The proposal would not contribute significantly to the operation of clearing as a threatening process at the local or regional level, since the bulk of the subject site is already cleared. The clearing likely to result from the proposal has been quantified in section 8.1.1. The proposal would remove up to 12.01 ha of box gum woodland, an endangered ecological community, including up to 1.47 ha in good, moderate-

f) whether the action proposed is consistent with the objectives or action of a recovery plan or threat abatement plan

good or moderate condition. Clearing areas would be reduced by avoiding individual trees and woodland stands at the finescale site planning stage wherever practicable. Larger remnants in better condition and threatened flora habitats at the subject site would generally be excluded from the development area and protected during construction. A small area of woodland (0.14 ha) of woodland in good condition in cluster 4b would be cleared to provide an access track and cable trench. Special measures would be used to minimise impacts in this area.

The proposal would also result in the clearing of up to 50 ha of pasture dominated by native grasses. These assemblages are depauperate and are likely to be abundant on ridges and slopes elsewhere in the district. 'Clearing' of the groundcover is reversible over time, unless highly invasive exotics are introduced to the site during the works. Given the limited area of clearing involved and the condition of vegetation to be cleared, the proposal is not likely to contribute significantly to the operation of clearing as a threatening process at the local or regional level.

3. **Loss and/or degradation of sites used for hill-topping by butterflies**. Hill-topping in butterflies is a very complex behaviour that often facilitates meeting of the sexes. Factors which determine whether an area is suitable can be subtle so that even small changes may cause butterflies to abandon the area. Disturbance of plants on, or topography of, the hill-top, or to its slopes and immediate surroundings, may render it unsuitable to butterflies as a hill-topping site. In the absence of other hill-topping sites, butterflies may disappear entirely from a district. Loss of hill-top habitats throughout NSW would affect butterfly species which rely on such sites and some local extinctions have undoubtedly occurred due to hill-top alteration. Loss of hill-topping sites due to habitat alteration, may lead to loss of resting sites for male butterflies, loss of focal points for mating and thus local extinctions. 'Habitat alteration' includes loss of vegetation for agriculture, urban development, forestry, tourist development, communication towers or power transmission lines.

   The ridge crests of the subject site are generally cleared of woodland tree cover with a degraded understorey and no shrub layer. The site is likely to provide marginal habitat for butterflies and are unlikely to represent important hill-topping habitat. The proposal is not expected to significantly exacerbate this threatening process in the study area.

4. **Loss of hollow-bearing trees.** In NSW, terrestrial vertebrate species that are reliant on tree hollows for shelter and nests include at least 46 mammals, 85 birds, 32 reptiles and 16 frogs (Gibbons and Lindenmayer 1997, Gibbons and Lindenmayer 2002). Of these, 45 species are listed as threatened. Hollow-nearing trees are in decline for reasons including lack of recruitment and clearing. Trees bearing large hollows in particular are increasingly rare. Generally hollow-bearing trees near riparian habitat are most valuable. No large hollows were observed at the subject site, although medium and small hollows are present in woodland and isolated trees at the site. The trees to be removed generally have no regeneration and tree cover is likely to be lost when the current generation die. With the exception of cluster 4, seedling recruitment is generally uncommon throughout the subject site. While some small-medium hollows may be lost during clearing required for the proposal, hollows of this size do not appear to be locally limiting. Powerline and access track routes and turbine placement would avoid hollow-bearing trees wherever practicable. The limited clearing required is not expected to significantly exacerbate this threatening process in the study area.

5. **Removal of dead wood and dead trees.** The removal of standing or fallen dead wood removes hollows as well as forest floor litter. The forests and woodlands of Western Slopes are considered most at risk from this process mainly due to firewood collection. Standing dead timber is present at most cluster sites, and is still relatively common on ridges throughout the district. The limited clearing required is not expected to significantly exacerbate this threatening process in the study area.

6. **Invasion of native vegetation by exotic perennial grasses.** The Box-Gum Woodland EEC is vulnerable to the introduction and spread of perennial grasses such as African Love Grass, Serrated Tussock, Phalaris, Cocksfoot, Yorkshire Fog and Paspalum. Unnecessary disturbance of areas adjacent to the works should be avoided so as not to increase risks of spreading exotic grasses. Washing of vehicles and plant prior to arrival on the site would help to ameliorate this impact, by preventing the introduction of additional weeds. Section 8 identifies further safeguards to minimise risks from weeds, and the proposal is not expected to significantly increase the impact of this Key Threatening Process in the study area. Few perennial exotic pasture grasses appeared to be present within the site at the time of the survey, with most exotic grasses being annuals, such as Barley Grass (**Hordeum leporinum*). It seems unlikely that exotic perennial grasses will increase as a result of the disturbance, though exotic forbs such as thistles may well do so, at least in the short term.

Conclusion

Flora and ecological communities

This assessment concludes that impact to generally poor and poor-moderate condition stands of the EEC White Box - Yellow Box –Blakely's Red Gum Grassy Woodland will occur as a result of the development, but will not be significant in the local context, since degraded remnants of the community are still relatively common in the local area. Stands in moderate-good and good condition would be excluded from the development envelope and protected from direct and indirect impacts during the works. Similarly, the core populations of the Yass Daisy and potential habitat for other threatened woodland flora species would be excluded from the development envelope, and the proposal would not produce impacts to these species such that local populations would be placed at risk of extinction.

Fauna

The construction of the wind farm would result in the loss of a small area of marginal habitat for threatened woodland bird and reptile species. The habitat affected is generally degraded and woodland habitat in similar condition is relatively abundant in the study area. The operation of the wind farm would create risks of bladestrike for some threatened bird and microbat species and additional risks of barotrauma for bat species. While a degree of uncertainty remains regarding specific responses from these species, current knowledge regarding the behaviour and ecology, and experiences at other wind farms suggest that impacts will not significantly affect local populations of these species.

Specifically, the proposal would not be likely to:

- reduce the long-term viability of a local population of threatened species, populations or ecological communities;
- accelerate the extinction of the species, population or ecological community or place it at risk of extinction; or
- adversely affect critical habitat.

This conclusion is provisional, subject to the further assessment of potential impacts to threatened microbats. This assessment, based on additional surveys undertaken in January 2009, has been prepared as a separate specialist report attached to the Yass Wind Farms Environmental Assessment (**ngh**environmental 2009).

Specific safeguards have been identified in Section 8 to avoid and minimise impacts to these values, including the finescale siting of components, the protection of forest remnants and hollow-bearing trees, weed hygiene and control, soil and water quality protection, appropriate rehabilitation measures, and structural and operational measures to reduce risks to birds and bats.

Appendix F ASSESSMENT OF SIGNIFICANCE (COMMONWEALTH)

A proponent must refer a proposal to the Commonwealth Minister for the Environment if they believe that the proposal will have, or is likely to have, a significant impact on a matter of national environmental significance, unless the proposal is covered by an exemption specified in the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The EPBC Act Principal Significant Impact Guidelines (DEH 2005a) identify a series of criteria to be taken into account in deciding whether a development is likely to significantly affect threatened species and communities, and migratory species listed in the Act. The Draft Supplementary Significant Impact Guidelines 2.1.3 (DEH 2005b) provide additional guidance in relation to wind farm proposals.

The following assessment is based on the requirements of the EPBC Act and relevant policy guidelines. The assessment should be read in conjunction with the Assessment of Significance under the NSW EP&A Act (Appendix E), and the separate Bird Impact Risk Assessment report which contain background in relation to species ecology, species and community distribution and scale, specific development impacts, and impact risks.

The Threatened Species Evaluation in Appendix C assesses the potential for threatened species to be present at the proposal site, based on available habitat, known ecological requirements and local distribution records. Species which have at least moderate potential to occur at the proposal site are included in the Assessment of Significance.

This assessment of significance addresses:

- the Critically Endangered Ecological Community (CEEC) White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (‘box gum woodland’);
- the threatened flora species *Ammobium craspedioides, Caladenia* sp Burrinjuck (syn *C. concolor* sens lat.) and *Thesium australe;*
- threatened and migratory fauna species with potential to be present at the subject site.

An action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will:

a) ***reduce the extent of a community,***

   The proposal would result in the clearing of a small area of box gum woodland comprising intact understorey and an open regenerating Blakely’s Red Gum tree layer in cluster 4b (refer Map Set 2) which forms part of CEEC. A small area (0.14 ha) would be cleared to provide construction access and to instal underground cabling in a 0-5-1 metre wide trench. Specific measures to minimise impacts to this area are included in section 8.1.5 Impact avoidance and mitigation. These include minimising track width, siting to avoid the need for road battering, using the natural soil and vegetation surface for the track, low impact clearing and trenching methods and rehabilitation with native grass species following the works.

b) ***fragment or increase fragmentation of the community, for example by clearing vegetation for roads or transmission lines;***

The box gum woodland community is heavily fragmented and degraded in the locality. The minor clearing of poor and poor-moderate condition ridgetop native pasture and generally poor—moderate and moderate condition woodland required for the proposal would not add significantly to the existing level of fragmentation. The powerline and turbines have been sited to avoid the need for tree clearing wherever possible.

c) adversely affect habitat critical to the survival of an ecological community which consists of, or includes, fauna species;

The development would have relatively minor impacts on fauna habitat and would not significantly affect habitat critical to the survival of the community. The area of vegetation likely to be cleared or modified is relatively small and in generally poor-moderate condition. The proposal is not likely to significantly affect any fauna species which perform critical ecological functions for the CEEC.

d) modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for the community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns;

Soils and nutrient balance in cleared parts of the subject site are already highly disturbed due to grazing impacts. It is apparent from differences in soil levels across some fences on ridge crests within the site that there has been substantial soil loss from some areas due to exposure of the soil from overgrazing and sheep trampling, and wind erosion. Elevated nutrient levels are clearly present in areas favoured as sheep camps, with vegetation dominated by thistles and nettles. Some modification of surface water drainage patterns has undoubtedly also occurred due to soil compaction and loss of vegetation cover. Salinisation is active in some parts of the site.

The ridgeline turbine and road construction activities have potential to cause soil erosion, sedimentation and chemical pollution in the adjacent CEEC stands. The stands located close to the development area would be protected from indirect impacts such as soil erosion and sedimentation. The limited scale of clearing and soil disturbances, timely restoration of landform and vegetation and the adoption of best practice soil and water conservation measures should mean that any indirect physical impacts to the CEEC are minimal.

Special measures to minimise impacts to soils at the cluster 4b CEEC include minimising road width, siting to avoid the need for road battering, clearing trees and shrubs by hand and using the natural soil and vegetation surface for the road driving surface.

e) cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting;

The development would have localised effects on composition of the CEEC at the cluster 4b site, by removing the tree layer over the powerline corridor. This is not likely to cause a decline or loss of functionally important species such as Kangaroo Grass, which are adapted to open woodland conditions.

f) cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to: - assisting invasive species, that are harmful to the listed ecological community, to become established; and - causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community;

The construction phase of the proposal has the potential to introduce or assist the spread of invasive weed species. The invasion of native vegetation by exotic perennial grasses is a particular risk for the CEEC. Perennial exotic grasses appeared to be uncommon at the subject site during the survey. These risks would be reduced to acceptable levels through weed hygiene protocols, pre and post works weed control, soil erosion and sedimentation control, effective and timely site rehabilitation and the avoidance of fertiliser use in areas adjacent to the CEEC.

Chemical pollution risks would be reduced using chemical spill kits, site sediment control structures and permanent bunding of the turbine sites. The works are not expected to result in significant impacts from weeds or pollutants.

Soil disturbance would be avoided at the cluster 4b site by clearing by hand, avoiding the need for road battering and using the natural soil and vegetation as the track driving surface.

g) interfere with the recovery of an ecological community.

Most CEEC remnants are excluded from the development envelope and would be protected from direct and indirect impacts. The proposal is not expected to affect the recovery of these remnants or exacerbate existing threatening processes affecting the parts of the CEEC (including grazing, fertiliser use, weed invasion, soil erosion). The cluster 4b remnant would have the regenerating tree layer remove over the 20 metre wide powerline corridor and track route, for a distance of around 312 metres. This will prevent the recovery of the tree stratum in this area, but would not interfere with the recovery of the groundlayer vegetation over the majority of the area.

Threatened flora and fauna species

a) Will the action lead to a long-term decrease in the size of a population of a species?

Threatened flora

The majority of the box gum woodland remnants which provide potential habitat to the Yass Daisy and Austral Toadflax have been excluded from the development envelope and would be protected from direct and indirect impacts. The proposed clearing of a small area of box gum woodland (0.14 ha) in cluster 4b (refer Map Set 2) is located adjacent to a Yass Daisy colony.

Specific measures to minimise impacts to this area are included in section 8.1.5 *Impact avoidance and mitigation*. These include minimising track width, siting to avoid the need for road battering, using the natural soil and vegetation surface for the track, low impact clearing and trenching methods and rehabilitation with native grass species following the works. This should ensure that the impacts to these species are minimal and would not affect the size of the local populations.

A small dry forest remnant in the south of cluster 7 provides marginal potential habitat for the Burrinjuck Spider Orchid (listed as part of *Caladenia concolor*). The species was not recorded during a targeted search undertaken in September 2008. The isolation of the remnant, disturbance history, grazing pressures and highly restricted distribution of the species reduce the likelihood of its presence at the site.

If the cluster 7 remnant would be impacted by the proposed works, another targeted survey would be undertaken in mid-October. If found to be present, works would be excluded from the habitat area of this species. The works are not expected to result in a decrease in the size of the population of this species if present at the site.

Threatened fauna

Regent Honeyeater

There is a potential risk that a Regent Honeyeater population may be affected by collisions with turbines and associated infrastructure. The Regent Honeyeater feeds mainly on the eucalypt nectar (particularly prolifically flowering box and ironbark species), but also eats invertebrates and exotic fruits (Blakers *et al*. 1984). Local feed species include Yellow Box, Blakely's Red Gum and Red Stringybark. Potential foraging habitat in the study area is confined to remnant woodland/forest areas, and is unlikely to include the largely treeless ridges of the northern turbine sites. Yellow Box trees are sparsely scattered in lowland pasture areas and ridge slopes, saddles and crests in the study area.

Research in grazing landscapes in southern NSW showed a pronounced trend for nectarivores to move along densely vegetated areas, and using the same route for return journeys (Fischer and Lindenmayer 2002a). On current knowledge, the Regent Honeyeater is considered unlikely to fly high above the turbine ridges, and therefore the risk of bladestrike would be low.

Superb Parrot

There is a potential risk that a local Superb Parrot population may be affected by collisions with turbines and associated infrastructure. West of Yass forms part of the core breeding population of the Superb Parrot. This species nests in September-January in small colonies, using tree hollows in open Box-Gum Woodland or isolated paddock trees. Blakely's Red Gum is the main source of nesting hollows (Davey 1997). Superb Parrot nest trees tend to be close to watercourses (Webster 1988).

The Superb Parrot disperses north in winter to the upper Namoi and Gwydir Rivers (DNRE 1992). Local migration routes are not known.

The species feeds in trees and understorey shrubs and on the ground. Food items are mainly flowers, fruits and seeds, including Yellow Box (*E. melliodora*), Box Mistletoe (*Amyema miquelii*), insect parasites such as lerps, grasses such as Common Wallaby-grass (*Austrodanthonia caespitosa*), numerous wattle species, and introduced plants including cereal grains, barley-grasses (DNRE 1992). Most records in the Yass region are of single birds or pairs. The species may forage up to 10 kilometres from nesting sites (Webster 1988; Garnett1992a), although north of Canberra the nesting and foraging areas coincide and the birds move very little distance at all during breeding (Webster and Ahern 1992, Martin 1996, Davey 1997 in ACT Government 1999).

The Superb Parrot avoids open areas on foraging flights (DNRE 1992). While Superb Parrots use woodland remnants as corridors, they rarely cross extensive open ground (Webster 1988, Davidson and Chamber 1992, Webster and Ahern 1992, Higgins 1999).

A variety of other parrot species are known to fly at turbine blade height at times, although the great majority of recorded flights are from below that zone (Biosis Research 2006). Superb Parrots have been observed flying high over open areas in the South-West Slopes. However, they do tend to occur more in the lower elevation/relief parts of the landscape where the Box-Gum Woodlands, including scattered paddock trees, are located - this is where nest trees and food are likely to occur (A. Manning, CRES ANU, pers. comm.).

Because of the extent of clearing, the ridgetop turbine sites are unlikely to provide quality foraging or migration habitat for the Superb Parrot. The frequency of parrots flying high over the turbine ridgetops, and the risk of bladestrike, are likely to be low.

The scarcity of intact woodland vegetation with hollow-bearing trees in close proximity to the turbines would mean that the risk of nest abandonment due to visual or noise disturbance would be low.

Swift Parrot

There is a potential risk that a Swift Parrot population may be affected by collisions with turbines and associated infrastructure. The Swift Parrot breeds in Tasmania and Furneaux Group islands, migrating to the mainland in Feb-April, where it becomes nomadic in response to the availability of blossoms and other food (Pizzey et al 2006). In southern and eastern NSW, it inhabits eucalypt forests and woodlands (Blakers *et al* 1984), feeding on eucalypt blossom and psyllids, particularly large prolifically flowering trees. Food sources and distribution varies year to year. Marginal habitat is present in the winter-flowering Long-leaved Box remnants scattered on sideslopes in the study area which provide a potential food source. The Swift Parrot has been recorded in Booroowa Shire to the north (NPWS 2002).

The species may use forest habitat at the site, although the Long-leaved Box stands are generally regrowth and heavily fragmented. Better habitat is likely to be present in timbered lowland areas.

No flight height data is available for this species; a variety of other parrot species are known to fly at turbine blade height at times, although the great majority of recorded flights are from below that zone (Biosis Research 2006). Migratory routes and durations of residency are likely to be variable depending on food supplies. Flights between roost and foraging areas are likely to be at tree canopy level. The frequency of flights over the turbine ridges is likely to be low.

A recent cumulative assessment of 39 wind farms located in the distribution range of the Swift Parrot concluded that the combined bladestrike impact of all of these wind farms would not be significant (Biosis Research 2006).

General

A monitoring and adaptive management program would be implemented to provide timely and appropriate responses to any mortality of threatened fauna (refer section 5.3).

b) Will the action reduce the area of occupancy of the species?

Threatened flora species

The actual and potential area of occupancy for the Yass Daisy and Austral Toadflax within box gum woodland remnants have generally been excluded from the development envelope and would be protected from direct and indirect impacts. The access track and underground cable proposed for the cluster 4b remnant will reduce the capacity to support these species over a small area (0.14 ha).

Specific measures to minimise impacts to this area are included in section 8.1.5 *Impact avoidance and mitigation*. These include minimising track width, siting to avoid the need for road battering, using the natural soil and vegetation surface for the track, low impact clearing and trenching methods and rehabilitation with native grass species following the works.

The Yass Daisy colony was centred some distance from the proposed track route (refer Map Set 2) and habitat for the Austral Toadflax is marginal at this site. The proposal would not result in a substantial decrease in the area of occupancy for these species (refer NSW seven part test).

A small dry forest remnant in the south of cluster 7 provides marginal potential habitat for the Burrinjuck Spider Orchid (listed as part of *Caladenia concolor*). The species was not recorded during a targeted search undertaken in September 2008. The isolation of the remnant, disturbance history, grazing pressures and highly restricted distribution of the species reduce the likelihood of its presence at the site.

If the cluster 7 remnant would be impacted by the proposed works, another targeted survey would be undertaken in mid-October. If found to be present, works would be excluded from the habitat area of this species. The works are not expected to result in a decrease in the size of the population of this species if present at the site.

Threatened fauna

The proposal would not remove local threatened fauna habitats, including intact box gum woodland understorey. In view of the distance between the turbine sites and potential woodland bird habitats, the proposal is considered unlikely to alienate or fragment woodland habitats, or alter natural life cycle behaviours of woodland fauna species.

c) Will the action fragment an existing population into two or more populations?

The action would be very unlikely to significantly add to existing levels of habitat fragmentation for the three threatened flora species. The grassy woodland species already have a highly fragmented distribution due to past clearing and farming activities in the district.

The proposal would not add to the existing level of fragmentation of threatened flora populations. The wind turbines have the potential to create a barrier between habitat areas for bird species, exacerbating existing levels of habitat fragmentation. Woodland habitat of varying quality exists north, east and west of the proposal site.

The Regent Honeyeater, Superb Parrot and Swift Parrot are highly mobile, but dependent on remnant forest and woodland habitat. Precise migration routes at the site are not known, but woodland species dependent on tree cover (such as the Regent Honeyeater and Superb Parrot) could be expected to use scattered trees and remnant patches as 'stepping stones' during migratory or foraging movements.

There are valley areas with scattered trees providing east-west and north-south connectivity within 5 kilometres of the site. Black Range Road to the south and Illalong Road/Illalong Creek to the west provide linear remnants with tree cover that may be used for woodland bird foraging and dispersal. The heavily cleared nature of the involved properties, and the turbine ridges in particular, would appear to make their frequent use for bird migration unlikely.

d) Will the action adversely affect habitat critical to the survival of a species?

The subject site area that will be impacted by the proposal is not habitat critical to the survival of threatened flora or fauna species.

e) Will the action disrupt the breeding cycle of a population?

Impacts would not occur within the area of occupancy of the Yass Daisy or Austral Toadflax or remove a significant area of potential habitat. If found to be present at the site, the Burrinjuck Spider Orchid habitat would also be protected. No disruption to the flowering or seeding processes of threatened flora are therefore anticipated.

The potential for bladestrike, decompression and habitat impacts to affect bird and bat populations is addressed in Appendix D. The assessment concludes that the proposal is not likely to significantly affect local bird or bat species at the population level.

The visual and noise impact of the wind turbines has the potential to disrupt nesting behaviour. Given the distance of the turbines from potential nesting habitats for woodland bird species, the risks of nest abandonment are considered low.

f) Will the action modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

Yass Daisy and Austral Toadflax actual and potential habitats within box gum woodland remnants have generally been excluded from the development envelope and would be protected from direct and indirect impacts. The access track and cable trench proposed for the cluster 4b remnant will result in minor habitat impacts over a small area (0.14 ha). Specific measures to minimise impacts to this area are included in section 8.1.5 *Impact avoidance and mitigation*. These include minimising track width, siting to avoid the need for road battering, using the natural soil and vegetation surface for the track, low impact clearing and trenching methods and rehabilitation with native grass species following the works.

The Yass Daisy colony was centred some distance from the proposed track route (refer Map Set 2) and habitat for the Austral Toadflax is marginal at this site. The proposal is not expected to produce habitat impacts that would result in the decline of these species.

If found to be present at the cluster 7 forest remnant site, the Burrinjuck Spider Orchid habitat would also be protected. The works are therefore not likely to result in the decline of this species.

The powerline and turbines would be sited to avoid potential threatened species habitat. The clearing required by the proposal is not likely to result in the long term decline of threatened fauna species.

The proposal is not likely to be located on migration or dispersal routes for threatened fauna (refer c) above). This conclusion is provisional, subject to the further assessment of potential impacts to threatened microbats. This assessment, based on additional surveys undertaken in January 2009, has been prepared as a separate specialist report attached to the Yass Wind Farms Environmental Assessment (**ngh**environmental 2009).

g) Will the action result in invasive species that are harmful to a critically endangered or endangered/vulnerable species becoming established in the endangered or critically endangered species/vulnerable habitat?

The proposal could have this impact, if seed of invasive plants were introduced on machinery or vehicles, or enabled to spread from nearby pasture as a result of disturbance of the groundcover or soil on the site. A dense infestation of weeds could reduce the amount of bare ground available for orchids or other native forbs, and lead to the local extinction of a population, should one occur on this site. However, given that the locations where the Yass Daisy currently occurs adjacent to the works site are not particularly weedy, despite intense disturbance from grazing and weeds nearby, it seems unlikely that the additional disturbance caused by this proposal will greatly affect the undisturbed habitat areas.

Weed risks would be reduced to acceptable levels through weed hygiene protocols, pre and post works weed control and monitoring, soil erosion and sedimentation control, effective and timely site rehabilitation and the avoidance of fertiliser use in areas adjacent to the CEEC and potential threatened species habitats.

h) Will the action interfere with the recovery of the species?

Yass Daisy and Austral Toadflax woodland habitats are generally excluded from the development envelope and would be protected from direct and indirect impacts. Impacts to the cluster 4b woodland habitat would be minimised by reducing road width, siting to avoid the need for road battering, clearing trees and shrubs by hand and using the natural soil and vegetation for the road driving surface. The proposal is not expected to affect the recovery of these species remnants or exacerbate existing threatening processes.

If found to be present at the cluster 7 forest remnant site, the Burrinjuck Spider Orchid habitat would also be protected. The works would not conflict with the objectives and actions contained in the recovery plan prepared for this species (NPWS 2003a).

The recovery plan has been prepared for the Regent Honeyeater lists the main causes for concern regarding this species:

- specialised habitat requirements,
- significant reductions in extent of habitat,
- demonstrable reduction in habitat quality throughout its range,
- apparent reliance on a small number of favoured sites,

- clear reduction in range in recent decades,
- low population level
- low population densities over a large proportion of the range with aggregations occurring for breeding.

The Plan states that only long-term changes to land management, on both public and private land, will lead to a significant improvement in the status of this species.

The development would not exacerbate known risks or be detrimental to recovery actions. Habitat suitable to the Regent Honeyeater would not be significantly removed or altered by the development.

A national recovery plan has been prepared for the Swift Parrot (Swift Parrot Recovery Team 2001). Among other things, the plan aims to reduce the incidence of collisions with man-made structures.

Collisions with chain-link fences, cars and windows are a significant cause of mortality during the breeding season (Swift Parrot Recovery Team 2001). These collisions occur mainly in urban areas where concentrated foraging occurs at native and introduced flowering eucalypts, particularly when natural food supplies are low because of drought or other factors. These conditions would not apply at the proposed wind farm site, where foraging would occur well below blade height and foraging resources would not be so concentrated. To date, no wind farms have been implicated in Swift Parrot collisions (Biosis Research 2006). The construction of a chain-link fence around the proposed substation would create a collision risk for local birds, although, given the size of the fence, this risk is not expected to be significant. The proposal would not conflict with the recovery plan.

MIGRATORY SPECIES

Of the four migratory terrestrial species indicated as having potential to be present within 50 kilometres of the proposal site by the Search Tool report, the White-throated Needle-tail (*Hirundapus caudacutus*), Regent Honeyeater (*Anthochaera phrygia*) and Satin Flycatcher (*Myiagra cyanoleuca*) have at least moderate potential to use aerial habitat at the proposal site. The significance of potential impacts to the Regent Honeyeater has been addressed above.

The White-throated Needle-tail is a summer migrant to Australia from Asia. It feeds on flying insects, and is frequently sighted over cities. Roosting habits and local migration routes are not known. The species has been recorded in Wee Jasper Nature Reserve, 30 kilometres to the south of the proposal site. The Satin Flycatcher was recorded in Long-leaved Box woodland at the subject site (cluster 6) and the risks to this species from the proposal are assessed in Appendix D. The small patch of regrowth woodland habitat at this site is considered marginal for this species.

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:

a) substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat of the migratory species,

The development would not substantially modify, destroy or isolate an area of important migratory bird habitat, including White-throated Needle-tail and Satin Flycatcher habitat.

b) result in invasive species that is harmful to the migratory species becoming established in an area of important habitat of the migratory species,

The development would not result in the introduction or spread of any exotic species harmful to migratory species. Weed hygiene and control and monitoring would ensure that wetland areas are not degraded by weed species introduced during the works.

c) ***seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of the species.***

There is potential for the wind turbine collisions to affect local populations of the White-throated Needle-tail and Satin Flycatcher. The risk of population level impact is heightened by the flocking behaviour in migrating birds. The White-throated Needle-tail appears readily capable of habituating to artificial structures and humanised landscapes. The Satin Flycatcher favours heavily vegetated gullies and taller woodlands during breeding, and uses woodlands, scrubs, trees in open country during migration (Pizzey et al 2006). The single bird sighted at Marilba may have been foraging or migrating south from Papua New Guinea. The site does not provide optimal habitat for this species and habitat use is expected to be infrequent. Mortality rates affecting the lifecycle of a significant proportion of the populations of these species are not anticipated. The risk assessment in Appendix D for these species indicates a low-moderate risk at the individual level and low risk at the population level.

A monitoring and adaptive management program would be developed and implemented to respond to any unforeseen impacts on this species, and other significant fauna (refer section 5.3).

Conclusion

Flora and ecological communities

One Critically Endangered Ecological Community (box gum woodland) and one threatened flora species (Yass Daisy) were recorded in the survey area. Two other flora species (Austral Toadflax and the Burrinjuck Spider Orchid) have some potential to be present at the site. This assessment concludes that the proposal would not significantly affect remnant stands of the box gum woodland CEEC at the subject site. Most box gum woodland stands in moderate-good and good condition would be excluded from the development envelope and protected from direct and indirect impacts during the works. Impacts to the cluster 4b woodland would be minimised by reducing road width, siting to avoid the need for road battering, clearing trees and shrubs by hand and using the natural soil and vegetation for the road driving surface.

However, an action is considered likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will reduce the extent of a community. The proposed clearing would reduce the extent of the box gum woodland CEEC at the site, and a referral to the Commonwealth Environment Minister will be made on this basis.

Similarly, the core populations of the Yass Daisy and potential habitat for other threatened woodland flora species would be excluded from the development envelope. The potential Burrinjuck Spider Orchid habitat at the subject site would be intensively re-surveyed later in the flowering period and protected if this species is recorded. The proposal would not produce impacts to these species such that local populations would be placed at risk of extinction.

Fauna

There is at least moderate potential for three threatened bird species and two migratory bird species to occur within or close to the subject site and to be impacted by the proposal (refer Appendix C).

The relatively small area of clearing required by the proposal would not be likely to significantly affect threatened fauna species at the subject site. Threatened species habitat and CEEC areas at the subject site would generally be avoided or protected from indirect or peripheral impacts.

The proposal has the potential to introduce a hazard to aerial habitat, in the form of bladestrike risk for threatened and migratory bird species. Bladestrike and habitat impact risks for birds have been assessed in detail in Appendix D. In view of the assessed likelihood of these species being present at the site, their likely responses to the wind turbines and the experiences of existing wind farms elsewhere in Australia, the potential for unacceptable mortality rates or habitat impacts is considered low.

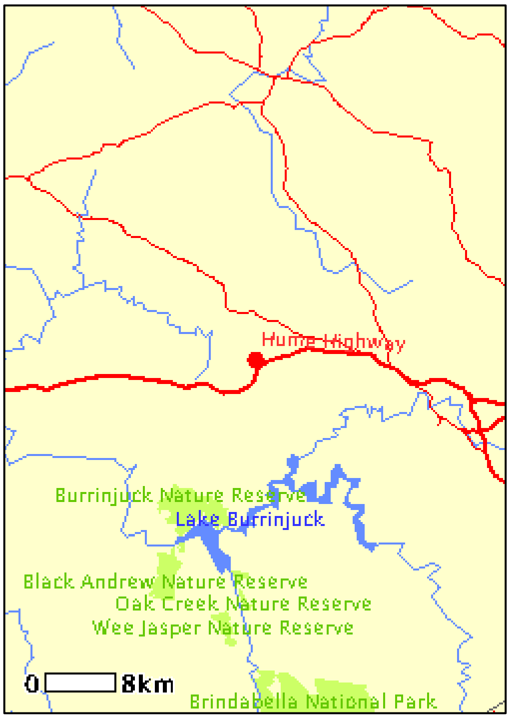
A monitoring and adaptive management program would be developed and implemented to ensure appropriate and timely responses to unforeseen mortalities or habitat impacts (refer section 8).

Appendix G MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE REPORT

Matters of National Environmental Significance search report (biodiversity components)

- based on 50km buffer around proposal site
- report generated 21 August 2008

Summary



World Heritage Properties:	**None**
National Heritage Places:	**None**
Wetlands of International Significance: (Ramsar Sites)	**1**
Commonwealth Marine Areas:	**None**
Threatened Ecological Communities:	**2**
Threatened Species:	**19**
Migratory Species:	**12**
Commonwealth Lands:	**2**
Commonwealth Heritage Places:	**None**
Places on the RNE:	**34**
Listed Marine Species:	**10**
Whales and Other Cetaceans:	**None**
Critical Habitats:	**None**
Commonwealth Reserves:	**None**
State and Territory Reserves:	**4**
Other Commonwealth Reserves:	**None**
Regional Forest Agreements:	**1**

Full report

Wetlands of International Significance (Ramsar Sites)		
Fivebough and Tuckerbil Swamps		Within same catchment as Ramsar site
Threatened Ecological Communities	**Status**	**Type of Presence**
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Critically Endangered	Community likely to occur within area
Natural Temperate Grassland of the Southern Tablelands of NSW and the Australian Capital Territory	Endangered	Community likely to occur within area
Threatened Species	**Status**	**Type of Presence**
Birds		
Lathamus discolor * Swift Parrot	Endangered	Species or species habitat may occur within area
Polytelis swainsonii * Superb Parrot	Vulnerable	Breeding likely to occur within area
Rostratula australis * Australian Painted Snipe	Vulnerable	Species or species habitat may occur within area
Anthochaera phrygia * Regent Honeyeater	Endangered	Species or species habitat likely to occur within area
Frogs		
Litoria booroolongensis Booroolong Frog	Endangered	Species or species habitat likely to occur within area
Fishes		
*Maccullochella peelii peelii** Murray Cod, Cod, Goodoo	Vulnerable	Species or species habitat may occur within area
Macquaria australasica * Macquarie Perch	Endangered	Species or species habitat may occur within area
Insects		
Synemon plana * Golden Sun Moth	Critically Endangered	Species or species habitat likely to occur within area
Mammals		

Dasyurus maculatus maculatus (SE mainland population)	Endangered	Species or species habitat likely to occur within area
Nyctophilus timoriensis (South-eastern form) Eastern Long-eared Bat	Vulnerable	Species or species habitat may occur within area
Pseudomys fumeus * Konoom, Smoky Mouse	Endangered	Species or species habitat may occur within area
Reptiles		
Aprasia parapulchella * Pink-tailed Worm-lizard	Vulnerable	Species or species habitat likely to occur within area
Delma impar * Striped Legless Lizard	Vulnerable	Species or species habitat likely to occur within area
Plants		
Ammobium craspedioides * Yass Daisy	Vulnerable	Species or species habitat likely to occur within area
Caladenia concolor * Crimson Spider-orchid, Maroon Spider-orchid	Vulnerable	Species or species habitat likely to occur within area
Diuris sheaffiana * Tricolour Diuris	Vulnerable	Species or species habitat may occur within area
Leucochrysum albicans var. *tricolor* ***** Hoary Sunray	Endangered	Species or species habitat likely to occur within area
Grevillea iaspicula * Wee Jasper Grevillea	Endangered	Species or species habitat likely to occur within area
Thesium australe * Austral Toadflax, Toadflax	Vulnerable	Species or species habitat likely to occur within area
Migratory Species	**Status**	**Type of Presence**
Migratory Terrestrial Species		
Birds		
Haliaeetus leucogaster White-bellied Sea-Eagle	Migratory	Species or species habitat likely to occur within area
Hirundapus caudacutus White-throated Needletail	Migratory	Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher	Migratory	Breeding likely to occur within area
Anthochaera phrygia	Migratory	Species or species habitat likely to occur within area

Regent Honeyeater

Migratory Wetland Species

Birds

Ardea alba Great Egret, White Egret	Migratory	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Migratory	Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe	Migratory	Species or species habitat may occur within area
Rostratula benghalensis s. lat. Painted Snipe	Migratory	Species or species habitat may occur within area

Migratory Marine Species

Birds

Apus pacificus Fork-tailed Swift	Migratory	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Migratory	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Migratory	Species or species habitat may occur within area

Listed Marine Species	Status	Type of Presence
Birds		
Apus pacificus Fork-tailed Swift	Listed - overfly marine area	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Listed - overfly marine area	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Listed - overfly marine area	Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe	Listed - overfly marine area	Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle	Listed	Species or species habitat likely to occur within area
Hirundapus caudacutus White-throated Needletail	Listed - overfly marine area	Species or species habitat may occur within area
Lathamus discolor	Listed - overfly	Species or species habitat may occur within area

Swift Parrot	marine area	
Merops ornatus Rainbow Bee-eater	Listed - overfly marine area	Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher	Listed - overfly marine area	Breeding likely to occur within area
Rostratula benghalensis s. lat. Painted Snipe	Listed - overfly marine area	Species or species habitat may occur within area

Places on the RNE (natural)

Derringullen Creek Area NSW

Hattons Corner Area NSW

Lake Burrinjuck Grevillea iaspicula Site 1 NSW

Lake Burrinjuck Grevillea iaspicula Site 2 NSW

Upper Lake Burrinjuck Area NSW

State and Territory Reserves

Black Andrew Nature Reserve, NSW

Burrinjuck Nature Reserve, NSW

Hattons Corner Nature Reserve, NSW

Oak Creek Nature Reserve, NSW

Regional Forest Agreements

Southern RFA

Appendix H BOX-GUM WOODLAND EEC DETERMINATION

White box yellow box Blakely's red gum woodland - endangered ecological community listing (NSW Scientific Committee 2002)

NSW Scientific Committee - final determination

The Scientific Committee, established by the Threatened Species Conservation Act, has made a Final Determination to list the White Box Yellow Box Blakely's Red Gum Woodland as an ENDANGERED ECOLOGICAL COMMUNITY on Part 3 of Schedule 1 of the Act. The listing of Endangered Ecological Communities is provided for by Part 2 of the Act. The Scientific Committee previously made a Preliminary Determination to support the proposal to list the White Box-Yellow Box Woodland. The Scientific Committee considers that the White Box Yellow Box Blakely's Red Gum Woodland is a more appropriate name for this Community.

The Scientific Committee has found that:

1. White Box Yellow Box Blakely's Red Gum Woodland is the name given to the ecological community characterised by the assemblage of species listed in paragraph 3. White Box Yellow Box Blakely's Red Gum Woodland is found on relatively fertile soils on the tablelands and western slopes of NSW and generally occurs between the 400 and 800 mm isohyets extending from the western slopes, at an altitude of c. 170m to c. 1200 m, on the northern tablelands (Beadle 1981). The community occurs within the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands and NSW South Western Slopes Bioregions.

2. White Box Yellow Box Blakely's Red Gum Woodland includes those woodlands where the characteristic tree species include one or more of the following species in varying proportions and combinations - Eucalyptus albens (White Box), Eucalyptus melliodora (Yellow Box) or Eucalyptus blakelyi (Blakely's Red Gum). Grass and herbaceous species generally characterise the ground layer. In some locations, the tree overstorey may be absent as a result of past clearing or thinning and at these locations only an understorey may be present. Shrubs are generally sparse or absent, though they may be locally common.

3. White Box Yellow Box Blakely's Red Gum Woodland is characterised by the following assemblage of species.

Acacia buxifolia
Acacia implexa
Acacia paradoxa
Allocasuarina verticillata
Alectryon oleifolius
Aristida behriana
Aristida ramosa
Asperula conferta
Atalaya hemiglauca
Austrodanthonia auriculata
Austrodanthonia bipartita
Austrodanthonia racemosa
Eucalyptus bridgesiana
Eucalyptus conica
Eucalyptus goniocalyx
Eucalyptus melliodora
Eucalyptus microcarpa
Eucalyptus nortonii
Eulalia aurea
Exocarpos cupressiformis
Geijera parviflora
Geranium solanderi
Glycine clandestina
Glycine tabacina

Austrodanthonia richardsonii
Austrostipa aristiglumis
Austrostipa blackii
Austrostipa nodosa
Austrostipa scabra
Bothriochloa macra
Brachychiton populneus
Brachyloma daphnoides
Bracteantha viscosa
Brunoniella australis
Bulbine bulbosa
Bursaria spinosa
Callitris endlicheri
Callitris glaucophylla
Capparis mitchellii
Cassinia longifolia
Cassinia quinquefaria
Cheilanthes sieberi
Chloris truncata
Chloris ventricosa
Chrysocephalum apiculatum
Cymbopogon refractus
Dianella longifolia
Dianella revoluta
Dichanthium sericeum
Dichelachne micrantha
Dichelachne sciurea
Diuris dendrobioides
Dodonaea viscosa
Echinopogon caespitosus
Ehretia membranifolia
Elymus scaber
Eremophila mitchellii
Eucalyptus blakelyi
Eucalyptus albens
Glycine tomentella
Gonocarpus elatus
Goodenia pinnatifida
Hibbertia linearis
Hibbertia obtusifolia
Hypericum gramineum
Jacksonia scoparia
Jasminum lineare
Jasminum suavissimum
Leptorhynchos squamatus
Lissanthe strigosa
Lomandra filiformis
Melichrus urceolatus
Microseris lanceolata
Notelaea microcarpa
Olearia elliptica
Olearia viscidula
Oxalis perennans
Pandorea pandorana
Panicum queenslandicum
Parsonsia eucalyptophylla
Pimelea curviflora
Plantago debilis
Plantago gaudichaudii
Poa labillardieri
Poa sieberiana
Rostellularia adscendens
Rumex brownii
Sida corrugata
Sorghum leiocladum
Stackhousia monogyna
Stackhousia viminea
Swainsona galegifolia
Templetonia stenophylla
Themeda australis
Wahlenbergia communis

The total flora and fauna species list for the community is considerably larger than that given above, with many species present in only some sites or in very small quantity. In any particular site not all of the assemblage listed above may be present. At any one time, seeds of some species may only be present in the soil seed bank with no above-ground individuals present. The species composition of the site will be influenced by the size of the site, recent rainfall or drought conditions, its disturbance history and geographic and topographic location. The community is an important habitat for a diverse fauna (vertebrates and invertebrates), but detailed records are not available from most stands and the invertebrate fauna is poorly known.

4. Woodlands with Eucalyptus albens are most common on the undulating country of the slopes region while Eucalyptus blakelyi and Eucalyptus melliodora predominate in grassy woodlands on the tablelands. Drier woodland areas dominated by Eucalyptus albens often form mosaics with areas dominated by Eucalyptus blakelyi and Eucalyptus melliodora occurring in more moist situations, while areas subject to waterlogging may be treeless. E microcarpa is often found in association with E. melliodora and E. albens on the south western slopes. Woodlands including Eucalyptus crebra, Eucalyptus dawsonii and Eucalyptus moluccana (and intergrades with Eucalyptus albens), for example in the Merriwa plateau, Goulburn River

National Park and western Wollemi National Park, are also included. Intergrades between Eucalyptus blakelyi and Eucalyptus tereticornis may also occur here.

5. Latitudinal and climatic gradients in the patterns of species present are found across the range of the community (eg. see Prober 1996 for variation in White Box). This is reflected in a gradual change in herb and grass species from northern to southern NSW (eg. Prober 1996). Within White Box Yellow Box Blakely's Red Gum Woodland, species such as Rostellularia adscendens, Chloris ventricosa, Austrodanthonia racemosa, Brunoniella australis, Cymbopogon refractus, Swainsona galegifolia, Notelaea microcarpa, Stackhousia viminea, Olearia elliptica, Jasminum suavissimum, Plantago gaudichaudii, Dichanthium sericeum, Plantago debilis and Wahlenbergia communis are generally more restricted to more northern areas (eg. Prober 1996). Some other species in White Box Yellow Box Blakely's Red Gum Woodland were generally restricted to southern areas. These include Gonocarpus elatus, Austrostipa blackii, Aristida behriana, Bracteantha viscosa, Austrodanthonia auriculata and Austrostipa nodosa (Prober 1996).

6. White Box Yellow Box Blakely's Red Gum Woodland includes vegetation described as Eucalyptus albens alliance and E. melliodora / E. blakelyi alliance in Beadle (1981), the Eucalyptus albens alliance in Moore (1953a,b), the grassy white box woodlands of Prober and Thiele (1993,1995) and Prober (1996) and the Grassy white box woodland of the Commonwealth Environmental Protection and Biodiversity Conservation Act 1999. In the southern tablelands and parts of the southwest slopes, White Box Yellow Box Blakely's Red Gum Woodland are described in Thomas et al. (2000).

7. Related communities are the Eucalyptus microcarpa, Eucalyptus pilligaensis Grey Box/ Eucalyptus populnea Poplar Box communities of the western slopes and plains and the Eucalyptus moluccana, Grey Box, communities of the Clarence, lower Hunter Valley and Western Sydney. These are not covered by this Determination. Similarly the natural temperate grasslands and the Eucalyptus pauciflora grassy woodlands of the cooler parts of the southern tablelands are not covered by this Determination.

8. White Box Yellow Box Blakely's Red Gum Woodland has been drastically reduced in area and highly fragmented because of clearance for cropping and pasture improvement. Austin et al. (2000) found the community had been reduced to less than 1% of its pre-European extent in the Central Lachlan region. Comparable degrees of reduction have been documented for NSW south western slopes and southern Tablelands (estimated <4% remaining, Thomas et. al. 2000), and for the Holbrook area (estimated <7% remaining, Gibbons and Boak (2000). Gibbons and Boak (2000) found remnants of woodlands dominated by Eucalyptus albens, E. melliodora and E. blakelyi were severely fragmented. Further remnants of the community are degraded as a consequence of their disturbance history. Some remnants of these communities survive with the trees partly of wholly removed by post European activities, and conversely, often remnants of these communities survive with these tree species largely intact but with the shrub or ground layers degraded to varying degrees through grazing or pasture modification. Remnants are subject to varying degrees of threat that jeopardise their viability. These threats include: further clearing (for cropping, pasture improvement or other development); deterioration of remnant condition (caused by firewood cutting, increased livestock grazing, weed invasion, inappropriate fire regimes, soil disturbance and increased nutrient loads); degradation of the landscape in which remnants occur (including soil acidification, salinity, and loss of connectivity between remnants).

9. The understorey may be highly modified by grazing history and disturbance. A number of native species appear not to tolerate grazing by domestic stock and are confined to the least disturbed remnants (Dianella revoluta, Diuris dendrobioides, Microseris lanceolata, Pimelea curviflora, Templetonia stenophylla (Prober & Thiele 1995). Dominant pasture species typically change from Themeda australis, Austrostipa aristiglumis and Poa spp. to Austrostipa falcata,

Austrodanthonia spp. and Bothriochla macra as grazing intensity increases (Moore 1953a). This may reflect differences in palatability of these species and their ability to tolerate grazing pressure. Light grazing and burning may also be a problem and lead to Aristida ramosa dominance (Lodge & Whalley 1989).

10. The condition of remnants ranges from relatively good to highly degraded, such as paddock remnants with weedy understories and only a few hardy natives left. A number of less degraded remnants have survived in Travelling Stock Routes, cemeteries and reserves, although because of past and present management practices understorey species composition may differ between the two land uses. Some remnants of the community may consist of only an intact overstorey or an intact understorey, but may still have high conservation value due to the flora and fauna they support. Other sites may be important faunal habitat, have significant occurrences of particular species, form part of corridors or have the potential for recovery. The conservation value of remnants may be independent of remnant size.

11. Disturbed remnants are still considered to form part of the community including remnants where the vegetation, either understorey, overstorey or both, would, under appropriate management, respond to assisted natural regeneration, such as where the natural soil and associated seed bank are still at least partially intact.

12. The community is poorly represented in conservation reserves. There are small occurrences of White Box Yellow Box Blakely's Red Gum Woodland in Border Ranges National Park, Goobang National Park, Goulburn River National Park, Manobalai Nature Reserve, Mt Kaputar National Park, Oxley Wild Rivers National Park, Queanbeyan Nature Reserve, Towari National Park, Warrumbungle National Park, Wingen Maid Nature Reserve and Wollemi National Park. The community also occurs in the following State Conservation Areas, Copeton State Conservation Area, Lake Glenbawn State Conservation Area and Lake Keepit State Conservation Area.

13. Fauna species of conservation significance found in some stands of White Box Yellow Box Blakely's Red Gum Woodland include,

Aprasia parapulchella - Pink-tailed Legless Lizard
Burhinus grallarius - Bush Stone-curlew
Cacatua leadbeateri - Major Mitchell's Cockatoo
Climacteris picumnus victoriae - Brown Treecreeper
Dasyurus maculatus - Spotted-tailed Quoll
Delma impar - Striped Legless Lizard
Grantiella picta - Painted Honeyeater
Hoplocephalus bitorquatus - Pale-headed Snake
Lathamus discolor - Swift Parrot
Lophoictinia isura - Square-tailed Kite
Melanodryas cucullata cucullata - Hooded Robin
Melithreptus gularis gularis - Black-chinned Honeyeater
Neophema pulchella - Turquoise Parrot
Ninox connivens - Barking Owl
Petaurus norfolcensis - Squirrel Glider
Phascolarctos cinereus - Koala
Polytelis swainsonii - Superb Parrot
Pomatostomus temporalis temporalis - Grey-crowned Babbler
Pyrrholaemus sagittata - Speckled Warbler
Saccolaimus flaviventris - Yellow-bellied Sheathtail-bat
Stagonopleura guttata - Diamond Firetail
Synemon plana - Golden Sun Moth
Tyto novaehollandiae - Masked Owl

Varanus rosenbergi - Rosenberg's Goanna
Xanthomyza phrygia - Regent Honeyeater
A number of plant species of conservation significance are likely to occur in White Box Yellow Box Blakely's Red Gum Woodland
Ammobium craspedioides
Bothriochloa biloba
Dichanthium setosum
Discaria pubescens
Diuris spp.
Prasophyllum petilum
Pterostylis spp.
Rutidosis leptorhynchoides
Swainsona spp.

A number of key threatening processes also occur in White Box Yellow Box Blakely's Red Gum Woodland. These include: Clearing of native vegetation, Predation by the European Red Fox Vulpes vulpes, Predation by the Feral Cat, Felis catus.

14. In view of the small size of existing remnants, and the threat of further clearing, disturbance and degradation, the Scientific Committee is of the opinion that White Box Yellow Box Blakely's Red Gum Woodland is likely to become extinct in nature in New South Wales unless the circumstances and factors threatening its survival or evolutionary development cease to operate and that listing as an endangered ecological community is warranted.

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Appendix I YASS DAISY PROFILE

Yass Daisy – DECC species profile

Scientific name: *Ammobium craspedioides*
Conservation status in NSW: Vulnerable
National conservation status: Vulnerable

Description

The Yass Daisy is a rosette-forming perennial. Leaves are spoon-shaped, to 12 cm long and 17 mm wide, hairy on top and white and woolly underneath. The spring flowerheads are hemispherical buttons, to 20 mm wide, and surrounded at the base by papery leaf-like structures (bracts). The solitary flowerheads are borne on unbranched stems to 60 cm tall; the stems are sparsely leafed, and edged with narrow "wings". Rosettes die off after fruiting.

Foliage and buds,
Image: John Briggs
© John Briggs

Location and habitat

Distribution
Found from near Crookwell on the Southern Tablelands to near Wagga Wagga on the South Western Slopes. Most populations are in the Yass region.

Flower, Yass Daisy
Image: Colin Totterdell
© Colin Totterdell

Habitat and ecology

Found in dry forest, Box-Gum Woodland and secondary grassland derived from clearing of these communities.

Grows in association with a large range of eucalypts (*Eucalyptus blakelyi*, *E. bridgesiana*, *E. dives*, *E. goniocalyx*, *E. macrorhyncha*, *E. mannifera*, *E. melliodora*, *E. polyanthemos*, *E. rubida*).

Apparently unaffected by light grazing, as populations persist in some grazed sites.

Found in a number of cemeteries in the region.

Threats

Agricultural developments, intensification of grazing regimes, invasion of weeds, road works (particularly widening or re-routing), inappropriate mowing or slashing in the cemetery sites where species occurs.

Management actions

Protect known populations from changes to land use.

Do not undertake road works, pasture modification or other changes in land use that may affect populations.

Do not increase grazing pressures on sites where populations persist -

reduce grazing pressures where possible.

Undertake weed control in and adjacent to populations, taking care to spray or dig out only target weeds.

Maintain traditional cemetery mowing regimes, taking care not to mow during the species' active period in spring and summer.

Mark sites and potential habitat onto maps (of the farm, shire, region, etc) used for planning (e.g. road works, residential and infrastructure developments, remnant protection, rehabilitation).

Search for new populations in potential habitat.

Habitat during flowering, Yass Daisy
Image: Colin Totterdell
© Colin

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Appendix J PHOTOGRAPHS OF THE SITE

1. Cluster 1 crest dominated by weeds (Scotch Thistle, European Nettle)

2. Cluster 2 – exotic groundcover in foreground, Long-leaved Box woodland over native grasses in background

3. Cluster 2 - White Box with exotic understorey on crest

4. Cluster 2 – rocky crest reptile habitat

5. Cluster 4a/4b – remnant woodland in valley, with EEC/CEEC and Yass Daisy colonies

6. Cluster 4b – Blakely's Red Gum regeneration on ridge with diverse woodland understorey (EEC, CEEC)

7. Cluster 4a – Yellow Box on saddle over native grass understorey

8. Cluster 6 – Long-leaved Box remnant with Yass Daisy

9. Cluster 7 – diverse grassland likely to be derived from box gum woodland

10. Cluster 7 – diverse grassland (note circular remnant Kangaroo Grass patch)

11. Yellow-footed Antechinus – inhabitant of dry grass forest

12. Threatened Yass Daisy in grassland at cluster 7

13. Broad-leaved Peppermint – Brittle Gum dry forest at the southern end of cluster 7

Appendix K WINDFARM RISKS TO BIRDS AND BATS

Please see Attachment 3.3 of the Yass Valley Wind Farm Environmental Assessment

Appendix 3.3 Wind Farm Risks to Birds and Microbats

EPURON
POWER FOR PORTFOLIOS

Proposed Yass Wind farm

WINDFARM RISKS TO BIRDS AND MICROBATS

MAY 2009

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Revision	Date	Prepared by		Checked by		Approved by	
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Contents

1 INTRODUCTION

Wind farm development has been steadily increasing over recent decades in many countries. However there are few Australian examples from which to draw upon when assessing the potential impact of wind farms on Australian birds and microchiropteran bats (microbats). By drawing on overseas examples and applying the specific ecological attributes of Australian native species, this addendum builds a base upon which to assess the risks of wind farm development to birds and bats in an area bridging the Southern Tablelands / South West Slopes and Plains of NSW where three wind farm precincts are proposed for development.

This addendum examines relevant background information in the areas of:

- Collision with wind turbines: mortality caused by direct collision with turbine blades and by birds and microbats being swept down by the wake behind a turbine blade.
- Sudden decompression: Rapid or excessive air-pressure change near moving turbine blades has been linked to microbat fatalities as a result of hemorrhaging of the lungs (pulmonary barotrauma) (Baerwald et al., 2008).
- Behavior modification, for example, avoidance of foraging areas due to the presence of the turbines and associated infrastructure.

A literature review is followed by a discussion of implications for this proposal and of monitoring and design of management and mitigation measures, specific to three proposed wind farm precincts west of Yass, NSW.

2 LITERATURE REVIEW

2.1 BIRDS

2.1.1 Quantifying mortalities at existing wind farms

There are a growing number of studies and monitoring programs in Australia and overseas which provide some insight into the nature and scale of potential risks to birds from wind farms.

Internationally

A review of overseas wind farms showed low mortality rates for most wind farms (Langston and Pullen 2002). On average for all birds, new generation projects in the US (outside California) have recorded three fatalities per megawatt per year (Erikson *et al.* 2001). A review of European and North American wind farms indicates that most wind farms in agricultural settings affect between 2 and 4 birds per turbine per year (Lane and Associates 2004). In Washington, America the estimated mortality was 3.59 birds per turbine per year (Erickson et al., 2003). However, the most commonly recorded bird group to collide with European and North American turbines were night-migrating songbirds, of which there are comparatively few in Australia.

In Europe, Winkelman (1994) produced an estimated average of 0.04 to 0.09 mortalities per turbine per day, or 14.6 to 32.9 mortalities per turbine per year. Forty-three percent of these were killed by being swept down by the wake behind a blade, 36% flew directly into a blade, and for 21% the cause of death was unknown. At Altamont Pass in the United States, 55% of raptors were killed by striking a blade, 8% from electrocution, 11% from wire collision and 26% from unknown causes (Orloff and Flannery 1992, cited in Canada Bird Studies 2001). Winkelman concluded that the number of birds killed per unit of energy produced is low compared to other human-related causes of bird death. A review of bird fatalities at 32 wind farms in North America produced an average of 1.4 birds per turbine per year, with a range of zero to 4.3 (Barclay et al., 2007).

Australia

There are relatively few published bird mortality studies at Australian wind farms, and most are of short duration. The studies do however suggest a generally low rate of blade collision, and that species at most risk are locally common birds which are active at the bladeswept height, including some raptors, skylarks, magpies and some seabirds (Meredith 2003, Hydro Tasmania 2004).

Monitoring research at the three operational wind farms in Victoria has recorded no rare, threatened or endangered birds killed by wind turbines to date. Searches for dead birds around seven turbines at the Codrington Wind farm (Victoria) showed three bird deaths attributable to impact with wind turbines (Biosis Research, 2006). The species concerned were the introduced skylark (1), Richard's pipit (1) and Australian magpie (1). Incidental carcass finds showed a further adult Brown Falcon death. The estimated total number of deaths likely from Codrington's 14 turbines over one year is 18 to 38 birds, or 1.2 to 2.7 birds per turbine per year (Brett Lane and Associates 2005).

At the Toora Wind Farm in Victoria, no bird carcasses were found during a year of monitoring or during informal inspections. Wedge-tailed eagles were regularly observed before and after operations began at this site. Eagles were observed to avoid the turbines by flying around or between them, not into them (Brett Lane and Associates 2005). A study at Codrington also found that all birds approaching the turbines were observed to take avoidance action, by flying over, around or under the rotating turbine blades (Biosis Research 2002).

The rate of bird collisions at Woolnorth Wind Farm stage 1 in north-west Tasmania is estimated at 14 native birds per year or 2.3 birds/turbine/year (Hydro Tasmania 2004). Monitoring at Woolnorth recorded 18 bird collisions in 2003, 7 of which were the introduced Skylark. One of these collisions was a Wedge-tailed Eagle, which is threatened in Tasmania. Eagles have been observed living near the turbines for more than 12 months and the collision occurred during a period of limited visibility (Hydro Tasmania 2003).

A summary of the average number of recorded bird fatalities from literature reviewed is provided in Table 2-1, where possible represented as birds per turbine per year.

Table 2-1 Average number of bird fatalities in reviewed literature

Location	Author	Average fatalities
North America	Erikson *et al*. 2001	3 per MegaWatt per year
Europe/North America	Lane and Associates 2004	3 per turbine per year
Europe	Winkelman 1994	23.5 per turbine per year
North America	Erickson *et al.* 2003	3.59 per turbine per year
North America	Barclay *et al*. 2007	1.4 per turbine per year
Victoria, Australia	Brett Lane Associates	2 per turbine per year
Tasmania, Australia	Hydro Tasmania 2003	2.3 per turbine per year

2.1.2 Risk factors for bird impacts

It is logical to assume that there may be a number of factors which affect the risk of birds colliding with wind farm infrastructure, and that some of these relate to the ecology of a species, site-specific features or to the design and location of the infrastructure.

Species-specific risks

The capacity of birds to 'habituate' to turbines may vary between species. Some species groups appear disproportionately vulnerable to bladestrike. Northern hemisphere studies point to three groups which are most vulnerable to bladestrike; gulls, raptors and migrant songbirds (Airiola 1987, cited in Canada Bird Studies 2001). Risk factors include:

- Foraging in the bladesweep area
- Flocking or colonial movements
- Awkward flight characteristics
- Migrating at night

Night-flying waterbirds have been identified as a risk group for wind farm developments. Small numbers of waterbirds were recorded throughout the proposed Yass Wind farm, in dams and wet drainage lines. Short-range foraging journeys by these species may follow chains of small wetland habitats scattered over the lowland areas of the district. Major migration routes for these species are not known.

Experience elsewhere in Australia suggests that Wedge-tailed Eagle mortality is a possibility, although there are examples of this species habituating to, and co-existing with wind turbines. Of greater concern may be the alienation of hunting habitat ('behaviour modification'), and the longer term affect on Wedge-tailed Eagle breeding success.

Species which are rare or declining, or which are naturally distributed at low density (such as top order raptors) may be at greater risk. While collision rates may be low, each mortality has a higher significance. Similarly, species with low reproductive rates, or poor capacity to disperse and recolonise habitats may be at greater risk of significant impacts from blade collisions or avoidance behaviour at the population level.

Environmental risks

Many studies have shown that poor weather conditions increase the occurrence of turbine collisions (Canada Bird Studies 2001). Weather conditions which reduce the ability of birds to perceive the turbine blades or avoid collisions (such as fog and strong gusty winds) add to risks for susceptible species. Hence, sites which experience these conditions at higher frequency may be correspondingly riskier for these species. The relative location of key habitat areas (such as updraft zones, prey populations, wetlands and nesting sites) and natural diurnal and seasonal migration routes also affects risks to birds.

Structural characteristics of the development

Features such as guy lines, aerial cabling and perching opportunities (especially lattice structures) may also be critical factors affecting the frequency of collisions (Erickson *et al.* 2001). Warning lights on towers may attract night migrating birds (Cochran and Graber 1958 in Canada Bird Studies 2001). US studies suggest that red flashing lights on wind turbines do not attract night migrants (Kerlinger and Kerns 2003), and would not attract insects, which are generally not sensitive to the red end of the spectrum.

2.1.3 Behaviour modification

In Europe, the effects of wind farms on habitat utilisation are considered to have a greater impact on birds than collision mortality (Strickland 2004). Bird abundance data from 19 globally-distributed windfarms found a significant negative impact on bird abundance (Stewart *et al.* 2007). Howeverit was unclear whether this related to a decline in population abundance or a decline owing to avoidance behavior. European studies suggest that most habitat displacement involves migrating, resting and foraging birds. Studies have reported displacement effects ranging from 75 metres to as far as 800 metres from turbines (Strickland 2004, Winkelman 1994). This is likely to reduce the risk of bird mortality, but may affect populations where the alienated habitat is particularly important or limiting.

Wind farm developments can alter resource availability and distribution by removing or creating water bodies, removing vegetation and hollows for foraging and roosting, creating an obstacle, increasing or decreasing prey activity. Construction impacts such as clearing may increase edge effects and fragmentation which for some species may represent a barrier to dispersal or movement (Lindemayer & Fischer 2006). The activity patterns of local bird species may also alter based on food resource movements (Kunz et all 2007, Grindal & Bingham 1998).

2.2 MICROBATS

There has been little study of wind farm impacts on microbat species Most papers, both in Australia and overseas, are focused on identifying species presence and qualifying possible impacts. Sterner et al (2007) claim that study in the USA to c.2007 were post operation of wind energy centres. Many of the scientific programs in the USA designed to test impacts have been hampered by operational requirements at wind farms (Kunz et al 2007).

Without this information, assumptions must be made using what we know of species ecology and limited case studies and investigations. The difficulty in estimating impact to microbats is compounded by the fact that relatively little is known about their ecology and behaviour.

2.2.1 *Quantifying mortalities at existing wind farms*

Compared to available data on bird mortalites, microbat collision events appear to be greater in number. Migratory microbats comprise the majority of mortalities in all wind farm studies to date (Erickson *et al.* 2002, Arnett 2005).

Fatalities at USA wind-energy facilities went as high as 53.3bat/MW/year at the Buffalo Mountain Wind Energy Centre for small Vestas V47 turbines producing 0.66-MW and 38.7 bats/MW/year for larger Vestas V80 turbines producing 1.8MW(Kunz et al 2007). Erickson *et al.* (2003) found an estimated mortality of 3.21 bats per turbine per year in North America.

Erickson *et al.* (2002) in a North American study, state that based on available data, microbat collisions during the breeding season are virtually non-existent. Further, North American research has shown that most microbat collisions have occurred with adults, hence collisions in this area were not thought to be attributed to dispersing juveniles (ABS 2005).

A review of 32 North American wind farm monitoring studies demonstrates a trend between turbine height and mortality numbers, with higher towers appearing to cause more bat deaths. The same review shows an average of 5.9 bat fatalities per turbine per year, with a range of zero to 42.7, when towers are at or greater than 65 metres in height (Barclay et al., 2007) . The variation of impact to microbats would appear dependent on the nature of the receiving environment and the siting of turbines.

While microbat fatalities in the USA at wind farms have been high, extrapolation of this data to Australian conditions would be inappropriate. This is mainly because climatic patterns are quite different, in the USA where extreme changes occur during winter as the jetstream moves southwards, rendering much of the country unsuitable for bat foraging (Greg Richards pers. comm. May 2009). These extreme changes cause dramatic changes to the areas occupied by a number of bat species that move very long distances as they migrate, making them more susceptible to collision in much larger numbers (Greg Richards pers. comm. May 2009). Monitoring in Victoria, based on carcass monitoring, has identifies fatality rates in the order of 1-2 bats per turbine per year (Brett Lane pers. Comm., via Greg Richards). This data from Victoria is likely to represent more accurate data in an Australian context. Fatalities may however be higher, but this would be dependent on habitat quality and proximity of significant bat roosts.

2.2.2 *Risk factors for microbat impacts*

In addition to the collision and habitat avoidance risks as described for birds, decompression, or pulmonary barotrauma, has been identified as a significant mortality causing factor for microbats.

Rapid or excessive air-pressure change has the potential to cause fatalities as a result of haemorrhaging of the lungs (pulmonary barotrauma) as fauna pass near moving turbine blades. Moving turbine blades can cause a drop in air pressure by 5 to 10 kPa (Horn et al 2008; G. Richards 2008 pers. comm. Via Vanessa Place). Mammals are thought to be more susceptible to barotrauma than birds (Baerwald et al., 2008) demonstrated by a recent Canadian study, which found evidence of barotrauma in 90% of 75 microbats that had been killed at wind turbines, while only 50% of these had had direct contact with turbine blades (Baerwald *et al* (2008).

Barotrauma potentially poses significant risks to microbats at wind farms as microbats are unable to detect rapid pressure reductions, even though echolocation may allow microbats to detect and avoid turbine blades.

Species-specific risks

There are a number of factors which make Microchiropteran order as a whole susceptible to negative impacts from wind farm developments. These include:

- Low reproductive rates
- Foraging patterns in response to weather conditions and resource pulses
- Flocking or colonial movements

All species of microbat have a low fecundity with most producing only 1 young per year (Law 1996). Species with low reproductive rates, or poor capacity to disperse and recolonise habitats may be at greater risk of significant impacts from blade collisions at the population level. This suggests that populations would recovery slowly from one-off large scale mortality events, or perhaps not recover at all from an ongoing threat (Racey and Entwhistle 2003 in Arnett 2005).

Many microchiropteran bat species hibernate or aestivate during cold periods to reduce their energy requirements when resources are low. In a compilation of survey results for wind farms in the United States, most microbat mortality documented occurred in late summer and autumn (nearly 90% from mid-July through mid- September) (Erickson *et al.* 2002). Resource abundance at this time would be expected to be high and bats requiring fat stores for aestivation would need to take advantage of the resource pulse. This higher rate of activity is likely to be the reason for a greater number of collisions.

Horn *et al.* (2008) noted direct collision with moving turbine blades during their study at the Mountaineer Wind Energy Centre, West Virginia. Many microbats actively investigated turbine structures when blades were both moving or stationary, be it for possible roosting, stop-over roosting in migration or as a mating site.

It is not known whether particular groups of microbats are more vulnerable than others, however risk factors are likely to include:

- Long distance migration (nocturnal)
- Foraging within the blade-sweep area

Current theory suggests that in the eastern United States, the microbats most likely to be impacted by wind energy turbines are long-distance migratory species (USGS 2008; Reynolds 2006). In Australia, long-distance migrating microbats include the Eastern Bentwing-bat and Yellow-bellied Sheath-tailed Bat, both recorded in the Carrolls Ridge Precinct proposal area. During migration, microbats may cease the use of echolocation to conserve energy (Keeley et al 2001 cited in Sterner et al 2007). Echolocation has been assessed as functional only over small distances of c.20 metres (Grindal & Bringham 1998). Navigational aids such as rivers, waterbodies, tracks and ridges may also be used by microbats during foraging or migration movements (Grindal & Bringham 1998; Vestjens and Hall 1977; Richards 2001). Tracks and riparian areas facilitate movement through the canopy (Law & Chidel 2002).

Foraging behaviour is a key risk factor to consider when determining species risk. The majority of microbats rely on forested areas for hollow bearing trees for roosts, and/or aggregations of insects to prey upon. Different species utilise different levels of the forest canopy, though Law & Chidel (2002) found that activity levels dropped in heavily cluttered regrowth areas or thick understorey rainforest.

It is considered that species which fly along the edges or above the canopy during foraging are most at risk from turbine impacts, compared to those that forage close to the ground or within the forest. These species include Eastern Bentwing-bat, Yellow-bellied Sheath-tailed Bat, Gould's Wattled Bat.

While most microbats are known for their highly manoeuvrable flight , some species are less mobile than others. Species which utilise open areas and tend to forage above the canopy may have limited manoeuvrability, such as the Eastern Free-tailed Bat and Gould's Wattled Bat (Van Dyck and Strahan, 2008).

Environmental risks

Monitoring in the USA has revealed that large numbers of microbats are killed in windfarms situated in forested, ridge top areas as opposed to agricultural areas (Kunz et al 2007). Whilst most microbat species do not utilise open paddocks for foraging, isolated paddock trees are important resources in fragmented landscapes (Lumsden and Bennett 2003).

Evidence suggests that microbat collisions with structures during migration are common, and that these are normally associated with inclement weather (Erickson *et al.* 2002). US studies show that bats tend to be killed on low wind nights, when blade speeds were at or close to full operational speed (17 rpm) (Arnett 2005). Fatalities tended to increase just before and just after the passage of storm fronts, when microbat activity would increase in response to insect abundance, in a similar manner to swallows during the day. This study also found that microbat activity was greatest during the first two hours after sunset, which may also be a relatively high risk time for collisions. However, based on echolocation recordings within the three precincts, it appears that different species are more active at different times of the night, rather than all active during a short period.

Structural characteristics of the development

German studies have shown higher collision rates from turbines located near hedgerows, suggesting turbine placement adjacent to or within forest patches may increase risk to microbats (Australian Bat Society 2005). Further, many species use linear vegetation or topographic features while commuting (Limpens and Kapteyn 1991, in Erickson *et al.* 2002) and migrating (Humphrey and Cope 1976, Timm 1989, in Erickson *et al.* 2002).

Lights on turbines may increase the probability of microbat collisions, as insect abundance is higher under lights (Erickson *et al.* 2002). However, similar mortality rates at sites lit by aircraft lighting and sites which had no lights was found by Arnett, 2005. As a precaution where lighting is required, mitigation may involve the use of red flashing lights that are less likely to attract insects, which are generally not sensitive to the red end of the spectrum.

Table 2-2 Risk factors based on microbat ecology and turbine structures

Turbine Structure Risk Factors	Microbat Risk factor
• Lattice design appears most attractive for roosting • Turbine height and blade length • Turbine number	• Low fecundity, limited ability to recover from stochastic events • Long distance migration • Curiosity/attraction to turbine structures

Turbine Structure Risk Factors	Microbat Risk factor
• Constructed along forested ridges	• Forage and roost in forested ridgetops, including about the canopy
• Lighting ▪ May attract night migrating species ▪ May attract insects (prey)	• Periods of high activity: ▪ Just before and just after storm fronts ▪ First two hours after sunset (unsubstantiated) ▪ Summer ▪ Low wind conditions ▪ During resource pulses • Utilise flyways and topographic features (such as ridges) for navigation • Different species forage at different levels of forest, including above the canopy

2.3 SUMMARY

Good design and turbine placement is the first step to minimising bird and microbat mortalities. Key risk factors identified from the literature review were:

- Between areas of forest or waterways (animals will cross the turbine areas to move between fragments
- Along forested ridge or waterways (often used as navigational aids by birds and bats
- Abutting forest or remnants (increased foraging activity along edges)
- Reducing the attractiveness of turbine areas for birds and bats by minimising perching opportunities (e.g. guy lines) and lighting.

Once built, ongoing management to reduce deaths during periods of high risk, such as those listed below, may be necessary:

- During peak foraging activity times
- Poor weather conditions (rainy, foggy, poor visibility)

3 A FRAMEWORK FOR MANAGEMENT

Monitoring habitat utilisation prior to finalising turbine layout is important to effectively manage potential impacts to birds and microbats, firstly through avoidance and minimisation. There are three main parts to a bird and microbat management plan (California Energy Commission and California Department of Fish and Game, 2007; DEH, 2005):

1. Impact avoidance and minimisation (monitor and avoid)
2. Impact mitigation and adaptive management (monitor and mitigate)
3. Operations monitoring and reporting (monitor, report and adjust)

Step 1 is about avoiding impacts in the first place, which is preferable to mitigating against impacts. Steps 2 and 3 are not discrete phases, but rather will constantly inform each other as part of an adaptive management cycle. Each step would be part of the Bird and Bat Management Plan for each of the Yass Wind Farm Precincts.

Central to the management of hazards to birds and bats are biologically appropriate triggers, informed by both pre-operation monitoring and ecological species information. A management plan will specify requirements to adjust management or mitigation measures if trigger points are met (e.g. x number of x species fatalities over x period of time), and provide realistic timelines for periodic review and adjustments to both monitoring and mitigation phases of the management plans (California Energy Commission and California Department of Fish and Game, 2007).

The management plans should utilise the principle of adaptive management. Adaptive management allows the initiation of a project in the absence of complete knowledge by providing a framework to incorporate new information as it comes to hand. With new information, management strategies can be adapted appropriately (Johnson, 1999). Adaptive management is similar to a “monitor-and-modify” approach, but is more flexible in response to new information (Johnson, 1999).

3.1 IMPACT AVOIDANCE AND MINIMISATION

The first principle is to avoid and minimise potential impacts. Further recommendations for monitoring and managing significant microbat species will come from the *Microbat Study,* and should be considered in concert with this addendum report. The actions described in Table 3-1 provide a framework for impact and avoidance at the Yass Wind Farms Precincts, although each action may not relevant to all the precincts.

Table 3-1 Impact aviodance and minimisation actions

Action to avoid/minimise impact	Detail
Minimise habitat disturbance and fragmentation	This can be achieved by creating detailed maps of habitat utilisation (through early monitoring) and then avoiding high use areas.
Establish buffer zones to minimise collision hazards	The appropriate extent of buffer zones can be determined based on high habitat value features (e.g. hollow-bearing trees or raptor nests) and biological and species-specific information.
Reduce impacts with appropriate wind farm siting	Wind farms should not be sited near habitat of listed threatened or migratory species, or areas of high bird or bat movement and activity. All associated infrastructure should avoid: • Wetlands • Important breeding, roosting or feeding habitat for threatened or migratory species
Reduce impacts with appropriate turbine design	Turbine selection should consider biodiversity constraints. For example: • Turbines that operate at low speeds may cause a greater number of microbat fatalities. • Guy lines should be avoided as known to pose a hazard to birds. If guy lines area necessary, bird deterrents such as markers should be part of the design.
Reduce impacts with appropriate turbine layout	It is assumed that careful siting of turbines could significantly reduce the risk of high bird and bat mortalities: • Turbines should not fragment areas of habitat, as this poses a greater hazard to birds and microbats passing between them. • Turbines should avoid core areas of microbat activity, such as winter hibernacula, important foraging areas and areas close to potential migration routes. • Turbines at the end of linear ridges have been identified as responsible for greater numbers of collisions, as animals appear to use topographical features as a navigational aids.
Avoid making turbine areas attractive for foraging	The proposal should not increase habitat for prey species such as insects and small mammals (e.g. rabbits).
Avoid lighting that attracts birds and bats	Red flashing lights with a long dark interval and short flash on-time is thought to be the safest lighting configuration for night flying birds (California Energy Commission and California Department of Fish and Game, 2007). Lighting at operation and maintenance facilities should be on sensors, hooded and directed to minimise skyward illumination (Horn *et al.* 2008). Bats do not appear to be attracted to lights,

Action to avoid/minimise impact	Detail
	although there has been little study on this.
Minmise power-line impacts	All powerlines should be underground rather than overhead where possible to minimise impacts to birds, unless this is considered to have a greater potential impact.
Decommission non-operational turbines	Remove non-operational turbines so they do not continue to present a collision hazard for birds (microbats appear not to collide with stationary turbines).
Offset	To achieve a 'maintain or improve' environmental outcome, a wind farm development would need to be accompanied by offsets to compensate for the loss of biodiversity values in the long term. Considering the key impacts are bird and microbat collisions, offset options are presented below: • Conservation of lands important to species at greatest risk (i.e. Eastern Bentwing-bat) • Proactively addressing DECC priority actions for species at greatest risk • Funding scientific research that would address information gaps and areas of uncertainty, i.e. barotrauma, low and high speed rates of movement for bats, modeling work based on microbat activity periods/weather conditions. Information should be passed into the public arena to assist in future assessments.

3.2 IMPACT MITIGATION AND ADAPTIVE MANAGEMENT

The first step is to avoid potential impacts. However, where this is not possible, mitigation actions can be undertaken. In all cases, mitigation is second best to good turbine design and layout (California Energy Commission and California Department of Fish and Game, 2007; DEH, 2005). Potential mitigation options include:

1. Appropriate timing of construction activities to minimise impacts to birds and microbats, i.e. outside of known nesting periods.
2. Maintenance activities or habitat modification to make the site less attractive as habitat
    a) Carcasses should be removed as soon as possible to avoid attraction of scavengers (e.g. Wedge-tailed Eagle)
    b) Acoustic deterrents, such as high frequency sonar emissions, are currently being investigated for their use in discouraging microbats from utilising areas around turbines. This method has been trialled in Australia for removing flying-fox colonies from urban areas.
3. Seasonal changes to cut-in speed. Pre-operational monitoring will help to determine peak activity periods (seasonal or event-based) for birds and bats, such as:

a) Before and after storm fronts (bats – high activity)

b) Prior to migration (bats – high activity)

c) During times of high insect abundance (bats and insecivorous birds – high activity)

d) Periodic feathering of turbines during low wind nights during migratory or peak activity periods (for example, the Eastern Bentwing-bat will not fly in wind speeds greater than 20-25km/hr; birds tend to fly less in high wind also)

4. Removal of particular turbines or seasonal shut-down if high levels of fatalities (exceed trigger values and mitigation methods ineffective to reduce mortality rates).

3.3 OPERATIONS MONITORING AND REPORTING

The rationale for operations monitoring at the Yass Wind Farm Precincts is to collect bird and bat fatality data and habitat utilisation data. Monitoring options were discussed in detail in Section 3. Before and after monitoring information is required to evaluate, verify, and report on effectiveness of avoidance and minimisation measures. At a minimum, the primary objectives for operations monitoring are to determine (California Energy Commission and California Department of Fish and Game, 2007):

- Whether the avoidance, minimisation, and mitigation measures implemented for the project were adequate or whether additional corrective action or compensatory mitigation is warranted
- Whether overall bird and bat fatality rates are low, moderate, or high relative to other projects

4 MONITORING

Monitoring of birds and microbats around wind farms should be undertaken during two discrete phases: during the planning phase (prior to construction and preferably prior to final layout determination) and during the operational phases.

The accepted experimental design for monitoring the impacts of a proposal is the 'Before-After-Control-Impact' (BACI) design. This involves establishing monitoring sites both where impact is expected (impact site) and where the proposal would not have an effect (control site). Monitoring data from the operational phase at both points is compared to the baseline (planning phase data), with the control site helping to account for effects of environmental variables (such as unusual seasonal conditions) (Brett Lane & Associates, 2005).

The Interim standards for assessing the risks to birds from wind farms in Australia recommend planning phase surveys at three levels, described below, depending on the level of risk (Brett Lane & Associates, 2005). Level One investigations have been undertaken for each of three Precincts.

Level One	Initial risk assessment. Where risk is low or can be reduced to low through planning, management and/or mitigation measures, no further investigation is required; otherwise, Level Two investigation are recommended
Level Two	More intensive surveys are undertaken to determine whether or how risk can be reduced to low; otherwise Level Three investigations are recommended.
Level Three	More intensive surveys provide baseline data for use in design and planning to avoid risks as well as to inform monitoring during the operational phase. Risk assessment at this level is more rigorous and may include estimates of collision impacts (i.e., x number of birds/bats per turbine per year), which will be re-evaluated after operational monitoring.

The 'population source-sink' model may provide a context to guide the design of monitoring to measure local populations and activity both before and after development. Monitoring of a good quality habitat patches close to proposed turbine sites may give an indication of the level of use (see Richards, 2005). Conversely, pre-construction monitoring in areas of degraded habitat (potential sink-habitat areas), may provide an indication of the robustness of nearby source populations (Jonzen et al., 2005). An effective monitoring program will utilise a range of methods to ensure data collection is robust.

4.1 BEFORE: MONITORING IN THE PLANNING PHASE

Monitoring programs should have multiple methods of data collection, to increase the reliability of data. Kunz *et al.* (2007) found that reliance on one method alone did not give adequate risk predictions for operational aspects of wind energy facilities. Appropriate monitoring options during the planning phase include the following and are shown in Table 4-1 below:

- Anabat recording and/or harp trapping to determine species present
- Habitat utilisation monitoring to determine habitat use
- Roaming surveys
- Raptor nest searches

Table 4-1 Methods used for monitoring potential impacts of wind farms to birds

	Investigation level	Direct impacts	Indirect impacts
Pre-operational risk assessment	Level One	• regional overview • indicative bird utilisation survey • roaming surveys	• regional overview • indicative bird utilisation survey • roaming surveys
	Level Two	• continuing bird utilisation studies • gradient studies • roaming surveys • risk modelling	• continuing bird utilisation studies • gradient studies • roaming surveys • risk modelling
	Level Three	• population assessment • population viability analysis	• population assessment • population viability analysis

Source: (Brett Lane & Associates, 2005)

4.1.1 Descriptions of monitoring methods for Levels One to Two

Combinations of the following monitoring methods are suggested for use in the planning or pre-operation phase of wind farm monitoring to determine the level of risk to birds and bats from the proposal. The information obtained would also inform the Bird and Bat Management Plan.

Habitat utilisation monitoring (Level 1/2)

Habitat utilisation is used to provide baseline data on bird and bat species composition, occurrence, frequency, and behavior to compare with operations use and fatality data, inform micrositing decisions, provide estimates of potential collision risk based on time spent in rotor-swept area and provide an estimate of spatial and temporal use of site by all bird and bat species. Monitoring should be undertaken regularly over a full year to establish seasonal patterns (California Energy Commission and California Department of Fish and Game, 2007).

For microbats, acoustic detectors can be located on wind monitoring towers and set to record information every night, ideally within the proposed rotor-swept zone (California Energy Commission and California Department of Fish and Game, 2007)

Habitat utilisation monitoring aims to answer the following questions (Brett Lane & Associates, 2005):

- Which bird and bat species use the site?
- With what frequency does each species occur at the site?
- At which height do birds and bats of each species fly?
- What is the distribution of bird and bat species across the site?

Roaming surveys (Level 1/2)

Roaming surveys are practical to survey particular diurnal birds, such as rare or threatened species. The purpose is to describe the usage of the proposal area and the region by the target species in the context of regional population levels, as well determine management and mitigation options. This method is used (Brett Lane & Associates, 2005):

- Where there are known populations of a threatened species within or near (within around 5 kilometres) the proposal that could be potentially affected (e.g. Superb Parrot)
- Where there are known congregations of birds, such as on wetlands
- Where initial risk assessment has found a particular species, or groups of species (e.g. raptors) are at high risk from collision impacts

  (Brett Lane & Associates 2005)

Migration counts can be part of a roaming survey to provide a more complete picture of species composition, passage rates, and flight height if diurnal migrants are known to congregate at or near the proposal area, or if the proposal site is within a known or likely migration corridor (California Energy Commission and California Department of Fish and Game, 2007).

Raptor nest searches (Level 1/2)

Where initial surveys demonstrate that raptors are of concern, raptor nest searches can be used to boost habitat utilisation monitoring. These provide baseline data on location and activity level of nesting raptors in relation to proposed wind turbine sites (California Energy Commission and California Department of Fish and Game, 2007). This information can then be used to:

- Microsite turbines to reduce potential impacts to nesting raptors
- Develop appropriate buffer zones around breeding territories

Gradient studies (Level 2)

Gradient studies provide an extra level of information to habitat utilisation monitoring by ascertaining how bird and bat habitat useage changes across an environmental gradient, such as topography or time (Brett Lane & Associates, 2005). This method is appropriate where turbines are situated near important habitat features (such as Lake Burrinjuck near Carrolls Ridge) or known core breeding or foraging habitats for a species of concern (such as Eastern Bentwing-bat) at Carrols Ridge.

Reynolds (2006) conducted a spatial and temporal study of microbat activity at a proposed wind energy site in Northeastern USA, recording microbat activity through acoustics (Anabat) and mist netting. Dividing nights into three distinct phases, early (7pm to 10.59pm), middle (11pm to 2.59am) and late (3am to 7am), he measured activity over multiple areas (ie varying habitat types- riparian, trackways, dams, open fields, and closed and open forests). Anabats were stationed at three levels vertically (ground, 25metres, and 50 metres) to record microbats using different canopy levels (Reynolds 2006). Acoustic monitoring provides information about bat presence and activity, as well as seasonal changes in species composition.

Collision risk modelling (Level 2)

The data from habitat utilisation, gradient studies and roaming surveys informs collision risk modelling, which basically provides a quantitative species-specific impact assessment. Modelling is useful where the proposal is considered likely to cause high risk to populations based on qualitative assessments. Modelling will help to inform turbine layout options as well as any operational adjustments (such as restricted periods of operation) by providing an estimate of the number of bird and bat passes that may result in a collision based on variables including the following (Brett Lane & Associates, 2005):

- Turbine layout
- Turbine number
- Wind direction information
- Bird or bat species habitat utilisation data

4.1.2 Descriptions of monitoring methods for Level Three

If the risk to a population of bird or bat species is still deemed to be above low following Level One and Two investigations and a suite of management and mitigation measures, further study is recommended under the Interim Standards to more accurately gauge population scale risks. This would involve population assessments and population viability analyses. Once these studies are complete, another risk assessment should be undertaken, after which a decision on viability of the project can be made (Brett Lane & Associates, 2005).

Population assessments

This would involve desktops assessments to collate regional information about a species from a variety of scientific and other published sources, and entail detailed analysis of the nature and scope of impacts based on species life history and distribution data.

Population viability analysis

This is a detailed formal modelling study to determine the likelihood of a species' extinction based on the additional threat (additional to the range of threats faced by a threatened species) posed by the proposal. This would involve substantial research and consultation and would result in a range of impact scenarios being presented for a particular species.

4.1.3 Population source-sink

The source-sink model (Pulliam 1988) provides a model for population dynamics based on the quality of habitat patches. Patches of good quality habitat, known as sources, have a net positive population growth. Patches of poorer habitat, known as sinks, have a net negative population growth (Hill et al., 2005). The source is usually a large tract of forest, and the sink a series of patches in a developed landscape (Ferriere et al., 2004).

In the case of this proposal, large nearby tracts of forest (such as Burrinjuck Nature Reserve and privately owned forest in the area of Carrols Ridge Precinct) may provide a population source for species breeding in the area, such as Superb Parrot. Population sinks may be areas of heavily cleared farmland or the freeway, for example, where the habitat quality is degraded and ongoing species mortality occurs.

The aim of this proposal would be to ensure the precincts do not create a population sink due to habitat degradation and ongoing species mortality from either blade-strike, barotrauma or habitat loss (due to avoidance). Monitoring during operation, such as through carcass searches, will help to inform and refine management strategies. Monitoring of potential sink-populations is the most effective method for detecting the affect on the source population, as migration to the sink depends on source populations breaching carrying capacity (therefore reflecting breeding health) (Jonzen et al., 2005).

Modelling of source-sink populations has shown that a small amount of habitat loss (10%) resulting from development could lead to significant reductions in populations (49%) through source-sink dynamics (Aurambout et al., 2005). However, alternative research suggests that populations may adapt to sub-optimal conditions in sink habitats, thereby stabilising these sink-populations (Ferriere et al., 2004). The ability of a population to adapt to habitat change would be species-specific and therefore it is important to gather site-specific data at the proposed Yass windfarm precincts.

4.2 AFTER: MONITORING DURING OPERATIONAL PHASE

Appropriate monitoring options during the operational phase of a wind farm include:

- Carcass searches (Kunz et al 2007; (Brett Lane & Associates, 2005)
- Indirect disturbance impact assessments (Brett Lane & Associates, 2005)
- Avoidance studies (Brett Lane & Associates, 2005)
- Radar (weather information radar recording has also been used in the USA to assist in identifying migration routes and timing, as well as peak activity times/movement patterns of microbat species in relation to wind turbines; Kunz et al 2007).

Carcass searches

In most cases reviewed, monitoring for bird and microbat strike at wind farms has relied principally on carcass searches under turbines. Carcass monitoring involves searches for dead birds and bats within a 50m radius around the base of each turbine, in circular transects. This may be undertaken twice weekly (Hydro Tasmania 2003) and should be done equally within each season and during peak activity time for target species (breeding periods, summer activity, pre aestivation activity).

However, carcass searches alone have not proven to be an efficient monitoring method, as it provides a poor measure of population size and health. Carcass monitoring tends to underestimate the bird and bat fatalities (CaliforniaEnergyCommissionandCaliforniaDepartmentofFishandGame., 2007). This is likely to be due to:

- High level of search effort and searcher error,
- Injured animals may move out of the monitoring area, or under cover and so not be recorded (Sterner et al 2007)
- Subsequent deaths of a young after a female is killed or injured go unrecorded
- Predation of carcasses by foxes, rats, mice, birds etc (Kunz et al 2007)

Erickson *et al.* (2003) estimate that the mean carcass removal time, that is, the time it takes for scavengers to remove or a carcass to break down, is approximately 11 days for small birds and 33 days for large birds (in America), suggesting that searches should be done at least weekly. Other studies suggest scavenging rates are as high as 50-75% over one to four weeks after death (Brett Lane & Associates, 2005).

Conversely, this method alone could also overestimate the fatality rates, attributing deaths from other sources (such as vehicles) to turbines. Both monitoring at the control site (BACI design) and pre-operation monitoring can assist remove 'background' fatalities by providing baseline data (California Energy Commission and California Department of Fish and Game, 2007). Maintaining the BACI design for carcass monitoring is particularly important where there is moderate to high risk for any species before the implementation of mitigation measures, as the data will be more accurate (Brett Lane & Associates, 2005).

Indirect disturbance impact assessment

Changes in habitat utilisation (caused by indirect disturbance) can be monitored using habitat utilisation surveys, gradient studies and roaming surveys. Experimental design must be using BACI for operational phase monitoring to be meaningful. Survey effort for both phases should be equal to allow for comparison and statistical analyses (Brett Lane & Associates, 2005).

Avoidance studies

Avoidance studies attempt to figure out how a bird (or bat) responds when encountering turbines as well the success of avoidance responses, resulting in an avoidance rate figure (e.g. Brown Falcon 97% avoidance rate – manages to avoid turbine blades 97% of the time it encounters them). This information would be used for wind farm assessments in the future. Avoidance studies do not determine whether an area of habitat is avoided by a species due to the presence of turbines (Brett Lane & Associates, 2005).

4.3 REPORTING

Monitoring assists the future development of wind farms in Australia by providing a pool of data, collected using methods consistent with other wind farms, that will improve planning on upcoming projects. Information about the occurrence, magnitude, and reasons for bird and bat fatalities will help to refine the development of avoidance, minimisation, and mitigation measures for wind farm projects. Hence, regular (e.g. annual) publically available monitoring reports are fundamental to the usefulness of data (California Energy Commission and California Department of Fish and Game, 2007).

5 CONCLUSION

The risks of collision with wind farm infrastructure for birds and microbats relate to species ecology, environmental conditions and structural characteristics of the infrastructure proposed. The extent to which species may modify their utilisation of habitat may be influenced by a number of factors including; the pattern of infrastructure placement, the degree to which indirect and offsite impacts are managed, the distribution of habitat features before and after site development (for example, water bodies or perch opportunities) as well as species ecology.

A Bird and Bat Management Plan would be adopted for each of the Yass Wind Farm Precincts, recognising that the issues would likely be different at each precinct with regard to both target species and magnitude. Monitoring would be part of the Bird and Bat Management Plan. Any bird and microbat monitoring program should include a combination of techniques to measure impact. Monitoring should be well planned and designed as a Before –After – Controlled - Impact (BACI) study to collect valuable baseline data from which to compare future results.

The recommendations of this addendum report are:

1. Pre-operational monitoring of habitat utilisation by birds and microbats in order to acquire baseline data, acurately assess risk and calculate potential mortality rates
2. Impact avoidance and minimisation through good design and layout (informed by pre-operational monitoring data) and offsets (preferable to mitigation)
3. Impact mitigation and adaptive management where avoidance has not been possible. Mitigation strategies should be informed by pre-operational monitoring findings and be adaptive and responsive to findings during operational monitoring.
4. Operational monitoring of habitat utilisation and mortalities to calculate actual mortality rates and compare data to the precinct's baseline information and other wind farms
5. Annual reporting during the period of monitoring (one or more years) with reports publicly available for use in future wind farm developments

Further recommendations for monitoring and managing significant microbat species will come from the *Microbat Study,* and should be considered in concert with this addendum report.

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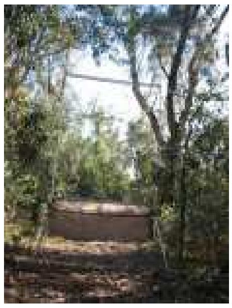
Appendix 3.4 Microbat Study: Proposed Yass Valley Wind Farm

Microbat Study

PROPOSED YASS WIND FARM :

CARROLLS RIDGE, MARILBA AND COPPABELLA PRECINCTS



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Job title: Microbat Study Proposed Yass Wind Farm : Carrols Ridge, Marilba and Coppabella Precincts

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1 INTRODUCTION

Epuron is seeking project approval for the proposed Yass wind farm. The proposed Yass wind farm consists of three separate precincts; Carrols Ridge, Coppabella and Marilba. The Bird and Bat Risk Assessment within Biodiversity Assessments for these development sites identified that several threatened microbat species could be present. A known maternity cave for the threatened Eastern bentwing Bat (*Miniopterus orianae oceanensis*) with a maternity colony size estimated at 60,000 individuals (Dwyer 1968) is located 19 kilometres from the proposed Carrols Ridge Precinct. The Bird and Bat Risk Assessment concluded that additional study of the microbats of the locality was required to inform the likely impact of the proposal and any potential mitigation measures that could minimise these (**ngh**environmental 2009a).

This specialist study has several objectives. Firstly, it provides a comprehensive overview of the microbat diversity recorded at each of the three precincts. From this data, conclusions are drawn on each species including activity levels and landform use where appropriate. Specifically, as the survey was conducted within the known period of time when female Eastern bentwing bats are at the maternity site, information on the importance of each precinct is sought. The study also has an objective of informing recommendations for any proposed Bat Monitoring Program. Finally, this report builds on the knowledge base which to assess the risks of future wind farm development to microbats in the Southern Tablelands and South-west Slopes Bioregions of New South Wales.

2 METHODS

2.1 STUDY AREA

The study area comprises of three precincts; Carrols Ridge, Coppabella and Marilba west of Yass in southern New South Wales (Figure 1).

2.1.1 Marilba

The proposed Marilba Precinct is located on private farmland north and south of the Hume Highway, near Conroys Gap, approximately 17 kilometres west of Yass, New South Wales. The site extends along a number of north-south oriented ridgelines over a distance of 9 kilometres in a north-south direction and eight kilometres east-west.

The wider study area is characterised by undulating to hilly terrain, mostly on volcanic geology. The proposed wind farm site is situated in the upper catchment of Jugiong Creek, which drains to the Murrumbidgee River and the Murray River.

2.1.2 Coppabella

The proposed Coppabella Precinct is located on farmland north the Hume Highway, approximately 35 kilometres west of Yass, New South Wales.

The site consists of one main north-west to south-east oriented ridgeline with surrounding hills. Areas that would be developed contain a combination of native and exotic pasture and remnant and regrowth woodland. The ridges most likely to contain turbines have been cleared and grazed for many decades and generally carry only scattered remnant trees or small isolated woodland patches. The area is characterised by undulating to hilly terrain with broken ridgelines, mostly on volcanic geology.

The site is situated in the upper catchment of Jugiong Creek, which drains to the Murrumbidgee River and the Murray River. There are no major watercourses present at the subject site and there is little remnant tree cover. Several small or intermittent watercourses drain the site northwards to the Jugiong Creek system and south to Lake Burrinjuck.

2.1.3 Carrols Ridge

The proposed Carrols Ridge Precinct encompasses cleared farmland, as well as woodland and forest areas on the northern edge of Lake Burrinjuck, approximately 25 kilometres west of Yass, New South Wales. The site extends along one main generally north – south ridgeline and includes four smaller ridge tops at the south-west end of the main ridge. It is characterised by undulating to hilly terrain, mostly on volcanic and metamorphic geology. Within the northern cluster, the ridge and upper slopes are partially cleared, with flanking forest and woodland. The southern portion of the development envelope is more wooded, with patches of cleared land.

There are no major watercourses present at the subject site however, several farm dams and steep ephemeral drainage lines are present and Lake Burrinjuck is directly south.

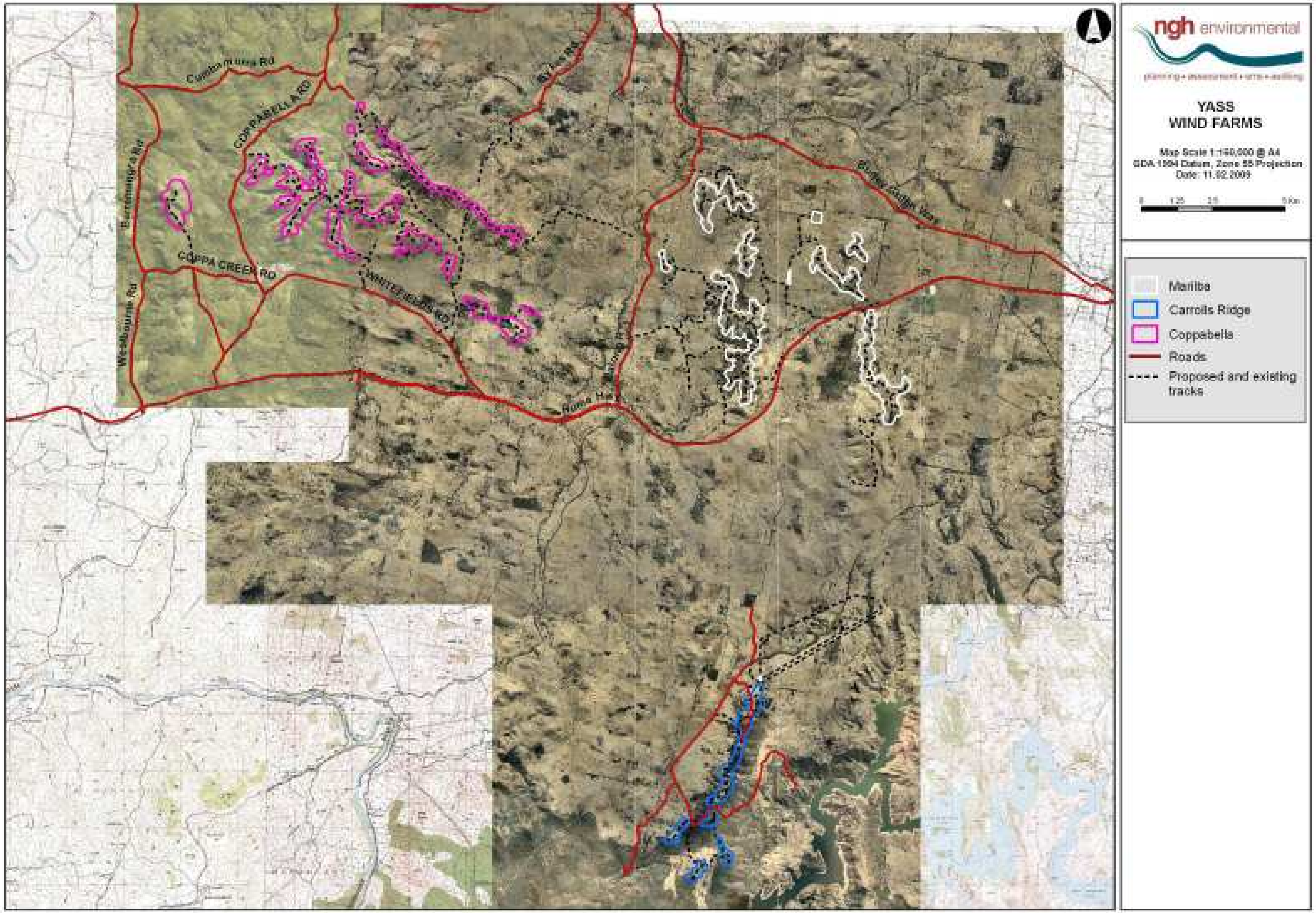

Figure 1: Locations of proposed Marilba, Carrols Ridge and Coppabella Precincts.

2.2 PREVIOUS MICROBAT SURVEYS

Previous fauna surveys undertaken in September and November 2008, collected echolocation calls of microbats using ultrasonic detectors. The microbat data and survey effort from these previous surveys is relevant to this study as it provides a temporal variation in microbat species richness for each of the study sites. The survey effort of these surveys is provided (Table 1).

Further information relative to these previous microbat surveys such as results and weather conditions should be sourced from the Biodiversity Assessment relevant to each precinct.

2.3 JANUARY MICROBAT SURVEYS

The microbat surveys for this study were undertaken between 19th January and 23rd January 2009 during weather conditions considered conducive to maximising the detection of microbat species (Table 2). Two recognised methods for detecting microbat species were used: Ultrasonic echolocation detection and Harp trapping (DEC 2004).

Table 1: Survey effort for microbats from previous biodiversity investigations at each of the study sites (**ngh**environmental 2009b; c; d)

Survey effort for previous surveys	
SITE	ANABAT
CARROLS RIDGE	6 nights in November 2008
COPPABELLA	4 nights in September 2008
MARILBA	3 nights in September 2008

Table 2: Weather Observations during the January field survey at Burrinjuck Dam (Source: Bureau of Meteorology, 2009). N/A= No information available.

Burrinjuck Dam			
DATE	MIN TEMP	MAX TEMP	RAINFALL (MM)
19.01.2009	15.4	35.8	0
20.01.2009	18.2	39.0	0
21.01.2009	19.5	37.0	7.5
22.01.2009	22.0	31.3	0
23.01.2009	20.1	33.1	25.8

2.3.1 Ultrasonic echolocation detection

The echolocation calls of insectivorous microbats were recorded using ultrasonic detectors, Anabat II Bat Detectors, coupled with Compact Flash Crossing Analysis Interface Modules (CF ZCAIMS, Titley Electronics, Ballina, NSW) and stored on compact flash (CF) memory cards for later subsequent analysis using ANALOOK Computer software. Ultrasonic echolocation recording is more likely to reveal high-flying species that are not detectable using trapping techniques (DEC 2004).

Calls analysis was undertaken using the latest guide to call identification (Pennay *et al.* 2004). All identified calls were ranked using a confidence rating (confident, probable, possible) (DEC 2004; Pennay *et al.* 2004). Where the call analysis indicates the possibility of a threatened species, the species was assumed present in accordance with DEC guidelines (DEC 2004).

The total survey effort using this method is expressed in the number of survey nights (Table 3) with site specific information also provided (Table 4). The locations of these survey sites, along with the survey sites outlined in section 2.2 are provided for Carrols Ridge (Figure 2), Coppabella (Figure 3) and Marilba (Figure 4).

2.3.2 Harp Trapping

While Ultrasonic echolocation detection recordings provide a non-invasive technique to determine microbat species richness, many species are either difficult to record as they have low intensity calls, fly at low heights or cannot be identified to species level alone (DEC 2004). Captured microbats were collected from the harp traps within one hour of sunrise (DEC 2004) and identified according to Churchill (1998), with the exception of female Vespadalus where Menkhorst & Knight (2001) was also used (Menkhorst and Knight 2001). All individuals were identified to species level, aged, sexed and reproduction condition recorded. The total survey effort expressed in the number of survey nights using this method is provided (Table 3) with site-specific details also provided (Table 5). The locations of these survey sites are provided for Carrols Ridge (Figure 2), Coppabella (Figure 3) and Marilba (Figure 4).

Table 3: The survey effort for January surveys across all study sites expressed

Survey effort for this study		
SITE	ANABAT	HARP TRAP
CARROLS RIDGE	4 survey nights	10 trap nights
COPPABELLA	2 survey nights	-
MARILBA	2 survey nights	-

2.3.3 Nomenclature

Nomenclature in this report follows that of Churchill (2008).

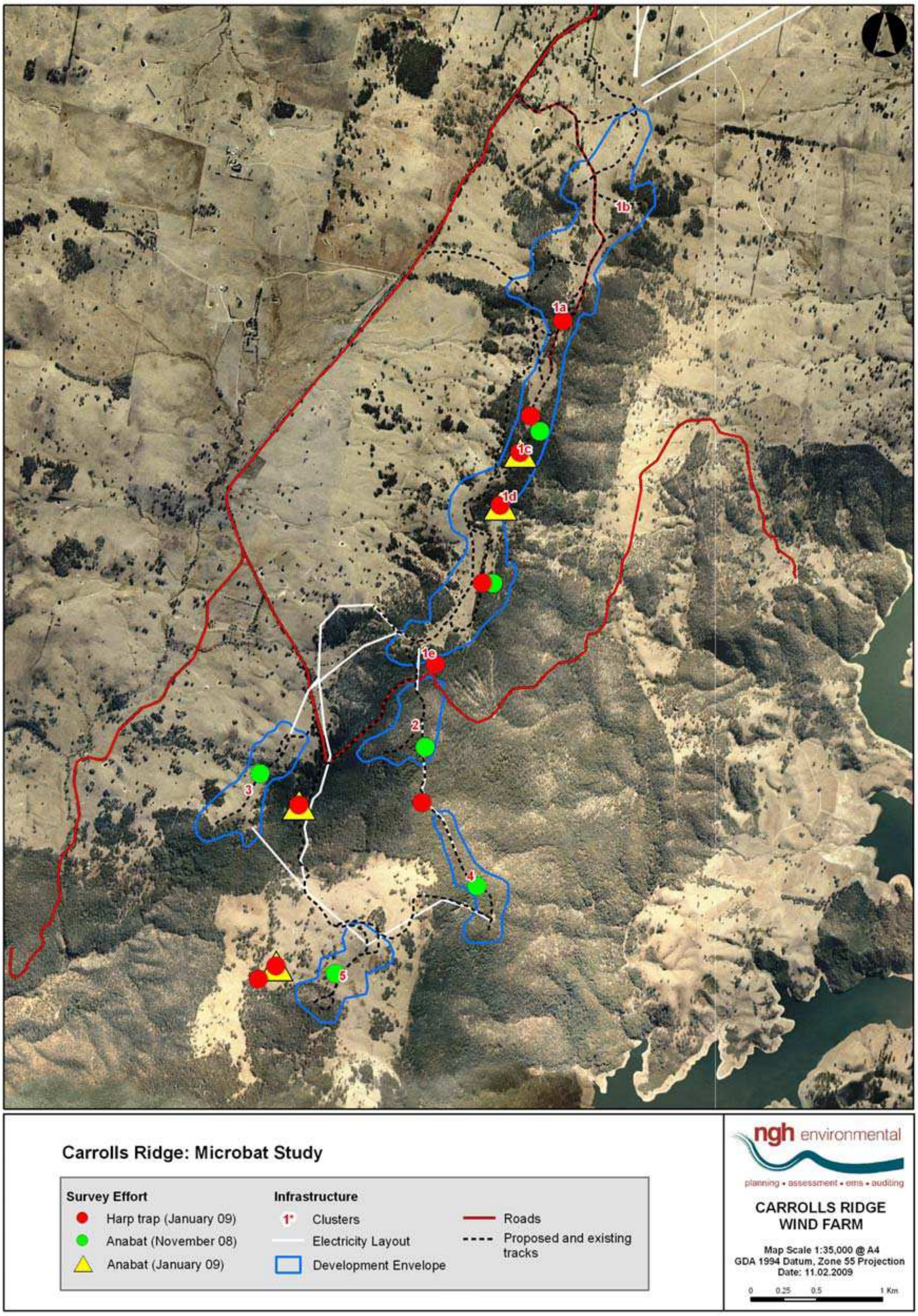

Figure 2: Locations of Anabat and Harp traps surveys at Carrols Ridge (This study and previous surveys).

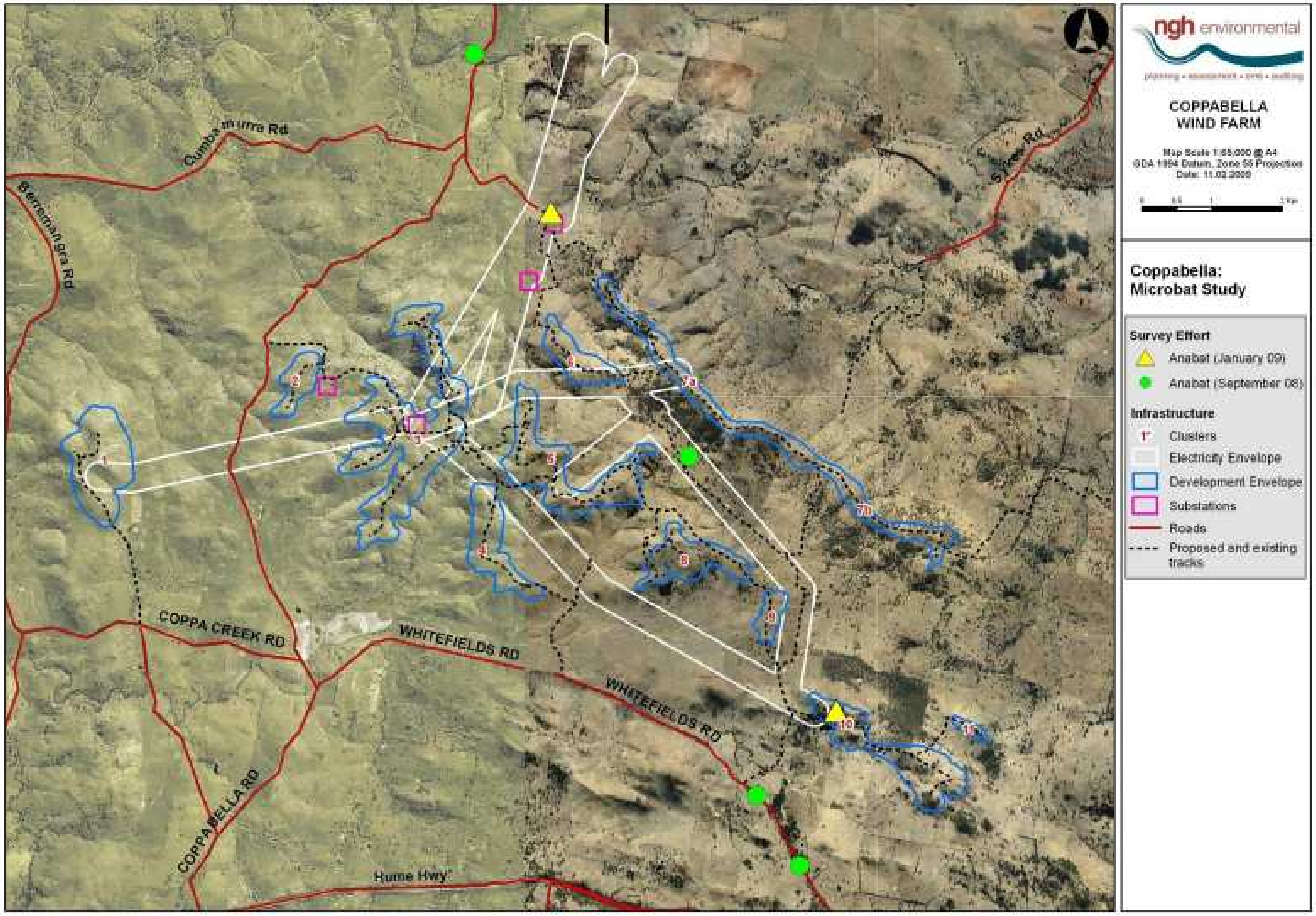

Figure 3: Locations of Anabat and Harp traps surveys at Coppabella (This study and previous surveys).

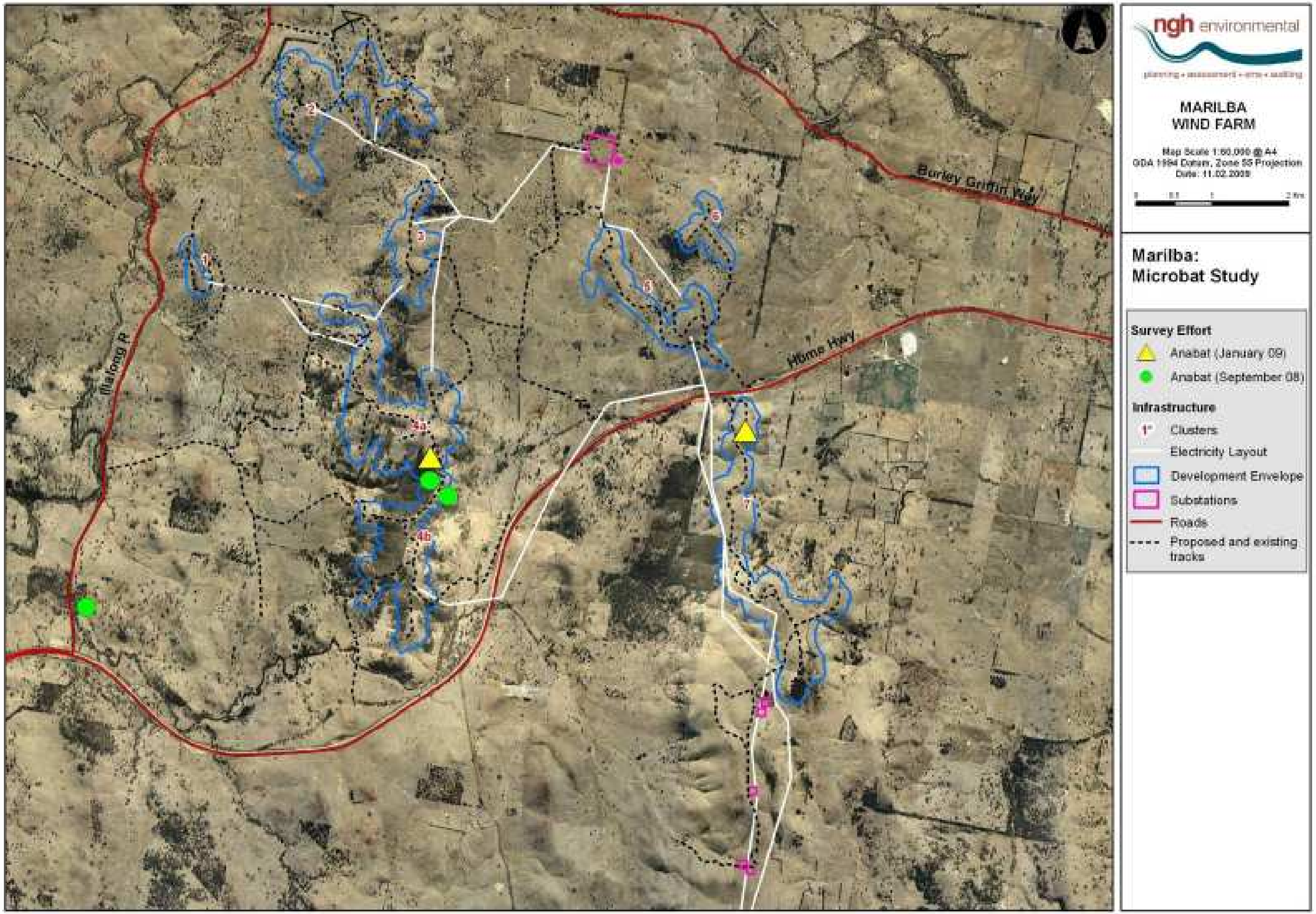

Figure 4: Locations of Anabat and Harp trap surveys at Marilba (This study and previous surveys).

Table 4: Details of Anabat echolocation survey sites undertaken during this study.

Site	Cluster	Method	Date	E	N	Habitat Description	Survey Nights
Coppabella	10	Anabat	21-Jan-09	644435	6150538	On rocky knob with clump of trees. Anabat facing south over edge of ridge (steep drop down). Degraded paddock, heavily grazed.	1
Coppabella	7	Anabat	22-Jan-09	640378	6157615	In paddock near dam and old house, on flat/gentle slope, in degraded cleared paddock, not much vegetation.	1
Marilba	4	Anabat	20-Jan-09	654126	6149516	On ridge, at very edge of woodland area facing extensive cleared area (grazed sheep paddock) with isolated trees.	1
Marilba	7	Anabat	22-Jan-09	658266	6149866	On knoll, looped through lower branches of wind monitoring tower, surrounded by heavily grazed and cleared paddock and Hume highway to the north (about 300m by flight)	1
Carrolls	1c	Anabat	19-Jan-09	653510	6134602	Set with harp trap in thick regen forest (hot fire) along ridge	1
Carrolls	5	Anabat	21-Jan-09	651649	6130685	Set in branches of isolated paddock tree mid slope (facing west) near harp trap	1
Carrolls	1d	Anabat	21-Jan-09	653358	6134199	Set in understorey on side of track in dense-ish forest, facing toward potential fly-way. Dam in paddock about 50m away. Set with harp trap.	1
Carrolls	Gully	Anabat	22-Jan-09	651825	6131913	Set on rocky outcrop over harp trap in gully/creek line. This creek runs alongside the track providing access to Clusters 2,4 and 5	1

Table 5: Details of Harp trapping survey sites undertaken during this study.

Site	Cluster	Method	Date	E	N	Description	Trap Nights
Carrolls	1e	Harp trap	22-Jan-09	652865	6132988	End of Cluster 1e along old track with intensive fire regrowth - on southern side of small knob. Forms part of the edge of the forest surrounding cleared paddocks.	1
Carrolls	Gully	Harp trap	22-Jan-09	651825	6131913	Set across creek (dry when set, small flow when checked) in gully between clusters. Regen (fires) blue gum and rocky outcrop. Set with anabat.	1
Carrolls	1c	Harp trap	21-Jan-09	653590	6134883	Under spreading branch of mature tree at edge of forest patch on upper slope of what is otherwise cleared paddock in moderate condition	1
Carrolls	5	Harp trap	21-Jan-09	651649	6130685	Set in open grassy area across slight gully with isolated paddock tree nearby and small dam below. Set with anabat	1
Carrolls	1d	Harp trap	21-Jan-09	653358	6134199	Set under spreading branch of large tree along old track in dense-ish forest. Dam in paddock about 50 m away. Set with anabat	1
Carrolls	1e	Harp trap	20-Jan-09	653224	6133607	Down in dam hole with water on one side and dam wall/bush on other side with slight potential fly-way between dam and old track in the bush. Open spaces to either side	1
Carrolls	C2-4	Harp trap	20-21 Jan	652763	6131931	Across track between Clusters 2 and 4 in Brittle gum forest (moderate fire effects), dry open forest. Set for night one across flyway and night two off to side	2
Carrolls	5	Harp trap	20-Jan-09	651516	6130582	Set between trees in small clump of trees near dam between bush patch and open paddock	1

Site	Cluster	Method	Date	E	N	Description	Trap Nights
Carrolls	1a	Harp trap	19-Jan-09	653835	6135612	Open grassy forest, with few mature trees and fire regrowth. Low level of grazing disturbance. Harp set across track under spreading branch of large tree	1
Carrolls	1c	Harp trap	19-Jan-09	653510	6134602	Set across track dense regrowth forest (fires) on ridge for two nights (first night with anabat), lots of standing dead timber around	2

3 RESULTS

3.1 MICROBAT SPECIES RICHNESS

3.1.1 CARROLS RIDGE

January surveys across the Carrols Ridge study site revealed high levels of microbat species richness. A total of 15 species were revealed from echolocation call analysis, while 7 species were recorded during harp trapping. Combining both methods, 16 microbat species were recorded (Table 6).

Table 6: Microbat species recorded at Carrols Ridge by Echolocation Analysis and Harp Trapping, January 2009. (Asterisk denotes Possible, Probable or Confident Echolocation Analysis or captured in Harp Trap)

Carrols Ridge **Microbat species recorded**		
SPECIES	ECHOLOCATION	HARP TRAPPING
Chocolate wattled bat (*Chalinolobus morio*)	*	*
Eastern bentwing bat (*Miniopterus oriane oceanensis*)	*	
Eastern falsistrelle (*Falistrelle tasmaniensis*)	*	
Goulds longeared bat (*Nyctophilus gouldi*)		*
Goulds wattled bat (*Chalinolobus gouldii*)	*	
Inland broadnosed bat (*Scotorepens balstoni*)	*	
Eastern freetail bat (*Mormopterus ridei*)	*	
Large forest bat (*Vespadelus darlingtoni*)	*	*
Lesser longeared bat (*Nyctophilus geoffroyi*)		*
Little broadnosed bat (*Scotorepens greyii*)	*	
Little forest bat (*Vespadelus vulturnus*)	*	*

Carrols Ridge **Microbat species recorded**		
SPECIES	ECHOLOCATION	HARP TRAPPING
Long-eared bat (*Nyctophilus sp.)*	*	
Southern forest bat (*Vespadelus regulus*)	*	*
Southern freetail bat (*Mormopterus* Species 4)	*	*
White-striped freetail bat (*Austronomus australis*)	*	
Yellow-belled Sheathtail bat (*Saccolaimus flaviventris*)	*	
TOTAL	15 Species	7 species

Note- species in **bold** listed under Schedule 2 of the NSW *Threatened Species Conservation Act 1995*.

3.1.2 COPPABELLA

January surveys across the Coppabella study site revealed moderate level microbat species richness with 8 species recorded from Echolocation analysis (Table 9). No threatened microbats were recorded.

Table 7: Microbat species recorded at Coppabella by Echolocation Analysis, January 2009.

Coppabella **Microbat species recorded**	
SPECIES	ECHOLOCATION
Chocolate wattled bat (*Chalinolobus morio*)	*
Goulds wattled bat (*Chalinolobus gouldii*)	*
Eastern freetail bat (*Mormopterus ridei*)	*
Large forest bat (*Vespadelus darlingtoni*)	*

Coppabella **Microbat species recorded**	
SPECIES	ECHOLOCATION
Little forest bat (*Vespadelus vulturnus*)	*
Long-eared bat (*Nyctophilus sp.)*	*
Southern freetail bat (*Mormopterus Species 4*)	*
White-striped freetail bat (*Austronomus australis*)	*
TOTAL	8 Species

3.1.3 MARILBA

January surveys across the Marilba study site revealed low microbat species richness with echolocation analysis identifying only 2 microbat species (Table 8). It should be noted that a large number (>500 files) consisted of noise or interference from an unknown source.

Table 8: Microbat species recorded at Marilba by Echolocation Analysis, January 2009.

Marilba **Microbat species recorded**	
SPECIES	ECHOLOCATION
Chocolate wattled bat (*Chalinolobus morio*)	*
Long-eared bat (*Nyctophilus sp.)*	*
TOTAL	2 Species

3.2 TEMPORAL VARIATION IN SPECIES RICHNESS

3.2.1 CARROLS RIDGE

Microbat surveys have been conducted at Carrols Ridge in November 2008 and January 2009. The November surveys resulted in 9 species of microbat recorded (**ngh**environmental 2009b) while in the January survey, a total of 16 species were recorded (Table 9).

Table 9: Temporal variation of microbats recorded at Carrols Ridge (Asterisk denotes recorded during survey).

Carrols Ridge **Temporal variation of microbats recorded**		
SPECIES	NOVEMBER 2008	JANUARY 2009
Chocolate wattled bat (*Chalinolobus morio*)	*	*
Eastern bentwing bat (*Miniopterus oriane oceanensis*)	*	*
Eastern falsistrelle (*Falistrelle tasmaniensis*)		*
Goulds longeared bat (*Nyctophilus gouldi*)		*
Goulds wattled bat (*Chalinolobus gouldii*)	*	*
Inland broadnosed bat (*Scotorepens balstoni*)	*	*
Eastern freetail bat (*Mormopterusridei*)		*
Large forest bat (*Vespadelus darlingtoni*)	*	*
Lesser longeared bat (*Nyctophilus geoffroyi*)		*
Little broadnosed bat (*Scotorepens greyii*)		*
Little forest bat (*Vespadelus vulturnus*)	*	*
Long-eared bat (*Nyctophilus sp.)*		*
Southern forest bat (*Vespadelus regulus*)	*	*

Carrols Ridge **Temporal variation of microbats recorded**		
SPECIES	NOVEMBER 2008	JANUARY 2009
Southern freetail bat (*Mormopterus*Species 4)	*	*
White-striped freetail bat (*Austronomus australis*)	*	*
Yellow-belled Sheathtail bat (*Saccolaimus flaviventris*)		*
TOTAL	9 Species	16 species

Note- species in bold listed under Schedule 2 of the NSW *Threatened Species Conservation Act 1995*.

3.2.2 COPPABELLA

Microbat surveys have been conducted at Coppabella in September 2008 and January 2009. The September survey resulted in only 4 species of microbat recorded (**ngh**environmental 2009c) while in the January survey, a total of 8 species were recorded (Table 10). Not all species recorded in the September surveys were recorded in January when weather conditions were conducive to maximising the detection of microbats.

Table 10: Temporal variation of microbats recorded at Coppabella (Asterisk denotes recorded during the survey).

Coppabella **Temporal variation of microbats recorded**		
SPECIES	SEPTEMBER 2008	JANUARY 2009
Chocolate wattled bat (*Chalinolobus morio*)	*	*
Goulds wattled bat (*Chalinolobus gouldii*)		*
Inland broadnosed bat (*Scotorepens balstoni*)	*	
Eastern freetail bat (*Mormopterusridei*)		*
Large forest bat (*Vespadelus darlingtoni*)		*

Coppabella **Temporal variation of microbats recorded**		
SPECIES	SEPTEMBER 2008	JANUARY 2009
Little forest bat (*Vespadelus vulturnus*)		*
Long-eared bat (*Nyctophilus sp.)*	*	*
Southern freetail bat (*Mormopterus*Species 4)	*	*
White-striped freetail bat (*Austronomus australis*)		*
TOTAL	4 species	8 species

Note- species in bold listed under Schedule 2 of the NSW *Threatened Species Conservation Act 1995*.

3.2.3 MARILBA

Microbat surveys have been conducted at Marilba in September 2008 and January 2009. The September survey resulted in 12 species of microbat recorded (**ngh**environmental 2009d) while in the January survey, only 2 species were recorded (Table 11). As stated in section 3.1.3, interference was recorded during the Anabat surveys resulting in large number of files that were not microbat calls.

Table 11: Temporal variation of microbats recorded at Marilba (Asterisk denoted recorded during the survey).

Marilba **Temporal variation of microbats recorded**		
SPECIES	SEPTEMBER 2008	JANUARY 2009
Chocolate wattled bat (*Chalinolobus morio*)	*	*
Eastern bentwing bat (*Miniopterus oriane oceanensis*)	*	
Goulds wattled bat (*Chalinolobus gouldii*)	*	
Inland broadnosed bat (*Scotorepens balstoni*)	*	
Eastern freetail bat (*Mormopterus ridei*)	*	
Large forest bat (*Vespadelus darlingtoni*)	*	
Little broadnosed bat (*Scotorepens greyii*)	*	
Little forest bat (*Vespadelus vulturnus*)	*	
Long-eared bat (*Nyctophilus sp.)*	*	*
Southern forest bat (*Vespadelus regulus*)	*	
Southern freetail bat (*Mormopterus Species 4)*	*	
White-striped freetail bat (*Austronomus australis*)	*	
TOTAL	12 species	2 species

Note- species in bold listed under Schedule 2 of the NSW *Threatened Species Conservation Act 1995*.

3.3 MICROBAT ACTIVITY

Data collected from the Echolocation call recording provides information on the number of passes of each species during a given time period at each of the study sites. While many individual passes can be made by an individual microbat, this data provides a baseline to infer levels of microbat activity.

3.3.1 CARROLS RIDGE

Echolocation call analysis revealed a total of 713 calls in the January surveys (Table 12). On a nightly basis, 42 passes were recorded on the 19th January 2009 (1 anabat recorder), 191 passes were recorded on the 21st January 2009 (2 anabat recorders) and 474 passes were recorded on the 22nd January 2009 (1 anabat recorder).

Of all microbat passes recorded at Carrols Ridge (713), 48% (342) could be attributed to bat species listed under Schedule 2 of the NSW *Threatened Species Conservation Act 1995.* Eastern bentwing bats passes comprised of around 80% (284 passes) of all threatened species recorded or 39% of the total number of microbat passes at Carrols Ridge. The number of passes each hour for the Eastern bentwing bat, other threatened microbat species, and non-threatened microbat species is detailed for each survey night at Carrols Ridge (Figures 5,6,7). The most common non-threatened microbat was the Large forest bat with 125 calls (17.5%) recorded.

Harp trapping resulted in the capture of 76 individuals from 7 species (Table 13). No threatened microbats were recorded using this method. The most commonly trapped microbats were the non-threatened Large forest bat and Southern forest bat with a total of 40 captures (19 and 21 respectively) accounting for 52.6% of the total captures.

3.3.2 COPPABELLA

Echolocation data was collected over two nights at Coppabella (21st, 22nd January 2009). A total of 40 passes by microbats were recorded (Table 14). On a nightly basis, 39 passes on the 21st and 1 pass was recorded on the 22nd January. The most common species was the non-threatened Goulds wattled bat with 17 calls (42.5% of calls).

Of all microbat passes recorded at Coppabella, none of these could be attributed to species listed under Schedule 2 of the NSW *Threatened Species Conservation Act 1995.*

Table 12: Number and confidence ranking of echolocation calls recorded at Carrols Ridge, January 2009.

Carrols Ridge Echolocation Call Analysis				
SPECIES	POSSIBLE	PROBABLE	CONFIDENT	TOTAL
Chocolate wattled bat (*Chalinolobus morio*)	25	31	7	63

Carrols Ridge **Echolocation Call Analysis**				
SPECIES	POSSIBLE	PROBABLE	CONFIDENT	TOTAL
Eastern bentwing bat (*Miniopterus oriane oceanensis*)	100	125	59	284
Eastern falsistrelle (*Falistrelle tasmaniensis*)	39	14	5	58
Goulds wattled bat (*Chalinolobus gouldii*)	10	6	4	20
Inland broadnosed bat (*Scotorepens balstoni*)	1	2	0	3
Eastern freetail bat (*Mormopterusridei*)	2	7	0	9
Large forest bat (*Vespadelus darlingtoni*)	62	57	6	125
Little broadnosed bat (*Scotorepens greyii*)	0	2	0	2
Little forest bat (*Vespadelus vulturnus*)	4	12	1	17
Long-eared bat (*Nyctophilus sp.)*	6	30	25	61
Southern forest bat (*Vespadelus regulus*)	16	26	9	51
Southern freetail bat (*Mormopterus*Species 4)	0	4	1	5
White-striped freetail bat (*Austronomus australis*)	1	2	3	6
Yellow-belled sheathtail bat (*Saccolaimus flaviventris*)	6	1	2	9

Note- species in bold listed under Schedule 2 of the NSW *Threatened Species Conservation Act 1995*.

Table 13: A breakdown of the microbats recorded during harp trapping at Carrols Ridge.

Carrols Ridge **Harp Trapping results**

SPECIES	MALE	FEMALE	JUVENILE	TOTAL
Chocolate wattled bat (*Chalinolobus morio*)	12	1	0	13
Goulds longeared bat (*Nyctophilus gouldi*)	1	9	0	10
Large forest bat (*Vespadelus darlingtoni*)	1	14	4	19
Lesser longeared bat (*Nyctophilus geoffroyi*)	0	4	4	8
Little forest bat (*Vespadelus vulturnus*)	1	2	0	3
Southern forest bat (*Vespadelus regulus*)	11	9	1	21
Southern freetail bat (*Mormopterus* Species 4)	2	0	0	2

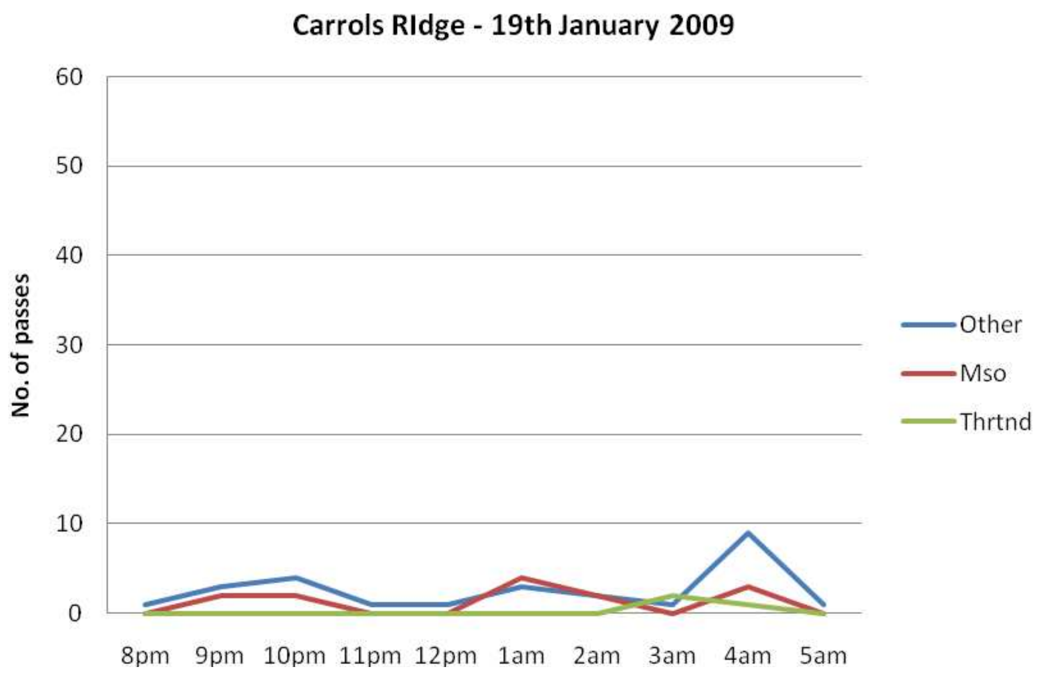

Figure 5: Number of passes each hour for the Eastern Bentwing Bat (Mso), other threatened microbat species (Thrtnd) and non-threatened microbat species (Other) at Carrols Ridge, 19th January 2009.

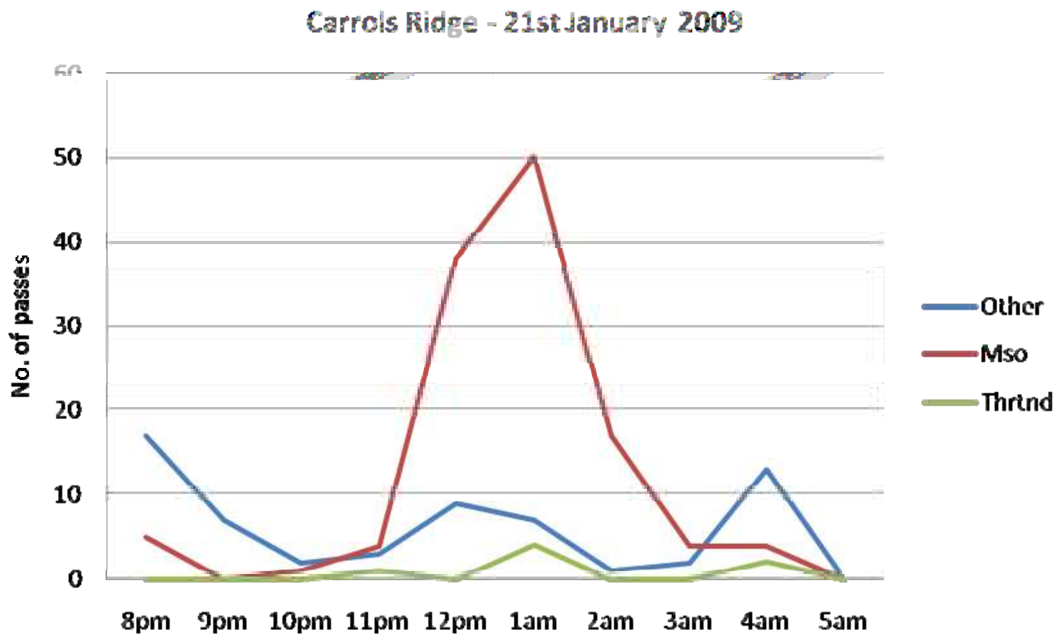

Figure 6: Number of passes each hour for the Eastern Bentwing Bat (Mso), other threatened microbat species (Thrtnd) and non-threatened microbat species (Other) at Carrols Ridge, 21st January 2009.

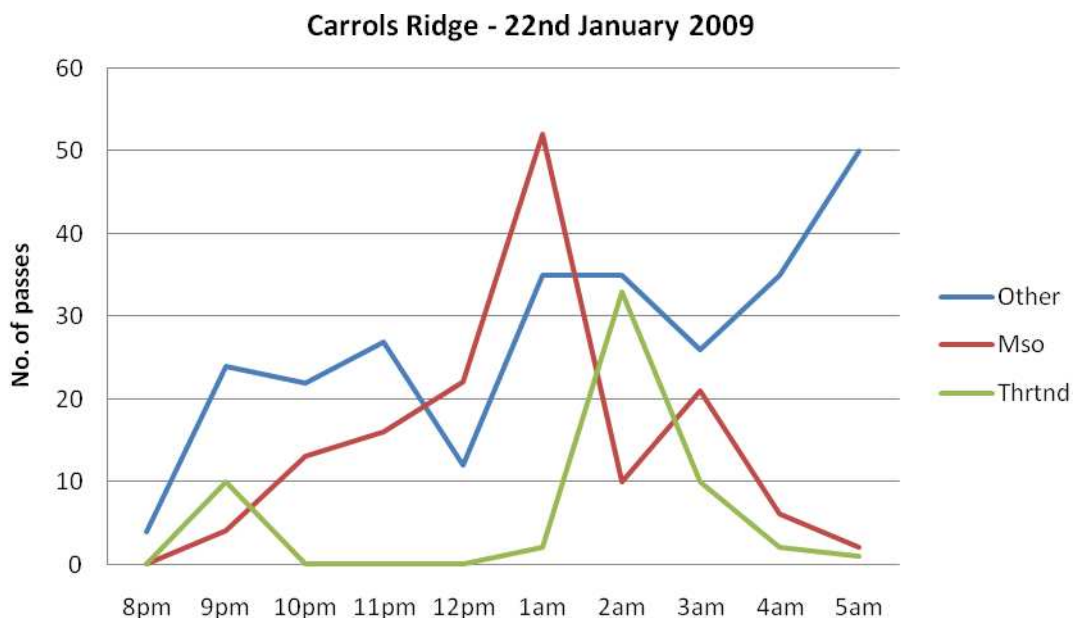

Figure 7: Number of passes each hour for the Eastern Bentwing Bat (Mso), other threatened microbat species (Thrtnd) and non-threatened microbat species (Other) at Carrols Ridge, 22nd January 2009.

Table 14: Number and confidence ranking of echolocation calls recorded at Coppabella by January 2009.

Coppabella Echolocation Call Analysis				
SPECIES	POSSIBLE	PROBABLE	CONFIDENT	TOTAL
Chocolate wattled bat (*Chalinolobus morio*)	5	3	0	8
Goulds wattled bat (*Chalinolobus gouldii*)	9	6	2	17
Eastern freetail bat (*Mormopterusridei*)	3	1	1	5
Large forest bat (*Vespadelus darlingtoni*)	2	1	0	3
Little forest bat (*Vespadelus vulturnus*)	0	1	0	1
Long-eared bat (*Nyctophilus sp.)*	0	1	0	1
Southern freetail bat (*Mormopterus*Species 4)	3	1	0	4
White-striped freetail bat (*Austronomus australis*)	0	0	1	1

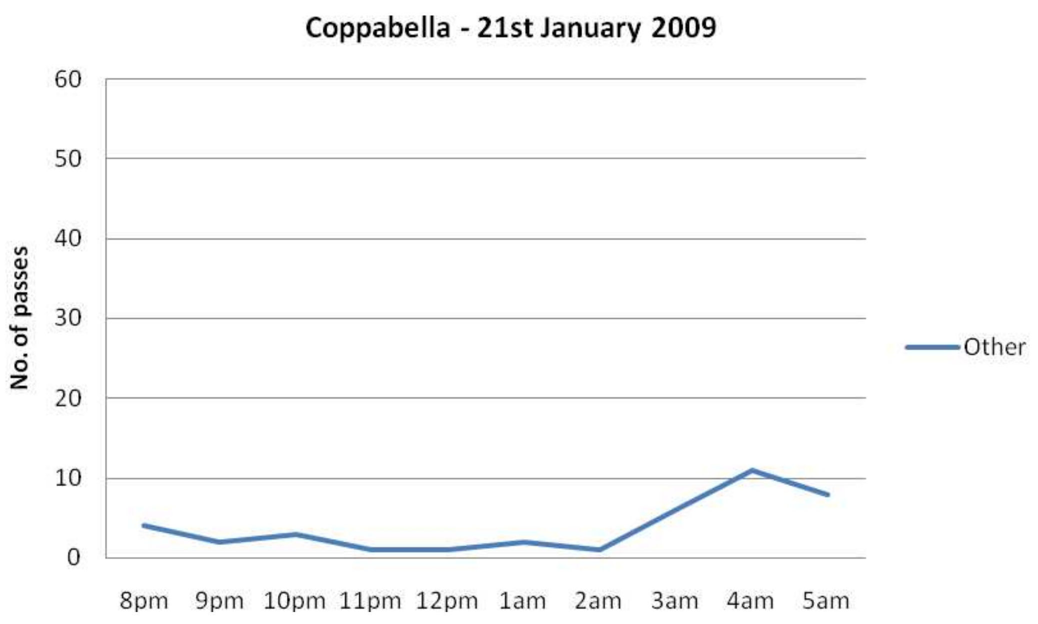

Figure 8: Number of passes each hour for non-threatened microbat species (Other) at Coppabella, 21st January 2009.

3.3.3 MARILBA

Echolocation data collection revealed a total of 4 passes by microbats (Table 15). No microbats listed under Schedule 2 of the NSW *Threatened Species Conservation Act 1995* were recorded.

It should be noted that a large number (>500 files) consisted of noise or interference likely from insects.

Table 15: Number and confidence ranking of echolocation calls recorded at Marilba by January 2009.

Marilba **Echolocation Call Analysis**			
SPECIES	POSSIBLE	PROBABLE	CONFIDENT
Chocolate wattled bat (*Chalinolobus morio*)	0	2	1
Long-eared bat (*Nyctophilus sp.)*	0	0	1

3.4 LANDFORM COMPARISON OF MICROBAT ACTIVITY

Microbat activity from the number of calls is used to make this comparison by summing all passes of all species, species groups and unidentifiable bat calls. The low number of echolocation calls recordings collected at Coppabella and Marilba has resulted in no comparison being able to be completed for these two sites.

3.4.1 CARROLS RIDGE

Pooled data from the Echolocation Analysis resulted in data collected from two landform types: Ridge and Gully. Each landform was subject to two survey nights each using Anabat detectors.

This study has revealed that the highest level of microbat activity was recorded at gullies (67% of passes) when pooling the data from all three interest groups (Eastern Bentwing Bat, Other threatened microbat species, and Non-threatened microbat species). For some groups such as the non-threatened microbat species, 75% of all microbat activity was recorded in a gully location. Conversely, Eastern Bentwing Bat was evenly distributed across each landform, with 53% of all calls recorded in gullies and 47% recorded on ridges.

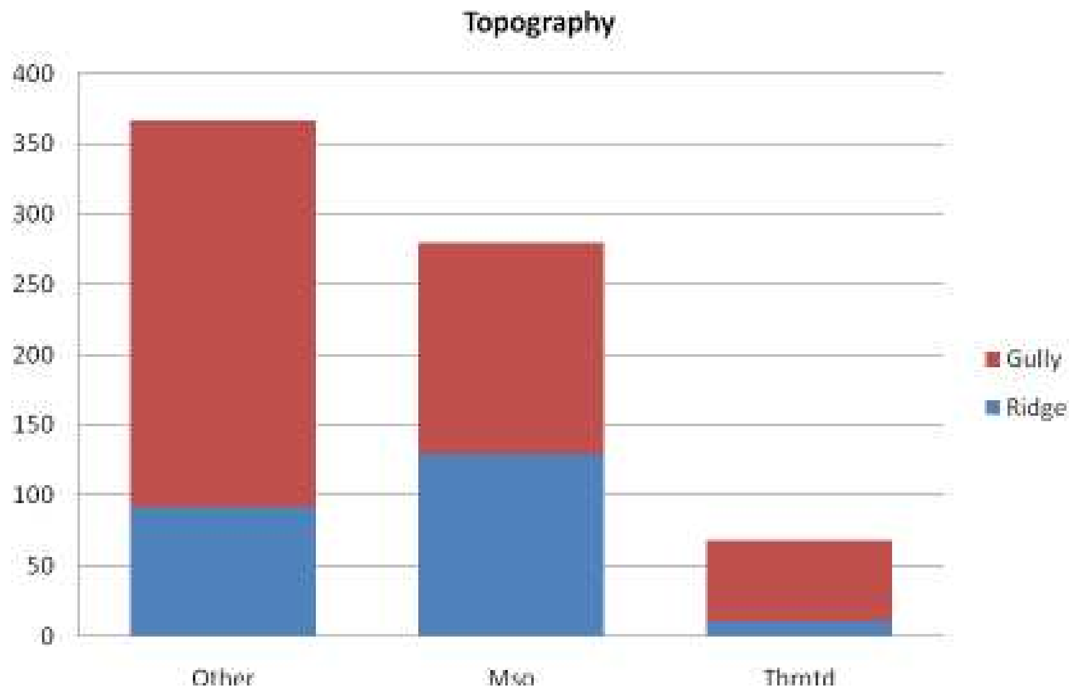

Figure 9: Number of microbat passes recorded on ridges and gullies at Carrolls Ridge of Eastern Bentwing Bat (Mso), other threatened microbat species (Thrntd) and non-threatened microbat species (Other).

3.5 EASTERN BENTWING BAT

Eastern bentwing bat has been recorded at two of the three study sites: Carrols Ridge and Marilba.

At Marilba, 22 echolocation calls were collected over two survey nights (average of 11 calls per survey night) in September 2008. However, the species was not recorded subsequently in the January 2009 surveys despite a further two survey nights using Anabat detectors.

At Carrols Ridge, 24 ecolocation calls were recorded during six survey nights (average of 4 calls per survey night) in November 2008. During the January 2009 survey, 284 echolocation calls were recorded during four survey nights (average of 71 calls per survey night). This increase in calls recorded represents a 1700% increase in Eastern bentwing bat activity above the November survey.

4 DISCUSSION

4.1 MICROBATS AND WINDFARMS

There has been few studies of wind farm impacts on microbat species and no long term studies that can be called “Before and After Controlled Impact (BACI) studies”. Without this information, assumptions must be made using what is known of species ecology and limited case studies and investigations. The difficulty in estimating impact to microbats is compounded by the fact that relatively little is known about their ecology and behaviour. However, compared to available data on bird mortalities, microbat collision events appear to be greater in number. Migratory microbats comprise the majority of mortalities in all wind farm studies to date (**ngh**environmental 2009a).

Microbat fatalities in the USA at wind farms have been high (eg. Mountaineer Wind Energy Centre in West Virginia - 44 x 1.5 MW turbines - accounting for 4000 microbat deaths in the autumn of 2004), however extrapolation of this data to Australian conditions would be inappropriate. This is mainly because climatic patterns are quite different. In the USA where extreme changes occur during winter as the jetstream moves southwards, rendering much of the country unsuitable for bat foraging (Greg Richards pers. Comm.). These extreme changes cause dramatic changes to the areas occupied by a number of bat species that move very long distances as they migrate, making them more susceptible to collision in much larger numbers (Greg Richards pers. Comm.). Monitoring in Victoria, based on carcass monitoring, has identifies fatality rates in the order of 1-2 bats per turbine per year (Brett Lane pers. Comm., via Greg Richards). This data from Victoria is likely to represent more accurate data in an Australian context. Fatalities may however be higher, but this would be dependent on habitat quality and proximity of significant bat roosts.

The Bird and Bat Risk Biodiversity Addendum recently completed by **ngh**environmental, provides a greater review of the risks from wind farms to microbats (**ngh**environmental 2009a).

4.1.1 RISKS SPECIFICALLY TO MICROBATS

The recent literature review conducted by **ngh**environmental concluded that there are a number of risks specifically to microbats from wind farm development (**ngh**environmental 2009a). Conclusions that can be drawn from this review identify that risks specifically to microbats include:

1. Habitat avoidance.
2. Collision risks.
3. Pulmonary barotraumas (Rapid or excessive air-pressure change resulting in haemorrhaging of the lungs as fauna pass near moving turbine blades).
4. Species-specific risks (such as those species that fly above the forest canopy).
5. Environmental risks (**ngh**environmental 2009a).

The key risk factors relating directly to turbines placement and design identified within this review were:

1. Along forested ridge or waterways (often used as navigational aids by bats).
2. Abutting forest or remnants (increased foraging activity along edges).
3. Reducing the attractiveness of turbine areas by minimising lighting.

4.2 STUDY SITES

4.2.1 CARROLS RIDGE

The Carrols Ridge study site has, to date, revealed 16 microbat species. Three threatened microbat species listed under Schedule 2 of the NSW *Threatened Species Conservation Act 1995* have been recorded at Carrols Ridge. These being the Eastern bentwing bat, Eastern falsistrelle and Yellow-bellied sheathtail bat.

Some temporal variation of the assemblage of microbats recorded at Carrols Ridge was recorded. Five additional species were recorded in the January surveys that were not recorded in November. Weather conditions conducive to maximising the detection of microbats are likely to be the main factor attributing to this. These results also suggesting some level of site fidelity to foraging or roosting resources or movement corridors present at Carrols Ridge.

Four maternity caves are known in NSW- Willi Willi and Riverton in the north and Church/Pylon 58 and Drum in southern NSW (Dwyer 1968).

The cave system known as Church Cave/Pylon 58 Cave at Wee Jasper is a known maternity cave site for the Eastern bentwing bat (Dwyer 1968). These caves are located less than 19kms to the south of Carrols Ridge and the presence of the Eastern bentwing bat during the first surveys of the site in November, lead to additional surveys to gain a greater understanding of the importance of the Carrols Ridge study site. Each maternity cave often has an associated “staging” cave close by (Wee Jasper’s is Mt Fairy Cave situated in the triangle between Bungendore, Tarago and Doughboy) (Dwyer 1968), which is south-west of Carrols Ridge. While exact migration routes are unknown, it could be assumed that any movement from Mt Fairy to Church Cave would avoid Carrols Ridge, which is 19kms to the north of the maternity cave.

High levels of microbat activity were recorded at Carrols Ridge during the January survey. Of all microbat passes recorded at Carrols Ridge (713), 48% (342) could be attributed to microbat species listed under Schedule 2 of the NSW *Threatened Species Conservation Act 1995.* Eastern bentwing bats passes comprised of around 80% (284 passes) of all threatened species recorded or 39% of the total number of microbat passes at Carrols Ridge.

Analysis of microbat activity across each evening presents some limited information on the activity of microbats during the survey. Higher levels of activity are present for the threatened Eastern bentwing bat from around 10pm on each survey night, peaking between Midnight and 2am before activity decreases. On two nights, a second ‘mini’ peak occurs between 3 and 4am.

The double peak in activity levels recorded over two separate evenings indicates that Eastern bentwing bat are also foraging elsewhere at an unsurveyed site in the locality using Carrols Ridge as a movement corridor. Increases in activity later in the night could be presumed individuals returning to Church Cave. Almost continual activity throughout each night during the survey confirms that the Carrols Ridge site is also foraging habitat for the species regardless if it is moving elsewhere. While no Eastern bentwing bat were recorded during the harp trap surveys, this high-flying species is difficult to catch using this method, with echolocation call recordings proving most successful. The results confirm that Carrolls Ridge is within foraging distance by females from the maternity site. However, activity levels are likely to vary throughout the breeding season. In a study on Eastern bentwing bat on the NSW North Coast, it was found that emergence was correlated strongly with astronomical sunset, though slight differences in caves was based on the light intensity it received (ie facing West or North etc) (Dwyer 1962). However, re-entry was not as precise and it was proposed that this was based more on food availability or that females would forage longer when lactating.

Associations with gully formations and riparian areas have previously been recorded in microbats (Law and Chidel 2002) and this study revealed the highest level of bat activity across all species within gullies except for the Eastern bentwing bat where this association did not exist, with there being an even distribution of calls across both gullies and ridges. This data may suggest that while some individuals were foraging on the site, this high flying species may be using the ridges of Carrols Ridge as a movement corridor to other foraging areas in the locality.

While the exact nature of the foraging pattern of Eastern bentwing bats from the maternity site is unknown, the data does show that the Carrols Ridge site should be a considered both a movement corridor and forage habitat during occupation of the Church Cave maternity site.

4.2.2 COPPABELLA

The Coppabella study site has, to date, revealed 10 microbat species with a relatively low level of microbat activity across the September 2008 and January 2009 surveys. No threatened microbat species listed under Schedule 2 of the NSW *Threatened Species Conservation Act 1995* have been recorded at Coppabella.

A small temporal variation of the assemblage of microbats recorded at Coppabella was noticed with 5 species detected in January that were not recorded in September and one species recorded in September that was not recorded in January. The September absences are likely to be explained by cooler weather conditions lowering the activity levels of microbats such that the detection of these species by Echolocation was reduced. This deficiency has been amended by the January survey where survey conditions were conducive to maximising microbat detection. The January absence of the Inland broadnosed bat may be that Coppabella is used infrequently by this species. Coppabella is likely to be at the easterly extent of the inland distribution of the species (Churchill 1998) and that the sites resources in terms of foraging or roosting for this inland species are limited. The most commonly recorded microbat at Coppabella was the non-threatened Goulds wattled bat. This species is found across Australia where it roosts in tree hollows and forages in almost any habitat type (Churchill 1998).

In general terms, the very small number of microbat passes of all species recorded at Coppabella suggests that microbats were uncommon in the study site at the time of the surveys.

One of the aims of the current survey was to assess whether female Eastern bentwing bats were using the study sites during their known period of occupation at the Church Cave maternity site. The Eastern bentwing bat was not recorded in either the September 2008 (**ngh**environmental 2009c) or January 2009 surveys. The Coppabella site is 42kms (straight line distance) from Church Cave. While the exact foraging distance from Church Cave is unknown, it is unlikely that the species would forage as far as Coppabella in one evening.

The absence of Eastern bentwing bat at Coppebella may also be attributed to the information exchange that has been demonstrated for other species of cave-dwelling microbats. Wilkinson (1992) showed that for a North American cave dwelling species, *Nycticeius humeralis,* that also congregates into maternity caves, exchanged information at roosts (and by 'eavesdropping' on echolocation of other bats) and followed successful bats to rich sources of insects. An absence of an adequate food resource at Coppabella combined with the extended distance from Church Cave is likely to support this theory.

4.2.3 MARILBA

The Marilba study site has, to date, revealed 12 microbat species with a relatively low level of bat activity across the September 2008 and January 2009 surveys. One threatened microbat species listed under Schedule 2 of the NSW *Threatened Species Conservation Act 1995* was recorded at Marilba during the September survey, the Eastern bentwing bat (**ngh**environmental 2009d).

A large temporal variation of the assemblage of microbats recorded at Marilba was noticed with 10 species detected in September that were not recorded in January. A large number of files from echolocation recording in January 2008 were of insect origin suggesting that equipment failure was not attributing to the low numbers of microbats recorded. Rather, specific onsite conditions are the likely reason for the non-detection of microbats. It could also be suggested that Marilba forms part of a foraging range, that, during the time of the January survey, had very little microbat activity and therefore, were absent, or if present, were very uncommon at the study site at the time of the survey.

One of the aims of the current survey was to assess whether female Eastern bentwing bats were using the study sites during their known period of occupation at the known maternity site, Church Cave at Wee Jasper. The Eastern bentwing bat was not recorded in the January 2009 surveys. However, the species was detected during the September 2008 surveys from 22 passes (**ngh**environmental 2009d). Such a low number of passes suggests that Marilba was not important foraging habitat for Eastern bentwing bat at the time of the survey. Their absence in January further confirms this theory in that any females would have moved onto the Church Cave maternity site. The Marilba site is 34kms (straight line distance) from Church Cave. While the exact foraging distance from Church Cave is unknown, it is unlikely that the species would forage as far as Marilba in one evening. However, males would still have been detected if they were at Marilba. The data collected suggests they were absent, or if present, in very low numbers making detection difficult. This suggests that Marilba provides only a small portion of a wider foraging area that Eastern bentwing are unlikely to rely on.

The absence of Eastern bentwing bat at Marilba may also be attributed to the information exchange that has been demonstrated for other species of cave-dwelling microbats. Wilkinson (1992) showed that for a North American cave dwelling species, *Nycticeius humeralis,* that also congregates into maternity caves, exchanged information at roosts (and by 'eavesdropping' on echolocation of other bats) and followed successful bats to rich sources of insects. An absence of an adequate resource at Marilba combined with the extended distance from Church Cave is likely to support this theory.

5 RECOMMENDATIONS

nghenvironmental recommends the following measures to address operational impacts of the proposed wind farms. Each location has been considered for their potential to impact on threatened microbats through an Assessment of Significance, and each, has a set of specific recommendations relative based on this.

The Assessment of Significance for each of the three wind farm locations provided (Appendix A,B,C) relies on the adoption and implementation of these recommendations to ensure that the proposed activity at each location, is *'unlikely'* to have a *'significant effect'* on any threatened species under the NSW *Threatened Species Conservation Act* 1995.

5.1 CARROLS RIDGE

Adaptive Bat Research and Monitoring Program (ABRMP)

It is recommended that an Adaptive Bat Research and Monitoring Program (ABRMP) would be implemented prior to construction and during the operation of the Carrolls Ridge Precinct, to monitor and research habitat use by microbats, including the Eastern Bentwing Bat (EBB) use and activity at this precinct.

The primary aim of the program would be to define high risk periods in relation to the EBB. Management strategies would be adaptive, in response to the ongoing findings of the ABRMP. The Proponent would develop and implement the ABRMP in consultation with the Department of Conservation and Climate Change (DECC) and the Department of Planning (DoP). Additionally, the program would have the objective of managing the risk that bat-strike or barotrauma from the proposal would result in a reduction in the EBB maternity population that utilises Church Cave.

The ABRMP would focus on use and activity of the EBB in relation to seasonal and climatic conditions, migration, and how these relate to the use of the Carrolls Ridge site. Opportunities to improve survival rates of maternity population and therefore abundance of bats utilising Church Cave would also be investigated. These may include providing assistance with recovery strategies (outlined at www.threatenedspecies.environment.nsw.gov.au/tsprofile/pas_profile.aspx?id=10534), such as site protection, control of foxes and feral cats around roosting sites, particularly maternity caves and hibernation sites.

Specific research questions that would need to be investigated as part of the ABRMP would include:

1. Use of the Carrolls Ridge Precinct by the EBB inside and outside of the period when Church Cave is known to be utilised as a maternity cave by the EBB.
2. Technologies available to;

   a) monitor use of the site and Church Cave to assist in developing future adaptive operational procedures of the turbines (ie. developing infrastructure that would allow shut-down of turbines if EBB activity reaches a predetermined threshold)

   b) deter bats from entering the blade sweep area and wake.
3. Use of the Carrolls Ridge site in relation to the migration to Church Cave, and forage activities at the site (between 1st October and 31st March). This would include;

a) investigation of the migration of the EBB to and from Church Cave (and Dip Cave) in relation to the use of Carrolls Ridge during this migration

b) frequency and seasonality of activity of the EBB at Carrolls Ridge, use of the site as a movement corridor and a forage resource.

4. Potential opportunities to provide offsets / benefits to the Eastern Bentwing Bat populations.

The approach would, where necessary, include input from a biometrician in relation to survey design and effort necessary to obtain sufficient data to assess seasonal correlates, in addition to developing methodologies for the analysis of the data.

Development of mitigation strategies

Adaptive management strategies would be informed by the data and research collected in the research Program. Specifically, appropriate operational criteria for the wind farm would be developed. These would include:

1. Operational limitations on turbine usage. The turbines should be switched off during periods identified as being high risk in relation to the maternity population that utilizes Church Cave (during the active months of the Eastern Bentwing Bat cave).
2. Offsite protection to EBB population. Implement outcomes of research program in relation to protection of bat populations at Church Cave. This may include feral animal control and other mitigation to reduce mortality at the cave.
3. Mitigation at site. Develop on-site mitigation that could provide deterrents to the EBB or systems that could shut down turbines automatically if pre-determined criteria in relation to the EBB are reached.

Recommendation

To meet these recommendations the following mitigation tasks should be incorporated into the proposed Statement of Commitment.

The Proponent would commit to developing and implementing an *Adaptive Bat Research and Monitoring Program* (ABRMP) prior to construction and during operation of the Carrolls Ridge Precinct. The ABRMP would comprise of the following measures:

1. Research and investigate the use of the Precinct by the EBB and develop appropriate operational criteria.
2. Operational limitations would be placed on the turbines. The turbines would be switched off during the periods identified as being high risk of population level impact in relation to the maternity population that uses Church Cave.
3. Investigate and implement on-site mitigation (including deterrents to the EBB to reduce risk, or systems that could shut down turbines automatically if pre-determined criteria in relation to the EBB are reached) to reduce risk to the EBB population to acceptable levels.
4. Identify potential offsets by implementing offsite protection to the Eastern Bentwing Bat (EBB) population at Church cave using the outcomes of the research program.

5.2 COPPABELLA AND MARILBA

1) An adaptive Bat Monitoring Program should be implemented prior to construction to monitor habitat use by microbats. This would continue into the operational phase and management strategies would be adaptive in response to monitoring findings. The efficacy of mitigation measures should be

documented and be publically available in order to add to the knowledge base on this subject. As a basis for this program, the following is recommended:

(a) Ensure specific recommended mitigation measures outlined in this report are implemented and their effectiveness reviewed.

(b) Specify on-going monitoring procedures of the assessment and documentation of all collision and barotrauma-related injury or mortality observed, focusing in particular on moderate and high risk species as detailed within the Biodiversity Assessments. Timing for monitoring should be specific to the most at-risk target species.

(c) Specify procedures to investigate and implement adaptive management measures to reduce impacts should injury or mortality occur. Ensure that all injuries and mortalities of any threatened or migratory species are reported to DECC.

(d) Specify procedures to review adaptive mitigation measures to ensure their effectiveness at reducing collision and barotrauma related mortality.

(e) Coordinate the monitoring and adaptive actions for all wind farms within the regions to ensure cumulative impacts are appropriately documented and managed.

(f) Develop a standardised and publicly available database to increase the knowledge base on this subject.

5.3 GENERAL

1) Marker lights, if required, should be minimised in number and fitted to reduce their ability to attract insects. Red lights are preferred, with the least number of flashes per minute. It is understood that CASA requirements will prevail.
2) Infrastructure layout should be designed to minimise impact to remnant vegetation.
3) Infrastructure layout should be designed to minimise impact to remnant vegetation.
4) In the case of any hollow-bearing tree removal, a dedicated fauna specialist (with microbat experience and vaccinated for Lyssavirus) must be on hand to supervise the removal of this vegetation to ensure the safety of any microbats should they be present. Clearing of these features should be kept to a minimum as stated within the Biodiversity Assessments and should only occur during Winter (outside of known breeding seasons).
5) A Biodiversity Management Plan should be prepared and implemented prior to construction using the recommendations herein as a basis. The plan would aim to protect and minimise loss of native vegetation and native fauna habitat as a result of construction of the project.

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Appendix A ASSESSMENT OF SIGNIFICANCE – CARROLS RIDGE

In accordance with section 5A of the *Environmental Planning and Assessment Act 1979,* an Assessment of Significance has been prepared by using seven factors which must be considered when determining if the proposed activity '*is likely to have a significant effect on the threatened species, populations or ecological communities, or their habitats'* that are listed as under the Schedule 1 & 2 of the *Threatened Species Conservation Act 1995.* These seven factors must be taken into account by the consent or determining authority when considering a development proposal or development application. This enables a decision to be made as to whether there is likely to be a significant effect on the species and hence if a Species Impact Statement is required. The following Assessment of Significance relates only to microbats the subject of this report.

The following species of threatened bat have been recorded at Carrols Ridge: Eastern bentwing bat, Eastern falsistrelle and Yellow-bellied sheathtail bat (Table 9). The previous biodiversity assessment also considered Large-footed myotis and Little pied bat for the Assessment of Significance based on habitat attributes and previous records in the locality (**ngh**environmental 2009b).

As such, this Assessment of Significance will be undertaken on these five microbat species.

(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

Eastern bentwing bat

The distribution of this species covers a wide area along the east coast of Australia, with populations dispersed within 300 kilometres of each of the known maternity roosts (DECC 2009b). Eastern bentwing bat is a long-lived species with low fecundity. Churchill (1998) records an adult banded female being recaptured 18 years post banding.

Four maternity caves are known in NSW- Willi Willi and Riverton in the north and Church/Pylon 58 and Drum in southern NSW (Dwyer 1968). Each maternity cave often has an associated "staging" cave close by (Wee Jasper's is Mt Fairy Cave situated in the triangle between Bungendore, Tarago and Doughboy) (Dwyer 1968).

The Church Cave/Pylon 58 maternity site is located less than 19kms to the south of Carrols Ridge and the results of this study confirm use of the study site by this species in the November and January surveys. The study site is considered within foraging distance of the maternity site (Doug Mills, DECC, Personal communication, 13th February 2008).

Female Eastern bentwing bat migrate to specific cave sites in c.October-November each year to give birth in December and raise a single young (Churchill 1998). Post weaning, females leave maternity sites in late February-March (Dwyer in Strahan 1983), with young dispersing from the sites approximately two weeks later (late March) (G. Richards pers. comm via Vanessa Place, 2008).

Eastern bentwing bats require forested areas to forage in, flying above the canopy to capture insects on the wing feeding mostly on moths (Churchill 1998). The species also forage along flyways (along clear areas such as tracks or streams), and are known to utilise cleared paddocks during dispersal (Dwyer 1968). There is no evidence that they have a strong affiliation with gradient, being recorded on ridges and gullies at Carrols Ridge.

In an analysis of 78,319 records from banding data, 95% of movements were 100kms or less (Wilson 2003). Dwyer (1968) documented distances far less. For females, he found that nearly half of all movements by adult females were less than 16km with 80% lower than 31kms.

The study also confirmed that female Eastern bentwing bat show strong fidelity as evidenced by seasonality data. The Church Cave/Pylon 58 Cave maternity site less than 19kms from Carrols Ridge is considered extremely important to the southern population of the Eastern bentwing bat (Dwyer 1968) and therefore, any impact on foraging females is likely to result in population-scale impacts.

Given its high-flying habits and even distribution across the ridges and gullies of the site, the risk of significant impacts from blade-strike and barotrauma on the species is likely to be high. Further, given the large proportion of the female population utilising the area around the maternity cave (some 30,000 individuals), a high mortality of foraging females would be considered significant. As the species is known to travel over a range of habitat types and was recorded at all surveys sites at Carrols Ridge, it is difficult to delegate these potential impacts to specific clusters within the proposal; the impact is likely to be throughout the subject site.

While our results show the species at Carrols Ridge in November, it is unlikely that the study site is used during migration given that the staging area for the southern population is at Mt Fairy, 100kms to the south-east (Dwyer 1968).

Flight speed has been recorded at 5.8metres/second or c.20kms/hour (Bullen and McKenzie 2008).

Considering the information relative to Carrols Ridge and the maternity site, the proposed Carrols Ridge wind farm could result in a population scale impact on the Eastern bent wing bat. However, in accordance with the recommendations outlined section 5.1 of this report, their is potential to reduce this impact is reduced such that the proposal is unlikely to have an adverse effect on the life cycle of the species and that the viable local population is unlikely to be placed at risk of extinction.

Little pied bat

The Little pied bat roosts in caves, mines, buildings, and tree hollows in small groups, though one colony of 40 individuals has been recorded (Churchill, 1998). It prefers open, dry forests such as Mulga woodlands, chenopod shrublands or mallee with access to water sources (Churchill 1998; DECC 2009b). Little pied bats forage within the canopy (or sub-canopy), as with most of the Vespertilinidae in Australia. It often forages along watercourses (Menkhorst and Knight 2004) where it feeds on moths and possibly other flying invertebrates. It gives birth usually to two young in November.

Little pied bat is a sedentary species, little is known of home ranges for foraging but the species has been known to travel up to 34 km to gain access to water in more arid environments. While this species was not recorded during this survey, or the 2008 surveys, a single record exists near Bowning from the DECC NSW Wildlife Atlas database (DECC 2009a). Considering the known ecology and habitat requirements of the species, the locality provides little, if any, potential habitat for the species. While the exact origin of this record is unknown, it could be suggested that it is an incorrect identification or entry into the database. Regardless, if it is correct, the species could only be considered a very occasional vagrant to the district as they are known from arid inland areas.

The study site is unlikely to provide suitable habitat for the species, as it contains dry sclerophyll forests and woodland. The dams on the site may provide marginal habitat although the species was not recorded on site. The proximity of Carrolls Ridge to Burrinjuck Dam may have an effect if a population occurred locally, but as the only record is some distance from the proposal site (and the dam) it is highly unlikely that the species occurs in the area.

Considering the information relative to the study site, the proposed Carrols Ridge wind farm is unlikely to have an adverse effect on the life cycle of the species and that a viable local population, if it exists, is unlikely to be placed at risk of extinction if the recommendations within section 5.1 of this report.

Eastern falsistrelle

The Eastern falsistrelle utilises tree hollows for roosting, and has also been found under loose bark and in buildings (DECC 2009b). Colonies are very small, ranging from 3 to 36 individuals often segregated by sex (Churchill 1998).

The Eastern falsistrelle relies on forested areas and forages within or just above the forest canopy. It is a relatively fast, manouverable flyer that hunts prey by pursuit. The species prefers tall wet sclerophyll forest with trees approximately 20 metres in height, though has been found in drier forests foraging. It travels medium distances to forage (c. 12km) (Churchill 1998). It is a winter hibernating species and it has been suggested that some highland populations migrate to the coast for winter (Parnaby in Strahan 1983), though by what route is unknown. Eastern falsistrelle give birth to one young in late Spring/Summer (December usually) and young are weaned by late February (Churchill 1998).

This species are known to occur within sclerophyll forests of the Great Dividing Range. The proximity of the site to Burrinjuck Dam (water source), Burrinjuck Nature Reserve and their presence in the study site confirms the presence of a local colony.

Considering the information relative to the study site, the proposed Carrolls Ridge wind farm is unlikely to have an adverse effect on the life cycle of the Eastern falsistrelle and that a viable local population, is unlikely to be placed at risk of extinction in-concurrence with the recommendations of section 5.1 of this report.

Large-footed myotis

The Large-footed myotis is known to use tree hollows, caves, mines, under bridges, storm water drains, and vegetation such as Pandanus for roosting. Foraging is dependent on the presence of water bodies, both riparian and artificial such as dams (Churchill 1998). The species gleans insects from the waters surface and just below, as well as aerial prey. In NSW one young born per year in November / December (Churchill 1998). The relevant threats to this species are loss or disturbance of roosting sites and clearing adjacent to foraging areas (DECC 2008). Only one record exists in the locality at Wee Jasper near Burrinjuck Dam.

Generally, the species is found within 100km from the coast or major rivers and water bodies. While, there are no major water bodies or large dams within the study site, the nearest distance to Lake Burrinjuck is 1.8km (Cluster 4). The lake lies between the study site and the nearest record. Foraging moments are likely to be restricted to riparian corridors rather than along ridges, reducing the likelihood of frequent or sustained movement within turbine areas. However, the species may come into contact with turbines during travel between foraging grounds (Lake Burrinjuck) and potential roosting sites, however, given the extent of potential roosting sites closer to Lake Burrinjuck, it is unlikely that the species would use the study site.

Considering the information relative to the study site, the proposed Carrolls Ridge wind farm is unlikely to have an adverse effect on the life cycle of the Large-footed myotis and that a viable local population, if it exists, is unlikely to be placed at risk of extinction in-concurrence with the recommendations of section 5.1 of this report.

Yellow-bellied sheathtail bat

Listed as vulnerable under the NSW TSC Act, this cryptic species is known to use a variety of habitats (DECC 2009b). Yellow-bellied sheathtailed bats roost solitarily or in small groups in hollows, old buildings or occasionally abandoned nests of other species such as Sugar Gliders (Churchill 1998). The species is sedentary and possibly territorial, though has been found in Southern Australia only between January and June (Churchill 1998) which may suggest some movement for hibernation. In the Murrumbidgee catchment, the species is thought to be associated with dry sclerophyll forests, although there are no records in the catchment (DECC 2009b). A fast flying species with low manoeuvrability, it favours a range of insect species, mainly beetles (Churchill 1998; Richards 2001). One young are born December to mid-March, though peak is likely to be December (Churchill 1998). The relevant threats to this species are loss of hollow-bearing trees and clearing and fragmentation of forest and woodland habitat (DECC 2009b).

Little is known about the migratory and foraging movements of the species, however, a small number of echolocation calls of this species were recorded in January 2009. Richards (2001) claims that the species may favour habitat in large tracts of vegetation with a dense understory. The forest and woodland in the study area generally have sparse understorey due to disturbance from grazing and fire, although Cluster 1e is a notable exception. The small number of calls suggests these habitat attributes are minimising the use of the study site by this species. The habitat preferences are more likely to be in the nearby Burrinjuck Nature Reserve and larger gazetted lands to the south.

Considering the information relative to the study site, the proposed Carrolls Ridge wind farm is unlikely to have an adverse effect on the life cycle of the Yellow-belled sheathtail bat and that a viable local population is unlikely to be placed at risk of extinction in-concurrence with the recommendations of section 5.1 of this report.

(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 microbats defined as an endangered population as listed under the NSW *Threatened Species Conservation Act 1995* occur in the vicinity of the proposal.

(c) in the case of an endangered ecological community or critically 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 microbats are listed under the NSW *Threatened Species Conservation Act 1995* as an endangered ecological community.

(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,

i) The total development envelope is 286ha. Within this envelope 8.8 ha of forest is likely to be removed, the remainder would be considered to be modified, if these species avoid turbines. The proposal would increase open areas (tracks along ridges between turbines) and thereby edge effects.

ii) Habitat within Cluster 1 is already fragmented or isolated to an extent (particularly slopes to the west). Works in Clusters 2 & 4 would result in habitat loss for species dependent on large tracts of forest. However, this is likely to be less important to highly mobile species such as microbats. Avoidance of the Carrols Ridge site by large number of foraging Eastern bentwing bat, may disrupt localised and perhaps specialist foraging paths.

iii) While seemingly suitable habitat is reserved nearby (Burrinjuck and Andrew Black Nature Reserves), and occurs adjacent to the study area, results of this study suggest that Eastern bentwing bat use Carrols Ridge during their occupation of the maternity site. The subject land is considered important to this species in terms at a population level scale.

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

There is no critical habitat as listed by the *TSC Act 1995*, found within the study site.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,

At the time of writing, no recovery plan was in place for any microbat species considered in this assessment.

A number of priority actions are identified for threatened microbats, and are of relevance to the recommendations outlined in section 5.1 of this report. These are:

- Identification of important foraging areas and habitat around maternity caves
- Study of the ecological requirements of maternity colonies where foraging or potential movement corridors exist

(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.

Several key threatening processes are relevant to the proposed activity in relation to microbats. These include:

- *Clearing of native vegetation*
- *Loss of hollow-bearing trees*
- *Human caused climate change*

The 'clearing of native vegetation' is recognised as a major factor contributing to the loss of biodiversity. Around 8.8ha of forest will be removed by this proposal which has been identified as habitat for a number of threatened microbats.

An unknown number of hollow-bearing trees will be removed within the 8.8ha of forest. These features are likely to provide habitat to non-threatened, and potentially threatened microbat species. The biodiversity assessment recommended the absolute minimum of hollow-bearing tree removal (**ngh**environmental 2009b). Based on these, the final area will be updated following the receipt of the final site layout.

Although the construction activities that would occur as part of site development may seem minor, they contribute to a global, cumulative impact on atmospheric greenhouse gas concentrations and potential for climate change impact. However, the operation of a wind farm is a renewable energy source that will contribute to the minimisation of green-house gas emissions and overall human caused climate change.

Conclusion

The proximity of the site to a known maternity cave for the Eastern bentwing bat introduces a high potential of the development and operation of a wind farm at Carrolls Ridge having a significant impact at a population level on this species. There is potential to reduce this risk via the implementation of mitigation measures discussed in section 5.1 above. Implementation of these safeguards would ensure the potential to impact on this species, and other microbats is minimised to the lowest possible risk. Based on the above assessment and the adoption and implementation of the recommendations (as per section 5.1) of this report, the proposed Carrols Ridge Precinct is *'unlikely'* to have a *'significant effect'* on any threatened species under the NSW TSC Act.

Appendix B ASSESSMENT OF SIGNIFICANCE – COPPABELLA

In accordance with section 5A of the *Environmental Planning and Assessment Act 1979,* an Assessment of Significance has been prepared by using seven factors which must be considered when determining if the proposed activity '*is likely to have a significant effect on the threatened species, populations or ecological communities, or their habitats'* that are listed as under the Schedule 1 & 2 of the *Threatened Species Conservation Act 1995.* These seven factors must be taken into account by the consent or determining authority when considering a development proposal or development application. This enables a decision to be made as to whether there is likely to be a significant effect on the species and hence if a Species Impact Statement is required. The following Assessment of Significance relates only to microbats the subject of this report.

No species of threatened microbat have been recorded at Coppabella (Table 10). However, based on the threatened microbats that occurred at Carrols Ridge, the Assessment of Significance will be undertaken on four species: Eastern bentwing bat, Eastern falsistrelle, Yellow-bellied sheathtail bat and Little pied bat. The Large-footed myotis is not considered due to the absence of a large body of water.

(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

Eastern bentwing bat

The distribution of this species covers a wide area along the east coast of Australia, with populations dispersed within 300 kilometres of each of the known maternity roosts (DECC 2009b). Eastern bentwing bat is a long-lived species with low fecundity. Churchill (1998) records an adult banded female being recaptured 18 years post banding.

Four maternity caves are known in NSW- Willi Willi and Riverton in the north and Church/Pylon 58 and Drum in southern NSW (Dwyer 1968). Each maternity cave often has an associated "staging" cave close by (Wee Jasper's is Mt Fairy Cave situated in the triangle between Bungendore, Tarago and Doughboy) (Dwyer 1968).

The Church Cave/Pylon 58 maternity site is located 42 kilometres to the south of Coppabella. Surveys in both September and January failed to reveal the presence of this species. Dwyer (1968) documented nearly half of all movements by adult females were less than 16km with 80% of all movements less than 31kms, well outside of the range of Coppabella. At least 84 kms would be required for an Eastern bentwing bat to travel to Coppabella and return, without any onsite foraging activity. Given the data of Dwyer (1968) this is very unlikely.

Eastern bentwing bats require forested areas to forage in, flying above the canopy to capture insects on the wing feeding mostly on moths (Churchill 1998). Few areas exist at Coppabella. The species also forage along flyways (along clear areas such as tracks or streams), and are known to utilise cleared paddocks during dispersal (Dwyer 1968). The lack of habitat at Coppabella and the distance from the Church Cave maternity colony make it unlikely that Eastern bentwing bat would occur there. Further, their absence may also be attributed to the information exchange that has been demonstrated for other species of cave-dwelling microbats. Wilkinson (1992) showed that for a North American cave dwelling species, *Nycticeius humeralis,* that also congregates into maternity caves, exchanged information at roosts (and by 'eavesdropping' on echolocation of other bats) and followed successful bats to rich sources of insects. An absence of an adequate food resource at Coppabella combined with the extended distance from Church Cave is likely to provide an explanation to their absence.

Considering the information relative to Coppabella, the lack of potential habitat on the site and the distance from the maternity site, the proposed Coppabella wind farm is unlikely to have an adverse effect on the life cycle of the species and that any viable local population, is unlikely to be placed at risk of extinction in-concurrence with the recommendations outlined in section 5.2 of this report.

Little pied bat

The Little pied bat roosts in caves, mines, buildings, and tree hollows in small groups, though one colony of 40 individuals has been recorded (Churchill, 1998). It prefers open, dry forests such as Mulga woodlands, chenopod shrublands or mallee with access to water sources (Churchill 1998; DECC 2009b). Little pied bats forage within the canopy (or sub-canopy), as with most of the Vespertilinidae in Australia. It often forages along watercourses (Menkhorst and Knight 2004) where it feeds on moths and possibly other flying invertebrates. It gives birth usually to two young in November.

Little pied bat is a sedentary species, little is known of home ranges for foraging but the species has been known to travel up to 34 km to gain access to water in more arid environments. While this species was not recorded during this survey, or the 2008 surveys, a single record exists near Bowning from the DECC NSW Wildlife Atlas database (DECC 2009a). Considering the known ecology and habitat requirements of the species, the locality provides little, if any, potential habitat for the species. While the exact origin of this record is unknown, it could be suggested that it is an incorrect identification or entry into the database. Regardless, if it is correct, the species could only be considered a very occasional vagrant to the district as they are known from arid inland areas.

The study site is unlikely to provide suitable habitat for the species, as it dominated by open pasture with occasional woodland. The dams on the site may provide marginal habitat although the species was not recorded on site.

Considering the information relative to the study site, the proposed Coppabella wind farm is unlikely to have an adverse effect on the life cycle of the species and that a viable local population, should one exist, is unlikely to be placed at risk of extinction if the recommendations within section 5.2 of this report.

Eastern falsistrelle

The Eastern falsistrelle utilises tree hollows for roosting, and has also been found under loose bark and in buildings (DECC 2009b). Colonies are very small, ranging from 3 to 36 individuals often segregated by sex (Churchill 1998).

The Eastern falsistrelle relies on forested areas and forages within or just above the forest canopy. It is a relatively fast, manouverable flyer that hunts prey by pursuit. The species prefers tall wet sclerophyll forest with trees approximately 20 metres in height, though has been found in drier forests foraging. It travels medium distances to forage (c. 12km) (Churchill 1998). It is a winter hibernating species and it has been suggested that some highland populations migrate to the coast for winter (Parnaby in Strahan 1983), though by what route is unknown. Eastern falsistrelle give birth to one young in late Spring/Summer (December usually) and young are weaned by late February (Churchill 1998).

This species are known to occur within sclerophyll forests of the Great Dividing Range. However, the general lack of this vegetation type at Coppabella which is dominated by open pasture or grassland is unlikely to provide habitat for the species. This is confirmed by the lack of detection by Echolocation call analysis.

Considering the information relative to the study site, the proposed Coppabella wind farm is unlikely to have an adverse effect on the life cycle of the Eastern falsistrelle and that a viable local population, should one exist, is unlikely to be placed at risk of extinction in-concurrence with the recommendations of section 5.2 of this report.

Yellow-bellied sheathtail bat

Listed as vulnerable under the NSW TSC Act, this cryptic species is known to use a variety of habitats (DECC 2009b). Yellow-bellied sheathtailed bats roost solitarily or in small groups in hollows, old buildings or occasionally abandoned nests of other species such as Sugar Gliders (Churchill 1998). The species is sedentary and possibly territorial, though has been found in Southern Australia only between January and June (Churchill 1998) which may suggest some movement for hibernation. In the Murrumbidgee catchment, the species is thought to be associated with dry sclerophyll forests, although there are no records in the catchment (DECC 2009b). A fast flying species with low manoeuvrability, it favours a range of insect species, mainly beetles (Churchill 1998; Richards 2001). One young are born December to mid-March, though peak is likely to be December (Churchill 1998). The relevant threats to this species are loss of hollow-bearing trees and clearing and fragmentation of forest and woodland habitat (DECC 2009b).

Little is known about the migratory and foraging movements of the species, however, it has not been recorded in either the September or January surveys. Richards (2001) claims that the species may favour habitat in large tracts of vegetation with a dense understory. This habitat is not present at Coppabella. The lack of potential habitat and the non-detection of this species make it unlikely that the species occurs on site.

Considering the information relative to the study site, the proposed Coppabella wind farm is unlikely to have an adverse effect on the life cycle of the Yellow-belled sheathtail bat and that a viable local population, should one exist, is unlikely to be placed at risk of extinction in-concurrence with the recommendations of section 5.2 of this report.

(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 microbats defined as an endangered population as listed under the NSW *Threatened Species Conservation Act 1995* occur in the vicinity of the proposal.

(c) in the case of an endangered ecological community or critically 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 microbats are listed under the NSW *Threatened Species Conservation Act 1995* as an endangered ecological community.

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

ii) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

iii) 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

iv) 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 total development envelope is 2,143ha. At this stage of the proposal, although the design has not yet been finalized, around 2 ha of woodland is likely to be removed.

The study site is already extremely modified by clearing and fragmentation effects from extensive agricultural activities. Minimal fragmentation by the loss of 2ha is likely to be less important to highly mobile species such as microbats.

While 10 species of microbat have been recorded across two seasons, low bat activity and the lack of threatened microbats suggests that the Coppabella site is of little importance. However, locally it does contribute to general microbat diversity likely to occur across this largely agricultural landscape.

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

There is no critical habitat as listed by the *TSC Act 1995*, found within the study site.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,

At the time of writing, no recovery plan was in place for any microbat species considered in this assessment.

(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.

Several key threatening processes are relevant to the proposed activity in relation to microbats. These include:

- *Clearing of native vegetation*
- *Loss of hollow-bearing trees*
- *Human caused climate change*

The 'clearing of native vegetation' is recognised as a major factor contributing to the loss of biodiversity. Around 2ha of woodland will be removed by this proposal. No threatened species of microbat have been recorded at Coppabella. An unknown number of hollow-bearing trees will be removed within the 2ha of woodland. These features are likely to provide habitat to non-threatened microbat species. The biodiversity assessment recommended the absolute minimum of hollow-bearing tree removal (**ngh**environmental 2009c).

Although the construction activities that would occur as part of site development may seem minor, they contribute to a global, cumulative impact on atmospheric greenhouse gas concentrations and potential for climate change impact. However, the operation of a wind farm is a renewable energy source that will contribute to the minimisation of green-house gas emissions and overall human caused climate change.

Conclusion

While the Coppabella study site does provide some habitat to common microbat species, the absence of any threatened microbats suggests it is of low importance to these species in the wider locality. Nonetheless, based on the above assessment and the adoption and implementation of the recommendations outlined in section 5.2 of this report, the proposed Coppabella Precinct is *'unlikely'* to have a *'significant effect'* on any threatened species under the NSW TSC Act.

Appendix C ASSESSMENT OF SIGNIFICANCE - MARILBA

In accordance with section 5A of the *Environmental Planning and Assessment Act 1979,* an Assessment of Significance has been prepared by using seven factors which must be considered when determining if the proposed activity '*is likely to have a significant effect on the threatened species, populations or ecological communities, or their habitats*' that are listed as under the Schedule 1 & 2 of the *Threatened Species Conservation Act 1995.* These seven factors must be taken into account by the consent or determining authority when considering a development proposal or development application. This enables a decision to be made as to whether there is likely to be a significant effect on the species and hence if a Species Impact Statement is required. The following Assessment of Significance relates only to microbats the subject of this report.

Only one species of threatened microbat has been recorded at Marilba, the Eastern bentwing bat (Table 11). However, based on the threatened microbats that occurred at Carrols Ridge, the Assessment of Significance will be undertaken on three additional species: Eastern falsistrelle, Yellow-bellied sheathtail bat and Little pied bat. The Large-footed myotis is not considered due to the absence of a large body of water.

(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

Eastern bentwing bat

The distribution of this species covers a wide area along the east coast of Australia, with populations dispersed within 300 kilometres of each of the known maternity roosts (DECC 2009b). Eastern bentwing bat is a long-lived species with low fecundity. Churchill (1998) records an adult banded female being recaptured 18 years post banding.

Four maternity caves are known in NSW- Willi Willi and Riverton in the north and Church/Pylon 58 and Drum in southern NSW (Dwyer 1968). Each maternity cave often has an associated "staging" cave close by (Wee Jasper's is Mt Fairy Cave situated in the triangle between Bungendore, Tarago and Doughboy) (Dwyer 1968). The Church Cave/Pylon 58 maternity site is located 34 kilometres to the south of Marilba.

Eastern bentwing bats require forested areas to forage in, flying above the canopy to capture insects on the wing feeding mostly on moths (Churchill 1998). Few areas exist at Coppabella. The species also forage along flyways (along clear areas such as tracks or streams), and are known to utilise cleared paddocks during dispersal (Dwyer 1968).

September 2008 surveys revealed 22 passes of this species. Such a low number of passes suggests that Marilba was not important habitat for Eastern bentwing bat at the time of the survey. Their absence in the January 2009 survey further confirms this theory in that any females would have moved onto the Church Cave maternity site by this time, and that the Marilba site did not form part of their foraging range. The distance of Marilba to the maternity site suggests that it is unlikely that the species would forage as far as Marilba in one evening. However, males would still have been detected if they were at Marilba. The data collected suggests they were absent, or if present, in very low numbers making detection difficult. This suggests that Marilba provides only a small portion of a wider foraging area that Eastern bentwing are likely to rely on, such as the habitat at Carrols Ridge.

The exact migration route taken by females to reach or disperse from Church Cave is unknown, though supposed by Dwyer (1968) to be strongly related to topography- both waterways and divides, with the species flying along ridges or waterways, rather than over them, using them as navigation aides. Home ranges are not confined to river basin areas (Wilson 2003). In light of the fact that the species would migrate to and from coastal areas, impacts from the proposed Marilba wind farm, located to the north of the maternity cave, are considered unlikely. Dwyer (1968) documented nearly half of all movements by adult females were less than 16km with 80% of all movements less than 31kms. At least 68 kms of flight would be required for an Eastern bentwing bat to travel to Marilba and return from Church Cave, without any onsite foraging activity.

The absence of Eastern bentwing bat at Marilba in the January surveys may also be attributed to the information exchange that has been demonstrated for other species of cave-dwelling microbats. Wilkinson (1992) showed that for a North American cave dwelling species, *Nycticeius humeralis,* that also congregates into maternity caves, exchanged information at roosts (and by 'eavesdropping' on echolocation of other bats) and followed successful bats to rich sources of insects. An absence of an adequate resource at Marilba combined with the extended distance from Church Cave is likely to provide an explanation to their absence during peak breeding.

Considering the information relative to Marilba, and the distance from the maternity site, the proposed Marilba wind farm is unlikely to have an adverse effect on the life cycle of the species and that any viable local population, is unlikely to be placed at risk of extinction in-concurrence with the recommendations outlined in section 5.3 of this report.

Little pied bat

The Little pied bat roosts in caves, mines, buildings, and tree hollows in small groups, though one colony of 40 individuals has been recorded (Churchill, 1998). It prefers open, dry forests such as Mulga woodlands, chenopod shrublands or mallee with access to water sources (Churchill 1998; DECC 2009b). Little pied bats forage within the canopy (or sub-canopy), as with most of the Vespertilinidae in Australia. It often forages along watercourses (Menkhorst and Knight 2004) where it feeds on moths and possibly other flying invertebrates. It gives birth usually to two young in November.

Little pied bat is a sedentary species, little is known of home ranges for foraging but the species has been known to travel up to 34 km to gain access to water in more arid environments. While this species was not recorded during this survey, or the 2008 surveys, a single record exists near Bowning from the DECC NSW Wildlife Atlas database (DECC 2009a). Considering the known ecology and habitat requirements of the species, the locality provides little, if any, potential habitat for the species. While the exact origin of this record is unknown, it could be suggested that it is an incorrect identification or entry into the database. Regardless, if it is correct, the species could only be considered a very occasional vagrant to the district as they are known from arid inland areas.

The study site is unlikely to provide suitable habitat for the species, as it dominated by open pasture with occasional woodland. The dams on the site may provide marginal habitat although the species was not recorded on site.

Considering the information relative to the study site, the proposed Marilba wind farm is unlikely to have an adverse effect on the life cycle of the species and that a viable local population, should one exist, is unlikely to be placed at risk of extinction if the recommendations within section 5.3 of this report.

Eastern falsistrelle

The Eastern falsistrelle utilises tree hollows for roosting, and has also been found under loose bark and in buildings (DECC 2009b). Colonies are very small, ranging from 3 to 36 individuals often segregated by sex (Churchill 1998).

The Eastern falsistrelle relies on forested areas and forages within or just above the forest canopy. It is a relatively fast, manouverable flyer that hunts prey by pursuit. The species prefers tall wet sclerophyll forest with trees approximately 20 metres in height, though has been found in drier forests foraging. It travels medium distances to forage (c. 12km) (Churchill 1998). It is a winter hibernating species and it has been suggested that some highland populations migrate to the coast for winter (Parnaby in Strahan 1983), though by what route is unknown. Eastern falsistrelle give birth to one young in late Spring/Summer (December usually) and young are weaned by late February (Churchill 1998).

This species are known to occur within sclerophyll forests of the Great Dividing Range. However, the general lack of this vegetation type and their quality at Marilba which is dominated by open pasture or grassland is unlikely to provide habitat for the species. This is confirmed by the lack of detection by Echolocation call analysis during two seasonal surveys.

Considering the information relative to the study site, the proposed Marilba wind farm is unlikely to have an adverse effect on the life cycle of the Eastern falsistrelle and that a viable local population, should one exist, is unlikely to be placed at risk of extinction in-concurrence with the recommendations of section 5.3 of this report.

Yellow-bellied sheathtail bat

Listed as vulnerable under the NSW TSC Act, this cryptic species is known to use a variety of habitats (DECC 2009b). Yellow-bellied sheathtailed bats roost solitarily or in small groups in hollows, old buildings or occasionally abandoned nests of other species such as Sugar Gliders (Churchill 1998). The species is sedentary and possibly territorial, though has been found in Southern Australia only between January and June (Churchill 1998) which may suggest some movement for hibernation. In the Murrumbidgee catchment, the species is thought to be associated with dry sclerophyll forests, although there are no records in the catchment (DECC 2009b). A fast flying species with low manoeuvrability, it favours a range of insect species, mainly beetles (Churchill 1998; Richards 2001). One young are born December to mid-March, though peak is likely to be December (Churchill 1998). The relevant threats to this species are loss of hollow-bearing trees and clearing and fragmentation of forest and woodland habitat (DECC 2009b).

Little is known about the migratory and foraging movements of the species. However, it has not been recorded in either the September or January surveys. Richards (2001) claims that the species may favour habitat in large tracts of vegetation with a dense understory. This habitat is not present at Marilba and combined with the non-detection of this species, it is unlikely that the species occurs on site.

Considering the information relative to the study site, the proposed Marilba wind farm is unlikely to have an adverse effect on the life cycle of the Yellow-belled sheathtail bat and that a viable local population, should one exist, is unlikely to be placed at risk of extinction in-concurrence with the recommendations of section 5.3 of this report.

(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 microbats defined as an endangered population as listed under the NSW *Threatened Species Conservation Act 1995* occur in the vicinity of the proposal.

(c) in the case of an endangered ecological community or critically 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 microbats are listed under the NSW *Threatened Species Conservation Act 1995* as an endangered ecological community.

(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,

The total development envelope is 2,918ha. At this stage of the proposal, although the design has not yet been finalized, around 6.74 ha of woodland is likely to be removed. Hollow-bearing trees would be removed, however, the exact number is unclear. The biodiversity assessment recommends an absolute minimum.

The study site is already extremely modified by clearing and fragmentation effects from extensive agricultural activities. Minimal fragmentation by the loss of 6.74ha is likely to be less important to highly mobile species such as microbats.

While 12 species of microbat have been recorded across two seasons, low bat activity and the lack of threatened microbats suggests that the Marilba site is of minor importance to regional populations of threatened species.

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

There is no critical habitat as listed by the *TSC Act 1995*, found within the study site.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,

At the time of writing, no recovery plan was in place for any microbat species considered in this assessment.

(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.

Several key threatening processes are relevant to the proposed activity in relation to microbats. These include:

- *Clearing of native vegetation*
- *Loss of hollow-bearing trees*
- *Human caused climate change*

The 'clearing of native vegetation' is recognised as a major factor contributing to the loss of biodiversity. Around 6.74ha of woodland will be removed by this proposal.

An unknown number of hollow-bearing trees will be removed within this area of woodland. The biodiversity assessment recommended the absolute minimum of hollow-bearing tree removal (**ngh**environmental 2009c).

Although the construction activities that would occur as part of site development may seem minor, they contribute to a global, cumulative impact on atmospheric greenhouse gas concentrations and potential for climate change impact. However, the operation of a wind farm is a renewable energy source that will contribute to the minimisation of green-house gas emissions and overall human caused climate change.

Conclusion

While the Marilba study site does provide some habitat to common microbat species, one threatened microbat, the Eastern bentwing bat was detected in the September surveys. The absence of this species during the known occupation of the Church Cave maternity site which is some 34kms south, suggests that Marilba is of lesser importance for foraging during the known breeding season than other areas, such as Carrols Ridge.

Nonetheless, based on the above assessment and the adoption and implementation of the recommendations outlined in section 5.3 of this report, the proposed Marilba Precinct is *'unlikely'* to have a *'significant effect'* on any threatened species under the NSW TSC Act.

Appendix D QUALIFICATIONS AND EXPERIENCE OF PERSONNEL

NAME	ROLE	SPECIALIST SKILLS AND ABILITIES
Nicholas Graham-Higgs	**Director and senior review**	Nicholas has worked as an environmental planning and resource consultant since 1992, specialising in natural resource management. A wide range of assignments covering diverse natural and modified environments, have enabled Nick to develop a broad knowledge base in the area of natural resource planning and management. Nick is accredited as a Certified Environmental Practitioner by the Environment Institute of Australia and New Zealand.
Brooke Marshall	**Project Manager** **Peer review**	Brooke graduated as a first class honours Natural Resources graduate of the University of New England (UNE). She specialised in wildlife management, ecosystem rehabilitation and natural resource management in developing countries and was awarded a University Medal in recognition of high academic achievement. Brooke completed her honours project in association with CRC Pest Animal Control at CSIRO Sustainable Ecosystems Canberra, investigating conditioned aversion (CA) as a means to reduce the impact of fox predation upon colonies of threatened ground-nesting birds. This project used novel statistical analyses to investigate the responses of captive foxes to treated prey items. The paper summarising the findings of this study is currently being peer reviewed and will hopefully be published in the near future. Since joining **ngh**environmental, Brooke has prepared impact assessment reports relating to a variety of infrastructure development (including roads, wind farms, telecommunications, water supply management and residential development) as well as river modification and prescribed burning works. These reports have included threatened floral and faunal species assessments, research, fieldwork and GIS components. Her major projects have included impact assessments for numerous wind farm developments, a Species Impact Statement involving 33 subject species, a natural values desktop study to be used for strategic planning in the Snowy River Shire and Biocertification investigations in the Bega Valley Shire.

NAME	ROLE	SPECIALIST SKILLS AND ABILITIES
Steven Sass B. App. Sci. (Env.Sci) (Hons) CSU	**Senior Ecologist** **Senior Author/ Anabat Analysis**	Steven joined **ngh**environmental in August 2006 with expertise in environmental consulting and biodiversity assessment. In the four years prior, he played a key role at Charles Sturt University, undertaking flora and fauna impact assessment for the Johnstone Centre (Environmental Consulting) and as a senior research officer within the biodiversity research and education team with much of his work in western NSW. Steven is an experienced ecologist having undertaken more than 500 aquatic and terrestrial threatened flora and fauna surveys and habitat assessments. As a Certified Environmental Practitioner by the Environment Institute of Australia and New Zealand and as Senior Ecologist, Steven provides technical advice and peer-review to the **ngh**environmental ecology team.
Bianca Heinze B.App.Sci (ERM/Coastal Mngt) SCU	**Ecologist** **Field surveys/Data control**	Bianca completed her Bachelor of Applied Science (Environmental Resource/Coastal Management) at Southern Cross University, Lismore in 2006. Since joining **ngh**environmental Bianca has been mentored in the preparation of Assessments of Significance for threatened biota (7-part tests), Biodiversity Assessments and Review of Environmental Factors for clients including Epuron and Country Energy. Bianca also has field experience in biodiversity assessments including terrestrial fauna surveys and habitat evaluation across a variety of ecosystems.
Ally Madden B.Sc (App.Geo) (Hons) UNSW	**Spatial Analyst** **GIS Mapping**	Ally graduated as a first class Honours student at the University of NSW in 2006. Since the completion of her studies she has specialised in Geographic Information Systems (GIS) working with ArcMap version 9.2. Prior to joining **ngh**environmental, Ally worked for the National Parks and Wildlife Service managing the design and development of interactive park maps for the NPWS website. Ally was also involved in mapping fire management strategies, Aboriginal Cultural Heritage sites and worked on the mapping and data analysis for the SE Koala Discovery Surveys. Ally is now involved in managing GIS data and the preparation and presentation of maps for biodiversity, heritage and environmental assessment projects, including wind farm projects and other major infrastructure projects across NSW.