APPENDIX 11

Sapphire Wind Farm Part 3A Ecological Assessment

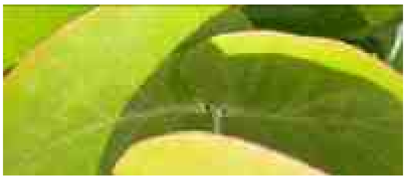
Eco Logical Australia Pty Ltd

SAPPHIRE WIND FARM
Part 3A Ecological Assessment

Prepared for
Wind Prospect CWP

30 September 2011





DOCUMENT TRACKING

ITEM	DETAIL
Project Name	Sapphire Wind Farm Part 3A Ecological Assessment
Project Number	10SYDECO-0056
File location	G:\Synergy\Projects\10SYDECO\10SYDECO-0056 Sapphire Wind Farm Part 3A\Report\Final Reports
Prepared by	Tammy Haslehurst, Anna Foley, Danielle Bennett, Emma Garraway, Karen Spicer, Darren James, Melanie Pursey
Approved by	Rob Humphries, Bruce Mullins, Mark Adams
Status	FINAL
Version Number	2
Last saved on	30 September 2011
Cover photos	Clockwise from top left: *Chrysocephalum apiculatum*; view south-west from Mt Buckley Range in Swan Vale cluster; *Wahlenbergia* spp.; stag within Wellingrove cluster; cattle within Sapphire cluster, panorama of study area within Sapphire cluster; *Amphibolurus muricatus* (Jacky Lizard); juvenile foliage of *Eucalyptus banksii* (Tenterfield Woollybutt). Photography by A. Foley.

This report should be cited as 'Eco Logical Australia 2011. *Sapphire Wind Farm Part 3A Ecological Assessment*. Prepared for Wind Prospect CWP'.

ACKNOWLEDGEMENTS

This document has been prepared by Eco Logical Australia Pty Ltd with support from Sapphire Wind Prospect CWP and Anna Lloyd.

Contents

List of Figures

List of Tables

Abbreviations

ABBREVIATION	DESCRIPTION
APZ	Asset Protection Zone
BAM	Biobanking Assessment Methodology
BAMCCOM	Biobanking Assessment Methodology and Credit Calculator Operational Manual
BCPTGNLI	Black Cypress Pine -Tumbledown Gum – Narrow-leaved Ironbark open forest
BEP	Bushfire Emergency Plan
BGW	Box-Gum Woodland
BOM	Bureau of Meteorology
BRGCAP	Border Rivers - Gwydir Catchment Action Plan
BRGRARS	Blakely's Red Gum – Rough-barked Apple – Red Stringybark grassy open forest
BRGYB	Blakely's Red Gum – Yellow Box grassy open forest or woodland
CAP	Catchment Action Plan
CEEC	Critically Endangered Ecological Community
CEMP	Construction Environmental Management Plan
CMA	Catchment Management Authority
CMP	Conservation Management Plan
DBH	Diameter at Base Height
DEC	Department of Environment and Conservation (now DECCW)
DECC	Department of Environment and Climate Change (now DECCW)
DECCW	Department of Environment, Climate Change and Water
DEWHA	Commonwealth Department of Department of the Environment, Water, Heritage and the Arts (now DSEWPAC)
DSEWPAC	Commonwealth Department of Sustainability, Environment, Water, Population and Communities.
DGRs	Director General's Requirements
DoP	NSW Department of Planning
DPI	NSW Department of Primary Industries
DNG	Derived Native Grassland
EARs	Environmental Assessment Requirements
EEC	Endangered Ecological Community
ELA	Eco Logical Australia Pty Ltd
EMP	Environmental Management Plan

ABBREVIATION	DESCRIPTION
EP&A Act	NSW *Environmental Planning and Assessment Act 1979*
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
FM Act	*Fisheries Management Act 1994*
ha	Hectares
HBT	Hollow-bearing trees
km	Kilometres
km /hr	Kilometres per hour
kph	Kilometres per hour
kV	Kilovolt
LEP	Local Environment Plan
LGA	Local Government Area
Locality / local area	Within 10 km radius of the site
LPMA	Land and Property Management Authority (formerly Department of Lands)
m	Metres
MGRAYB	Manna Gum – Rough-barked Apple – Yellow Box grassy woodland/open forest
m^3	Metres cubed
ML	Mega litres
mm	millimetres
MRET	Mandatory Renewable Energy Target
MW	Mega Watt
NES	National Environmental Significance
NPWS	National Parks and Wildlife Service (now part of DECCW)
NW Act	*Noxious Weeds Act 1993*
OEH	NSW Office of Environment and Heritage (formerly DECCW)
OEMP	Operations Environmental Management Plan
PMST	Protected Matters Search Tool
RBVT	Revised Biometric Vegetation Type
RGMGSGGW	Ribbon Gum – Mountain Gum - Snow Gum Grassy Woodland of the New England Tableland Bioregion
RFS	Rural Fire Service
RoTAP	Rare or Threatened Australian Plants
rpm	Revolutions per minute
SEPP	State Environmental Planning Policy

ABBREVIATION	DESCRIPTION
TSC Act	NSW *Threatened Species Conservation Act 1995*
TWSS	Tenterfield Woollybutt – Silvertop Stringybark open forest
WB	White Box grassy woodland
Wind Prospect	Wind Prospect CWP Pty Ltd
WMP	Weed Management Plan
WONS	Weeds of National Significance
WPCWP	Wind Prospect CWP Pty Ltd
°C	Degrees Celsius

Executive Summary

Introduction

Eco Logical Australia Pty Ltd (ELA) was commissioned by Wind Prospect CWP Pty Ltd to undertake an ecological assessment of a wind energy facility known as Sapphire Wind Farm at Kings Plain in the northern New England Tablelands between Inverell and Glen Innes. The proposal is to be assessed under Part 3A of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act).

The proposed project is located 28 km east of Inverell and 18 km west of Glen Innes in the north east of NSW within administrative boundary of the Border Rivers – Gwydir Catchment Management Authority. The project site is located along the spines of the ridges surrounding the Kings Plains district. The moderate to high elevation (750 to 1,100 metres above sea level) gives the locality an unusually cool climate compared with other areas on the same latitude in Australia. Features of the project site include cattle and sheep grazing, a handful of unsealed roads, and a 330 kV Transgrid transmission line connecting Queensland and NSW.

Sapphire Wind Farm is proposed in the context of growing global recognition of the need to mitigate the environmental effects associated with fossil fuel energy generation. The project will contribute to the Federal Government's proposed Mandatory Renewable Energy Target (MRET) of 20% by 2020. Sapphire Wind Farm will potentially supply over 138,000 households with energy and save approximately 863,000 tonnes of CO_2-e per annum.

The Sapphire Wind Farm proposal comprises up to 159, 1.5 MW wind turbines or 125 3.4 MW wind turbines or equivalent to be constructed over 22 different properties. The proposed project will have an installed capacity of up to 238.5 - 425 MW, depending on the model of the turbine selected. The choice between these two design layouts largely depends on the wind turbines available through the successful tenderer, post-consent. The wind farm will also comprise one or more collector substations, and a single switching substation connecting to underground electrical interconnection lines and control cables within the turbine clusters; overhead powerlines; access roads; crane hardstand areas at turbine locations; temporary construction facilities and storage areas; mobile concrete batching plants and rock crushing facilities, as well as signage across the project site.

The wind farm layout has been prepared to maximise utilisation of the available wind resource whilst gaining regulatory and broad community acceptance of the development. Some of the impacts from the development footprint will be for the duration of the wind farm operation and some are temporary impacts during the construction phase to allow for a temporary increase in traffic volume and over-sized traffic.

This ecological assessment addresses the requirements of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act) and related NSW environmental legislation and policy. An assessment was made of the potential impacts of the proposal in accordance with the Part 3A requirements and the Director-General’s Requirements (DGRs) pursuant to Section 75U(f) of the EP&A Act.

Furthermore, a Biobank assessment was undertaken for the proposal to provide guidance on the size / area of the offset requirements in accordance with the ‘improve and maintain’ requirement included in the DGRs. Surveys and assessments were made regarding threatened species, populations and ecological communities (or their potential habitat) listed under the *Threatened Species Conservation Act 1995* (TSC Act). In accordance with section 75U of the EP&A Act, applications for separate permits under section 201, 205 or 219 of the *Fisheries Management Act 1994* are not required as these matters are addressed and approved as part of the EP&A Part 3A process. The NSW *Catchment Management Authorities Act 2003*, *Noxious Weeds Act 1993*, *State Environmental Planning Policy 44* (Koala Habitat) were also considered. Both Glen Innes Severn and Inverell Shire Council provided input into the requirements of the environmental assessment.

A literature review of all readily available documents and databases pertaining to the ecology of the study area and surrounding locality were undertaken to provide important background information. Existing vegetation mapping and other available GIS data were also utilised. An assessment of likelihood of occurrence was made for threatened and migratory species identified from the database searches or considered to have the potential to occur within the locality.

Field surveys were undertaken by ecologists from ELA from October 2008 to January 2011. Throughout the 2008/2009 surveys, the conditions during the survey period were generally mild, with very little rainfall. Heavy rainfall, and in some cases minor flooding, and a flush of vegetation growth occurred during the 2010/2011 survey period. Surveys included vegetation and biometric vegetation type and condition mapping, and mapping of threatened vegetation communities. Many methods were used for targeted searches of potential habitat for threatened flora and fauna, including Anabat analysis, seasonal and systematic searches (random meander transects), rock rolling, diurnal bird surveys, spotlighting, call playback, infrared cameras and incidental observations. The survey effort and study design optimised collection of field data, but a number of limitations in this assessment are acknowledged (including the transient and cryptic nature of some species).

Results

Six Revised Biometric Vegetation Types (RBVTs) were mapped throughout the study area and the broader locality; they included:

- BR110: Black Cypress Pine – Tumbledown Gum – Narrow-leaved Ironbark open forest of northern parts of the Nandewar Bioregion (BCPTGNLI);
- BR114: Blakely's Red Gum – Rough-barked Apple – Red Stringybark grassy open forest of the Western New England Tablelands (BRGRARS);
- BR116: Blakely's Red Gum – Yellow Box grassy open forest or woodland of the New England Tablelands (BRGYB);
- BR153: Manna Gum – Rough-barked Apple – Yellow Box grassy woodland/open forest of the New England Tablelands and North Coast (MGRAYB); and,
- BR227: Tenterfield Woollybutt – Silvertop Stringybark open forest of the New England Tablelands (TWSS)
- BR240: White Box grassy woodland of the Nandewar and Brigalow Belt South Bioregions (WB).

The MGRAYB community corresponds to the Ribbon Gum, Mountain Gum, Snow Gum Grassy Forest/Woodland of the New England Tableland Bioregion EEC listed under the TSC Act. The BRGYB and WB communities correspond to the EEC *White Box Yellow Box Blakely's Red Gum Woodland* listed under the TSC Act and the CEEC *White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland* - both more commonly known as Box Gum Woodland (BGW).

Condition classes were assigned to all areas based on the condition criteria of "low" and "moderate to good" as outlined in the Biobanking Assessment Methodology.

A total of 391 species of vascular plants were recorded across the study area. Of these 278 (71%) were native and 116 (29%) were exotic species.

Four threatened flora species were recorded across the study area:

- *Bothriochloa biloba* (Lobed Bluegrass) (EPBC Act only);
- *Dichanthium setosum* (Bluegrass);
- *Eucalyptus mckieana* (McKie's Stringybark)*;* and,
- *Thesium australe* (Austral Toadflax).

Other threatened flora (not recorded within the study area) but for which potential habitat was observed included: *Acacia pubifolia* (Velvet Wattle); *Astrotricha roddii* (Rod's Star Hair); *Digitaria porrecta* (Finger Panic Grass); *Diuris pedunculata* (Small Snake Orchid); *Eucalyptus nicholii* (Narrow-leaved Black Peppermint); and, *Picris evae* (Hawkweed). These species were not recorded during the surveys.

The study area supports a diversity of fauna habitat types comprising woodland, grassland including tussock grasses, farm dams, creeks, rocky outcrops, fallen timber, stags, leaf litter, hollow-bearing trees, defoliating bark, winter-flowering eucalypts and koala feed trees. A total of 135 fauna species were recorded throughout the study area during the field surveys (13 introduced). These were spilt over the following fauna groups: seven reptile species; four frog species; 83 bird species of which 2 were introduced; 19 mammals (non-bat) of which 11 were introduced; and, 22 microbat species.

Seven threatened bird species have been recorded across the study area; including:

- *Climacteris picumnus victoriae* (Brown Treecreeper);
- *Stagonopleura guttata* ((Diamond Firetail);
- *Melanodryas cucullata cucullata* (Hooded Robin);
- *Glossopsitta pusilla* (Little Lorikeet);
- *Petroica boodang* (Scarlet Robin);
- *Pyrrholaemus saggitatus* (Speckled Warbler*)*; and,
- *Neophema pulchella* (Turquoise Parrot).

Other threatened bird species for which the study area may provide potential habitat include: *Anthochaera phrygia* (Regent Honeyeater); *Circus assimilis* (Spotted Harrier); *Daphoenositta chrysoptera* (Varied Sittella); *Hieraaetus morphnoides* (Little Eagle); *Lophoictinia isura* (Square-tailed Kite); and, *Lathamus discolor* (Swift Parrot). These species were not recorded during the surveys.

Potential habitat also exists for *Phascolarctos cinereus* (Koala), *Dasyurus maculatus* (Spotted-tailed Quoll), and *Petaurus norfolcensis* (Squirrel Glider); however none of these species were recorded during the surveys.

A number of threatened bat species were recorded across the study area; including:

- *Falsistrellus tasmaniensis* (Eastern False Pipistrelle);
- *Miniopterus schreibersii* (Eastern Bentwing-bat);
- *Mormopterus norfolkensis* (Eastern Freetail-bat);
- *Saccolaimus flaviventris* (Yellow-bellied Sheathtail-bat);
- *Scoteanax rueppellii* (Greater Broad-nosed Bat); and
- *Vespadelus troughtoni* (Eastern Cave Bat).

No threatened amphibians were recorded within the study area although the Booroolong Frog (*Litoria booroolongensis*) was listed as having the potential to occur within the study areas (DSEWPAC 2011a, Biobanking). Based on the assessment of the habitat within the study area and historical data, it was considered unlikely that this species would occur within the study area.

Potential habitat is only present for one threatened reptile, *Underwoodisaurus sphyrurus* (Border Thick-tailed Gecko). No records were found during the surveys; however areas of potential and marginal potential habitat have been mapped given the diversity of habitat over which this species can occur.

Matters of National Environmental Significance (NES)

Threatened Species

Four threatened flora species listed under the EPBC Act were recorded across the study area:

- *Bothriochloa biloba* (Lobed Bluegrass);
- *Dichanthium setosum* (Bluegrass);
- *Eucalyptus mckieana* (McKie's Stringybark); and
- *Thesium australe* (Austral Toadflax).

Flora species listed under the EPBC Act for which potential habitat is present within the study area are listed below. However, none of these species were recorded within the study area during the surveys.

- *Astrotricha roddii* (Rod's Star Hair);
- *Digitaria porrecta* (Finger Panic Grass);
- *Diuris pedunculata* (Small Snake Orchid);
- *Eucalyptus nicholii* (Narrow-leaved Black Peppermint); and
- *Picris evae* (Hawkweed).

No threatened bird species listed under the EPBC Act have been recorded across the study area athough potential habitat is present for the following:

- *Anthochaera phrygia* (Regent Honeyeater); and
- *Lathamus discolor* (Swift Parrot).

Anabat was used to survey for microciropteran bats in the study. However, the echolocation calls of the genus *Nyctophilus* are difficult to distinguish between species, for the purposes of the impact assessment, the presence of EPBC Act listed *Nyctophilus corbeni* (South-eastern Long-eared Bat) has been assumed.

Although not recorded on the site, potential habitat exists for *Dasyurus maculatus* (Spotted-tailed Quoll) which is listed under the EPBC Act.

No threatened amphibians were recorded within the study area although Booroolong Frog (*Litoria booroolongensis*) was listed as potentially occurring within the study areas (DSEWPAC 2011a, Biobanking). Based on the assessment of the habitat within the study area and historical data, it is unlikely that this species would occur within the study area.

Potential habitat is only present for one threatened reptile, *Underwoodisaurus sphyrurus* (Border Thick-tailed Gecko). No records were found during the surveys; however, areas of potential and marginal potential habitat have been mapped given the diversity of habitat over which this species can occur.

Migratory Species

A total of twelve listed migratory bird species were identified from the EPBC Act Protected Matters Search Tool (PMST) (DSEWPAC 2011a). Those species for which there is potential habitat within the study area are listed below. None were recorded within the study area during the surveys.

- *Hirundapus caudacutus* (White-throated Needletail)
- *Merops ornatus* (Rainbow Bee-eater)
- *Anthochaera phrygia* (Regent Honeyeater)
- *Ardea alba* (Great Egret)
- *Ardea ibis* (Cattle Egret)
- *Apus pacificus* (Fork-tailed Swift)
- *Lathamus discolor* (Swift Parrot)

Mitigation Measures

Given the above findings, a number of mitigation measures were formulated to further minimise the impacts from the proposal. These will or have been implemented to minimise impacts on the ecological integrity of the site whilst maintaining the engineering and economic feasibility of the wind farm. For example, access roads and power line routes have been re-aligned to avoid threatened plants recorded within the study area.

In order to protect the ecological values of the site a number of management and mitigation measures have been recommended. These are outlined within the assessment and full details will be provided in detailed Construction Environmental Management Plan, Operation Environmental Management Plan and the Weed Management Plan proposed to be prepared post-approval.

The residual direct and indirect impacts were outlined in accordance with each phase of the project (i.e. construction, operation and decommissioning) and cumulative impacts and key threatening processes considered.

Direct Impacts

During the construction phase, although the proposal involves the removal of vegetation across a large area, impacts are primarily restricted to a narrow, linear pathway with clearance occurring in narrow bands throughout an open, woodland and grassland landscape. The worst-case scenario is discussed, which includes the 80 m turbine layout (159), and a 12 m clearance area for roads (which will be revegetated back to 6 m with passing bays following construction). The proposal comprises both permanent and temporary vegetation removal with areas such as underground reticulation requiring trenching for installation which can then be filled and revegetated to prevent weed invasion and erosion once installed.

As a worst-case scenario, the proposal involves the permanent removal of 140.72 ha of habitat and 148.05 ha of temporary loss of habitat. This includes the clearing of trees from vegetation in various conditions for the provision of overhead electrical infrastructure.

However, in terms of native vegetation, this clearance represents the permanent removal of 108.55 ha of RBVTs comprising 43.19 ha of remnant woodland, 48.28 ha of derived grassland/native pasture, and

17.08 ha of low condition vegetation (predominantly exotic with some native species present). It will also require 148.05 ha of temporary clearance of vegetation and the permanent removal of trees from 32.17 ha of the MGRAYB community.

The direct impact to EEC/CEECs will be the the permanent removal of up to 116.22 ha of *Ribbon Gum - Mountain Gum - Snow Gum Grassy Forest/Woodland of the New England Tableland Bioregion EEC,* comprising 68.64 ha of remnant woodland, 33.28 ha of highly modified derived native grassland/native pasture and 14.3 ha in low condition, however this represents only a small proportion of the community mapped within the study area (7.8 %) and project site (1.5 %). The impact on the BGW EEC/CEEC will be the permanent removal of up to 23.07 ha of BGW, comprising 6.15 ha of remnant woodland, and 16.92 ha of derived grassland. An additional 15.44 ha of temporary clearance is proposed for roads, reticulation and construction facilities. This temporary removal comprises 4.67 ha of remnant woodland and 17.75 ha of derived native grassland/native pasture. This represents 12.5 % of the BGW present within the study area, but only 2.4 % of the BGW present within the project site.

The direct impact on fauna habitat, as a worst-case scenario will be the permanent removal of up to approximately 148.34 ha of potential habitat for a variety of species, including 75.36 ha of woodland and 48.28 ha of native pasture, with the remainder comprising highly modified vegetation in low condition and cleared areas of exotic vegetation. Additionally, 107.57 ha of temporary clearance is proposed, including 37.11 ha of woodland and 67.81 ha of native pasture, again with the remainder comprising highly modified or exotic vegetation. This includes the clearing of trees from vegetation in various conditions for the provision of overhead electrical infrastructure. Direct impacts of construction on known and potential habitat for threatened fauna varies significantly depending on the habitat requirements of each species. These have been addressed in the Part 3A species assessments, along with the direct impacts on known and potential habitat for threatened fauna.

Turbine operation is the focus of direct impacts to ecological values during the operation phase of the project. There are several aspects to consider when looking at the impact of turbines on bats and birds, including lighting, tower height and barotrauma. Impacts of the turbines in terms of collision with bats and birds was assessed using risk matrices, taking into account the behaviour, flight patterns and proximity of the turbines to roosting habitat. Of the species recorded across the study area, the White-striped Freetail Bat, the Yellow-bellied Sheathtail-bat and the Southern Freetail Bat were the species considered to have a high potential for collisions with turbines. There is moderate potential for collisions by other microbats, birds of prey, raptors and passerines across the study area.

Indirect Impacts

Potential indirect impacts of the construction phase of the proposal include: runoff, sedimentation and erosion; hydrological changes; edge effects or increased weed invasion; wildfire; and, noise.

Potential indirect impacts of the operation phase of the proposal include: displacement of birds, predation by feral animals; and, wildfire and noise.

Indirect impacts anticipated from the decommissioning works at the end of the life of the wind farm are likely to include: disturbance of vegetation adjacent to turbines from machinery during deconstruction, cutting back of tower bases, and storing of turbine components prior to removal from site; soils disturbance resulting in sedimentation and erosion; spread of weeds through site disturbance; accidental fire during cutting back; and, disturbance of fauna habitat from machinery and storing of turbine components prior to removal from site.

Based on the discussion of direct and indirect impacts of the proposal, a number of Key Threatening Processes were identified from lists published under the TSC and EPBC Acts.

Offsets

For any impacts that could not be avoided or mitigated, a number of offset options have been considered. The DGRs stipulate that and an offset strategy which aims to meet “improve and maintain” principles is provided. The proposed offset strategy has been designed to meet the principles of both the NSW and Commonwealth policies.

Based on discussions with landowners surrounding the project site, a number of land holders have expressed interest in placing part of their properties under conservation covenants (including Biobank Agreements) and/or currently have their properties listed for sale. Preliminary assessments of the conservation values of these properties have been undertaken to determine whether they have the right vegetation types and area to meet the offset requirements for the project.

Three properties have been identified where the vegetation types and condition have been verified as being in equivalent or better condition than the impact sites and a combination of Property 1 with either of the two other properties will provide an offset area between 506 ha (Properties 1 and 2) and 568 ha (Properties 1 and 3) and meet the “like for like or better” offsetting principles with a minimum 2:1 offset ratio i.e. consistent with a Tier 3 negotiated offset outcome.

Whilst there will be some variation in the offset ratios between each of the vegetation types and condition states, the overall offset ratio for 288.8 ha of impact will be between 1.75 and 1.97:1, however this includes 60.3 ha of vegetation mapped as biometric low condition (Paddock trees with an exotic ground cover). The biodiversity values in areas mapped as low condition (i.e. scattered trees) can be easily avoided. If low condition is removed the offset ratios increase to between 2.2 and 2.5:1.

Subject to the project being approved, Wind Prospect CWP will enter into negotiations with the relevant landowners to either register the identified parts of the property as a conservation area with an appropriate covenant to provide in perpetuity (DSEWPAC have requested an in perpetuity offset) based protection on title or purchase those properties listed for sale. Any properties purchased will also be registered for conservation or discussions with the Office of Environment and Heritage (OEH) entered into regarding the possible dedication of the land as a conservation reserve under the *National Parks and Wildlife Act 1974* (NPW Act). The conservation values of the properties will be fully documented and a conservation management plan prepared and a budget for it’s in perpetuity implementation provided.

1 Introduction

Wind Prospect CWP Pty Ltd is proposing to develop and build a wind energy facility known as Sapphire Wind Farm at Kings Plain in the northern New England Tablelands. The proposed project is located 28 km east of Inverell and 18 km west of Glen Innes in the north east of NSW (Figure 2).

The proposed development comprises the wind turbines and ancillary structures and equipment which will be positioned in accordance with site constraints. The ancillary structures and equipment include underground electrical cabling (reticulation), access tracks, wind measuring masts, collector substations and switching substations with facilities building and temporary/compound facilities during the construction phase (Figure 3).

Sapphire Wind Farm is proposed in the context of growing global recognition of the need to mitigate the environmental effects associated with fossil fuel energy generation. The project will provide an important contribution to the Federal Government's proposed Mandatory Renewable Energy Target (MRET) of 20 % by 2020. Sapphire Wind Farm will potentially supply over 138,000 households with energy and save approximately 863,000 tonnes of CO_2-e per annum.

The wind farm will have a capacity of 238.5 - 425 megawatts (MW), depending on the use of one of two current options, being: up to 159, 1.5 MW turbines or 125, 3.4 MW turbines.

Eco Logical Australia Pty Ltd (ELA) was commissioned by Wind Prospect CWP Pty Ltd to undertake an ecological assessment of the proposed turbine wind farm. The proposal is to be assessed under Part 3A of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act).

REPORT STRUCTURE

The report is structured the following chapters:

1. **Introduction** – provides context for the landscape in which the study area is located.
2. **Description of Project** – Outlines the proposal, layout options and all project components and their likely impact areas.
3. **Planning and Assessment Framework** – Outlines the legislative framework under which the proposal is to be assessed include Commonwealth and NSW legislation and any requirements under State Environmental Planning Policies (SEPPs).
4. **Ecological Site Assessment** – outlines the survey methodology and findings of the surveys.
5. **Impact Evaluation** – Outlines the measures undertaken to avoid and mitigate impacts from the proposal and assesses the likely direct and indirect impacts from the proposal.
6. **Offset Requirements and Strategy** – presents the proposed offset options and strategy for those residual impacts that cannot be avoided or mitigated.
7. **Conclusion** – Summarises the key findings of this assessment under state and Commonwealth legislation.

KEY TERMS

For the purposes of this report the following terminology has been used.

The Proposal (action): The proposed Sapphire Wind Farm project including turbines, roads, reticulation, sub-stations and associated facilities. This is also called the 'action' as defined in the EPBC Act.

Project site: Land within the cadastre boundaries of all properties likely to be directly impacted by the proposal.

Locality: The broader location of the Sapphire Wind Farm represented in Figure 2, nominally the Kings Plains district. For the purposes of database searches, the locality is defined as a 10 km radius of the study area.

Study area / development envelope: Defined by the 100 metre buffer around the development footprint as seen in Figure 3 (i.e. a 200 metre survey corridor). The study area is 1,982.13 hectares and was the area subject to survey effort and is the area in which changes to the proposed layout may occur. Where the boundary of the study area appears in close proximity to land that is not part of the wind farm proposal, note that turbines will not be micro-sited into these areas.

Development footprint: The area directly impacted upon by the construction of the proposed action. 'Development footprint' is used in this report as an alternative to 'subject site' as defined by DEC (2004). The development footprint of the proposed wind facility will have a maximum area of 297.08 ha (2.05 MW turbines). This includes turbines, access tracks and the associated ancillary structures required for the running of the wind farm. This number also includes small areas of previously cleared land. Temporary impacts needed to allow construction (e.g. widening roads), will be rehabilitated post construction (Table 1).

Table 1: Areas of project site, study area and development footprint

ATTRIBUTE		AREA IN HECTARES
Project Site		14,189.33
Study Area / Development Envelope		1,982.13
Development Footprint	159 turbines	297.08*
	125 turbines	277.16*

Note: * This value includes all land within the development footprint including cleared land

Turbine clusters: The site has been broken into three main areas for ease of referencing in this report. These are listed below in Table 2 and shown on Figure 3.

Table 2: Turbine clusters

TURBINE CLUSTERS	1.5 MW TURBINES (80 m)	3.4 MW TURBINES (112 m)	GENERAL LOCATION
Sapphire	56	45	Western cluster
Swan Vale	66	51	Southern cluster
Wellingrove	37	29	Eastern cluster

Direct impacts: Those that directly affect individuals and their associated habitats. They include, but are not limited to loss of individuals and, removal of suitable habitat. Direct impacts associated with the proposal are limited to the **development footprint** and are summarised in Section 5.6.

Indirect impacts: Occur when project-related activities affect species, populations or ecological communities in a manner other than direct loss. Indirect impacts can include loss of individuals through starvation, exposure, predation by domestic and/or feral animals, loss of breeding opportunities, loss of shade/shelter, deleterious hydrological changes, increased soil salinity, erosion, weed invasion, increased noise and/or light, or increased human activity within or directly adjacent to sensitive habitat areas. A specific area for indirect impacts associated with the proposal has not been defined in this assessment, however, the nature and extent of indirect impacts is identified in Section 5.7 & 5.8.

Threatened Biodiversity: Threatened species, populations or ecological communities as listed under the NSW *Threatened Species Conservation Act 1995* (TSC Act) and/or the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

1.1 STUDY AREA

1.1.1 Site Location

The area of the wind farm is located north of the Gwydir Highway approximately 18km west of Glen Innes and 28km east of Inverell, New South Wales. The turbines extend over a 10km span north-south and 15km span east-west. The individual turbine positions are located on land with elevations ranging from approximately 750m to 1,100m Australian Height Datum (AHD) (Figure 2).

The project site is on rural land within the Inverell Shire and Glen Innes Severn Council areas and includes 22 privately owned properties.

Roads of significance are Gwydir Highway to the south and Waterloo Rd running through the centre of the study area. Western Feeder Rd, Eastern Feeder Rd, Kings Plains Rd and Polhill Rd are adjacent to the project site (Figure 3).

Table 3: Site location details

LATITUDE (S)			LONGITUDE (E)		
Degrees	Minutes	Seconds	Degrees	Minutes	Seconds
29	38	46.531	151	32	44.727
29	46	30.524	151	32	44.727
29	46	30.524	151	22	25.089
29	38	46.531	151	22	25.089

1.1.2 Rivers, Creeks and Watercourses

The study area is within the administrative catchment of the Border Rivers – Gwydir Catchment Management Authority (CMA) and is divided into two CMA sub-regions; Severn River Volcanics and Glen Innes – Guyra Basalts (Figure 4). Geographically, drainage to the north, west and south is into the McIntyre River catchment via one of five creeks; Kings Plains Creek, Spring Gully, Frazers Creek, Horse Gully and Swan Brook. Drainage to the east is into the Severn River catchment via Wellingrove Creek. The waterways within the locality are ephemeral, typified by low-flows and dry creek-beds. Some farm dams occur within the locality. The study area is mostly confined to the ridges of the locality with limited direct impact on waterways.

1.1.3 Soils and Geology

Landscape

The Sapphire Wind Farm proposal is located along the spines of the ridges surrounding the Kings Plains district of the northern New England Tableland. The landscape is a basin dominated by undulating to steep hills in the eastern, southern and western sections and Kings Plains nestled between these ridge-lines and heading north. Three Mitchell Landscapes (DECC 2008) have been mapped for the study area; Glen Innes – Guyra Basalts across the majority of the site and Ashford Mole Valleys in the west and Inverell Plateau Granites in the north east.

Geology

The study site is within a geological domain that comprises a large area of tertiary basalts (Lea *et al.* 1977a). Alluvial sediments are present along water courses in the valleys. Outcrops of Palaeozoic Volcanics (granite) can also be found. The key geological unit that underlies the study site is an unnamed unit of Basalt Flows, with a small area underlain by Emmaville Volcanics in the north and west (Department of Mineral Resources 2003). While Emmaville Volcanics have a minor distribution within the study area (Sapphire cluster and Wellingrove cluster only), it is the dominant geological unit of the area that borders the northern and western portions. An unnamed unit (comprised of Quaternary alluvial, residual or colluvial deposits of sand, silt, clay and gravel) is found in the central portion of the Swan Vale cluster, and extends northward along the Kings Plains Creek.

Soils

No recent soil landscape mapping has been published for the Glen Innes locality (DECCW pers. comm., 14 March 2011). Soil characteristics provided here for the project site are based on soil mapping published in the 1970s (Lea et al. 1977a; Lea *et al.* 1977b).

A generalized map of soil associations (using the earlier Great Soil Groups classification) was reviewed in an attempt to determine dominant soil/s of the project area. Historical soils mapping shows Chocolate-Prairie soils are found on the upper slopes of the eastern portion of the study area, while Black Earth-Euchrozem soils make up the western portion. Black Earth-Prairie soils are mapped along the valleys and major drainage lines (mainly Kings Plains Creek, Wellingrove Creek and Swan Brook). Based on visual observations of the study area and review of literature, Chocolate-Prairie soils are the dominant soils of the project area (ELA 2011b).

1.1.4 Vegetation Communities

The native vegetation of the study area is described in detail in Section 4.3.1. The locality is characterised by a mix of native woodland and open-forest, native pasture, exotic pasture and cleared land.

1.1.5 Land Use

Historical

Archaeological evidence suggests that the Aborigines of the tablelands primarily traded with those of the western slopes and moved seasonally between the coast and western river systems and the tablelands. Local and traded implements (e.g. spears) and skins for clothing and decoration were used and carved trees, bora grounds and art-sites have also been found. In more recent times, Aboriginal men of the New England Tablelands worked as stockmen on stations such as Strathbogie, Wellingrove and Kingsplains. Generally, the women were engaged in domestic duties.

Squatters began to occupy the area in the 1830s, seeking suitable land for grazing (NPWS 2004).

Cattle grazing was the dominant land use of the bioregion in the early days of European settlement, but by the end of the 1800s sheep grazing was expanded due to improved pastures and better fencing. The government established an experimental farm at Glen Innes in 1902.

As in the Nandewar Bioregion, softwood timber was abundant but difficult to retrieve. Many forests were dedicated as state forests around 1900 and most are still managed by State Forests of NSW.

Within the Kings Plains district, land use has historically followed a familiar pattern of grazing in conjunction with land clearance (logging/thinning, firewood collection, broad-scale clearance), ploughing and, finally, pasture improvement, with the ultimate result being vast areas of exotic pasture. Cattle grazing is also the dominant land use within some of the more wooded areas which tend to support better condition native pasture. The predominance of *Angophora floribunda* (Rough-barked Apple) as paddock trees and regrowth throughout the landscape suggests a selection against this species for logging and firewood (P. Richards pers. comm., 2009).

Transmission Line

The 330 kilovolt (kV) Transgrid transmission line runs north-south through the western part of the locality. Maintenance beneath the powerlines is minimal due to the predominance of grassland. Some tree and shrub removal is required where the transmission line intersects with woodland.

Mining

The main extractive industries within the locality include sapphire mining and quarrying for local aggregates. Further to the north in the rugged landscapes of the acid volcanics, tin and molybdenum are mined. The study area itself does not impact on any mineral leases; however, the proposal will require the sourcing of aggregates for concrete batching and road-base.

Agricultural

The majority of the landscape is currently used for agricultural and farming practises under varying management regimes. This includes seasonal cropping for fodder and sheep and cattle grazing.

1.1.6 Surrounding Reserves

Several lots within the locality are owned and managed by the NSW Land and Property Management Authority (LPMA) (formerly the Department of Lands) including the Travelling Stock Route (TSR) along Kings Plains Road. Sections of this TSR are now managed for conservation and represent some of the best condition woodland within the locality.

A number of areas reserved under the NSW *National Parks and Wildlife Act 1975* lie within the Inverell Local Government Area.

These areas include:

- Kings Plain National Park
- Severn River Nature Reserve
- Kwiambal National Park
- Arakoola Nature Reserve
- Goonoowigal State Conservation Area
- Dthinna Dthinnawan National Park and Nature Reserve Park
- Taringa Nature Reserve
- Nullamanna National Park
- Barayamal National Park
- Burral Yurrul National Park

Kings Plains National Park is the nearest conservation area and is approximately 3.7 kilometres to the north-west of the study area at its nearest point.

Kings Plain National Park

Kings Plains National Park is located on the Northern Tablelands, approximately 50 kilometres north west of Glen Innes and 47 kilometres north east of Inverell. An area of 3,143 hectares was formally reserved as the National Park in January 1988 and subsequent additions to the park brings the total area to approximately 6,919 hectares.

Kings Plains National Park is located entirely within the Inverell LGA and is within traditional Ngarrabul Aboriginal country and the Anaiwan Local Aboriginal Land Council. Elevation within the park ranges from 690 metres above sea level to 1,009 metres. Kings Plains Creek is a visually spectacular feature of the park with its associated deep rocky gorge, waterfalls and rapids.

Kings Plain National Park consists of open woodland vegetation of ironbark, cypress pine, boxes, stringybarks and gums. There are many patches of heath containing uncommon or rare species including the *Hibbertia obtusifolia* (Grey Guinea Flower) and *Astrotricha roddii* (Rodd's Star-hair). Native fauna include *Macropus giganteus* (Eastern Grey Kangaroo), *Macropus robusta* (Wallaroo), *Wallabia bicolor* (Swamp Wallaby), *Macropus rufogriseus* (Red-necked Wallaby), *Phascolarctos cinereus* (Koala), *Petrogale penicillata* (Brush-tailed Rock Wallaby) and *Ornithorhynchus anatinus* (Platypus). A variety of native birds are also located at the park (Inverell Council 2009).

Environmentally Sensitive Land

The Inverell Shire has a number of areas that are protected and not suitable for development. These include National Parks, Nature Reserves, State Forests and wilderness areas. Through the Local Planning Instrument, Council has established Environmental Protection Zones which place restrictions on development within the area; however, agriculture is generally permissible throughout this zone.

1.1.7 Climate

The nearest meteorological station to the study area is Glen Innes Agricultural Research Station (Station No. 056013, elevation 1,060 m) which is located approximately 6 kilometres to the north-west of Glen Innes and approximately 14 kilometres to the east of the study area. Climate data for Glen Innes Agricultural Research Station are summarised below.

Table 4: Climate data for Glen Innes Agricultural Research Station, 14 km east of the project site (Bureau of Meteorology 2011)

AVERAGE WEATHER CONDITIONS	MEASUREMENTS
Annual rainfall	844.7 mm
Highest monthly rainfall	109.8 mm (December)
Lowest monthly rainfall	4.05 mm (April)
Annual minimum / maximum temperature	7.3° C / 19.5° C
Highest mean monthly temperature	13.4° C to 25.3° C (January)
Lowest mean monthly temperature	0.7° C to 12.5° C (July)

2 Description of Project

The Sapphire Wind Farm proposal comprises a wind farm with 159 1.5 MW wind turbines or 125 3.4 MW wind turbines or equivalent to be constructed over 22 different properties.

Ultimately the choice between these two design layouts is largely dependent on the availability of wind turbines to the project, selection based on a competitive tendering basis post-consent. It is important to note that the same 'Study Area' will be utilised irrespective of the final selection whereas the development footprint differs slightly with respect to the two layouts (see Figure 3). Micro siting is likely to occur during detailed engineering design and construction. The wind farm layout will be prepared to maximise utilisation of the available wind resource whilst gaining regulatory and broad community acceptance of the development. The planning and design stages of the wind farm layout have and will continue to consider any potential environmental impacts on flora communities, fauna habitat, heritage aspects as well as the location of neighbouring human residences. Some of the impacts from the development footprint will be for the duration of the wind farm operation and some are temporary impacts during the construction phase to allow for a temporary increase in traffic volume and over-sized traffic.

The proposal will have an installed capacity of up to 238.5 – 425 MW, depending on the model of the turbine selected, and will consist of the following components (Table 5):

- the installation of up to 159 wind turbines 28 km east of Inverell and 18 km west of Glen Innes, NSW (refer to Figure 3);
- a combined main collector and switching substations comprising cable marshalling, switchgear and transformers, site operations facilities and services building;
- site operations facilities and services building;
- underground electrical reticulation cables (up to 33 kilovolt (kV) capacity) and control cables within each of the wind turbine clusters, potentially connecting to up to three cluster collector substations comprising cable marshalling, switchgear and step up transformers to 66 kV;
- overhead power line approximately 10 km in length, up to 132kV capacity including a 45 m easement;
- access roads to the turbine locations and substation;
- crane hardstand areas for the erection, commissioning, maintenance, recommissioning and decommissioning of the wind turbines;
- up to six permanent wind monitoring masts;
- temporary construction facilities including site office, parking and materials storage areas;
- appropriate wind farm signage both during the construction and operational phases of the proposed development; and
- mobile concrete batching plant(s) and rock crushing facilities.

Details of each of the component parts of the development are described in the following sections and in the accompanying images. An outline of the construction and operational phases of the development are also provided. A detailed site plan is presented in Figure 3, showing the two potential turbine layout designs. These layouts are based on a number of technical, environmental and social factors and more detailed site assessments. The layouts ensure optimum, undisturbed use of the measured and predicted wind resource, after accommodating constraints, for the range of turbines currently being considered for the wind farm.

Table 5: Project components and approximate dimensions

PROJECT COMPONENT	APPROXIMATE DIMENSIONS
Wind farm infrastructure	
Turbine footings	20 x 20 m
Turbine Assembley / Crane hardstand areas	50 x 25 m
Collector and Switching Substation	100 x 200 m
Cluster collector substation	25 x 25 m
Facilities building	30 x 6 m
Site access: new roads *	78 km x 12 m
Underground cabling on-site	160 km x 1m
Internal overhead electrical interconnection / easement #	10 km x 2 m / 10 km x 45 m
	Temporary construction facilities
Earthworks alongside permanent infrastructure (roads/hardstands)+	78 x 10 m (est.)
Concrete batch plant (8)	50 x 100 m (ea.)
Rock crushing facility (3)	50 x 60 m (ea.)
Site office (3)	40 x 100 m (ea.)
Construction compound (3)^	150 x 200 m (ea.)

** It is expected that if a 12m wide road design is considered appropriate for construction, then up to 6m of road width will undergo rehabilitation after the infrastructure has been installed (post construction phase). The width of the road required is dependent on final turbine selection and availability of suitable cranes. Track-mounted cranes require roads up to 12 m in width where as tyre-mounted cranes require roads 6 m in width. If a 6 m road design is constructed then no rehabilitation would occur to the road after the infrastructure has been installed (post construction phase).*

 # The estimated easement width is up to 45 m for the internal overhead powerlines, though the actual impact area has been estimated to be 5 % of this total area given the low level of impacts associated with installing the power/transmission lines and the sparse vegetation cover along the selected routes.

+ Construction of the internal road network will require earth works that are beyond the limits of the permanent road impact within the Study Area. This is required to level areas of steep gradient to a design suitable for safely transporting project components into position. Detailed civil designs have been prepared for Layout Option 1 (considered to have the greatest impact when compared to Layout Option 2) that include impacts associated with permanent road, hardstand and turning head areas in addition to the area considered the extent of the earth works. A thorough assessment of these impacts has been undertaken

^ The construction compound will consist of a fenced off area for the storage/laydown of tools, vehicles, equipment, construction materials, and turbine components. Following construction, one compound will be retained as a permanent laydown area for the operational life of the wind farm.

Given the scale of the proposed wind farm it is likely that 'clusters' of turbines will be constructed and commissioned in stages. Consequently, and for the benefit of stakeholder understanding, the project has been broken down into three clusters (see Table 6 below).

Table 6: Turbine clusters

TURBINE CLUSTER	1.5 MW TURBINES (80 m)	3.4 MW TURBINES (112 m)	GENERAL LOCATION
Sapphire	56	45	Western cluster
Swan Vale	66	51	Southern cluster
Wellingrove	37	29	Eastern cluster

2.1 WIND FARM INFRASTRUCTURE

It is not yet known which model of wind turbine will be used for the development as final turbine selection will occur through a competitive tender process pending development approval. However, in terms of generation capacity, the wind turbines under consideration for this project vary in the range from between 1.5 and 3.4 MW. By way of example the Suzlon S88, 2.1 MW machine (as installed at the Capital wind farm, east of Lake George, NSW) is typical of the type of wind turbine that could be installed.

Turbines

The turbines used for the project will be three-bladed, semi-variable speed, pitch regulated machines with rotor diameters between 80 m and 117 m and a swept area of 5,027 to 10,756 m^2. Typically turbines of this magnitude begin to generate energy at wind speeds in the order of 4 ms^{-1} (14.4 kilometres per hour (kph)) and shut down (for safety reasons) in wind speeds greater than 25 ms^{-1} (90 kph). Wind turbine blades are typically made from glass fibre reinforced with epoxy or plastic attached to a steel hub, and include lightning rods for the entire length of the blade. The blades typically rotate at about 12 revolutions per minute (rpm) at low wind speeds and up to 18 rpm at higher wind speeds. Consideration will also be given to the use of different turbine sizes and manufacturers across the site to better utilise the on-site wind resource profile. For example, the use of Vestas V112 turbines for two Clusters and Siemens SWT-2.3-101 turbines for the third Cluster may result in a more productive wind farm based on the wind resource profile across the site. Turbine dimensions would still fall within the permissible turbine sizes considered in this assessment.

Image 1: Component Parts of a Wind Turbine
Photo courtesy: Wind Prospect CWP

Towers

The supporting structure is comprised of a reducing cylindrical steel tower fitted with an internal ladder or lift. The largest tower height under consideration is 101.5 m with an approximate diameter at the base of 4.5 m and 2.5 m at the top. However it is important to note that the rotor diameter suitable for this wind turbine is 101 m and therefore falls within the maximum proposed blade tip height of 156 m. Alternative tower heights of 80, 85, 91, 94 and 100 m are also under consideration however this is not an exhaustive list since new models and certified designs are continually entering the market place. The tower will typically be manufactured and transported to site in three to five sections for on-site assembly.

Blade Tip

The blade tip will comprise the highest point of the wind turbine when in a vertical position. Given the turbines under consideration, a blade tip height of 156 m is considered to be the maximum. As new turbine models are regularly appearing on the market, blade tip height may vary by up to 5 m to accommodate the wide-range of tower heights and blade lengths.

Nacelle

The nacelle is the housing constructed of steel and fibreglass that is mounted on top of the tower and can be 10 m long and 4 m high and 4 m wide. It encloses the gearbox, generator, transformers, motors, brakes, electronic components, wiring and hydraulic and lubricating oil systems. Weather monitoring equipment located on top of the nacelle will provide data on wind speed and direction for the automatic operation of the wind turbine.

Footings

Three types of foundation for the turbines will be considered pending geotechnical investigation of the ground conditions at the site.

- Slab (gravity) foundations will involve the excavation of 15 x 15 m area to a depth of approximately 2.5 m. Approximately 200 m^3 of excavated material will, if suitable, be used as backfill around the turbine base. A slab foundation would involve installation of shuttering and steel reinforcement, followed by the pouring of concrete.
- If slab plus rock anchor foundations are required, the construction of the foundation for each machine would involve the excavation of approximately $300m^3$ of ground material to a depth of approximately 2.5 m. Slab plus rock anchor foundations require shuttering and steel reinforcement, drilling of rock anchor piles up to a depth of approximately 20 m, concrete pour, after which the rock anchors are stressed and secured once the concrete has cured sufficiently.
- Alternatively, if a single mono-pile foundation is required (rock anchor), approximately 50 m^3 of ground material would be removed by a rock drill to a depth of approximately 10 m, of which 30 m^3 would, if suitable, be used as back fill. If a mono-pile foundation is used, a tubular section with tower connection flange attached is inserted in the hole and concrete is then poured in-situ.

Image 2 (a) & (b): Typical Gravity (left) and Rock Anchor (right) Footings.
Photo courtesy: Wind Prospect CWP

Detailed geotechnical surveys will be carried out during pre-construction work to determine the necessary foundation type per turbine. It is feasible that more than one type of turbine foundation may be required for the project, following the assessment of the individual turbine locations. New turbines are continually coming on to the market and it is possible that minor variations to these typical dimensions could occur prior to final turbine selection.

Crane Hardstand

Site access roads would have areas of hardstand (approximately 50 m by 25 m) adjacent to each wind turbine for use by cranes during construction. Clearing native vegetation for the construction of access roads and hardstand areas will be avoided where possible. If clearing is unavoidable, this will be appropriately managed and carried out in accordance with the Environmental Management Plan. The roads would be surfaced with local stone (where possible) to required load bearing specifications. The nature and colour of surfacing would be selected to minimise visual impact prior to construction. The roads and hardstand areas would be maintained throughout the operational life of the wind farm and used principally for the periodic maintenance of the wind turbines.

Image 3: Typical Hardstand area adjacent to a Rock Anchor footing
Photo courtesy: Wind Prospect CWP

Monitoring Masts

Up to six permanent wind monitoring masts up to 100 m high, two per cluster, are proposed to be installed on-site. The purpose of the additional monitoring masts is to provide information for the performance monitoring of the wind turbines. The wind monitoring masts would be of a guyed, narrow lattice or tubular steel design.

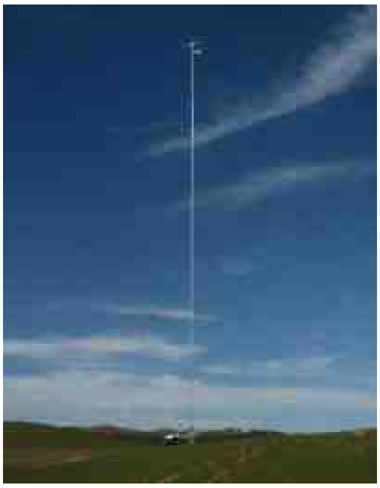


Image 4: Wind monitoring mast. Photo courtesy: Wind Prospect CWP

Electrical Infrastructure

The electrical works, including those incorporated in the wind turbine structures are shown in Figure 12, and will involve:

- up to 159 wind turbine generator transformers;
- the establishment of 100 m by 200 m collector substations and switching substation with either 132 kV or 330 kV transformer circuit breakers and isolators depending on the point of connection;
- the establishment of up to three separate 25 by 25 m cluster collector substations with up to 132 kV transformers and isolators;
- approximately 160 km of up to 132 kV entrenched underground cables;
- approximately 10 km of up to 330 kV overhead electrical interconnection cables;
- approximately 170 km of underground control cables (10 km may be underground or overhead); and
- the establishment of a 30 m by 6 m operation facilities building to house control and communications equipment.

Generator Transformer

The wind turbine generators typically produce electricity at nominally 0.69 kV which is raised to 33 kV (or greater) by the transformer located either in the nacelle, the base of the tower or close to the base of the tower on a concrete pad.

Image 5: Transformer adjacent to wind turbine
Photo courtesy: Wind Prospect CWP

The generator transformer may be oil-filled or a dry type depending on the wind turbine. Where oil-filled transformers are used, appropriate measures will be incorporated to prevent any oil loss reaching local water courses. The volume of oil used for generator transformers is in the order of 1,000 litres (L). The output from each of the turbines will be directed via 33 kV (or greater) cables that link to the 132 or 330 kV collector and switching substation.

Collector and Switching Substations

The collector and switching substation (the "Substation") locations have been chosen to minimise access distance and electrical losses, and to reduce its visibility from surrounding public viewpoints (Figure 12). The 132 kV substation will be 1.1 km from the Adavale property (non-involved) whilst the 330 kV substation will be 0.63 km from the Kingshill property (involved). Following construction, and if warranted, raised earthwork perimeters and small areas of tree planting could be undertaken to screen any part of the substation that are visible from the surrounding country to reduce visual impact.

The Substation will include one or two 150 or 200 megavolt ampere (MVA) transformers to step-up the voltage to 132 or 330 kV, together with ancillary equipment. It will occupy an area approximately 100 by 200 m and will be surrounded by a 2 m high security fence, surmounted by strands of barbed wire. The Substation arrangement will include an array of busbars, circuit breakers, isolators, various voltage and current transformers and a static compensator-capacitor as agreed with TransGrid. A buried earth grid will extend one metre beyond the fence on all sides. The ground surface within the Substation enclosure will be covered partly with a layer of crushed rock and partly by concrete slabs. As the transformer may contain upwards of 80,000 L of oil, provision will be made in the design for primary and secondary containment of any oil that may leak or spill from the transformers or associated components. This would involve constructed concrete bunds around each transformer and a spill oil retention basin or oil/water separator outside the Substation compound. The 2 ha area includes a provision for a 20 m buffer of land surrounding the equipment.

Overhead and Underground Cables

The electrical cables from the Wellingrove, Swan Vale and Sapphire Clusters will comprise a mix of underground or overground cabling and will connect via the cluster collector substations to either the 132 or 330 kV connection points. Where feasible, overhead transmission lines will be used to export power from each of the Clusters to the Substation. The underground cable routes will generally be between the turbines and follow the route of the internal access roads. The final route will minimise vegetation clearing and avoid potential erosion and heritage sites and will also depend on the ease of excavation, ground stability and cost. Markers may be placed along the route of the underground cables, if agreed by the participating landowners. Placement of these cables below ground will result in minimal visual impact.

Control cables will interconnect the wind turbine generators and the operation facilities building. Computerised controls within each wind turbine will automatically control start-up, speed of rotation and cut-out at high wind speeds and during faults. Recording systems will monitor wind conditions and energy output at each of the turbines. Remote monitoring and control of the Project will also be employed. Control cables will consist of optic fibre, twisted pair or multi-core cable and will be located underground within the groups of turbines and potentially above ground between Clusters and the facilities building located at the Substation location. Above ground control cables would be strung from the poles of the internal overhead lines located between the Clusters.

The installation of buried earthing conductors and electrodes will also be required in the vicinity of the turbines, the facilities building and the substation.

Image 7: Laying underground electrical cable within road network
Photo courtesy: Wind Prospect CWP

Operation Facilities Building

A facilities building approximately 30 m by 6 m will be constructed at the same location as the switching substation. The general location has been chosen to minimise the length of overhead lines and underground cables and also to minimise the visibility of the facilities building and substation. The building will house instrumentation, electrical and communications equipment, routine maintenance stores, a small work area and staff amenities.

The structure is proposed to be a slab on ground construction with steel frame, metal or brick walls and a sheet steel roof or alternatively a transportable type building constructed on piers. It will be of sturdy construction, suitable for the weather conditions it will be exposed to and will be compatible with the rural environment. Roof drainage will collect rainwater for domestic use. A septic system or composting toilet system, which complies with Council requirements, will be installed to treat the small amount of waste water produced.

Cluster Collector Substations

The cluster collector substation (the “cluster substation”) locations will be chosen to minimise access distance and electrical losses, and to reduce its visibility from surrounding public viewpoints. The quantity and positioning of the cluster substations will dependant on final turbine selection and the point of export into either the 330 kV or 132 kV transmission lines via the main substation. The maximum number of cluster substations for the Project is expected to be three, one per cluster, located in close proximity to the overhead internal transmission lines.

Each cluster substation will occupy an area approximately 25 by 25 m and will be surrounded by a 2 m high security fence, surmounted by strands of barbed wire. A cluster collector station would consist of up to three medium voltage transformers stepping up to 66 kV to minimise on site reticulation losses alongside other ancillary electrical assets such as transformer hardstands, environmental bunding, circuit breakers, busbars, voltage control and communication equipment.

The design of the substation, electrical installations and operation facilitates building will be developed in conjunction with TransGrid and comply with relevant technical, electrical and planning standards.

Site Entry

The project can be reached via the Gwydir Highway between Glen Innes and Inverell, with direct access from local roads such as Waterloo Road, Polhill Road and Western Feeder Road. The RTA, Glen Innes Severn and Inverell Shire Councils have ongoing maintenance and improvement programs for the roads and bridges under their control.

On-site Access Roads

Other access consists of new on-site roads between turbines and hardstand areas. The on-site access road system will be rationalised and, where possible, these roads will follow existing farm tracks that traverse the ridgelines and plateaus. All roads leading from the arterial roads and all on-site access roads are likely to require a full or partial upgrade to accommodate the construction traffic loads, as well as for maintenance purposes during operation.

The required on-site access for the three Clusters is described below:

- Wellingrove Cluster: No existing roads will be upgraded and 16 km of new interal on-site access track will be required;
- Swan Vale Cluster: No existing roads will be upgraded and 30 km of new internal on-site access track will be required; and
- Sapphire Cluster: No existing road will be upgraded and 32 km of new internal on-site access track will be required.

Access roads will be up to 12 m wide in parts during construction to allow for safe passage of construction traffic and wind turbine components, and at least 6 m wide once the wind farm is operational. Additional areas of cut and fill clearance will also be required. The roads will be surfaced with compactable, engineered base material with suitable drainage. Materials will be sourced locally where possible and in consultation with the local councils. Measures will be taken to minimise the risk of the spread of weeds and disease from materials brought in for construction purposes.

General Vehicle Movements

Access to turbines located at the end of a spur on a ridge generally requires a T or Y-section of road (referred to as a turning head) close to the hardstand area to allow semi-trailer trucks to turn around. These are graded the same as the proposed internal access roads and are typically 30 to 40 m in length.

Alternatively, semi-trailer trucks can reverse back out of an access route, provided the project site safety regulations permit, or entrances made wider (bell-mouth) to allow manoeuvring.

Hardstand areas equal 50 x 25 m with additional area equal to 20 x 20 m to accommodate the turbine foundation and roads up to 12 m wide during the construction phase are proposed as maximum impacts. These dimensions would be sufficient to allow for passing and turning vehicles unless obstructed by a component such as a blade laid down on the hardstand awaiting assembly. In such an instance semi-trailer trucks could either turn around in the adjacent turning head, or continue to the next turbine hardstand area to turn around. Construction contractors generally avoid double-handling of components and as such manage the delivery and installation process under a just-in-time management process, thereby reducing the number of components laid down on site at any one time.

The proposed dimensions are sufficient for two cranes per turbine site to lift the components from the semi-trailer trucks, and for the trucks to drive on past to a suitable turning point, as described above.

Ancillary Roads and Remediation

Some additional roads may also be required for construction of the overhead transmission line, cable routes and for access to erosion control sites. The erosion control sites will benefit from the use of excess rock excavated from turbine footings and will be chosen based on the availability of excess material, the need for erosion repair, and minimising the distance for material transport.

If roads are not required for the ongoing operation and maintenance works of the project they will be removed and revegetated on completion of the construction phase, and in accordance with landowner preferences where possible.

Utility Services

The Project will be connected to TranGrid's 132 or 330 kV transmission network and when not generating will draw a minor amount of electricity from the local grid.

Water will be provided to the proposed facilities and auxiliary services building from a storage tank designed to collect water from roof drainage. An approved septic system or composting system will be installed to treat minor quantities of waste water. T he Proponent will be responsible for the removal of all other wastes from the Project site.

Resource Requirements

Resource requirements are typical of any new development site, including the provision of cement, gravel, sand, water and road base material.

Cement for foundations will be sourced by the civil construction company awarded to undertake the Project. This may be sourced locally or from alternative suppliers.

Gravel and sands will be sourced locally and as close to the project area as possible. There are two existing gravel quarries located to the north of the Project on Kings Plains Road, as well as additional quarries within 10 km of the Project. Several landowners have expressed interest in allowing gravel extraction from their properties, which would require the necessary extraction permits prior to use. Both gravel and sand will be required to mix the high strength concrete to pour the wind turbine foundations. Gravel will also be required to dress the turbine sites and provide a low resistivity apron around the substations.

Water requirements will be met by sourcing water from within the project area as long as the relevant permits can be obtained under current water control regulations. Bore water will be utilised from involved landowner properties where available, requiring the transfer of bore licensing from agricultural to temporary industrial use for construction purposes. If water cannot be sourced locally, then it will be brought to site by external water suppliers under contract to the Project.

In addition, approximately a further 15.5 ML of water would be required for road construction and dust suppression activities. This would provide sufficient volume for all new and upgraded internal road construction and dust suppression activities, including those associated with the 21 km of unsealed arterial road. These activities are not embargoed and as such require the Proponent to apply for a permit

Road base material will be required for construction of access roads to turbine sites and the substation. Part of the road base requirement may be sourced from material extracted from turbine footings with the remainder imported to the Project site. Where additional material is required, local supplies of the same geological type could be sourced from the quarries indicated above, local landowner gravel supplies or external aggregate suppliers.

Given the scale of the project it is anticipated that there will be no waste material exported from the site during construction. Top soil cleared from surfaces during the construction phase will be used for remediation, and rock excavated for turbine footing preparations will be used for road base, back fill for foundations and/or erosion control purposes as far as practicable. Ancillary waste, such as packaging, associated with component and stock pile deliveries will be disposed of according to local Council requirements and form part of the Construction Environmental Management Plan.

Potential Design Layout Variations

Alterations may be required to the project layout which could result in the minor relocation of infrastructure (wind turbines, access tracks, cabling, etc) prior to construction. Considerations such as final turbine selection, ongoing energy yield analysis, unforseen environmental constraints, constructability/cost-reduction and pre-construction engineering investigations can impact on the final design and affected area of the project.

The constant roll-out of new turbine models by a variety of manufacturers makes it impossible to select a preferred turbine model at this stage. It is proposed an allowance of up to 5 m for blade tip height would accommodate any new wind turbines which would be suitable for the project, subject to conditions of approval as issued.

2.2 WIND FARM DEVELOPMENT PHASES – DEVELOPMENT APPROVAL TO OPERATION

Anticipated Project Timeline

Approval is sought for the final positioning of up to 159 turbines and associated infrastructure within a radius of 100 m of the locations based on two preferred layouts. The Proponent is applying for Development Approval to allow for substantial construction to begin within five years of the date of Consent. The actual timing of construction will principally be driven by the length of time taken to obtain other permits and authorisations, attaining Board approval/project financing for commencement and the long lead times for wind farm components. An indicative project timeline is presented below. Staging of the development is also a consideration.

The following provides a guide to the anticipated activities subject to approval for the project.

		2011		2012				2013				2014				2033/34
		Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	
Wind Farm Related Activities	Wind Farm Development Approval															
	Detailed Design and Contract Development															
	Preconstruction Works															
	Construction Works															
	Commissioning (in line with NER *)															
	Operation															
	Maintenance															
	Decommissioning or Equipment Replacement															

** National Electricity Rules*

Pre-construction Works

Prior to the main construction commencing, a number of enabling works and further site planning would be undertaken by the selected Contractor, including:

- detailed site investigation including geotechnical investigations involving a series of trial pits and/or boreholes;
- upgrading the surfaces of local roads and access roads where required;
- widening the junctions or corners of local roads, entrance/access points where required;
- upgrading of causeways and bridges where required;
- widening the existing gateways, or inserting new gateways as necessary along fence lines;
- stripping and careful storage of existing soil from the areas which would be affected by construction activities, including the tower bases, switchgear/substation yards, access road areas, crane hardstand areas and temporary lay down/car park areas;
- the construction of a secure works facility, with project owner and subcontractors field offices (portables), car park, lay down yard and toilet facilities (temporary);
- erection of signage on roads;
- enabling works for the locating of a mobile concrete batching plant(s) (temporary, if required);
- enabling works for the locating of a rock crushing plant(s) (temporary, if required);
- environmental survey and refinement (if necessary) of the Environmental Management Plan in line with the Draft Statement of Commitments, Health and Safety Plan, Traffic Management Plan and any other documentation as required under the planning authorisation;
- survey of critical boundaries and pegging of infrastructure locations;
- detailed cultural heritage and flora/fauna surveys across entire site (if required);
- preparation of works procedures and Project Implementation Plan; and
- engineering design works and submission for Building Rules Consent.

Construction Works

Construction activities include activities that cross over with pre-construction works and comprise site establishment, earthworks for access roads, footings and crane hardstand areas, erection of up to 159 wind turbines, approximately six permanent wind monitoring masts, a collector substations, switching substation, above and below ground cabling and temporary site facilities. Construction activity is likely to occur over a period of approximately 18 to 24 months with restoration following the completion of works.

Community Construction Awareness Program

Prior to the commencement of the site construction activities, a program of community awareness initiatives will be implemented. Information will be disseminated to the local community through the Wind Prospect CWP website, local newspapers and direct mail to advise them of the nature of the construction activities, their timing and potential impacts. Contact details will be provided for individuals to gain further information or if required to express concerns or complaints. Updates on the progress of construction works and relevant impacts will be provided during the construction period.

Site Establishment and Temporary Site Infrastructure

Site works will require the erection of temporary infrastructure such as portable field offices, toilet facilities, materials storage areas and parking bays. This infrastructure will be typical of that used at construction sites, and is unlikely to include full accommodation facilities.

Three preferred areas for the temporary site office, toilet facilities and construction compound and parking bays have been considered. One is located off Polhill Road in the Wellingrove Cluster, the second located off Waterloo Road in the Swan Vale Cluster and the third off the Western Feeder Road in the Sapphire Cluster. The temporary site office facilities will be approximately 40 by 100 m and the construction compound approximately 150 by 200 m, with a combined area of approximately 3.4 ha. The area will be fully fenced with sufficient access to allow vehicle movement, stockpiling of materials, and office facilities. The selection criteria for identifying these locations were with respect to the following:

- Flat accessible location to the arterial roads to allow for vehicle movement to all Clusters;
- Minimising the ecological impact – avoidance of Endangered Ecological Communities (EEC's), avoidance of hollow bearing trees (where possible), away from recorded Threatened Species, and avoidance of major creeks;
- Minimising traffic and transport activity during construction;
- Minimising visual impact from publicly accessible locations; and
- Minimising noise impacts at receptor locations.

Pending approval, a construction contractor will be appointed to the project. If alternative locations for these temporary facilities are sought then the same selection criteria will be considered to determine suitable locations.

Traffic signage required as part of traffic safety during construction will be installed by the contractor, in compliance with relevant regulations and in accordance with any permits obtained for traffic management.

Signage will be erected on the Gwydir Highway and other critical locations from the outset of construction, directing all vehicles associated with the construction site to the site office. Additional signage would be located near to the site, providing information about the turbines, the companies involved in the projects, essential safety information and telephone numbers. Negotiations with the Inverell Shire Council and Glen Innes Severn Council, NSW Road Transport Authority and other affected parties will be initiated to determine final signage locations and various works required.

Image 8: Temporary site infrastructure. Photo courtesy: Wind Prospect CWP

Ancillary Construction Activities: On-site Concrete Batch Plant(s) / Rock Crusher(s)

Up to six locations and three rock crusher locations are proposed to supply concrete and aggregate for the wind turbines foundations and access tracks. As each Cluster will be built in turn, it is unlikely that more than two of these will be operational at any time during the construction period.

An on-site batching plant facility would occupy an area of approximately 50 by 100 m and likely consist of a trailer-mounted concrete mixer, cement bins, sand and aggregate stockpiles and a storage container for various equipment and tools. Sufficient area will be required for the use of front-end loaders, delivery of materials and entry and exit of vehicles. A batch plant would be powered by a diesel generator and have a production capacity of approximately 40 cubic metres per hour (m^3/h).

A rock crusher would occupy an area of approximately 50 m by 60 m and consist of a tracked mobile crushing unit, conveyor belts, feeder and engine. Sufficient area will be required for the use of front-end loaders, delivery of materials and entry and exit of vehicles.

The selection criteria for identifying these locations were with respect to the following:

- Minimising the ecological impact – avoidance of EEC's, avoidance of hollow bearing trees (where possible), away from recorded Threatened Species, and avoidance of major creeks;
- Minimising traffic and transport activity during construction;
- Minimising visual impact from publicly accessible locations;
- Minimising noise impacts at receptor locations; and
- Close to an accessible water source.

Pending approval, a construction contractor will be appointed to the project. If alternative locations for these temporary facilities are sought then the same selection criteria will be considered to determine suitable locations.

The final location of concrete batching plants and rock crushers will be determined at the construction planning stage and will be strategically sited to minimise impact on the local area.

Under the *Protection of the Environment Operations Act 1997* 'Concrete Works' are considered a scheduled activity requiring a Licence from the OEH if the capacity of production of concrete exceeds

30,000 tonnes per year. A licence for its operation will be applied for to the OEH following Part 3A approval.

Image 9: Temporary on-site concrete batching plant. Photo courtesy: Wind Prospect CWP

Site Access Roads and Crane Hardstand Areas

Site access roads and crane hardstand areas require surfacing in order to cater for construction traffic and machinery. This involves the excavation of the roads and hardstand areas to an agreed depth, prior to the laying of a compacted quarry rubble base. It is anticipated that the majority of material retrieved from cuttings and excavations will be used on-site or in the immediate vicinity of the site. Site access points would be gated and secured, and appropriate warning signs erected.

During construction, site access roads are constructed at a width of up to 12 m to allow for passing construction traffic, large mobile cranes, and other long and wide loads. Additional cut and fill clearance will also be required in some areas. Once the wind farm is operational, the access roads will be reduced in size to 6 m in width, acknowledging that traffic from this point onwards will principally involve commercial vehicles. The crane hardstand areas will be sized at approximately 50 m x 25 m.

Dust suppression is a key consideration during the construction and use of roads. A permit will be sought from the NOW for the extraction of the required quantity of water to enable the construction and dust suppression of up to 91 km of new and upgraded internal access roads and up to 21.2 km of unsealed arterial roads that are likely to be used for site access. If on-site water cannot be sourced from within the Project area, then water will be brought into the site from appropriate suppliers.

Footing Construction

Should gravity foundations be required, the construction of the foundation for each wind turbine will involve the excavation of approximately 450 m^3 of ground material to a depth of 2.5 m. Shuttering and steel reinforcement would then be put in place and concrete poured to form the base in-situ. The upper surface of each base would finish approximately 0.5-1 m below ground level with either a central reinforced concrete plinth to support the tower, or a base steel tower section set into the concrete.

If rock anchor foundations are required, the construction of the foundation for each wind turbine would involve the excavation of approximately 100 m^3 of ground material to a depth of approximately 2.5 m.

The rock anchor cores are drilled into the bed-rock prior to concrete pour, and are up to a depth of approximately 20 m. The rock anchor tendons are grouted into place, stressed and secured once the concrete has cured sufficiently. Steel forms shuttering and steel reinforcement would then be put in place and concrete poured to form the base in-situ. The upper surface of each base would finish at ground level with either a central reinforced concrete plinth to support the tower, or a base steel tower section set into the concrete.

On-site Electrical Reticulation

Either prior to or during turbine base construction, the underground site electrical system would be installed. This would involve the cutting or excavation of trenches to a depth of up to 1.2 m, for the laying of the underground cabling that links the turbines. All trenches would be backfilled and marked with warning tape and back-filled once the cables were laid.

The majority of the underground cabling will be located adjacent to the access roads. The general procedure followed for the laying of underground cables will be:

- Preparation work, including installation of gates/temporary removal of fences as required;
- Use of an excavator or rock saw to dig a trench (0.45 m wide by 1.2 m deep);
- Material excavated is stored adjacent to the trench for subsequent back-filling;
- Laying of bundled cables within a bed of protective sand; and
- Backfilling and compaction of previously excavated material in layers by use of a vibration plate compactor, all in accordance with Engineering Specifications.

On completion the cable route may be marked with small marker posts. The surrounding vegetation will be allowed to regrow and managed in accordance with a Vegetation Management Plan (VMP).

Collector Substation and Switchgear Compound

A location for the on-site collector and switchgear substation has been selected for both the 132 kV and 330 kV possible connection points (Figure 12). The total compound area will be in the order of 100 x 200 m incorporating a 20 m Asset Protection Zone (APZ) area extending from the boundary of the installed equipment. The yard will be surfaced with compacted quarry rubble to form a hardstand area. Reinforced concrete footings will then be constructed to support electrical infrastructure and buildings. Infrastructure required within the yard includes 132 or 330 kV transformers, switchgear, power conditioning equipment and operation facilities building.

Cluster Collector Substation

A cluster collector station would consist of up to three medium voltage transformers stepping up to 66 kV to minimise on site reticulation losses alongside other ancillary electrical assets such as circuit breakers, busbars, voltage control and communication equipment. Physical footprint of the station should not exceed 25 m by 25 m and will include transformer hard stands, environmental bunding and security fencing at 2 m high.

Turbine Erection

The turbine components would be delivered to the site on semi-trailers. The method of construction would involve the use of a small mobile crane (up to 100 tonne) for the ground assembly operation. A larger 600-1000 tonne mobile crane (or alternatively a 300-400 tonne crawler crane) together with the small mobile crane, would be required to erect the turbines once ground assembly is complete.

Assembly of the rotor blade to the turbine requires a defined working area; accordingly a 25 m radius buffer (involving clearing of vegetation) has been used to ensure safe construction. Erection is likely to take approximately 2-3 days per turbine. Depending on the configuration, the crane may require up to 2 days to disassemble and remobilise to a new site.

Image 10: A range of typical turbine construction photographs. Photos courtesy: Wind Prospect CWP

Operation

Once operational, the wind farm would be monitored both by on-site staff and through remote monitoring. Aspects of the wind farm operation to be dealt with by on-site staff would include safety management, environmental condition monitoring, landowner management, routine servicing, malfunction rectification and site visits. Those functions to be overseen by remote monitoring include turbine performance assessment, wind farm reporting, remote resetting and maintenance coordination.

Pro-active computer control systems monitor the performance of the wind turbines and ensure that any issues are dealt with by on-site staff or contractors, as appropriate.

Servicing and Maintenance

Maintenance staff are likely to be on-site throughout the year, making routine checks of the wind turbines on an ongoing basis. Major planned servicing would be carried out approximately twice a year on each wind turbine. Each major service visit would potentially involve a number of service vans (two technicians per van) on-site.

Refurbishment

After approximately 20-25 years of operation (or sooner if deemed economically viable) the blades, nacelles (top section of the turbine) and towers could be removed and replaced. Old blades, nacelles and towers are removed from site for recycling and new components installed on existing or new foundations, as appropriate. Refurbishment would extend the life of the wind farm for a further 20 years.

Any material change to the wind farm layout, or significant changes to the turbine technology, will be referred to the NSW Department of Planning as an amended proposal. It would also be subject to the regulations and guidelines of the day, including a new planning consent for the proposed redevelopment. Refurbishment requires the transportation and installation equipment and facilities, similar to that used during initial construction.

De-commissioning

At the end of the operational life of the wind farm, the turbines and all above ground infrastructure will be dismantled and removed from the site. This includes all the interconnection and substation infrastructure. The tower bases would be cut back to below ploughing level or topsoil built up over the footing to achieve a similar result. The land will be returned to prior condition and use. A compressor and rock breaker may be needed to carry out the cutting work.

The access roads, if not required for farming purposes or fire access, would be removed and the site reinstated to its original condition and use. Access gates, if not required for farming purposes, would also be removed. Individual landowners will be involved in any discussion regarding the removal or hand-over of infrastructure on their property.

The underground cables are buried below ploughing depth and contain no harmful substances. They can be recovered if economically viable or left in the ground. Terminal connections would be cut back to below ploughing levels.

Fire Management

A fire management plan is an important part of both wind farm planning and the community consultation process. All aspects of the Project will adhere to the relevant current guidelines on bushfire protection.

Despite the low risk that wind farms present, fire management is a major concern within the Northern Tablelands region of NSW, and planning for fire prevention and an effective and informed response is important. Planning with regard to fire management not only provides wind farm proponents with assurance that minimum damage would result from a fire incident, it also reassures the landowners/local community and enables the RFS to confidently plan and execute an effective response.

The RFS has been notified of the project and further consultation will continue. Details of the project site (such as turbines, access tracks and gate locations) will be provided to assist their internal response planning. Specific fire prevention and response measures are outlined in the Project EMP. Furthermore, an Emergency Response Plan will be developed in consideration of RFS guidelines and further consultation with regional and local rural fire groups, and would include agreed notification protocols, contacts and response actions.

A Bushfire Assessment has been completed for the site under a separate report for the Ecological Assessment.

3 Planning and Assessment Framework

3.1 COMMONWEALTH LEGISLATION

Sapphire Wind Farm is proposed in the context of growing global recognition of the need to mitigate the environmental effects associated with fossil fuel energy generation. The Sapphire Wind Farm will provide an important contribution to the Federal Government's Mandatory Renewable Energy Target (MRET) of 20 % by 2020.

The MRET scheme was introduced in 2001 by the Australian Government with the aim of increasing the uptake of renewable energy in Australia's electricity supply. In 2007, the Government committed to ensuring that 20 % of Australia's electricity supply comes from renewable energy sources by 2020. In July 2008, to inform design of the RET scheme, the COAG Working Group on Climate Change and Water released a consultation paper on the key design issues. Exposure draft legislation on the design of the Renewable Energy Target scheme was released for public comment. This exposure draft legislation reflects the design being considered by the COAG Working Group Climate Change and Water.

3.1.1 Environment Protection and Biodiversity Conservation Act 1999

The primary objective of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is to ‘provide for the protection of the environment, especially those aspects of the environment that are matters of National Environmental Significance.’

Environmental approvals under the EPBC Act may be required for an ‘action’ that is likely to have a significant impact on:

- Matters of National Environmental Significance (known as ‘matters of NES’) being:
  - World Heritage Areas;
  - National Heritage Places;
  - Ramsar wetlands of international importance;
  - Nationally listed threatened species and ecological communities;
  - Listed migratory species;
  - Nuclear actions; and
  - Great Barrier Reef Marine Park.
- Commonwealth marine areas; and
  - Commonwealth heritage places.
    - Actions taken on Commonwealth land that are likely to have a significant impact on the environment;
    - Actions that are likely to have a significant impact on the environment of Commonwealth land, even if the action is taken outside Commonwealth land; and
    - Any action taken by a Commonwealth agency that is likely to have a significant impact on the environment.

An ’action’ is considered to include a project, development, undertaking, activity or series of activities.

Of potential relevance to the site are matters of NES which include nationally listed threatened species and ecological communities and listed migratory species.

One Critically Endangered Ecological Community (CEEC) listed under the EPBC Act is present across the study area, White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (DNG) (hereafter referred to as ‘Box-Gum Woodland’ and ‘derived Box-Gum Woodland’).

Four threatened flora species listed under the EPBC Act have been recorded within the Project Site and Study Area of Sapphire Wind Farm:

- *Bothriochloa biloba* (Lobed Bluegrass);
- *Dichanthium setosum* (Bluegrass);
- *Eucalyptus mckieana* (McKie’s Stringybark); and
- *Thesium australe* (Austral Toadflax).

A number of migratory and threatened bird species also have the potential to occur within the study area but were not recorded during the field surveys.

A Referral under the EPBC Act was submitted to Department of Sustainability, Environment, Water, Population and Communities (DSEWPAC) in February 2011 for the likely impacts of the proposal on the Box-Gum Woodland (BGW). All impacts on threatened flora have been avoided through modifications to the proposal layout. A decision to deem the proposal a Controlled Action under the EPBC Act was made on 31 March 2011 (EPBC Ref: 2011/5854).

In January 2007, the Commonwealth and NSW Governments signed a Bilateral Agreement which allows the assessment regimes under Part 3A of the NSW EP&A Act to be automatically accredited under the EPBC Act. However, in light of recent planning reforms the Commonwealth is reviewing the application of the NSW Assessment Bilateral to projects subject to this part of the Act which have been determined a Controlled Action under the EPBC Act. The review is scheduled for completion but until a decision has been made the NSW Bilateral Assessment will no longer automatically apply to eligible Part 3A projects which have been deemed a Controlled Action.

Consequently, the Department of Planning and Infrastructure (DoPI, formerly the Department of Planning) has requested that the assessment for Sapphire Wind Farm under Part 3A be subject to a one-off accredited assessment process and agreed that the assessment would be subject to the general administrative steps outlined in the NSW Assessment Bilateral administrative procedures.

Initial DGRs for the proposal were issued in 2008 and revised DGRs were also issued on 23 February 2011. As a consequence of the one-off accredited assessment process, supplementary DGRs were prepared in consultation with DSEWPAC and issued in May 2011.

EPBC Act Significance Assessments have been conducted for those Matters of NES considered to have the potential to occur within the study area. The supplementary DGRs also listed a number of threatened species for which DSEWPAC required EPBC Significance Assessments to be completed. These are included in Appendix K.

3.2 NEW SOUTH WALES LEGISLATION

3.2.1 Environmental Planning and Assessment Act 1979

The NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) is the principal planning legislation for NSW. It provides a framework for land use control and assessment, determination and management of development. Part 3A of the Act facilitates major project and infrastructure delivery of development which is of significance to the State and encourages economic development, while strengthening environmental safeguards and community participation.

In 2008, the Department of Planning issued the initial Director-General's Requirements (DGRs) pursuant to Section 75U (f) of the EP&A Act to Wind Prospect CPW Pty Ltd. On 23 February 2011, supplementary DGRs were issued to Wind Prospect CPW Pty Ltd. Glen Innes Severn and Inverell Councils, NSW Department of Primary Industries and the Office of Environment and Heritage (which at the time was named the Department of Environment, Climate Change and Water (DECCW)) were provided with the opportunity to have input into the DGRs for this project prior to their issuing. As a consequence of a one off accredited assessment process, further DGRs were issued in May 2011 to incorporate EPBC Act Matters of National Environmental Significance (NES) and DSEWPAC requirements,

A copy of the DGRs for the Sapphire Wind Farm are included at **Appendix B**.

On 11 November 2009, the Minister for Planning declared certain power generating facilities "critical infrastructure projects" under Part 3A if they have capacity to generate at least 30 MW and are subject to an application lodged pursuant to Section 75E or section 75M of the EP&A Act. The proposal has the capacity to generate more than 30 MW of energy and is the subject of an application lodged prior to 1 January 2013. As such it is to be assessed under Part 3A of the EP&A Act as a Critical Infrastructure Project. The NSW Department of Planning and Infrastructure (DoPI) (formerly Department of Planning) will be the assessment authority and consent is required from the Minster for Planning and Infrastructure.

An assessment of the potential impacts of the proposal in accordance with the Part 3A requirements and the DGRs was made. For those residual impacts that could not be avoided or mitigated, environmental offsets consistent with the DECCW Interim Policy on assessing and offsetting biodiversity impacts of Part 3A development (DECCW 2010) were investigated, including application of the Biobanking Assessment Methodology (BAM) to "inform" the quantum of offsets required in accordance with the Biodiversity Offset Principles.

Biobanking

Biobanking is a voluntary market-based scheme that provides a streamlined biodiversity assessment process for development, a rigorous and credible offsetting scheme as well as an opportunity for rural landowners to generate income by managing land for conservation. Biobanking establishes an 'improve or maintain' test for biodiversity values. Improving or maintaining biodiversity values means avoiding areas of high biodiversity value, and offsetting impacts on other areas. The offsets are measured in terms of credits, using the Biobanking Credit Calculator Tool.

A Biobank assessment was undertaken by an accredited Biobank Assessor (Appendix I) for the proposal to provide guidance on the size/area of the offset requirements in accordance with the 'improve and maintain' requirement included in the DGRs.

3.2.2 Threatened Species Conservation Act 1995

The TSC Act aims to protect and encourage the recovery of threatened species, populations and communities listed under the Act. The Act is integrated with the NSW EP&A Act and requires consideration of whether a major infrastructure or other project (Part 3A of the EP&A Act), a development (Part 4 of the EP&A Act) or an activity (Part 5 of the *EP&A Act*) is likely to significantly affect threatened species, populations and ecological communities or their habitat.

The following species and communities listed under the TSC Act have been recorded across the study area:

- White Box-Yellow Box-Blakely's Red Gum Woodland and derived native grassland (EEC);
- Ribbon Gum, Mountain Gum, Snow Gum Grassy Forest/Woodland of the New England Tableland Bioregion (EEC);
- *Stagonopleura guttata* (Diamond Firetail);
- *Glossopsitta pusilla* (Little Lorikeet);
- *Climacteris picumnus victoriae* (Brown Treecreeper);
- *Melanodryas cucullata cucullata* (Hooded Robin);
- *Neophema pulchella* (Turquoise Parrot);
- *Petroica boodang* (Scarlet Robin);
- *Pyrrholaemus sagittatus* (Speckled Warbler);
- *Falsistrellus tasmaniensis* (Eastern False Pipistrelle);
- *Saccolaimus flaviventris* (Yellow-bellied Sheathtail Bat);
- *Scoteanax rueppellii* (Greater Broad-nosed Bat);
- *Miniopterus schreibersii* (Eastern Bentwing-bat);
- *Vespadelus troughtoni* (Eastern Cave Bat);
- *Dichanthium setosum* (Bluegrass);
- *Eucalyptus mckieana* (McKie’s Stringybark); and
- *Thesium australe* (Austral Toadflax).

3.2.3 Fisheries Management Act 1994

The *Fisheries Management Act 1994* (FM Act) aims to conserve, develop and share the fishery resources of NSW for the benefit of present and future generations. The FM Act defines ‘fish’ as any marine, estuarine or freshwater fish or other aquatic animal life at any stage of their life history, exclude whales, mammals, reptiles, birds, amphibians or species specifically excluded.

No threatened fish species, or endangered populations are known to occur within the study area. In accordance with section 75U of the EP&A Act, applications for separate permits under section 201, 205 or 219 of the *Fisheries Management Act 1994* are not required as these matters are addressed and approved as part of the EP&A Part 3A process.

3.2.4 Noxious Weeds Act 1993

The *Noxious Weeds Act 1993* defines the roles of government, councils, private landholders and public authorities in the management of noxious weeds. The Act sets up categorisation and control actions for the various noxious weeds, according to their potential to cause harm to our local environment.

The objectives of the *Noxious Weeds* Act 1993 (NW Act) include:

- To identify noxious weeds in respect of which particular control measures need to be taken;
- To specify those control measures;
- To specify the duties of public and private landholders as to the control of those noxious weeds; and
- To provide a framework for the State-wide control of those noxious weeds by the Minister and local control authorities.

Under this Act, noxious weeds have been identified for Local Government Areas and assigned Control Categories (e.g. 1, 2, 3, 4 or 5). Part 3 provides that occupiers of land (this includes owners of land) have responsibility for controlling noxious weeds on the land they occupy.

Noxious Weeds will be controlled in accordance with the Act with measures typically outlined in CEMP and OEMPs.

3.3 STATE ENVIRONMENTAL PLANNING POLICIES

3.3.1 State Environmental Planning Policy 44 (Koala Habitat)

State Environmental Planning Policy 44 (Koala Habitat) aims to encourage the proper conservation and management of areas of natural vegetation that provide habitat for koalas to ensure a permanent free-living population over their present range and reverse the current trend of koala population decline. SEPP 44 applies to the Inverell LGA.

Koalas have previously been recorded within the locality and there is one record of this species within the study area along the Western Feeder (1994) and a number of other Koala records along Kings Plains Road (1986, 1996), outside the study area (DECCW 2011a). Schedule 2 of SEPP 44 includes a list of Koala feed tree species. *Eucalyptus viminalis* (Ribbon Gum) and *Eucalyptus albens* (White Box) is listed on Schedule 2 and is present across the project site.

Section 75R of the EP&A Act excludes, with respect to critical infrastructure projects, all environmental planning instruments (other than SEPPs that specifically relate to the project) and council orders under Division 2A of Part 6. An assessment under SEPP 44 is, therefore, not required. However, as a threatened species Koala habitat has been assessed as part of the proposed development impacts.

3.4 LOCAL GOVERNMENT PLANS

The Sapphire Wind Farm falls within the Glen Innes Severn and Inverell Shire Council areas. The proposal is to be assessed under Part 3A of the EP&A Act and, therefore, DoPI are the consent authority. However, both Councils provided input into the EARs prior to their issuing. The issues that these Councils requested to be considered in the EARs included:

- Cumulative Effects;
- Mitigation of noise;
- Erosion and sediment control;

- Sourcing of and impacts on local materials and water resources used in construction;
- The capacity for Council infrastructure to be able to withstand the construction;
- Noxious and environmental weed management;
- Bushfire risk;
- Impact on traffic during construction; and
- Social impacts.

The wind farm site is currently zoned 1(a) Rural under both the Inverell Local Environmental Plan (LEP) 1988 and the Glen Innes Severn LEP 1991. The Inverell LEP neither prohibits the development, nor allows it without development consent; therefore, it is permissible once development consent has been granted.

Glen Innes Severn Council has a specific Development Control Plan (DCP) relating to Wind Power Generation adopted on the 22nd of May 2008. These DCPs do not prohibit the development of wind power generation.

- These DCPs recommend flora and fauna assessments include consideration of the following: AUSWIND Wind farms and Birds: Interim standards for risk assessment (as amended); and

- Department of Environment and Heritage, Wind Farm Collision Risks for birds – Cumulative Risk for threatened and migratory species.

4 Ecological Site Assessment

4.1 LITERATURE REVIEW

A review of all readily available literature and database records pertaining to the ecology of the study area and surrounding locality were reviewed to provide important background information for this assessment. Existing vegetation mapping and other available GIS data were also utilised. Information reviewed included:

- Office of Environment and Heritage (OEH) (formerly DECCW) Threatened Species Database (10 km radius) (DECCW 2011a);
- Department of Sustainability, Environment, Water, Population and Communities (DSEWPAC) Online search for Matters of National Environmental Significance (Accessed February 2011);
- Australian Museum Fauna Database Records (2008);
- Royal Botanic Gardens Threatened Flora Database Records (2008);
- Birds Australia Threatened and Migratory Species Database Records (2009);
- SPOT Imagery (2009);
- Vegetation of the Bellata, Gravesend, Horton and Boggabri 1:100 000 map sheets (Cannon *et. al.* 2002);
- Vegetation of the Cobbora, Coolah, Coonabarabran, Mendooran, Tambar Springs 1:100 000 map sheets (Centre for Natural Resources 2004); and,
- Yallaroi, Ashford, Bingara and Inverell 1:100 000 map sheets (Geoscience Australia 1998).

An assessment of likelihood of occurrence was made for threatened and migratory species identified from the database searches or considered to have the potential to occur within the locality. Five terms for the likelihood of occurrence of species are used in this report. This assessment was based on database or other records, presence or absence of suitable habitat, features of the proposal study area, results of the field survey and professional judgement. The terms for likelihood of occurrence are defined below:

- “yes” = the species was or has been observed on the site;
- “likely” = a medium to high probability that a species uses the site;
- “potential” = suitable habitat for a species occurs on the site, but there is insufficient information to categorise the species as likely to occur, or unlikely to occur;
- “unlikely” = a very low to low probability that a species uses the site; and
- “no” = habitat on site and in the vicinity is unsuitable for the species.

4.2 METHODS

Field surveys were undertaken by ELA ecologists from October 2008 to January 2011. Surveys included vegetation and biometric vegetation type and condition mapping and targeted searches for threatened flora and fauna considered likely to occur or with potential habitat (**Appendix C**). Surveys began as full systematic surveys in Spring/Summer 2008, before Biobanking surveys were adopted from February 2009 so that Biobanking could be used to inform quantum of offsets. Further detail regarding the methodology used for the project has been provided below and a list of field staff and their qualifications is provided in Table 7.

Table 7: Eco Logical Australia field team

STAFF MEMBER	QUALIFICATIONS
Bruce Mullins	Master of Science, University of Technology, Sydney. Bachelor of Science, University of Technology, Sydney
Nathan Smith	Bachelor of Science (Resource & Environmental Management), School of Earth Sciences, Macquarie University, Sydney. Certificate IV Bushland Regeneration, School of Horticulture, Northern Sydney Institute of Technology and Further Education, Ryde.
Peter Richards	Bachelor of Science, majors in Botany and Zoology, University of New England, Armidale, NSW,
Lachlan Copeland	Bachelor of Natural Resources (Honours), University of New England.
Liz Norris	Master of Science, Macquarie University, Sydney. Bachelor of Science, Macquarie University, Sydney.
Tammy Haslehurst	Bachelor of Environmental Science (Honours), Macquarie University.
Anna Foley	Bachelor of Science (Honours) in Geography (Freshwater Ecology), University of Melbourne, Parkville VIC.
Simon Tweed	Bachelor of Environmental Science Honours (Class II, Division 1) University of Wollongong
Hamish MacKinnon	Bachelor of Natural Resources\Bachelor of Urban and Regional Planning - University of New England
Alicia Lyon	Bachelor of Science (Ecology and Biogeography), University of Wollongong 1998
Rhiannan Smith	PhD in Natural Resources, University of New England Bachelor of Natural Resources, University of New England

4.2.1 Survey Conditions

Weather conditions for each survey period are summarised below in Table 8. Weather conditions varied over the life of the project. Throughout the 2008/2009 surveys the conditions during the survey period were generally mild, with very little rainfall. Heavy rainfall, and in some cases minor flooding, and a flush of vegetation growth occurred during the 2010/2011 survey period.

Wind patterns were highly variable with moderate winds experienced on many days throughout the survey period with very few still days. In some instances, strong winds were experienced although this was not common.

The prolonged drought being experienced throughout the northern tablelands throughout 2008 / 2009 is likely to have influenced the findings of this study during this period. The change in vegetation condition was particularly noticeable between the 2010 September surveys and December 2010 / January 2011 as the high levels of rainfall fell between September 2010 and January 2011.

Table 8: Summary of Survey Conditions (averages) (BOM 2011)

SURVEY PERIOD	MAXIMUM TEMPERATURE (°C)	MINIMUM WIND SPEED (KM/HR)	MAXIMUM WIND SPEED (KM/HR)	MAXIMUM AVERAGE WIND SPEED PER MONTH (KM/HR)	NOTABLE WEATHER CONDITIONS
27-30 October 2008	26.5	7	56	NA	
10-14 Nov 2008	21.4	13	56	NA	
1-3 Dec 2008	25.5	11	54	NA	
20-24 Apr 2009	20.8	13	50	NA	
4-15 May 2009	17.1	4	46	NA	
20-29 Sep 2010	21	2	54	40.6	Highest temp for the month occurring during survey period. 55mm of rainfall fell throughout the survey period
13-15 Oct 2010	18	9	72	41	
1-3 Dec 2010	21	17	46	41	Total of 17.9 mm rain
10-14 Jan 2011	25.5	13	61	44	Total of 118mm of rain , 80mm occurring on 11/01/11
17-21 Jan 2011	29.5	11	70	44	Highest wind speed for the month occurring during survey period. 12.2mm of rainfall during the survey period

4.2.2 Site Reconnaissance

A site reconnaissance was undertaken 27 – 30 October 2008, prior to the detailed field surveys, to verify site access, the broad vegetation types and condition, fauna habitat present across the study area and to select survey sites for the detailed surveys. This information was then used in conjunction with the DGRs and Biobanking “species requiring survey” to determine the survey requirements. Incidental flora and fauna observations were also made at this time.

4.2.3 Vegetation Mapping

Vegetation mapping was undertaken across two survey periods as a consequence of changes to the proposed layout; December 2008 and September 2010. Mapping was undertaken to coincide with periods considered appropriate for determining the overall condition of the vegetation types (i.e. dominance of native or exotic species) and detailed floristic surveys were undertaken during the season in which there was the greatest likelihood of detecting the majority of herbs and forbs present within the study area.

The boundaries of vegetation communities were mapped onto an aerial photograph and marked using a GPS. Mapping within the study area was ground-truthed and areas across the project site that fell outside the study area were mapped based on visual observations and predictions based on the findings within the study area.

ArcMap Version 9.2, a Geographic Information System (GIS), was used to map and interpret data in this report. Vegetation communities and records of threatened species were plotted onto geo-referenced aerial photographs and other maps at scales of 1:50,000. This program was then used to calculate areas of each vegetation community and other habitats across the site.

Revised Biometric Vegetation Types

Vegetation mapping was undertaken in accordance with the Biobanking Assessment Methodology using Revised BioMetric Vegetation Types (RBVTs) as this allowed the Biobanking Credit Calculator to be used to inform the quantum of any required offsets (DECC 2009). RBVTs are the only vegetation types used in Biobanking assessments. For Biobanking, the RBVT from the relevant CMA region that has the closest resemblance to the vegetation at the site is selected / mapped (i.e. in 1750, or pre-clearing). That is, the RBVT should be the original type at the site, not the derived type. Derived types must only be selected where the original vegetation type cannot be determined (DECC 2009). Some vegetation observed in the field did not fit neatly into any of the RBVTs listed for the Border – Rivers Gwydir CMA (e.g., where the vegetation lies in an ecotone between two types). In such cases, the professional judgment of the assessor was used to select the closest matching RBVT. Further details on the Biobanking methodology, with respect to vegetation mapping and flora and fauna survey, is provided in Sections 4.2.5 and Appendix I.

As the study area has been modified and subject to many years of clearing and grazing, the dominant species and vegetation boundaries present today are unlikely to accurately reflect the vegetation types and boundaries of the past. Given the difficulty in determining historical RBVT boundaries, there is the potential for a degree of professional judgement in this mapping.

Biobanking Condition Assessment

The condition of each of the RVBTs was categorised as being in either biometric ‘moderate – good’ or ‘low’ condition or ‘cleared’ land, thus creating ‘Biobanking Vegetation Zones’.

Ancillary Codes were also assigned to each of the Vegetation Zones in moderate - good condition to create the Threatened Species Sub-zones. No Ancillary Codes were assigned to vegetation in ‘low’ condition.

Box–Gum Woodland EEC as Defined by the EPBC Act

Under the EPBC Act, the Box–Gum Woodland EEC includes areas of ‘derived’ native pasture provided:

- The patch has a predominantly native understorey
- The patch size is greater than 0.1 hectares in size;
- The patch has 12 or more native non-grass species; and
- At least one ‘important’ herbaceous species (including grasses) is present.

Within the study area, species lists for RBVTs equivalent to Box–Gum Woodland (i.e. BR116 and BR240) from the Biobanking quadrats were utilised to determine whether the areas mapped as these units equated to the EPBC Act definition of Box–Gum Woodland.

4.2.4 Flora and Fauna Surveys

Detailed flora and fauna surveys were undertaken across the study area from October 2008 to January 2011 in accordance with the Department of Environment and Climate Change’s (DEC) *Threatened Biodiversity Survey and Assessment Guidelines* Working draft (DEC 2004), those species requiring site survey as determined by the Biobanking Credit Calculator, and the DGRs issued by DoP. Survey periods were designed to target species during the seasons in which they were likely to be most detectable, active or in flower. Surveys included vegetation and Biobanking mapping and targeted searches for threatened flora and fauna.

Survey Effort & Timing

Table 9 outlines the survey effort undertaken across the study area and the timing of each survey. Surveys for Booroolong Frog were not conducted as no suitable habitat (i.e. rocky creeks/streams) existed within the study area.

Table 9: Survey effort and timing

TARGET SPECIES	SAMPLING TECHNIQUE	SURVEY PERIOD	SURVEY EFFORT
Endangered Ecological Communities			
White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Vegetation validation and quadrats	December 2008 – January 2011	Vegetation validation and mapping 55 Biobanking and 4 full floristic quadrats (some within and some adjacent to study area) 18 Local benchmark plots
Ribbon Gum, Mountain Gum, Snow Gum Grassy Forest/Woodland of the New England Tableland	Vegetation mapping, quadrats, traverses	December 2008 – January 2011	

TARGET SPECIES	SAMPLING TECHNIQUE	SURVEY PERIOD	SURVEY EFFORT
Threatened Flora			
Threatened Flora Requiring Survey	Seasonal and systematic searches (random meander transects) across all areas of potential habitat within a 200 m wide corridor.	27 – 30 October 2008 10 – 14 November 2008 1 – 3 December 2008 20 – 24 April 2009 4 – 15 May 2009 20 – 29 September 2010 13 – 15 October 2010 1 – 3 December 2010 10 – 14 January 2011 17 – 21 January 2011	Approximately 376 person hours
Threatened Fauna			
Booroolong Frog	Surveys not conducted as no habitat present.		
Border Thick-tailed Gecko	Rock rolling	10 – 14 November 2008 1 – 3 December 2008 4 – 15 May 2009	6 person hours (in potential habitat) plus opportunistic rolling (in marginal habitat)
Threatened Birds	Diurnal bird surveys Incidental observations	27 – 30 October 2008 10 – 14 November 2008 1 – 3 December 2008 20 – 24 April 2009 4 – 15 May 2009	48 diurnal bird surveys – 16 person hours (20 min each)
Mammals	Spotlighting	10 – 14 November 2008	16 person hours
	IR camera	4 – 15 May 2009 20 – 29 September 2010	11 nightsper camera (3 cameras) 8 nights per camera (4 camera)
Owls	Call playback	10 – 14 November 2008 20 – 29 September 2010	4 call playback nights 7 call playback nights
	Spotlighting	10 – 14 November 2008	16 person hours
Microbats	Anabat Detection	1 – 3 December 2008 4 – 15 May 2009 20 – 29 September 2010	47 Anabat nights 13 Anabat nights

Matters of NES

***Anthochaera phrygia* (Regent Honeyeater) and *Lathamus discolor* (Swift Parrot)**

April 2009 and May 2009 survey periods coincided with the survey periods for the Regent Honeyeater and Swift Parrot. Although surveys were not undertaken strictly in accordance with DEWHA guidelines of 20 hrs of survey per 50 ha of habitat over 10 days and 8 days respectively (DEHWA 2010a), the survey effort undertaken is considered a significant amount of survey effort for these species. Furthermore, the period during which bird surveys were undertaken for this project pre-date the release of the SEWPAC survey guidelines.

Regent Honeyeater is known to breed in only a few locations, and the study site is not one of these sites. Therefore, the site represents potential foraging habitat. In the absence of a survey that complied with the survey guidelines, this species has been presumed to occur on site for foraging.

***Dasyurus maculatus* (Spot-tailed Quoll)**

Seven infra-red cameras were placed across the study area during May 2009 and September 2010 over a total of 18 nights. A lurer of chicken wings was used to attract quolls into the cameras field of view during May 2009 to target Quolls. Although surveys for this species pre-dated the release of suvrey guidelines, the use of remote cameras over a three week period is recommended. Based on the current surveys, approximately 65 camera nights were surveyed which would exceed the guideline requirements.

***Nyctophilus corbeni* (South-eastern Long-eared Bat)**

Nyctophilus corbeni inhabits a variety of vegetation types, including mallee, *Allocasuarina leuhmanni* (Bulloke) and box eucalypt dominated communities, but it is more common in box/ironbark/cypress-pine vegetation that occurs in a north-south belt along the western slopes and plains of NSW and southern Queensland (DECCW 2011b). The species roosts in tree hollows, crevices, and under loose bark. Anabat surveys were undertaken across the site. However, the calls of *Nyctophilus* spp. are difficult to tell apart. For this reason, presence of the species on site has been assumed when undertaking the assessment of impacts on this species.

***Astrotricha roddii* (Rod's Star Hair)**

Vegetation surveys and targeted surveys were conducted across the proposed development footprint in suitable habitat during October-December 2008, September-October 2010 and January 2011, during the species known flowering period.

***Digitaria porrecta* (Finger Panic Grass)**

Vegetation surveys and target surveys were conducted across the proposed development footprint in suitable habitat during January 2011, during the species known flowering period.

***Diuris pedunculata* (Small Snake Orchid)**

Vegetation surveys and target surveys were conducted across the proposed development footprint in suitable habitat during October 2008 and September-October 2010, during the species known flowering period.

***Picris evae* (Hawkweed)**

Vegetation surveys and targeted surveys were conducted across the proposed development footprint in potential habitat during October-December 2008, September-October and December 2010 and January 2011, during the species known flowering period.

Flora Quadrats

In accordance with the DEC (2004) *Draft Survey Guidelines* and Biobanking Assessment Methodology as outlined in the *Biobanking Assessment Methodology and Credit Calculator Operational Manual* (BAMCCOM) (DECC 2009), 55 biometric vegetation condition plots were randomly placed within each vegetation zone in accordance with the minimum number of plots required (Table 4 of the BAMCCOM).

Four full floristic (i.e. non-biobanking plots) were also undertaken. All species present within each quadrat were recorded and a cover abundance ranking assigned to each species. Notes were also taken on the dominant species, the level of weed invasion and any other signs of disturbance. Figure 5 shows the location of each of the vegetation quadrats throughout the study area.

Any specimens unidentifiable in the field were retained and later identified. Any specimens that were thought to be threatened species or for which identification was problematic were sent to the Herbarium at the Royal Botanic Gardens, Sydney for verification.

Fauna Habitat

For highly mobile species such as birds and bats, habitat was not mapped across the study area although areas of potential habitat are identified within Section 5.4.4 of this report. Habitat for arboreal mammals was not mapped as the boundaries of woodland vegetation can be clearly seen on the aerial photograph.

A summary of key habitat features present across the site has been included and the vegetation types in which each is present identified.

Hollow-bearing Tree Counts

Given the size and extent of the study area it was not possible to map all hollow-bearing trees across the site. However, data on the density and distribution of hollows was collected and used to estimate the likely number of hollows to be impacted by the proposal.

Plot data (20 m x 50 m) collected as part of the Biobanking assessment has been used to estimate the likely number of hollows per hectare of vegetation type and a broad estimate of the number of hollows to be cleared by the proposal. It is crucial to note that this data is extrapolated and an estimate.

Notes were also made in the field for areas where hollow densities were noticeably high.

4.2.5 Biobanking

The Biobanking Assessment was undertaken in accordance with the BAMCCOM (DECC 2009). Full details of the assessment are included in **Appendix I**.

Biobanking Target Species

The Biobanking Credit Calculator requires targeted survey for six threatened flora and eight threatened fauna species (Table 10). Whilst not predicted by the credit calculator, *Eucalyptus mckieana*, has been recorded in the study area and has thus been included in the survey requirements.

Table 10: Biobanking Species Requiring Survey

SCIENTIFIC NAME	COMMON NAME
Flora	
Dichanthium setosum	Bluegrass
Diuris pedunculata	Small Snake Orchid
Eucalyptus nicholii	Narrow-leaved Black Peppermint
Picris evae	Hawkweed
Polygala linariifolia	Native Milkwort
Thesium australe	Austral Toadflax
Fauna	
Circus assimilis	Spotted Harrier
Hieraaetus morphnoides	Little Eagle
Hoplocephalus bitorquatus	Pale-headed Snake
Litoria booroolongensis	Booroolong Frog
Lophoictinia isura	Square-tailed Kite
Poephila cincta cincta	Black-throated Finch (southern subspecies)
Pteropus poliocephalus (Breeding Habitat)	Grey-headed Flying-fox (Breeding Habitat)
Underwoodisaurus sphyrurus	Border Thick-tailed Gecko

Given that an application for a Biobanking Statement is not being requested for the proposal, as it will be assessed under Part 3A of the EP&A Act, more detailed flora and fauna surveys were undertaken across the site in accordance with the DGRs (**Appendix B**). Surveys were undertaken for nine of the species listed on the basis that potential habitat was present on site.

4.2.6 Limitations

General

The survey effort and study design optimised the potential for species to be recorded during a range of climatic situations and over a number of seasons. Nonetheless, it is not possible to record every species that may either be resident or transitory across a site as generally some species may have been inactive, dormant or with cryptic habits, or some may be nomadic or migratory in nature. Additionally, some fauna species are mobile or transient in their use of resources. Consequently, it is likely that not all species would have been recorded during the study period even though it extended from October 2008 to January 2011 and, therefore, the likelihood of occurrence within the study area of some threatened species was assessed based on the presence of potential habitat.

Given the limitations associated with all surveys, this assessment was not intended to provide an inventory of all species present across the site but instead aims to provide an overall assessment of the ecological values of the site with particular emphasis on threatened species, endangered ecological communities and key fauna habitat features.

Vegetation community boundaries

Vegetation mapping of an area seeks to describe the distribution of the plant species in that area at that time by defining a number of vegetation units (assemblages or communities), which are relatively internally homogeneous. This generalised approach can over simplify the real situation as plants rarely occur in well-defined communities with distinct boundaries. Accordingly, vegetation units used for mapping should be viewed as indicative of their extent.

Species composition

Due to ongoing grazing within some parts of the study area (the study area consists of 22 rural properties that are primarily run as sheep and cattle enterprises), difficulty was experienced identifying some species as specimens were inadequate. Flora were identified to the lowest taxonomic level possible with the vegetative material available.

Biobanking ancillary codes

The condition of each vegetation zone across the landscape in terms of grazing intensity is dynamic, with routine agricultural clearance permitted. Therefore, our assessment and use of ancillary condition codes illustrates a snap shot in time that does not necessarily reflect the future condition of each vegetation zone.

Mapping data limitations

Spatial co-ordinates for features, habitats or species, recorded in the field were captured using a Garmin GPSmap 76 (GPS) and transferred to ArcGIS Geographic Information Systems (GIS) programs. The accuracy of GPS readings varies depending on the number of signals obtained by the GPS unit from satellites. Where possible GPS points were only taken when the accuracy was < 10 m. Sub 10 m accuracy was considered appropriate for this assessment.

4.3 RESULTS

4.3.1 Vegetation Mapping

Six Border Rivers – Gwydir CMA RBVTs were mapped throughout the study area and the broader locality (Figure 8). They are outlined in Table 11 along with their TSC and EPBC Act EEC equivalents. A brief description of each of the RBVTs found within the study area is provided below.

Table 11: Revised Biometric Vegetation Types and EEC Equivalent

REVISED BIOMETRIC VEGETATION TYPE	TSC ACT EEC	EPBC ACT CEEC
BR110: Black Cypress Pine – Tumbledown Gum – Narrow-leaved Ironbark open forest of northern parts of the Nandewar Bioregion	-	-
BR114: Blakely's Red Gum – Rough-barked Apple – Red Stringybark grassy open forest of the Western New England Tablelands	-	-
BR116: Blakely's Red Gum – Yellow Box grassy open forest or woodland	White Box Yellow Box Blakely's Red Gum Woodland (Box Gum	White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (Box-Gum

REVISED BIOMETRIC VEGETATION TYPE	TSC ACT EEC	EPBC ACT CEEC
of the New England Tablelands	Woodland)	Woodland)
BR153: Manna Gum – Rough-barked Apple – Yellow Box grassy woodland/open forest of the New England Tablelands and North Coast	Ribbon Gum, Mountain Gum, Snow Gum Grassy Forest/Woodland of the New England Tableland Bioregion	-
BR227: Tenterfield Woollybutt – Silvertop Stringybark open forest of the New England Tablelands	-	-
BR240: White Box grassy woodland of the Nandewar and Brigalow Belt South Bioregions	White Box Yellow Box Blakely's Red Gum Woodland (Box Gum Woodland)	White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (Box-Gum Woodland)

Given the study area is used for agricultural purposes these vegetation types are impacted by varying degrees of weed invasion, grazing and soil disturbance depending on the land use practices on each property.

BR110: Black Cypress Pine – Tumbledown Gum – Narrow-leaved Ironbark open forest

BR110 was an open forest type largely associated with acid volcanic outcrops in the locality. For the most part this RBVT had been cleared within the study area, however, resilience (i.e. regenerative capacity) was considered to be good due to a lack of disturbance to the soil profile in these areas.

BR110 was dominated by *Eucalyptus dealbata* (Tumbledown Gum) and *E. crebra* (Narrow-leaved Ironbark), while *Callitris endlicheri* (Black Cypress Pine) was present mostly as juvenile regrowth. *Eucalyptus laevopinea* (Silvertop Stringybark) was present as a co-dominant tree species while *Notelaea microcarpa* (Native Olive), *Monotoca scoparia*, *Lespedeza juncea* subsp. *sericea* and *Indigofera australis* (Australian Indigo) were occasionally present as shrubs. A variety of native herbs and grasses dominated the ground layer and included species such as *Aristida ramosa* (Purple Wiregrass), *Bothriochloa macra* (Red Grass), *Poa sieberiana* (Snow Grass), *Calotis cuneata* (Mountain Burr-Daisy), *Desmodium varians* (Slender Tick-trefoil), *Geranium solanderi* (Native Geranium) and *Wahlenbergia communis* (Tufted Bluebell).

<u>Conservation Significance</u>

BR110 does not equate to an EEC as listed under the TSC or EPBC Acts.

It is estimated that 40% of this vegetation type has been cleared within the Border Rivers-Gwydir CMA.

BR114: Blakely's Red Gum – Rough-barked Apple – Red Stringybark grassy open forest

BR114 was an open forest type and was associated with acid volcanic outcrop within the study area. This vegetation has been modified in some areas, but has retained some ecological integrity due to a lack of soil disturbance (and avoiding subsequent weed invasion).

Within the study area, BR114 was dominated by *Eucalyptus blakelyi* (Blakely's Red Gum) and *E. macrorhyncha* (Red Stringybark). *Acacia terminalis* (Sunshine Wattle), *N. microcarpa* and *L. juncea* subsp. *sericea* were occasionally present as shrubs. The ground layer was dominated by a variety of native herbs and grasses that were in common with BR110.

Conservation Status

BR114 does not equate to an EEC as listed under the TSC or EPBC Acts.

It is estimated that 50% of this vegetation type has been cleared within the Border Rivers-Gwydir CMA.

BR116: Blakely's Red Gum – Yellow Box grassy open forest or woodland

Within the study area BR116 was present as an open forest type or woodland and was associated with the basalt flows of the study area. Clearing and grazing were substantial within this RBVT within the study area. Some areas show some resilience with a variety of native grasses and herbs present but for the most part BR116 was degraded due to soil disturbance (tilling and pasture improvement and subsequent weed invasion).

Within the study area, BR116 was dominated by *Eucalyptus blakelyi* (Blakely's Red Gum) and *E. melliodora* (Yellow Box). *Acacia implexa* (Hickory Wattle), *Exocarpos cupressiformis* (Native Cherry) and *Lespedeza juncea* subsp. *sericea* were only present as a sparse layer of shrubs at the benchmark plots. The ground layer of this RBVT was dominated by a variety of herbs and grasses including *Aristida* spp., *Asperula conferta* (Common Woodruff), *Carex inversa* (Knob Sedge), *Cymbopogon refractus* (Barbed Wire Grass), *Desmodium varians* (Slender Tick-trefoil), *Wahlenbergia communis* (Tufted Bluebell) and *Themeda australis* (Kangaroo Grass).

Conservation Status

BR116 equates to the Box–Gum Woodland EEC as listed under the TSC and EPBC Acts.

It is estimated that 80% of this vegetation type has been cleared within the Border Rivers-Gwydir CMA which is considered significant (>70% cleared).

BR153: Manna Gum – Rough-barked Apple – Yellow Box grassy woodland/open forest

Within the study area, BR153 was dominated by *Eucalyptus viminalis* (Ribbon/Manna Gum) and *Angophora floribunda* (Rough-barked Apple), with *E. melliodora* (Yellow Box) less common. Shrubs were largely absent from this RBVT within the study area and the ground layer was dominated by a similar variety of herbs and grasses to BR116.

Conservation Status

BR153 equates to the *Ribbon Gum, Mountain Gum, Snow Gum Grassy Forest/Woodland of the New England Tableland Bioregion* as listed on the TSC Act. There is no equivalent EEC listing on the EPBC Act for this RBVT.

It is estimated that 80% of this vegetation type has been cleared within the Border Rivers-Gwydir CMA which is considered significant (>70% cleared).

BR227: Tenterfield Woollybutt – Silvertop Stringybark open forest

BR227 was an open forest type and was associated with acid volcanic outcrops within the locality.

Within the study area, BR227 was dominated by *Eucalyptus banksii* (Tenterfield Woollybutt), *E. subtilior* and *E. crebra*. The shrub layer was largely removed, however, *Indigofera australis* (Australian Indigo) and *Lespedeza juncea* subsp. *sericea* were occasionally present. The ground layer was typical of the RBVTs associated with acid volcanics as previously described for BR110 and BR114.

Conservation Status

BR227 does not equate to an EEC as listed under the TSC or EPBC Acts.

It is estimated that 30% of this vegetation type has been cleared within the Border Rivers-Gwydir CMA.

BR240: White Box grassy woodland

Within the study area BR240 was present as a woodland type and was associated with the basalt flows largely in the western part of the study area. Clearing and grazing were substantial within this RBVT within the study area. Some areas retained some resilience with a variety of native grasses and herbs present but for the most part BR240 was degraded due to soil disturbance (tilling and pasture improvement) and subsequent weed invasion.

Within the study area, BR240 was dominated by *Eucalyptus albens* (White Box) with *A. floribunda* as an associated species. Shrubs were largely absent while the ground layer was typical of the other units associated with basalt geology, BR116 and BR153.

Conservation Status

BR240 equates to the Box–Gum Woodland EEC as listed under the TSC and EPBC Acts.

It is estimated that 85% of this vegetation type has been cleared within the Border Rivers-Gwydir CMA which is considered significant (>70% cleared).

4.3.2 Biometric Condition Mapping

Condition classes were assigned to all areas based on the condition criteria of "low" and "moderate to good" as outlined in the Biobanking Assessment Methodology (DECC 2009a) (Figure 8).

Ancillary Codes of 'NP' (native pasture) and 'TREES' (wooded areas) were also assigned to each of the RBVTs in moderate/good condition to create 14 Vegetation Zones. Areas of native pasture were defined as those meeting the threshold for moderate -good condition vegetation in the ground-cover but with limited over-storey cover. No Ancillary Codes were assigned to vegetation in biometric low condition.

Table 12: Vegetation zones within the study area

REVISED BIOMETRIC VEGETATION TYPE	BIOBANKING CONDITION (LOW OR MODERATE/GOOD)	VEGETATION ZONE
BR110: Black Cypress Pine – Tumbledown Gum – Narrow-leaved Ironbark open forest	BR110_Moderate/Good	BR110_Moderate/Good_TREES
		BR110_Moderate/Good_NP
BR114: Blakely's Red Gum – Rough-barked Apple – Red Stringybark grassy open forest	BR114_Moderate/Good	BR114_Moderate/Good_TREES
		BR114_Moderate/Good_NP
BR116: Blakely's Red Gum – Yellow	BR116_Moderate/Good	BR116_Moderate/Good_TREES

REVISED BIOMETRIC VEGETATION TYPE	BIOBANKING CONDITION (LOW OR MODERATE/GOOD)	VEGETATION ZONE
Box grassy open forest or woodland		BR116_Moderate/Good_NP
	BR116_LOW	BR116_LOW
BR153: Manna Gum – Rough-barked Apple – Yellow Box grassy woodland/open forest	BR153_Moderate/Good	BR153_Moderate/Good_TREES
		BR153_Moderate/Good_NP
	BR153_LOW	BR153_LOW
BR227: Tenterfield Woollybutt – Silvertop Stringybark open forest	BR227_Moderate/Good	BR227_Moderate/Good_TREES
		BR227_Moderate/Good_NP
BR240: White Box grassy woodland	BR240_Moderate/Good	BR240_Moderate/Good_TREES
		BR240_Moderate/Good_NP
	BR240_LOW	BR240_LOW

4.3.3 Flora

General Flora

A total of 394 species of vascular plants were recorded across the study area. Of these 278 (70 %) were native and 116 (29 %) were exotic species. A list of all species recorded across the study area in included in **Appendix D** by Revised Biometric Vegetation type.

Weeds accounted for approximately 29 % of all species recorded across the study area and often occur in localised patches in paddocks where clearing or spraying had been undertaken. Exotic species common throughout the study area include *Bidens pilosa* (Cobbler's Pegs), *Bromus* spp., *Centaurea solstitialis* (St Barnaby's Thistle), *Carthamus lanatus* (Saffron Thistle), *Chloris truncata* (Windmill Grass), *Cirsium vulgare* (Scotch Thistle), *Conyza bonariensis* (Flax-leaf Fleabane), *Cyclospermum leptophyllum* (Slendery Celery), *Hypochaeris radicata* (Cat's-ear), *Lolium* spp., *Medicago* spp., *Paronychia brasiliana* (Chilean Whitlow Wort), *Paspalum dilatatum* (Paspalum), *Petrorhagia nanteuilii*, *Rosa rubiginosa* (Sweet Briar), and *Trifolium* spp.

Threatened Flora

A number of threatened species are known to occur within the locality or have the potential to occur. Database searches of the locality were undertaken and the results are included in **Appendix C** (DECCW 2011a, RBG 2008, DSEWPAC 2011a). An assessment of the likelihood of each species being present within the study area has been included in **Appendix C** together with their conservation status under both state and Commonwealth legislation and habitat requirements.

Four threatened flora species were recorded across the study area:

- *Bothriochloa biloba* (Lobed Bluegrass) (EPBC Act only);
- *Dichanthium setosum* (Bluegrass);
- *Eucalyptus mckieana* (McKie's Stringybark)*;* and,
- *Thesium australe* (Austral Toadflax).

The locations of each of these species are shown in Figure 9 and population estimates are provided in Table 13.

Table 13: Population estimates for threatened flora recorded within the study area

SPECIES	MAPPED HABITAT AREA (HA)	NUMBER OF INDIVIDUALS WITHIN STUDY AREA
Lobed Bluegrass	1569.45	9,372
Bluegrass	1581.91	6,353
McKie's Stringybark	12.71	10
Austral Toadflax	1581.91	7,350

Other threatened flora (not recorded within the study area) but for which potential habitat was observed include:

- *Acacia pubifolia* (Velvet Wattle);
- *Astrotricha roddii* (Rod's Star Hair);
- *Digitaria porrecta* (Finger Panic Grass);
- *Diuris pedunculata* (Small Snake Orchid);
- *Eucalyptus nicholii* (Narrow-leaved Black Peppermint); and
- *Picris evae* (Hawkweed).

Matters of NES – Threatened Flora

Four threatened flora species listed under the EPBC Act were recorded across the study area:

- *Bothriochloa biloba* (Lobed Bluegrass);
- *Dichanthium setosum* (Bluegrass);
- *Eucalyptus mckieana* (McKie's Stringybark); and
- *Thesium australe* (Austral Toadflax).

Flora species listed under the EPBC Act for which potential habitat is present within the study area are listed below. However, none of these species were recorded within the study area during the surveys.

- *Astrotricha roddii* (Rod's Star Hair);
- *Digitaria porrecta* (Finger Panic Grass);
- *Diuris pedunculata* (Small Snake Orchid);
- *Eucalyptus nicholii* (Narrow-leaved Black Peppermint); and
- *Picris evae* (Hawkweed).

ROTAP and Regionally Significant Flora

Only one ROTAP listed species was found the study area: *Bothriochloa biloba* (3V). The ROTAP code 3V denotes Distribution Category 3 (Geographic range in Australia greater than 100 km) and Vulnerable Conservation Status (ANBG 1999).

Both Glen Innes Severn Council and Inverell Shire Council were contacted on 9 March 2011 to enquire whether regionally significant species lists have been issued for either local government area. No regionally significant species lists exist for either Council, as both rely on the NPWS databases for their vegetation information.

Noxious Weeds

Four weed species or species groups (listed as noxious weeds under the NSW *Noxious Weeds* Act 1993 (NW Act) for the Glen Innes Severn and Inverell Shire LGAs (DoID 2011) and one Weed of National Significance (WONS) were recorded within the study area. These weeds are listed in Table 14 together with their Control Class under the NW Act.

Table 14: Noxious weeds recorded within the study area

SPECIES	GLEN INNES SEVERN LGA	INVERELL LGA	NW ACT CLASS	WONS
Bathurst/Noogoora/Hunter/South American/Californian/cockle burr *Xanthium occidentale* *Xanthium spinosum* *Xanthium spp.*	x	-	4	-
Blackberry *Rubus fruticosus* aggregate species]	x	x	4	x
St. John's wort *Hypericum perforatum*	x	x	3	-
Sweet briar *Rosa rubiginosa*	x	x	4	-

Note:

WONS Weeds of National Significance

NW Act *Noxious Weeds Act 1993*

Class 3 The plant must be fully and continuously suppressed and destroyed

Class 4 the growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority.

4.3.4 Fauna and Fauna Habitat

The study area supports a diversity of fauna habitat types including woodland, grassland, farm dams, ephemeral creeks, rocky outcrop and hollow-bearing trees. A total of 135 fauna species were recorded throughout the study area during the field surveys (13 introduced) and these are listed in Appendix E. These were spilt over the following fauna groups:

- Seven reptile species;
- Four frog species;
- 83 bird species of which two were introduced;
- 19 mammals (non-bat) of which 11 were introduced; and
- 22 microbat species.

A summary of the key fauna habitat features across the site is provided below and a discussion of fauna species recorded across the study area also included.

Fauna Habitat

Fauna habitat within the study area fell in one of three broad habitat types, namely; open forest, woodland and grassland. These provide habitat for a variety of fauna including birds, owls, bats, arboreal mammals, reptiles and in areas where dams and creeks are present, amphibians. Given that a large number of trees within the study area supported hollows (see next sub-section), the open forest and woodland habitats provide potential habitat for a range of hollow-dependant species including threatened species. Grassland occurs across large portions of the study area as either native pasture (Derived Native Grasslands) or improved exotic pasture and the understorey of the woodland areas is also grassy. Depending on season and grazing intensity, the grassland areas provide habitat for a variety of ground-dwelling fauna and granivorous bird species (particularly finches and parrots).

Table 15 summaries the key habitat features within the study area, identifies the habitat type in which they are present and the species for which each feature would provide habitat.

Table 15: Key fauna habitat features present across the study area

HABITAT FEATURES	VEGETATION TYPES	SPECIES
Hollow-bearing Trees	BCPTGNLI, BRGRARS, BRGYB, MGRAYB, WB	Arboreal mammals, microchiropteran bats, hollow-dependent birds including owls, reptiles
Stags	BCPTGNLI, BRGRARS, BRGYB, MGRAYB, WB	Birds, particularly birds of prey
Rocky outcrops	TWSS, DG	Reptiles
Dams, watercourses and ephemeral drainages	BRGRARS, BRGYB, MGRAYB, WB	Amphibians, birds, reptiles, microchiropteran bats
Autumn / winter-flowering Eucalypts	Blakely's Red Gum *Eucalyptus blakelyi*, Silvertop Stringybark *E. laevopinea*, White Box *E. albens*, Tumbledown Red Gum *E. dealbata* and Narrow-leaved Ironbark *E. crebra*	Birds, microchiropteran bats and reptiles
Tussock grasses	BCPTGNLI, BRGRARS, BRGYB, MGRAYB, WB, TWSS, DG	Birds and bats
Fallen timber	BCPTGNLI, BRGRARS, BRGYB, MGRAYB, TWSS	Reptiles and birds

HABITAT FEATURES	VEGETATION TYPES	SPECIES
Leaf litter	Limited across study area. Primarily grassy.	Foraging resources for birds and mammals.
Defoliating bark	BRGRARS, BRGYB, MGRAYB	Small mammals and reptiles
SEPP 44 Koala Feed Trees	*Eucalyptus viminalis* (Ribbon Gum) *Eucalyptus albens* (White Box)	Koala

Note: BCPTGNLI - Black Cypress Pine - Tumbledown Gum – Narrow-leaved Ironbark open forest, BRGRARS = Blakely's Red Gum – Yellow Box grassy open forest or woodland, BRGYB = Blakely's Red Gum – Yellow Box grassy open forest or woodland, MGRAYB = Manna Gum – Rough-barked Apple – Yellow Box grassy woodland/open forest, TWSS = Tenterfield Woollybutt – Silvertop Stringybark open forest, WB = White Box grassy woodland, DG = Derived Grassland

Tree Hollows

Tree hollows are common throughout remnant woodland areas (BCPTGNLI, BRGRARS, BRGYB, MGRAYB, WB). A large proportion of trees across the landscape support hollows and, therefore, potential habitat for hollow-dependant species is abundant. However, many trees are senescing and there is little evidence of recruitment in the landscape. Therefore, the protection of hollow-bearing trees and measures to encourage / promote recruitment are important to retain these faunal assemblages.

The proposal has been designed such that tree removal has been minimised wherever possible and will be further minimised during the detailed design phase. All turbines will be at least 30 m from hollow-bearing trees following construction. Given the extent of the study area, it was not possible to map the distribution of hollow-bearing trees across the site. However, plot data (20 m x 50 m) collected as part of the Biobanking assessment has been used to estimate the number of hollows per hecatre of vegetation type and estimate the maximum number of hollows that could potentially be cleared by the proposal. It is important to note that this data is extrapolated and assumes impacts occur evenly to each vegetation type. However, as stated above, turbines locations and road layouts have been designed to avoid HBTs and the number of HBT likely to be impacted is, therefore, likely to be significantly less (Table 16).

Table 16: Estimated hollow-bearing tree habitat clearance per vegetation type and condition

BIOBANKING CONDITION	VEGETATION ZONE	NUMBER OF HBT WITHIN 0.1 ha	ESTIMATED NUMBER OF HBT PER HECTARE	AMOUNT OF VEGETATION TYPE WITHIN STUDY AREA (ha)	ESTIMATED NUMBER OF HBT PRESENT WITHIN THE STUDY AREA	IMPACT AREA (ha)	ESTIMATED NUMBER OF HBT TO BE REMOVED#	PERCENT CLEARED
BR110_Moderate/Good	BR110_Moderate/Good_TREES	0	0	0	0	0	0	0
	BR110_Moderate/Good_NP	0.697	6.97	12.71	88.59	0.74	5.16	5.8
BR114_Moderate/Good	BR114_Moderate/Good_TREES	1.000	10.00	1.70	17.00	0	0	0
	BR114_Moderate/Good_NP	0	0	0	0	0	0	0
BR116_Moderate/Good	BR116_Moderate/Good_TREES	0.500	5.00	20.19	100.95	1.36	6.80	6.7
	BR116_Moderate/Good_NP	0.126	1.26	81.68	102.92	9.39	11.83	11.5
BR116_LOW	BR116_LOW	0.070	0.70	17.91	12.54	0	0	0
BR153_Moderate/Good	BR153_Moderate/Good_TREES	1.670	16.70	765.66	12786.52	91.89	1534.56	12.0
	BR153_Moderate/Good_NP	0.119	1.19	499.65	594.58	58.86	70.04	11.8
BR153_LOW	BR153_LOW	0.127	1.27	225.48	286.36	24.09	30.59	10.7
BR227_Moderate/Good	BR227_Moderate/Good_TREES	0.200	2.00	12.46	24.92	1.17	2.34	9.4
	BR227_Moderate/Good_NP	0	0	0	0	0	0	0
BR240_Moderate/Good	BR240_Moderate/Good_TREES	1.800	18.00	94.78	1706.04	7.43	133.74	7.8
BR240_LOW	BR240_Moderate/Good_NP	0.153	1.53	105.79	161.86	11.89	18.19	11.2
	BR240_LOW	0.115	1.15	44.98	51.73	3.09	3.55	6.9
			TOTAL	**1882.99**	**15934**	**209.91**	**1816.82**	**11.4**

Note: *# Assumes all HBTs present will be impacted, however, location of turbines and roads has been designed to avoid HBTs wherever possible and practical.*

Fauna Groups and Threatened Fauna

A variety of threatened fauna species have been recorded within the locality (DECCW 2011a, Birds Australia 2009) or considered to have the potential to occur (DSEWPAC 2011a) are listed in Appendix C together with their conservation status and an assessment of the likelihood that they would occur at the site.

Avifauna

A total of 83 bird species were recorded within the study area during the surveys. These species are listed in Appendix E. Common species recorded included *Manorina melanocephala* (Noisy Miner), *Glossopsitta concinna* (Musk Lorikeet), *Platycercus elegans* (Crimson Rosella), *Gymnorhina tibicen* (Australian Magpie), *Platycercus adscitus eximius* (Eastern Rosella), *Anthochaera carunculata* (Red Wattlebird), *Cacatua galerita* (Sulphur-crested Cockatoo), *Todiramphus sanctus* (Sacred Kingfisher) and *Pardalotus punctatus* (Spotted Pardalote).

Two nocturnal bird species were recorded and these included the *Eurostopodus mystacalis* (White-throated Nightjar) and *Podargus strigoides* (Tawny Frogmouth). No owl species were recorded.

The study area supports potential foraging, nesting and roosting habitat for a large variety of bird species. Nesting habitat for hollow-dependent species is abundant in areas of BCPTGNLI, BRGRARS, BRGYB, MGRAYB and WB where there are numerous hollow-bearing trees. The abundance of native flora provides extensive foraging resources throughout all seasons.

Birds of prey were recorded within the study area, including the *Falco cenchroides* (Nankeen Kestrel), *Aquila audax* (Wedge-tailed Eagle), *Elanus axillaris* (Black-shouldered Kite), *Accipiter fasciatus* (Brown Goshawk) and *Haliastur sphenurus* (Whistling Kite).

Habitat for wetland birds across the site is largely limited to farm dams and the emphemeral drainage lines across the study area. Most farm dams had water during the 2010 / 2011 survey period due to extensive heavy rain although there habitat value for waterbirds is limited.

Threatened Birds

Seven threatened bird species have been recorded across the study area. These are listed below and their location shown in Figure 9.

- *Climacteris picumnus victoriae (*Brown Treecreeper);
- *Stagonopleura guttata* (Diamond Firetail);
- *Melanodryas cucullata cucullata* (Hooded Robin);
- *Glossopsitta pusilla* (Little Lorikeet);
- *Petroica boodang* (Scarlet Robin);
- *Pyrrholaemus saggitatus* (Speckled Warbler) and
- *Neophema pulchella* (Turquoise Parrot).

Brown Treecreeper

The Brown Treecreeper has been recorded on a number of occasions to the north of Kings Plains Road (DECCW 2011a) and also to the west of the project site (Birds Australia 2009). This species was recorded in the north east of the study area immediately south of Kings Plains Road.

Hooded Robin

There are no previous records of the Hooded Robin present within a 15 km radius of the study area (DECCW 2011a, Birds Australia 2009). However, this species was recorded within a wooded area to the east of the eastern feeder during the surveys. This location is outside the current study area but within the project site.

Scarlet Robin

The Scarlet Robin has previously been recorded Kings Plains National Park (Birds Australia 2009) although there are no previous records within the study area. This species was recorded in the north east of the site during the surveys.

Diamond Firetail

The Diamond Firetail has been recorded throughout the locality on a number of occasions including within Kings Plains National Park and south of the site along the Gwydir Highway (DECCW 2011a, Birds Australia 2009). This species was also recorded along the eastern feeder during the current survey.

Little Lorikeet

There are a number of records for the Little Lorikeet within Kings Plains National Park (DECCW 2011a) and this species was recorded flying over the study area during the surveys.

Turquoise Parrot

The Turquoise Parrot has been recorded to the north of the site within Kings Plains National Park (Birds Australia 2009) and this species was also recorded in the south of the study area in a wooded area.

Speckled Warbler

The Speckled Warbler has been recorded within King Plans National Park to the north west of the site (DECCW 2011a) and was also recorded along the Eastern Feed outside the study area.

Other threatened bird species for which the study area is likely to provide potential habitat include:

- *Anthochaera phrygia* (Regent Honeyeater);
- *Circus assimilis* (Spotted Harrier);
- *Daphoenositta chrysoptera* (Varied Sittella);
- *Hieraaetus morphnoides* (Little Eagle);
- *Lophoictinia isura* (Square-tailed Kite); and
- *Lathamus discolor* (Swift Parrot).

None of these species were recorded within the study area during the surveys although there is an historical record (1968) of the Regent Honeyeater to the south of the site and a more recent record (1994) along Wellingrove Road to the north east of the study area (DECCW 2011a). Areas of potential habitat for the Regent Honeyeater are shown on Figure 10. Sapphire is not a breeding site for this species and given the transitory and migratory nature of this species, it likely to only be used periodically for foraging.

There are no database records for the Swift Parrot or Square-tailed Kite within a 10 km radius of the study area although potential habitat is present.

The Speckled Warbler and Varied Sittella have both been recorded within the Kings Plains National Park (DECCW 2011a).

Surveys were undertaken across the study area for the Masked Owl, Powerful Owl and Barking Owl although there are no records of these species within the locality (DECCW 2011a and Birds Australia 2009). No individuals were recorded during the surveys.

Migratory Birds

A total of twelve listed migratory bird species were identified from the EPBC Act Protected Matters Search Tool (PMST) (DSEWPAC 2011a). Those species for which there is potential habitat within the study area are listed below. None were recorded within the study area during the surveys.

- *Hirundapus caudacutus* (White-throated Needletail)
- *Merops ornatus* (Rainbow Bee-eater)
- *Anthochaera phrygia* (Regent Honeyeater)
- *Ardea alba* (Great Egret)
- *Ardea ibis* (Cattle Egret)
- *Apus pacificus* (Fork-tailed Swift)
- *Lathamus discolor* (Swift Parrot)

<u>Ground-dwelling and Arboreal Mammals</u>

Habitat within the study area for ground-dwelling mammals is limited as there is no or a very limited shrub layer and the ground layer in many areas is grazed, in places and at times, heavily. However, in those areas where woodland is present and grazing is less intense, tussock grasses and fallen timber / logs provide nesting and shelter resources for ground-dwelling mammals. *Macropus giganteus* (Eastern Grey Kangaroo), *Macropus robustus* (Common Wallaroo) and *Macropus rufogriseus* (Red-necked Wallaby) were recorded within the study area.

Eleven introduced mammals were also recorded within the study area including *Vulpes vulpes* (European Red Fox), *Oryctolagus cuniculus* (European Rabbit) and *Felis catus* (Domestic Cat).

Trees provide habitat for arboreal mammals such as gliders, *Pseudocheirus peregrines* (Common Ringtail possum) and *Trichosurus vulpecular* (Common Brushtail Possum). No threatened ground mammals were recorded.

Threatened Mammals

Three threatened arboreal mammals have been recorded in within 10 km of the study area. There are a number of *Phascolarctos cinereus* (Koala) records to the north of the site with one record present within the study area along the western feeder (1994) (DECCW 2011a). Despite the historical records (1986, 1996 for Kings Plains), no Koalas were sighted within the study area during the surveys. Given Koalas were ecosystem species under the Biobanking methodology targeted surveys for this species were not undertaken. However, given the number of records of this species present in the locality and the presence of potential Koala feed trees across the study area, their presence has been assumed.

Targeted surveys were undertaken for *Dasyurus maculatus* (Spotted-tailed Quoll) as this species has been recorded within the locality south of the Gwydir Highway. This species was not recorded within the study area and there is only one historical record (2006) of this species within the locality. However, there is potential for this species to utilise the study area.

Petaurus norfolcensis (Squirrel Glider) has been recorded within Kings Plain National Park and it is possible that this species utilises the site as suitable habitat and hollow-bearing trees are present.

Given the proximity of past records and that extensive habitat is present across the project site, for the purposes of impact assessment it has been assumed that this species is present.

Megachiropteran and Microchiropteran Bats

Habitat for microchiropteran bats is present across the study area and 22 species of microchiropteran bats have been recorded foraging across the study area. Bat activity was common across the site with an average of 55 calls per night. This number would be lower if the small number of high volume call nights (e.g. 491 calls, 140 calls and 127 calls) were removed from the data when calculating the average.

Appendix F lists those species recorded across the study area during anabat surveys and their preferred flight heights. The *Chalinolobus morio* (Chocolate Wattled Bat), *Chalinolobus gouldii* (Gould's Wattled Bat), *Vespadelus* spp. and *Miniopterus schreibersii oceansis* (Eastern Bentwing-bat) were the most commonly recorded species.

Threatened Bats

No threatened bat species have been recorded within the locality prior to this study, although the *Nyctophilus corbeni* (South-eastern Long-eared Bat) and *Chalinolobus dwyeri* (Large-eared Pied Bat) were both listed species with the potential to occur within the locality under the EPBC protected matters search tool (DSEWPAC 2011a). However, based on the habitat present within the study area, it was considered unlikely that the Large-eared Pied Bat would inhabit the site.

The paucity of historical records is likely to reflect the limited survey effort undertaken prior to this survey. During the current study, a number of threatened bat species were recorded across the study area. These are listed below and their location shown in Figure 9.

- *Falsistrellus tasmaniensis* (Eastern False Pipistrelle);
- *Miniopterus schreibersii* (Eastern Bentwing-bat);
- *Mormopterus norfolkensis* (Eastern Freetail-bat);
- *Saccolaimus flaviventris* (Yellow-bellied Sheathtail-bat);
- *Scoteanax rueppellii* (Greater Broad-nosed Bat); and
- *Vespadelus troughtoni* (Eastern Cave Bat).

A total of 499 possible calls for the Eastern Cave Bat and 12 for Eastern Bentwing-bat were identified over three survey seasons. Although these are not confirmed records, there is the potential that this species utilises the site and they have been included in the list above, particularly given the high number of calls for the Eastern Cave Bat.

The calls of the three *Nyctophilus* species are difficult to tell apart. In some cases calls were identified as 'possible' calls to species level. However, in most cases, they were identified as *Nyctophilus* spp. which may include *N. geoffroyi, N. gouldi* or *N. timoriensis*. For this reason, all three bat species have been included in the bat risk matrix.

The hollow-bearing trees across the study area provide potential roosting habitat for the majority of the aforementioned threatened bats (with the exception of Eastern Bentwing-bat and Eastern Cave Bat) and potential foraging habitat is abundant across the study area. Areas of habitat include flyways, tracks, woodland, grassland, emphemeral watercourses and farm dams and hollow-bearing trees.

There are no caves within the study area which the Eastern Bentwing-bat or Eastern Cave Bat require for roosting.

Amphibians

Habitat for amphibians is limited across the study area. Ephemeral drainage lines, a small number of creeks (Kings Plains Creek and Wellingrove Creek (east of the study area boundary)) and farm dams provide potential habitat for amphibians across the study area. Incidental records of four species were made by identifying calls heard during nocturnal surveys: *Crinia parinsignifera* (Eastern Sign-bearing Froglet), *Limnodynastes tasmaniensis* (Spotted Marsh Frog), *Litoria peroni* (Peron's Tree Frog), and *Litoria verreauxii* (Verreaux's Tree Frog).

Threatened Amphibians

No threatened amphibians were recorded within the study area although *Litoria booroolongensis* (Booroolong Frog) was listed as having the potential to occur within the study area (DSEWPAC 2011a, Biobanking). Based on the assessment of the habitat within the study area and historical data, it was considered unlikely that this species would occur within the study area.

Reptiles

Habitat across the site for reptiles includes woodland and grassland areas and scattered rocky outcrops. There is limited woody debris and leaf litter is also limited although where this is present it provides habitat for reptiles. The many drainage lines are also likely to provide habitat with the *Chelodina* sp. (Long-Necked Turtle) commonly recorded in these areas. Other reptiles recorded across the study area include *Amphibolus muricatus* (Jacky Lizard), *Carlia tetradactyla* (Southern Rainbow-skink), *Pogona barbata* (Bearded Dragon), *Pseudonaja textilis* (Eastern Brown Snake), *Physignathus lesueurii* (Eastern Water Dragon) and *Tiliqua scincoides* (Eastern Blue-tongue).

Threatened Reptiles

Three threatened reptile species were listed on the database searches as having the potential to occur within the study area (DECCW 2011a, DSEWPAC 2011a). However, potential habitat is only present for *Underwoodisaurus sphyrurus* (Border Thick-tailed Gecko).

Habitat for the Border Thick-tailed Gecko is present across the study area but not all habitat would be considered potential habitat. Habitat mapping has been undertaken for this species and areas of potential and marginal potential habitat have been mapped given the diversity of habitat over which this species can occur (Figure 11). The Border Thick-tailed Gecko shows a preference for steep rocky or scree slopes, especially granite although there are recent records from basalt and metasediment slopes and flats. This species favours forest and woodland areas with boulders, rock slabs, fallen timber, deep leaf litter and often a dense tree canopy that helps create a sparse understorey. They have been recorded in areas that were cleared for agriculture in the past (DECCW 2011b). It is likely that the majority of the study area is extremely marginal habitat for the Border Thick-tailed Gecko as woody debris is sparse and the understorey in most areas is grassy. Those areas mapped as potential are more likely to support this species should it be present at the site as they support either rocky outcrops or fallen timber and also a dense canopy.

Mapping in Figure 10 is based on the following:

- Potential – granite or basalt, dense canopy, rocky outcrops and/or fallen timber; and
- Marginal potential – granite or basalt, agricultural land, limited rocky outcrops and/or fallen timber.

The majority of the habitat mapped as marginal is likely to be extremely marginal habitat for this species as it would primarily support a grassy understory with scattered woody debris and has been mapped as a precaution given that this species has been recorded in disturbed areas such as those cleared for agriculture in the past.

Matters of NES – Threatened Fauna

No threatened bird species listed under the EPBC Act have been recorded across the study area athough potential habitat is present for the following:

- *Anthochaera phrygia* (Regent Honeyeater); and
- *Lathamus discolor* (Swift Parrot).

Distinguishing the calls of the various *Nyctophilus* spp. is difficult and therefore given *Nyctophilus* calls that could not be determined to species level were caputured by anabat survey within the study area, for the purposes of impact assessment the presence of *Nyctophilus corbeni* (South-eastern Long-eared Bat) has been assumed.

Although not recorded on the site, potential habitat also exists for the *Dasyurus maculatus* (Spotted-tailed Quoll) which is listed under the EPBC Act.

No threatened amphibians were recorded within the study area although the Booroolong Frog (*Litoria booroolongensis*) was listed as having the potential to occur within the study areas (DSEWPAC 2011a, Biobanking). Based on the assessment of the habitat within the study area and historical data, it was considered unlikely that this species would occur within the study area.

Potential habitat is only present for one threatened reptile, *Underwoodisaurus sphyrurus* (Border Thick-tailed Gecko). No records were found during the surveys; however areas of potential and marginal potential habitat have been mapped given the diversity of habitat over which this species can occur.

Matters of NES - Migratory Species

A total of twelve listed migratory bird species were identified from the EPBC Act Protected Matters Search Tool (PMST) (DSEWPAC 2011a). Those species for which there is potential habitat within the study area are listed below. None were recorded within the study area during the surveys.

- *Hirundapus caudacutus* (White-throated Needletail)
- *Merops ornatus* (Rainbow Bee-eater)
- *Anthochaera phrygia* (Regent Honeyeater)
- *Ardea alba* (Great Egret)
- *Ardea ibis* (Cattle Egret)
- *Apus pacificus* (Fork-tailed Swift)
- *Lathamus discolor* (Swift Parrot)

<u>Corridors and Movement Pathways</u>

Local

The historic land use of the Sapphire-Kings Plains region has impacted on the presence of fauna corridors within the landscape. Extensive land clearing has occurred as part of the 'improvement' of the land for agricultural uses including grazing of sheep and cattle, agistment of horses and private forestry. In several areas, particularly on the flood plain, soil has been tilled for a variety of crops including oats – often requiring removal of significant amounts of surface rock. The intensive agricultural use of the land over the past 150 years is typical of many areas on the Great Dividing Range, where native vegetation was cleared to make way for food production.

Within the project site itself, the corridors are highly fragmented, consisting of dense native vegetation on the steepest slopes of the ranges inaccessible to livestock or farm machinery, and lightly wooded areas on spurs and gentle slopes where access for livestock is available. The extent of retained wooded areas remaining varies from property to property depending on the individual land management practices of existing and previous land managers, though generally speaking, as the topography becomes gentler, tree cover becomes sparser.

The main corridor through the study area occurs along the Mount Buckley range, which generally runs south-east to north-west. The highest, most densely wooded areas occur around Mount Buckley itself, and then the wooded vegetation fragments as it runs west towards Kings Hill. Outside of the study area, the fragmented corridor connects with other ranges south of the Gwydir Highway, to Maybole where it approaches the headwaters of several streams and toward Ben Lomond.

A secondary fragmented corridor edges along the northern edge of the study area including the Kings Plains Road reserve (formerly an active Travelling Stock Route). The Kings Plains Road corridor has some links to the Kings Plains National Park which arches over the Sapphire turbine cluster, approximately five kilometres north of Kings Plains Road (Figure 1).

Regional Corridors

A number of regional corridors within north east NSW have also been identified within the Inverell State of the Environment Report (Inverell Council 2009). These include:

- Kings Plains - Severn River Links-Severn River NP to-King Plains NP;
- Severn River Links-Severn River NP to-Taronga Corridor;
- Kings Plain Links-Kings Plains NP to-Stony Creek Corridor;
- Single NP - Mt Topper Links-Single NP to-Lowes Creek;
- Sutherlands Links-Slurry Gully to-Moore Creek; and,
- Ventura Links-Copes Creek to-Sandy Creek.

Glen Innes Severn Council identified the most useful wildlife habitat corridors in the Glen Innes Severn LGA as roads, reserves and Travelling Stock Routes. Over 50,000 hectares of land within the Local Government Area is managed as Travelling Stock Routes (Glen Innes Severn Council 2009).

SEPP 44 Koala Habitat

The Koala is known to have been recorded on the fringes of the study area and the surrounding lands. *Eucalyptus viminalis* (Ribbon Gum) and *Eucalyptus albens* (White Box) are listed as a Koala feed tree under Schedule 2 of SEPP 44 and are present in areas of MGRAYB, WB and DG. In some areas of MGRAYB, Ribbon Gum would constitute at least 15% of the total number of trees in the upper or lower strata of the tree component this is likely for White Box in areas where WB is present also. Therefore, these parts of the site would normally be considered an area of potential koala habitat without the Part 3A exemption for this SEPP. The area of potential habitat as defined by the SEPP gas has been used in considering impacts on the Koala under the Threatened Species Conservation Act.

Watercourses

Impacts of the proposal on watercourses and lakes have been assessed in a separate section within the Environmental Assessment and, therefore, have not been addressed in this report. There are no large rivers present within the project site with the MacIntyre and Severn Rivers being the closest large rivers at 15 km away.

Smaller creeks running through the project site include:

- Kings Plains Creek; and
- Wellingrove Creek (east of the study area boundary)

There are a number of other small creeks around the project site but that are not within the study area. These include:

- Frazer Creek (west)
- Mary Anne Creek (south west)
- Limekiln Gully (south west)
- Apple Tree Gully (south west)
- Youngs Creek (south)
- Chinamans Gully (south)
- Maids Valley Creek (east)
- Small Creek (north)

These ephemeral drainage lines and creeks are likely to be utilised in various capacities by most fauna assemblages on site, however provided sediment and erosion controls are managed they will not be impacted by the majority of the proposed works.

5 Impact Evaluation

5.1 INTRODUCTION

This section of the report outlines the anticipated impacts from the proposal on the ecological values of the site. It is structured in order of process as initially impacts have been avoided and minimised wherever possible. A number of mitigation measures were then formulated to further minimise the impacts from the proposal. The residual direct and indirect impacts are then outlined in accordance with each phase of the project (i.e. construction, operation and decommissioning) and cumulative impacts and key threatening processes considered.

This approach is consistent with the requirements of the DGRs (i.e. the EA report should describe actions taken to avoid or mitigate impacts and then compensate for unavoidable impacts). For any impacts that cannot be avoided or mitigated, a number of offset options have been considered and an offset strategy provided (see Chapter 6).

5.2 AVOIDANCE MEASURES

Environmental Impact Assessment and Biodiversity Offset Principles have been established by the Office of Environment and Heritage (OEH, formerly DECCW) and the first of these principles states that impacts must first be avoided using prevention and mitigation measures (DECC 2008). Based on the results of the ecological assessment, the proponent has made a number of amendments to the proposed layout to minimise and avoid impacts of the proposal on the ecological values of the site.

Given the extensive areas of EEC across the study area, and the requirement for turbines to be placed on the ridge top, the opportunities to avoid all impacts are limited. Whilst it is also not possible to completely avoid placing turbines in any areas supporting woodland, as this would impact upon the project feasibility, a number of amendments have been made to minimise impacts in these areas. The linear layout of turbines along ridgelines, required for the wind farm to function at maximum capacity and be economically feasible, in some cases limits the areas to which turbines can be moved to avoid impacts.

Detailed below are the avoidance measures that will or have been implemented to minimise impacts on the ecological integrity of the site whilst maintaining the engineering and economic feasibility of the wind farm.

- Access has been designed around current tracks and roads present within the study area where possible to avoid additional vegetation clearance for access;
- Turbines have been placed in cleared or treeless areas, wherever possible, to minimise tree clearance;
- Turbines locations have been modified to avoid direct impacts on the *Eucalyptus mckieana* recorded within the study area;

- Where turbines have been placed in woodland areas they have been situated where ground layer disturbance has previously taken place (e.g. sown areas) wherever possible;
- Construction compounds, substations and rock crushing facilities have been located outside ecologically sensitive areas where possible;
- Hollow-bearing tree clearance has been avoided where possible to date and will be further avoided where practical during the detailed design phase;
- A buffer of 30 m will be maintained between all turbines and hollow-bearing trees (where practical) to minimise the likelihood of bird and bat strike during operation;
- Access roads and power line routes have been re-aligned to avoid threatened plants recorded within the study area; and
- The reticulation has been placed underground and within the road footprint where possible to allow for temporary rather than permanent disturbance. Reticulation will pass overhead across gullies and waterways to reduce impacts.

Construction Facilities

Eight locations have been identified for concrete batching plants. Each has been selected with operation requirements and environmental constraints in mind and all are located in previously disturbed areas or paddocks that have been sown and, therefore, ecological impacts are likely to be minimal (Figure 2).

A preferred substation location, three construction compound sites, three rock crushing facilities and three site office locations have also been identified (Figure 2). Their locations will be determined depending on the turbine selection and the associated requirements. These will be located to minimise ecological impacts, wherever possible.

Matters of NES - Avoidance

Many of the aforementioned avoidance measures apply generally to vegetation communites and habitat for threatened species listed under the EPBC Act. Those specific to threatened species listed under the EPBC Act include:

- Access has been designed around existing tracks and roads within the study area, where possible, to avoid additional vegetation clearance for access (BGW);
- Turbines have been placed in cleared or treeless areas, wherever possible, to minimise tree clearance (BGW);
- Turbines locations have been modified to avoid direct impacts on the *Eucalyptus mckieana* recorded within the study area;
- Hollow-bearing tree clearance has been avoided where possible to date and will be further avoided where practical during the detailed design phase (*Nyctophilus corbeni*);
- A buffer of 30 m will be maintained between all turbines and hollow-bearing trees (where practical) to minimise the likelihood of bird and bat strike during operation (*Nyctophilus corbeni*);

- Access roads and power line routes have been aligned to avoid threatened plants recorded within the study area (*Bothriochloa biloba, Dichanthium setosum, Eucalyptus mckieana* and *Thesium australe*).

5.3 MITIGATION MEASURES

In order to protect the ecological values of the site a number of management and mitigation measures have been recommended. These are outlined in Table 17 together with the project stage during which each should be implemented. Full details will be provided post approval in detailed plans including Construction Environmental Management Plan, Operation Environmental Management Plan, Soil and Water Management Plan and the Weed Management Plan. It is envisaged that these mitigations measures will form part of the conditions of consent for the wind farm and all measures will be approved or endorsed by the Minister for Planning or delegate as part of the Part 3A approval process.

Table 17: General mitigation measures

IMPACT	RELEVANT SPECIES / GUILD	MITIGATION MEASURE	TIMEFRAME	DETAILED DESIGN	PRE-CONSTRUCTION	DURING CONSTRUCTION	OPERATION	DECOMMISSIONING	COST ESTIMATE	PREDICTED EFFECTIVENESS OF MEASURE
General construction, and operational impacts	All	Preparation of Construction Environmental Management Plan (CEMP)			✓				$10,000	
		Preparation of Operations Environmental Management Plan (OEMP)			✓				$10,000	
		Preparation of a Conservation Management Plan (CMP)			✓				$10,000	
		Preparation of Weed Management Plan (WMP)			✓				$10,000	
		Preparation of Soil and Water Management Plan (SWMP)			✓				$10,000	
Spread of weeds										
Spread of weeds through soil disturbance and vegetation clearance	All	Piling of soil that may contain seeds of exotic species at least 50 m away from the creeks, drainage lines and other areas of native vegetation, where possible, to prevent spread into adjacent areas of ecological significance during rainfall or wind events.				✓		✓	NA	High
Spread of weeds through movement of vehicles and machinery between sites	All	All machinery, equipment and vehicles are to be washed down before entering and leaving a site.	Wash down area locations to be identified during the detailed design phase			✓	✓	✓	NA	High

IMPACT	RELEVANT SPECIES / GUILD	MITIGATION MEASURE	TIMEFRAME	DETAILED DESIGN	PRE-CONSTRUCTION	DURING CONSTRUCTION	OPERATION	DECOMMISSIONING	COST ESTIMATE	PREDICTED EFFECTIVENESS OF MEASURE
Spread of weeds through topsoil removal	All	Topsoil recovery will be undertaken in areas that have a high proportion of native vegetation and few weeds in the ground layer of vegetation. Topsoil is harvested to salvage the native soil seed bank and reintroduce seed bank back into areas where it has been depleted by past land use such as intensive grazing. The site receiving the topsoil has its topsoil including the weed growth stripped and disposed of. The relocated topsoil is spread evenly and mulched lightly using the vegetation and leaf litter removed from the source site.				✓		✓	$50,000	Moderate
Spread of noxious weed through soil disturbance and vegetation clearance	All	All onsite staff and contractors will be made aware of noxious weeds present at the site and ways to prevent their spread.	Prior to commencement of construction works		✓				NA	Moderate – High
Spread of weeds through importation of soil, rubble etc	All	It should be ensured that any soil, rubble etc imported to the site is certified that it is free of weeds and weed seed.			✓	✓		✓	NA	High
Spread of weeds through revegetation	All	Revegetation with locally native endemic species characteristic of the cleared vegetation type. Recommended an aggressive coloniser such as *Austrostipa* spp. is used.	Species should be sourced prior to construction to ensure availability.		✓	✓		✓	$500,000	High
	All	Weed management measures implemented to control perennial weed grasses.	3 years following construction.			✓	✓	✓	$40,000	High
	All	Management of stock access during periods of vegetation and soil disturbance to prevent weed spread.				✓		✓	NA	Moderate

IMPACT	RELEVANT SPECIES / GUILD	MITIGATION MEASURE	TIMEFRAME	DETAILED DESIGN	PRE-CONSTRUCTION	DURING CONSTRUCTION	OPERATION	DECOMMISSIONING	COST ESTIMATE	PREDICTED EFFECTIVENESS OF MEASURE
Sedimentation, Erosion and Runoff										
Sedimentation, and soil erosion	All	Before any remediation works that will further disturb the soil, grazing will be removed and the grass sward allowed time to recover and minimise any areas of bare soil. Jute matting or similar should be used to stabilise the soil and prevent weed invasion.				✓	✓	✓	$10,000	Moderate – dependant on the time of year and time left ungrazed.
Sedimentation, and soil erosion	All	All stockpiles should be covered to prevent the loss of material during high wind and rain events. Where practicable stock piles should be placed in areas sheltered from the wind.	Location to be determined during detailed design phase.	✓	✓	✓		✓	$5,000	High
		Implement provisions of SWMP.	Prior to the commencement of construction.		✓	✓		✓	$50,000	High
Sedimentation, and soil erosion through soil disturbance	All	All disturbed soil surfaces shall be stabilised as soon as practicable after works have ceased in the area.				✓		✓	Part of the revegetation works	Moderate – depending on time between disturbance and stabilisation.
Reduced water quality through uncontrolled runoff and sedimentation	Aquatic species	Management measures implemented to prevent sediment and runoff entering the watercourse in accordance with SWMP.	Prior to the commencement of construction.		✓	✓		✓	$50,000 (part of SWMP implementation)	High
Sedimentation and erosion	All	All erosion and sedimentation control devices should be regularly monitored, cleared and repaired, particularly after periods of heavy rainfall.	Monthly and after heavy rainfall			✓		✓	NA	High
Spread of pesticides through runoff	Aquatic species	Management measures implemented to prevent sediment and runoff entering the watercourse in accordance with SWMP.				✓		✓	$50,000 (part of SWMP implementation)	High

IMPACT	RELEVANT SPECIES / GUILD	MITIGATION MEASURE	TIMEFRAME	DETAILED DESIGN	PRE-CONSTRUCTION	DURING CONSTRUCTION	OPERATION	DECOMMISSIONING	COST ESTIMATE	PREDICTED EFFECTIVENESS OF MEASURE
Smothering of threatened plant due to dust suppression	Threatened plants	A buffer of 30 m should be left between any proposed construction areas and access tracks (including those to be used post construction) and threatened plant populations.		✓	✓	✓	✓		NA	Moderate – High – depending on wind levels and weather conditions.
		Where possible, construction should be undertaken outside of summer in areas in close proximity to threatened plants to minimise impacts (eg. *Thesium australe*)	To optimise the timing of construction, this measure needs to be addressed during the detailed design phase.	✓	✓	✓			NA	High
Vegetation Clearance / Disturbance										
Vegetation disturbance through the movement of vehicles and machinery between site	All	All vehicles are to remain on formed road or tracks designed specifically for the purposes of the wind farm construction / operation.				✓	✓	✓	NA	High
Damage to surrounding tree roots	Flora	Care is to be taken when working near treed areas to prevent damage to adjacent tree roots.			✓	✓		✓	NA	High
		Where possible, trenches should be dug at least 15 m away from the base of trees and outside of drip lines.				✓			NA	High
Vegetation clearance and revegetation for underground cabling	All	On completion, the cable route will be fenced (with landowner agreement) to allow the controlled revegetation with locally endemic species (e.g. *Austrostipa* spp.).				✓		✓	$100,000	High

IMPACT	RELEVANT SPECIES / GUILD	MITIGATION MEASURE	TIMEFRAME	DETAILED DESIGN	PRE-CONSTRUCTION	DURING CONSTRUCTION	OPERATION	DECOMMISSIONING	COST ESTIMATE	PREDICTED EFFECTIVENESS OF MEASURE
Smothering of vegetation by dust	All	Minimise dust during construction via the use of water carts. Due to high winds, stage disturbance areas and ensure sufficient local water supplies are available for the construction period.				✓		✓	NA	High
	Threatened Plants	A 30 m buffer between all threatened plants and access roads and construction areas is to be maintained.		✓		✓			NA	Moderate – High – depending on wind levels and weather conditions.
Flora										
Trampling of threatened flora	Threatened Plants	A 30 m buffer between all threatened plants and access roads and construction areas is to be maintained.		✓		✓	✓		NA	High
		Fencing off of all construction areas to prevent breaching of construction boundaries			✓	✓			$12,000 / km	High
Fauna										
Temporary removal of fauna habitat / dead wood	Ground-dwelling species	All logs and large rocks removed from within the proposed development areas are to be relocated to adjacent areas to supplement habitat.			✓	✓		✓	NA	Moderate
Accidental capture of fauna during trenching for reticulation	Ground-dwelling species	Suitable fencing will be erected along trenches to prevent fauna falling into trench.			✓	✓		✓	$25,000	High
		Trenches will checked daily by the Environmental Compliance Manager or field officer. Any fauna captured at the site, managed in accordance with the provisions of the EMP.				✓		✓	$100,000 (assumed salary for 2 year construction period)	High

IMPACT	RELEVANT SPECIES / GUILD	MITIGATION MEASURE	TIMEFRAME	DETAILED DESIGN	PRE-CONSTRUCTION	DURING CONSTRUCTION	OPERATION	DECOMMISSIONING	COST ESTIMATE	PREDICTED EFFECTIVENESS OF MEASURE
Disturbance of nests, dens and roosts through hollow-bearing tree removal	Hollow-dependant species	Pre-clearing surveys undertaken to determine if roosts, nests or dens present in any trees proposed for clearing.		✓					$1,000	High
		A pre-clearance protocol should be designed to identify how hollow-bearing fauna will be surveyed for and managed during clearing.			✓				$60,000 - $100,000	High
		Ecologist on site during clearing to capture and re-release fauna (where appropriate)				✓			$100,000 (assumes salary for 2 years of construction)	High
Death and injury through bird and bat strike	Birds and bats	Should turbine require lighting, select lighting that minimises the likelihood of attracting insects and foraging bats, subject to CASA requirements.		✓					NA	High
		Monitoring will be undertaken in accordance with the monitoring guidelines provided by the Australian Wind Energy Association (Brett Lane & Associates 2005). If results show that longer term monitoring is required then a monitoring programme will be developed in consultation with the Office of Environment and Heritage and other departments/agencies as required. An adaptive management approach should be implemented, whereby additional measures are implemented should significant bird and bat strike at certain turbines be recorded.					✓		$75,000	Moderate – not all impacts potentially identified during the monitoring may be preventable / mitigated
		Maintaining 'corridors' or wide separation distances between groups of turbines.		✓					NA	Moderate – would need to be in conjunction with other measures to be most effective

IMPACT	RELEVANT SPECIES / GUILD	MITIGATION MEASURE	TIMEFRAME	DETAILED DESIGN	PRE-CONSTRUCTION	DURING CONSTRUCTION	OPERATION	DECOMMISSIONING	COST ESTIMATE	PREDICTED EFFECTIVENESS OF MEASURE
Soil										
Soil compaction through the movement of vehicles and machinery between sites	All	All vehicles are to remain on formed road or tracks designed specifically for the purposes of the wind farm construction / operation.				✓	✓	✓	NA	High
Soil compaction trampling and weed spread by stock	All	Management of stock access during periods of vegetation and soil disturbance.	During periods of soil and vegetation disturbance			✓		✓	NA	Moderate – dependant on landowner co-operation
		Removal of stock access from construction areas for the active construction periods to allow for regeneration – subject to landowner participation.	During active construction periods			✓			NA	Moderate – dependant on the time of year, time left ungrazed and landowner co-operation.
Fire										
Accidental fire resulting in loss of property, life, vegetation and injury to fauna	All	Adherence to all regulations Implementation of fire prevention measures in accordance with Bushfire Emergency Plan (BEP).	BEP to be prepared prior to commencing construction		✓	✓	✓	✓	$60,000	High
		Provision of basic fire-fighting equipment at each active site, including fire extinguishers, knapsacks and other equipment suitable for initial response actions.			✓	✓	✓	✓	$60,000	High
		Installation of access tracks with intermittent passing bays and with appropriate vertical clearance and suitability for all weather conditions.				✓	✓	✓	NA	High
		Maintaining provision for mobile telephone and UHF radio communications.		✓	✓				NA	High

IMPACT	RELEVANT SPECIES / GUILD	MITIGATION MEASURE	TIMEFRAME	DETAILED DESIGN	PRE-CONSTRUCTION	DURING CONSTRUCTION	OPERATION	DECOMMISSIONING	COST ESTIMATE	PREDICTED EFFECTIVENESS OF MEASURE
		Provision of onsite identification of individual turbine locations and access gates for fire-fighting services, and an undertaking to provide local rural fire service groups with access to gates.			✓				NA	High
		Consideration of total fire ban days in regard to hours within which construction takes place based on fire risk.				✓		✓	NA	High
		Providing the Rural Fire Service (RFS) with: • A construction works schedule • Maps of final turbine layout and identification information for individual turbine sites • Access road plans and locations of access gates • Security information such as location of locked gates and restricted access areas • Location of any additional water supplies installed for construction activities • Location of potential landing pads for fire-fighting aircraft or helicopters			✓				NA	High

IMPACT	RELEVANT SPECIES / GUILD	MITIGATION MEASURE	TIMEFRAME	DETAILED DESIGN	PRE-CONSTRUCTION	DURING CONSTRUCTION	OPERATION	DECOMMISSIONING	COST ESTIMATE	PREDICTED EFFECTIVENESS OF MEASURE
Hazardous Materials										
Spills of hazardous material (e.g. oil)	All	Hazardous materials must be stored on or off-site in specific lay-down/storage areas, and will be handled and stored according to regulatory requirements and Australian Standards AS1940.				✓	✓	✓	NA	High
		The transformer as part of the collector substation may contain upwards of 20,000 litres of oil. Provisions will be made as part of the design for containment of any oil which may leak or spill. Prevention and containment of any potential spills will be described in detail in the EMP.			✓	✓	✓	✓	NA	High
Others										
Boundary encroachment	All	The boundaries of the construction area will be clearly marked to prevent construction works breaching the boundaries.	Prior to commencement of construction works		✓			✓	$25,000	High
Upgrading of creek crossing causing bank instability	Aquatic species	Measures implemented to ensure bank stability. Jute matting or similar used in any revegetation to prevent weed invasion and increase bank stability.			✓				Part of revegetation works costs	Moderate – depending on time between disturbance and stabilisation.

5.4 DIRECT IMPACTS - CONSTRUCTION

5.4.1 Vegetation clearance

Although the proposal involves the removal of vegetation across a large area, impacts are primarily restricted to a narrow, linear pathway with clearance occurring in narrow bands throughout an open, woodland and grassland landscape. The proposal comprises both permanent and temporary vegetation removal with areas such as underground reticulation requiring trenching for installation which can then be filled and revegetated. Measures can then be implemented to prevent weed invasion and erosion once installed.

Table 18 summarises the proposed vegetation clearance for each component of the proposal for each turbine layout option. Two road layout options are being investigated in order to reduce the likely vegetation clearance from the proposal:

- 12 m clearance area which will be revegetated back to 6 m following construction;
- Roads 6 m wide with intermittent passing bays 12 m wide.

The most feasible road layout will be determined during the detailed design phase of the proposal and will depend on final turbine selection and crane availability. Table 19 lists the total area of permanent and temporary vegetation loss for each vegetation type and condition, based on the worst case scenario road option (i.e. 12 m road including cut and fill).

Eight proposed locations have been identified for the required concrete batching plants. All have been selected based on their proximity to access roads, their limited ecological values and other project construction requirements (Figure 3).

The removal / loss of some vegetation for the proposal is unavoidable. However, all unavoidable native vegetation clearance has been minimised and it is proposed that all remaining impacts will be offset in accordance with a quantitative assessment using 'improve or maintain' principles as determined by the use of the Biobanking credit calculator. The results of the Biobank credit calculations is included in a standalone report (Appendix I) and summarised in the proposed offset strategy (Section 6).

Table 18: Proposed impact areas for each layout and road option

PROJECT COMPONENT	ESTIMATED IMPACT AREA (ha) - 80 m LAYOUT (12 m ROAD)			ESTIMATED IMPACT AREA (ha) - 110 m LAYOUT (12 m ROAD)		
	PERMANENT (ha)	TEMPORARY (ha)	TREES ONLY (ha)	PERMANENT (ha)	TEMPORARY (ha)	TREES ONLY (ha)
Roads	93.72	93.11	0.00	89.60	81.69	0.00
Turbine footings and assembly	20.48	0.00	0.00	16.52	0.00	0.00
Substation	1.97	0.00	0.00	1.97	0.00	0.00
Internal overhead electrical interconnection / easement	32.17	0.00	55.67	32.23	0.00	55.23
Temporary construction facilities						
Concrete batching plants (8)	0.00	3.71	0.00	0.00	3.70	0.00
Site office (3)	0.00	1.09	0.00	0.00	1.10	0.00
Rock crushing plants (3)	0.00	0.86	0.00	0.00	0.79	0.00
Construction compounds (3)	0.00	8.80*	0.00	0.00	8.72*	0.00
Total						
Study area (ha)	**1,955.85**					
Project site area (ha)	**14,189.33**					
Total development footprint (ha)	**148.34**	**107.57**	**55.67**	**140.32**	**96.00**	**55.23**

Note: *These areas have been generated using GIS (Geographic Information System) calculations. The absolute difference between proposed impact areas and the footprint of construction features (Table 5) reflects areas where features slightly overlap. Therefore, overlapping impacts have only been included for one of the components to avoid duplication (e.g. roads and construction compounds).

Table 19: Estimated clearance of each vegetation type under each layout option.

REVISED BIOMETRIC VEGETATION TYPE	BIOBANKING CONDITION	ANCILLARY CODE	AREA MAPPED WITHIN PROJECT SITE (ha)	AREA MAPPED WITHIN STUDY AREA (ha)	ESTIMATED IMPACT AREA – 80 m LAYOUT*			ESTIMATED IMPACT AREA – 100 m LAYOUT*		
					PERMANENT CLEARANCE (ha)	PERMANENT CLEARANCE FOR POWERLINE (TREES ONLY) (ha)	TEMPORARY CLEARANCE (ha)	PERMANENT CLEARANCE (ha)	PERMANENT CLEARANCE FOR POWERLINE (TREES ONLY) (ha)	TEMPORARY CLEARANCE (ha)
BR110: Black Cypress Pine – Tumbledown Gum – Narrow-leaved Ironbark open forest	Moderate /Good	Trees	11.54	0	0	0	0	0	0	0
		Native Pasture	62.17	12.71	0.86	0	0.45	0.46	0	0.28
BR114: Blakely's Red Gum – Rough-barked Apple – Red Stringybark grassy open forest	Moderate /Good	Trees	34.08	1.7	0	0	0	0	0	0
		Native Pasture	0	0	0	0	0	0	0	0
BR116: Blakely's Red Gum – Yellow Box grassy open forest or woodland	Moderate /Good	Trees	241.58	20.19	0.98	0	0.48	0.86	0	1.36
		Native Pasture	358.71	81.68	6.23	0	4.43	5.97	0	9.80
	Low	-	113.39	17.91	0	0	5.50	0	0	5.50
BR153: Manna Gum – Rough-barked Apple – Yellow Box grassy woodland/open forest	Moderate /Good	Trees	5397.39	765.66	36.47	32.17	31.90	32.62	32.23	93.21
		Native Pasture	1703.04	499.65	33.28	0	56.59	32.69	0	88.86
	Low	-	730.15	225.48	14.30	0	36.15	13.68	0	46.88

REVISED BIOMETRIC VEGETATION TYPE	BIOBANKING CONDITION	ANCILLARY CODE	AREA MAPPED WITHIN PROJECT SITE (ha)	AREA MAPPED WITHIN STUDY AREA (ha)	ESTIMATED IMPACT AREA – 80 m LAYOUT*			ESTIMATED IMPACT AREA – 100 m LAYOUT*		
					PERMANENT CLEARANCE (ha)	PERMANENT CLEARANCE FOR POWERLINE (TREES ONLY) (ha)	TEMPORARY CLEARANCE (ha)	PERMANENT CLEARANCE (ha)	PERMANENT CLEARANCE FOR POWERLINE (TREES ONLY) (ha)	TEMPORARY CLEARANCE (ha)
BR227: Tenterfield Woollybutt – Silvertop Stringybark open forest	Moderate/ Good	Trees	109.27	12.46	0.57	0	0.54	0.57	0	1.17
		Native Pasture	3.53	0	0	0	0	0	0	0
BR240: White Box grassy woodland	Moderate /Good	Trees	537.25	94.78	5.17	0	4.19	4.82	0	7.43
		Native Pasture	471.81	105.79	7.91	0	6.34	7.19	0	11.88
	Low	-	181.29	44.98	2.78	0	1.48	2.05	0	3.10
TOTAL			9955.20	1882.99	108.55	32.17	148.05	100.91	32.23	136.79

Note: * All calculations are based on a worst case scenario (i.e. 12 m road layout with cut and fill)

Impacts to Endangered Ecological Communities (EECs) and Critically Endangered Ecological Communities (CEECs)

Ribbon Gum - Mountain Gum - Snow Gum Grassy Forest/Woodland of the New England Tableland Bioregion EEC

This EEC is listed under the TSC Act and includes the Manna Gum – Rough-barked Apple – Yellow Box grassy woodland/open forest community recorded across the study area (1,490.79 ha mapped) and project site (7,830.58 ha mapped). The proposal involves the permanent removal of up to 116.22 ha of MGRAYB in various conditions from the study area. This comprises 68.64 ha of remnant woodland, 33.28 ha of highly modified derived native grassland/native pasture and 14.3 ha in low condition (Table 19). This loss represents only a small proportion of the MGRAYB present within the study area (7.8%) and project site (1.5%) (Table 19).

An additional area will be temporarily cleared (124.64 ha) for roads, reticulation and construction facilities, the majority of which is modified native pasture (56.59 ha) (Table 19).

Box Gum Woodland (BGW) EEC & CEEC

Both BRGYB and WB are characteristic of the EEC *White Box Yellow Box Blakely's Red Gum Woodland* listed under the TSC Act and the CEEC *White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland* listed under the EPBC Act - both more commonly known as Box Gum Woodland (BGW). Areas of Low condition BGW meet the TSC Act criteria. However, areas mapped as Moderate/Good condition only reflect the EPBC Act listed BGW community as Low condition areas do not retain sufficient integrity to be considered the CEEC under the EPBC Act. BGW is present primarily in the lower lying parts of the study area. The impact on the BGW EEC/CEEC will be the permanent removal of up to 23.07 ha of BGW, comprising 6.15 ha of remnant woodland, and 16.92 ha of derived grassland. An additional 15.44 ha of temporary clearance is proposed for roads, reticulation and construction facilities. This temporary removal comprises 4.67 ha of remnant woodland and 17.75 ha of derived native grassland/native pasture. This represents 12.5 % of the BGW present within the study area and only 2.4% of the BGW present within the project site (Table 19).

5.4.2 Loss of threatened flora habitat

Habitat for a variety of threatened flora species is present across the study area and the vegetation clearance outlined above will also result in the removal of potential habitat for threatened plants. Although threatened plants were recorded within the study area, all have been avoided and mitigation measures will be implemented to prevent indirect impacts. Table 20 outlines the amount of potential habitat likely to be impacted by the proposal for those threatened plants recorded within the study area.

Table 20: Population estimates for TSC & EPBC listed threatened flora found within study area

SPECIES	VEGETATION TYPES SUPPORTING HABITAT*	NUMBER OF INDIVIDUALS WITHIN STUDY AREA	INDIVIDUALS WITHIN DEVELOPMENT FOOTPRINT	POTENTIAL HABITAT WITHIN PROJECT SITE (ha)	POTENTIAL HABITAT WITHIN STUDY AREA (ha)	80 m LAYOUT WITH 12 m ROADS		100 m LAYOUT WITH 12 m ROADS	
						AMOUNT OF POTENTIAL HABITAT IMPACTED (ha)			
						PERMANENT	TEMPORARY	PERMANENT	TEMPORARY
Bothriochloa biloba (EPBC Act only)	BRGRARS, BRGYB, MGRAYB, WB, DG	9,372	0	8743.86	1,569.45	122.21	103.93	116.38	96.16
Dichanthium setosum	BRGRARS, BRGYB, MGRAYB, TWSS, WB, DG	6,353	0	8856.66	1,581.91	122.78	104.47	116.95	96.76
Eucalyptus mckieana	BCPTGNLI	10	0	73.71	12.71	0.57	0.54	0.57	0.60
Thesium australe	BRGRARS, BRGYB, MGRAYB, TWSS, WB, DG	7,350	0	8856.66	1,581.91	122.78	104.47	116.95	96.76

Note:

* Low condition vegetation not included

BCPTGNLI - Black Cypress Pine =Tumbledown Gum – Narrow-leaved Ironbark open forest, BRGRARS = Blakely's Red Gum – Yellow Box grassy open forest or woodland, BRGYB = Blakely's Red Gum – Yellow Box grassy open forest or woodland, MGRAYB = Manna Gum – Rough-barked Apple – Yellow Box grassy woodland/open forest, TWSS = Tenterfield Woollybutt – Silvertop Stringybark open forest, WB = White Box grassy woodland, DG = Derived Grassland

5.4.3 Loss of riparian vegetation

The proposal involves the establishment of a small number of creek crossings. Where powerlines cross creek lines these will be strung over the creek and poles placed outside the riparian zone to prevent impacts. Vegetation and habitat clearance for these works has been calculated in the previous tables. A more detailed assessment of the impacts of the proposal on riparian areas has been included within the Environment Assessment documentation. Given the landscape is highly modified and riparian vegetation primarily consists of a grassy ground layer with no overstorey, the impacts are likely to be minimal.

5.4.4 Loss of fauna habitat

As a worst-case scenario, the proposal involves the permanent removal of up to approximately 140.72 ha of potential habitat for a variety of species, including 75.36 ha of woodland and 48.28 ha of native pasture and 17.08 ha of low condition vegetation. Additionally, 148.05 ha of temporary clearance is proposed, including 37.11 ha of woodland and 67.81 ha of native pasture and 43.13 ha of low condition vegetation. This includes the clearing of trees from vegetation in various conditions for the provision of overhead electrical infrastructure.

Given the proposal is linear in structure, and as such does not result in large consolidated areas of clearing, the proposed habitat removal is unlikely to be considered large with respect to the remaining areas of potential habitat present throughout the project site. Furthermore, the proposed clearance will not isolate areas of potential habitat for fauna.

Approximately 15,934 hollow-bearing trees (HBTs) are estimated to be present across the study area and as a worst-case scenario it is estimated that up to 1,816 HBT (11.4 %) may be removed for the proposal. The distribution of HBT across the study area in not uniform and, therefore, this estimate is indicative only and likely to be a significant over estimate as roads and turbines have been sited to avoid HBTs.

5.4.5 Loss of threatened fauna habitat

Woodland Birds

The following threatened woodland birds were recorded within the study area:

- Brown Treecreeper
- Hooded Robin
- Scarlet Robin
- Diamond Firetail
- Little Lorikeet
- Turquoise Parrot
- Speckled Warbler

Table 21 outlines the amount of habitat present within the study area and the amount likely to be impacted. Given the amount of habitat present for these species within the study area in comparison to that to be cleared, it is unlikely that the proposal would result in a significant reduction in habitat for these species within the study area.

Table 21: Habitat for woodland birds and likely impacts (reflecting 80m layout)

SPECIES	HABITAT WITHIN STUDY AREA	HABITAT MAPPED IN PROJECT SITE (HA)	BREEDING HABITAT PRESENT WITHIN STUDY AREA (HA)	FORAGING HABITAT PRESENT WITHIN STUDY AREA (HA)	AMOUNT OF HABITAT TO BE IMPACTED (HA)
Brown Treecreeper	BCPTGNLI, BRGRARS, BRGYB, MGRAYB, TWSS, WB	6331.11	894.79	894.79	75.36 (permanent) 37.11 (temporary)
Hooded Robin	BCPTGNLI, BRGRARS, BRGYB, MGRAYB, TWSS, WB	6331.11	94.79	94.79	75.36 (permanent) 37.11 (temporary)
Scarlet Robin	BCPTGNLI, BRGRARS, BRGYB, MGRAYB, TWSS, WB	6331.11	94.79	94.79	75.36 (permanent) 37.11 (temporary)
Diamond Firetail	BCPTGNLI, BRGRARS, BRGYB, MGRAYB, TWSS, WB, DG	8930.37	1594.62	1594.62	123.64 (permanent) 104.92 (temporary)
Little Lorikeet	BCPTGNLI, BRGRARS, BRGYB, MGRAYB, TWSS, WB, DG	8930.37	1594.62	1594.62	123.64 (permanent) 104.92 (temporary)
Turquoise Parrot	BCPTGNLI, BRGRARS, BRGYB, MGRAYB, TWSS, WB, DG	8930.37	1594.62	15194.62	123.64 (permanent) 104.92 (temporary)
Speckled Warbler	BCPTGNLI, BRGRARS, BRGYB, MGRAYB, TWSS, WB	6331.11	94.79	94.79	75.36 (permanent) 37.11 (temporary)

BCPTGNLI - Black Cypress Pine =Tumbledown Gum – Narrow-leaved Ironbark open forest, BRGRARS = Blakely's Red Gum – Yellow Box grassy open forest or woodland, BRGYB = Blakely's Red Gum – Yellow Box grassy open forest or woodland, MGRAYB = Manna Gum – Rough-barked Apple – Yellow Box grassy woodland/open forest, TWSS = Tenterfield Woollybutt – Silvertop Stringybark open forest, WB = White Box grassy woodland, DG = Derived Grassland

Koala

The Koala was not recorded at the site during the surveys, although six species of Koala feed tree are present across the study area and there are nearby historical records. For this reason it has been assumed that the Koala may utilise the site. Approximately 860.44 ha of potential habitat is present within the study area and 5,934.64 ha within the project site. It is anticipated that the proposal would impact approximately 76.55 ha of potential habitat for this species. This is unlikely to represent a significant amount of habitat in the context of the amount of habitat present within the project site (1.3 % ha) and will occur over a large linear area rather than one consolidated stand.

Squirrel Glider

Extensive areas of potential habitat for the Squirrel Glider are present across the study area and some will be cleared for the proposal. It is anticipated that up to 880.63 ha of potential habitat is present within the study area and 6,176.22 ha within the project site. Approximately 74.79 ha is likely to be impacted by the proposal. This represents 1.2 % of the habitat within the project site and is unlikely to represent a significant amount of habitat for this species given the extent of potential habitat within the project site (880.63 ha). Furthermore, this clearance is to occur over a large linear area rather than one consolidated stand

Microchiropteran Bats

A number of microchiropteran bats have been recorded within the study area. Breeding habitat in the form of hollow-bearing trees is present for the majority of these species (with the exception of Eastern Bentwing-bat and Eastern Cave Bat which require caves for breeding). Approximately 15, 934 HBT are estimated to be present across the study area and it is anticipated that up to 1,816 HBT (11.4%) may be removed for the proposal. However as discussed previously, the distribution of HBT across the study area is not uniform and, therefore, these indicative values are likely to be a significant over-estimate as roads and turbines have been sited to avoid HBT.

Areas of woodland and grassland provide potential foraging habitat for microchiropteran bat species. Of the 1,883 ha of habitat present across the study site, up to approximately 140.72 ha of this will be permanently removed and 148.05 ha will be temporarily cleared. Combined, the proposed 288.77 ha of impact represents 15.3 % of the fauna habitat within the study area and approximately 2.9 % of the potential habitat mapped within the project site. Extensive areas of potential habitat are present in the areas around the study area (e.g. 9955.2 ha of mapped within the project site) and throughout the locality. Furthermore, the proposed habitat removal occurs over a large linear area and not in one consolidated block. Therefore, it is unlikely that the habitat loss due to the proposal would significantly reduce the available habitat for these species within the locality.

Border Thick-tailed Gecko

This species is likely to be restricted to rocky outcrop areas particularly on granite soils and areas where there are rocky outcrops and leaf litter. Potential habitat for the Border Thick-tailed Gecko is present in isolated patches across the study area (Figure 11). Given the broad nature of the habitat requirements listed for this species such as areas cleared for agriculture in the past (DECCW 2011), much larger areas of marginal potential habitat are present across the study area throughout woodland areas. This species was not detected during the targeted surveys undertaken. However, this is a cryptic species that can often take significant survey effort to detect. It is likely that the majority of the study area is extremely marginal habitat for the Border Thick-tailed Gecko as woody debris is sparse and the understorey in most areas is grassy. Those areas mapped as potential habitat are more likely to support this species should it be present at the site as they support either rocky outcrops or fallen timber and also a dense canopy. Table 22 outlines the anticipated impacts.

Table 22: Potential impacts on Border Thick-tailed Gecko

TURBINE LAYOUT OPTION	TOTAL AREA OF HABITAT MAPPED (HA)		HABITAT PRESENT WITHIN THE PROJECT SITE (HA)		HABITAT PRESENT WITHIN THE STUDY AREA (HA)		HABITAT TO BE IMPACTED (HA)		PERCENTAGE OF TOTAL MAPPED HABITAT IMPACTED		PERCENTAGE OF HABITAT IMPACTED WITHIN STUDY AREA	
	Potential	Marginal Potential	Potential	Marginal Potential	Potential	Marginal Potential	Potential	Marginal Potential	Potential	Marginal Potential	Potential	Marginal Potential
110m layout	1183.58	4033.67	1089.54	4031.96	127.29	440.78	19.32	46.62	1.6%	1.2 %	15.2 %	10.6 %
80m layout							18.73	49.65	1.6%	1.2 %	14.7 %	11.3 %

Migratory Bird Species

Habitat for the following migratory fauna species was present within the study area:

- White-throated Needletail (*Hirundapus caudacutus*)
- Rainbow Bee-eater (*Merops ornatus*)
- Regent Honeyeater (*Anthochaera phrygia*)
- Great Egret (*Ardea alba*)
- Cattle Egret (*Ardea ibis*)
- Fork-tailed Swift (*Apus pacificus*)
- Swift Parrot (*Lathamus discolor*)

None of the migratory species listed above were recorded on site during field surveys. Each of these species travel long distances between sites and therefore, has the potential to be impacted by operational turbines, should they visit the site. The proposal involves the permanent removal of up to approximately 148.34 ha of potential habitat for these species and 163.24 ha of temporary clearance within the study area. However, impacts in terms of disturbance to habitat for these species within the study site are likely to be negligible given they forage widely and the minimal amount of clearing required comparative to the amount of habitat present within the project site.

Regent Honeyeater

There were no records of the Regent Honeyeater on the Birds Australia data search (2009) although there is an historical record on the OEH (formerly DECCW) database (1968) to the south of the site and a more recent record (1994) along Wellingrove Road to the north east of the study area (DECCW 2011a). The proposal will remove up to 112.47 ha of potential foraging habitat for this species. This represents 12.6 % of the habitat present within the study area and only 1.45 % of the available habitat mapped. Sapphire is not a known breeding site for this species and given the transitory and migratory nature of this species, it is likely to only be used periodically for foraging and may not be used at all.

Table 23: Regent Honeyeater habitat and anticipated impacts

<table>
<tr><th>TURBINE LAYOUT OPTION</th><th>TOTAL AREA OF HABITAT MAPPED (ha)</th><th>HABITAT PRESENT WITHIN THE PROJECT SITE</th><th>HABITAT PRESENT WITHIN THE STUDY AREA (ha)</th><th>HABITAT TO BE IMPACTED (ha)</th><th>PERCENTAGE OF HABITAT IMPACTED WITHIN STUDY AREA</th><th>PERCENTAGE OF TOTAL MAPPED HABITAT IMPACTED</th></tr>
<tr><td>100m layout</td><td rowspan="2">7,764.84</td><td rowspan="2">6,331.09</td><td rowspan="2">894.79</td><td>103.16</td><td>11.5 %</td><td>1.33 %</td></tr>
<tr><td>80m layout</td><td>112.47</td><td>12.6 %</td><td>1.45 %</td></tr>
</table>

5.5 DIRECT IMPACTS - OPERATION

Impacts of the proposal on bird and bat species are inevitable during the operational phase although they will be minimised. Impacts include the potential for birds and bats to accidentally collide with moving turbines. Much literature addresses potential impacts of wind farms on birds and bats, although most studies have been undertaken overseas. The impacts appear to be dependent on a number of factors:

- Proximity to wetlands
- Whether the wind farm occurs along migratory pathways
- Proximity to bird concentrations (Brett Lane & Associates 2005)
- Wind farm layout (Brett Lane & Associates 2005)
- Type of habitat and surrounding area (Kevin Mills & Associates 2005)
- Spacing (DEH Australian Greenhouse Office 2006)
- Location on the landscape (DEH Australian Greenhouse Office 2006)
- Proximity to forested areas (DEH Australian Greenhouse Office 2006)
- Type of wind turbine used (Brett Lane & Associates 2005)
- Lighting used on turbine (Brett Lane & Associates 2005)
- Turbines located on forested ridges (Arnett 2005)

5.5.1 Bats

Risk Matrix - Bats

A risk matrix has been prepared to assess the likelihood that bats present within the study area would be impacted by the proposal (Appendix F, Table 38). Consideration has been given to bat behaviour, habitat requirements and flight character and the potential for bats to be impacted has been assessed based on the following criteria:

- **Low** – do not migrate, do not fly above canopy, do not roost in hollows or roost in hollows but fly below canopy
- **Moderate** – do not migrate, fly above canopy, roost in hollows
- **High** – migrate or have large foraging range, fly above canopy, roost in hollows

The general consensus appears to be that the highest bat fatalities occur on nights when wind speed is low (< 6 m s–1), which is when aerial insects are most active (Ahlén 2003; Fiedler 2004; Arnett 2005, Horn *et al*. 2008, Kunz *et al.* 2007). A significant positive correlation between insect passes and bat passes was also observed by Arnett (2005). A number of studies have also found bats actively foraging around turbines sites rather than passing through and bats approaching both moving and non-moving turbines out of what was thought to be curiosity with bats investigating the various parts of the turbine with repeated fly-bys (Arnett 2005, Kunz *et al.* 2007, Horn *et. al* 2008). Given this behaviour there is the potential for bats to collide with turbines on the proposed wind farm.

It is difficult to determine whether bat strike at wind farms is due to bats being unable to detect or visualise blades, a consequence of curiosity or due to bats following or being trapped in blade-tip vortices (Kunz *et al*. 2007). As noted by Richards (unpublished) little is known about the likelihood that bats would not visualise a blade. However, bats can detect objects from a range of sizes including tree branches, moving vehicles and flying insects, therefore, given the size of the rotor blades the probability that a bat would not distinguish a blade or rotor in the open air is considered by Richards to be low (Richards unpublished).

Conversely, others believe that for most bat species, echolocation is ineffective at distances greater than 10 m (Fenton 2004) and, therefore, bats foraging in the vicinity of wind turbines may miscalculate rotor velocity or fail to detect the large, rapidly moving turbine blades (Ahlén 2003; Bach and Rachmel 2004; Dürr and Bach 2004). Whilst it is unlikely that measures can be implemented to increase the likelihood of blade detection through echolocation, siting of turbines outside obvious potential fly ways will help to decrease the likelihood of bats colliding with turbines.

Due to the open nature of the project site, identification of potential flyways is difficult. The open woodland structure means that bats may forage relatively unobstructed across the majority of the site and even more so in the grassland areas in the west. Nevertheless, as a precautionary measure, turbines will be situated such that they are at least 30 m from any hollow-bearing trees to minimise the potential for impacts on potential roosting and nesting sites following construction. The White-Striped Freetail Bat, *Mormopterus* sp. 4 and Yellow-bellied Sheathtail-bat appear to be at most risk of turbine strike in areas where turbines are in proximity to hollows as these species roost in hollows and forage above the canopy (Appendix F).

A number of other species also have a moderate potential of strike due to their foraging activities either occurring within or above the canopy and / or their migratory nature (Table 38, Appendix F)

Studies have found that on average, greater than 80% of bat fatalities currently recorded at wind energy developments in North America involve migratory species, while only a small proportion of fatalities (up to 25 % in some areas) are year-round residents (Arnett *et al.* 2008, Kunz *et al.* 2007). In addition most have been shown to be migratory, tree-roosting species (Kunz *et al.* 2007). The White-striped Freetail Bat and Yellow-bellied Sheathtail-bat were the only migratory, tree roosting species recorded within the study area. Given that the proposal is to take place in an open landscape where flight pathways are less influenced by canopy density and vegetation structure, it is likely the openness of the landscape would help to reduce the likelihood that these bats would collide with turbines. The Eastern Bentwing-bat is a migratory species and, therefore, is likely to be at greater risk of strike than the non-migratory species.

Lighting

Studies of the correlation between bat activity and lighting have been conducted. Whilst insect activity was found to be somewhat higher at turbines with Federal Aviation Administration lights, aviation lighting did not appear to affect the incidence of foraging bats around turbines and there was no difference between numbers of bat passes at lit and unlit turbines (Arnett 2005). Preliminary evidence also suggests that bats are not attracted to the lighting attached to wind turbines (Arnett 2005; Kerlinger *et al.* 2006, Kunz *et al*. 2007). Although preliminary studies have shown that bats are not attracted to certain types of lighting, research is in its infancy and, therefore, as a precautionary measure it is recommended that the use of lighting is avoided where it is not required for safety reasons. Where lighting is a necessity, thought should be given to the type of lighting used on the turbines to minimise the potential for insects and hence bats to be attracted to turbines, subject to requirements of the Civil Aviation Safety Authority.

Tower Height

Tower height has also been identified as a factor in influencing the likelihood of bat strike at wind farms. Arnett *et al.* (2008) found that towers 65 m in height compared to 78 m towers killed fewer bats but more bats per Mega Watt (MW). Taller turbines with greater rotor-swept areas killed more bats [per turbine and per MW] compared with smaller turbines (Arnett *et al.* 2008). Although decreasing the height of turbines or rotor-swept areas may not be possible for some projects as it may reduce the feasibility of the wind farm, where turbine heights and rotor-swept areas can be modified and reduced, these measures should be implemented to reduce the potential for bat strike.

Barotrauma

Barotrauma, as a consequence of rapid decompression due to changes in atmospheric pressure as the turbine blades rotate downward, has also been suggested as a threat to bats. Whilst the results of initial studies are inconclusive, some bats killed at wind turbines have shown no sign of external injury, but evidence of internal tissue damage which is consistent with decompression (Dürr and Bach 2004). Potential measures that could be implemented at wind farms to mitigate or reduce the likelihood of barotrauma at this stage remain unknown.

Affected Species

Based on the results of literature reviews and an understanding of bat behaviour, those species considered most likely to come in contact with turbine blades during the operation of the wind farm include those which forage above the canopy, are migratory or have large foraging areas and may roost in the trees across the study area. Of the species recorded across the study area, the White-striped Freetail Bat, the Yellow-bellied Sheathtail-bat and the Southern Freetail Bat were the species considered to have a high potential for strike due to their migratory nature, foraging behaviour and for most, the fact that they can travel large distances whilst foraging.

Bat activity was monitored across the study area over a number of seasons throughout a three year period via anabat detection. Results indicated high levels of bat activity across the study area for *Chalinolobus morio* (Chocolate Wattled Bat), *Chalinolobus gouldii* (Gould's Wattled Bat), *Vespadelus* spp. and *Miniopterus schreibersii oceansis* (Eastern Bentwing-bat) being the most commonly recorded species.

Although in areas directly surrounding turbines, bat foraging activity may decrease due to bats avoiding collisions with turbine blades, extensive areas of foraging habitat will remain, extensive tree clearance is not proposed and significant changes to foraging activities are not anticipated. Measures to prevent bat strike wherever possible will be implemented. However, based on the findings of past studies, it is likely that some collisions will be unavoidable even with mitigation measures.

The White-striped Freetail Bat appears to be at the greatest risk of collision as this species migrates to northern regions during winter, roosts in hollows, has a fast and direct flight pattern, forages above the canopy and can commute 50 km between roost and feeding sites. A small number of calls for this species were recorded in the Sapphire cluster within the central group of turbines and also immediately west of the current power line easement.

A small number of calls for the Yellow-bellied Sheathtail-bat were recorded in the Sapphire cluster in the very north-west of the site and also near the current power line in the centre of the Sapphire cluster. Given that this species migrates to southern Australia between January and April, flies above canopy but lower at edges of forest, uses tree hollows for roosting and has a fast flight pattern, the chances of collision with turbines is likely to be greater than for other bat species that do not migrate and forage below the canopy.

The Southern Freetail-bat was also identified as having a high potential of collision given that it forages above the canopy including along the edges of remnants, can forage up to 12 km from roosts and in hollows.

The Eastern Bentwing-bat was the only threatened bat frequently recorded across the study area and is both migratory and can travel up to 65 km in one night. This species forages above the canopy and in open areas. There is the potential for this species to be struck when foraging across the woodland given this species is an above canopy feeder or when moving between feeding areas.

5.5.2 Birds

Impacts from the proposed wind farm on bird species include the potential for collisions with turbines and avoidance of areas where turbines are present. A number of studies have been conducted to assess the impacts of wind farms on birds and it has been found that those species most commonly impacted include:

- wetland birds that form large flocks;
- birds of prey; and
- species that flock and fly above the canopy (Kevin Mills & Associates 2005).

As suggested by Erickson *et al.* (2001) the vulnerability of a species to collisions is species and habitat, specific. Many of the studies on bird collision have been conducted overseas in coastal landscapes where bird migration activities are high. Few studies have been conducted in Australia and few have focused on agricultural landscapes such as those present within the study area. In addition, the many gaps in the literature make it difficult to draw conclusions about the impacts of wind farms on avifauna.

A number of threatened bird species have been recorded within the study area although the likelihood of most of these species colliding with turbines is considered low as the majority are woodland birds which forage amongst the woodland areas within the canopy or close to the ground. Of those species recorded on site, the Little Lorikeet and the Turquoise Parrot are at the most risk given their fast, flight patterns and that they may fly at height particularly when moving between feeding areas.

A number of birds of prey were recorded within the study area. These included *Falco cenchroides* (Nankeen Kestrel), *Aquila audax* (Wedge-tailed Eagle), *Elanus axillaris* (Black-shouldered Kite), *Accipiter fasciatus* (Brown Goshawk) and *Haliastur sphenurus* (Whistling Kite). Birds of prey are also at risk of collision with turbines although given the large home ranges of these species it is likely that only a small number of individuals inhabit the area covered by the wind farm.

Risk Matrix - Birds

A risk matrix anticipating the likelihood of collision with turbines has been prepared for those species most commonly recorded within the study area, birds of prey and any threatened species recorded at the site and is included in Appendix G. Factors such as the flight character, distribution across the site and whether the species is migratory have been considered when determining the likely risk. Those species considered to be a greatest risk are those that fly at high altitudes, at speed and are migratory. Based on the risk matrix it considered unlikely that many of the species common to the study area would be likely to collide with turbine although the risk is considered to be slightly higher for raptors and birds of prey which may collide with turbines whilst hunting prey. Passerine species due to their fast flight patterns and sometimes high flight may also be a risk of collision.

Those species identified as at moderate risk of collision included:

- Little Lorikeet
- Crimson Rosella
- Turquoise Parrot
- Musk Lorikeet
- Eastern Rosella
- Nankeen Kestrel
- Wedge-tailed Eagle
- Black-shouldered Kite
- Brown Goshawk
- Whistling Kite

Lighting

There has been suggestion that the use of lighting on turbines increases the potential for avian collisions as some species are attracted to the lighting for navigation purposes or for feeding on the insects that often centre on the light source. However, results from studies are relatively inconclusive with some studies identifying a relationship between lighting and avian collisions (US Department of Interior Fish & Wildlife Service 1993) and others identifying no significant difference between turbines lit with L-864 obstruction lights and those without (Jain *et al*. 2007). Many of the species recorded across the project site are not nocturnal and, therefore, would not be affected by light sources on turbines. However, as a precautionary measure, it would be prudent to design turbine lighting that reflects the findings and recommendations of previous studies to reduce the potential for collision with those nocturnal species that do utilise the study area. For safety reasons lighting will need to meet CASA requirements.

Affected Species

Migratory Birds

Migratory birds have been listed amongst the species most commonly impacted by wind turbines. Whilst wind turbines are likely to be below the flight altitude of most migratory species, weather and other factors have been suggested to potentially reduce flight height and, therefore, may result in collisions by migratory birds (Erickson *et al.* 2001).

The study area may form part of a migratory route for the Regent Honeyeater. Although habitat within the study area is unlikely to be key habitat, historical records of the Regent Honeyeater exist and, therefore, there is the potential that this species may migrate across the site when moving to northern areas. Given that birds tend to fly at altitudes well above the turbines when on migratory paths, the potential for accidental collisions when these species are migrating is considered low. There is the potential for the study area to be used as a stopover during migration and, therefore, at this time there is a risk of collision.

There a no records for any other migratory species within the study area and, therefore, impacts on migratory species are likely to be low or negligible.

Birds of Prey

A number of birds of prey were recorded across the study area although no nests were recorded within the study area. Given the number of birds of prey using the project site and the location of some of the turbines on ridge tops, there is the potential for some individuals to collide with turbines. In general, birds of prey have large home ranges and low reproductive rates and, therefore, loss of these individuals is likely to have a greater effect on population numbers than it may on other species that are present in greater densities, have greater reproductive rates and have smaller home ranges. Studies have shown that in general, mortality rates for birds at wind farm sites is between 1 and 2 individuals per turbine per year (Illinois Department of Natural Resources 2007, Smales 2005a). Studies of the likely cumulative impacts of the eight existing and proposed wind farms in the range of the Tasmanian Wedge-tailed Eagle were conducted by Biosis Research and it was found that the likely cumulative impacts from wind farms would result in a 0.001 per cent increase in the mortality rate, which is ‘not significantly different from that indicated for the population in the absence of those wind farms’ or approximately one bird per annum (Smales and Muir 2005). However, the potential for collision cannot be ruled out. There is also the potential for collisions by immature birds when dispersing from natal territories.

Owls

Owls are likely to utilise the study area from time to time. Surveys of woodland areas where conducted but despite the presence of numerous hollow-bearing trees and areas of potential foraging habitat the Tawny Frogmouth and White-throated Nightjar were the only nocturnal bird species recorded. There is the potential for owls to collide with turbines although this is considered to be more likely when they are moving between patches of woodland during foraging rather than when foraging amongst a woodland patch. Given owl activity across the site appears to be low, the potential for impacts on owl populations is considered low.

5.6 SUMMARY OF DIRECT IMPACTS

- The 159 (80 m) turbine layout (with 12 m clearance for roads) is likely to have the greatest impacts. Therefore, based on this layout, approximately:
  - 0.86 ha permanent and 0.45 ha of temporary removal of BCPTGNLI
  - 0 ha permanent and 0 ha of temporary removal of BRGRARS
  - 7.21 ha permanent and 10.41 ha of temporary removal of BRGYB
  - 116.22 ha permanent and 124.64 ha of temporary removal of MGRAYB
  - 0.57 ha permanent and 0.54 ha of temporary removal of TWSS
  - 15.86 ha permanent and 12.01 ha of temporary removal of WB
- Removal of the up to approximately 140.72 ha of potential habitat for a variety of species and 148.05 ha of temporary clearance based on the 80 m turbine layout (with 12m clearance for roads);
- Approximately 15,934 HBT are estimated to be present across the study area and it is anticipated that up to 1,816 HBT (11.4 %) may be removed for the proposal;
- Of the species recorded across the study area, the White-striped Freetail Bat, the Yellow-bellied Sheathtail-bat and the Southern Freetail Bat were the species considered to have a high potential for collisions with turbines; and
- There is moderate potential for collisions by birds of prey, raptors and passerines across the study area.

Summary of Impacts on Matters of NES

The 159 (80 m) turbine layout (with 12 m clearance for roads) is likely to have the greatest impacts. Table 24 lists the anticipated impacts on Matter of NES based on this layout.

Table 24: Summary of Impacts on Matters of NES

MATTER OF NES	PERMANENT CLEARANCE (HA)	TEMPORARY CLEARANCE	TOTAL CLEARANCE	% OF PROJECT SITE IMPACTED
Critically Endangered Ecological Community				
BGW	**20.29**	**15.44**	**35.73**	**2.2**
Woodland	6.15	4.67	10.82	1.4
Derived Grassland	14.14	10.77	24.91	3.0
Threatened Flora				
Bothriochloa biloba	122.21	**103.93**	226.14	2.59
Dichanthium setosum	122.78	104.47	227.25	2.57
Eucalyptus mckieana	0.86	0.45	1.31	1.78

MATTER OF NES	PERMANENT CLEARANCE (HA)	TEMPORARY CLEARANCE	TOTAL CLEARANCE	% OF PROJECT SITE IMPACTED
Thesium australe	122.78	104.47	227.25	2.57

Note:

No direct impacts on any threatened flora species are anticipated. The proposal layout has been modified to ensure all known individuals are avoided,

No threatened or migratory fauna listed under the EPBC Act were recorded on site

5.7 INDIRECT IMPACTS - CONSTRUCTION

5.7.1 Runoff, sedimentation and erosion

The study area is located upslope of a number of creeks and tributaries and a small number pass through or occur adjacent to the study area. Therefore, there is the potential for indirect impacts on these water bodies during and following construction from runoff, erosion and sedimentation if management measures are not implemented. There is also a high potential for seeds of exotic species present at the site to be spread into adjacent areas and creeks through runoff and to be transported downstream during construction works. Therefore, a Construction Environmental Management Plan (CEMP) should be prepared and implemented to prevent such occurrences. Measures to prevent pollutants from being transported from the site into the creek should also be addressed in this plan.

Soils within the study area are highly mobile and, therefore, will require stringent dust suppression, erosion prevention and sediment control measures to be implemented. This is particularly important in areas adjacent to recorded threatened plants. Dust, if uncontrolled, could impact on the viability of nearby plants. For this reason, it is has been recommended that a 30 m buffer be established between all construction areas (including access tracks) during construction and this buffer remain along all access tracks during operation. It has also been recommended that construction is avoided in areas in close proximity to threatened plants during summer where possible.

5.7.2 Hydrological changes

The proposal involves the establishment of large impervious surfaces in the form of turbine footings and areas of soil compaction that will have a decreased porosity for roads. Impervious surfaces and changes to natural hydrological processes can have a number of potential effects including:

- limiting groundwater recharge by preventing rainwater from infiltrating through the ground;
- alter the ecology of an area including the vegetation composition and loss of fauna habitat;
- changes in soil moisture content; and
- may create conditions conducive to invasion by exotic species.

Given the mobility of the soils, water will need to be continuously added to areas of bare earth during construction for dust suppression. The runoff produced from this water addition will need to be trapped and managed to prevent changes to the hydrology of the site. Any increases in moisture will be temporary and only occur during the construction phase of the project.

5.7.3 Edge effects / increased weed invasion

Vegetation clearance has been proposed, wherever possible, in already disturbed areas through the upgrading of existing tracks. However, parts of the reticulation and some turbines will pass through areas of relatively undisturbed vegetation. It is likely that indirect and edge impacts have already occurred in connection with current roads and tracks and that any additional impacts would be shifted further within the current stands of vegetation as a consequence of the proposal. Areas of less disturbed vegetation throughout the study area often supported a small level of weed invasion and there is the potential for this to increase as a consequence of the proposed soil disturbance. In the long-term there is also the potential for these areas to be impacted by edge effects.

Stringent weed management measures need to be implemented during and post construction to ensure weed invasion and edge effects do not increase across the study area. These need to include the control of runoff that may contain weed seeds and the washing down of vehicles to prevent the spread of weeds between areas. Revegetation and ongoing weed management of disturbed areas for a period of 3 years is also required. Two road layout options are currently being investigated in an attempt to minimise areas of temporary vegetation clearance as these areas will be susceptible to weed invasion.

5.7.4 Wildfire

According to the *Northern Tablelands Draft Bushfire Risk Management Plan* and consultation with Ron Bridge of the Inverell and Glen Innes Rural Fire Districts, the development site has not been affected by a large bushfire within the last 10 years. The last major fire within the locale surrounding the site was a fire in 2002 further to the north of the Wellington cluster. The Sapphire and Swan Vale clusters have experienced very little fire history due to the dominance of grazing and cropping in the area. The Wellingrove cluster is thought to be the most likely cluster to experience a large bushfire (ELA 2011a).

The site and surrounding area demonstrated a scattered pattern of ‘medium’ bushfire hazard on the steeper slopes supporting remnants of good condition Manna Gum. Most of the hazard is rated as ‘low’ due to the prevalence of grasslands within the area.

An assessment of the risk of fire spreading from the site and impacting on nearby assets was undertaken whereby a risk classification scheme developed through qualitative scales of likelihood and of consequence resulted generally in a ‘minor’ risk of damage at a variety of scales. An ‘insignificant’ risk of a widespread loss of property and loss of human life was also recorded. The highest risk rating scored was ‘moderate’ for the possible short-term damage to nearby stock, crops and vegetation (ELA 2011a).

The threatened species occurring in study area are likely to be dependent on very low or no fire frequency. The greatest potential for accidental fires due to the wind farm activities is likely to be during construction and maintenance works. Therefore, a number of preventative measures would need to be implemented during these phases to reduce the likelihood of accidental fires from the construction and maintenance activities. Details of these measures are outlined in the mitigation section of this report and include the preparation of a Bushfire Emergency Plan.

5.7.5 Noise

Construction activities will generate noise that may disturb some fauna. The response of fauna to noise is inconsistent between and within species. Therefore, while noise may displace some fauna, the impact will be short term.

5.8 OPTIONAL 132KV POWERLINE

The Project will connect to either the TransGrid 330 kV double-circuit overhead transmission line running through the Sapphire Cluster (included in this assessment) or the TransGrid 132 kV double-circuit overhead transmission line running adjacent to the Gwydir Highway to the south of the project (alternative connection).

The current assessment has been based on a 330 kV overhead transmission line as this represents the worst case scenario in terms of potential ecological impacts. However, it is possible that either option will be selected and, therefore, the anticipated impacts from the 132 kV line have been summarised below (Table 25). The proposed 132 kV route and associated substation were the subject of ecological survey as part of the overall wind farm survey and, therefore, habitat along the route has been assessed for the potential presence of threatened species and their habitat.

The impacts are calculated based on a 45 m wide corridor and it is anticipated that only one vegetation type, *Manna Gum - Rough-barked Apple - Yellow Box,* would be impacted for the 132 kV line. Should this option be selected, the impacts are anticipated to be much smaller than for the 330 kV line. Approximately 15.54 ha of vegetation clearance is anticipated for the 132 kV in comparison to 32.17 ha for the 330 kV line. Furthermore, the size of the wind farm would be constrained by the available spare capacity of the 132 KV and, therefore, if a 132 kV powerline is used, the western portion of the wind farm is likely to be eliminated from the proposal. This is likely to result in an overall reduction of approximately 1/3 to 1/2 of the impacts for the current wind farm which includes the western cluster.

The Biobanking Assessment Methodology has been used to calculate the likely offset requirements in hectares. The analysis provides an indication of the potential offset size required depending on whether the offset is in either moderate-good condition, or within benchmark condition. Note that field work or on site assessment has not been undertaken for any offset sites at this stage. Offset estimates have been calculated through a desktop approach, but provide an accurate indication of the area required. Two offset scenarios have been tested, including an offset site in benchmark condition (generating 7 credits per hectare) and an offset site in moderate/good condition (generating 9 credits per hectare) and, therefore, a range has been provided for each proposed offset amount.

Table 25: Estimated Impacts for 132 kV Powerline

VEGETATION COMMUNITY	IMPACT (HA)	CREDITS REQUIRED / HA	TOTAL CREDITS REQUIRED	INDICATIVE OFFSET REQUIRED (ha)
External 132kV Powerline 45m Corridor				
Manna Gum - Rough-barked Apple - Yellow Box, Moderate to Good, Trees	15.54	28.64	445	49.45 - 63.58
Connecting Substation				
Manna Gum - Rough-barked Apple - Yellow Box, Moderate to Good, Trees	3.98	28.64	114	12.67- 16.28

5.9 OPTIONAL SUBSTATION LOCATION

The current assessment has been based on one ‘preferred’ substation location. However, depending on the configuration of the powerlines and wind farm infrastructure a small number of other options may be considered (see numbered locations 1-6 in Figure 12). The impacts associated with each of these options have been outlined below in Table 26. It it noted that all of the prosposed alternative substation locations would have a slightly greater impact than the ‘preferred’ substation location. Consequently, a revised offset calculation has been provided for each alternative location to account for any changes in impacts. All of the proposed substation locations have been the subject of ecological survey and, therefore, assessed for the potential presence of threatened species. No additional surveys are therefore required to determine any additional impacts from these alternative locations.

In order to determing the likely offset requirements in hectares, the average increase in site value, using the Biobanking Assessment Methodology, has been calculated. The analysis provides an indication of the potential offset size required depending on whether the offset is in either moderate-good condition, or within benchmark condition. Note that field work or on site assessment has not been undertaken for any offset sites at this stage. Offset estimates have been calculated through a desktop approach, but provide an accurate indication of the area required. Two offset scenarios have been tested, including an offset site in benchmark condition (generating 7 credits per hectare) and an offset site in moderate/good condition (generating 9 credits per hectare) and, therefore, a range has been provided for each proposed offset amount.

Table 26: Alternative Substation Options (330kV) - Impacts

VEGETATION	MANNA GUM - ROUGH-BARKED APPLE - YELLOW BOX GRASSY WOODLAND/OPEN FOREST OF THE NEW ENGLAND TABLELANDS AND NORTH COAST, LOW	MANNA GUM - ROUGH-BARKED APPLE - YELLOW BOX GRASSY WOODLAND/OPEN FOREST OF THE NEW ENGLAND TABLELANDS AND NORTH COAST, MODERATE TO GOOD, NATIVE PASTURE	MANNA GUM - ROUGH-BARKED APPLE - YELLOW BOX GRASSY WOODLAND/OPEN FOREST OF THE NEW ENGLAND TABLELANDS AND NORTH COAST, MODERATE TO GOOD, TREES	TOTAL
O’BRIEN - CURRENT PREFERRED - OPTION 1				
IMPACT (ha)	1.97	-	-	**1.97**
O’BRIEN - OPTION 2				
IMPACT (ha)	2.69			2.69
OFFSET (credit)	1.66 credits / ha Total Credits Required: 31.37			**13.37**
OFFSET (ha)	3.48 – 4.48			**3.48 – 4.48**

FREND - OPTION 3				
IMPACT (ha)	2.00			**2.00**
OFFSET (credit)	11.66 credits / ha Total Credits Required: 23.32			**23.32**
OFFSET (ha)	2.59 - 3.33			**2.59 - 3.33**
TURNER - OPTION 4				
IMPACT (ha)			2.00	**2.00**
OFFSET (credit)			28.64 credits / ha Total Credits Required: 57.28	**57.28**
OFFSET (ha)			6.36 - 8.18	**6.36 - 8.18**
GALLAGHER - OPTION 5				
IMPACT (ha)		0.01	3.98	**3.99**
OFFSET (credit)		13.56 credits / ha Total Credits Required: 0.14	28.64 credits / ha Total Credits Required: 113.99	**114.13**
OFFSET (ha)		0.02 - 0.02	12.67 - 16.28	**12.69 – 16.30**
OPPOSITE NUGENT - OPTION 6				
IMPACT (ha)			3.99	**3.99**
OFFSET (credit)			28.64 / credits / ha Total Credits Required: 114.27	**114.27**
OFFSET (ha)			12.69 - 16.32	**12.69 - 16.32**

5.9.1 Impacts on Threatened and Migratory Species for Alternative Infrastructure

Species for which the alternative substation locations and 132 kV may impact on potential habitat are listed below. All substation locations will avoid direct impacts to any known habitat for threatened flora species. The impact of each option is marginally greater than those of the preferred locations although in some cases moderate – good condition vegetation would be impacted instead of low condition vegetation. Furthernmore, all of the proposed substation locations have been the subject of ecological survey and, therefore, assessed for the potential presence of threatened species. Given that MGRAYB is the most common vegetation type across the project site, it is unlikely that the modifications to impacts based on any of the aformentioned options would result in a significant impact on this community or any threatened species which rely on the MGRAYB for habitat.

Recorded on site:

- *Bothriochloa biloba* (Lobed Bluegrass) (EPBC Act only);
- *Dichanthium setosum* (Bluegrass);
- *Thesium australe* (Austral Toadflax);

Potential habitat on site:

- *Acacia pubifolia* (Velvet Wattle);
- *Astrotricha roddii* (Rod's Star Hair);
- *Digitaria porrecta* (Finger Panic Grass);
- *Diuris pedunculata* (Small Snake Orchid);
- *Eucalyptus nicholii* (Narrow-leaved Black Peppermint); and
- *Picris evae* (Hawkweed).

Recorded on site:

- *Climacteris picumnus victoriae (*Brown Treecreeper);
- *Stagonopleura guttata* (Diamond Firetail);
- *Melanodryas cucullata cucullata* (Hooded Robin);
- *Glossopsitta pusilla* (Little Lorikeet);
- *Petroica boodang* (Scarlet Robin);
- *Pyrrholaemus saggitatus* (Speckled Warbler);
- *Neophema pulchella* (Turquoise Parrot);
- *Phascolarctos cinereus* (Koala);
- *Falsistrellus tasmaniensis* (Eastern False Pipistrelle);
- *Miniopterus schreibersii* (Eastern Bentwing-bat);
- *Mormopterus norfolkensis* (Eastern Freetail-bat);
- *Saccolaimus flaviventris* (Yellow-bellied Sheathtail-bat);

- *Scoteanax rueppellii* (Greater Broad-nosed Bat); and
- *Vespadelus troughtoni* (Eastern Cave Bat).

Potential habitat on site:

- *Anthochaera phrygia* (Regent Honeyeater);
- *Circus assimilis* (Spotted Harrier);
- *Daphoenositta chrysoptera* (Varied Sittella);
- *Hieraaetus morphnoides* (Little Eagle);
- *Lophoictinia isura* (Square-tailed Kite);
- *Lathamus discolor* (Swift Parrot);
- *Dasyurus maculatus* (Spotted-tailed Quoll);
- *Petaurus norfolcensis* (Squirrel Glider);
- *Nyctophilus corbeni (South-eastern Long-eared Bat)*; and
- *Underwoodisaurus sphyrurus* (Border Thick-tailed Gecko).

Migatory species for which potential habitat will be impacted by the proposed alternative locations include:

- *Hirundapus caudacutus* (White-throated Needletail);
- *Merops ornatus* (Rainbow Bee-eater);
- *Anthochaera phrygia* (Regent Honeyeater);
- *Ardea alba* (Great Egret);
- *Ardea ibis* (Cattle Egret);
- *Apus pacificus* (Fork-tailed Swift) and
- *Lathamus discolor* (Swift Parrot).

5.10 INDIRECT IMPACTS - OPERATION

5.10.1 Displacement of Birds

Devereux *et al.* (2008) conducted a study of the effects of wind turbines on the distribution of wintering farmland birds in Europe. This study showed that turbine location, in a farmland landscape (controlling for other effects such as boundary location and crop type), did not affect the distribution of four groups of farmland birds namely, seed-eaters, corvids, gamebirds and Eurasian skylarks at differing distances from wind turbines ranging from 0–150 m to 600–750 m. Whilst it is difficult to extrapolate results from overseas studies to an Australian context, some common behaviour is likely amongst species such as seed-eaters and corvids and, therefore, these results may be applicable to Australian farmlands. Given the vegetation types to be impacted by the proposal are extensive across the landscape, it is unlikely that the turbines would permanently displace bird species such that vegetation types that once provided foraging habitat would no longer do so due to turbine avoidance behaviour.

Studies of White-bellied Sea-eagles at wind farm sites conducted by Biosis Research also support this conclusion as White-bellied Sea-eagles have been known to continue to occupy operational wind farm sites in southern Australia, including the Bluff Point Wind Farm in Tasmania (Smales 2005a). Furthermore, through post construction monitoring of the Klondike, Oregon Wind Farm (Johnson *et al.* 2003) found that avian and bat fatality rates were minimal, and that the wind farm did not appear to have resulted in displacement of breeding raptors.

Based on the findings of these studies and given potential habitat is widely spread across the project site, it is considered unlikely that the proposed wind farm would displace any local bird species.

5.10.2 Avoidance during migration

Studies have been conducted overseas that have shown that some birds actively avoid wind farms and turbines by altering their flight and migratory paths (Masden *et al.* 2009, Pearce-Higgins *et al.* 2009).

Pearce-Higgins *et al.* (2009) conducted a study of nine wind farms located within unenclosed upland habitats (moor land, rough grassland and blanket bog) in Scotland to assess the effects of proximity to wind farm infrastructure on bird distribution on a variety of birds including raptors, plovers, snipe, pipits and skylarks. Turbine proximity was found to be significantly correlated with bird distribution with seven of the 12 species studied exhibiting significantly lower frequencies of occurrence close to the turbines, after accounting for habitat variation, with equivocal evidence of turbine avoidance in a further two and no species found more likely to occur close to the turbines (*Pearce-Higgins et al.* 2009).

There was no evidence that raptors altered flight height close to turbines. Two of the three raptors also showed significant turbine avoidance extending to at least 500 m and 250 m from the turbines for *Buteo buteo L* (Buzzard) and *Circus cyaneus* (Hen harrier). Turbines were avoided more strongly than tracks. There was no evidence for consistent avoidance of overhead transmission lines connecting sites to the national grid.

The extent of such avoidance was found to range from 100 m to 800 m, but was not absolute with modelled reductions in frequency of occurrence close to the turbines of between 20% and 80. It is not known whether the observations of avoidance of turbines reflect a behavioural displacement, the local population consequences of collision mortality or reduced productivity, or both (*Pearce-Higgins et al.* 2009).

This study shows that birds actively avoid turbines thereby reducing the potential for collision. However, in areas where there are breeding populations or habitat is limited, wind farm may displace bird species due to avoidance behavioural patterns. Given that the majority of the species utilising the Sapphire project site are not migratory and that habitat for all species is extensive throughout the project site and locality, it is considered unlikely that turbine avoidance would displace any populations or species such that their habitat requirements would no longer be met.

5.10.3 Predation by feral animals

The potential for the proposal to increase predation by feral animals across the study area is considered limited. The already open nature of the vegetation at the site means that additional openings in vegetation, potentially creating movement pathways for feral animals such as the Red Fox, are unlikely to be increased beyond current levels or increase the carry capacity of resident fox populations. In heavily vegetated areas, feral animals often use tracks and open areas for movement. However, in the study landscape it is unlikely that restrictions to feral animal movement due to vegetation cover occurs. Furthermore, the linear nature of the proposal, through an open landscape, means large open areas will not result.

Landholders currently implement feral animal control programs across the site, particularly around lambing/calving time.

5.10.4 Wildfire

The risk of fire with wind farms during operation is inherently low (CFA 2007). A low risk is associated with malfunctioning turbine bearings, inadequate crankcase lubrication, cable damage during rotation, electrical shorting or arcing occurring in transmission and distribution facilities (CFA 2007). The location of wind turbines away from tall, dense vegetation in the study area minimises the risk of fire. A buffer of at least 25 m between turbine pads and treed areas is anticipated. Furthermore, the implementation of regular maintenance to ensure turbines are functioning correctly and the implementation of general bushfire preventative measures during maintenance activities will reduce the likelihood that fires would occur due to the wind farm. Such measures have been outlined in the Mitigation section of this report and are outlined in further detail in the Bushfire Emergency Plan, *Auswind Best Practice Guidelines - Fire Management Guidelines 2006 and Site Environmental Management Plan.*

5.11 DECOMMISSIONING

At the end of the operational life of the wind farm, the turbines and all above ground infrastructure will be dismantled and removed from the site. This includes all the interconnection and substation infrastructure. The tower bases would be cut back to below ploughing level or topsoil built up over the footing to achieve a similar result. The land will be returned to prior condition and use.

The access roads, if not required for farming purposes or fire access, would be removed and the site reinstated to its original condition and use. Access gates, if not required for farming purposes, would also be removed. Individual landowners will be involved in any discussion regarding the removal or hand-over of infrastructure on their property.

The underground cables are buried below ploughing depth and contain no harmful substances. They can be recovered if economically viable or left in the ground. Terminal connections would be cut back to below ploughing levels.

Indirect impacts anticipated from the decommissioning works at the end of the life of the wind farm are likely to include:

- Disturbance of vegetation adjacent to turbines from machinery during deconstruction, cutting back of tower bases, and storing of turbine components prior to removal from site;

- Soils disturbance resulting in sedimentation and erosion;
- Spread of weeds through site disturbance;
- Accidental fire during cutting back; and
- Disturbance of fauna habitat from machinery and storing of turbine components prior to removal from site.

5.12 CUMULATIVE IMPACTS

There are currently three other wind farms proposed for the Northern Tablelands in close proximity to Sapphire Wind Farm.

- **Glen Innes Wind Farm** (25 turbines) has been consented and is situated 12 km to the west of Glen Innes and approximately 5 km to the south east of the proposed Sapphire Wind Farm along the Waterloo Range.

- **White Rock Wind Farm** (up to 119 turbines) is located south of the Gwydir Highway 18 km west of Glen Innes and approximately 5 km south east of the Sapphire Wind Farm. The project is currently on exhibition with the NSW Department of Planning (as of June 2011).

- **Ben Lomond Wind Farm** (up to 98 turbines) is located the north of the township of Lomond approximately 10 km west of the New England Highway. This wind farm is also located 20 km south east of the proposed Sapphire Wind Farm. It is understood that the DGRs for this project have expired and therefore there is some doubt as to if this wind farm will be constructed.

The majority of the locality is used for agricultural purposes. The protection and management of a large parcel of land as part of an offset for the impacts of the proposal will assist in protecting areas of habitat for threatened species within the locality, and EECs such as Box-Gum Woodland and Manna Gum–Rough-barked Apple–Yellow Box grassy woodland, which may otherwise be degraded and impacted by agricultural practices.

The Sapphire Wind Farm is not located within any known migratory bird pathways. However, there may be some cumulative impacts on birds and bats that forage widely if the White Rock Wind Farm proposed to the south of the Gwydir Highway is also approved. However, the majority of species inhabiting each wind farm study area are unlikely, due to their home ranges, to forage across both wind farms.

Two other wind farms have also been proposed to the south and east of the Sapphire Wind Farm. Neither of these wind farms is directly adjacent or connected to habitat associated with the Sapphire Wind Farm. Therefore, likely cumulative impacts are associated with multiple wind farms being present within the region and are likely to be restricted to highly mobile species and potentially the cumulative loss of vegetation communities present across numerous wind farms.

Cumulative impacts from Sapphire Wind farm and the other wind farms in the area have been assessed as low to negligible. Impacts on migratory and mobile species in the New England area are not expected as the wind farms are not known to be situated in any important migratory pathways nor near any significant wetlands where large numbers of birds are likely to congregate. Additionally the vegetation clearing associated with the wind farms constitutes a very small proportion of existing vegetation and available woodland habitat in the region.

5.13 KEY THREATENING PROCESSES

The following key threatening processes are considered relevant to the proposal:

- Bushrock removal (TSC Act)

  The proposal may result in the removal of a small amount of bushrock. However, scattering of some of this rock in adjacent areas is proposed and the amount of rock to be removed is considered minimal. Therefore, it is unlikely that the proposed rock removal for construction would result in this resource becoming limited across the project site in areas where it is currently present.

- Clearing of native vegetation (TSC Act) / Land clearance (EPBC Act)

  Impacts of the proposal on native vegetation have been outlined in Section 5.4.1. Whilst some vegetation removal is unavoidable, vegetation clearance has been avoided wherever possible and offsets will be provided to compensate for vegetation loss.

- Competition and grazing by the feral European Rabbit (TSC Act) / Competition and land degradation by rabbits (EPBC Act)

  The European Rabbit currently inhabits the site and given that the proposal would not create additional conditions that would favour the European Rabbit it is unlikely that the proposal would exacerbate this key threatening process. Furthermore, management of the proposed offset site will include measures for the management of feral animals and, therefore, will contribute to reducing the problem of this species.

- Ecological consequences of high frequency fires (TSC Act)

  The potential for fire during the construction and operation phase of the proposal is considered low however, there is the potential for accidental fires during construction, operation and maintenance work. As such a package of mitigation measures have been proposed to reduced the likelihood of fire during these phases. Provided the prevention and mitigation measures are implemented it is unlikely that the proposal would alter current fire regimes across the site.

- Human-caused climate change (TSC Act) / Loss of terrestrial climatic habitat caused by anthropogenic emissions of greenhouse gases (EPBC Act)

  Wind energy offers a cleaner alternative to current energy generation sources such as coal and will directly displace the greenhouse gas emissions that would otherwise be produced by fossil fuel energy production. Therefore, the proposal will contribute to ameliorating factors that contribute to climate change rather than contributing to climate change.

- Invasion of native plant communities by exotic perennial grasses (TSC Act)

  There is the potential for the proposal to result in the spread of exotic perennial grasses. However, a number of mitigation measures have been proposed to prevent the spread of weeds and in particular species such as Serrated Tussock and thereby protect adjacent areas from weed invasion. Revegetation of temporary disturbance areas with aggressive local native provenance such as *Austrostipa* spp. and a commitment to ongoing weed management within disturbance areas for a period of three years will help to reduce the potential for native vegetation to be invaded by exotic perennial grasses.

  Revegetation of disturbed area will be timed to maximise success. Average rainfall is steady thoughout the year with a slightly higher average number of rain days in spring. With spring being the typical growth period of many flora, revegetation is likely to be undertaken at this time. The CEMP will include provide Key Performance Indicators to measure the success of the revegetation process and adaptive responses will be applied relative to the observed success.

Further details about revegetation techniques and considerations regarding timing will be provided in a CEMP.

- Loss of hollow-bearing trees (TSC Act)

  Hollow-bearing tree removal has been avoided wherever possible. The proposal is to go through a detailed design phase following approval and, therefore, further avoidance during micro-siting is possible to ensure hollow-bearing tree clearance is avoided. It is important to note that topographic and design constraints prevent the ability to avoid every tree particularly in heavily wooded areas, however, trees will be avoided during micro-siting wherever possible and turbines have been situated in cleared areas if possible to date.

- Predation by feral cats (TSC Act & EPBC Act)

  Feral cats were recorded across the study area during the surveys. Given that the proposal would not create additional conditions that would favour feral cats and all onsite food waste at site offices would be contained in lidded bins, it is unlikely that the proposal would exacerbate this KTP. Furthermore, management of the proposed offset site would include measures for the management of feral animals and, therefore, will contribute to reducing the problem of this species.

- Predation by the European Red Fox (TSC Act & EPBC Act)

  The European Red Fox is present across the site with a number sighted in both woodland and grassland areas during surveys. Given the inherent open nature of the landscape allows this species to move relatively unrestricted across the site, it is unlikely that the proposed roads would increase the activity of this species across the site. Furthermore, management of the proposed offset site would include measures for the management of feral animals and, therefore, will contribute to reducing the problem of this species.

- Removal of dead wood and dead trees (TSC Act)

  Dead wood is primarily limited to larger woodland stands across the project site. In areas where dead wood occurs within the proposed construction area, it will be moved to adjacent woodland areas prior to construction and not destroyed or removed from the project site. Therefore, removal of dead wood is not proposed.

  Whilst a number of senescing trees are present across the site, dead trees / stags are scarce. The removal of dead trees for the proposal is not anticipated.

- Degradation of native riparian vegetation along NSW watercourses (FM Act)

  The majority of riparian areas within or in proximity to the study area are highly degraded with the exception of Kings Plains Creek where a narrow but intact riparian zone exists in some parts. Given the proposal will not directly impact on this area and where the proposal crosses drainage lines the vegetation is degraded, it is unlikely that the proposal would exacerbate this Key Threatening Process (KTP). Impacts associated with riparian areas have been more formally addressed in a separate report.

6 Offset Requirements, Strategy & Proposed Package

6.1 INTRODUCTION

The DGRs for the Sapphire Wind Farm require the proponent to "*describe the measures to avoid, mitigate or offset impacts associated with the construction and operation of the project components consistent with improve or maintain principles. Sufficient details must be proved to demonstrate the availability of viable and achievable options to offset the impacts of the project*".

The measures to avoid and mitigate the impacts of the project are outlined in Section 5. This section provides a detailed description of the proposed offset strategy which aims to meet "improve and maintain" principles as required by the DGRs. In summary the proposed Biodiversity Offset Strategy provides for:

- an improve or maintain quantification of the impacts of the project using the Biobanking Assessment Methodology;
- a package of covenanted offset properties where existing biodiversity values would be enhanced to meet the calculated offset requirement; and
- in perpetuity biodiversity management of these properties.

An outline of the NSW and Commonwealth Offset Principles, offset options available, an assessment of the potential area of offset required and the potential offset opportunities are provided.

6.2 OFFSET PRINCIPLES

Principles that must be considered when proposing an offset strategy are defined by the State (DECC 2008) and the Commonwealth (CoA 2008). The following principles are outlined in these documents.

NSW (DECC 2008)

1. Impacts must be avoided first by using prevention and mitigation measures.
2. All regulatory requirements must be met.
3. Offsets must never reward ongoing poor performance.
4. Offsets will complement other government programs.
5. Offsets must be underpinned by sound ecological principles.
6. Offsets should aim to result in a net improvement in biodiversity over time.
7. Offsets must be enduring and they must offset the impact of the development for the period that the impact occurs.
8. Offsets should be agreed prior to the impact occurring.
9. Offsets must be quantifiable and the impacts and benefits must be reliably estimated.

10. Offsets must be targeted.
11. Offsets must be located appropriately.
12. Offsets must be supplementary.
13. Offsets and their actions must be enforceable through development consent conditions, licence conditions, conservation agreements or a contract.

Commonwealth (CoA 2008)

1. Environmental offsets should be targeted to the matter protected by the EPBC Act that is being impacted.
2. A flexible approach should be taken to the design and use of environmental offsets to achieve long-term and certain conservation outcomes which are cost effective for proponents.
3. Environmental offsets should deliver a real conservation outcome.
4. Environmental offsets should be developed as a package of actions - which may include both direct and indirect offsets.
5. Environmental offsets should, as a minimum, be commensurate with the magnitude of the impacts of the development and ideally deliver outcomes that are 'like for like'.
6. Environmental offsets should be located within the same general area as the development activity.
7. Environmental offsets should be delivered in a timely manner and be long lasting.
8. Environmental offsets should be enforceable, monitored and audited.

The Commonwealth policy identifies two kinds of biodiversity offset, 'direct offsets' including such measures as long-term protection of existing habitat, and 'indirect offsets' for such measures as implementing recovery plan actions or contributions to relevant research.

The proposed offset strategy has been designed to meet the principles of both the NSW and Commonwealth policies.

6.3 OFFSET OPTIONS

Wind Prospect CWP has explored the establishment of an offset site with adjacent land holders. There are a range of mechanisms available that meet the offsetting principals. These are illustrated in Figure 1 on the following page. Biobanking is a covenanting option that meets all of the principles of offsets outlined above (i.e. it is on title and provides secure funds for active management in perpetuity), but is not the only option available. Biobanking is DECCW's preferred offset mechanism.

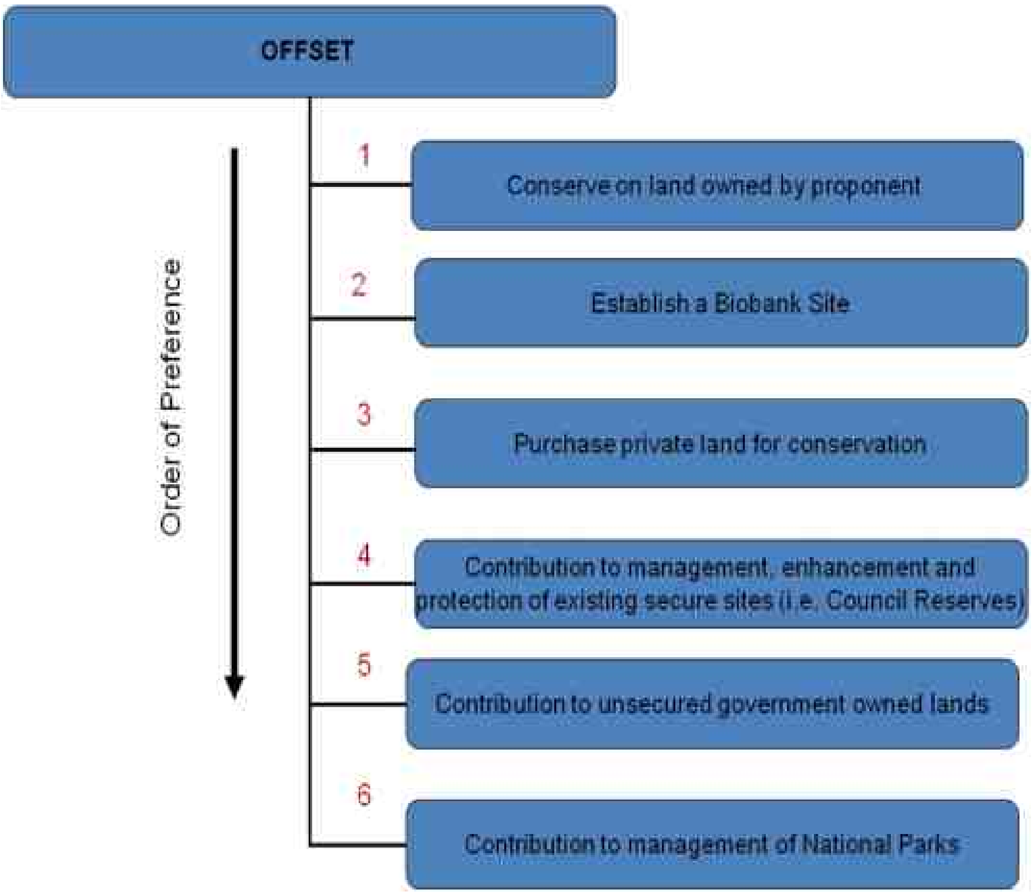


Figure 1: Available Offsetting Principals in order or preference

During the preparation of the Ecological Assessment report the options of purchasing suitable properties to dedicate for conservation purposes and identifying land owners who were interested in covenanting their properties, including registration of Biobank Agreements, were investigated. Several land owners expressed interest in entering into such agreements and selling the credits generated to Wind Prospect CWP to meet their offset requirements.

Preliminary ecological investigations indicate that several of these properties are large enough and provide the "like for like" vegetation types required to improve or maintain outcome consistent with the credit report from the Biobank Assessment and the NSW and Commonwealth offsetting principles. There are also several properties currently for sale which also provide the appropriate vegetation types that could be purchased and managed for conservation by Wind Prospect CWP (or contractors on their behalf) through an appropriate covenant or transferred to the Minister for the Environment and gazetted as Conservation reserves (subject to agreement with the Minister for the Environment).

6.4 OFFSET REQUIRMENT TO MEET IMPROVE OR MAINTAIN CONSERVATION OUTCOME

Other than the Biobanking Assessment Methodology (BAM), there is no standardised quantitative method of assessing whether a proposal meets the 'improve and maintain' standard specified in the DGRs. Accordingly, an indicative Biobanking Assessment has been conducted for the proposed Sapphire wind farm to inform the "quantum" of biodiversity offsets required to meet a improve and maintain outcome in accordance with the Department of Environment, Climate Change and Water's (DECCW) interim policy on Biodiversity Offsets for Part 3A projects (DECCW 2010) (Appendix I).

The DECCW Interim Policy specifically acknowledges that proposals assessed under Part 3A of the EP&A Act do not have to meet the "improve or maintain" standard which is required under the biobanking scheme. The approach taken by Wind Prospect CWP is consistent with this policy in that the BAM has been used to inform the quantum of offset required, and whilst it is DECCW's preference that a Tier 1 "improve or maintain" outcome is achieved, the policy provides a structured approach for assessing proposals that meet one or two alternative standards (Tier 2 "no net loss" and Tier 3 "mitigated loss), which take into consideration the environmental, social and economic benefits provided by the project.

The assessment completed represents the 'worst case' scenario, in terms of ecological impact, caused by the various wind farm options. The assessment has assumed that the maximum number of turbines layout (159 turbines) will be selected, and has also utilised the 12 m wide road design in the calculations, including all three potential access routes to the Sapphire cluser, one of which is required. The impact of the wind farm may actually be less than calculated in this report should the final design utilise a smaller number of turbines and 6 m wide roads (with 12 m wide passing bays).

A summary of the credits required to offset the impact of the proposal is provided below. A full credit assessment report is provided in Appendix I.

6.4.1 Ecosystem Credits Required at Offset Site

When using the BAM (and the Improve or Maintain test embedded in the methodology) the area of offset required for ecosystem credits is determined by both the condition of the development site and the condition of the offset site. Generally a development site in good condition will require a larger offset than a site in moderate or low condition. In addition, due to the way the methodology assesses improvement in vegetation condition, an offset site in moderate condition will produce more credits than a site in low or good condition, as the improvement expected by a site in moderate condition is expected to be larger than that achieved on a good or low condition site. Therefore, the offset required will be smaller if a moderate condition site is used as an offset, rather than a low or good condition site.

Biobanking calculations have been undertaken to give an indication of the "quantum" of the offset required should the potential offset site be in moderate or benchmark (good) condition. The credits generated by moderate and good condition sites have been calculated using the observed (but not formally measured) condition of the potential offset sites and knowledge of the likely increase in condition at Biobank site, but have not yet been confirmed through formal Biobanking field assessment. The results, however, provide a relatively robust figure of the offset required for the project.

As indicated in Appendix I, the offset calculations assume a worst case scenario in terms of the level of impact and have been calculated for the 159 turbine option with a 12 metre wide road layout.

Based on this scenario, a total of 5,464 ecosystem credits are required to offset the impacts to five vegetation types. Table 25 provides a breakdown of the offset requirements per RVT. Depending on the condition of the offset site, and on the assumption that a site in benchmark condition would generate approximately 7 credits per hectare and a site in moderate condition, 9 credits per hectare, this means that the offset would need to be between 607 and 781 hectares in size to fully meet a Tier 1 or 2 IoM offset (Appendix I).

The Biobanking Credit report also indicates that the offsets can be secured in a range of similar vegetation types and CMA subregions, including the impact region (Glen Innes-Gurya Basalts) and the adjacent Seven River Volcanics).

6.4.2 Species Credits Required at Offset Site

As with ecosystem credits, the area of offset required for species credits is determined by the condition of the offset site, however the Biobanking Assessment Methodology allows a “default” increase (60%) for species credits which has been utilised to determine the offset required for each species.

Approximately 41.5 ha of potential habitat for the Border Thick-tailed Gecko is required to offset the 18.7 ha of potential habitat being impacted. Under Biobanking these credits can be obtained from the same Biobank site as the ecosystem credits or a different Biobank site should that be required (Table 28 and Appendix I).

Species credits can be obtained from the same offset site as the ecosystem credits, and where possible Wind Prospect CWP will aim to secure the offset from the same site.

Table 27: Ecosystem credit requirements for 159 turbine layout with 12 m road option

VEGETATION TYPE	CREDITS REQ.	TOTAL IMPACT (HA)	CREDITS/HA	AVERAGE NO. CREDITS GENERATED/HA-M/G SITE	OFFSET REQUIRED (HA)	AVERAGE NO. CREDITS GENERATED/HA-BENCHMARK SITE	OFFSET REQUIRED (HA)
Black Cypress Pine - Tumbledown Gum - Narrow-leaved Ironbark open forest of northern parts of the Nandewar Bioregion	23	1.3	17.9	9	3	7	3
Blakely's Red Gum - Yellow Box grassy open forest or woodland of the New England Tablelands	218	17.6	12.4	9	24	7	31
Manna Gum - Rough-barked Apple - Yellow Box grassy woodland/open forest of the New England Tablelands and North Coast	4,686	240.9	19.5	9	521	7	669
Tenterfield Woollybutt - Silvertop Stringybark open forest of the New England Tablelands	33	1.1	29.7	9	4	7	5
White Box grassy woodland of the Nandewar and Brigalow Belt South Bioregions	504	27.9	18.1	9	56	7	72
Total	**5,464**	**288.8**	**18.9**	**9**	**607**	**7**	**781**

Table 28: Estimated Border Thick-tailed Gecko Species Credit Offset for 159 turbine layout and 12 metre road option

HABITAT TYPE	AREA IMPACTED (HA)	CREDITS REQUIRED	AVERAGE NO. CREDITS GENERATED/HA	OFFSET REQUIRED (HA)
Potential	18.7	249	6	41.5

6.5 PROPOSED OFFSET PACKAGE

Based on discussions with landowners surrounding the project site, a number of land holders have expressed interest in placing part of their properties under conservation covenants (including Biobank Agreements) and/or currently have their properties listed for sale. Preliminary assessments of the conservation values of these properties have been undertaken to determine whether they have the right vegetation types and area to meet the offset requirements for the project.

Three properties have been identified where the vegetation types and condition have been verified as being in equivalent or better condition that the impact sites and combinations of any two of the properties will provide an offset area between 504 ha (Properties 1 and 2) and 569 ha (Properties 1 and 3) and meet the “like for like or better” offsetting principles with a minimum 2:1 offset ratio i.e. consistent with a Tier 3 negotiated offset outcome (Figure 13, Figure 14 and **Figure** 15).

Whilst there will be some variation in the offset ratios between each of the vegetation types and condition states, the overall offset ratio for 288.8 ha of impact will be between 1.75 and 1.97:1, however this includes 60.3 ha of vegetation mapped as biometric low condition (paddock trees with an exotic ground cover). The biodiversity values in areas mapped as low condition (i.e. scattered trees) can be easily avoided (Table 29 and Table 30). If low condition is removed from the tables the offset ratios increase to between 2.2 and 2.5:1.

Table 29 provides a summary of the area and condition of each TSC Act listed vegetation type impacted and the area of offset available in each of the three properties. Depending on the final combination of properties that form the offset package, the combined offset ratios for impacts to 10.8 ha of TSC Act listed White Box – Yellow Box- Blakely’s Red Gum woodland will be around 15:1 and 5.4:1 for 24.9 ha of the derived native grassland component. Similarly, impacts to 100.50 ha of the TSC Act listed Manna Gum – Rough-barked Apple – Yellow Box grassy woodland community will be offset with up to 277 ha of Manna Gum woodland, a ratio of 2.76:1. The offset ratio for loss of the native grassland component of Manna Gum woodland is significantly less at only 0.3:1, but this is made up with a significant surplus of Blakely’s Red Gum offset which matches the credit profile (Refer to Biobanking Assessment Report in Appendix I).

Table 30 indicates that if Property 3 is included in the offset package, the loss of 18.7 ha of potential Border Thick-tailed Gecko potential habitat would be offset with 184.65 ha of potential habitat, an offset to impact ratio of nearly 10:1.

Table 31 provides a summary for each Matter of National Environmental Significance impacted by condition and the corresponding offset ratios. Depending on the final combination of properties that form the offset package, the combined offset ratios for impacts to 10.8 ha of EPBC Act listed White Box – Yellow Box- Blakely’s Red Gum woodland will be around 15:1 and 5.4:1 for 24.9 ha of the derived native grassland component.

Whilst there were no confirmed records of the Border Thick-tailed Gecko in the project site, the 18.7 ha of impact to potential habitat will be offset with up to 184.65 ha of potential habitat in offset Property 3, a ratio of nearly 10:1. Furthermore, potential habitat for the Border Thick-tailed Gecko is also present on Properties 1 and 2. The extent is yet to be mapped and will be mapped in detail post-consent.

The loss of 113.7 ha of potential foraging habitat for the Regent Honeyeater and Swift Parrot will be offsets with between 350 and 427 ha of potential foraging habitat, a ratio of up to 3.76:1. However, a significant proportion of the 13.7 ha of impact is in the Manna Gum community which is not optimal or preferred foraging habitat. If this is removed from the calculation, the offset ratio for impacts to 10.8 ha of White Box and Blakely's Red Gum preferred foraging habitat is around 150 ha of White Box – Blakely's red Gum woodland protected, a ration of almost 14:1. This is further increased with the regeneration of the derived native grassland components of these communities.

Subject to the project being approved, Wind Prospect CWP will enter into negotiations with the relevant landowners to either register the identified parts of the property as a conservation area with an appropriate covenant to provide in perpetuity protection on title or purchase those properties listed for sale. Any properties purchased will also be registered for conservation or discussions with the Office of Environment and Heritage entered into regarding the possible dedication of the land as a conservation reserve under the NPW Act. The conservation values of the properties will be fully documented and a conservation management plan prepared and a budget for it's in perpetuity implementation provided.

Table 29: Offset measures for overall impacts to biodiversity values (NSW) – Ecosystem credits

Biometric Vegetation Type	Condition	Impact			Proposed Offsets					IoM Offset Target (ha)	Offset : Impact Ratio
		Impact Area (ha)	Credits required	Credits Required /ha	Property 1 Area (ha)	Property 2 Area (ha)	Property 3 Area (ha)	Total Area (ha)	Credits Generated (Est)		
Property Area					**317.00**	**223.00**	**608.62**	**1,148.62**			
Blakely's Red Gum - Yellow Box grassy open forest or woodland of the New England Tablelands	Woodland	1.50	47	31.33	133.79	12.31		146.10	1,023		97.40
Blakely's Red Gum - Yellow Box grassy open forest or woodland of the New England Tablelands	Derived Native Grassland	10.60	153	14.43	108.31	24.15		132.46	1,192		12.50
Blakely's Red Gum - Yellow Box grassy open forest or woodland of the New England Tablelands	Low (Paddock trees)	5.50	18	3.27							0.00
Sub-total		**17.60**	**218**	**12.39**	**242.10**	**36.46**		**278.56**	**2,215**	**24-31**	**15.83**
White Box grassy woodland of the Nandewar and Brigalow Belt South Bioregions	Woodland	9.30	245	26.34	16.22			16.22	114		1.74
White Box grassy woodland of the Nandewar and Brigalow Belt South Bioregions	Derived Native Grassland	14.30	226	15.80	2.06			2.06	19		0.14

Biometric Vegetation Type	Condition	Impact			Proposed Offsets					IoM Offset Target (ha)	Offset : Impact Ratio
		Impact Area (ha)	Credits required	Credits Required /ha	Property 1 Area (ha)	Property 2 Area (ha)	Property 3 Area (ha)	Total Area (ha)	Credits Generated (Est)		
White Box grassy woodland of the Nandewar and Brigalow Belt South Bioregions	Low (Paddock trees)	4.30	33	7.67							0.00
Sub-total		**27.90**	**504**	**18.06**	**18.28**			**18.28**	**132**	**56-72**	**0.66**
Manna Gum - Rough-barked Apple - Yellow Box grassy woodland/open forest of the New England Tablelands and North Coast	Woodland	100.50	2,878	28.64	43.84	144.75	233.15	421.74	2,952		4.20
Manna Gum - Rough-barked Apple - Yellow Box grassy woodland/open forest of the New England Tablelands and North Coast	Derived Native Grassland	89.90	1,219	13.56	5.24	13.93	21.58	40.74	367		0.45
Manna Gum - Rough-barked Apple - Yellow Box grassy woodland/open forest of the New England Tablelands and North Coast	Low (Paddock Trees)	50.50	589	11.66			4.31	4.31	39		0.09
Sub-total		**240.90**	**4,686**	**19.45**	**49.08**	**158.68**	**259.03**	**466.78**	**3,358**	**521-669**	**1.94**

Biometric Vegetation Type	Condition	Impact			Proposed Offsets					IoM Offset Target (ha)	Offset : Impact Ratio
		Impact Area (ha)	Credits required	Credits Required /ha	Property 1 Area (ha)	Property 2 Area (ha)	Property 3 Area (ha)	Total Area (ha)	Credits Generated (Est)		
Black Cypress Pine - Tumbledown Gum - Narrow-leaved Ironbark open forest of northern parts of the Nandewar Bioregion	Derived Grassland	1.30	23	17.69						3.00	0.00
Tenterfield Woollybutt - Silvertop Stringybark open forest of the New England Tablelands	Open Forest	1.10	33	30.00							0.00
Total		**288.80**	**5,464**	**18.92**	**309.46**	**195.14**	**259.03**	**763.62**	**5,705**	**607-781**	**2.64**

Table 30: Offset measures for overall impacts to biodiversity values (NSW) – Species credits

Species	Condition	Impact			Proposed Offsets					IoM Offset Target (ha)
		Impact Area (ha)	Credits required	Credits Required /ha	Property 1 Area (ha)	Property 2 Area (ha)	Property 3 Area (ha)	Total Area (ha)	Credits Generated (Est)	
Border Thick-tailed Gecko	Potential Habitat	18.70	249	13.32	0.00	0.00	184.65	184.65	1,108	41.50

Table 31: Offset measures for impacts to Matter of NES (EPBC Act)

EPBC Act listed Community	Condition	Impact Area (ha)	Property 1 Area (ha)	Property 2 Area (ha)	Property 3 Area (ha)	Total Area (ha) (P1+P2)	Total Area (ha) (P1+P3)	Offset: Impact Ratio (P1+2)	Offset: Impact Ratio (P1+3)
Property Area			**317.00**	**223.00**	**608.62**	**540.00**	**925.62**		
Blakely's Red Gum - Yellow Box grassy open forest or woodland of the New England Tablelands	Woodland	1.50	133.79	12.31		146.10	**133.79**	97.40	89.19
White Box grassy woodland of the Nandewar and Brigalow Belt South Bioregions	Woodland	9.30	16.22			16.22	**16.22**	1.74	1.74
White-Box, Yellow Box, Blakely's Red Gum grassy woodland and Derived Native Grassland grassy woodland	**Woodland**	**10.80**	**150.01**	**12.31**		**162.31**	**150.01**	**15.03**	**13.89**
Blakely's Red Gum - Yellow Box grassy open forest or woodland of the New England Tablelands	Derived Native Grassland	10.60	108.31	24.15		132.46	**108.31**	12.50	10.22
White Box grassy woodland of the Nandewar and Brigalow Belt South Bioregions	Derived Native Grassland	14.30	2.06			2.06	**2.06**	0.14	0.14
White-Box, Yellow Box, Blakely's Red Gum grassy woodland and Derived Native Grassland grassy woodland	**Derived Native Grassland**	**24.90**	**110.37**	**24.15**		**134.52**	**110.37**	**5.40**	**4.43**
Total		**35.70**	**260.38**	**36.46**		**296.84**	**260.38**	**8.31**	**7.29**
EPBC Act listed Species									
Border Thick-tailed Gecko (Potential Habitat)	**Potential**	**18.70**			**184.65**	**0.00**	**184.65**	**0.00**	**9.87**
Swift Parrot and Regent Honeyeater (Potential Foraging Habitat)									
Blakely's Red Gum - Yellow Box grassy open forest or woodland of the New England Tablelands	Woodland	1.50	133.79	12.31		146.10	133.79	97.40	89.19

EPBC Act listed Community	Condition	Impact Area (ha)	Property 1 Area (ha)	Property 2 Area (ha)	Property 3 Area (ha)	Total Area (ha) (P1+P2)	Total Area (ha) (P1+P3)	Offset: Impact Ratio (P1+2)	Offset: Impact Ratio (P1+3)
White Box grassy woodland of the Nandewar and Brigalow Belt South Bioregions	Woodland	9.30	16.22			16.22	16.22	1.74	1.74
Manna Gum - Rough-barked Apple - Yellow Box grassy woodland/open forest of the New England Tablelands and North Coast **	Woodland	100.50	43.84	144.75	233.15	188.59	276.99	1.88	2.76
Black Cypress Pine - Tumbledown Gum - Narrow-leaved Ironbark open forest of northern parts of the Nandewar Bioregion	Derived Native Grassland	1.30							
Tenterfield Woollybutt - Silvertop Stringybark open forest of the New England Tablelands	Open Forest	1.10							
Total		**113.70**	**193.85**	**157.06**	**233.15**	**350.91**	**427.00**	**3.09**	**3.76**
Swift Parrot and Regent Honeyeater (Future Potential Foraging Habitat) #									
Blakely's Red Gum - Yellow Box grassy open forest or woodland of the New England Tablelands	Derived Native Grassland to be regenerated		108.31	24.15		132.46	108.31		
White Box grassy woodland of the Nandewar and Brigalow Belt South Bioregions	Derived Native Grassland to be regenerated		2.06			2.06	2.06		
Manna Gum - Rough-barked Apple - Yellow Box grassy woodland/open forest of the New England Tablelands and North Coast	Derived Native Grassland to be regenerated		5.24	13.93	21.58	19.16	26.81		
Total			**115.61**	**38.08**	**21.58**	**153.69**	**137.19**		
Spot-tailed Quoll (Potential habitat)									
Blakely's Red Gum - Yellow Box grassy open forest or woodland of	Woodland	1.50	133.79	12.31		146.10	**133.79**	97.40	89.19

EPBC Act listed Community	Condition	Impact Area (ha)	Property 1 Area (ha)	Property 2 Area (ha)	Property 3 Area (ha)	Total Area (ha) (P1+P2)	Total Area (ha) (P1+P3)	Offset: Impact Ratio (P1+2)	Offset: Impact Ratio (P1+3)
the New England Tablelands									
White Box grassy woodland of the Nandewar and Brigalow Belt South Bioregions	Woodland	9.30	16.22			16.22	16.22	1.74	1.74
Manna Gum - Rough-barked Apple - Yellow Box grassy woodland/open forest of the New England Tablelands and North Coast **	Woodland	100.5	43.84	144.75	233.15	188.59	276.99	1.88	2.76
Tenterfield Woollybutt - Silvertop Stringybark open forest of the New England Tablelands	Open Forest	1.1	-	-	-	-	-	-	-
Total		**112.40**	**193.85**	**157.06**	**233.15**	**350.91**	**427.00**	**3.12**	**3.80**
South-eastern Long-eared Bat (Potential habitat)									
Blakely's Red Gum - Yellow Box grassy open forest or woodland of the New England Tablelands	Woodland	1.50	133.79	12.31	-	146.10	133.79	97.40	89.19
White Box grassy woodland of the Nandewar and Brigalow Belt South Bioregions	Woodland	9.30	16.22	-	-	16.22	16.22	1.74	1.74
Manna Gum - Rough-barked Apple - Yellow Box grassy woodland/open forest of the New England Tablelands and North Coast **	Woodland	100.50	43.84	144.75	233.15	188.59	276.99	1.88	2.76
Total		**111.3**	**193.85**	**157.06**	**233.15**	**350.91**	**427.00**	**3.15**	**3.84**
***Astrotricha roddii* (Potential habitat)**									
Blakely's Red Gum - Yellow Box grassy open forest or woodland of the New England Tablelands	Woodland	1.50	133.79	12.31	-	146.10	133.79	97.40	89.19
White Box grassy woodland of the Nandewar and Brigalow Belt South Bioregions	Woodland	9.30	16.22	-	-	16.22	16.22	1.74	1.74

EPBC Act listed Community	Condition	Impact Area (ha)	Property 1 Area (ha)	Property 2 Area (ha)	Property 3 Area (ha)	Total Area (ha) (P1+P2)	Total Area (ha) (P1+P3)	Offset: Impact Ratio (P1+2)	Offset: Impact Ratio (P1+3)
Manna Gum - Rough-barked Apple - Yellow Box grassy woodland/open forest of the New England Tablelands and North Coast **	Woodland	100.50	43.84	144.75	233.15	188.59	276.99	1.88	2.76
Tenterfield Woollybutt - Silvertop Stringybark open forest of the New England Tablelands	Open Forest	1.10	-	-	-	-	-	-	-
Total		**112.4**	**193.85**	**157.06**	**233.15**	**350.91**	**427.00**	**3.12**	**3.80**
***Digitaria porrecta & Diuris pedunculata* (Potential habitat)**									
Blakely's Red Gum - Yellow Box grassy open forest or woodland of the New England Tablelands	Woodland	1.50	133.79	12.31	-	146.10	133.79	97.40	89.19
Blakely's Red Gum - Yellow Box grassy open forest or woodland of the New England Tablelands	Derived Native Grassland	10.6	108.31	24.15	-	132.46	108.31	12.50	10.22
White Box grassy woodland of the Nandewar and Brigalow Belt South Bioregions	Woodland	9.30	16.22	-	-	16.22	16.22	1.74	1.74
White Box grassy woodland of the Nandewar and Brigalow Belt South Bioregions	Derived Native Grassland	14.3	2.06	-	-	2.06	2.06	0.14	0.14
Manna Gum - Rough-barked Apple - Yellow Box grassy woodland/open forest of the New England Tablelands and North Coast	Woodland	100.50	43.84	144.75	233.15	188.59	276.99	1.88	2.76
Manna Gum - Rough-barked Apple - Yellow Box grassy woodland/open forest of the New England Tablelands and North Coast	Derived Native Grassland	89.90	5.24	13.93	21.58	19.17	26.82	0.21	0.30
Tenterfield Woollybutt - Silvertop Stringybark open forest of the New England Tablelands	Open Forest	1.10	-	-	-	-	-	-	-

EPBC Act listed Community	Condition	Impact Area (ha)	Property 1 Area (ha)	Property 2 Area (ha)	Property 3 Area (ha)	Total Area (ha) (P1+P2)	Total Area (ha) (P1+P3)	Offset: Impact Ratio (P1+2)	Offset: Impact Ratio (P1+3)
Total		**227.20**	**309.46**	**195.14**	**254.73**	**504.60**	**564.19**	**2.22**	**2.48**
***Picris evae* (Potential Habitat)**									
Blakely's Red Gum - Yellow Box grassy open forest or woodland of the New England Tablelands	Woodland	1.50	133.79	12.31	-	146.10	133.79	97.40	89.19
White Box grassy woodland of the Nandewar and Brigalow Belt South Bioregions	Woodland	9.30	16.22	-	-	16.22	16.22	1.74	1.74
Manna Gum - Rough-barked Apple - Yellow Box grassy woodland/open forest of the New England Tablelands and North Coast **	Woodland	100.50	43.84	144.75	233.15	188.59	276.99	1.88	2.76
Tenterfield Woollybutt - Silvertop Stringybark open forest of the New England Tablelands	Open Forest	1.10	-	-	-	-	-	-	-
Total		**112.4**	**193.85**	**157.06**	**233.15**	**350.91**	**427.00**	**3.12**	**3.80**

Note:

** Manna Gum open forest is not optimal or preferred foraging habitat for Swift Parrot and Regent Honeyeater, however, has been included here on a precautionary basis. If removed from these calculations, offset ratios for impacts to 10.8 ha of White Box and Blakely's Red Gum woodland is almost 14:1.

Whilst Swift Parrot and Regent Honeyeater will utilise scattered paddock tress for foraging, they have not been included in the impact totals as these trees will not be affected by the proposal. Roads, powerlines and turbine pads will be located to avoid scattered paddock trees as outlined in Chapter 5.

6.6 CONCURRENCE OF OFFSET PACKAGE WITH NSW AND COMMONWEALTH OFFSET PRINCIPLES

6.6.1 NSW Offset Principles

DECC (2008) provides a number of offset principles that should be met for all offsets. Each of the key principles has been addressed below with respect to the proposed offset strategy and package:-

- the vegetation on the potential offset properties is generally of equal or better condition that the impact sites and includes a greater proportion of higher conservation status vegetation than the impact site (Principle 10 Offsets must be targeted on a like for like or better conservation outcome).
- the proposed offset area is larger than the impact area and will result in a net improvement to biodiversity values over time (Principle 6 offsets should aim to result in a net improvement in biodiversity over time;
- the offset area has been informed through a biometric calculation that considers the structure, function and compositional elements of biodiversity (Principle 9 Offsets must be quantifiable).
- the offset properties will have Conservation Covenants registered on title, management plans prepared and implemented in perpetuity (Principle 7 Offsets must be enduring);
- the offset sites will be actively managed via property specific management plan with in-perpetuity management costs provided; (Principle 7 Offsets must be enduring)
- a commitment has been provided to secure the proposed offsets prior to any construction occurring and (Principle 8 offsets must be agreed to prior to the impact occurring),
- the offset properties are located in the same vicinity as the proposal and provides important linkages to Crown reserves and other conservation areas in the locality (Principle 11 Offset must be located appropriately);
- the proposed offset area is supplementary (Principle 12) and has not been used to offset other impacts or received any other funding; and
- the proposed offsets will be enforceable through development consent conditions (Principle 13 Offsets must be enforceable through development conditions).

6.6.2 Draft Commonwealth Offset Principles

The offset package proposed is consistent with the draft Commonwealth offset principles in that:-

- the offset package has been targeted to the EPBC Act matters being impacted (White Box – Yellow Box- Blakely's Red Gum grassy woodland and derived native grassland and Border Thick-tailed Gecko habitat) (Principle 1);
- the offset package is flexible in that it has considered a number of options to achieve the most cost effective option for the proponent including those landholders who have expressed interest in managing their properties for conservation (Principle 2);
- the offset package will deliver a viable conservation outcome due to the size, location and condition of the proposed offset properties (Principle 3);

- the offset proposed is a direct package that aims to offset the impacts on a on a “like for like” basis (Principle 4);
- the proposed offset package provides a “like for like” outcome in terms of EPBC Act listed communities and species habitat being impacted as well as the condition of the habitats impacted and will be up to 15 times the area of woodland impacted and 5 times the area of derived native grassland impacted. (Principle 5);
- the offset area is within the overall project site but will not be directly or indirectly impacted by the proposed Wind Farm (Principle 6);
- the offsets will be agreed prior to any development commencing and registered in perpetuity on title (Principle 7); and
- the offsets will be enforceable and will be monitored and audited in accordance with development approval conditions (Principle 8).

The cost to secure the proposed offset package (500 - 570 ha) is estimated to be in the range $3.2 - $3.94 M to secure the land and provide for in perpetuity conservation land management. This is based on land value of between $2,500 and $3,000 per hectare and in perpetuity management costs of up to $3,900 per ha. The social and economic opportunity costs of securing the offset package is the loss of 500-570 productive agricultural land.

7 Conclusion

Under Part 3A of the EP&A Act, the DGRs require the EA to provide details of the measures to avoid, mitigate or offset impacts associated principles of the 'maintain and improve' test. The Sapphire Wind Farm proposal is subject to a one-off accredited assessment process and subject to the general administrative steps outlined in the NSW Assessment Bilateral administrative procedures. Therefore, the principles of the Part 3A maintain and improve have also been applied to Matters of National Environmental Significance and in particular Box Gum Woodland and threatened species. Furthermore, key offsetting principles between the state and Commonwealth generally align and therefore the offsets proposed have been designed to meet the requirements of both jurisdictions.

Whilst complete avoidance of all impacts on threatened species, their habitat and areas of native vegetation is not possible, a number of avoidance measures including realignment of proposed roads to avoid threatened plants have been implemented. Furthermore, stringent mitigation measures will be implemented as part of the proposal and will further reduce potential impacts from the proposal.

For those impacts that cannot be mitigated or avoided, a variety of offset options have been proposed that will make a substantial contribution to the protection of EECs, threatened species and their habitat on the Northern Tablelands through *in perpetuity* protection of large, viable offset areas.

The suite of avoidance, mitigation and offset measures will be consistent with principles of the 'maintain and improve.'

8 References

Ahlén I. 2003. *Wind turbines and bats: a pilot study* [in Swedish]. Report to the Swedish National Energy Administration. Eskilstuna, Sweden: Swedish National Energy Commission [English translation by I Ahlén]. Dnr 5210P-2002-00473, O-nr P20272-1.

Allison, F.R. and Hoye, G.A. 1998. 'Eastern Freetail-bat', In: Strahan, R. (Ed.) *The Mammals of Australia*, pp. 484-485, Australian Museum/ Reed Publications, Sydney

Arnett, E.B., Brown, W. K.., Erickson, W.P., Fielder, J.K., Hamilton, B.L., Henry, T.H., Jian, A., Johnson, G.D., Kerns, J., Rolf, R.K., Nicholson, C.P., O'Connell, T.J., Piorkowski, M.D., and Tankersley, R.D. Jr. 2008. *Patterns of Bat Fatalities at Wind Energy Facilities in North America*. Journal of Wildlife Management 72(**1**):61-78, 2008

Arnett, E. 2005. *Relationships between Bats and Wind Turbines in Pennsylvania and West Virginia: An Assessment of Fatality Search Protocols, Patterns of Fatality, and Behavioural Interactions with Wind Turbines*. Prepared for Bats and Wind Energy Cooperative. Online: http://www.batsandwind.org/pdf/ar2004.pdf

Australian Museum Business Services 1995. *Fauna impact statement for proposed forestry activities in the Urbenville Management Area*., Report prepared for State Forests of New South Wales. Australian Museum Business Services, Sydney.

Australian Museum 2008. *Australian Museum Database Records* [online]. Available: http://chapman.australianmuseum.net.au/search.htm

Australian National Botanic Gardens (ANBG) 1999. *Pteridophytes of conservation significance in Australia – Definitions, ROTAP codes* [online]. Available: http://www.anbg.gov.au/fern/conservation.html#rotap (25 May 2011).

AustWind 2006. *Best Practice Guidelines - Fire Management Guidelines* [online]. Available: http://www.cleanenergycouncil.org.au/cec/resourcecentre/reports/Past-Reports/mainColumnParagraphs/0/text_files/file21/bestpracguidelines06.pdf

Bach, L. and Rachmel, U. 2004. *Summary of wind turbine impacts on bats: assessment of a conflict.* Brem Beitr Naturk Naturs **7**:245–52.

Birds Australia 2009. *Birds Australia Threatened and Migratory Species Database Records* [online]. Available: http://www.birdsaustralia.com.au/resources/threatened-bird-lists.html

Blakers, M., Davies, S., and Reilly, P.N 1984. The Atlas of Australian Birds. RAOU Melbourne University Press.

Brett Lane and Associates Pty Ltd associated with Aria Professional Services Pty Ltd 2005. *Wind Farms and Birds: Interim Standards for Risk Assessment*. Prepared for the Australian Wind Energy Association, July 2005.

Bureau of Meteorology 2011. *Climate statistics for Australian locations - Glen Innes Ag Research Station* [online]. Available: http://www.bom.gov.au/climate/averages/tables/cw_056013.shtml (4 April 2011).

Border Rivers – Gwydir Catchment Management Authority 2007. *Border Rivers – Gwydir Catchment Action Pla*n. Border Rivers – Gwydir Catchment Management Authority, Inverell

Cannon, G., Cannon, M., Harding, W., McCosker, R., Spunner, B., Steenbeeke, G. and Watson, G. (2002). *Native Vegetation Map Report Series No. 3: Bellata, Gravesend, Horton and Boggabri 1:100 000 map sheets*. NSW Department of Infrastructure and Planning, Sydney, NSW.

Centre for Natural Resources 2004. *NSW Native vegetation report - Cobbora, Coolah, Coonabarabran, Mendooran, Tambar Springs 1: 100 000 map sheets*, New South Wales Department of Infrastructure, Planning and Natural Resources, Parramatta, NSW.

Churchill, S. 1998. *Australian Bats*. Reed New Holland, Sydney.

Clarke, P.J., L.M. Copeland, J.T. Hunter, C.E. Nano, J.B. Williams & K.E. Wills (1998). *The Vegetation and Plant Species of Torrington State Recreation Area*. Univeristy of New England. Armidale, Division of Botany.

Commonwealth of Australia (2008). *Environment Protection and Biodiversity Conservation Act 1999 – Introduction Guide to Environmental Offsets* (Final Draft).

Copeland, L.M. & J.T. Hunter 1999. Range extensions and conservation status of 18 restricted plant species in north-eastern NSW. *Cunninghamia*. 6(2):395-400. Sydney: National Herbarium of NSW, Royal Botanic Gardens.

Country Fire Authority (CFA) 2007. *Emergency Management Guidelines for Wind Farms* [online]. Available: http://www.cfa.vic.gov.au/documents/CFA_Guidelines_For_Wind_Farms.pdf (8 April 2011).

Creamer, H. 1999. *A landholders guide to threatened species: tips for saving threatened species in New England*.

Department of Environment and Conservation NSW 2004. *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (working draft)*. DEC, Hurstville, NSW.

Department of Environment and Climate Change 2008. *Principles for the use of biodiversity offset in NSW.* Online http://www.environment.nsw.gov.au/biocertification/offsets.htm (Accessed 22 July 2009)

Department of Environment and Climate Change 2009. *Biobanking Assessment Methodology and Credit Calculator Operation Manual*. DECC Sydney, NSW.

Department of the Environment and Heritage 2006. *National Code for Wind Farms – A Discussion Paper.* Australian Greenhouse Office

Department of Environment, Climate Change and Water 2010. *Interim Policy on Assessing and Offsetting Biodiversity Impacts of Part 3A development*. DECCW Sydney, NSW.

Department of Environment, Climate Change and Water (DECCW) 2011a. Threatened Species Database (10 km radius search). DECCW Sydney, NSW.

Department of Environment, Climate Change and Water 2011b. Threatened Species Profile [online]. Available: http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/home_species.aspx (Accessed: 8 April 2011).

Department of the Environment and Heritage 2006. *National Code for Wind Farms* – A Discussion Paper. Australian Greenhouse Office

Department of the Environment, Water, Heritage and the Arts (DEWHA) 2008. *Approved Conservation Advice for Digitaria porrecta* [online]. Available: http://www.environment.gov.au/biodiversity/threatened/species/pubs/12768-conservation-advice.pdf (30th March 2011).

Department of the Environment, Water, Heritage and the Arts (DEWHA) 2010a. *Survey guidelines for Australia's threatened birds Guidelines for detecting birds listed as threatened under the - Environment Protection and Biodiversity Conservation Act 1999* [online]. Available: http://www.environment.gov.au/epbc/publications/pubs/survey-guidelines-birds.pdf Accessed 6 September 2011

Department of the Environment, Water, Heritage and the Arts (DEWHA) 2010b. Survey guidelines for Australia's threatened mammals - Guidelines for detecting mammals listed as threatened under the Environment Protection and Biodiversity Conservation Act 1999 [Online]. Available: http://www.environment.gov.au/epbc/publications/pubs/survey-guidelines-mammals.pdf Accessed 6 September 2011.

Department of Industry and Development 2011a. Noxious Weed Declarations. Available from: http://www.dpi.nsw.gov.au/agriculture/pests-weeds/weeds/noxweed/ [online] [Accessed: 11th March 2011]

Department of Mineral Resources 2003. *Statewide (NSW) Digital Geology 1:250 000*. DMR, NSW.

Department of Sustainability and Environment (DSE) 2003. *Flora & Fauna Guarantee Action Statement – Austral Toad Flax Thesium australe* [online]. Available: http://www.dse.vic.gov.au/CA256F310024B628/0/76D0A781B2E0FBBDCA2570EC001E3AEE/$File/056+Austral+Toad-flax+1994.pdf (12 April 2011).

Department of Sustainability, Environment, Water, Populations and Communities 2008. Approved Conservation Advice for *Bothriochloa biloba* (Lobed Blue-grass) [online]. Available: http://www.environment.gov.au/biodiversity/threatened/species/pubs/3153-conservation-advice.pdf

Department of Sustainability, Environment, Water, Populations and Communities 2009. Regent Honeyeater Fact Sheet 'A yellow flash no more' [online]. Available: http://www.environment.gov.au/biodiversity/threatened/publications/regent-honeyeater.html (2 June 2011).

Department of Sustainability, Environment, Water, Populations and Communities 2011a. Protected Matters Search Tool [online]. Available: http://www.environment.gov.au/epbc/protect/index.html (Accessed: 8 April 2011).

Department of Sustainability, Environment, Water, Populations and Communities 2011b. Species Profile and Threats Database [online]. Available: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl (Accessed: 8 April 2011).

Devereux, C.L., Denny, M.J.H. and Wittingham, M.J. 2008. *Minimal effects of wind turbines on the distribution of wintering farmland birds*. Journal of Applied Ecology, 45, 1689 – 1694.

Duncan, A, Baker, GB and Montgomery, N (eds) 1999. *The Action Plan for Australian Bats*, Environment Australia, Canberra.

Dürr, T. and Bach, L. 2004. *Bat deaths and wind turbines: a review of current knowledge and of information available in the database for Germany*. Brem Beitr Naturk Naturs 7: 253–64.

Dwyer, P.D. 1981 'Common Bent-wing Bat, *Miniopterus schreibersii'*, *ANH*, 20(6):187-190.

Dwyer, P.D. 1995. 'Common Bent-wing Bat (*Miniopterus schreibersii*)', In: R. Strahan (Ed.) *The Australian Museum Complete Book of Australian Mammals*, pp494-495, Angus and Robertson Publishers, Sydney.

Eby, P. 1998. 'An analysis of the diet specialisation in frugivorous *Pteropus poliocephalus* in Australian subtropical rainforest', *Austral Ecology*, 23:443-456

Environment Australia 2000. *Comprehensive and Regional Assessments for North-East NSW*. Report to National Parks and Wildlife Service.

Eco Logical Australia 2011a. *Sapphire Wind Farm Bushfire Risk Assessment*. . Eco Logical Australia, NSW.

Eco Logical Australia 2011b. *Sapphire Wind Farm Soils assessment*. . Eco Logical Australia, NSW.

Erickson, W.P., G.D.Johnson, M.D. Strickland, D.P.Young,JR., K.J. Sernka and R.E. Good 2001. *Avian collisions with wind turbines: A summary of existing studies and comparisons to other sources of avian collision mortality in the United States*. Prepared by W.E.S.T., Inc. for the National Wind Coordinating Committee (NWCC).

Fenton, M.B. 2004. *Bat natural history and echolocation*. In: Brigham RM, Kalko EKV, Jones G, (Eds). Bat echolocation research: tools, techniques and analysis. Austin, TX: Bat Conservation International.

Fielder, J. K. 2004. *Assessment of bat mortality and activity at Buffalo Mountain Windfarm, eastern Tennessee*. Master of Science Thesis, The University of Tennessee, Knoxville.

Garnett, S. (Ed) 1993. *Threatened and extinct birds of Australia.* Royal Australian Ornithologists Union and Australian NPWS, Royal Australian Ornithologists Union Report, No. 82.

Geoscience Australia (GA) 1998. '1:100 000 Scale Australian Geoscience Map Sheet Index' (National Geoscience Dataset) - Yallaroi, Ashford, Bingara and Inverell 1:100k map sheets. GA, Canberra, ACT.

Glen Innes Severn Council 2008. *Development Control Plan (DCP) – Wind Power Generation*. Glen Innes Severn Council. [online]. Available: http://www.gisc.nsw.gov.au/files/50470/File/DCPWindPower.pdf

Glenn Innes Severn Council 2009. *State of the Environment Comprehensive Report 2005 – 2009* [online]. Available: http://www.gisc.nsw.gov.au/files/56427/File/SOE2009.pdf (Accessed 24 February 2011)

Halford, D 1995, 'Digitaria porrecta *S.T. Blake (Poaceae) A Conservation Statement*', Australian Nature Conservation Agency, Canberra.

Harden, G.J. (ed.) 1992. *Flora of New South Wales.* Vol. 3. UNSW Press, Kensington, NSW.

Holzapfel, S. 1994 A revision of the genus *Picris* (Asteraceae, Lactuceae) s.l. in Australia. Willdenowia 24: 97-218.

Horn, J.W., Arnett, E, and Kunz, T. 2008. *Behavioural response of bats to operating Wind turbines*. Journal of Wildlife Management 72 (1): 123 – 132

Hoye, G.A. and Hall, L.S. 2008. *Eastern Bent-winged- Miniopterus schreibersii oceanensis*. In 'The Mammals of Australia', Editors Van Dyck, S. and Strahanm R. Third Edition. Reed New Holland, Sydney.

Hoye, G. and Richards, G. 1998. 'Greater Broad-nosed Bat', In: Strahan, R. (ed.) *The Australian Museum Complete Book of Australian Mammals*, Angus and Robertson Publishers, Sydney.

Illinois Department of Natural Resources 2007. *The Possible Effects of Wind Energy on Illinois Birds and Bats*. Report of the Illinois Department of Natural Resources to Governor Rod Blagojevich and the 95th Illinois General Assembly.

Inverell Council 2009. *State of the Environment Report 2008 – 2009* [online]. Available: http://www.inverell.nsw.gov.au/images/stories/ISC/Environmental%20Services/SOE_2008-09.pdf (Accessed 24 February 2011)

Inverell-Yallaroi Regional Vegetation Management Committee, 2002, *Draft Inverell-Yallaroi Regional Vegetation Management Pla*n, NSW Department of Land and Water Conservation.

Jain, A., P. Kerlinger, R. Curry, and L. Slobodnik. 2007. *Annual report for the Maple Ridge Wind Power Project: post-construction bird and bat fatality study- 2006*. Report to PPM Energy and Horizon Energy and Technical Advisory Committee for the Maple Ridge Project Study, McLean, Virginia, USA. Curry & Kerlinger LLC, McLean, Virginia, USA.

Jersáková, J., S.D. Johnson & P. Kindlmann 2006. *Mechanisms and evolution of deceptive pollination in orchids*. Biological Review. 81:219-235.

Johnson, G., Erickson, W., White, J. and McKinney, R. 2003. *Avian and Bat Mortality During the First Year of Operation at the Klondike Phase I Wind Project, Sherman County, Oregon*. Draft report prepared for Northwester Wind Power

Kerlinger, P., Curry, R., Culp, L., Lain, A., Wilkerson, C., Fischer, B and Hesch, A. 2006. *Post-construction avian and bat fatality monitoring study for the High Winds Wind Power Project, Solano County, California: two year report*. Prepared for FPL Energy and Mountaineer Wind Energy Center Technical and Review Committee. Prepared by McLean, NJ and Curry and Kerlinger LLC.

Kevin Mills & Associates 2005. *Flora and Fauna Assessment Capital Wind Farm Southern Tablelands, NSW*. Prepared for Capital Wind Farms, March 2005.

Kluge, A.G. 1974. *A taxonomic revision of the lizard family Pygopodidae*. Miscellaneous Publications of the Museum of Zoology, University of Michigan. 147 (i-iv):1-221.

Kunz, T.H., Arnett, T.H., Erickson, W.P., Hoar, A.R, Johnson, G.D., Larkin, R.P., Strickland, M.D., Thresher, R.W. and Tuttle, M.D. 2007. *Ecological impacts of wind energy development on bats, questions, research needs and hypothesis*. Front Ecological Environment; 5(6), 315-324.

Law, B.S., Herr, A. and Phillips, W. 2008. *Eastern False Pipstrelle – Falsistrellus tasmaniensis*. In The Mammals of Australia, Editors Van Dyck, S. and Strahanm R. Third Edition. Reed New Holland, Sydney.

Lea, D., Pigram, J. And Greenwood, L. 1977a. *An Atlas of New England: Volume 1 The Maps*. University of New England, Department of Geography.

Lea, D., Pigram, J. And Greenwood, L. 1977b. *An Atlas of New England: Volume 2 The Commentaries*. University of New England, Department of Geography.

Leigh, J, Boden, R & Briggs, J 1984, *Extinct and Endangered Plants of Australia*, Melbourne, Macmillan.

Mansergh, I. M. 1984 'The status, distribution and abundance of *Dasyurus maculatus* (Tiger Quoll) in Australia with particular reference to Victoria', *Australian Zoolology*, 21(2):109-22.

Marchant and Higgins 1993. *Handbook of Australian, New Zealand and Antarctic Birds*. Oxford University Press, Melbourne.

Masden, E. A., Haydon, D.T.; Fox, A.D.; Furness, R.W.; Bullman, R.; Desholm, M. 2009. *Barriers to movement: Impacts of wind farms on migrating birds*. ICES Journal of Marine Science / Journal du Conseil, May2009, Vol. 66 Issue 4, p746-753,

McKilligan, N. 2005 *Herons, Egrets and Bitterns*, CSIRO Publishing.

Menkhorst, P. and Knight, F. 2004 *A Field Guide to the Mammals of Australia*, 2nd Edn., Oxford University Press, South Melbourne.

Menkhorst, P., Schedvin, N. and Geering, D. 1999. *Regent Honeyeater (Xanthomyza phrygia) Recovery Plan 1999-2003.* Department of Natural Resources and Environment 1999.

Menkhorst, P., Weavers, B. and Alexander, J. 1988. 'Distribution, habitat and conservation status of the Squirrel Glider *Petaurus norfolcensis* in Victoria', *Aust. Wildl. Res.* 15: 59 -71

Murray, L. and Brown, E.A. 1992. *Picris*. In Harden, G.J. (ed.) Flora of New South Wales. Volume 3 (New South Wales University Press: Sydney)

NSW National Parks and Wildlife Service 1995. *Endangered Fauna of Western New South Wales*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 1997. *Urban Bushland Biodiversity Study - Western Sydney,* National Parks and Wildlife Service.

NSW National Parks and Wildlife Service 2004. *Kings Plains National Park Plan of Management* [online]. Available: http://www.environment.nsw.gov.au/resources/parks/PoMKingsPlainsNP.pdf (5 April 2011)

Orchard, A.E. & A.J.G. Wilson, eds. 2001. Flora of Australia, Volume 11B, Mimosaceae, Acacia Part 2. **In:** *Flora of Australia*. Canberra, ACT: ABRS & CSIRO.

Pearce-Higgins, J.W., Stephen, L., Langston, R.H.W., Bainbridge, I.P. and Bullman, R. 2009. *The distribution of breeding birds around upland wind farms*. Journal of Applied Ecology 46: 1323-1331.

Pizzey, G. and Knight, F. 1997. *The Field Guide to the Birds of Australia*, Harper Collins, Sydney, NSW.

Pizzey, G. and Knight, F. 2003. *The Field Guide to the Birds of Australia*. Peter Menkorst (Ed) HarperCollins, Sydney, NSW.

Porter, R. 1998. 'A preliminary field investigation of the collared delma *Delma torquata'* (Reptilia: Pygopodidae). Queensland: Lone Pine Koala Sanctuary.

Quinn, D.G. 1995. *Population ecology of the Squirrel Glider and the Sugar Glider at Limeburners Creek, on the Central North Coast of NSW*. Wildlife Research. 22: 471-505.

Quinn, F., J.B. Williams, C.L. Gross & J. Bruhl 1995. *Report on rare and threatened plants of north-eastern New South Wales*. Armidale: University of New England.

Richards, G.C. unpulished. *Preliminary Assessment of Potential Impacts Upon the Bat Fauna Expected at the proposed Capital Wind Farm, NSW*. Prepared for Connell Wagner March 2005.

Rouse, D.T. 2003. Discovery of *Diuris pedunculata* R.Br. in Victoria. *The Orchadian*. 14(6):256-259.

Royal Botanical Gardens 2008. *Threatened Flora Database Search*. Royal Botanic Gardens, Sydney.

Schodde, R. and Tidemann, S. (Eds) 1986. *Readers Digest complete book of Australian Birds*, 2nd Edn., Reader's Digest Services Pty Ltd, Sydney.

Simpson, K. and Day, N. 1999. *Field guide to the birds of Australia* 6th edn., Penguin Books Australia Ltd, Ringwood Victoria.

Smales, I. and Muir, S. 2005. *Modeled cumulative impacts on the Tasmanian Wedge-tailed Eagle of wind farms across the species' range*. Report prepared by Biosis Research Pty Ltd for the Department of Environment and Heritage.

Smales, I. 2005a. *Modelled cumulative impacts on the White-bellied Sea-eagle of wind farms across the species' Australian range*. Report prepared by Biosis Research Pty Ltd for the Department of Environment and Heritage.

Smales, I. 2005b. *Modelled cumulative impacts on the Swift Parrot of wind farms across the species' range in south-eastern Australia*. Report prepared by Biosis Research Pty Ltd for the Department of Environment and Heritage.

Strahan, R. (Ed.) 1998. *The Australian Museum Complete Book of Australian Mammals*, Angus and Robertson Publishers, Sydney.

Swift Parrot Recovery Team 2001. *Swift Parrot Recovery Plan.* Department of Primary Industries, Water and Environment, Hobart, Tasmania.

US Department of Interior Fish & Wildlife Service 1993. *Service Interim Guidance on avoiding and minimizing wildlife impacts from Wind Turbines*.

Van Dyck, S. & Strahan, R. (Eds) 2008. *The Mammals of Australia.* Reed New Holland, Sydney NSW.
Wahren, C-H. A., Papst, W.A. and William, R.J. 2002. *Early post-fire regeneration in subalpine heathland and grassland in the Victorian Alpine National Park, south-eastern Australia.* Austral Ecology Vol 26 (6) (pp670-679)

Woolcock, C. & Woolcock, D. 1984. *Australian Terrestrial Orchids*. Melbourne, Thomas Nelson Australia.

Appendix A: Figures

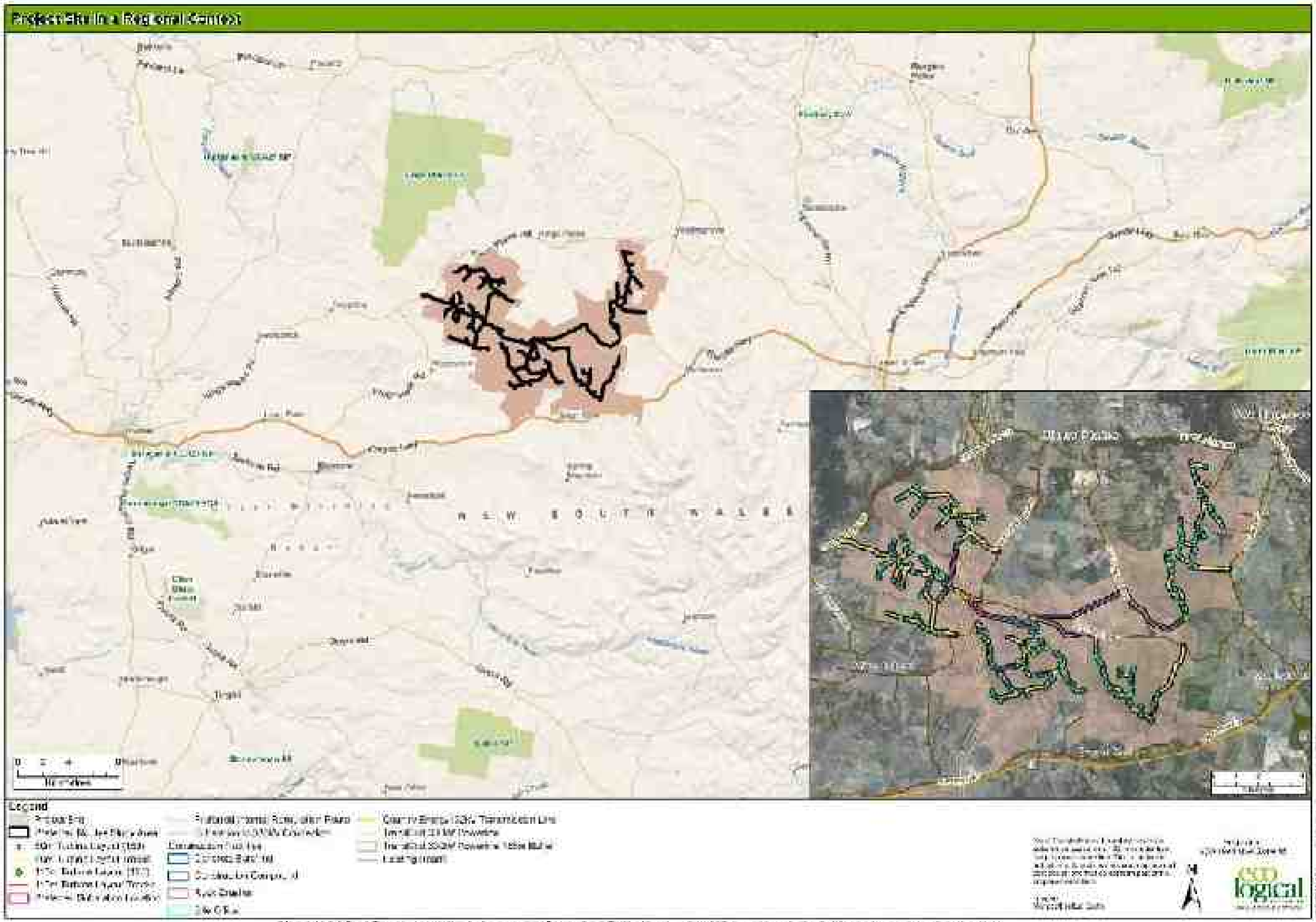


Figure 2: Project site in a regional context

Figure 3: Proposed turbine layout, access roads, reticulation and infrastructure

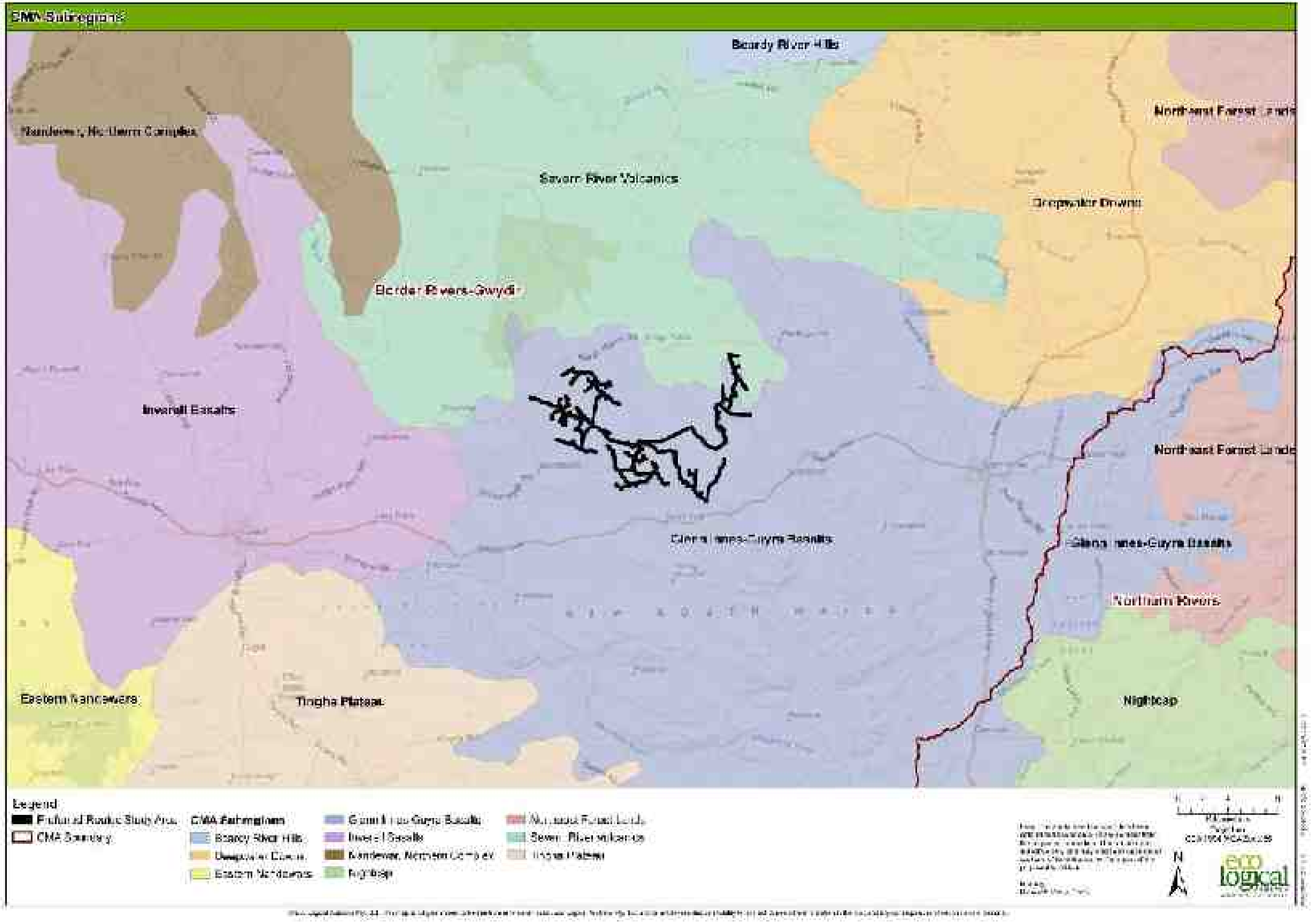


Figure 4: CMA sub-regions

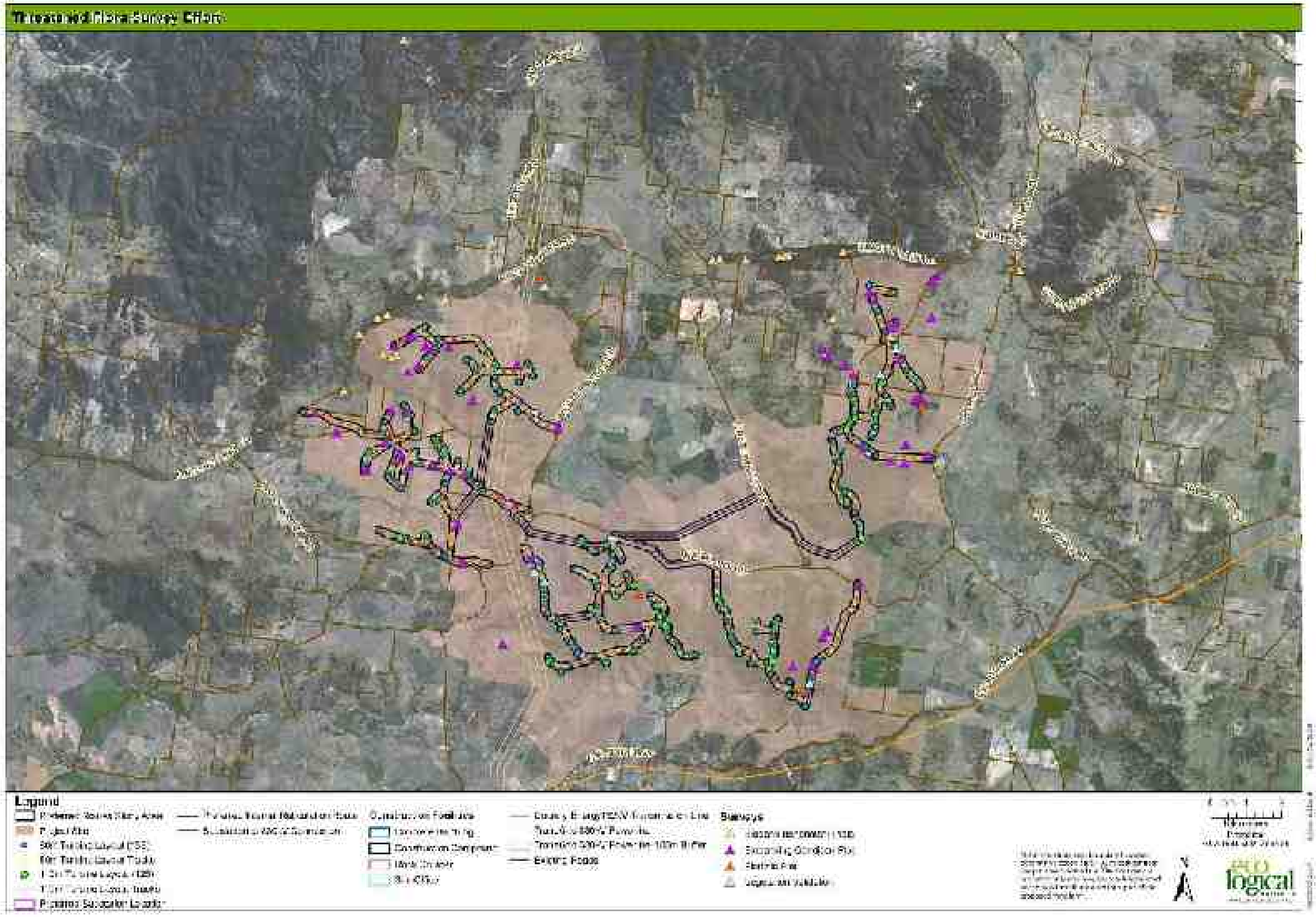


Figure 5: Survey locations flora

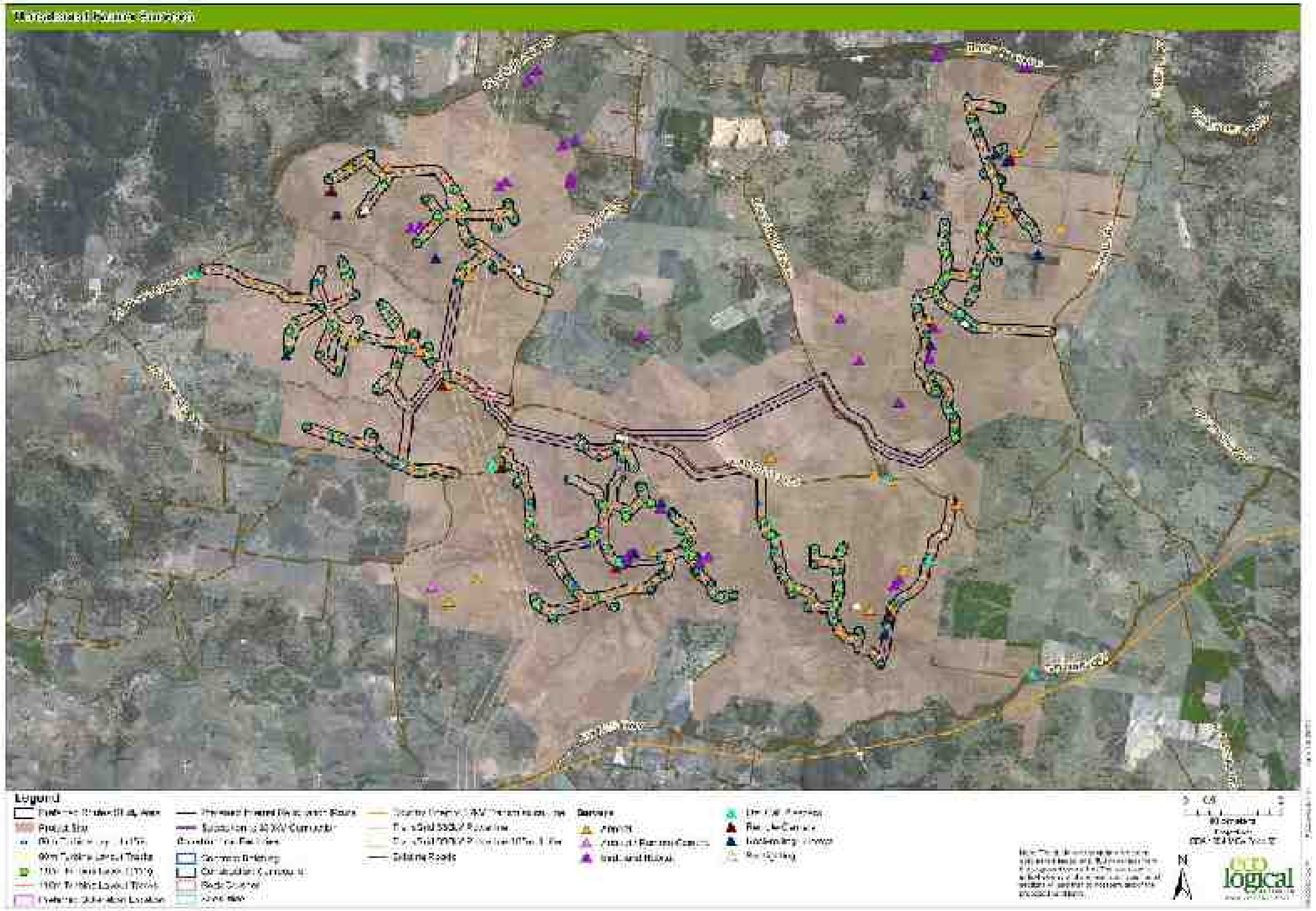


Figure 6: Survey locations fauna

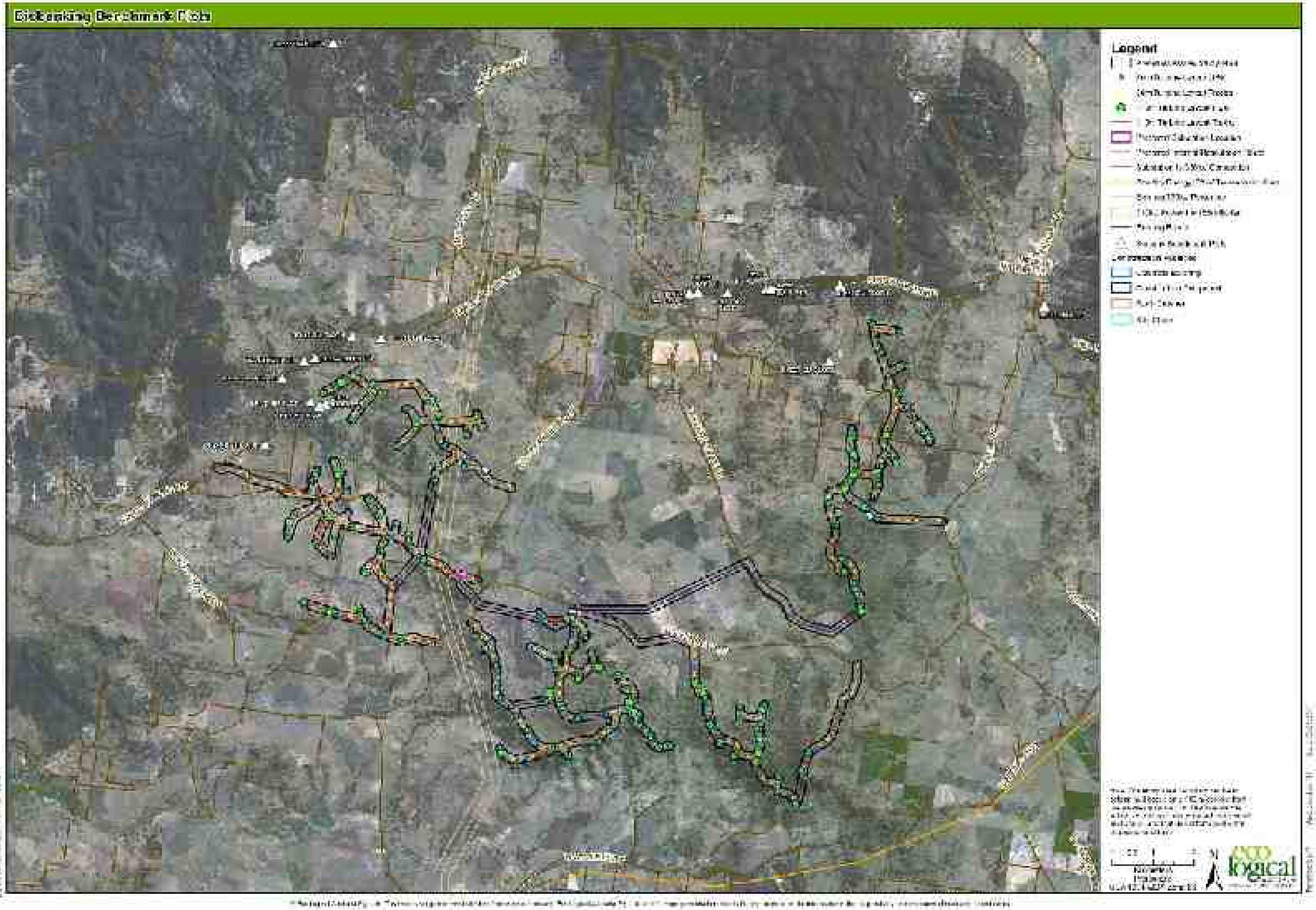


Figure 7: Local Benchmark plot locations

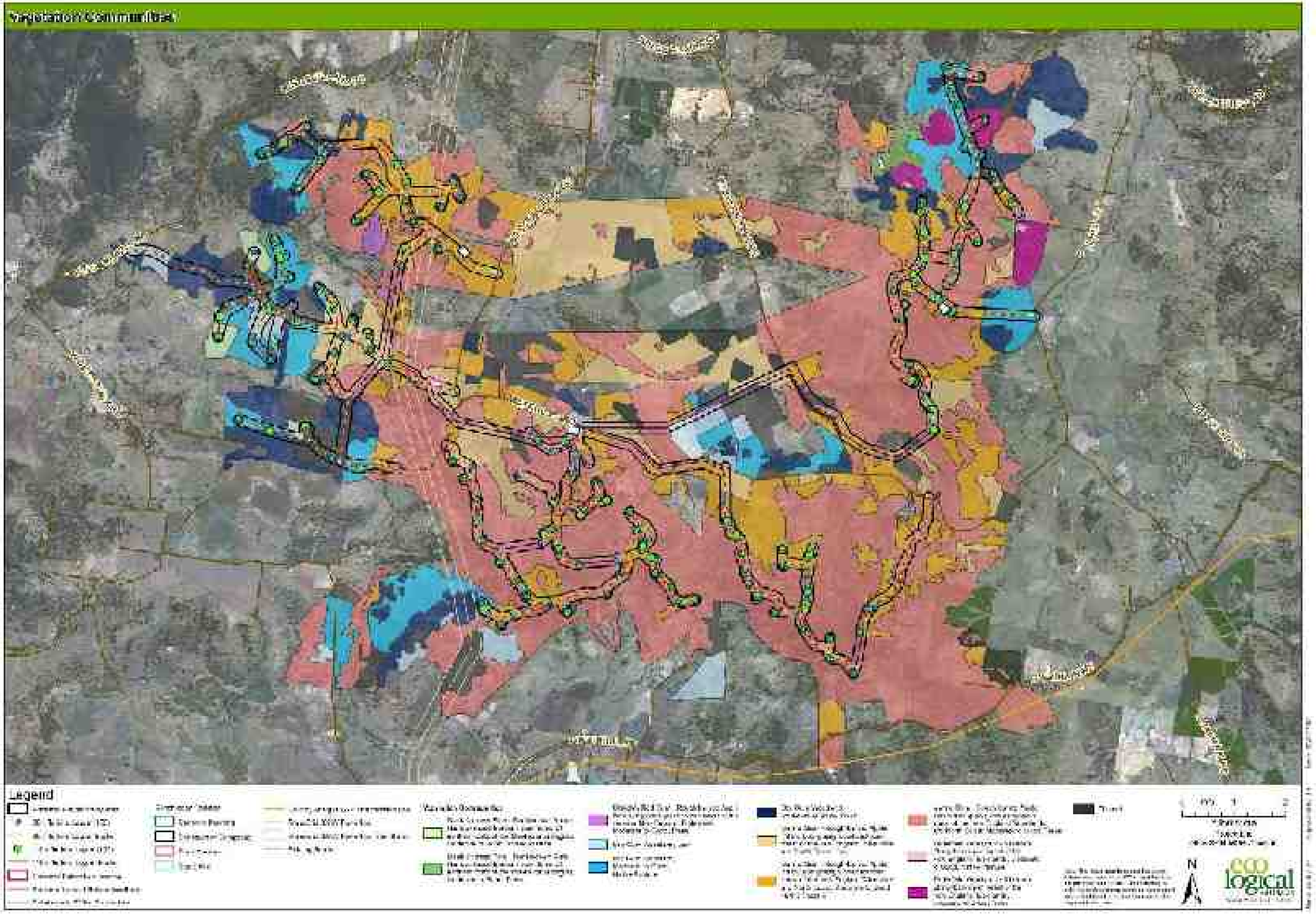


Figure 8: Vegetation mapping

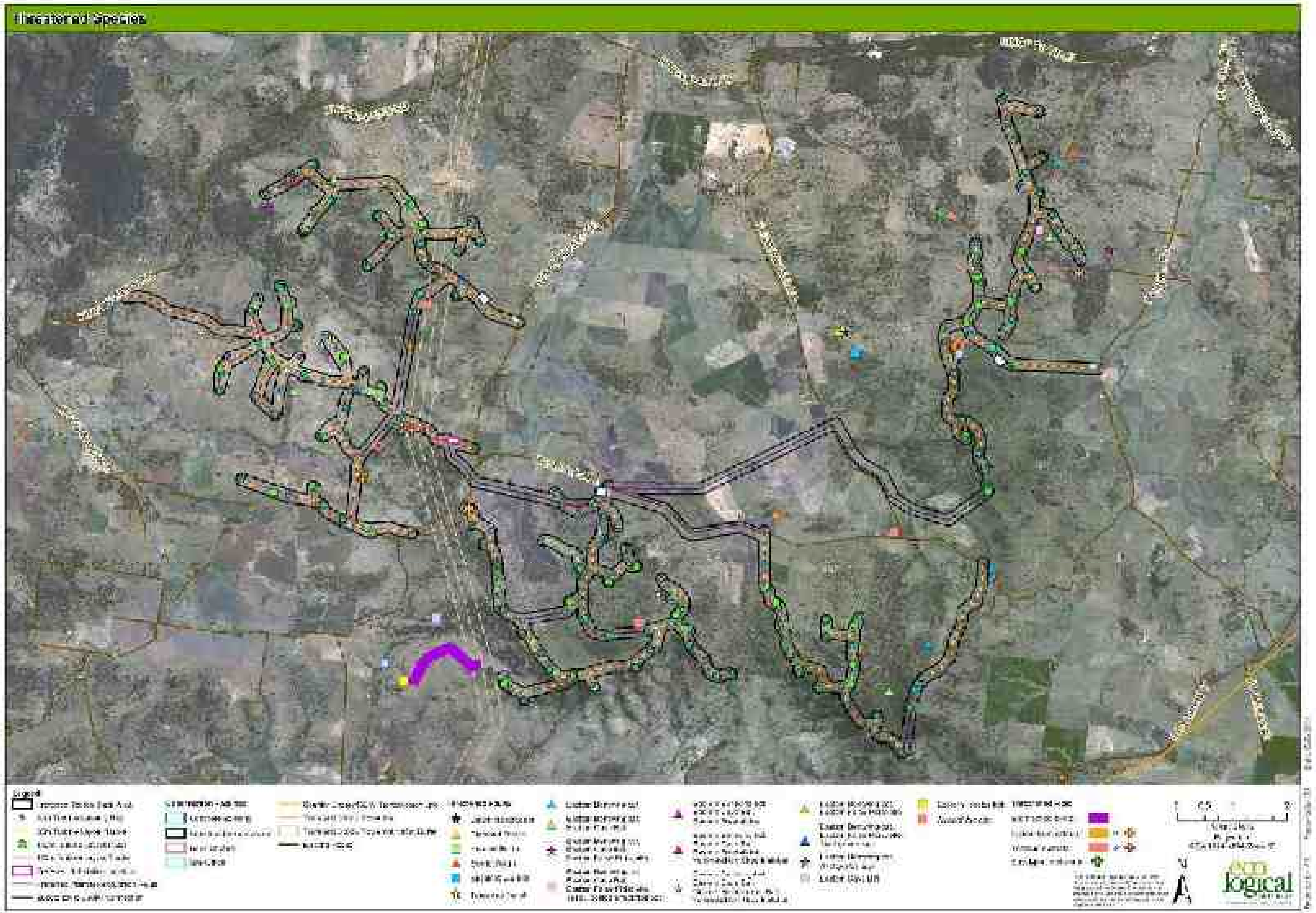


Figure 9: Threatened species records

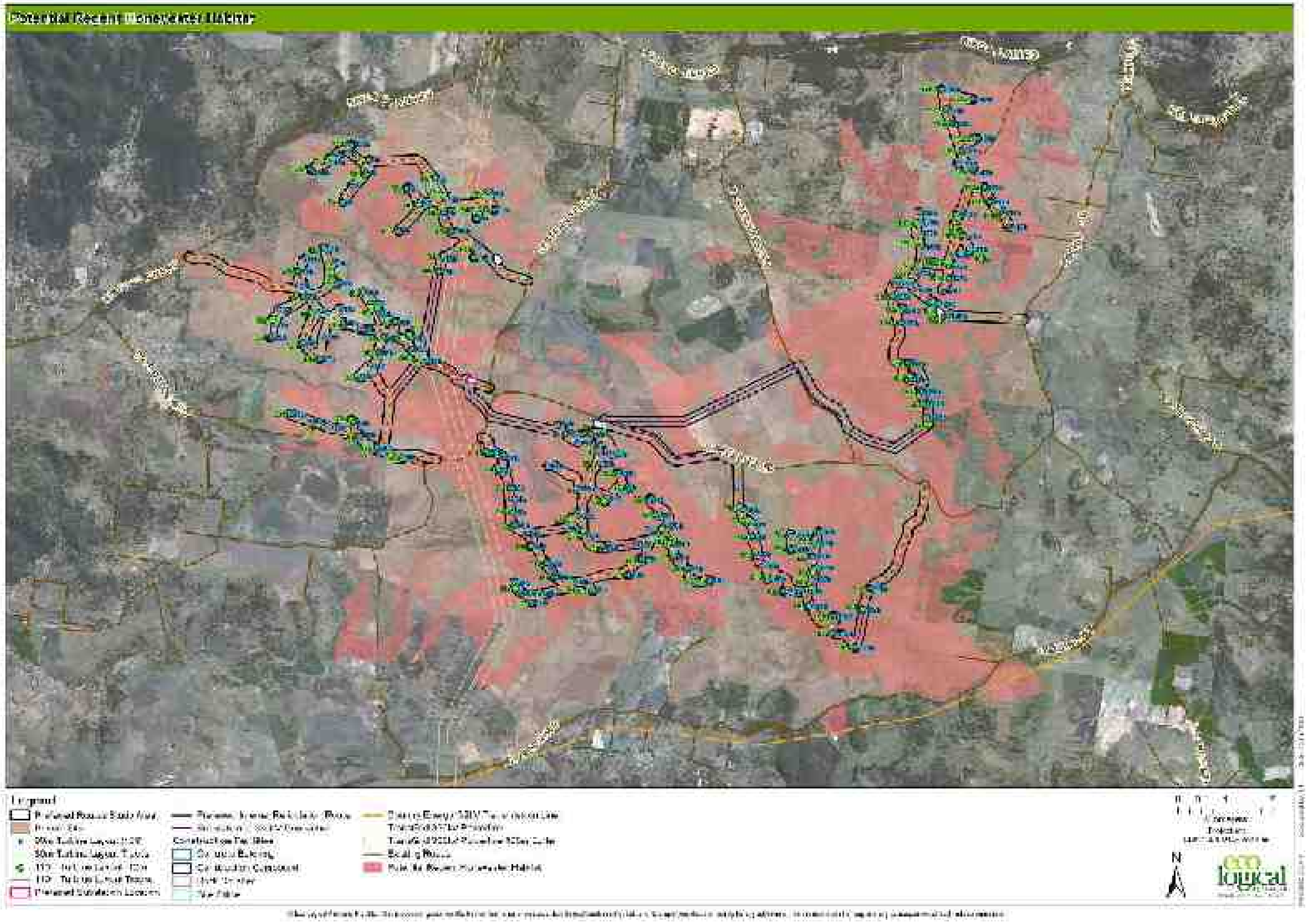


Figure 10: Regent Honeyeater Habitat

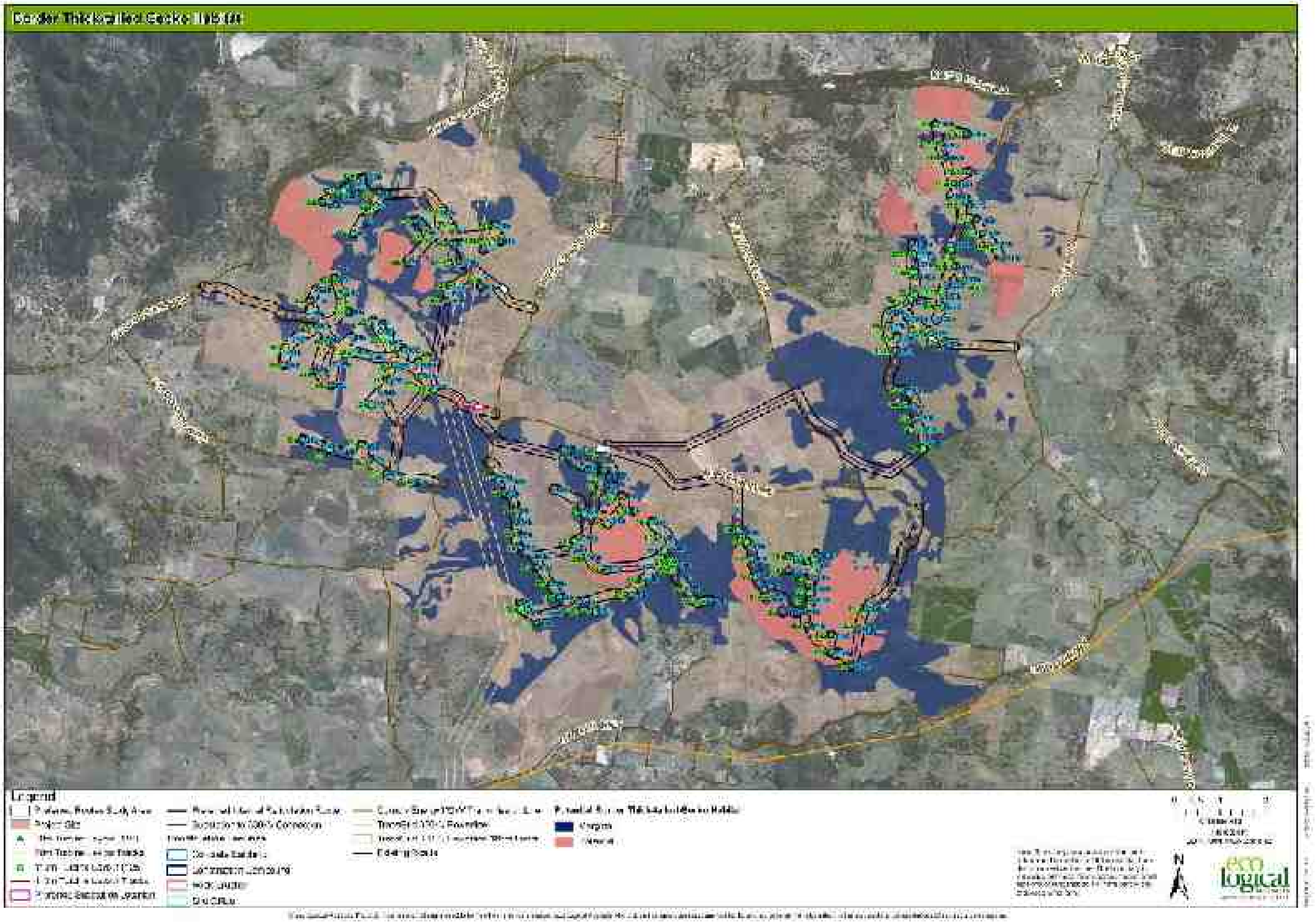


Figure 11: Border Thick-tailed Gecko Habitat

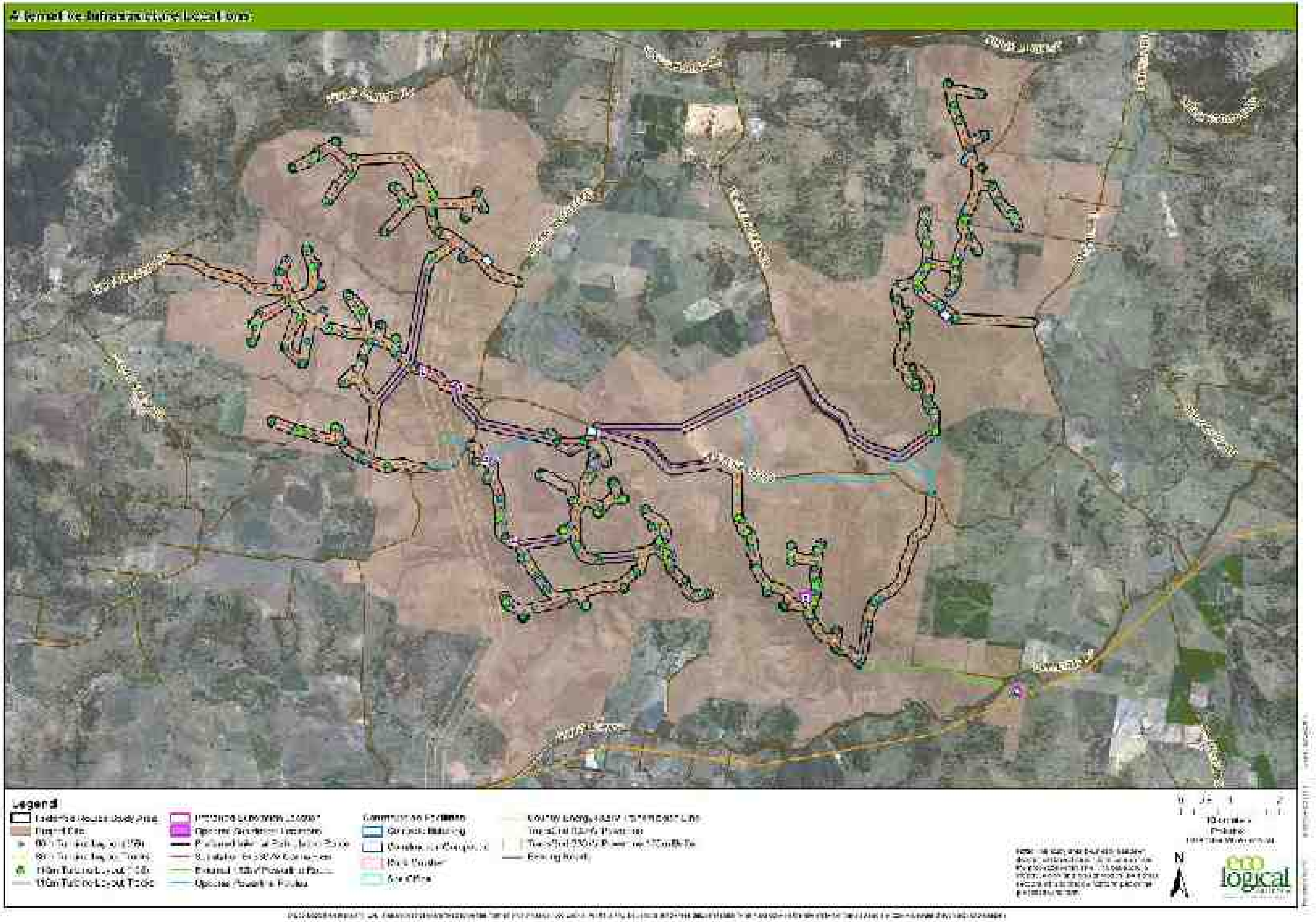


Figure 12: Alternative Infrastructure Locations

Figure 13: Potential Offset

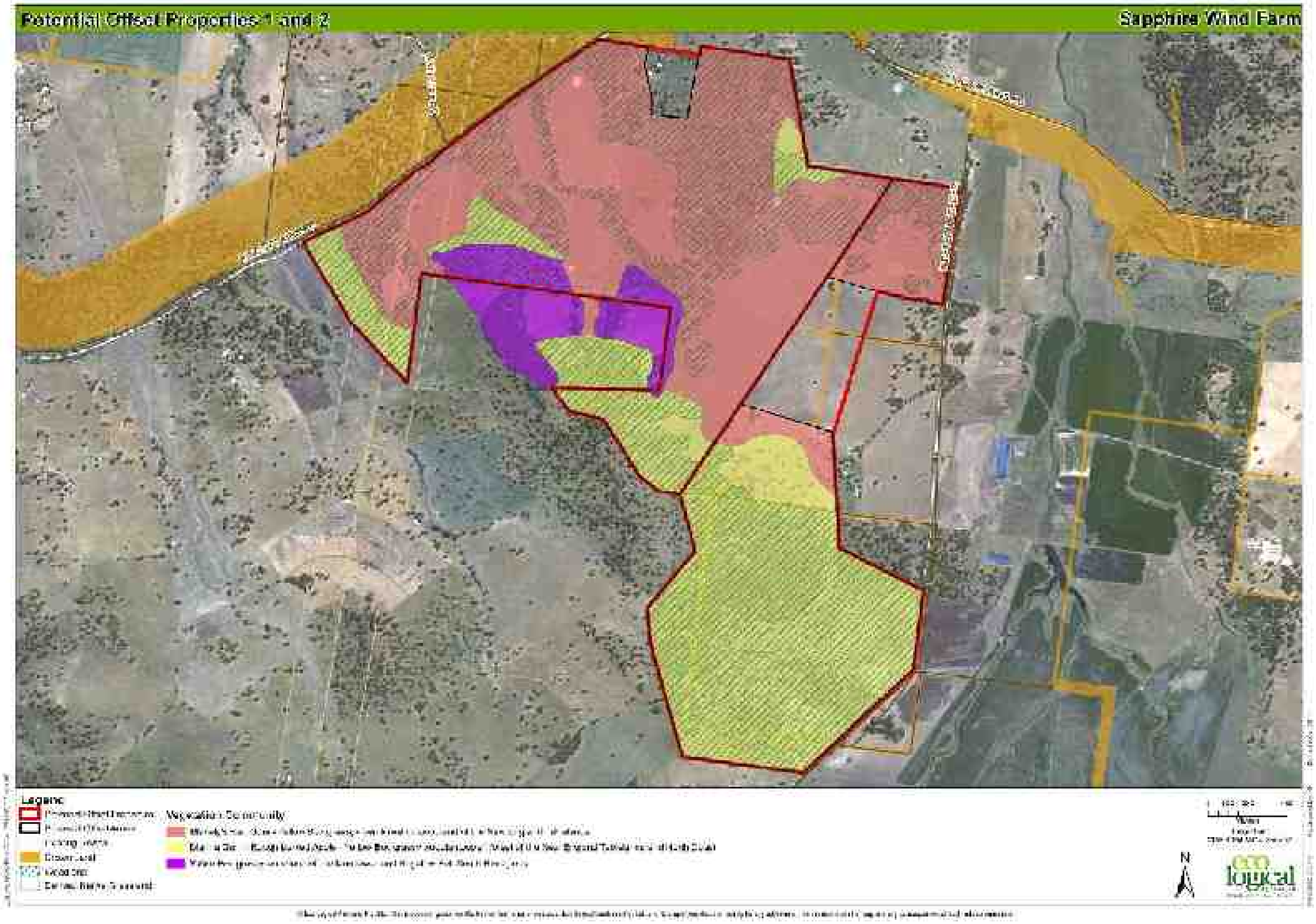


Figure 14: Offset Properties 1 & 2

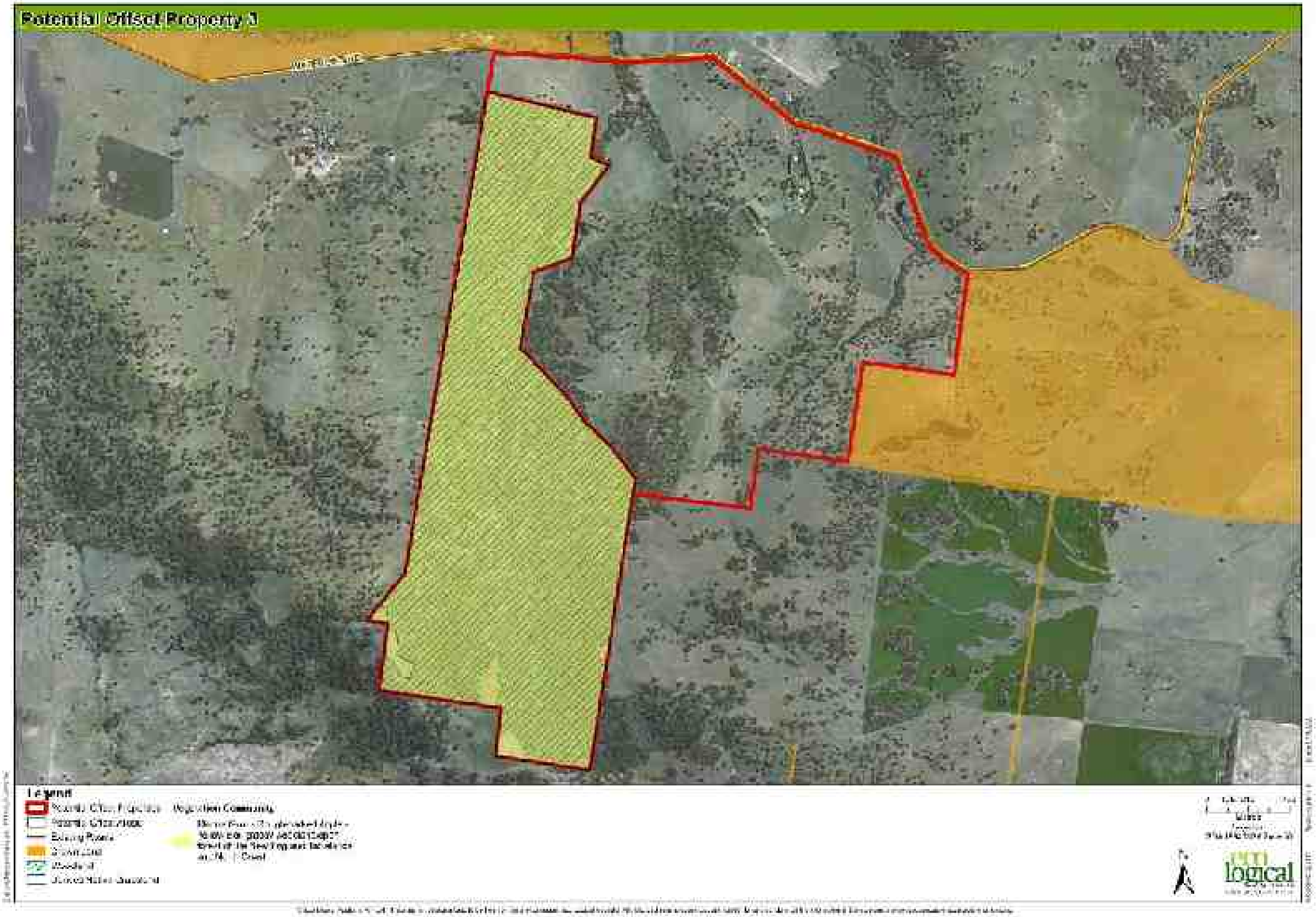


Figure 15: Offset Property 3

Appendix B: Director-General's Requirements

SUBJECT OF IMPACT	REQUIREMENTS	EA REFERENCE
Department of Planning		
General requirements	Supporting maps/plans clearly identifying existing environmental features (e.g. vegetation), and the location/siting of the project (including associated infrastructure) in the context of this existing environment	Appendix A
	Consideration of any relevant statutory provisions including the consistency of the project with the objects of the *Environmental Planning and Assessment Act 1979*	Chapter 3
	Assessment of the key issues outlined below, during construction, operation and decommissioning (as relevant). The proposal should assess the worst case and representative impact for all key issues and also consider cumulative impacts	Chapter 5
	A draft Statement of Commitments detailing measures for environmental mitigation, management, offset and monitoring for the project	Table 17, Chapter 6
Key Assessment Requirements – Flora and Fauna	Include an assessment of all project components on flora and fauna and their habitat consistent with the *Draft Guidelines for Threatened Species Assessment* (DEC 2005) including demonstrating how the project design has avoided impacts where possible and clearly identifying the existing condition and extent of vegetation and habitat on site	Chapter 4, Chapter 5
	Specifically consider impacts to: threatened species and communities listed under both State and Commonwealth legislation that have been recorded on the site and surrounding land; native vegetation (including fragmentation impacts and impacts to biodiversity corridors); and habitat types (including riparian and/or instream habitat in the case of disturbance of waterways)	Chapter 5
	Document and map each of the ecosystems (vegetations communities) that will be impacted, quantify the impacts, and assess the significance of the impact within the context of the landscape and region in which ecosystem is located, including the location, intensity and areal extent of impact;	Appendix A, Chapter 4 & 5
	Assess the impact of the project on birds and bats from blade strikes, low air pressure zones at the blade tips, and alteration to movement patterns, roost sites and nesting areas resulting from the turbines and any above ground transmission lines, including demonstration of how the project has been sited to avoid and/or minimise such impacts. If any of the bat and bird species likely to be impacted by the wind turbines are also listed species under the State and Commonwealth legislation, then the significance assessment for each of these species must consider impacts from the wind turbines as well as impacts from habitat loss;	Chapter 5, Appendix F, G, H and K
	Provide details of how flora and fauna impacts would be managed during construction and operation of all project components, including adaptive management and maintenance protocols and monitoring programs; and,	Table 17

SUBJECT OF IMPACT	REQUIREMENTS	EA REFERENCE
	Describe the measures to avoid, mitigate or offset impacts associated with the construction and operation of all project components consistent with "improve or maintain" principles. Sufficient details must be provided to demonstrate the availability of viable and achievable options to offset the impacts of the project.	Chapter 5
Department of Environment, Climate Change and Water		
Threatened species/biodiversity and native vegetation	*Demonstrate that proposal avoids impacts, mitigates and provides suitable offsets where required.*	
Ecosystems	The EA must document each of the ecosystems (using vegetation communities as a surrogate) that will be impacted	Section 5.4.1
	For each vegetation community, the significance of impact must be assessed. The intensity and areal extent of impact should be evaluated and reported against the current status of each ecosystem within the context of the landscape and region in which each respective ecosystem is located	Chapter 5, Appendix H & K
	Fragmentation and impacts of a reduction in habitat area must be quantified and assessed for those species most sensitive to these effects	Chapter 5, Appendix H & K
	The EA must investigate the use of previously cleared corridors so that biodiversity impacts are avoided wherever possible	Section 5.2
Threatened species, communities and their habitats	A field survey of the site should be conducted and documented in accordance with these guidelines	Chapter 4
	Likely impacts on threatened species and their habitat need to be assessed, evaluated and reported on. The assessment should specifically report on the considerations listed in Step 3 of the draft guideline	Chapter 5
	The EA must describe the actions that will be taken to avoid of mitigate impacts of compensate to prevent unavoidable impacts of the project on threatened species and their habitat. This should include and assessment of the effectiveness and reliability of the measures and any residual impacts after these measures are implemented.	Chapter 5 & 6
	Step 4 of the draft guidelines requires that where measures to avoid or mitigate are not possible, offset strategies need to be considered. Unavoidable residual impacts must be countered by biodiversity offsets that are secure in the long term so that a "maintain or improve" outcome is achieved. The opportunities, and the costs and benefits of offsetting should be evaluated and an offsetting strategy outlined. The Office of Environment and Heritage (formerly DECCW) has developed/is currently developing tools and methodologies (available on the website) that provide a consistent approach to evaluating suitable offsets.	Chapter 5 & 6
	The EA needs to clearly state whether it meets each of the key thresholds set out in Step 5 of the draft guideline.	Chapter 5 & 6
Department of Primary Industries		
Weed and pest management	The management of weeds and pests in a rural landscape is important in order to avoid future land use conflicts and ensure that the area affected by the development doesn't become a point source for introduced weeds and a harbour for pests	Table 17

<table>
<tr><th>SUBJECT OF IMPACT</th><th>REQUIREMENTS</th><th>EA REFERENCE</th></tr>
<tr><td colspan="3">Department of Sustainability, Environment, Water, Population and Communities</td></tr>
<tr><td>Description of relevant impacts</td><td>An assessment of all relevant impacts with reference to the EPBC Act Policy Statement 1.1 Significant Impact Guidelines Matters of National Environmental Significance (2009) that the controlled action has, will have or is likely to have on relevant migratory and threatened species and / or ecological communities listed under sections 18, 18A, 20 and 20A of the EPBC Act, including:
• White Box – Yellow Box – Blakely’s Red Gum Grassy Woodland and Derived Grassland (Box-Gum Woodland)
• Regent Honeyeater
• Swift Parrot
• South-eastern Long-eared Bat
• Large-eared Pied Bat
• Spot-tailed Quoll
• Border Thick-tailed Gecko
• Dichanthium setosum
• Thesium australe
• Astrotricha roddii
• Digitaria porrecta
• Diuris pedunculata
• Picris evae
• Rutidosis hetergama</td><td>Appendix K</td></tr>
<tr><td></td><td>Information must include:
• Justification of the likelihood of occurrence within the proposed development envelope for each relevant threatened species and ecological communities.</td><td>Section 4.3, Appendix C</td></tr>
<tr><td></td><td>• A description and analysis of significance of the potential inter alia, direct, indirect, cumulative and facilitative impacts, both in the short and long term, of the action to each relevant species and ecological community, including, but not limited to:
o Disruption to breeding, foraging or other key lifecycle stages
o Habitat loss and fragmentation
o Aviation lighting
o Turbine collisions (i.e. blade strike) and barotraumas (i.e. low pressure zones around the blades)
o Alienation (i.e. behavioural avoidance of species to habitat near turbines)</td><td>Section 5.4 - 5.10, Appendix H, Appendix K</td></tr>
<tr><td></td><td>Relevant technical data or other information, within the context of the proposed development site and region, for example:
• The area of occupancy
• The availability and condition of potential foraging, roosting, sheltering and breeding habitat for the species
• The relative activity levels and areas of importance (eg. roost sites) of threatened birds and bats
• The abiotic (non-living) factors which may be necessary for the survival and functioning of the community, for example ground or surface water</td><td>Section 4.3, Appendix G & E, Section 5.5.1 & Section 5.5.2</td></tr>
</table>

SUBJECT OF IMPACT	REQUIREMENTS	EA REFERENCE
	levels, soils and nutrients • A map showing the hydrology and topography within the development envelope	Included in the Riparian Assessment Report
	A statement as to whether any relevant impacts are likely to be unknown, unpredictable or irreversible.	Section 5.5, 5.7
	Where there is potential habitat for EPBC Act listed species, surveys should be undertaken, or justification why surveys were not necessary. Any surveys must be time appropriately and undertaken for a suitable period of time by a qualified person.	Section 4.2
Proposed safeguards and mitigation measures	A description of feasible mitigation measures, changes to the controlled action or procedures, which have been proposed by the proponent or suggested in public submissions, and which are intended to prevent or minimise relevant impacts. Information must include:	Section 5.3, Table 17
	• A consolidated list of mitigation measures proposed to be undertaken to prevent, minimise or compensate for the relevant impacts of the action • A description and assessment of the expected or predicted effectiveness of the mitigation measures • Any statutory or policy basis for the mitigation measures • The cost of the mitigation measures • An outline of an EMP that sets out the framework for continuing management, mitigation and monitoring programs for the relevant impacts of the action, including any provisions for independent environmental auditing • The name of the agency responsible for endorsing or approving each mitigation measure or monitoring program	Section 5.3, Table 17 Appendix L Section 5.3
Offsets	Should any residual impact exist that cannot be mitigated it may be necessary for offset measures to be considered in order to ensure the protection of matters of NES in perpetuity. Information required includes: • A description of the proposed offset measure/s, such as, how, when and where the offset will be delivered and managed • Detail of how the offset/s compensate for the impact on each relevant matter of NES resulting from the action • A description of how the offset/s will ensure the protection, conservation and management of the relevant matter of NES, in perpetuity • Description of how the offset/s are consistent with relevant Commonwealth policies or advice on offsets under the EPBC Act • The cost (financial and other) of the offsets	Chapter 6
Department of Water and Energy		
Riparian corridors	Although Part 3A Major Projects are exempt from requiring a controlled activity approval (s91 of WMA), the assessment is required to take into account the objectives and provisions of	Riparian Assessment

SUBJECT OF IMPACT	REQUIREMENTS	EA REFERENCE
	relevant legislation and guidelines	
Erosion and sediment control	Measures taken to prevent or minimise adverse impacts on water quality and aquatic habitat with particular focus on erosion and sediment control (an Erosion and Sediment Control Plan should be included in the EA)	Table 17
Glen Innes Severn Council		
Weeds	Measures to be undertaken to reduce the spread of both noxious and environmental weeds	Table 17
Inverell Shire Council		
Noxious Weeds	A detailed Noxious Weeds Management Plan indicating how noxious weeds are to be controlled before, during and after construction.	Table 17

Appendix C: Threatened Species Likelihood of Occurrence

Table 32: Threatened flora likelihood of occurrence

Species	TSC Act	EPBC Act	Habitat Requirements	Likelihood of Occurrence	Requires Survey under Biobanking Methodology	Predicted by EPBC Reporting Tool
Acacia pubifolia Velvet Wattle	E	V	Velvet Wattle occurs in NSW and Qld. In NSW it is known from two main populations, one north of Emmaville and the other near Warrabah National Park. Velvet Wattle generally grows in dry shrubby woodland on granite and metasediment soils. Flowers September. Emmaville and Torrington areas, and near Kingstown; rare. Grows in dry sclerophyll forest on granite. Related to A. pycnostachya which has larger and decurrent phyllodes. May be confused with A. *binervia* which has ± appressed hairs on the phyllodes.	Potential	x	√

Species	TSC Act	EPBC Act	Habitat Requirements	Likelihood of Occurrence	Requires Survey under Biobanking Methodology	Predicted by EPBC Reporting Tool
Astrotricha roddii Rod's Star Hair	E	E	Flowers Oct–Feb. Grows in low dry sclerophyll woodland on granite and porphyry outcrops in the Ashford area; rare. NSW subdivisions: NT, NWS. Other Australian states: Qld. The dull purplish flowers grow on stems up to 40 cm long, and appear during October-February. Rod's Star Hair is thought to be only short-lived, with a life-span of possibly less than 10 years. Occurs in NSW in the Ashford area north of Inverell, including Kwiambal and Kings Plains National Parks, Severn River Nature Reserve and Severn River State Forest, and has also been recorded at one site in southern Queensland. Rod's Star Hair usually grows in low dry woodland and shrublands on granite and acid volcanic outcrops, often in rock crevices.	Potential	x	√
Boronia granitica Granite Boronia	V	E	Bright pink flowers 6 - 10 mm long appear from July to October. Granite Boronia occurs in scattered localities on the New England Tablelands and North West Slopes north from the Armidale area to the Stanthorpe district in southern Queensland. Grows on granitic soils amongst rock outcrops, often in rock crevices, and in forests and woodlands on granite scree and shallow soils. At Severn River it grows on deep red soils.	Unlikely	x	√
Bothriochloa biloba Lobed Blue-grass	-	V	Grows in woodland on poorer soils (Harden 1994). Flowers in summer. NSW subdivisions: NC, CC, NT, NWS, CWS, NWP, SWP. Other Australian states: Qld. No longer listed as vulnerable on NSW TSC Act.	Yes	x	√

Species	TSC Act	EPBC Act	Habitat Requirements	Likelihood of Occurrence	Requires Survey under Biobanking Methodology	Predicted by EPBC Reporting Tool
Callistemon pungens	-	V	Flowers in summer. Grows in or near rocky watercourses, usually in sandy creek beds on granite or sometimes on basalt; from near Inverell to the eastern escarpment at New England N.P. NSW subdivisions: NT, NWS. Other Australian states: Qld.	Unlikely	x	√
Dichanthium setosum Bluegrass	V	V	Bluegrass occurs on the New England Tablelands, North West Slopes and Plains and the Central Western Slopes of NSW. Associated with heavy basaltic black soils. Often found in moderately disturbed areas such as cleared woodland, grassy roadside remnants and highly disturbed pasture (DECCW 2011b). It occurs widely on private property, including in the Inverell, Guyra, Armidale and Glen Innes areas. Flowering time is mostly in summer. Locally common or found as scattered clumps in populations.	Yes	√	√
Digitaria porrecta Finger Panic Grass	E	E	Native grassland, woodlands or open forest with a grassy understorey, on richer soils (DECCW 2011b). Often found along roadsides and travelling stock routes where there is light grazing and occasional fire (DECCW 2011b).	Potential	x	√

Species	TSC Act	EPBC Act	Habitat Requirements	Likelihood of Occurrence	Requires Survey under Biobanking Methodology	Predicted by EPBC Reporting Tool
Diuris pedunculata Small Snake Orchid	E	E	Flowers Aug.–October. Grows in moist grassy areas in sclerophyll forest; chiefly from Port Jackson to Tenterfield. NSW subdivisions: NC, NT, ST, CWS, SWS, SWP. Other Australian states: Qld. It was originally found scattered from Tenterfield south to the Hawkesbury River, but is now mainly found on the New England Tablelands, around Armidale, Uralla, Guyra and Ebor. The Small Snake Orchid grows on grassy slopes or flats. Often on peaty soils in moist areas. Also on shale and trap soils, on fine granite, and among boulders.	Potential	√	√
Eucalyptus mckieana McKie's Stringybark	V	V	Confined to the drier western side of the New England Tablelands of NSW, from Torrington to Bendemeer. *Eucalyptus mckieana* is found in grassy open forest or woodland on poor sandy loams, most commonly on gently sloping or flat sites. Resprouts from epicormic buds after fire. The species is remarkable for its very narrow and numerous sucker leaves, the narrowest of all the stringybarks and which persist to a height of 2 to 4 metres.	Yes	√	√
Eucalyptus nicholii Narrow-leaved Black Peppermint	V	V	Grows in dry grassy woodland, on shallow and infertile soils, mainly on granite (DECCW 2011b). This species is widely planted as an urban street tree and in gardens but is quite rare in the wild (DECCW 2011a). It is confined to the New England Tablelands of NSW, where it occurs from Nundle to north of Tenterfield (DECCW 2011b).	Potential	√	√

Species	TSC Act	EPBC Act	Habitat Requirements	Likelihood of Occurrence	Requires Survey under Biobanking Methodology	Predicted by EPBC Reporting Tool
Lepidium peregrinum Wandering Pepper-cress	E	E	Thought to be extinct until recently rediscovered in NSW and Queensland. Targeted searches conducted in 2001 confirmed the species occurs in scattered refugia in north-eastern NSW (near Tenterfield) and south-eastern Queensland. This species flowers from January to April. The largest population of Wandering Pepper Cress occurs in an open riparian forest on the banks of the Tenterfield creek at Clifton. Sandy alluvium is the main soil type at the site. Associated species at the Clifton site are dominated by *Eucalyptus camaldulensis* and *Casuarina cunninghamiana*, with a variably dense shrubby understorey of *Hymenanthera dentata, Bursaria spinosa, Acacia fimbriata, Acacia floribunda, Callistemon viminalis* and *Leptospermum brachyandrum*. *Lepidium peregrinum* was most abundant in the tussock grassland fringe of the riparian open forest, comprising *Poa* species, *Lomandra longifolia* and *Paspalum dilatatum* (DECCW 2011b).	Unlikely	x	√
Micromyrtus grandis Severn River Heath-myrtle	E	E	Severn River Heath-myrtle grows in heath and low woodland in crevices of acid volcanic rocky outcrops and in the shallow soil of surrounding areas, at altitudes of 600 to 750 m. It occurs in open and exposed sites. Restricted to Severn River Nature Reserve and an adjacent property, about 60km north-west of Glen Innes on the New England Tablelands. (DECCW 2011b)	Unlikely	x	

Species	TSC Act	EPBC Act	Habitat Requirements	Likelihood of Occurrence	Requires Survey under Biobanking Methodology	Predicted by EPBC Reporting Tool
Picris evae Hawkweed	V	V	Known in NSW north from the Inverell area, in the north-western slopes and plains regions. All recent collections appear to come from modified habitats such as weedy roadside vegetation. Its main habitat is open *Eucalyptus* forest and *Dichanthium* grassland, roadsides and cultivated areas (paddocks). Soils are black, dark grey or red-brown (specified as shallow, stony soil over basalt for one collection) and reddish clay-loam or medium clay soils.	Potential	√	√
Polygala linariifolia Native Milkwort	E	-	Flowers from spring to summer. Native Milkwort is an annual or perennial herb about 20 cm high with a woody tap root and more-or-less upright branches. North from Copeton Dam and the Warialda area to southern Queensland. Also found on the NSW north coast near Casino and Kyogle and in Western Australia. Occurs in sandy soils in dry eucalypt forest and woodland with a sparse understorey. The species has been recorded from the Inverell and Torrington districts growing in dark sandy loam on granite in shrubby forest of *Eucalyptus caleyi*, *Eucalyptus dealbata* and *Callitris*, and in yellow podsolic soil on granite in layered open forest.	Unlikely	√	x

Species	TSC Act	EPBC Act	Habitat Requirements	Likelihood of Occurrence	Requires Survey under Biobanking Methodology	Predicted by EPBC Reporting Tool
Rutidosis heterogama Heath Wrinklewort	V	V	A small perennial herb up to 30cm. The flowers are yellow and up to 2 cm wide and flowering time is chiefly in Autumn (Harden 1992). Scattered coastal locations between Wyong and Evans Head, and on the New England Tablelands from Torrington and Ashford south to Wandsworth southwest of Glen Innes. Grows in heath on sandy soils and moist areas in open forest, and has been recorded along disturbed roadsides (DECCW 2011b).	Unlikely	x	√
Thesium australe Austral Toadflax	V	V	Occurs in grassland or grassy woodland. Often found in damp sites in association with Kangaroo Grass (Themeda australis) (DECC 2007). Flowers in spring–summer. Widespread but rare. NSW subdivisions: NC, CC, SC, NT, ST, NWS, CWS. Other Australian states: Qld, Tas.	Yes	√	√
Tylophora linearis	V	E	Grows in dry scrub and open forest. Recorded from low-altitude sedimentary flats in dry woodlands of *Eucalyptus fibrosa, Eucalyptus sideroxylon, Eucalyptus albens, Callitris endlicheri, Callitris glaucophylla* and *Allocasuarina luehmannii.* Also grows in association with *Acacia hakeoides, Acacia lineata, Melaleuca uncinata, Myoporum* species and *Casuarina* species. Flowers in spring, with flowers recorded in November or May with fruiting probably 2 to 3 months later (DECCW 2011b).	Unlikely	x	√

Species	TSC Act	EPBC Act	Habitat Requirements	Likelihood of Occurrence	Requires Survey under Biobanking Methodology	Predicted by EPBC Reporting Tool
Zieria ingramii Keith's Zieria	-	E	Flowers in spring. Grows in dry sclerophyll forest on light sandy soils. NSW subdivisions: CWS. Known only from Goonoo Goonoo State Forest, about 40 km north-east of Dubbo. Mostly from gentle slopes in red-brown and yellow-brown sandy loams, often with a rocky surface.	Unlikely	x	√

Table 33: Threatened fauna likelihood of occurrence

Species	TSC Act	EPBC Act	Habitat Requirements	Likelihood of Occurrence	Requires Survey under Biobanking Methodology	Predicted by EPBC Reporting Tool
FISH						
Murray Cod *Muccullochella peelii peelii*	-	E	Widespread throughout the Murray-Darling system originally being found in virtually all waterways of that system. Habitat varies greatly, from quite small clear, rocky, upland streams with riffle and pool structure on the upper western slopes of the Great Dividing Range to large, meandering, slow-flowing, often silty rivers in the alluvial lowland reaches of the Murray-Darling Basin. Prefer deep holes with cover in the form of large rocks, fallen trees, stumps, clay banks and overhanging vegetation.	Unlikely	x	√

Species	TSC Act	EPBC Act	Habitat Requirements	Likelihood of Occurrence	Requires Survey under Biobanking Methodology	Predicted by EPBC Reporting Tool
FROGS						
Booroolong Frog *Litoria booroolongensis*	E	E	The Booroolong Frog is restricted to NSW and north-eastern Victoria, predominantly along the western-flowing streams of the Great Dividing Range. It has disappeared from the Northern Tablelands and is now rare throughout most of the remainder of its range. Most recent records are from the south-west slopes of NSW. Live along permanent streams with some fringing vegetation cover such as ferns, sedges or grasses. Adults occur on or near cobble banks and other rock structures within stream margins. Shelter under rocks or amongst vegetation near the ground on the stream edge. Sometimes bask in the sun on exposed rocks near flowing water during summer. Breeding occurs in spring and early summer and tadpoles metamorphose in late summer to early autumn. Eggs are laid in submerged rock crevices and tadpoles grow in slow-flowing connected or isolated pools.	Unlikely	√	√
Yellow Spotted Tree Frog *Litoria castanea*	E	E	Ponds, wetlands and slowly moving streams with abundant marginal growth of bulrushes and other vegetation (DECCW 2011b). The southern population has been noted to occur in both woodland and improved pastoral areas (DECCW 2011b). The species has not been recorded in the wild since the 1970s.	Unlikely	x	√

Species	TSC Act	EPBC Act	Habitat Requirements	Likelihood of Occurrence	Requires Survey under Biobanking Methodology	Predicted by EPBC Reporting Tool
REPTILES						
Delma torquata Collared Delma	-	V	In general, the species occurs on rocky hillsides on basalt and lateritic soils supporting open eucalypt and *Acacia* woodland with a sparse understorey of shrubs and tussocks or semi-evergreen vine thicket. The holotype was collected on a small grassy hill with few trees which was grazed by cattle (Low in Kluge 1974). The population at Mount Crosby occurs in an area with many small, scattered loose rocks and some exposed bedrock. The vegetation consists of open, dry eucalypt woodland with an understorey of native and introduced grasses and some open shrubby species. The substrate is covered by 5 - 20 mm of dry leaf litter (Porter 1998). Specimens are usually found beneath rocks, logs and mats of leaf litter. At Mount Crosby, lizards showed a preference for rocks larger than the mean rock size available (preferred mean 172 cm) and vegetation cover lower than that available (preferred mean 31%). Pitfall trapping captured lizards in vegetation some distance from rocky outcrops, suggesting the species is not totally reliant on rocky habitat (Porter 1998).	Unlikely – there are no records of this species on the Inverell and Glen Innes (1:100,000) map sheets DECCW (2011a) database records.	x	√

Species	TSC Act	EPBC Act	Habitat Requirements	Likelihood of Occurrence	Requires Survey under Biobanking Methodology	Predicted by EPBC Reporting Tool
Bell's Turtle *Elseya belli*	V	V	Found only in the upper reaches of the Namoi, Gwydir and MacDonald Rivers on the North West Slopes of NSW. Shallow to deep pools in upper reaches or small tributaries of major rivers in granite country. Usually found in narrow stretches of river 30 - 40 m wide, running through grazing land	Unlikely	x	√
Border Thick-tailed Gecko *Underwoodisaurus sphyrurus*	V	V	Found only on the tablelands and slopes of northern NSW and southern Queensland, reaching south to Tamworth and west to Moree (DECCW 2011b). Most common in the granite country of the New England Tablelands (DECCW 2011b). Rocky hills with dry open eucalypt forest or woodland (DECCW 2011b). Favours forest and woodland areas with boulders, rock slabs, fallen timber and deep leaf litter (DECCW 2011b).	Potential	√	√
Pale-headed Snake *Hoplocephalus bitorquatus*			Found mainly in dry eucalypt forests and woodlands, cypress woodland and occasionally in rainforest or moist eucalypt forest. Favours streamside areas, particularly in drier habitats. Shelter during the day between loose bark and tree-trunks, or in hollow trunks and limbs of dead trees.	Unlikely	√	x

Species	TSC Act	EPBC Act	Habitat Requirements	Likelihood of Occurrence	Requires Survey under Biobanking Methodology	Predicted by EPBC Reporting Tool
BIRDS						
Black-throated Finch (southern subspecies) *Poephila cincta cincta*	E	E	A small stocky bird with a distinctive black throat that forms a large bib. Once found from southern Cape York in Queensland to the Inverell district in northern NSW. It is now very rare in NSW. *Eucalypt* woodland and riverside vegetation, including paperbark and wattle shrubland. Areas close to water with a dense understorey of seeding grass and shrubs are favoured.	Unlikely	√	√

Species	TSC Act	EPBC Act	Habitat Requirements	Likelihood of Occurrence	Requires Survey under Biobanking Methodology	Predicted by EPBC Reporting Tool
Brown Treecreeper *Climacteris picumnus victoriae*	V	-	Found in eucalypt woodlands (including Box Gum Woodland) and dry open forest of the inland slopes and plains inland of the Great Dividing Range; mainly inhabits woodlands dominated by stringybarks or other rough-barked eucalypts, usually with an open grassy understorey, sometimes with one or more shrub species; also found in mallee and River Red Gum (*Eucalyptus camaldulensis*) Forest bordering wetlands with an open understorey of acacias, saltbush, lignum, cumbungi and grasses; usually not found in woodlands with a dense shrub layer; fallen timber is an important habitat component for foraging; also recorded, though less commonly, in similar woodland habitats on the coastal ranges and plains. Hollows in standing dead or live trees and tree stumps are essential for nesting. The species breeds in pairs or co-operatively in territories which range in size from 1.1 to 10.7 ha (mean = 4.4 ha). Each group is composed of a breeding pair with retained male offspring and, rarely, retained female offspring. Often in pairs or cooperatively breeding groups of two to five birds (DECCW 2011b).	Yes	x	x

Species	TSC Act	EPBC Act	Habitat Requirements	Likelihood of Occurrence	Requires Survey under Biobanking Methodology	Predicted by EPBC Reporting Tool
Diamond Firetail *Stagonopleura guttata*	V	-	Found in grassy eucalypt woodlands, including Box Gum Woodlands and Snow Gum *Eucalyptus pauciflora* Woodlands. Also occurs in open forest, mallee, Natural Temperate Grassland, and in secondary grassland derived from other communities. Often found in riparian areas (rivers and creeks), and sometimes in lightly wooded farmland. Feeds exclusively on the ground, on ripe and partly-ripe grass and herb seeds and green leaves, and on insects (especially in the breeding season). Groups separate into small colonies to breed, between August and January. Nests are globular structures built either in the shrubby understorey, or higher up, especially under hawk's or raven's nests. Birds roost in dense shrubs or in smaller nests built especially for roosting. Appears to be sedentary, though some populations move locally, especially those in the south (DECCW 2011b).	Yes	x	x

Species	TSC Act	EPBC Act	Habitat Requirements	Likelihood of Occurrence	Requires Survey under Biobanking Methodology	Predicted by EPBC Reporting Tool
Glossy black-Cockatoo *Calyptorhynchus lathami*	V	-	The species is uncommon although widespread throughout suitable forest and woodland habitats. Inhabits open forest and woodlands of the coast and the Great Dividing Range up to 1000 m in which stands of she-oak species, particularly Black She-oak (*Allocasuarina littoralis*), Forest She-oak (*A. torulosa*) or Drooping She-oak (*A. verticillata*) occur. Nests in large trees with large hollows (DECCW 2011b).	Unlikely	x	x
Hooded Robin (southeastern subspecies) *Melanodryas cucullata cucullata*	V	-	Associated with a wide range of Eucalypt woodlands, Acacia shrubland and open forests (Blakers et al. 1984). In temperate woodlands, the species favours open areas adjoining large woodland blocks, with areas of dead timber and sparse shrub cover. Hooded Robin home ranges are relatively large, averaging 18ha for birds from the New England Tableland (DECCW 2011b).	Yes	x	x
Little Eagle *Hieraaetus morphnoides*	V	-	The Little Eagle is widespread in mainland Australia, central and eastern New Guinea. The Little Eagle is seen over woodland and forested. The population of Little Eagle in NSW is considered to be a single population (DECCW 2010). This species was recently listed as vulnerable due to a moderate reduction in population size based on geographic distribution and habitat quality lands and open country, extending into the arid zone. It tends to avoid rainforest and heavy forest.	Potential	√	X

Species	TSC Act	EPBC Act	Habitat Requirements	Likelihood of Occurrence	Requires Survey under Biobanking Methodology	Predicted by EPBC Reporting Tool
Little Lorikeet *Glossopsitta pusilla*	V	-	In New South Wales Little Lorikeets are distributed in forests and woodlands from the coast to the western slopes of the Great Dividing Range, extending westwards to the vicinity of Albury, Parkes, Dubbo and Narrabri. Little Lorikeets mostly occur in dry, open eucalypt forests and woodlands. They have been recorded from both old-growth and logged forests in the eastern part of their range, and in remnant woodland patches and roadside vegetation on the western slopes. They feed primarily on nectar and pollen in the tree canopy, particularly on profusely-flowering eucalypts, but also on a variety of other species including melaleucas and mistletoes. On the western slopes and tablelands White Box Eucalyptus albens and Yellow Box E. melliodora are particularly important food sources for pollen and nectar respectively (DECCW 2011b).	Yes	x	X
Painted Snipe (Australian subspecies) *Rostratula benghalensis australis*	E	E M	Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber (DECCW 2011b). Nests on the ground amongst tall vegetation, such as grasses, tussocks or reeds (*ibid.*). Breeding is often in response to local conditions; generally occurs from September to December (DECCW 2011b). Roosts during the day in dense vegetation (DECCW 2011b). Forages nocturnally on mud-flats and in shallow water (DECC 2007). Feeds on worms, molluscs, insects and some plant-matter (*ibid.*).	Unlikely	x	√

Species	TSC Act	EPBC Act	Habitat Requirements	Likelihood of Occurrence	Requires Survey under Biobanking Methodology	Predicted by EPBC Reporting Tool
Regent Honeyeater *Anthochaera phrygia*	E	E, M	Associated with temperate eucalypt woodland and open forest including forest edges, wooded farmland and urban areas with mature eucalypts, and riparian forests of River Oak (*Casuarina cunninghamiana*) (Garnett 1993). Areas containing Swamp Mahogany (*Eucalyptus robusta*) in coastal areas have been observed to be utilised (NPWS 1997). The Regent Honeyeater primarily feeds on nectar from box and ironbark eucalypts and occasionally from banksias and mistletoes (NPWS 1995). As such it is reliant on locally abundant nectar sources with different flowering times to provide reliable supply of nectar (Environment Australia 2000).	Potential	x	√
Scarlet Robin *Petroica boodang*	V	-	The Scarlet Robin is found in south-eastern and south-western Australia, as well as on Norfolk Island. In Australia, it is found south of latitude 25°S, from south-eastern Queensland along the coast of New South Wales (and inland to western slopes of Great Dividing Range) to Victoria and Tasmania, and west to Eyre Peninsula, South Australia; it is also found in south-west Western Australia. The Scarlet Robin lives in open forests and woodlands in Australia, while it prefers rainforest habitats on Norfolk Island. During winter, it will visit more open habitats such as grasslands and will be seen in farmland and urban parks and gardens at this time.	Yes	x	x

Species	TSC Act	EPBC Act	Habitat Requirements	Likelihood of Occurrence	Requires Survey under Biobanking Methodology	Predicted by EPBC Reporting Tool
Speckled Warbler *Pyrrholaemus sagittatus*	V	-	Occupies a wide range of eucalypt dominated communities with a grassy understorey, often on rocky ridges or in gullies (DECCW 2011b). Typical habitat would include scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy (DECCW 2011b). Large, relatively undisturbed remnants are required for the species to persist in an area (DECCW 2011b). Pairs are sedentary and occupy a breeding territory of about ten hectares, with a slightly larger home-range when not breeding (DECCW 2011b).	Yes	x	X
Spotted Harrier *Circus assimilis*	V	-	The Spotted Harrier occurs throughout the Australian mainland, except in densely forested or wooded habitats of the coast, escarpment and ranges, and rarely in Tasmania. Occurs in grassy open woodland including acacia and mallee remnants, inland riparian woodland, grassland and shrub steppe. It is found most commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands (DECCW 2011b).	Potential	√	X
Square-tailed Kite *Lophoictinia isura*	V	—	In coastal areas associated tropical and temperate forests and woodlands on fertile soils with an abundance of passerine birds (Marchant & Higgins 1993, DECCW 2011b). May be recorded inland along timbered watercourses (DECCW 2011b). In NSW it is commonly associated with ridge or gully forests.	Potential	√	x

Species	TSC Act	EPBC Act	Habitat Requirements	Likelihood of Occurrence	Requires Survey under Biobanking Methodology	Predicted by EPBC Reporting Tool
Swift Parrot *Lathamus discolor*	E	E	Breeds in Tasmania between September and January. Migrates to mainland in autumn, where it forages on profuse flowering eucalypts (Blakers *et al.* 1984; Schodde and Tidemann 1986). Hence, in this region, autumn and winter flowering eucalypts are important for this species.	Potential	x	√
Turquoise Parrot *Neophema pulchella*	V	–	Steep rocky ridges and gullies, rolling hills, valleys and river flats and the plains of the Great Dividing Range compromise the topography inhabited by this species (Marchant & Higgins 1993). Spends much of the time on the ground foraging on seed and grasses (DECCW 2011b). It is associated with coastal scrubland, open forest and timbered grassland, especially low shrub ecotones between dry hardwood forests and grasslands with high proportion of native grasses and forbs (Environment Australia 2000).	Yes	x	x
Varied Sittella *Daphoensitta chrysoptera*	V	–	Varied Sitellas are endemic and widespread in mainland Australia. Varied Sitellas are found in eucalypt woodlands and forests throughout their range. They prefer rough-barked trees like stringybarks and ironbarks or mature trees with hollows or dead branches, mallee and Acacia woodland (DECCW 2011b).	Potential	x	x
MAMMALS						
Brush-tailed Rock-wallaby *Petrogale penicillata*	E	V	Rocky areas in a variety of habitats, typically north facing sites with numerous ledges, caves and crevices (Strahan 1995).	Unlikely	x	√

Species	TSC Act	EPBC Act	Habitat Requirements	Likelihood of Occurrence	Requires Survey under Biobanking Methodology	Predicted by EPBC Reporting Tool
Eastern Bentwing-bat *Miniopterus schreibersii oceanensis*	V	-	Associated with a range of habitats such as rainforest, wet and dry sclerophyll forest, monsoon forest, open woodland, paperbark forests and open grassland (Churchill 1998). It forages above and below the tree canopy on small insects (AMBS 1995, Dwyer 1995, Dwyer 1981). Will utilise caves, old mines, and stormwater channels, under bridges and occasionally buildings for shelter (Environment Australia 2000, Dwyer 1995).	Yes – identified as a probable call	x	x
Eastern Cave Bat *Vespadelus troughtoni*	V	-	Inhabit tropical mixed woodland and wet sclerophyll forest on the coast and the dividing range but extend into the drier forest of the western slopes and inland areas. Has been found roosting in sandstone overhand caves, boulder piles, mine tunnels and occasionally in buildings (Churchill 1998).	Yes – identified as possible calls	x	x
Eastern False Pipistrelle *Falsistrellus tasmeniensis*	V	-	Prefers moist habitats with trees taller than 20m (DECCW 2011b). Roosts in tree hollows but has also been found roosting in buildings or under loose bark (DECCW 2011b).	Yes- identified as possible calls	x	x

Species	TSC Act	EPBC Act	Habitat Requirements	Likelihood of Occurrence	Requires Survey under Biobanking Methodology	Predicted by EPBC Reporting Tool
Eastern Freetail-bat *Mormopterus norfolkensis*	V	-	Most records of this species are from dry eucalypt forest and woodland east of the Great Dividing Range (Churchill 1998). Individuals have, however, been recorded flying low over a rocky river in rainforest and wet sclerophyll forest and foraging in clearings at forest edges (Environment Australia 2000; Allison & Hoye 1998). Primarily roosts in hollows or behind loose bark in mature eucalypts, but have been observed roosting in the roof of a hut (Environment Australia 2000; Allison & Hoye 1998).	Yes- identified as possible calls	x	x
Greater Broad-nosed Bat *Scoteanax rueppellii*	V	-	Associated with moist gullies in mature coastal forest, or rainforest, east of the Great Dividing Range (Churchill, 1998), tending to be more frequently located in more productive forests (Hoye & Richards 1998). Within denser vegetation types use is made of natural and man-made openings such as roads, creeks and small rivers, where it hawks backwards and forwards for prey (Hoye & Richards 1998).	Yes- identified as a probable call	x	x

Species	TSC Act	EPBC Act	Habitat Requirements	Likelihood of Occurrence	Requires Survey under Biobanking Methodology	Predicted by EPBC Reporting Tool
Greater (Eastern) Long-eared Bat *Nyctophilus corbeni*	V	V	Preference for semi-arid areas, however, have been recorded in the high rainfall areas of south-western Australia (Churchill 1998). In South Australia this species has been associated with a range of mallee species, and found to the fringes of the treeless Nullarbor Plain (Duncan et al. 1999). In northern NSW, this species is thought to prefer structurally complex forest as foraging habitat, and breeding and sheltering is in tree hollows (Environment Australia 2000).	Potential	x	√
Grey-headed Flying-Fox *Pteropus poliocephalus*	V	V	Inhabits a wide range of habitats including rainforest, mangroves, paperbark forests, wet and dry sclerophyll forests and cultivated areas (Churchill 1998, Eby 1998). Camps are often located in gullies, typically close to water, in vegetation with a dense canopy (Churchill 1998).	Unlikely	√ (breeding habitat)	√
Koala *Phascolarctos cinereus*	V		Koalas inhabit eucalypt woodlands and forests. They feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species, but in any one area will select preferred browse species. They are inactive for most of the day, feeding and moving mostly at night. Home range size varies with quality of habitat, ranging from less than two ha to several hundred hectares in size. Generally solitary, but have complex social hierarchies based on a dominant male with a territory overlapping several females and sub-ordinate males on the periphery (DECCW 2011b).	Known – historical DECCW records within and around study area	x	x

Species	TSC Act	EPBC Act	Habitat Requirements	Likelihood of Occurrence	Requires Survey under Biobanking Methodology	Predicted by EPBC Reporting Tool
Large-eared Pied Bat *Chalinolobus dwyeri*	V	V	The Large-eared Pied Bat has been recorded in a variety of habitats, including dry sclerophyll forests, woodland, sub-alpine woodland, edges of rainforests and wet sclerophyll forests (Churchill 1998; DECCW 2011b). This species roosts in caves, rock overhangs and disused mine shafts and as such is usually associated with rock outcrops and cliff faces (Churchill 1998; DECCW 2011b).	Unlikely	x	√
Long-nosed Potoroo *Potorous tridactylus* (EPBC Act lists only the SE Mainland Population)	V	V	Associated with dry coastal heath and dry and wet sclerophyll forests (Strahan 1998) with dense cover for shelter and adjacent more open areas for foraging (Menkhorst & Knight 2004).	Unlikely	x	√
New Holland Mouse *Pseudomys novaehollandiae*	-	V	Recorded from Queensland to Tasmania, though with a sporadic and patchy distribution. Most records are coastal, though a population has recently been recorded up to 400km inland. The species includes heathlands, woodlands, open forest and paperbark swamps and on sandy, loamy or rocky soils. In coastal populations the species seems to have a preference for sandy substrates, a heathy understorey of legumes less than one metre high and sparse ground litter. Recolonisation of regenerating burnt areas occurs after one or two years and rehabilitated sand-mined areas after four to five years.	Unlikely	x	√

Species	TSC Act	EPBC Act	Habitat Requirements	Likelihood of Occurrence	Requires Survey under Biobanking Methodology	Predicted by EPBC Reporting Tool
Spotted-tailed Quoll *Dasyurus maculates* (EPBC Act lists only the SE Mainland Population)	V	E	The Spotted-tailed Quoll inhabits a range of forest communities including wet and dry sclerophyll forests, coastal heathlands and rainforests (Mansergh 1984; DECCW 2011b), more frequently recorded near the ecotones of closed and open forest. This species requires habitat features such as maternal den sites, an abundance of food (birds and small mammals) and large areas of relatively intact vegetation to forage in (DECCW 2011b). Maternal den sites are logs with cryptic entrances; rock outcrops; windrows; burrows (Environment Australia 2000).	Potential	x	√
Squirrel Glider *Petaurus norfolcensis*	V	-	Associated with dry hardwood forest and woodlands (Menkhorst et al. 1988; Quin 1995). Habitats typically include gum barked and high nectar producing species, including winter flower species (Menkhorst *et al.* 1988). The presence of hollow bearing eucalypts is a critical habitat value (Quin 1995).	Potential	x	x
Yellow-bellied Sheathtail-bat *Saccolaimus flaviventris*	V	-	Found in almost all habitats, from wet and dry sclerophyll forest, open woodland (Churchill 1998), open country, mallee, rainforests, heathland and waterbodies. Roosts in tree hollows; may also use caves; has also been recorded in a tree hollow in a paddock (Environment Australia 2000) and in abandoned sugar glider nests (Churchill 1998). The Yellow-bellied Sheathtail-bat is dependent on suitable hollow-bearing trees to provide roost sites, which may be a limiting factor on populations in cleared or fragmented habitats (Environment Australia 2000).	Yes- identified probable call	x	x

Species	TSC Act	EPBC Act	Habitat Requirements	Likelihood of Occurrence	Requires Survey under Biobanking Methodology	Predicted by EPBC Reporting Tool
MIGRATORY TERRESTRIAL SPECIES LISTED UNDER EPBC ACT						
Fork-tailed Swift *Apus pacificus*	-	M	This species of migratory bird breeds in the north-east and mid-east Asia and winters in Australia and southern New Guinea. It forages over open country and nests in cliffs and tall tress. Occasional mass movements occur and this species may spend nights on the wing (Pizzey and Knight 1997).	Potential	x	√
White-bellied Sea-Eagle *Haliaeetus leucogaster*	-	M	Forages over large open fresh or saline waterbodies, coastal seas and open terrestrial areas (Marchant & Higgins 1993, Simpson & Day 1999). Breeding habitat consists of tall trees, mangroves, cliffs, rocky outcrops, silts, caves and crevices and is located along the coast or major rivers. Breeding habitat is usually in or close to water, but may occur up to a kilometre away (Marchant & Higgins 1993).	Unlikely	x	√
White-throated Needletail *Hirundapus caudacutus*	-	M	Forages aerially over a variety of habitats usually over coastal and mountain areas, most likely with a preference for wooded areas (Marchant & Higgins 1993; Simpson & Day 1999). Has been observed roosting in dense foliage of canopy trees, and may seek refuge in tree hollows in inclement weather (Marchant & Higgins 1993).	Potential	x	√

Species	TSC Act	EPBC Act	Habitat Requirements	Likelihood of Occurrence	Requires Survey under Biobanking Methodology	Predicted by EPBC Reporting Tool
Rainbow Bee-eater *Merops ornatus*	-	M	Resident in coastal and subcoastal northern Australia; regular breeding migrant in southern Australia, arriving September to October, departing February to March, some occasionally present April to May (Pizzey and Doyle 1988). Occurs in open country, chiefly at suitable breeding places in areas of sandy or loamy soil: sand-ridges, riverbanks, road-cuttings, sand-pits, occasionally coastal cliffs (ibid). Nest is a chamber a the end of a burrow, up to 1.6 m long, tunnelled in flat or sloping ground, sandy back or cutting (ibid).	Likely (previously recorded in Kings Plains NP)	x	√
Satin Flycatcher *Myiagra cyanoleuca*	-	M	Associated with drier eucalypt forests, absent from rainforests (Blakers *et al.* 1984), open forests, often at height (Simpson & Day 1999).	Unlikely	x	√
Swift Parrot *Lathamus discolor*	E	E, M	SEE DIURNAL BIRDS ABOVE	Potential	x	√
Regent Honeyeater *Anthochaera phrygia*	E	E, M	SEE DIURNAL BIRDS ABOVE	Potential	x	√
MIGRATORY WETLAND SPECIES LISTED UNDER EPBC ACT						
Great Egret *Ardea alba*	—	M	The Great Egret is common and widespread in Australia (McKilligan, 2005). It forages in a wide range of wet and dry habitats including permanent and ephemeral freshwaters, wet pasture and estuarine mangroves and mudflats (McKilligan, 2005).	Potential	x	√

Species	TSC Act	EPBC Act	Habitat Requirements	Likelihood of Occurrence	Requires Survey under Biobanking Methodology	Predicted by EPBC Reporting Tool
Cattle Egret *Ardea ibis*	—	M	Cattle Egrets forage on pasture, marsh, grassy road verges, rain puddles and croplands, but not usually in the open water of streams or lakes and they avoid marine environments (McKilligan, 2005). Some individuals stay close to the natal heronry from one nesting season to the next, but the majority leave the district in autumn and return the next spring. Cattle Egrets are likely to spend the winter dispersed along the coastal plain and only a small number have been recovered west of the Great Dividing Range (McKilligan, 2005).	Potential	x	√
Latham's Snipe *Gallinago hardwickii*	—	M	A variety of permanent and ephemeral wetlands, preferring open fresh water wetlands with nearby cover (Marchant and Higgins 1993). Occupies a variety of vegetation around wetlands (Marchant and Higgins 1993) including wetland grasses and open wooded swamps (Simpson and Day 1999).	Unlikely	x	√
Painted Snipe *Rostratula benghalensis s. lat*.	—	M	Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber (DECCW 2011b). Nests on the ground amongst tall vegetation, such as grasses, tussocks or reeds (ibid.). Breeding is often in response to local conditions; generally occurs from September to December (DECCW 2011b). Roosts during the day in dense vegetation (DECCW 2011b). Forages nocturnally on mud-flats and in shallow water. Feeds on worms, molluscs, insects and some plant-matter (ibid.).	Unlikely	x	√

Appendix D: Flora Species List

Table 34: Flora recorded within and around the study area (RBVT 110, 114 & 116)

Revised Biometric Vegetation Type				110							114				116											
Scientific Name	Common Name	Legal Status	Native/ Exotic	110_BM_Plot1	110_BM_Plot2	110_BM_Plot3	110_NP_A	110_T_A	TRGMGNP1	TRGMGNP2	114 BM Plot 1	114 BM Plot 2	114 BM Plot3	114_T A	116_BM Plot 1	116 BM Plot 2	116 BM Plot 3	116_LOW	BRGYBL1	BRGYBL2	116_NP A	116_NP_B	116_NP C	BRGYBMGNP1	BRGMGNP1	116_T A
Acacia buxifolia	Box-leaved Wattle	U	N																							
Acacia deanei	Green Wattle	U	N																							
Acacia filicifolia	Fern-leaved Wattle	U	N										1				1									
Acacia implexa	Hickory Wattle	U	N			1		1				1				1										
Acacia neriifolia	Silver Wattle	U	N																							
Acacia terminalis	Sunshine Wattle	U	N			1								1												
Acacia ulicifolia	Prickly Moses	U	N								1															
Acaena agnipila		U	N																							
Acaena ovina		U	N										1	1		1									2	1
Acaena spp.		U	N																							
Aira spp.		U	E																							
Ajuga australis	Austral Bugle	U	N								1	1	1		1	1										
Alternanthera pungens	Khaki Weed	U	E																							
Alternanthera spp.		U	N																			1				
Amaranthus spp.		U	N															1								
Amyema miquelii		U	N																							1
Amyema spp.		U	N					1																		
Anagallis arvensis	Scarlet/Blue Pimpernel	U	E							1														1		
Angophora floribunda	Rough-barked Apple	U	N								1	1	1													1
Aristida leptopoda	White Speargrass	U	N																							
Aristida ramosa	Purple Wiregrass	U	N	1	1																		1			
Aristida ramosa var. *speciosa*		U	N				1				1	1														1

Revised Biometric Vegetation Type				110							114				116												
Scientific Name	Common Name	Legal Status	Native/ Exotic	110_BM_Plot1	110_BM_Plot2	110_BM_Plot3	110_NP_A	110_T_A	TRGMGNP1	TRGMGNP2	114 BM Plot 1	114 BM Plot 2	114 BM Plot3	114_T A	116_BM Plot 1	116 BM Plot 2	116 BM Plot 3	116_LOW	BRGYBL1	BRGYBL2	116_NP A	116_NP_B	116_NP C	BRGYBMGNP1	BRGMGNP1	116_T A
Aristida spp.		U	N			1		1		1			1	1	1	1	1					1				
Aristida vagans	Threeawn Speargrass	U	N									1											1			
Arthropodium minus		U	N						3																	
Arthropodium spp.		U	N	1												1	1									
Asperula conferta	Common Woodruff	U	N	2	1	1										1									3	1
Austrodanthonia caespitosa	Ringed Wallaby Grass	U	N																							
Austrodanthonia penicillata	Slender Wallaby Grass	U	N																							
Austrodanthonia racemosa		U	N														1									
Austrodanthonia spp.		U	N	1	1	1		1	1	4	1	1		1	1		1	1					1		4a	1
Austrodanthonia sp. 1 (thin)		U	N																							
Austrodanthonia sp. 2		U	N																							
Austrodanthonia sp. 3 (broad)		U	N																							
Austrostipa ramosissima	Stout Bamboo Grass	U	N																							
Austrostipa scabra	Speargrass	U	N				1		3																4a	
Austrostipa spp.		U	N							1																
Avena spp.		U	E																1	1						
Baumea rubiginosa		U	N																				1			
Bidens pilosa	Cobbler's Pegs	U	E	1	1	1	1	1			1		1	1		1										
Bidens subalternans	Greater Beggar's Ticks	U	E										1													
Billardiera scandens	Appleberry	U	N									1														
Bothriochloa biloba		U	N																							
Bothriochloa decipiens var. decipiens		U	N				1																			
Bothriochloa macra	Red Grass	U	N	1	1	1			3	4				1			1	1			1	1	1			1
Bothriochloa spp.		U	N																						3	
Brachyloma daphnoides	Daphne Heath	U	N					2				1														
Brachyscome microcarpa		U	N	1	1									1												

Revised Biometric Vegetation Type				110							114				116											
Scientific Name	Common Name	Legal Status	Native/ Exotic	110_BM_Plot1	110_BM_Plot2	110_BM_Plot3	110_NP_A	110_T_A	TRGMGNP1	TRGMGNP2	114 BM Plot 1	114 BM Plot 2	114 BM Plot3	114_T A	116_BM Plot 1	116 BM Plot 2	116 BM Plot 3	116_LOW	BRGYBL1	BRGYBL2	116_NP A	116_NP_B	116_NP C	BRGYBMGNP1	BRGMGNP1	116_T A
Brachyscome procumbens		U	N																							
Brachyscome spp.		U	N			1							1													
Brassica spp.		U	E				1											1								
Briza minor	Shivery Grass	U	E						1																	
Bromus catharticus	Praire Grass	U	E															1	4	4a						1
Bromus diandrus	Great Brome	U	E						4a																	
Bromus hordeaceus subsp. *molliformis*	Soft Brome	U	E							3									4	5	1					
Bromus spp.		U	N																					1	4a	
Bromus sp. 1 (little)		U	E																						4a	
Bromus sp. 2		U	E																							
Bromus sp. 3 (thin)		U	E						3																	
Bursaria spinosa	Native Blackthorn	U	N		1		1						1				1									
Callitris endlicheri	Black Cypress Pine	U	N												1											
Calotis cuneata	Mountain Burr-Daisy	U	N	1									1													
Calotis cuneifolia	Purple Burr-Daisy	U	N								1															
Calotis lappulacea	Yellow Burr-daisy	U	N					1				1			1	1	1	1								1
Calotis spp.		U	N																							
Carduus spp.		U	E																							
Carex breviculmis		U	N																					1		
Carex inversa	Knob Sedge	U	N	1	1						1	1	1			1		1					1			1
Carthamus dentatus	Toothed Thistle	U	E				1																			
Carthamus lanatus	Saffron Thistle	U	E							4																
Cassinia laevis	Cough Bush	U	N												1											
Cassinia quinquefaria		U	N												1											
Centaurea solstitialis	St Barnabys Thistle	U	E				1											1	1							
Centaurium erythraea	Common Centaury	U	E																					2		
Centaurium tenuiflorum		U	E							2																

Revised Biometric Vegetation Type				110							114				116											
Scientific Name	Common Name	Legal Status	Native/ Exotic	110_BM_Plot1	110_BM_Plot2	110_BM_Plot3	110_NP_A	110_T_A	TRGMGNP1	TRGMGNP2	114 BM Plot 1	114 BM Plot 2	114 BM Plot3	114_T A	116_BM Plot 1	116 BM Plot 2	116 BM Plot 3	116_LOW	BRGYBL1	BRGYBL2	116_NP A	116_NP_B	116_NP C	BRGYBMGNP1	BRGMGNP1	116_T A
Centaurium spp.		U	N																						3	
Chamaesyce spp.		U	N	1																						
Cheilanthes distans	Bristly Cloak Fern	U	N				1																			
Cheilanthes sieberi		U	N	1	1	1	1	1						1	1											
Chenopodium pumilio	Small Crumbweed	U	E																							
Chenopodium spp.		U	N																							
Chloris spp.		U	N																				1			
Chloris truncata	Windmill Grass	U	N							1														5	3	
Chloris ventricosa	Tall Chloris	U	N				1																			
Choretrum candollei	White Sour Bush	U	N												1											
Chrysocephalum apiculatum	Common Everlasting, Yellow But	U	N					1					1		1								1			
Cichorium intybus	Chicory	U	E																							
Cirsium vulgare	Spear Thistle	U	E							1			1		1			1			1				3	1
Clematis aristata	Old Man's Beard	U	N											1												
Clematis glycinoides	Headache Vine	U	N																							
Convolvulus erubescens		U	N																							
Convolvulus graminetinus		U	N																							
Conyza bonariensis	Flaxleaf Fleabane	U	E		1		1	1		4	1		1		1	1		1					1	1		1
Cotoneaster spp.		U	E												1											
Craspedia canens	Grey Billy-buttons	U	N																							
Crepis spp.		U	N																							
Cyclospermum leptophyllum	Slender Celery	U	E						3	1									3	3				2	4a	
Cymbonotus lawsonianus	Bear's Ear	U	N								1	1		1	1											1
Cymbopogon refractus	Barbed Wire Grass	U	N	1	1			1			1	1	1		1	1	1									
Cynodon dactylon	Couch	U	N							4														3	1	
Cynodon incompletus		U	E				1																			
Cynoglossum spp.		U	N				1								1		1									

Revised Biometric Vegetation Type				110							114				116											
Scientific Name	Common Name	Legal Status	Native/ Exotic	110_BM_Plot1	110_BM_Plot2	110_BM_Plot3	110_NP_A	110_T_A	TRGMGNP1	TRGMGNP2	114 BM Plot 1	114 BM Plot 2	114 BM Plot3	114_T A	116_BM Plot 1	116 BM Plot 2	116 BM Plot 3	116_LOW	BRGYBL1	BRGYBL2	116_NP A	116_NP_B	116_NP C	BRGYBMGNP1	BRGMGNP1	116_T A
Cyperus gracilis	Slender Flat-sedge	U	N	1			1		1																	
Cyperus spp.		U	N							1																
Dactylis glomerata	Cocksfoot	U	E						1																	
Daucus glochidiatus	Native Carrot	U	N		1	1				1			1		1		1									1
Daviesia genistifolia	Broom Bitter Pea	U	N												1		1									
Desmodium brachypodum	Large Tick-trefoil	U	N	1	1	1	1							1												
Desmodium gunnii	Slender tick trefoil	U	N		1	1					1		1	1												
Desmodium spp.		U	N																							
Desmodium varians	Slender Tick-trefoil	U	N	1			1						1			1	1						1		3	
Deyeuxia spp.		U	N												1											
Dianella caerulea	Blue Flax-lily	P13	N																							
Dianella longifolia		U	N										1			1										
Dianella revoluta		U	N					1			1	1	1	1	1	1	1									
Dianella spp.		U	N		1																					
Dichanthium sericeum	Queensland Bluegrass	U	N																						3	
Dichanthium setosum	Bluegrass	V	N																							
Dichelachne micrantha	Shorthair Plumegrass	U	N	1		1		1			1	1	1	1	1	1							1			
Dichelachne spp.		U	N																							
Dichondra repens	Kidney Weed	U	N	1	1									1											3	
Dichondra sp. A		U	N				1						1		1	1	1									1
Dichondra spp.		U	N																							
Digitaria brownii	Cotton Panic Grass	U	N				1																			
Dillwynia phylicoides		U	N																							
Dillwynia sieberi		U	N					1																		
Dipodium spp.		P13	N																							
Dodonaea viscosa subsp. *spatulata*		U	N																							
Echinochloa crusgalli	Barnyard Grass	U	E																							

Revised Biometric Vegetation Type				110							114				116											
Scientific Name	Common Name	Legal Status	Native/ Exotic	110_BM_Plot1	110_BM_Plot2	110_BM_Plot3	110_NP_A	110_T_A	TRGMGNP1	TRGMGNP2	114 BM Plot 1	114 BM Plot 2	114 BM Plot3	114_T A	116_BM Plot 1	116 BM Plot 2	116 BM Plot 3	116_LOW	BRGYBL1	BRGYBL2	116_NP A	116_NP_B	116_NP C	BRGYBMGNP1	BRGMGNP1	116_T A
Echinochloa spp.		U	N																							
Echinopogon caespitosus	Bushy Hedgehog-grass	U	N	1	1	1	1	1			1	1	1	1	1	1	1						1			1
Echinopogon cheelii	Long-flowered Hedgehog Grass	U	N																							1
Echinopogon ovatus	Forest Hedgehog Grass	U	N																							
Echinopogon spp.		U	N						4a	1															3	
Einadia nutans	Climbing Saltbush	U	N		1		1																			
Einadia polygonoides		U	N																							
Einadia spp.		U	N																							
Eleusine spp.		U	E																					4		
Eleusine indica	Crowsfoot grass	U	E																						1	
Eleusine tristachya	Goose Grass	U	E				1			3								1					1			
Elymus scaber		U	N							2			1			1										
Enteropogon acicularis		U	N							1																
Entolasia stricta	Wiry Panic	U	N																							
Epilobium billardiereanum		U	N																					1		
Eragrostis brownii	Brown's Lovegrass	U	N		1	1																				
Eragrostis cilianensis	Stinkgrass	U	E																							
Eragrostis curvula	African Lovegrass	U	E													1		1			1		1			
Eragrostis leptostachya	Paddock Lovegrass	U	N				1				1	1			1		1						1			
Eragrostis microcarpa		U	N							1																
Eragrostis molybdea		U	N																		1					
Eragrostis spp.		U	N																					5		
Eremophila debilis	Amulla	U	N																							
Erodium spp.		U	N				1																			
Eucalyptus albens	White Box	U	N																							
Eucalyptus banksii	Tenterfield Woollybutt	U	N								1	1														
Eucalyptus blakelyi	Blakely's Red Gum	U	N					1			1	1	1		1	1	1									1

Revised Biometric Vegetation Type				110							114				116											
Scientific Name	Common Name	Legal Status	Native/ Exotic	110_BM_Plot1	110_BM_Plot2	110_BM_Plot3	110_NP_A	110_T_A	TRGMGNP1	TRGMGNP2	114 BM Plot 1	114 BM Plot 2	114 BM Plot3	114_T A	116_BM Plot 1	116 BM Plot 2	116 BM Plot 3	116_LOW	BRGYBL1	BRGYBL2	116_NP A	116_NP_B	116_NP C	BRGYBMGNP1	BRGMGNP1	116_T A
Eucalyptus bridgesiana	Apple Box	U	N										1													
Eucalyptus caliginosa	Broad-leaved Stringybark	U	N																							
Eucalyptus crebra	Narrow-leaved Ironbark	U	N	1	1	1	1	1			1															
Eucalyptus dealbata	Tumbledown Red Gum	U	N	1	1	1		1						1												
Eucalyptus laevopinea	Silver-top Stringybark	U	N	1	1	1																				
Eucalyptus macrorhyncha	Red Stringybark	U	N					1						1												
Eucalyptus mckieana	McKie's Stringybark	V	N									1	1				1									
Eucalyptus melliodora	Yellow Box	U	N		1	1									1	1	1									1
Eucalyptus prava	Orange Gum	U	N																							
Eucalyptus subtilior		U	N								1															
Eucalyptus viminalis	Ribbon Gum	U	N																							
Euchiton sphaericus		U	N			1			3	3			1		1	1				2		1	1	4a	3	1
Euphorbia spp.		U	N																							
Exocarpos cupressiformis	Native Cherry	U	N	1												1										
Festuca elatior	Tall Fescue	U	E																							
Fimbristylis dichotoma	Common Fringe-sedge	U	N				1	1	3		1	1	1			1							1		3	
Galium aparine	Goosegrass	U	E	1																						
Galium gaudichaudii	Rough Bedstraw	U	N				1						1													
Galium spp.		U	N																							
Gamochaeta spicata		U	E																							
Geitonoplesium cymosum	Scrambling Lily	U	N																							
Geranium solanderi	Native Geranium	U	N	1	1	1	1	1	3	1			1	1		1	1								2	1
Glossogyne tannensis	Cobbler's Tack	U	N																							
Glycine clandestina		U	N	1			1	1			1			1	1	1	1						1			1
Glycine spp.		U	N		1	1																			3	
Glycine tabacina	Glycine	U	N	1					3			1	1	1			1				1					1
Gonocarpus tetragynus		U	N					1					1													
Goodenia bellidifolia		U	N					1			1		1		1	1	1									

Revised Biometric Vegetation Type				110							114				116											
Scientific Name	Common Name	Legal Status	Native/ Exotic	110_BM_Plot1	110_BM_Plot2	110_BM_Plot3	110_NP_A	110_T_A	TRGMGNP1	TRGMGNP2	114 BM Plot 1	114 BM Plot 2	114 BM Plot3	114_T A	116_BM Plot 1	116 BM Plot 2	116 BM Plot 3	116_LOW	BRGYBL1	BRGYBL2	116_NP A	116_NP_B	116_NP C	BRGYBMGNP1	BRGMGNP1	116_T A
Goodenia paniculata		U	N	1																						
Grevillea ramosissima subsp. *ramosissima*	Fan Grevillea	U	N																							
Haloragis exalata		V	N																							
Haloragis heterophylla		U	N						2			1				1					1	1		1		
Hardenbergia violacea	False Sarsaparilla	U	N			1						1	1				1									
Heliotropium spp.		U	N																							
Hibbertia obtusifolia	Hoary guinea flower	U	N	1	1	1	1	1						1												
Hirschfeldia incana	Hairy Brassica	U	E																							
Hordeum leporinum	Barley Grass	U	E																				1			
Hordeum spp.		U	E																							
Hovea heterophylla		U	N										1													
Hovea linearis		U	N			1		1																		
Hydrocotyle laxiflora	Stinking Pennywort	U	N																							
Hydrocotyle peduncularis		U	N										1													
Hydrocotyle spp.		U	N																							
Hydrocotyle tripartita	Pennywort	U	N																		1					
Hypericum gramineum	Small St John's Wort	U	N	1	1	1		1				1	1		1							1	1	1		
Hypericum perforatum	St. Johns Wort	U	E																							
Hypochaeris glabra	Smooth Catsear	U	E												1						1	1				
Hypochaeris radicata	Catsear	U	E	1	1	1	1	1	4a	1			1	1	1	1			4a	3	1	1	1	4	4a	
Hypoxis spp.		U	N																							
Imperata cylindrica var. *major*	Blady Grass	U	N																							
Indigofera australis	Australian Indigo	U	N	1								1														
Jacksonia scoparia	Dogwood	U	N			1		1																		
Joycea pallida	Silvertop Wallaby Grass	U	N								1		1													
Juncus bufonius	Toad Rush	U	E													1										
Juncus filicaulis		U	N						1																	

Revised Biometric Vegetation Type				110							114				116											
Scientific Name	Common Name	Legal Status	Native/ Exotic	110_BM_Plot1	110_BM_Plot2	110_BM_Plot3	110_NP_A	110_T_A	TRGMGNP1	TRGMGNP2	114 BM Plot 1	114 BM Plot 2	114 BM Plot3	114_T A	116_BM Plot 1	116 BM Plot 2	116 BM Plot 3	116_LOW	BRGYBL1	BRGYBL2	116_NP A	116_NP_B	116_NP C	BRGYBMGNP1	BRGMGNP1	116_T A
Juncus spp.		U	N						1	1											1					
Juncus usitatus		U	N								1	1	1		1	1					1	1	1		3	1
Lachnagrostis filiformis		U	N																							
Lactuca saligna	Willow-leaved Lettuce	U	E																							
Lactuca serriola	Prickly Lettuce	U	E				1								1											
Lagenifera spp.		U	N																							1
Lagenophora stipitata	Blue Bottle-daisy	U	N											1												
Lagurus ovatus	Hare's Tall Grass	U	E																							
Lamium amplexicaule	Henbit	U	E																							
Lepidium bonariense		U	E				1			1																
Lepidium spp.		U	N		1				1															2		1
Lepidosperma laterale		U	N																							
Leptospermum brevipes		U	N								1															
Lespedeza juncea subsp. *sericea*		U	N	1	1						1		1	1		1										
Leucochrysum albicans		U	N																							
Leucopogon muticus	Blunt Beard-heath	U	N									1														
Lissanthe strigosa	Peach Heath	U	N					1			1	1	1				1									
Lolium perenne	Perennial Ryegrass	U	E							5			1													
Lolium rigidum	Wimmera Ryegrass	U	E																							
Lolium spp.		U	E						4a										6	5				2	4a	
Lolium sp. 2		U	E																							
Lomandra confertifolia		U	N			1		1																		
Lomandra filiformis	Wattle Matt-rush	U	N													1										
Lomandra longifolia	Spiny-headed Mat-rush	U	N					1			1	1	1		1		1									
Lomandra multiflora subsp. *multiflora*	Many-flowered Mat-rush	U	N		1	1					1	1	1	1	1	1	1									
Lomandra spp.		U	N																							
Lotus australis	Australian Trefoil	U	N																							

Revised Biometric Vegetation Type				110							114				116											
Scientific Name	Common Name	Legal Status	Native/ Exotic	110_BM_Plot1	110_BM_Plot2	110_BM_Plot3	110_NP_A	110_T_A	TRGMGNP1	TRGMGNP2	114 BM Plot 1	114 BM Plot 2	114 BM Plot3	114_T A	116_BM Plot 1	116 BM Plot 2	116 BM Plot 3	116_LOW	BRGYBL1	BRGYBL2	116_NP A	116_NP_B	116_NP C	BRGYBMGNP1	BRGMGNP1	116_T A
Luzula spp.		U	N										1													
Malva spp.		U	E															1						1		
Marrubium vulgare	Horehound	U	E															1								
Medicago polymorpha	Burr Medic	U	E																							
Medicago sativa	Lucerne	U	E																							
Medicago spp.		U	E	1	1	1			4	3									3	3			1	2		
Medicago sp. 1		U	E																							
Medicago sp. 2 (small)		U	E							2																
Melichrus urceolatus	Urn Heath	U	N	1		1		1			1	1	1	1	1											
Mentha australis	River Mint	U	N																							
Mentha diemenica	Slender Mint	U	N																							
Mentha satureioides	Native Pennyroyal	U	N														1									
Mentha spp.		U	N																							
Micrantheum ericoides		U	N																							
Microlaena stipoides		U	N	1	1	1	1	1	3		1	1	1	1	1		1	1			1	1				1
Microseris lanceolata		U	N																							
Microtis spp.		U	N						2																	
Modiola caroliniana	Red-flowered Mallow	U	E				1			1								1								
Monotoca scoparia		U	N	1																						
Muellerina eucalyptoides		U	N									1														
Notelaea microcarpa	Native Olive	U	N	1	1	1								1												
Olearia elliptica	Sticky Daisy Bush	U	N																							
Olearia sp. aff. *elliptica*		U	N										1													
Onopordum acanthium	Scotch Thistle	U	E																						1	
Opercularia aspera	Coarse Stinkweed	U	N								1	1	1			1										
Opercularia diphylla		U	N	1	2	1								1												
Oxalis perennans		U	N	1	1	1	1			1		1			1											
Panicum effusum	Poison or Hairy Panic	U	N						1																	

Revised Biometric Vegetation Type				110							114				116											
Scientific Name	Common Name	Legal Status	Native/ Exotic	110_BM_Plot1	110_BM_Plot2	110_BM_Plot3	110_NP_A	110_T_A	TRGMGNP1	TRGMGNP2	114 BM Plot 1	114 BM Plot 2	114 BM Plot3	114_T A	116_BM Plot 1	116 BM Plot 2	116 BM Plot 3	116_LOW	BRGYBL1	BRGYBL2	116_NP A	116_NP_B	116_NP C	BRGYBMGNP1	BRGMGNP1	116_T A
Panicum queenslandicum	Yadbila Grass	U	N	1	1		1															1	1			
Panicum spp.		U	N						1																	
Paronychia brasiliana	Chilean Whitlow Wort	U	E				1											1				1	1	1		1
Paspalum dilatatum	Paspalum	U	E						1	4											1	1	1		1	
Pennisetum alopecuroides	Swamp Foxtail	U	E																		1		1			
Pennisetum clandestinum	Kikuyu Grass	U	E																							
Pennisetum sp. 1		U	E																							
Persoonia cornifolia		P13	N																							
Petrorhagia nanteuilii		U	E		1		1		3	1									3	3			1	1	2	1
Petrorhagia velutina		U	E							1																
Phalaris aquatica	Phalaris	U	E																							
Phyllanthus virgatus		U	N																							
Picris hieracioides	Hawkweed Picris	U	E		1																					
Pimelea curviflora		U	N																							1
Pimelea linifolia		U	N																							
Pimelea neo-anglica	Poison Pimelea	U	N																							
Plantago debilis		U	N		1	1																				2
Plantago lanceolata	Lamb's Tongues	U	E										1		1	1			4a	2						
Plantago spp.		U	E																							
Plantago varia		U	N																						3	
Platysace ericoides		U	N																							
Poa labillardierei	Tussock Grass	U	N																							
Poa sieberiana		U	N	1							1	1	1		1	1	1									1
Poa spp.		U	N		1				1																3	
Polycarpon tetraphyllum	Four-leaved Allseed	U	E																							1
Polygala japonica		U	N			1																				
Polygonum arenastrum		U	E																							
Polygonum aviculare	Wireweed	U	E							4								1								

Revised Biometric Vegetation Type				110							114				116											
Scientific Name	Common Name	Legal Status	Native/ Exotic	110_BM_Plot1	110_BM_Plot2	110_BM_Plot3	110_NP_A	110_T_A	TRGMGNP1	TRGMGNP2	114 BM Plot 1	114 BM Plot 2	114 BM Plot3	114_T A	116_BM Plot 1	116 BM Plot 2	116 BM Plot 3	116_LOW	BRGYBL1	BRGYBL2	116_NP A	116_NP_B	116_NP C	BRGYBMGNP1	BRGMGNP1	116_T A
Polygonum spp.		U	N																4a	3				1		
Pomax umbellata		U	N									1														
Poranthera microphylla		U	N	1		1																				
Portulaca oleracea	Pigweed	U	N				1																	1		
Pratia concolor	Poison Pratia	U	N																							
Pratia purpurascens	Whiteroot	U	N																					2		
Pterostylis spp.		P13	N																							
Pultenaea foliolosa		U	N																							
Pultenaea retusa		U	N																							
Pycnosorus globosus		P13	N																							
Ranunculus lappaceus	Common Buttercup	U	N													1										
Ranunculus repens	Creeping Buttercup	U	E																							
Rhodanthe spp.		U	N																							
Rosa rubiginosa	Sweet Briar	U	E										1	1	1	1		1								1
Rostellularia spp.		U	N																							
Rubus anglocandicans		U	E																							
Rubus fruticosus sp. agg.	Blackberry complex	U	E																							
Rubus parvifolius	Native Raspberry	U	N					1																		
Rubus rosifolius	Rose-leaf Bramble	U	N																							
Rubus ulmifolius	Blackberry	U	E																							
Rumex brownii	Swamp Dock	U	N				1		3	1								1			1	1	1	1	2	1
Rumex crispus	Curled Dock	U	E																							
Sarga leiocladum		U	N					1								1	1									
Schoenus apogon	Fluke Bogrush	U	N						2																	
Scleranthus biflorus		U	N					1								1	1									
Scleria mackaviensis		U	N				1																			
Scutellaria humilis	Dwarf Skullcap	U	N																							
Senecio hispidulus	Hill Fireweed	U	N														1									

Revised Biometric Vegetation Type				110							114				116											
Scientific Name	Common Name	Legal Status	Native/ Exotic	110_BM_Plot1	110_BM_Plot2	110_BM_Plot3	110_NP_A	110_T_A	TRGMGNP1	TRGMGNP2	114 BM Plot 1	114 BM Plot 2	114 BM Plot3	114_T A	116_BM Plot 1	116 BM Plot 2	116 BM Plot 3	116_LOW	BRGYBL1	BRGYBL2	116_NP A	116_NP_B	116_NP C	BRGYBMGNP1	BRGMGNP1	116_T A
Senecio prenanthoides		U	N										1													
Senecio quadridentatus	Cotton Fireweed	U	N						1	1																
Senecio spp.		U	N										1		1											
Setaria pumila	Pale Pigeon Grass	U	E																2	4a						
Sigesbeckia orientalis subsp. orientalis	Indian Weed	U	N	1	1	1																				
Silybum marianum	Variegated Thistle	U	E															1								
Sisyrinchium sp. A		U	E																					1		
Solanum nigrum	Black-berry Nightshade	U	E												1											1
Solenogyne bellioides		U	N																							
Sonchus oleraceus	Common Sowthistle	U	E	1	1										1	1										
Sorghum leiocladum	Wild Sorghum	U	N						1																1	
Spartothamnella juncea		U	N																							
Sporobolus creber	Slender Rat's Tail Grass	U	N				1		2	1			1								1	1	1	4a	3	
Stackhousia viminea	Slender Stackhousia	U	N																							
Stellaria angustifolia	Swamp Starwort	U	N																		1					
Stellaria media	Common Chickweed	U	E																							
Styphelia triflora	Pink Five-Corners	U	N																							
Styphelia viridis		U	N																							
Swainsona galegifolia	Smooth Darling Pea	U	N																							
Swainsona spp.		U	N			1																				
Tagetes minuta	Stinking Roger	U	E																							
Taraxacum officinale	Dandelion	U	E											1											3	
Themeda australis	Kangaroo Grass	U	N								1	1	1		1	1										
Themeda avenacea	Native Oatgrass	U	N																							
Thesium australe	Austral Toadflax	V	N																							
Trachymene incisa		U	N												1											
Tricoryne spp.		U	N																							

Revised Biometric Vegetation Type				110							114				116											
Scientific Name	Common Name	Legal Status	Native/ Exotic	110_BM_Plot1	110_BM_Plot2	110_BM_Plot3	110_NP_A	110_T_A	TRGMGNP1	TRGMGNP2	114 BM Plot 1	114 BM Plot 2	114 BM Plot3	114_T A	116_BM Plot 1	116 BM Plot 2	116 BM Plot 3	116_LOW	BRGYBL1	BRGYBL2	116_NP A	116_NP_B	116_NP C	BRGYBMGNP1	BRGMGNP1	116_T A
Trifolium arvense	Haresfoot Clover	U	E				1		3	1									1						4a	
Trifolium campestre	Hop Clover	U	E							3									4	4a						
Trifolium fragiferum	Strawberry Clover	U	E																4	4						
Trifolium repens	White Clover	U	E	1	1	1		1		4				1								1	1	2		1
Trifolium resupinatum	Shaftal Clover	U	E																							
Trifolium spp.		U	E						2									1			1				3	1
Trifolium sp. 2		U	E																							
Tripogon loliiformis	Fiveminute Grass	U	N																							
Urtica incisa	Stinging Nettle	U	N				1											1								1
Verbascum spp.		U	E																							
Verbascum thapsus subsp. *thapsus*	Blanket Weed	U	E																							
Verbascum virgatum	Twiggy Mullein, Green Mullein	U	E										1													
Verbena bonariensis	Purpletop	U	E																							
Verbena officinalis	Common Verbena	U	E																							
Verbena rigida		U	E						3																3	
Verbena rigida var. *rigida*	Veined Verbena	U	E																							
Verbena spp.		U	E																							
Vernonica cinerea		U	N	1	1	1					1	1					1									
Veronica calycina	Hairy Speedwell	U	N				1									1										
Veronica plebeia	Trailing Speedwell	U	N	1	1	1																				
Veronica spp.		U	N																							
Vicia sativa		U	E																							
Viola betonicifolia	Native Violet	U	N	1												1	1									1
Vittadinia cuneata	Fuzzweed	U	N	1			1				1			1											1	
Vittadinia muelleri		U	N																							
Vittadinia spp.		U	N																							
Vittadinia sp. 2		U	N																							

Revised Biometric Vegetation Type				110							114				116											
Scientific Name	Common Name	Legal Status	Native/ Exotic	110_BM_Plot1	110_BM_Plot2	110_BM_Plot3	110_NP_A	110_T_A	TRGMGNP1	TRGMGNP2	114 BM Plot 1	114 BM Plot 2	114 BM Plot3	114_T A	116_BM Plot 1	116 BM Plot 2	116 BM Plot 3	116_LOW	BRGYBL1	BRGYBL2	116_NP A	116_NP_B	116_NP C	BRGYBMGNP1	BRGMGNP1	116_T A
Vulpia bromoides	Squirrel Tail Fescue	U	E						4																	
Vulpia spp.		U	E																						4a	
Vuplia sp. (tall)		U	E							2																
Vulpia sp. (tiny)		U	E							1																
Wahlenbergia communis	Tufted Bluebell	U	N	1	1	1	1				1	1	1	1	1	1										1
Wahlenbergia gracilis	Sprawling Bluebell	U	N																							
Wahlenbergia luteola		U	N																							
Wahlenbergia planiflora		U	N				1																			
Wahlenbergia spp.		U	N						3															4a	1	
Westringia eremicola	Slender Westringia	U	N																							
Xanthium occidentale	Noogoora Burr	U	E																							
Xanthium spinosum	Bathurst Burr	U	E															1								
Xanthium spp.		U	E																							
Xanthorrhoea johnsonii		P13	N																							
Zornia spp.		U	N			1																				

Table 35 (continued): Flora recorded within and around the study area (RBVT 116 (cont.), 153, 227)

Revised Biometric Vegetation Type				116			153															227			
Scientific Name	Common Name	Legal Status	Native/ Exotic	116_T B	BRGYBMGT1	BRGYBMGT2	153 BM Plot 1	153 BM Plot 2	153 BM Plot 3	153_LOW	153 LOW_B	MGLQ1	153_NP D	153_NP_E	MGMGNP1	MGMGNP2	153_T A	153_T B	153_T C	153 T D	153 T E	MGMGT1	227 BM Plot 1	227 BM Plot 2	227 BM Plot 3	227_NP A
Acacia buxifolia	Box-leaved Wattle	U	N																				1			
Acacia deanei	Green Wattle	U	N																							
Acacia filicifolia	Fern-leaved Wattle	U	N																						1	
Acacia implexa	Hickory Wattle	U	N						1								1	1	1	1	2					
Acacia neriifolia	Silver Wattle	U	N																				1			
Acacia terminalis	Sunshine Wattle	U	N																							
Acacia ulicifolia	Prickly Moses	U	N																							
Acaena agnipila		U	N																							
Acaena ovina		U	N	1			1	1	1									1		1						
Acaena spp.		U	N									2					1									
Aira spp.		U	E																							
Ajuga australis	Austral Bugle	U	N				1																1		1	
Alternanthera pungens	Khaki Weed	U	E								1															
Alternanthera spp.		U	N																							
Amaranthus spp.		U	N																							
Amyema miquelii		U	N																							
Amyema spp.		U	N																						1	
Anagallis arvensis	Scarlet/Blue Pimpernel	U	E		1																					
Angophora floribunda	Rough-barked Apple	U	N		4	5	1	1	1								1						1			
Aristida leptopoda	White Speargrass	U	N																							
Aristida ramosa	Purple Wiregrass	U	N															1								
Aristida ramosa var. *speciosa*		U	N						1												1		1		1	
Aristida spp.		U	N	1													1							1		
Aristida vagans	Threeawn Speargrass	U	N																					1	1	
Arthropodium minus		U	N																							
Arthropodium spp.		U	N																							

Revised Biometric Vegetation Type				116			153																227			
Scientific Name	Common Name	Legal Status	Native/ Exotic	116_T B	BRGYBMGT1	BRGYBMGT2	153 BM Plot 1	153 BM Plot 2	153 BM Plot 3	153_LOW	153 LOW_B	MGLQ1	153_NP D	153_NP_E	MGMGNP1	MGMGNP2	153_T A	153_T B	153_T C	153 T D	153 T E	MGMGT1	227 BM Plot 1	227 BM Plot 2	227 BM Plot 3	227_NP A
Asperula conferta	Common Woodruff	U	N	1		3	1	1	1	1		4		1	4	4	1	1	1	1	1	4	1			1
Austrodanthonia caespitosa	Ringed Wallaby Grass	U	N																							
Austrodanthonia penicillata	Slender Wallaby Grass	U	N																							
Austrodanthonia racemosa		U	N	1			1			1	1									1					1	
Austrodanthonia spp.		U	N					1		1		5	1	1	4	4	1	1	1		1	4		1	1	
Austrodanthonia sp. 1 (thin)		U	N			5										3										
Austrodanthonia sp. 2		U	N			3						4a			5							3				
Austrodanthonia sp. 3 (broad)		U	N																							
Austrostipa ramosissima	Stout Bamboo Grass	U	N																							
Austrostipa scabra	Speargrass	U	N									1					1									
Austrostipa spp.		U	N																			1				
Avena spp.		U	E		1	2																				
Baumea rubiginosa		U	N																							
Bidens pilosa	Cobbler's Pegs	U	E										1	1					1	1	1					
Bidens subalternans	Greater Beggar's Ticks	U	E																							
Billardiera scandens	Appleberry	U	N																							
Bothriochloa biloba		U	N						1																	
Bothriochloa decipiens var. decipiens		U	N																						1	
Bothriochloa macra	Red Grass	U	N	1			1	1	1	1	1		1	1	4		1	1	1	1	1	1				2
Bothriochloa spp.		U	N			4a						3				4a										
Brachyloma daphnoides	Daphne Heath	U	N																							
Brachyscome microcarpa		U	N																							
Brachyscome procumbens		U	N																				1	1		
Brachyscome spp.		U	N					1																	1	
Brassica spp.		U	E							1	1								1		1					
Briza minor	Shivery Grass	U	E																							

Revised Biometric Vegetation Type				116			153																	227			
Scientific Name	Common Name	Legal Status	Native/ Exotic	116_T B	BRGYBMGT1	BRGYBMGT2	153 BM Plot 1	153 BM Plot 2	153 BM Plot 3	153_LOW	153 LOW_B	MGLQ1	153_NP D	153_NP_E	MGMGNP1	MGMGNP2	153_T A	153_T B	153_T C	153 T D	153 T E	MGMGT1	227 BM Plot 1	227 BM Plot 2	227 BM Plot 3	227_NP A
Bromus catharticus	Praire Grass	U	E			3					1								1	1						
Bromus diandrus	Great Brome	U	E																							
Bromus hordeaceus subsp. *molliformis*	Soft Brome	U	E												4					1						
Bromus spp.		U	N		4a							4a				1						2				
Bromus sp. 1 (little)		U	E																							
Bromus sp. 2		U	E									2										2				
Bromus sp. 3 (thin)		U	E																			2				
Bursaria spinosa	Native Blackthorn	U	N																		1					
Callitris endlicheri	Black Cypress Pine	U	N																							
Calotis cuneata	Mountain Burr-Daisy	U	N																	1						
Calotis cuneifolia	Purple Burr-Daisy	U	N																					1	1	
Calotis lappulacea	Yellow Burr-daisy	U	N	1																						
Calotis spp.		U	N			1																				
Carduus spp.		U	E																							
Carex breviculmis		U	N																							
Carex inversa	Knob Sedge	U	N		1	2	1	1	1	1	1		1								1			1		
Carthamus dentatus	Toothed Thistle	U	E																							
Carthamus lanatus	Saffron Thistle	U	E									3		1	4	2										
Cassinia laevis	Cough Bush	U	N																							
Cassinia quinquefaria		U	N																					1		
Centaurea solstitialis	St Barnabys Thistle	U	E							1	1	4				1			1							
Centaurium erythraea	Common Centaury	U	E																			1				
Centaurium tenuiflorum		U	E																			1				
Centaurium spp.		U	N		1																					
Chamaesyce spp.		U	N																							
Cheilanthes distans	Bristly Cloak Fern	U	N																							
Cheilanthes sieberi		U	N	1																				1	1	1

Revised Biometric Vegetation Type				116			153																227			
Scientific Name	Common Name	Legal Status	Native/ Exotic	116_T B	BRGYBMGT1	BRGYBMGT2	153 BM Plot 1	153 BM Plot 2	153 BM Plot 3	153_LOW	153 LOW_B	MGLQ1	153_NP D	153_NP_E	MGMGNP1	MGMGNP2	153_T A	153_T B	153_T C	153 T D	153 T E	MGMGT1	227 BM Plot 1	227 BM Plot 2	227 BM Plot 3	227_NP A
Chenopodium pumilio	Small Crumbweed	U	E			1																				
Chenopodium spp.		U	N		6																					
Chloris spp.		U	N																							
Chloris truncata	Windmill Grass	U	N		1	1				1				1	2	1		1				2				
Chloris ventricosa	Tall Chloris	U	N																	1						
Choretrum candollei	White Sour Bush	U	N																							
Chrysocephalum apiculatum	Common Everlasting, Yellow But	U	N																				1	1	1	1
Cichorium intybus	Chicory	U	E																							
Cirsium vulgare	Spear Thistle	U	E		2	4a	1	1		1	1	3	1	1	1		1	1		1	1	2	1		1	
Clematis aristata	Old Man's Beard	U	N																							
Clematis glycinoides	Headache Vine	U	N																							
Convolvulus erubescens		U	N																							
Convolvulus graminetinus		U	N																							
Conyza bonariensis	Flaxleaf Fleabane	U	E	1		1	1			1			1	1	1		1		1		1	1		1	1	2
Cotoneaster spp.		U	E																							
Craspedia canens	Grey Billy-buttons	U	N									3														
Crepis spp.		U	N																	1						
Cyclospermum leptophyllum	Slender Celery	U	E	1	1	3						2		1	3	3			1			3	1			
Cymbonotus lawsonianus	Bear's Ear	U	N	1																1			1			
Cymbopogon refractus	Barbed Wire Grass	U	N	1								2					1				1		1	1	1	1
Cynodon dactylon	Couch	U	N																			1				
Cynodon incompletus		U	E								1															
Cynoglossum spp.		U	N				1													1	1					
Cyperus gracilis	Slender Flat-sedge	U	N							1	1												1			
Cyperus spp.		U	N																							
Dactylis glomerata	Cocksfoot	U	E			3										2										
Daucus glochidiatus	Native Carrot	U	N	1		2	1											1		1	1	1	1			

Revised Biometric Vegetation Type				116			153																227			
Scientific Name	Common Name	Legal Status	Native/ Exotic	116_T B	BRGYBMGT1	BRGYBMGT2	153 BM Plot 1	153 BM Plot 2	153 BM Plot 3	153_LOW	153 LOW_B	MGLQ1	153_NP D	153_NP_E	MGMGNP1	MGMGNP2	153_T A	153_T B	153_T C	153 T D	153 T E	MGMGT1	227 BM Plot 1	227 BM Plot 2	227 BM Plot 3	227_NP A
Daviesia genistifolia	Broom Bitter Pea	U	N																							
Desmodium brachypodum	Large Tick-trefoil	U	N				1														1					
Desmodium gunnii	Slender tick trefoil	U	N																							
Desmodium spp.		U	N																							
Desmodium varians	Slender Tick-trefoil	U	N	1		3			1	1		3					1			1			1		1	
Deyeuxia spp.		U	N																							
Dianella caerulea	Blue Flax-lily	P13	N					1																		
Dianella longifolia		U	N				1		1																1	
Dianella revoluta		U	N				1		1												1		1	1		1
Dianella spp.		U	N																							
Dichanthium sericeum	Queensland Bluegrass	U	N						1			4a	1		4	3	1	1	1			2	1			
Dichanthium setosum	Bluegrass	V	N										1													
Dichelachne micrantha	Shorthair Plumegrass	U	N	1			1																1	1	1	
Dichelachne spp.		U	N													3						1				
Dichondra repens	Kidney Weed	U	N		2	4a							1	1			1	1				2				
Dichondra sp. A		U	N						1										1	1	1				1	1
Dichondra spp.		U	N																							
Digitaria brownii	Cotton Panic Grass	U	N																							
Dillwynia phylicoides		U	N																				1			
Dillwynia sieberi		U	N						1																1	1
Dipodium spp.		P13	N				1																			
Dodonaea viscosa subsp. *spatulata*		U	N																						1	
Echinochloa crusgalli	Barnyard Grass	U	E																							
Echinochloa spp.		U	N																							
Echinopogon caespitosus	Bushy Hedgehog-grass	U	N																				1	1	1	1
Echinopogon cheelii	Long-flowered Hedgehog Grass	U	N										1						1		1					
Echinopogon ovatus	Forest Hedgehog Grass	U	N																							

Revised Biometric Vegetation Type				116			153																227			
Scientific Name	Common Name	Legal Status	Native/ Exotic	116_T B	BRGYBMGT1	BRGYBMGT2	153 BM Plot 1	153 BM Plot 2	153 BM Plot 3	153_LOW	153 LOW_B	MGLQ1	153_NP D	153_NP_E	MGMGNP1	MGMGNP2	153_T A	153_T B	153_T C	153 T D	153 T E	MGMGT1	227 BM Plot 1	227 BM Plot 2	227 BM Plot 3	227_NP A
Echinopogon spp.		U	N														1					1				
Einadia nutans	Climbing Saltbush	U	N																	1						
Einadia polygonoides		U	N																	1	1					
Einadia spp.		U	N							1								1								
Eleusine spp.		U	E		3	3																				
Eleusine indica	Crowsfoot grass	U	E																							
Eleusine tristachya	Goose Grass	U	E							1	1			1				1								
Elymus scaber		U	N					1	1			4a		1	3											
Enteropogon acicularis		U	N																							
Entolasia stricta	Wiry Panic	U	N																				1			
Epilobium billardiereanum		U	N													1										
Eragrostis brownii	Brown's Lovegrass	U	N																							
Eragrostis cilianensis	Stinkgrass	U	E																							
Eragrostis curvula	African Lovegrass	U	E																					1	1	
Eragrostis leptostachya	Paddock Lovegrass	U	N	1																					1	1
Eragrostis microcarpa		U	N																							
Eragrostis molybdea		U	N																							
Eragrostis spp.		U	N		1																					
Eremophila debilis	Amulla	U	N						1																	
Erodium spp.		U	N																							
Eucalyptus albens	White Box	U	N															1								
Eucalyptus banksii	Tenterfield Woollybutt	U	N																				1	1	1	
Eucalyptus blakelyi	Blakely's Red Gum	U	N	1				1																1		
Eucalyptus bridgesiana	Apple Box	U	N																							
Eucalyptus caliginosa	Broad-leaved Stringybark	U	N																					1		
Eucalyptus crebra	Narrow-leaved Ironbark	U	N																				1	1		
Eucalyptus dealbata	Tumbledown Red Gum	U	N																							
Eucalyptus laevopinea	Silver-top Stringybark	U	N																							

Revised Biometric Vegetation Type				116			153																227			
Scientific Name	Common Name	Legal Status	Native/ Exotic	116_T B	BRGYBMGT1	BRGYBMGT2	153 BM Plot 1	153 BM Plot 2	153 BM Plot 3	153_LOW	153 LOW_B	MGLQ1	153_NP D	153_NP_E	MGMGNP1	MGMGNP2	153_T A	153_T B	153_T C	153 T D	153 T E	MGMGT1	227 BM Plot 1	227 BM Plot 2	227 BM Plot 3	227_NP A
Eucalyptus macrorhyncha	Red Stringybark	U	N																							
Eucalyptus mckieana	McKie's Stringybark	V	N																				1		1	
Eucalyptus melliodora	Yellow Box	U	N	1	4			1										1							1	
Eucalyptus prava	Orange Gum	U	N																							
Eucalyptus subtilior		U	N																				1	1	1	
Eucalyptus viminalis	Ribbon Gum	U	N				1	1	1								1	1	1	1	1					
Euchiton sphaericus		U	N		3	4a	1	2	1				1		3	3			1	1	1	3	1		1	1
Euphorbia spp.		U	N																							
Exocarpos cupressiformis	Native Cherry	U	N																							
Festuca elatior	Tall Fescue	U	E																							
Fimbristylis dichotoma	Common Fringe-sedge	U	N																						1	
Galium aparine	Goosegrass	U	E																							
Galium gaudichaudii	Rough Bedstraw	U	N																				1		1	
Galium spp.		U	N		1																					
Gamochaeta spicata		U	E																							
Geitonoplesium cymosum	Scrambling Lily	U	N																							
Geranium solanderi	Native Geranium	U	N	1	4a	1	1	1	1			4a	1	1	2		1	1	1	1		1	1	1	1	1
Glossogyne tannensis	Cobbler's Tack	U	N																							
Glycine clandestina		U	N					1	1									1	1	1				1	1	1
Glycine spp.		U	N									3										1				
Glycine tabacina	Glycine	U	N	1				1	1	1				1	2		1		1		1	2			1	
Gonocarpus tetragynus		U	N																							1
Goodenia bellidifolia		U	N																					1	1	
Goodenia paniculata		U	N																							
Grevillea ramosissima subsp. *ramosissima*	Fan Grevillea	U	N																				1			
Haloragis exalata		V	N																							
Haloragis heterophylla		U	N									1				1								1		1

Revised Biometric Vegetation Type				116			153																227			
Scientific Name	Common Name	Legal Status	Native/ Exotic	116_T B	BRGYBMGT1	BRGYBMGT2	153 BM Plot 1	153 BM Plot 2	153 BM Plot 3	153_LOW	153 LOW_B	MGLQ1	153_NP D	153_NP_E	MGMGNP1	MGMGNP2	153_T A	153_T B	153_T C	153 T D	153 T E	MGMGT1	227 BM Plot 1	227 BM Plot 2	227 BM Plot 3	227_NP A
Hardenbergia violacea	False Sarsaparilla	U	N																				1	1	1	
Heliotropium spp.		U	N																							
Hibbertia obtusifolia	Hoary guinea flower	U	N																					1	1	1
Hirschfeldia incana	Hairy Brassica	U	E																							
Hordeum leporinum	Barley Grass	U	E																							
Hordeum spp.		U	E								1															
Hovea heterophylla		U	N																						1	
Hovea linearis		U	N																							1
Hydrocotyle laxiflora	Stinking Pennywort	U	N										1										1			
Hydrocotyle peduncularis		U	N																							
Hydrocotyle spp.		U	N														1					1				
Hydrocotyle tripartita	Pennywort	U	N																							
Hypericum gramineum	Small St John's Wort	U	N																							
Hypericum perforatum	St. Johns Wort	U	E				1								1											
Hypochaeris glabra	Smooth Catsear	U	E	1																			1		1	
Hypochaeris radicata	Catsear	U	E	1	3	2	1	1	1			3	1		1	2		1	1	1	1	1	1	1		1
Hypoxis spp.		U	N		1																					
Imperata cylindrica var. *major*	Blady Grass	U	N				1														1					
Indigofera australis	Australian Indigo	U	N																				1	1	1	
Jacksonia scoparia	Dogwood	U	N																							
Joycea pallida	Silvertop Wallaby Grass	U	N																				1			
Juncus bufonius	Toad Rush	U	E																							
Juncus filicaulis		U	N																							
Juncus spp.		U	N																			1				
Juncus usitatus		U	N																							1
Lachnagrostis filiformis		U	N																			4		1		
Lactuca saligna	Willow-leaved Lettuce	U	E											1												

Revised Biometric Vegetation Type				116			153																227			
Scientific Name	Common Name	Legal Status	Native/ Exotic	116_T B	BRGYBMGT1	BRGYBMGT2	153 BM Plot 1	153 BM Plot 2	153 BM Plot 3	153_LOW	153 LOW_B	MGLQ1	153_NP D	153_NP_E	MGMGNP1	MGMGNP2	153_T A	153_T B	153_T C	153 T D	153 T E	MGMGT1	227 BM Plot 1	227 BM Plot 2	227 BM Plot 3	227_NP A
Lactuca serriola	Prickly Lettuce	U	E																						1	
Lagenifera spp.		U	N																							
Lagenophora stipitata	Blue Bottle-daisy	U	N														1		1				1		1	
Lagurus ovatus	Hare's Tall Grass	U	E																							
Lamium amplexicaule	Henbit	U	E			1																				
Lepidium bonariense		U	E							1	1				1						1					
Lepidium spp.		U	N		4												1	1	1							
Lepidosperma laterale		U	N																				1			
Leptospermum brevipes		U	N																				1			
Lespedeza juncea subsp. *sericea*		U	N				1	1	1								1	1	1				1	1		
Leucochrysum albicans		U	N																							
Leucopogon muticus	Blunt Beard-heath	U	N																				1			
Lissanthe strigosa	Peach Heath	U	N																					1	1	1
Lolium perenne	Perennial Ryegrass	U	E												4							2				
Lolium rigidum	Wimmera Ryegrass	U	E																							
Lolium spp.		U	E		4	4							1	1		1										
Lolium sp. 2		U	E																			2				
Lomandra confertifolia		U	N																		1					
Lomandra filiformis	Wattle Matt-rush	U	N														1									
Lomandra longifolia	Spiny-headed Mat-rush	U	N																				1	1	1	1
Lomandra multiflora subsp. *multiflora*	Many-flowered Mat-rush	U	N	1				1															1		1	
Lomandra spp.		U	N																							
Lotus australis	Australian Trefoil	U	N																							
Luzula spp.		U	N																					1		
Malva spp.		U	E		3						1															
Marrubium vulgare	Horehound	U	E																							
Medicago polymorpha	Burr Medic	U	E																							

Revised Biometric Vegetation Type				116			153																227			
Scientific Name	Common Name	Legal Status	Native/ Exotic	116_T B	BRGYBMGT1	BRGYBMGT2	153 BM Plot 1	153 BM Plot 2	153 BM Plot 3	153_LOW	153 LOW_B	MGLQ1	153_NP D	153_NP_E	MGMGNP1	MGMGNP2	153_T A	153_T B	153_T C	153 T D	153 T E	MGMGT1	227 BM Plot 1	227 BM Plot 2	227 BM Plot 3	227_NP A
Medicago sativa	Lucerne	U	E																1							
Medicago spp.		U	E		3	4a									2	3	1	1	1		1	1				
Medicago sp. 1		U	E												1							1				
Medicago sp. 2 (small)		U	E																							
Melichrus urceolatus	Urn Heath	U	N																				1	1	1	1
Mentha australis	River Mint	U	N																							
Mentha diemenica	Slender Mint	U	N																							
Mentha satureioides	Native Pennyroyal	U	N															1								
Mentha spp.		U	N															1				3				
Micrantheum ericoides		U	N																							
Microlaena stipoides		U	N	1		5	1							1						1	1			1	1	1
Microseris lanceolata		U	N				1																			
Microtis spp.		U	N																							
Modiola caroliniana	Red-flowered Mallow	U	E																							
Monotoca scoparia		U	N																				1			
Muellerina eucalyptoides		U	N																							
Notelaea microcarpa	Native Olive	U	N						1																	
Olearia elliptica	Sticky Daisy Bush	U	N																							
Olearia sp. aff. *elliptica*		U	N																							
Onopordum acanthium	Scotch Thistle	U	E																							
Opercularia aspera	Coarse Stinkweed	U	N																					1	1	
Opercularia diphylla		U	N																							
Oxalis perennans		U	N		2		1	1	1	1	1			1								1	1			
Panicum effusum	Poison or Hairy Panic	U	N																							
Panicum queenslandicum	Yadbila Grass	U	N	1			1	1					1													1
Panicum spp.		U	N		1																					
Paronychia brasiliana	Chilean Whitlow Wort	U	E	1	4a	1				1	1			1			1	1	1	1	1					
Paspalum dilatatum	Paspalum	U	E			3	1	1		1	1	3		1	3	4										

Revised Biometric Vegetation Type				116			153																227			
Scientific Name	Common Name	Legal Status	Native/ Exotic	116_T B	BRGYBMGT1	BRGYBMGT2	153 BM Plot 1	153 BM Plot 2	153 BM Plot 3	153_LOW	153 LOW_B	MGLQ1	153_NP D	153_NP_E	MGMGNP1	MGMGNP2	153_T A	153_T B	153_T C	153 T D	153 T E	MGMGT1	227 BM Plot 1	227 BM Plot 2	227 BM Plot 3	227_NP A
Pennisetum alopecuroides	Swamp Foxtail	U	E											1												1
Pennisetum clandestinum	Kikuyu Grass	U	E								1															
Pennisetum sp. 1		U	E																							
Persoonia cornifolia		P13	N																				1			
Petrorhagia nanteuilii		U	E	1	2	3				1		4a	1		1	3	1	1				1				1
Petrorhagia velutina		U	E																			1				
Phalaris aquatica	Phalaris	U	E											1	4	5						2				
Phyllanthus virgatus		U	N				1	1									1									
Picris hieracioides	Hawkweed Picris	U	E				1		1																	
Pimelea curviflora		U	N				1		1								1		1	1	1					
Pimelea linifolia		U	N														1									
Pimelea neo-anglica	Poison Pimelea	U	N																						1	
Plantago debilis		U	N				1	1	1				1				1	1	1	1						
Plantago lanceolata	Lamb's Tongues	U	E		1	2									1					1		1				1
Plantago spp.		U	E																			1				
Plantago varia		U	N									3										2				
Platysace ericoides		U	N																				1			
Poa labillardierei	Tussock Grass	U	N													4										
Poa sieberiana		U	N	1			1	1		1				1			1	1	1	1	1					1
Poa spp.		U	N			1						4			3							5				
Polycarpon tetraphyllum	Four-leaved Allseed	U	E																							
Polygala japonica		U	N																							
Polygonum arenastrum		U	E																							
Polygonum aviculare	Wireweed	U	E		2					1	1											2				
Polygonum spp.		U	N																							
Pomax umbellata		U	N																							
Poranthera microphylla		U	N																						1	
Portulaca oleracea	Pigweed	U	N		4a					1	1															

Revised Biometric Vegetation Type				116			153																227			
Scientific Name	Common Name	Legal Status	Native/ Exotic	116_T B	BRGYBMGT1	BRGYBMGT2	153 BM Plot 1	153 BM Plot 2	153 BM Plot 3	153_LOW	153 LOW_B	MGLQ1	153_NP D	153_NP_E	MGMGNP1	MGMGNP2	153_T A	153_T B	153_T C	153 T D	153 T E	MGMGT1	227 BM Plot 1	227 BM Plot 2	227 BM Plot 3	227_NP A
Pratia concolor	Poison Pratia	U	N						1																	
Pratia purpurascens	Whiteroot	U	N																							
Pterostylis spp.		P13	N																				1			
Pultenaea foliolosa		U	N																				1			
Pultenaea retusa		U	N																							
Pycnosorus globosus		P13	N				1	1																		
Ranunculus lappaceus	Common Buttercup	U	N																							
Ranunculus repens	Creeping Buttercup	U	E						1																	
Rhodanthe spp.		U	N				1																			
Rosa rubiginosa	Sweet Briar	U	E	1	1		1	1	1			1	1				1	1	1	1	1				1	
Rostellularia spp.		U	N																							
Rubus anglocandicans		U	E										1							1						1
Rubus fruticosus sp. agg.	Blackberry complex	U	E																							
Rubus parvifolius	Native Raspberry	U	N				1																			
Rubus rosifolius	Rose-leaf Bramble	U	N														1									
Rubus ulmifolius	Blackberry	U	E		1	1																				
Rumex brownii	Swamp Dock	U	N		1	2			1	1	1	3		1	1	1	1			1	1					
Rumex crispus	Curled Dock	U	E																							
Sarga leiocladum		U	N				1	1	2				1	1						1						1
Schoenus apogon	Fluke Bogrush	U	N																							1
Scleranthus biflorus		U	N				1	1					1								1					1
Scleria mackaviensis		U	N																							
Scutellaria humilis	Dwarf Skullcap	U	N																				1			
Senecio hispidulus	Hill Fireweed	U	N																		1					
Senecio prenanthoides		U	N				1																			
Senecio quadridentatus	Cotton Fireweed	U	N				1	1	1								1		1	1	1					
Senecio spp.		U	N														1	1					1	1		
Setaria pumila	Pale Pigeon Grass	U	E		0								1													

Revised Biometric Vegetation Type				116			153																227			
Scientific Name	Common Name	Legal Status	Native/ Exotic	116_T B	BRGYBMGT1	BRGYBMGT2	153 BM Plot 1	153 BM Plot 2	153 BM Plot 3	153_LOW	153 LOW_B	MGLQ1	153_NP D	153_NP_E	MGMGNP1	MGMGNP2	153_T A	153_T B	153_T C	153 T D	153 T E	MGMGT1	227 BM Plot 1	227 BM Plot 2	227 BM Plot 3	227_NP A
Sigesbeckia orientalis subsp. *orientalis*	Indian Weed	U	N																							
Silybum marianum	Variegated Thistle	U	E																							
Sisyrinchium sp. A		U	E																							
Solanum nigrum	Black-berry Nightshade	U	E		4a												1									
Solenogyne bellioides		U	N																	1						
Sonchus oleraceus	Common Sowthistle	U	E		1					1							1	1								
Sorghum leiocladum	Wild Sorghum	U	N									1										3				
Spartothamnella juncea		U	N																							
Sporobolus creber	Slender Rat's Tail Grass	U	N	1		3				1			1	1		1		1								1
Stackhousia viminea	Slender Stackhousia	U	N																							1
Stellaria angustifolia	Swamp Starwort	U	N																							
Stellaria media	Common Chickweed	U	E																							
Styphelia triflora	Pink Five-Corners	U	N																				1			
Styphelia viridis		U	N																							
Swainsona galegifolia	Smooth Darling Pea	U	N				1		1																	
Swainsona spp.		U	N							1								1								
Tagetes minuta	Stinking Roger	U	E																		1					
Taraxacum officinale	Dandelion	U	E					1									1				1					
Themeda australis	Kangaroo Grass	U	N				1	1	1				1											1	1	
Themeda avenacea	Native Oatgrass	U	N																							
Thesium australe	Austral Toadflax	V	N						1				1													1
Trachymene incisa		U	N																						1	
Tricoryne spp.		U	N																							
Trifolium arvense	Haresfoot Clover	U	E																							
Trifolium campestre	Hop Clover	U	E				1			1	1	5				4				1						
Trifolium fragiferum	Strawberry Clover	U	E										1													
Trifolium repens	White Clover	U	E							1			1	1	4			1	1	1		4				

Revised Biometric Vegetation Type				116			153																227			
Scientific Name	Common Name	Legal Status	Native/ Exotic	116_T B	BRGYBMGT1	BRGYBMGT2	153 BM Plot 1	153 BM Plot 2	153 BM Plot 3	153_LOW	153 LOW_B	MGLQ1	153_NP D	153_NP_E	MGMGNP1	MGMGNP2	153_T A	153_T B	153_T C	153 T D	153 T E	MGMGT1	227 BM Plot 1	227 BM Plot 2	227 BM Plot 3	227_NP A
Trifolium resupinatum	Shaftal Clover	U	E									2				3										
Trifolium spp.		U	E		4a	4						4a														1
Trifolium sp. 2		U	E		1																					
Tripogon loliiformis	Fiveminute Grass	U	N																							1
Urtica incisa	Stinging Nettle	U	N		2					1	1			1				1		1						
Verbascum spp.		U	E																							
Verbascum thapsus subsp. *thapsus*	Blanket Weed	U	E	1																						
Verbascum virgatum	Twiggy Mullein, Green Mullein	U	E																	1						
Verbena bonariensis	Purpletop	U	E																							
Verbena officinalis	Common Verbena	U	E																							
Verbena rigida		U	E																							
Verbena rigida var. *rigida*	Veined Verbena	U	E																				1			
Verbena spp.		U	E							1																
Vernonica cinerea		U	N																						1	
Veronica calycina	Hairy Speedwell	U	N																	1	1					
Veronica plebeia	Trailing Speedwell	U	N																							
Veronica spp.		U	N																							
Vicia sativa		U	E														1	1				1				
Viola betonicifolia	Native Violet	U	N				1	1													1		1			1
Vittadinia cuneata	Fuzzweed	U	N	1					1	1		3		1		1	1		1	1			1			
Vittadinia muelleri		U	N																							
Vittadinia spp.		U	N																			1				
Vittadinia sp. 2		U	N									3														
Vulpia bromoides	Squirrel Tail Fescue	U	E																							
Vulpia spp.		U	E																							
Vuplia sp. (tall)		U	E																							
Vulpia sp. (tiny)		U	E																							

Revised Biometric Vegetation Type				116			153																227			
Scientific Name	Common Name	Legal Status	Native/ Exotic	116_T B	BRGYBMGT1	BRGYBMGT2	153 BM Plot 1	153 BM Plot 2	153 BM Plot 3	153_LOW	153 LOW_B	MGLQ1	153_NP D	153_NP_E	MGMGNP1	MGMGNP2	153_T A	153_T B	153_T C	153 T D	153 T E	MGMGT1	227 BM Plot 1	227 BM Plot 2	227 BM Plot 3	227_NP A
Wahlenbergia communis	Tufted Bluebell	U	N	1			1	1		1			1				1	1					1		1	1
Wahlenbergia gracilis	Sprawling Bluebell	U	N						1																	
Wahlenbergia luteola		U	N																1	1	1					
Wahlenbergia planiflora		U	N																							
Wahlenbergia spp.		U	N												2							1				
Westringia eremicola	Slender Westringia	U	N																				1			
Xanthium occidentale	Noogoora Burr	U	E															1								
Xanthium spinosum	Bathurst Burr	U	E																							
Xanthium spp.		U	E																							
Xanthorrhoea johnsonii		P13	N																				1			
Zornia spp.		U	N																							

Table 36 (continued): Flora recorded within and around the study area (RBVT 227, 240)

Revised Biometric Vegetation Type				227				240																	
Scientific Name	Common Name	Legal Status	Native/ Exotic	227 T A	227_T B	227_T C	TWSSMGT1	240 BM Plot 1	240 BM Plot 2	240 BM Plot 3	240_LOW A	240_LOW B	WBL1	WB-L-2	240_NP A	240_NP B	240_NP C	240_NP D	WBMGNP1	WBMGNP2	240_T	240_T B	240_T_C	WBMGT1	WBMGT2
Acacia buxifolia	Box-leaved Wattle	U	N																						
Acacia deanei	Green Wattle	U	N					1	1	1															
Acacia filicifolia	Fern-leaved Wattle	U	N																						
Acacia implexa	Hickory Wattle	U	N		1																		1		
Acacia neriifolia	Silver Wattle	U	N																						
Acacia terminalis	Sunshine Wattle	U	N																						
Acacia ulicifolia	Prickly Moses	U	N																						
Acaena agnipila		U	N																		1				
Acaena ovina		U	N				3	1	1	1							1								
Acaena spp.		U	N																					2	
Aira spp.		U	E		1																				
Ajuga australis	Austral Bugle	U	N					1								1					1				
Alternanthera pungens	Khaki Weed	U	E																						
Alternanthera spp.		U	N																						
Amaranthus spp.		U	N																						
Amyema miquelii		U	N																						
Amyema spp.		U	N																						
Anagallis arvensis	Scarlet/Blue Pimpernel	U	E											1		1								1	
Angophora floribunda	Rough-barked Apple	U	N					1	1														1	1	
Aristida leptopoda	White Speargrass	U	N					1																	
Aristida ramosa	Purple Wiregrass	U	N							1											1		1		
Aristida ramosa var. *speciosa*		U	N		1	1																			
Aristida spp.		U	N						1						1										
Aristida vagans	Threeawn Speargrass	U	N				4a																		
Arthropodium minus		U	N																						
Arthropodium spp.		U	N																						

Revised Biometric Vegetation Type				227				240																	
Scientific Name	Common Name	Legal Status	Native/ Exotic	227 T A	227_T B	227_T C	TWSSMGT1	240 BM Plot 1	240 BM Plot 2	240 BM Plot 3	240_LOW A	240_LOW B	WBL1	WB-L-2	240_NP A	240_NP B	240_NP C	240_NP D	WBMGNP1	WBMGNP2	240_T	240_T B	240_T_C	WBMGT1	WBMGT2
Asperula conferta	Common Woodruff	U	N				2			1					1	1	1	1	3		1	1		4a	
Austrodanthonia caespitosa	Ringed Wallaby Grass	U	N																						4
Austrodanthonia penicillata	Slender Wallaby Grass	U	N											1											
Austrodanthonia racemosa		U	N																						
Austrodanthonia spp.		U	N		1	1				1	1	1	3		1	2	1	1	5	4a	1	1	1	4b	
Austrodanthonia sp. 1 (thin)		U	N				2																		
Austrodanthonia sp. 2		U	N										3											4b	
Austrodanthonia sp. 3 (broad)		U	N				5																		
Austrostipa ramosissima	Stout Bamboo Grass	U	N									1													
Austrostipa scabra	Speargrass	U	N							1								1							
Austrostipa spp.		U	N						1		1													4a	
Avena spp.		U	E											1											
Baumea rubiginosa		U	N																						
Bidens pilosa	Cobbler's Pegs	U	E					1	1						1						1		1		
Bidens subalternans	Greater Beggar's Ticks	U	E																						
Billardiera scandens	Appleberry	U	N																						
Bothriochloa biloba		U	N															1			1				
Bothriochloa decipiens var. decipiens		U	N										1			1	1								
Bothriochloa macra	Red Grass	U	N	1		1		1	1	1	1	1		4a	1	1	1	1	3		1	1	1		
Bothriochloa spp.		U	N				4a													1					
Brachyloma daphnoides	Daphne Heath	U	N																						
Brachyscome microcarpa		U	N						1																
Brachyscome procumbens		U	N																						
Brachyscome spp.		U	N		1																				3
Brassica spp.		U	E									1													
Briza minor	Shivery Grass	U	E				3																		

Revised Biometric Vegetation Type				227				240																	
Scientific Name	Common Name	Legal Status	Native/ Exotic	227 T A	227_T B	227_T C	TWSSMGT1	240 BM Plot 1	240 BM Plot 2	240 BM Plot 3	240_LOW A	240_LOW B	WBL1	WB-L-2	240_NP A	240_NP B	240_NP C	240_NP D	WBMGNP1	WBMGNP2	240_T	240_T B	240_T_C	WBMGT1	WBMGT2
Bromus catharticus	Praire Grass	U	E								1		3	2						3					4
Bromus diandrus	Great Brome	U	E										4a	4a											
Bromus hordeaceus subsp. *molliformis*	Soft Brome	U	E	1										4a											
Bromus spp.		U	N																4			1		4	
Bromus sp. 1 (little)		U	E																						
Bromus sp. 2		U	E																3						
Bromus sp. 3 (thin)		U	E										4												
Bursaria spinosa	Native Blackthorn	U	N																				1		
Callitris endlicheri	Black Cypress Pine	U	N																						
Calotis cuneata	Mountain Burr-Daisy	U	N	1		1																			
Calotis cuneifolia	Purple Burr-Daisy	U	N						1																
Calotis lappulacea	Yellow Burr-daisy	U	N																						
Calotis spp.		U	N																						
Carduus spp.		U	E												1	1	1								
Carex breviculmis		U	N																						
Carex inversa	Knob Sedge	U	N		1			1	1		1	1			1	1	1	1			1	1	1		
Carthamus dentatus	Toothed Thistle	U	E								1														
Carthamus lanatus	Saffron Thistle	U	E											1				1		4				1	
Cassinia laevis	Cough Bush	U	N					1																	
Cassinia quinquefaria		U	N																						
Centaurea solstitialis	St Barnabys Thistle	U	E								1	1		7											4a
Centaurium erythraea	Common Centaury	U	E				4a																	4a	
Centaurium tenuiflorum		U	E																					4a	
Centaurium spp.		U	N	1																					
Chamaesyce spp.		U	N					1																	
Cheilanthes distans	Bristly Cloak Fern	U	N																						
Cheilanthes sieberi		U	N	1			1			1													1		

Revised Biometric Vegetation Type				227				240																	
Scientific Name	Common Name	Legal Status	Native/ Exotic	227 T A	227_T B	227_T C	TWSSMGT1	240 BM Plot 1	240 BM Plot 2	240 BM Plot 3	240_LOW A	240_LOW B	WBL1	WB-L-2	240_NP A	240_NP B	240_NP C	240_NP D	WBMGNP1	WBMGNP2	240_T	240_T B	240_T_C	WBMGT1	WBMGT2
Chenopodium pumilio	Small Crumbweed	U	E																						
Chenopodium spp.		U	N													1									
Chloris spp.		U	N																						
Chloris truncata	Windmill Grass	U	N												1	1		1	1		1	1	1		
Chloris ventricosa	Tall Chloris	U	N							1													1		
Choretrum candollei	White Sour Bush	U	N																						
Chrysocephalum apiculatum	Common Everlasting, Yellow But	U	N		1	1																		1	1
Cichorium intybus	Chicory	U	E																						
Cirsium vulgare	Spear Thistle	U	E										5		1	1	1	1	1		1			2	3
Clematis aristata	Old Man's Beard	U	N																						
Clematis glycinoides	Headache Vine	U	N																						
Convolvulus erubescens		U	N														1				1				
Convolvulus graminetinus		U	N																						
Conyza bonariensis	Flaxleaf Fleabane	U	E	1					1		1		2	1	1	1		1			1			1	4
Cotoneaster spp.		U	E																						
Craspedia canens	Grey Billy-buttons	U	N																						
Crepis spp.		U	N																						
Cyclospermum leptophyllum	Slender Celery	U	E										1	4a					3						3
Cymbonotus lawsonianus	Bear's Ear	U	N	1				1	1									1			1		1		
Cymbopogon refractus	Barbed Wire Grass	U	N	1		1	4	1	1	1														2	
Cynodon dactylon	Couch	U	N																						5
Cynodon incompletus		U	E								1	1													
Cynoglossum spp.		U	N					1																	
Cyperus gracilis	Slender Flat-sedge	U	N									1											1		
Cyperus spp.		U	N										3									1			
Dactylis glomerata	Cocksfoot	U	E																4						
Daucus glochidiatus	Native Carrot	U	N	1						1	1					1		1				1	1	4a	

Revised Biometric Vegetation Type				227				240																	
Scientific Name	Common Name	Legal Status	Native/ Exotic	227 T A	227_T B	227_T C	TWSSMGT1	240 BM Plot 1	240 BM Plot 2	240 BM Plot 3	240_LOW A	240_LOW B	WBL1	WB-L-2	240_NP A	240_NP B	240_NP C	240_NP D	WBMGNP1	WBMGNP2	240_T	240_T B	240_T_C	WBMGT1	WBMGT2
Daviesia genistifolia	Broom Bitter Pea	U	N																						
Desmodium brachypodum	Large Tick-trefoil	U	N					1	1														1		
Desmodium gunnii	Slender tick trefoil	U	N						1								1								
Desmodium spp.		U	N																					4a	
Desmodium varians	Slender Tick-trefoil	U	N	1		1												1			1	1			
Deyeuxia spp.		U	N																						
Dianella caerulea	Blue Flax-lily	P13	N						1																
Dianella longifolia		U	N				1	1																	
Dianella revoluta		U	N					1																	
Dianella spp.		U	N				3																		
Dichanthium sericeum	Queensland Bluegrass	U	N						1	1	1					1	1	1	3		1	1	1	2	2
Dichanthium setosum	Bluegrass	V	N																						
Dichelachne micrantha	Shorthair Plumegrass	U	N		1	1		1	1												1				
Dichelachne spp.		U	N				4a																	1	
Dichondra repens	Kidney Weed	U	N						1								1	1			1	1	1	4a	
Dichondra sp. A		U	N	1				1																	
Dichondra spp.		U	N													1			3						
Digitaria brownii	Cotton Panic Grass	U	N																						
Dillwynia phylicoides		U	N																						
Dillwynia sieberi		U	N		1	1			1																
Dipodium spp.		P13	N					1																	
Dodonaea viscosa subsp. *spatulata*		U	N																						
Echinochloa crusgalli	Barnyard Grass	U	E																			1			
Echinochloa spp.		U	N												1								1		
Echinopogon caespitosus	Bushy Hedgehog-grass	U	N	1	1	1			1													1	1		
Echinopogon cheelii	Long-flowered Hedgehog Grass	U	N	1																					
Echinopogon ovatus	Forest Hedgehog Grass	U	N				4a																1		

Revised Biometric Vegetation Type				227				240																	
Scientific Name	Common Name	Legal Status	Native/ Exotic	227 T A	227_T B	227_T C	TWSSMGT1	240 BM Plot 1	240 BM Plot 2	240 BM Plot 3	240_LOW A	240_LOW B	WBL1	WB-L-2	240_NP A	240_NP B	240_NP C	240_NP D	WBMGNP1	WBMGNP2	240_T	240_T B	240_T_C	WBMGT1	WBMGT2
Echinopogon spp.		U	N																					4a	
Einadia nutans	Climbing Saltbush	U	N	1					1		1				1	1							1		
Einadia polygonoides		U	N																						
Einadia spp.		U	N														1				1	1			
Eleusine spp.		U	E										3												
Eleusine indica	Crowsfoot grass	U	E																						
Eleusine tristachya	Goose Grass	U	E								1	1					1								
Elymus scaber		U	N																					3	
Enteropogon acicularis		U	N																						
Entolasia stricta	Wiry Panic	U	N																						
Epilobium billardiereanum		U	N											1											
Eragrostis brownii	Brown's Lovegrass	U	N																						
Eragrostis cilianensis	Stinkgrass	U	E		1																				
Eragrostis curvula	African Lovegrass	U	E	1		1																			
Eragrostis leptostachya	Paddock Lovegrass	U	N	1	1	1												1							
Eragrostis microcarpa		U	N																						
Eragrostis molybdea		U	N																						
Eragrostis spp.		U	N				4a						2									1	1		
Eremophila debilis	Amulla	U	N							1															
Erodium spp.		U	N														1								
Eucalyptus albens	White Box	U	N					1	1	1											1	1	1		4
Eucalyptus banksii	Tenterfield Woollybutt	U	N	1	1	1																			
Eucalyptus blakelyi	Blakely's Red Gum	U	N																				1	4	
Eucalyptus bridgesiana	Apple Box	U	N																						
Eucalyptus caliginosa	Broad-leaved Stringybark	U	N																						
Eucalyptus crebra	Narrow-leaved Ironbark	U	N		1																				
Eucalyptus dealbata	Tumbledown Red Gum	U	N																						
Eucalyptus laevopinea	Silver-top Stringybark	U	N																						

Revised Biometric Vegetation Type				227				240																	
Scientific Name	Common Name	Legal Status	Native/ Exotic	227 T A	227_T B	227_T C	TWSSMGT1	240 BM Plot 1	240 BM Plot 2	240 BM Plot 3	240_LOW A	240_LOW B	WBL1	WB-L-2	240_NP A	240_NP B	240_NP C	240_NP D	WBMGNP1	WBMGNP2	240_T	240_T B	240_T_C	WBMGT1	WBMGT2
Eucalyptus macrorhyncha	Red Stringybark	U	N						1																
Eucalyptus mckieana	McKie's Stringybark	V	N		1																				
Eucalyptus melliodora	Yellow Box	U	N																		1				
Eucalyptus prava	Orange Gum	U	N		1																				
Eucalyptus subtilior		U	N			1																			
Eucalyptus viminalis	Ribbon Gum	U	N																						
Euchiton sphaericus		U	N	1	1		1	1	1		1		3	4a	1	1	1	1	2		1		1	1	4a
Euphorbia spp.		U	N												1										
Exocarpos cupressiformis	Native Cherry	U	N																						
Festuca elatior	Tall Fescue	U	E																						
Fimbristylis dichotoma	Common Fringe-sedge	U	N	1	1		4a																		
Galium aparine	Goosegrass	U	E																						
Galium gaudichaudii	Rough Bedstraw	U	N																						
Galium spp.		U	N																						
Gamochaeta spicata		U	E			1																			
Geitonoplesium cymosum	Scrambling Lily	U	N																						
Geranium solanderi	Native Geranium	U	N	1			1	1	1	1	1		1				1	1			1		1	4a	1
Glossogyne tannensis	Cobbler's Tack	U	N																				1		
Glycine clandestina		U	N			1		1	1						1			1			1		1		
Glycine spp.		U	N				1			1							1					1			3
Glycine tabacina	Glycine	U	N	1	1	1		1	1										1		1		1	2	
Gonocarpus tetragynus		U	N		1																				
Goodenia bellidifolia		U	N		1	1																			
Goodenia paniculata		U	N																						
Grevillea ramosissima subsp. *ramosissima*	Fan Grevillea	U	N																						
Haloragis exalata		V	N																						
Haloragis heterophylla		U	N		1	1	4a																		

Revised Biometric Vegetation Type				227				240																	
Scientific Name	Common Name	Legal Status	Native/ Exotic	227 T A	227_T B	227_T C	TWSSMGT1	240 BM Plot 1	240 BM Plot 2	240 BM Plot 3	240_LOW A	240_LOW B	WBL1	WB-L-2	240_NP A	240_NP B	240_NP C	240_NP D	WBMGNP1	WBMGNP2	240_T	240_T B	240_T_C	WBMGT1	WBMGT2
Hardenbergia violacea	False Sarsaparilla	U	N																				1		
Heliotropium spp.		U	N						1																
Hibbertia obtusifolia	Hoary guinea flower	U	N			1			1																
Hirschfeldia incana	Hairy Brassica	U	E																	3					
Hordeum leporinum	Barley Grass	U	E																						
Hordeum spp.		U	E																2	3					4
Hovea heterophylla		U	N																						
Hovea linearis		U	N																						
Hydrocotyle laxiflora	Stinking Pennywort	U	N		1			1																	
Hydrocotyle peduncularis		U	N																						
Hydrocotyle spp.		U	N						1	1														3	
Hydrocotyle tripartita	Pennywort	U	N																						
Hypericum gramineum	Small St John's Wort	U	N		1	1	2		1																
Hypericum perforatum	St. Johns Wort	U	E																						
Hypochaeris glabra	Smooth Catsear	U	E	1	1																				
Hypochaeris radicata	Catsear	U	E	1	1	1	4a		1				3			1	1	1		2		1	1	3	1
Hypoxis spp.		U	N																						
Imperata cylindrica var. *major*	Blady Grass	U	N																						
Indigofera australis	Australian Indigo	U	N																						
Jacksonia scoparia	Dogwood	U	N																						
Joycea pallida	Silvertop Wallaby Grass	U	N																						
Juncus bufonius	Toad Rush	U	E		1																				
Juncus filicaulis		U	N																						
Juncus spp.		U	N				2																		
Juncus usitatus		U	N		1																				
Lachnagrostis filiformis		U	N																						
Lactuca saligna	Willow-leaved Lettuce	U	E	1																					

Revised Biometric Vegetation Type				227				240																	
Scientific Name	Common Name	Legal Status	Native/ Exotic	227 T A	227_T B	227_T C	TWSSMGT1	240 BM Plot 1	240 BM Plot 2	240 BM Plot 3	240_LOW A	240_LOW B	WBL1	WB-L-2	240_NP A	240_NP B	240_NP C	240_NP D	WBMGNP1	WBMGNP2	240_T	240_T B	240_T_C	WBMGT1	WBMGT2
Lactuca serriola	Prickly Lettuce	U	E																						
Lagenifera spp.		U	N																						
Lagenophora stipitata	Blue Bottle-daisy	U	N						1						1						1		1		
Lagurus ovatus	Hare's Tall Grass	U	E																					1	
Lamium amplexicaule	Henbit	U	E																						
Lepidium bonariense		U	E									1		1									1	3	
Lepidium spp.		U	N								1		4a		1		1			4a	1	1			2
Lepidosperma laterale		U	N																						
Leptospermum brevipes		U	N																						
Lespedeza juncea subsp. *sericea*		U	N						1	1											1		1		
Leucochrysum albicans		U	N						1	1															
Leucopogon muticus	Blunt Beard-heath	U	N																						
Lissanthe strigosa	Peach Heath	U	N		1	1	3																		
Lolium perenne	Perennial Ryegrass	U	E	1												1									
Lolium rigidum	Wimmera Ryegrass	U	E								1														
Lolium spp.		U	E				1						3						4	4a		1			4
Lolium sp. 2		U	E																						
Lomandra confertifolia		U	N																						
Lomandra filiformis	Wattle Matt-rush	U	N																						
Lomandra longifolia	Spiny-headed Mat-rush	U	N																						
Lomandra multiflora subsp. *multiflora*	Many-flowered Mat-rush	U	N					1	1																
Lomandra spp.		U	N																						
Lotus australis	Australian Trefoil	U	N						1																
Luzula spp.		U	N																						
Malva spp.		U	E									1										1			
Marrubium vulgare	Horehound	U	E																						
Medicago polymorpha	Burr Medic	U	E									1													

Revised Biometric Vegetation Type				227				240																	
Scientific Name	Common Name	Legal Status	Native/ Exotic	227 T A	227_T B	227_T C	TWSSMGT1	240 BM Plot 1	240 BM Plot 2	240 BM Plot 3	240_LOW A	240_LOW B	WBL1	WB-L-2	240_NP A	240_NP B	240_NP C	240_NP D	WBMGNP1	WBMGNP2	240_T	240_T B	240_T_C	WBMGT1	WBMGT2
Medicago sativa	Lucerne	U	E																						
Medicago spp.		U	E						1		1		5	3	1	1	1		4	4	1	1	1	2	3
Medicago sp. 1		U	E																						
Medicago sp. 2 (small)		U	E																						
Melichrus urceolatus	Urn Heath	U	N		1	1																			
Mentha australis	River Mint	U	N																				1		
Mentha diemenica	Slender Mint	U	N					1										1							
Mentha satureioides	Native Pennyroyal	U	N													1					1	1		2	
Mentha spp.		U	N						1							1									1
Micrantheum ericoides		U	N							1															
Microlaena stipoides		U	N	1	1	1	2															1	1	1	
Microseris lanceolata		U	N																						
Microtis spp.		U	N				3																		
Modiola caroliniana	Red-flowered Mallow	U	E																			1			
Monotoca scoparia		U	N			1																			
Muellerina eucalyptoides		U	N																						
Notelaea microcarpa	Native Olive	U	N					1	1	1															
Olearia elliptica	Sticky Daisy Bush	U	N						1																
Olearia sp. aff. *elliptica*		U	N																						
Onopordum acanthium	Scotch Thistle	U	E														1								
Opercularia aspera	Coarse Stinkweed	U	N		1																				
Opercularia diphylla		U	N																						
Oxalis perennans		U	N				1	1		1	1			3	1		1	1	3		1			2	2
Panicum effusum	Poison or Hairy Panic	U	N	1			3																		
Panicum queenslandicum	Yadbila Grass	U	N																		1		1		
Panicum spp.		U	N			1																			
Paronychia brasiliana	Chilean Whitlow Wort	U	E	1							1	1	1		1		1	1			1	1	1		1
Paspalum dilatatum	Paspalum	U	E	1			3				1	1	1	4a	1		1			2				2	2

Revised Biometric Vegetation Type				227				240																		
Scientific Name	Common Name	Legal Status	Native/ Exotic	227 T A	227_T B	227_T C	TWSSMGT1	240 BM Plot 1	240 BM Plot 2	240 BM Plot 3	240_LOW A	240_LOW B	WBL1	WB-L-2	240_NP A	240_NP B	240_NP C	240_NP D	WBMGNP1	WBMGNP2	240_T	240_T B	240_T_C	WBMGT1	WBMGT2
Pennisetum alopecuroides	Swamp Foxtail	U	E												1							1			
Pennisetum clandestinum	Kikuyu Grass	U	E																						
Pennisetum sp. 1		U	E				1																		
Persoonia cornifolia		P13	N																						
Petrorhagia nanteuilii		U	E	1			1						3	4a			1	1	3		1	1	1	1	3
Petrorhagia velutina		U	E																						
Phalaris aquatica	Phalaris	U	E													1									
Phyllanthus virgatus		U	N							1															
Picris hieracioides	Hawkweed Picris	U	E						1																
Pimelea curviflora		U	N					1	1	1											1				
Pimelea linifolia		U	N															1						1	
Pimelea neo-anglica	Poison Pimelea	U	N																						
Plantago debilis		U	N					1		1						1	1	1			1	1	1		
Plantago lanceolata	Lamb's Tongues	U	E	1			3												2					4a	4a
Plantago spp.		U	E																					2	
Plantago varia		U	N																						
Platysace ericoides		U	N																						
Poa labillardierei	Tussock Grass	U	N																						
Poa sieberiana		U	N	1		1		1	1	1							1				1	1	1		
Poa spp.		U	N				5																	4	
Polycarpon tetraphyllum	Four-leaved Allseed	U	E																						
Polygala japonica		U	N					1																	
Polygonum arenastrum		U	E																						
Polygonum aviculare	Wireweed	U	E										3												
Polygonum spp.		U	N								1			1						2					3
Pomax umbellata		U	N																						
Poranthera microphylla		U	N																						
Portulaca oleracea	Pigweed	U	N												1										

Revised Biometric Vegetation Type				227				240																	
Scientific Name	Common Name	Legal Status	Native/ Exotic	227 T A	227_T B	227_T C	TWSSMGT1	240 BM Plot 1	240 BM Plot 2	240 BM Plot 3	240_LOW A	240_LOW B	WBL1	WB-L-2	240_NP A	240_NP B	240_NP C	240_NP D	WBMGNP1	WBMGNP2	240_T	240_T B	240_T_C	WBMGT1	WBMGT2
Pratia concolor	Poison Pratia	U	N							1															
Pratia purpurascens	Whiteroot	U	N																						
Pterostylis spp.		P13	N																						
Pultenaea foliolosa		U	N																						
Pultenaea retusa		U	N						1																
Pycnosorus globosus		P13	N																						
Ranunculus lappaceus	Common Buttercup	U	N																						
Ranunculus repens	Creeping Buttercup	U	E																						
Rhodanthe spp.		U	N																						
Rosa rubiginosa	Sweet Briar	U	E	1	1		1	1								1					1		1	2	
Rostellularia spp.		U	N							1															
Rubus anglocandicans		U	E		1																				
Rubus fruticosus sp. agg.	Blackberry complex	U	E												1										
Rubus parvifolius	Native Raspberry	U	N							1															
Rubus rosifolius	Rose-leaf Bramble	U	N																						
Rubus ulmifolius	Blackberry	U	E				4a																		
Rumex brownii	Swamp Dock	U	N	1							1	1	2	3				1	2	2	1	1		1	
Rumex crispus	Curled Dock	U	E												1	1	1								
Sarga leiocladum		U	N					1																	
Schoenus apogon	Fluke Bogrush	U	N				4a																		
Scleranthus biflorus		U	N						1																
Scleria mackaviensis		U	N																						
Scutellaria humilis	Dwarf Skullcap	U	N																						
Senecio hispidulus	Hill Fireweed	U	N					1																	
Senecio prenanthoides		U	N																						
Senecio quadridentatus	Cotton Fireweed	U	N					1																3	
Senecio spp.		U	N													1					1				
Setaria pumila	Pale Pigeon Grass	U	E		1		4a							2											

Revised Biometric Vegetation Type				227				240																	
Scientific Name	Common Name	Legal Status	Native/ Exotic	227 T A	227_T B	227_T C	TWSSMGT1	240 BM Plot 1	240 BM Plot 2	240 BM Plot 3	240_LOW A	240_LOW B	WBL1	WB-L-2	240_NP A	240_NP B	240_NP C	240_NP D	WBMGNP1	WBMGNP2	240_T	240_T B	240_T_C	WBMGT1	WBMGT2
Sigesbeckia orientalis subsp. orientalis	Indian Weed	U	N																						
Silybum marianum	Variegated Thistle	U	E																	3					
Sisyrinchium sp. A		U	E																						
Solanum nigrum	Black-berry Nightshade	U	E																		1				
Solenogyne bellioides		U	N																						
Sonchus oleraceus	Common Sowthistle	U	E	1									1												1
Sorghum leiocladum	Wild Sorghum	U	N				4																	5	
Spartothamnella juncea		U	N							1															
Sporobolus creber	Slender Rat's Tail Grass	U	N	1		1	4				1	1	1		1		1	1			1	1	1		
Stackhousia viminea	Slender Stackhousia	U	N																						
Stellaria angustifolia	Swamp Starwort	U	N																						
Stellaria media	Common Chickweed	U	E																					2	
Styphelia triflora	Pink Five-Corners	U	N																						
Styphelia viridis		U	N						1																
Swainsona galegifolia	Smooth Darling Pea	U	N					1	1																
Swainsona spp.		U	N												1	1					1		1	1	
Tagetes minuta	Stinking Roger	U	E																						
Taraxacum officinale	Dandelion	U	E						1						1	1	1				1	1	1		
Themeda australis	Kangaroo Grass	U	N					1	1	1											1				
Themeda avenacea	Native Oatgrass	U	N																						2
Thesium australe	Austral Toadflax	V	N																						
Trachymene incisa		U	N			1																			
Tricoryne spp.		U	N				1																		
Trifolium arvense	Haresfoot Clover	U	E				1						3	3										2	
Trifolium campestre	Hop Clover	U	E					1										1							
Trifolium fragiferum	Strawberry Clover	U	E																						
Trifolium repens	White Clover	U	E	1									3			1			3					4b	

Revised Biometric Vegetation Type				227				240																	
Scientific Name	Common Name	Legal Status	Native/ Exotic	227 T A	227_T B	227_T C	TWSSMGT1	240 BM Plot 1	240 BM Plot 2	240 BM Plot 3	240_LOW A	240_LOW B	WBL1	WB-L-2	240_NP A	240_NP B	240_NP C	240_NP D	WBMGNP1	WBMGNP2	240_T	240_T B	240_T_C	WBMGT1	WBMGT2
Trifolium resupinatum	Shaftal Clover	U	E																						
Trifolium spp.		U	E											4a			1			1	1	1			4a
Trifolium sp. 2		U	E																						
Tripogon loliiformis	Fiveminute Grass	U	N																						
Urtica incisa	Stinging Nettle	U	N	1							1	1			1							1	1		
Verbascum spp.		U	E																				1		
Verbascum thapsus subsp. *thapsus*	Blanket Weed	U	E																						
Verbascum virgatum	Twiggy Mullein, Green Mullein	U	E																						
Verbena bonariensis	Purpletop	U	E																						
Verbena officinalis	Common Verbena	U	E												1										
Verbena rigida		U	E																						
Verbena rigida var. *rigida*	Veined Verbena	U	E					1																	
Verbena spp.		U	E																						
Vernonica cinerea		U	N																						
Veronica calycina	Hairy Speedwell	U	N					1																	
Veronica plebeia	Trailing Speedwell	U	N						1												1		1		
Veronica spp.		U	N																						
Vicia sativa		U	E						1					1		1					1	1		3	
Viola betonicifolia	Native Violet	U	N		1			1	1																
Vittadinia cuneata	Fuzzweed	U	N						1		1				1	1							1		2
Vittadinia muelleri		U	N															1							
Vittadinia spp.		U	N																					4a	
Vittadinia sp. 2		U	N																						
Vulpia bromoides	Squirrel Tail Fescue	U	E																						
Vulpia spp.		U	E				4																		
Vuplia sp. (tall)		U	E																						
Vulpia sp. (tiny)		U	E																						

Revised Biometric Vegetation Type				227				240																	
Scientific Name	Common Name	Legal Status	Native/ Exotic	227 T A	227_T B	227_T C	TWSSMGT1	240 BM Plot 1	240 BM Plot 2	240 BM Plot 3	240_LOW A	240_LOW B	WBL1	WB-L-2	240_NP A	240_NP B	240_NP C	240_NP D	WBMGNP1	WBMGNP2	240_T	240_T B	240_T_C	WBMGT1	WBMGT2
Wahlenbergia communis	Tufted Bluebell	U	N	1	1	1		1	1	1						1	1	1			1	1	1		
Wahlenbergia gracilis	Sprawling Bluebell	U	N																						
Wahlenbergia luteola		U	N																						
Wahlenbergia planiflora		U	N																						
Wahlenbergia spp.		U	N				3																	1	3
Westringia eremicola	Slender Westringia	U	N																						
Xanthium occidentale	Noogoora Burr	U	E																						
Xanthium spinosum	Bathurst Burr	U	E									1						1							
Xanthium spp.		U	E																			1			
Xanthorrhoea johnsonii		P13	N																						
Zornia spp.		U	N																						

Appendix E: Fauna Species List

Table 37: Fauna recorded within and around the study area

SCIENTIFIC NAME	COMMON NAME
Birds	
Acanthiza nana	Yellow Thornbill
Acanthiza pusilla	Brown Thornbill
Acanthorhynchus tenuirostris	Eastern Spinebill
Accipiter fasciatus	Brown Goshawk
Anas superciliosa	Pacific Black Duck
Anhinga melanogaster	Darter
Anthochaera carunculata	Red Wattlebird
Anthus australis	Australian Pipit
Aplonis metallica	Metallic Starling
Aquila audax	Wedge-tailed Eagle
Artamus cinereus	Black-faced Woodswallow
Cacatua galerita	Sulphur-crested Cockatoo
Cacomantis flabelliformis	Fan-tailed Cuckoo
Chenonetta jubata	Australian Wood Duck
Climacteris picumnus	Brown Treecreeper
Colluricincla harmonica	Grey Shrike-thrush
Coracina novaehollandiae	Black-faced Cuckoo-shrike
Corcorax melanorhamphos	White-winged Chough
Cormobates leucophaea	White-throated Treecreeper
Corvus coronoides	Australian Raven
*Corvus orru**	Torresian Crow
Coturnix ypsilophora	Brown Quail
Cracticus nigrogularis	Pied Butcherbird
Cracticus torquatus	Grey Butcherbird
Dacelo novaeguineae	Laughing Kookaburra
Dicaeum hirundinaceum	Mistletoebird

SCIENTIFIC NAME	COMMON NAME
Egretta novaehollandiae	White-faced Heron
Elanus axillaris	Black-shouldered Kite
Entomyzon cyanotis	Blue-faced Honeyeater
Eolophus roseicapillus	Galah
Eopsaltria australis	Eastern Yellow Robin
Eurostopodus mystacalis	White-throated Nightjar
Eurystomus orientalis	Dollarbird
Falco berigora	Brown Falcon
Falco cenchroides	Nankeen Kestrel
Gallinula tenebrosa	Dusky Moorhen
Gerygone mouki	Brown Gerygone
Gliciphila melanops	Tawny-crowned Honeyeater
Glossopsitta concinna	Musk Lorikeet
Glossopsitta pusilla	Little Lorikeet
Grallina cyanoleuca	Magpie-lark
Gymnorhina tibicen	Australian Magpie
Haliastur sphenurus	Whistling Kite
Hirundo neoxena	Welcome Swallow
Lalage tricolor	White-winged Triller
Lichenostomus chrysops	Yellow-faced Honeyeater
Lichenostomus flavicollis	Yellow-throated Honeyeater
Lichenostomus fuscus	Fuscous Honeyeater
Lichenostomus melanops	Yellow-tufted Honeyeater
Lichmera indistincta	Brown Honeyeater
Malurus cyaneus	Superb Fairy-wren
Manorina melanocephala	Noisy Miner
Melanodryas cucullata culcullata	Hooded Robin
Neochmia temporalis	Red-browed Finch
Neophema pulchella	Turquoise Parrot
Ocyphaps lophotes	Crested Pigeon
Oriolus sagittatus	Olive-backed Oriole
Pachycephala rufiventris	Rufous Whistler

SCIENTIFIC NAME	COMMON NAME
Pardalotus punctatus	Spotted Pardalote
Pardalotus striatus	Striated Pardalote
Passer domesticus	House Sparrow
Petroica boodang	Scarlet Robin
Phalacrocorax melanoleucos	Little Pied Cormorant
Philemon citreogularis	Little Friarbird
Philemon corniculatus	Noisy Friarbird
Platycercus adscitus eximius	Eastern Rosella
Platycercus elegans	Crimson Rosella
Podargus strigoides	Tawny Frogmouth
Poliocephalus poliocephalus	Hoary-headed Grebe
Psephotus haematonotus	Red-rumped Parrot
Pyrrholaemus saggitatus	Speckled Warbler
Rhipidura albiscapa	Grey Fantail
Rhipidura leucophrys	Willie Wagtail
Scythrops novaehollandiae	Channel-billed Cuckoo
Sericornis frontalis	White-browed Scrubwren
Smicrornis brevirostris	Weebill
Stagonopleura guttata	Diamond Firetail
Strepera graculina	Pied Currawong
Struthidea cinerea	Apostlebird
Taeniopygia bichenovii	Double-barred Finch
Threskiornis spinicollis	Straw-necked Ibis
Todiramphus sanctus	Sacred Kingfisher
Vanellus miles	Masked Lapwing
Microbats	
Chalinolobus gouldii	Gould's Wattled Bat
Chalinolobus morio	Chocolate Wattled Bat
Chalinolobus pumilus	Eastern forest bat
Falsistrellus tasmaniensis	Eastern False Pipistrelle
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat
Mormopterus norfolkensis	Eastern Freetail-bat

SCIENTIFIC NAME	COMMON NAME
Mormopterus sp. 4	Southern Freetail-bat
Nyctophilus sp.	
Nyctophilus geoffroyi	Lesser Long-eared Bat
Nyctophilus gouldi	Gould's Long-eared Bat
Nctophilus corbeni	Greater Long-eared Bat
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat
Scoteanax rueppellii	Greater Broad-nosed Bat
Scotorepens balstoni	Inland Broad-nosed Bat
Scotorepens orion	Eastern Broad-nosed Bat
Scotorepens sp.	
Tadarida australis	White-striped Freetail-bat
Vespadelus darlingtoni	Large Forest Bat
Vespadelus pumilus	Eastern Forest Bat
Vespadelus regulus	Southern Forest Bat
Vespadelus troughtoni	Eastern Cave Bat
Vespadelus vulturnus	Little Forest Bat
Mammals	
Macropus giganteus	Eastern Grey Kangaroo
Macropus robustus	Common Wallaroo
Macropus rufogriseus	Red-necked Wallaby
Petaurus breviceps	Sugar Glider
Pseudocheirus peregrinus	Common Ringtail Possum
Trichosurus sp.	Brushtail Possum
Trichosurus vulpecula	Common Brushtail Possum
Wallabia bicolor	Swamp Wallaby
Reptiles	
Amphibolurus muricatus	Jacky Lizard
Carlia tetradactyla	Southern Rainbow-skink
Chelodina sp.	Long-Necked Turtle
Pogona barbata	Bearded Dragon
Physignathus lesueurii	Eastern Water Dragon
Pseudonaja textilis	Eastern Brown Snake

SCIENTIFIC NAME	COMMON NAME
Tiliqua scincoides	Eastern Blue-tongue
Frogs	
Crinia parinsignifera	Eastern Sign-bearing Froglet
Limnodynastes tasmaniensis	Spotted Marsh Frog
Litoria peroni	Peron's Tree Frog
Litoria verreauxii	Verreaux's Tree Frog
Feral Animals	
*Bos taurus**	European cattle
*Canis lupus familiaris**	Dog
*Capra hircus**	Goat
*Dama dama**	Fallow Deer
*Equus caballus**	Horse
*Felis catus**	Cat
*Lepus capensis**	Brown Hare
*Oryctolagus cuniculus**	Rabbit
*Ovis aries**	Sheep
*Sus scrofa**	Pig
*Vulpes vulpes**	Fox

* = exotic

Appendix F: Bat Collision Matrix

Table 38: Bat collision risk matrix

SCIENTIFIC NAME	COMMON NAME	CONSERVATION STATUS (TSC & / or EPBC Act)	SEASONAL RISKS (EG. MIGRATION)	FLIGHT CHARACTER	ROOSTING	FORAGING	BREEDING SEASON	LIKELIHOOD OF SPECIES BEHAVIOUR RESULTING IN COLLISIONS	COLLISION DUE TO TURBINES IN PROXIMITY TO ROOSTING HABITAT	LIKELIHOOD OF COLLISION WITH OVERHEAD CABLING	OVERALL RISK	MITIGATION
Chalinolobus gouldii	Gould's Wattled Bat		No	Within canopy & sub canopy, selecting for gaps in the canopy	Tree hollows, buildings	Forages 5-10 km and up to 15 km from roost sites. Will pass through open paddocks Agile and fast flight (up to 36km/h), tending to be on a fixed horizontal plane with abrupt zigzag changes of course May also be attracted to turbine lighting as the species is known to feed around floodlights	Mating in late autumn / winter Juveniles fly December or January	High	Moderate	Low	**Moderate**	Turbines located at least 30 m from hollow-bearing trees Turbine lighting should be a form that minimises attraction of insects.
Chalinolobus morio	Chocolate Wattled Bat		No - individuals in southern Australia do not migrate	Open zone between the top of the understorey and the canopy	Tree hollows, buildings and caves	Forage up to 5km from their roost sites Range of habitats including treeless regions A fast, direct and agile hunter with rapid wing beats, recorded flying at speeds of 28km/h	Mating in autumn and winter Birth in late spring or early summer	Low	Moderate - low	Low	**Low**	
Chalinolobus picatus	Little Pied Bat	V	No	Within the canopy	Mainly tree hollows, but also disused buildings and caves	Agile and manoeuvrable with fast, darting flight Have been found to make nightly return trips of 14-34km	Pregnancy from mid-September Birth in late spring (November), with young	High	Moderate	Low	**Moderate**	Turbines located at least 30 m from hollow-bearing trees

SCIENTIFIC NAME	COMMON NAME	CONSERVATION STATUS (TSC & / or EPBC Act)	SEASONAL RISKS (EG. MIGRATION)	FLIGHT CHARACTER	ROOSTING	FORAGING	BREEDING SEASON	LIKELIHOOD OF SPECIES BEHAVIOUR RESULTING IN COLLISIONS	COLLISION DUE TO TURBINES IN PROXIMITY TO ROOSTING HABITAT	LIKELIHOOD OF COLLISION WITH OVERHEAD CABLING	OVERALL RISK	MITIGATION
							leaving maternity roosts in early March					
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	No	Within or just below the canopy in gaps, along tracks, and also in open areas	Tree hollows and sometimes buildings	Swift and direct flight in a fixed horizontal plane with sudden darting changes in course Highly mobile, with large foraging range (up to 136 ha). Has been recorded foraging 12km from roost sites	Females pregnant late spring to early summer Birth in December with lactation continuing through January and February	Moderate	Moderate - high	Low	**Moderate - uncommon on ridgetop forests where soil fertility is low.**	Turbines located at least 30 m from hollow-bearing trees
Miniopterus schreibersii oceanensis	Eastern Bentwing Bat	V	Yes – travel up to several hundred kilometres to over-wintering roosts	High, from just above to many times above the canopy and in open areas	Caves, disused mines	Fast flight and typically level with swift shallow dives Can travel up to 65km in one night Forested areas opens areas, waterways, street lights and tracks	Mating in early winter Birth in spring /. Summer Juveniles leave cave in march	High	Low	Low	**Moderate – may also be attracted to turbine lighting**	Turbine lighting should be a form that minimises attraction of insects.
Mormopterus norfolkensis	Eastern Freetail Bat	V	No	Preference for open spaces in woodland or forest	Mainly in tree hollows but also under bark or in man-made structures	Forages within a few km from roost sites, although individuals have been recorded foraging up to 6 km from roost sites Fast flier in natural and artificial openings within dry eucalypt forest and woodland	Birth in late November or early December Young are free-flying by late January	Moderate	Moderate	Low	**Moderate**	Turbines located at least 30 m from hollow-bearing trees
Mormopterus sp. 4	Southern Freetail Bat			Above the canopy, in the spaces	Tree hollows and in the roofs of	Can forage up to 12 km from roosts Agile flier, although they	Young born in December or January.	High	Moderate	Low	**High**	Turbines located at least 30 m from hollow-

SCIENTIFIC NAME	COMMON NAME	CONSERVATION STATUS (TSC & / or EPBC Act)	SEASONAL RISKS (EG. MIGRATION)	FLIGHT CHARACTER	ROOSTING	FORAGING	BREEDING SEASON	LIKELIHOOD OF SPECIES BEHAVIOUR RESULTING IN COLLISIONS	COLLISION DUE TO TURBINES IN PROXIMITY TO ROOSTING HABITAT	LIKELIHOOD OF COLLISION WITH OVERHEAD CABLING	OVERALL RISK	MITIGATION
				between trees. Also along roadways, at the outer edge of remnant vegetation, and on the ground	houses	have difficulty taking off from the ground and will climb 1-2m from the ground before launching	Young are flying by March					bearing trees
Nyctophilus spp.	A Long-eared Bat		No	Below canopy and often fly close to the ground	Dead trees, exfoliating bark or hollows	Slow, manoeuvrable, undulating flight through dense canopy Can forage in open areas but most is in dense areas Capable of foraging up to 12 km from their roost – when commuting flight is rapid and direct	Birth October – November Young fly in December or January	Low	Low	Low	**Low**	
Nyctophilus gouldi	Gould's Long-eared Bat		No	Typically fly slowly in large circles approximately 2 – 5 m above the ground and below the canopy of forest trees. Ecolocation is not used for orientation except in unfamiliar environments, nor is it used when they	Rooftops, tree hollows and under peeling bark. Maternity roosts are located preferentially in hollows of large trees, usually in gullies.	Slow, manoeuvrable, flight for foraging in dense vegetation. Capable of foraging in open situations also. May sit and wait before dropping on its prey in the forest litter.	First young fly in January.	Low	Low	Low	**Low**	

SCIENTIFIC NAME	COMMON NAME	CONSERVATION STATUS (TSC & / or EPBC Act)	SEASONAL RISKS (EG. MIGRATION)	FLIGHT CHARACTER	ROOSTING	FORAGING	BREEDING SEASON	LIKELIHOOD OF SPECIES BEHAVIOUR RESULTING IN COLLISIONS	COLLISION DUE TO TURBINES IN PROXIMITY TO ROOSTING HABITAT	LIKELIHOOD OF COLLISION WITH OVERHEAD CABLING	OVERALL RISK	MITIGATION
				approach prey as they rely on listening.								
Nyctophilus geoffroyi	Lesser Long-eared Bat			Below canopy and often flies close to the ground. When commuting their flight is rapid and direct.	Dead trees, under exfoliating bark, in hollows or buildings.	Forages with slow, manoeuvrable, undulating flight pattern. Adapted to both urban and rural environments. Individuals move every day or two between a number of roost sites within a defined roosting area. Individuals capable of foraging up to 12 km from their roost site. In farmland areas they can fly across open paddocks but most foraging is concentrated around remnant vegetation.	Mating in autumn. Twin young born in October or November. Young commence flying in December or January.	Moderate – when commuting	Low	Low	**Low**	
*Nyctophilus corbeni***	Greater (eastern) Long-eared Bat	V	No	Utilises the understorey to hunt non-flying prey - especially caterpillars and beetles - and will even hunt on the ground.	Roosts in tree hollows, crevices, and under loose bark.	Slow flying agile bat, utilising the understorey to hunt non-flying prey - especially caterpillars and beetles - and will even hunt on the ground. Mating takes place in autumn with one or two young born in late spring to early summer. Probably forage within a few kilometres of their roosting area.	Mating in Autumn Birth late Spring – early Summer	Low	Low	Low	**Low**	

SCIENTIFIC NAME	COMMON NAME	CONSERVATION STATUS (TSC & / or EPBC Act)	SEASONAL RISKS (EG. MIGRATION)	FLIGHT CHARACTER	ROOSTING	FORAGING	BREEDING SEASON	LIKELIHOOD OF SPECIES BEHAVIOUR RESULTING IN COLLISIONS	COLLISION DUE TO TURBINES IN PROXIMITY TO ROOSTING HABITAT	LIKELIHOOD OF COLLISION WITH OVERHEAD CABLING	OVERALL RISK	MITIGATION
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	Migrate to southern Australia between January and April during the summer	Above canopy but lower in open areas and at forest edges	Tree hollows and buildings	Fast and straight flight, capable of tight lateral turns	December to mid-March	High	Moderate	Low	**High**	Turbines located at least 30 m from hollow-bearing trees
Scoteanax rueppellii	Greater Broad-nosed Bat	V	No	Flies at around 30m or so. In cluttered environments, flies low along creeks and small rivers	Tree hollows and sometimes the roof spaces of old buildings	Slow and direct pattern with limited manoeuvrability along flyways or forest edges	Birth in January	High	Moderate	Moderate	**Moderate**	Turbines located at least 30 m from hollow-bearing trees
Scotorepens balstoni	Inland Broad-nosed Bat		No	Among and below canopy, within 15m of the ground although may also forage on ground	Tree hollows and roofs	Fast, flickering wingbeats Flight is continuous with sudden rapid diversions in pursuit of prey Flight speeds have been recorded from 12-21km/h	Birth in November Young fly during their second month of life	Low	Low	Low	**Low**	
Scotorepens orion	Eastern Broad-nosed Bat		No	Unknown	Tree hollows and buildings	Large foraging range in a variety of environments May forage around flood lights in urban areas	Mates in autumn but ovulation and fertilisation delayed until spring. Births in November or December	Moderate	Moderate	Low	**Moderate**	Turbines located at least 30 m from hollow-bearing trees Turbine lighting should be a form that minimises attraction of insects.

SCIENTIFIC NAME	COMMON NAME	CONSERVATION STATUS (TSC & / or EPBC Act)	SEASONAL RISKS (EG. MIGRATION)	FLIGHT CHARACTER	ROOSTING	FORAGING	BREEDING SEASON	LIKELIHOOD OF SPECIES BEHAVIOUR RESULTING IN COLLISIONS	COLLISION DUE TO TURBINES IN PROXIMITY TO ROOSTING HABITAT	LIKELIHOOD OF COLLISION WITH OVERHEAD CABLING	OVERALL RISK	MITIGATION
Scotorepens sp.			No	Above and within canopy	Tree hollows and buildings	Fast flight, foraging by aerial pursuit	Pregnant females have been caught in mid October, November and December, and lactating females have been caught in December and January. Births are probably in December	Moderate	Moderate	Low	**Moderate**	Turbines located at least 30 m from hollow-bearing trees
Tadarida australis	White-striped Freetail Bat		Yes – migrate to northern regions during winter (non-hibernating species)	Above canopy	Large eucalypts (often in their hollows) Roosts in trees in a range of habitats from forest to open parklands	Fast and direct path High altitude feeding Can commute 50 km between roost and feeding	Birth mid-December to end of January Juveniles weaned by mid-February	High	High	Low	**High**	Turbines located at least 30 m from hollow-bearing trees Turbines located in north south rather than east west direction to minimise impacts on northern migration activities
Vespadelus darlingtoni	Large Forest Bat		No	Below canopy, within canopy and forest floor	Tree hollows and also buildings	Less manoeuvrable than most *Vespadelus* Flight characterised by rapid wing beats that are interrupted by gliding changes of direction	Birth November – December Juveniles fly from mid-January.	Low	Low	Low	**Low**	

SCIENTIFIC NAME	COMMON NAME	CONSERVATION STATUS (TSC & / or EPBC Act)	SEASONAL RISKS (EG. MIGRATION)	FLIGHT CHARACTER	ROOSTING	FORAGING	BREEDING SEASON	LIKELIHOOD OF SPECIES BEHAVIOUR RESULTING IN COLLISIONS	COLLISION DUE TO TURBINES IN PROXIMITY TO ROOSTING HABITAT	LIKELIHOOD OF COLLISION WITH OVERHEAD CABLING	OVERALL RISK	MITIGATION
						Foraging areas range from 10ha to over 300ha. Individuals can forage for up to 6km Cluttered vegetation avoided. Foraging and commuting focused along trails and streams						
Vespadelus pumilus	Eastern Forest Bat		No	Mainly within the spaces among trees and between the canopy and understorey	Tree hollows	Flight is more manoeuvrable than Large Forest Bat Foraging ranges are small averaging about 6 hectares and comprising a number of discrete centres of activity. Mature forest is preferred over flyways and tracks. In dense regrowth vegetation, makes extensive use of riparian zones.	Twinning is common Births in November	Low	Low	Low	**Low**	
Vespadelus regulus	Southern Forest Bat		No	Below canopy & within canopy	Tree hollows and roof cavities	Highly manoeuvrable, moderately fast flight with flight speeds of 5-25km/h Small foraging range of less than 10ha	Birth early summer	Low	Low	Low	**Low**	
Vespadelus troughtoni	Eastern Cave Bat	V	No	Air space above creeks and in spaces between trees, interspersed with occasional rapid flights	Well-lit areas in overhangs and caves, mine tunnels, road culverts, occasionally in buildings	Forage over a small area around 30 ha	In NSW, maternity colonies of up to 500 females congregate during November	Low	Low	Low	**Low**	

SCIENTIFIC NAME	COMMON NAME	CONSERVATION STATUS (TSC & / or EPBC Act)	SEASONAL RISKS (EG. MIGRATION)	FLIGHT CHARACTER	ROOSTING	FORAGING	BREEDING SEASON	LIKELIHOOD OF SPECIES BEHAVIOUR RESULTING IN COLLISIONS	COLLISION DUE TO TURBINES IN PROXIMITY TO ROOSTING HABITAT	LIKELIHOOD OF COLLISION WITH OVERHEAD CABLING	OVERALL RISK	MITIGATION
				across paddocks	and Fairy Martin nests							
Vespadelus vulturnus	Little Forest Bat		No	Below canopy	Roof cavities and hollows in dead timber	Very agile, with fluttery flight, feeding at the top of the shrub layer Forage up to 1.5km from roost sites	Birth early summer	Low	Low	Low	**Low**	

Note:

Flight characteristics sourced from Strahan (2008) or DECCW (2011)

**** = not recorded within the study area but predicted to occur**

Appendix G: Bird Collision Matrix

Table 39: Bird collision matrix – commonly recorded and threatened species recorded within the study area

SCIENTIFIC NAME	COMMON NAME	CONSERVATION STATUS	NUMBER OF RECORDS ON SITE	FLIGHT CHARACTERISTICS	MIGRATORY	DISTRIBUTION ACROSS SITE	RISK OF COLLISION WITH TURBINES	RISK OF COLLISION WITH OVERHEAD POWERLINES
Threatened species								
Climacteris picumnus victoriae	Brown Treecreeper	V	1	Moderate to low	No	Woodlands	Low	Low
Melanodryas cucullata cucullata	Hooded Robin	V	2	Moderate to low	No	Woodlands	Low	Low
Stagonopleura guttata	Diamond Firetail	V	2	Moderate to low	No	Woodlands & grassland	Low	Low
Glossopsitta pusilla	Little Lorikeet	V	11	Fast, high - low flight depending on activity	No	Woodlands & grassland	Moderate	Low
Neophema pulchella	Turquoise Parrot	V	1	Fast, high - low flight depending on activity	No	Woodlands & grassland	Moderate – primarily when moving between	Low

SCIENTIFIC NAME	COMMON NAME	CONSERVATION STATUS	NUMBER OF RECORDS ON SITE	FLIGHT CHARACTERISTICS	MIGRATORY	DISTRIBUTION ACROSS SITE	RISK OF COLLISION WITH TURBINES	RISK OF COLLISION WITH OVERHEAD POWERLINES
							sites	
Petroica boodang	Scarlet Robin	V	1	Moderate to low	No	Woodlands	Low	Low
Pyrrholaemus saggitatus	Speckled Warbler	V	1	Moderate to low	No	Woodlands	Low	Low
Commonly recorded species								
Manorina melanocephala	Noisy Miner	-	23	Moderate to low	No	Woodlands & grasslands	Low	Low
Glossopsitta concinna	Musk Lorikeet	-	22	Fast, high - low flight depending on activity	No	Woodlands	Moderate	Low
Platycercus elegans	Crimson Rosella	-	22	Fast, high - low flight depending on activity	No	Woodlands	Moderate	Low
Anthochaera carunculata	Red Wattlebird	-	18	Moderate to low	No	Woodlands & grasslands	Low	Low
Gymnorhina tibicen	Australian Magpie	-	18	Moderate to low	No	Woodlands & grasslands	Low	Low
Platycercus adscitus eximius	Eastern Rosella	-	18	Fast, high - low flight depending on activity	No	Woodlands	Moderate	Low
Pachycephala rufiventris	Rufous Whistler	-	14	Moderate to low	No	Woodlands	Low	Low

SCIENTIFIC NAME	COMMON NAME	CONSERVATION STATUS	NUMBER OF RECORDS ON SITE	FLIGHT CHARACTERISTICS	MIGRATORY	DISTRIBUTION ACROSS SITE	RISK OF COLLISION WITH TURBINES	RISK OF COLLISION WITH OVERHEAD POWERLINES
Cacatua galerita	Sulphur-crested Cockatoo	-	10	Moderate to low	No	Woodlands	Low	Low
Todiramphus sanctus	Sacred Kingfisher	-	10	Moderate to low	No	Woodlands	Low	Low
Birds of Prey								
Falco cenchroides	Nankeen Kestrel		2	High, soaring	Partially	Grassland	Moderate	Low
Aquila audax	Wedge-tailed Eagle		2	High, soaring	No	Grassland	Moderate	Low
Elanus axillaris	Black-shouldered Kite		1	High, soaring	Nomadic; populations may irrupt in response to mouse plagues in particular areas.	Grassland, woodland	Moderate	Low
Accipiter fasciatus	Brown Goshawk		1	High, soaring	Northern birds are sedentary, but southern birds tend to be nomadic, and immature birds move north when dispersing during the winter months.	Grassland, woodland	Moderate	Low

SCIENTIFIC NAME	COMMON NAME	CONSERVATION STATUS	NUMBER OF RECORDS ON SITE	FLIGHT CHARACTERISTICS	MIGRATORY	DISTRIBUTION ACROSS SITE	RISK OF COLLISION WITH TURBINES	RISK OF COLLISION WITH OVERHEAD POWERLINES
Haliastur sphenurus	Whistling Kite		1	High, soaring	Partially migratory, but mostly resident in northern and western Australia	Grassland, woodland	Moderate	Low

Note:
V = vulnerable

Appendix H: Part 3A Impact Assessment Criteria

ENDANGERED ECOLOGICAL COMMUNITIES

The following communities have been recorded throughout the study area:

- White Box Yellow Box Blakely's Red Gum Woodland (EEC)
- Ribbon Gum - Mountain Gum - Snow Gum Grassy Forest/Woodland of the New England Tableland Bioregion (EEC)

FLORA

The following species have been recorded across the project site:

- *Dichanthium setosum* (Bluegrass);
- *Eucalyptus mckieana* (McKie's Stringybark); and
- *Thesium australe* (Austral Toadflax).

The following species have the potential to occur:

- *Acacia pubifolia* (Velvet Wattle)
- *Astrotricha roddii* (Rod's Star Hair)
- *Digitaria porrecta* (Finger Panic Grass)
- *Diuris pedunculata* (Small Snake Orchid)
- *Eucalyptus nicholii* (Narrow-leaved Black Peppermint)
- *Picris evae* (Hawkweed)

FAUNA

The following species have been recorded across the project site:

- *Stagonopleura guttata* (Diamond Firetail);
- *Glossopsitta pusilla* (Little Lorikeet)
- *Climacteris picumnus victoriae* (Brown Treecreeper)

- *Melanodryas cucullata cucullata* (Hooded Robin)
- *Neophema pulchella* (Turquoise Parrot)
- *Petroica boodang* (Scarlet Robin)
- *Pyrrholaemus saggitatus* (Speckled Warbler)
- *Scoteanax rueppellii* (Greater Broad-nosed Bat)
- *Miniopterus schreibersii* (Eastern Bentwing-bat)
- *Vespadelus troughtoni* (Eastern Cave Bat)
- *Mormopterus norfolkensis* (Eastern Freetail-Bat)
- *Falsistrellus tasmaniensis* (Eastern False Pipistrelle)
- *Saccolaimus flaviventris* (Yellow-bellied Sheathtail Bat)

The following species have the potential to occur:

- *Anthochaera phrygia* (Regent Honeyeater)
- *Lophoictinia isura* (Square-tailed Kite)
- *Lathamus discolor* (Swift Parrot)
- *Daphoenositta chrysoptera* (Varied Sittella)
- *Hieraaetus morphnoides* (Little Eagle)
- *Circus assimilis* (Spotted Harrier)
- *Phascolarctos cinereus* (Koala)
- *Nyctophilus corbeni* (South-eastern Long-eared Bat)
- *Dasyurus maculatus* (Spotted-tailed Quoll)
- *Petaurus norfolcensis* (Squirrel Glider)
- *Underwoodisaurus sphyrurus* (Border Thick-tailed Gecko)

ENDANGERED ECOLOGICAL COMMUNITIES

White Box Yellow Box Blakely's Red Gum Woodland (BGW)

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Not applicable - BGW is not a threatened species or population.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The proposal will result in the permanent removal of up to 23.07 ha of BGW, comprising 6.15 ha of remnant woodland, and 16.92 ha of derived grassland. An additional 22.42 ha of temporary clearance is proposed for roads, reticulation and construction facilities. This temporary removal comprises 4.67 ha of remnant woodland and 17.75 ha of derived native grassland/native pasture. This represents 12.5 % of the BGW present within the study area, but only 2.4% of the BGW present within the project site.

The vegetation clearance will take place as small fragments across a large area and will not be one consolidated block. Management measures including a Weed Management Plan will be implemented to prevent degradation of adjacent remaining areas of BGW due to edge effects and weed invasion. Furthermore, extensive areas of BGW will remain within the study area (319.84 ha) and project site (1,858.54 ha) and offsets will be provided for all BGW clearance.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

BGW is not a threatened species or population. However, it is not at the limit of its known distribution at Sapphire.

How is the proposal likely to affect current disturbance regimes?

Current disturbances at the site include cattle and sheep grazing, soil disturbance and grazing by feral animals including the European Rabbit and European Hare and periods of drought and rainfall consistent with the southern oscillation index and resultant cycles of drought (El Niño) and wetter periods (La Niña). There have been no major fire events on the site in the last decade.

The site is grazed primarily by sheep and cattle. Due to extended drought, stocking rates were not high at the time of survey. Grazing pressure and management varies across the landscape, and the proposal is considered unlikely to exacerbate over-grazing at the site, but may, in fact, contribute to a more sustainable grazing regime through the mitigation measures proposed in some parts of the site. In the absence of fire, grazing can be an important form of disturbance to prevent the accumulation of biomass that may not be favourable to some native flora species. Grazing will be periodically removed during construction, but should be reintroduced post-construction. Rotational periods of grazing and spelling help to foster healthy native pastures in the absence of fire.

The risk of fire with wind farms is inherently low (CFA 2007). A low risk is associated with malfunctioning turbine bearings, inadequate crankcase lubrication, cable damage during rotation, electrical shorting or arcing occurring in transmission and distribution facilities (CFA 2007). The location of wind turbines primarily in grassy breaks away from / between tall vegetation in the study area minimises the risk of fire. It is unlikely that the proposal will significantly affect the fire regime and given the range of fire mitigation measures to be put in place during and post construction, it is unlikely that the proposal would result in a high intensity fire that would have a detrimental impact on the BGW. The proposed access roads will increase the accessibility across the site should a fire occur.

The study area is primarily located on ridge tops and, therefore, is largely not affected by the surrounding streams. Conversely, the proposal is not likely to significantly affect flooding or flow regimes for the study area. There may be a small and localised increase in run-off in areas where the ground within the construction area will be compacted, gravelled or concreted. Soil erosion and run-off control measures will be implemented as part of the mitigation measures undertaken for the proposal.

The proposal is considered unlikely to contribute to increasing feral animal activity across the project site and instead is likely to assist with the management of these species through the proposed mitigation measures to be implemented within the study area and on the proposed offset sites.

How is the proposal likely to affect habitat connectivity?

The proposal will result in minor fragmentation of BGW primarily through the construction of access roads and create small breaks in the vegetation where turbines are installed. However, the structure of BGW across the site is open woodland and therefore canopy gaps are common. Routes for access roads and turbine locations have been selected such that tree clearance is avoided wherever possible. Although the proposed infrastructure will create some fragmentation, principally of the ground later, this is considered to be minor and will not prevent seed dispersal mechanisms within and between stands of vegetation.

Furthermore, at least 319.84 ha of BGW will remain within the study area and 1858.54 ha within the project site.

Some existing vegetation corridors will be subject to disturbance within the study area, however, this is likely to consist of 100 m or 80 m turbine layout nodes, with only a 12 m access road joining these nodes. The corridors are already subject to some fragmentation from historic land uses (agriculture) and the development footprint has avoided the most intact sections of these vegetation corridors throughout the project site.

How is the proposal likely to affect critical habitat?

Not applicable - critical habitat has not been declared for this community.

Ribbon Gum - Mountain Gum - Snow Gum Grassy Forest/Woodland of the New England Tableland Bioregion (RGMGSGGW)

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Not applicable - RGMGSGGW is not a threatened species or population.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The proposal will result in the permanent removal of up to 116.22 ha of RGMGSGGW in various conditions from the study area. This comprises 68.64 ha of remnant woodland, 33.28 ha of modified derived native grassland/native pasture and 14.3 ha in Low condition.

An additional area will be temporarily cleared (124.64 ha) for roads, reticulation and construction facilities, the majority of which is modified native pasture (56.59 ha).

There is approximately 1,490.79 ha of RGMGSGGW mapped within the study area and 7,830.58 ha mapped within the project site. This proposed loss represents only a small proportion of the community present within the study area (7.8%) and project site (1.5%).

Small fragments of vegetation will be removed across a large area and rather than one consolidated block. Management measures including a Weed Management Plan will be implemented to prevent degradation of adjacent remaining areas of RGMGSGGW due to edge effects and weed invasion.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

RGMGSGGW is not a threatened species or population. However, it is not at the limit of its known distribution at Sapphire.

How is the proposal likely to affect current disturbance regimes?

Current disturbances at the site include cattle and sheep grazing, soil disturbance and grazing by feral animals including the European Rabbit and European Hare and periods of drought and rainfall consistent with the southern oscillation index and resultant cycles of drought (El Niño) and wetter periods (La Niña). There have been no major fire events on the site in the last decade.

The site is grazed primarily by sheep and cattle. Due to extended drought, stocking rates were not high at the time of survey. Grazing pressure and management varies across the landscape, and the proposal is considered unlikely to exacerbate over-grazing at the site, but may, in fact, contribute to a more sustainable grazing regime through the mitigation measures proposed in some parts of the site. In the absence of fire, grazing can be an important form of disturbance to prevent the accumulation of biomass that may not be favourable to some native flora species. Grazing will be periodically removed during construction, but should be reintroduced post-construction. Rotational periods of grazing and spelling help to foster healthy native pastures in the absence of fire.

The risk of fire with wind farms is inherently low (CFA 2007). A low risk is associated with malfunctioning turbine bearings, inadequate crankcase lubrication, cable damage during rotation, electrical shorting or arcing occurring in transmission and distribution facilities (CFA 2007). The location of wind turbines primarily in grassy breaks away from / between tall vegetation in the study area minimises the risk of fire. It is unlikely that the proposal will significantly affect the fire regime and given the range of fire mitigation measures to be put in place during and post construction, it is unlikely that the proposal would result in a high intensity fire that would have a detrimental impact on the RGMGSGGW. The proposed access roads will increase the accessibility across the site should a fire occur.

The study area is primarily located on ridge tops and, therefore, is largely not affected by the surrounding streams. Conversely, the proposal is not likely to significantly affect flooding or flow regimes for the study area. There may be a small and localised increase in run-off in areas where the ground within the construction area will be compacted, gravelled or concreted. Soil erosion and run-off control measures will be implemented as part of the mitigation measures undertaken for the proposal.

The proposal is considered unlikely to contribute to increasing feral animal activity across the project site and instead is likely to assist with the management of these species through the proposed mitigation measures to be implemented within the study area and on the proposed offset sites.

How is the proposal likely to affect habitat connectivity?

The proposal will result in minor fragmentation of RGMGSGGW primarily through the construction of access roads and create small breaks in the vegetation where turbines are installed. However, the structure of the RGMGSGGW across the site is open woodland and therefore canopy gaps are common. Routes for access roads and turbine locations have been selected such that tree clearance is avoided wherever possible. Although the proposed infrastructure will create some fragmentation, principally of the ground layer, this is considered to be minor and will not prevent seed dispersal mechanisms within and between stands of vegetation.

Furthermore, at least 1,249.93 ha of RGMGSGGW will remain within the study area and 7,589.72 ha within the project site.

Some vegetation corridors will be subject to disturbance within the study area, however this is likely to consist of 100 m or 80 m turbine layout nodes, with only a 12 m access road joining these nodes. The corridors are already subject to some fragmentation from historic land uses (agriculture) and the development footprint has avoided the most intact sections of these vegetation corridors throughout the project site.

How is the proposal likely to affect critical habitat?

Not applicable - critical habitat has not been declared for this community.

FLORA

***Acacia pubifolia* (Velvet Wattle)**

Acacia pubifolia is an erect or spreading tree that grows 3-8 m high with golden yellow flowers and dark-grey bark. The leaves are hairy and feel like velvet. Its flowers are clustered together in a long tube or spike 2 - 5 cm long (DECCW 2011b) and appear during September-November. (DSEWPC 2011b).

This *species* is confined to the Darling Downs, between Glen Aplin and Wallangarra, in south-eastern Qld and to northern NSW, where it is less common (Orchard & Wilson 2001).

In *NSW*, it is known from two disjunct localities:

1) Torrington State Recreation Area, north-west of Emmaville in the south-western portion of the reserve. There is one dense but small population along Gulf Rd, and scattered mature plants along the lower portion of Carpet Snake Fire Trail (Clarke *et al.* 1998; Copeland & Hunter 1999).
2) On private property near Warrabah NP, about 60 km west of Armidale. In consultation with the landholder, the NSW NPWS has fenced off the population and is monitoring its progress (Creamer 1999). This population consists of 95 plants (P.Metcalfe 1999, pers.comm. in Copeland & Hunter 1999).

This species generally grows on rocky granite hillsides, in sandy, stony or loamy soil in eucalypt-scrub woodland or *Eucalyptus-Callitris* forest (Orchard & Wilson 2001). In NSW it is recorded growing in shrubby woodland on granite (Clarke *et al.* 1998). The population near Warraba is in partially cleared country (Copeland & Hunter 1999). Within the study area, potential habitat occurs in woodland communities (DECCW 2011b), and within the study area would be associated with the Blakely's Red Gum – Rough-barked Apple – Red Stringybark grassy open forest, Blakely's Red Gum – Yellow Box grassy open forest, Manna Gum – Rough-barked Apple – Yellow Box grassy woodland/open forest, Tenterfield Woollybutt - Silvertop Stringybark open forest and White Box grassy woodland communities.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

There is potential for *Acacia pubifolia* to occur within areas of rocky hillsides and woodland. Vegetation surveys and target surveys were conducted across the proposed development footprint in suitable habitat during October-December 2008, and September, October, and December 2010, during the species' known flowering period.

The proposal is unlikely to disrupt the dispersal ability of *Acacia pubifolia* to spread throughout the landscape, as the primary means of dispersal are likely to be wind dispersal and animal vectors. The movement of animals, particularly stock, may be temporarily disrupted during the construction period, however it stock are likely to return following construction. Wind patterns at ground level are unlikely to affected by the proposed development. Given there are no *Acacia pubifolia* recorded within the study area, it is unlikely the proposal is likely to affect the lifecycle of *Acacia pubifolia*.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

Acacia pubifolia is a threatened species, listed as Endangered under the TSC Act.

Vegetation will be removed in linear strips (for turbines, access tracks and the associated ancillary structures required for the running of the wind farm). As a worst case scenario, the area of vegetation to be cleared consists of a permanent loss of 75.36 ha and a temporary impact to 37.11 ha of potential habitat, totalling 112.47 ha.

This loss of potential habitat is contiguous with other examples of the same vegetation communities in a similar condition mapped within the study area (amounting to 894.79 ha) and mapped within the project site (amounting to 6319.57 ha). The amount of potential habitat proposed to be impacted represents 12.6 % of the potential habitat mapped within the study area, but only 1.8 % of potential habitat mapped within the project site. Furthermore, only a fraction of the potential habitat mapped within the study area is likely to consistently support the low levels of disturbance and high species richness characteristic of habitat for this species. For these reasons, the proposal is unlikely to substantially reduce the amount of potential habitat for this species present in the project site.

Nonetheless, control measures will be implemented to ensure that impacts to habitat for the threatened species are minimised. Weed control measures will be implemented in areas disturbed by proposed works for a period of three years after the completion of construction works, thereby reducing potential impacts of the proposal to potential habitat for this species.

Given there are no *Acacia pupifolia* recorded on site it is unlikely the proposal is likely to directly affect any known habitat of *Acacia pubifolia.*

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

Acacia pubifolia has not been recorded in the study area. Furthermore, the known distribution of *Acacia pubifolia* extends to the north and south of the project site in two locations: Torrington State Recreation Area located south of the study area; and, on private property near Warrabah NP which is north of the study area. Any potential habitat for *Acacia pubifolia* within the study area is not at the limit of its known distribution.

How is the proposal likely to affect current disturbance regimes?

Clarke *et al.* (1998) reported that, in the Torrington area of NSW, this species is killed by fire and appears to be an obligate seeder. However, in the Wyberba district in Qld, *A. pubifolia* has been recorded as suckering after fire (BRI undated).

- Inappropriate fire regime. Fires may be too frequent (less than 5 years), too seldom (greater than 30 years) or not hot enough to promote seed germination.
- Grazing by domestic stock.

- Clearing and fragmentation of Central Hunter Grey Box - Ironbark Woodland for agriculture, development and mining.
- Destruction and disturbance of habitat for roadworks.

Current disturbances at the site include cattle and sheep grazing, soil disturbance and grazing by feral animals including the European Rabbit and European Hare, and periods of drought and rainfall consistent with the southern oscillation index and resultant cycles of drought (El Niño) and wetter periods (La Niña). There have been no major fire events on the site in the last decade.

The site is grazed primarily by sheep and cattle. Due to extended drought, stocking rates were not high at the time of survey. Grazing pressure and management varies across the landscape, and the proposal is considered unlikely to exacerbate over-grazing at the site, but may, in fact, contribute to a more sustainable grazing regime through the mitigation measures proposed in some parts of the site. In the absence of fire, grazing can be an important form of disturbance to prevent the accumulation of biomass that may not be favourable to some native flora species. Grazing will be periodically removed during construction, but should be reintroduced post-construction. Rotational periods of grazing and spelling help to foster healthy native pastures in the absence of fire.

The risk of fire with wind farms is inherently low (CFA 2007). A low risk is associated with malfunctioning turbine bearings, inadequate crankcase lubrication, cable damage during rotation, electrical shorting or arcing occurring in transmission and distribution facilities (CFA 2007). The location of wind turbines away from tall vegetation in the study area minimises the risk of fire. It is unlikely that the proposal will significantly affect the fire regime such that high intensity fire would have a detrimental impact *Acacia pubiflora* habitat. The proposed access roads will increase the accessibility across the site should a fire occur.

The study area is primarily located on ridge tops and, therefore, is largely not affected by the surrounding streams. Conversely, the proposal is not likely to significantly affect flooding or flow regimes for the study area. There may be a small and localised increase in run-off in areas where the ground within the construction area will be compacted, gravelled or concreted. Soil erosion and run-off control measures will be implemented as part of the mitigation measures undertaken for the proposal.

The proposal is considered unlikely to contribute to increasing feral animal activity across the project site and instead is likely to assist with the management of these species through the proposed mitigation measures to be implemented within the study area and on the proposed offset sites.

Therefore, changes the current disturbance regime that may impact *Acacia pubiflora* is not considered likely.

How is the proposal likely to affect habitat connectivity?

Acacia pubifolia is known from two locations in the locality: Torrington State Recreation Area located south of the study area; and, on private property near Warrabah NP which is north of the study area.

The linear construction area will not bisect any existing populations of *Acacia pubifolia*. Furthermore, the proposal is unlikely to impact upon habitat connectivity for *Acacia pubifolia* due to the availability of at least 894.79 ha of potential habitat within the study area, and 6319.57 ha of potential habitat mapped within the project site that will not be cleared. Some existing vegetation corridors will be subject to disturbance within the study area. However, this is likely to consist of 100 m or 80 m turbine layout nodes, with only a 12 m access road joining these nodes. The corridors are already subject to some fragmentation from historic land uses (agriculture) and the development footprint has avoided the most intact sections of these vegetation corridors throughout the project site.

How is the proposal likely to affect critical habitat?

Not applicable - critical habitat has not been declared for this species.

***Astrotricha roddii* (Rod's Star Hair)**

Astrotricha roddii is an upright, sparsely-branched shrub 1 - 3 m tall. The shiny, narrow leaves are 11-18 cm long and 1-2.5 cm wide with long pointed tips and hairy underside. The stems are covered with dense woolly hairs. The dull purplish flowers grow on stems up to 40 cm long, and appear during October-February. Rod's Star Hair is thought to be only short-lived, with a life-span of possibly less than 10 years (DECCW 2011b).

Astrotricha roddii occurs in NSW in the Ashford area north of Inverell, including Kwiambal and Kings Plains National Parks, Severn River Nature Reserve and Severn River State Forest, and has also been recorded at one site in southern Queensland (DECCW 2011b). *Astrotricha roddii* was not recorded at the site but has the potential to occur and is known from previous records in the locality.

Astrotricha roddii usually grows in low dry woodland and shrublands on granite and acid volcanic outcrops, often in rock crevices (DECCW 2011b). Potential habitat occurs in woodland communities (DECCW 2011b), and within the study area is associated with the Blakely's Red Gum – Rough-barked Apple – Red Stringybark grassy open forest, Blakely's Red Gum – Yellow Box grassy open forest, Manna Gum – Rough-barked Apple – Yellow Box grassy woodland/open forest, Tenterfield Woollybutt - Silvertop Stringybark open forest and White Box grassy woodland communities.

Astrotricha roddii is listed as an endangered species under the TSC Act. The proposal will affect potential habitat.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

There is potential for *Astrotricha roddii* to occur within areas of rocky outcrops within the study area. Vegetation surveys and targeted surveys were conducted across the proposed development footprint in suitable habitat during October-December 2008, September-October 2010 and January 2011, during the species' known flowering period. No individuals of this species were located.

In areas where potential habitat will be lost, the habitat may be affected within the development footprint. The proposal is unlikely to disrupt the dispersal ability of *Astrotricha roddii* to spread throughout the landscape, as the primary means of dispersal are likely to be wind dispersal and animal vectors. The movement of animals, particularly stock, may be temporarily disrupted during the construction period, however stock are likely to return following construction. Wind patterns at ground level are unlikely to be affected by the proposed development. Given the current extent of the population and the narrow linear nature of the proposal, the dispersal of seeds of this species is unlikely to be impeded by the proposal.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

Vegetation will be removed in linear strips (for turbines, access tracks and the associated ancillary structures required for the running of the wind farm). As a worst case scenario, the area of vegetation to be cleared consists of a permanent loss of 75.36 ha and a temporary impact to 37.11 ha of potential habitat, totalling 112.47 ha.

This loss of potential habitat is contiguous with similar vegetation mapped within the study area (amounting to 894.79 ha) and mapped within the project site (amounting to 6319.57 ha). The amount of potential habitat proposed to be impacted represents 12.6 % of the potential habitat mapped within the study area, but only 1.8 % of potential habitat mapped within the project site. Furthermore, only a fraction of the potential habitat mapped within the study area is likely to consistently support the low levels of disturbance and high species richness characteristic of habitat for this species. For these reasons, the proposal is unlikely to substantially reduce the amount of potential habitat for this species present in the project site.

Nonetheless, control measures will be implemented to ensure that impacts to habitat for the threatened species are minimised. Measures to avoid the spread of weeds will be implemented from pre-construction works, throughout construction and operation until decommissioning, thereby reducing potential impacts of the proposal to potential habitat for this species.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

Astrotricha roddii occurs in far northern NSW in the Ashford area north of Inverell, including Kwiambal and Kings Plains National Parks, Severn River Nature Reserve and Severn River State Forest, and has also been recorded at one site in southern Queensland (DECCW 2011b). The potential habitat for this species within the study area is located close to the known limit of its distribution; however no individuals were recorded during the surveys. The proposal will not affect any individuals at the limit of its known distribution.

How is the proposal likely to affect current disturbance regimes?

Current disturbances at the site include cattle and sheep grazing, soil disturbance and grazing by feral animals including the European Rabbit and European Hare, and periods of drought and rainfall consistent with the southern oscillation index and resultant cycles of drought (El Niño) and wetter periods (La Niña). There have been no major fire events on the site in the last decade.

The site is grazed primarily by sheep and cattle. Due to extended drought, stocking rates were not heavy at the time of survey. Grazing pressure and management varies across the landscape, and the proposal is considered unlikely to exacerbate over-grazing at the site, but may, in fact, contribute to a more sustainable grazing regime through the mitigation measures proposed in some parts of the site. In the absence of fire, grazing can be an important form of disturbance to prevent the accumulation of biomass that may not be favourable to some native flora species. Grazing will be periodically removed during construction, but should be reintroduced post-construction. Rotational periods of grazing and spelling help to foster healthy native pastures in the absence of fire.

The risk of fire with wind farms is inherently low (CFA 2007). A low risk is associated with malfunctioning turbine bearings, inadequate crankcase lubrication, cable damage during rotation, electrical shorting or arcing occurring in transmission and distribution facilities (CFA 2007). The location of wind turbines away from tall vegetation in the study area minimises the risk of fire. It is unlikely that the proposal will significantly affect the fire regime such that high intensity fire would have a detrimental impact on the *Astroticha roddii* habitat. The proposed access roads will increase the accessibility across the site should a fire occur.

The study area is primarily located on ridge tops and, therefore, is largely not affected by the surrounding streams. Conversely, the proposal is not likely to significantly affect flooding or flow regimes for the study area. There may be a small and localised increase in run-off in areas where the ground within the construction area will be compacted, gravelled or concreted. Soil erosion and run-off control measures will be implemented as part of the mitigation measures undertaken for the proposal.

The proposal is considered unlikely to contribute to increasing feral animal activity across the project site and instead is likely to assist with the management of these species through the proposed mitigation measures to be implemented within the study area and on the proposed offset sites.

How is the proposal likely to affect habitat connectivity?

The linear construction area will not bisect any existing populations of *Astrotricha roddii*. Furthermore, the proposal is unlikely to impact upon habitat connectivity for the species due to the availability of at least 1581.91 ha of potential habitat within the study area, and 8856.66 ha of potential habitat mapped within the project site. Some existing vegetation corridors will be subject to disturbance within the study area, however this is likely to consist of 100 m or 80 m turbine layout nodes, with only a 12 m access road joining these nodes. The corridors are already subject to some fragmentation from historic land uses (agriculture) and the development footprint has avoided the most intact sections of these vegetation corridors throughout the project site.

How is the proposal likely to affect critical habitat?

Not applicable - critical habitat has not been declared for this species.

Dichanthium setosum **(Bluegrass)**

Dichanthium setosum is an erect perennial tussock grass that grows less than one metre in height (DECCW 2011b). It's distribution is concentrated in the northern tablelands of NSW and north-western slopes, however it has been recorded as far west as Narrabri on the NSW western plains, and in Queensland as far north as Rockhampton. *Dichanthium setosum* occurs in woodland and grassland communities (DECCW 2011b), and within the study area is associated with the Blakely's Red Gum – Rough-barked Apple – Red Stringybark grassy open forest, Blakely's Red Gum – Yellow Box grassy open forest, Manna Gum – Rough-barked Apple – Yellow Box grassy woodland/open forest, Tenterfield Woollybutt - Silvertop Stringybark open forest and White Box grassy woodland communities.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

There is potential for *Dichanthium setosum* to occur within areas of woodland and derived grassland. Vegetation surveys and target surveys were conducted across the proposed development footprint in suitable habitat during October, November and December 2008 and January 2011, during the species' known flowering period. The surveys identified *Dichanthium setosum* in five locations within the study area (Figure 9); one large population outside the development footprint in the Wellingrove cluster; two small patches within the Sapphire cluster adjacent to the turbine layout and an internal reticulation route; and one relatively large patch at the western edge of the Swan Vale cluster (totalling 6353 individuals throughout the study area) which, although immediately adjacent to the proposed study area, will be avoided during construction.

The total area of potential habitat for *Dichanthium setosum* within the study area is 1581.91 ha. An 80 m turbine layout with 12 m roads would result in a permanent loss of 122.78 ha and a temporary impact to 104.47 ha of potential habitat.

Information regarding the lifecycle of *Dichanthium setosum* is sparse. In areas where potential habitat will be lost, the seedbank may be affected within the development footprint, however construction will avoid all areas where *Dichanthium setosum* has been recorded, thus keeping the seedbanks with the most potential intact. The proposal is unlikely to affect the dispersal ability of *Dichanthium setosum* to spread throughout the landscape, as the primary means of dispersal are likely to be wind dispersal and animal vectors. The movement of animals, particularly stock, may be temporarily disrupted during the construction period, however, stock are likely to return following construction. Wind patterns at ground level are unlikely to be affected by the proposed development. Given the current extent of the population and the narrow linear nature of the proposal, the dispersal of seeds of this species is unlikely to be impeded by the proposal. There are no known species interactions between *Dichanthium setosum* and other species.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

Vegetation will be removed in linear strips (for turbines, access tracks and the associated ancillary structures required for the running of the wind farm). As a worst case scenario, the area of vegetation to be cleared consists of a permanent loss of 122.78 ha and a temporary impact to 104.47 ha of potential habitat, totalling 227.25 ha.

This loss of potential habitat is contiguous with similar vegetation mapped within the study area (amounting to 1581.91 ha) and mapped within the project site (amounting to 8856.66 ha). The amount of potential habitat proposed to be impacted represents 14.4 % of the potential habitat mapped within the study area, but only 2.6 % of potential habitat mapped within the project site. Furthermore, only a fraction of the potential habitat mapped within the study area is likely to consistently support the low levels of disturbance and high species richness characteristic of habitat for this species. For these reasons, the proposal is unlikely to substantially reduce the amount of potential habitat for this species present in the project site.

Nonetheless, control measures will be implemented to ensure that impacts to habitat for the threatened species are minimised. Measures to avoid the spread of weeds will be implemented from pre-construction works, throughout construction and operation until decommissioning, thereby reducing potential impacts of the proposal to potential habitat for this species.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The known distribution of *Dichanthium setosum* extends west to Narrabri and north into south-east Queensland, and therefore the study area does not constitute the limit of its distribution (DECCW 2011b).

How is the proposal likely to affect current disturbance regimes?

The risk of fire with wind farms is inherently low (CFA 2007). A low risk is associated with malfunctioning turbine bearings, inadequate crankcase lubrication, cable damage during rotation, electrical shorting or arcing occurring in transmission and distribution facilities (CFA 2007). The location of wind turbines away from tall vegetation in the study area minimises the risk of fire. There is insufficient information available regarding the preferred fire regime for *Dichanthium setosum*, however, the existing fire regime within the study area is not expected to change as a result of the proposed development and, therefore, is considered unlikely to have a deleterious impact on *Dichanthium setosum*.

The development footprint is primarily located on ridge tops and, therefore, is largely not affected by the surrounding streams. Conversely, the proposal is not likely to significantly affect flooding or flow regimes for the study area: there may be a small and localised increase in run-off in areas where the ground within the construction area will be compacted, gravelled or concreted. Soil erosion and run-off control measures will be implemented as part of the mitigation measures undertaken for the proposal.

The site is grazed primarily by sheep and cattle. Due to extended drought, stocking rates were not heavy at the time of survey. Grazing pressure and management varies across the landscape, and the proposal is considered unlikely to exacerbate over-grazing at the site, but may, in fact, contribute to a more sustainable grazing regime through the mitigation measures proposed in some parts of the site. In the absence of fire, grazing can be an important form of disturbance to prevent the accumulation of biomass that may not be favourable to some native flora species. Grazing will be periodically removed during construction, but should be reintroduced post-construction. Rotational periods of grazing and spelling help to foster healthy native pastures in the absence of fire.

Feral animals can have a detrimental impact on threatened species and their habitat. In the case of threatened flora, grazing by feral animals such as the European Rabbit can result in the species being precluded from a site. The proposal is considered unlikely to contribute to increasing feral animal activity across the project site and instead is likely to assist with the management of these species through the proposed mitigation measures to be implemented within the study area and on the proposed offset sites.

How is the proposal likely to affect habitat connectivity?

The linear construction area will not bisect any existing populations of *Dichanthium setosum*. Furthermore, the proposal is unlikely to impact upon habitat connectivity for the *Dichanthium setosum* due to the availability of at least 1581.91 ha of potential habitat within the study area, and 8856.66 ha of potential habitat mapped within the project site that will not be cleared. Some existing vegetation corridors will be subject to disturbance within the study area, however this is likely to consist of 100 m or 80 m turbine layout nodes, with only a 12 m access road joining these nodes. The corridors are already subject to some fragmentation from historic land uses (agriculture) and the development footprint has avoided the most intact sections of these vegetation corridors throughout the project site.

How is the proposal likely to affect critical habitat?

Not applicable - critical habitat cannot be declared for vulnerable species.

***Digitaria porrecta (*Finger Panic Grass)**

Digitaria porrecta, is a loosely tufted perennial growing to 60 cm tall. It has grey leaves, 2–3 mm wide, with sharp hairs along the middle. The flowers are clustered together along a stalk in a cylinder shape. These flower clusters, which appear in late summer (mid January to late February), spread stiffly from the flowering stem, with the lower flower clusters arranged in a whorl of four to six, each up to 30 cm long. It seeds from March to April but also reproduces vegetatively by dying back to the tussock base, from which it resprouts in summer (DECCW 2011b).

Digitaria porrecta occurs in NSW and Queensland. This species occurs within the Border Rivers–Gwydir, Namoi and Central West Natural Resource Management Regions. It is found on the North West Slopes and Plains, from near Moree south to Tambar Springs and from Tamworth to Coonabarabran. It largely occurs on private land (DECCW 2011b).

Digitaria porrecta usually occurs in grasslands on extensive basaltic plains, and in undulating woodlands and open forests with an underlying basaltic geology. It usually occurs on dark and fine textured soils with some degree of seasonal cracking (Leigh *et al.* 1984, Halford 1995). It also persists in disturbed habitats, such as fallow paddocks, but its capability to maintain a viable population is unknown (Halford 1995b, DEWHA 2008).

Digitaria porrecta is listed as an Endangered species listed under the TSC Act.

It has not been recorded within the study area, however potential habitat occurs in woodland and grassland communities (DECCW 2011b), and within the study area is associated with the Blakely's Red Gum – Rough-barked Apple – Red Stringybark grassy open forest, Blakely's Red Gum – Yellow Box grassy open forest, Manna Gum – Rough-barked Apple – Yellow Box grassy woodland/open forest, Tenterfield Woollybutt - Silvertop Stringybark open forest and White Box grassy woodland communities.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

There is potential for *Digitaria porrecta* to occur within areas of woodland and derived grassland. Vegetation surveys and target surveys were conducted across the proposed development footprint in suitable habitat during January 2011, during the species' known flowering period.

In areas where potential habitat will be lost, the habitat may be affected within the development footprint. The proposal is unlikely to disrupt the ability of *Digitaria porrecta* to spread throughout the landscape, as the primary means of dispersal are likely to be wind dispersal, animal vectors and vegetative dieback. The movement of animals, particularly stock, may be temporarily disrupted during the construction period, however, stock are likely to return following construction. Wind patterns at ground level are unlikely to be affected by the proposed development. Given the current extent of the population and the narrow linear nature of the proposal, the dispersal of seeds of this species is unlikely to be impeded by the proposal.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

Vegetation will be removed in linear strips (for turbines, access tracks and the associated ancillary structures required for the running of the wind farm). As a worst case scenario, the area of vegetation to be cleared consists of a permanent loss of 122.78 ha and a temporary impact to 104.47 ha of potential habitat, totalling 227.25 ha.

This loss of potential habitat is contiguous with similar vegetation mapped within the study area (amounting to 1581.91 ha) and mapped within the project site (amounting to 8856.66 ha). The amount of potential habitat proposed to be impacted represents 14.4 % of the potential habitat mapped within the study area, but only 2.6 % of potential habitat mapped within the project site. For these reasons, the proposal is unlikely to substantially reduce the amount of potential habitat for this species present in the project site.

Nonetheless, control measures will be implemented to ensure that impacts to habitat for the threatened species are minimised. Measures to avoid the spread of weeds will be implemented from pre-construction works, throughout construction and operation until decommissioning, thereby reducing potential impacts of the proposal to potential habitat for this species.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The known distribution of *Digitaria porrecta* extends from the North West Slopes and Plains, from near Moree south to Tambar Springs and from Tamworth to Coonabarabran. This species is also found in Queensland, and therefore the study area does not constitute the limit of its distribution (DECCW 2011b).

How is the proposal likely to affect current disturbance regimes?

The main potential threat to *Digitaria porrecta* is competition from introduced grasses such as Rhodes Grass (*Chloris gayana*) and Liverseed Grass (*Urochloa panicoides*) (Halford, 1995). Other threats include clearing and habitat fragmentation, fire, trampling and grazing by livestock, physical disturbance by machinery and urban expansion (Leigh *et al*. 1984, Halford 1995; NSW DEC 2008a).

Current disturbances at the site include cattle and sheep grazing, soil disturbance and grazing by feral animals including the European Rabbit and European Hare, and periods of drought and rainfall consistent with the southern oscillation index and resultant cycles of drought (El Niño) and wetter periods (La Niña). There have been no major fire events on the site in the last decade.

The site is grazed primarily by sheep and cattle. Due to extended drought, stocking rates were not heavy at the time of survey. Grazing pressure and management varies across the landscape, and the proposal is considered unlikely to exacerbate over-grazing at the site, but may, in fact, contribute to a more sustainable grazing regime through the mitigation measures proposed in some parts of the site. In the absence of fire, grazing can be an important form of disturbance to prevent the accumulation of biomass that may not be favourable to some native flora species. Grazing will be periodically removed during construction, but should be reintroduced post-construction. Rotational periods of grazing and spelling help to foster healthy native pastures in the absence of fire.

The risk of fire with wind farms is inherently low (CFA 2007). A low risk is associated with malfunctioning turbine bearings, inadequate crankcase lubrication, cable damage during rotation, electrical shorting or arcing occurring in transmission and distribution facilities (CFA 2007). The location of wind turbines away from tall vegetation in the study area minimises the risk of fire. It is unlikely that the proposal will significantly affect the fire regime such that high intensity fire would have a detrimental impact on the *Digitaria porrecta* habitat. The proposed access roads will increase the accessibility across the site should a fire occur.

The study area is primarily located on ridge tops and, therefore, is largely not affected by the surrounding streams. Conversely, the proposal is not likely to significantly affect flooding or flow regimes for the study area. There may be a small and localised increase in run-off in areas where the ground within the construction area will be compacted, gravelled or concreted. Soil erosion and run-off control measures will be implemented as part of the mitigation measures undertaken for the proposal.

The proposal is considered unlikely to contribute to increasing feral animal activity across the project site and instead is likely to assist with the management of these species through the proposed mitigation measures to be implemented within the study area and on the proposed offset sites.

Therefore, changes the current disturbance regimes that may impact the *Digitaria porrecta* are not anticipated.

How is the proposal likely to affect habitat connectivity?

No records of *Digitaria porrecta* were made during the current survey. Furthermore, the proposal is unlikely to impact upon habitat connectivity for the *Digitaria porrecta* due to the availability of at least 1581.91 ha of potential habitat within the study area, and 8856.66 ha of potential habitat mapped within the project site that will not be cleared. Some existing vegetation corridors will be subject to disturbance within the study area. However, this is likely to consist of 100 m or 80 m turbine layout nodes, with only a 12 m access road joining these nodes. The corridors are already subject to some fragmentation from historic land uses (agriculture) and the development footprint has avoided the most intact sections of these vegetation corridors throughout the project site.

How is the proposal likely to affect critical habitat?

Not applicable - critical habitat cannot be declared for vulnerable species.

***Diurus pedunculata* (Small Snake Orchid)**

Diuris pedunculata is a small yellow orchid with two drooping side petals on a flowering stem less than 10 cm tall, and flowers between August and October.

Diuris pedunculata is endemic to NSW. It's original distribution was scattered extensively along the Great Dividing Range from Queensland to the Hawkesbury River, but is now primarily found on the northern tablelands (DECCW 2011b).

Diuris pedunculata prefers moist areas (Rouse 2003; Woolcock & Woolcock 1984), and has been found growing in open areas of dry sclerophyll forests with grassy understories, in riparian forests (including gallery rainforests), swamp forests, in sub-alpine grasslands and herbfields. The study area falls within the known altitude range of the species (DECCW 2011b), and although it has not been recorded within the study area, potential habitat occurs in woodland communities (DECCW 2011b). Within the study area potential habitat is associated with the Blakely's Red Gum – Rough-barked Apple – Red Stringybark grassy open forest, Blakely's Red Gum – Yellow Box grassy open forest, Manna Gum – Rough-barked Apple – Yellow Box grassy woodland/open forest, Tenterfield Woollybutt - Silvertop Stringybark open forest and White Box grassy woodland communities.

Diurus pedunculata is listed as an Endangered species under the TSC Act.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

There is potential for the *Diuris pedunculata* to occur within areas of intact woodland and derived grassland. Vegetation surveys and target surveys were conducted across the proposed development footprint in suitable habitat during October 2008 and September-October 2010, during the species' known flowering period. No individuals were recorded during the current survey in areas of potential habitat, although *Diuris pedunculata* was in flower at known reference sites near Guyra on the northern tablelands at the time of survey.

The nectar and strong scent of *Diuris pedunculata* is known to attract insects for pollination, primarily male bees (Jersáková et al. 2006),

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

Vegetation will be removed in linear strips (for turbines, access tracks and the associated ancillary structures required for the running of the wind farm). As a worst case scenario, the area of vegetation to be cleared consists of a permanent loss of 122.78 ha and a temporary impact to 104.47 ha of potential habitat, totalling 227.25 ha.

This loss of potential habitat is contiguous with similar vegetation mapped within the study area (amounting to 1581.91 ha) and mapped within the project site (amounting to 8856.66ha). The amount of potential habitat proposed to be impacted represents 14.4 % of the potential habitat mapped within the study area, but only 2.6 % of potential habitat mapped within the project site. Furthermore, only a fraction of the potential habitat mapped within the study area is likely to consistently support the low levels of disturbance and high species richness characteristic of habitat for this species. For these reasons, the proposal is unlikely to substantially reduce the amount of potential habitat for this species present in the project site.

Nonetheless, control measures will be implemented to ensure that impacts to habitat for the threatened species are minimised. Measures to avoid the spread of weeds will be implemented from pre-construction works, throughout construction and operation until decommissioning, thereby reducing potential impacts of the proposal to potential habitat for this species.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

Diurus pedunculata is mainly found on the northern tablelands, around Armidale, Uralla, Guyra and Ebor, which is located to the south-east of the study area. The potential habitat for this species within the study area is located outside the known limit of its distribution and however no individuals were recorded during the surveys. The proposal will not affect any individuals at the limit of its known distribution.

How is the proposal likely to affect current disturbance regimes?

Current disturbances at the site include cattle and sheep grazing, soil disturbance and grazing by feral animals including the European Rabbit and European Hare, and periods of drought and rainfall consistent with the southern oscillation index and resultant cycles of drought (El Niño) and wetter periods (La Niña). There have been no major fire events on the site in the last decade.

The site is grazed primarily by sheep and cattle. Due to extended drought, stocking rates were not heavy at the time of survey. Grazing pressure and management varies across the landscape, and the proposal is considered unlikely to exacerbate over-grazing at the site, but may, in fact, contribute to a more sustainable grazing regime through the mitigation measures proposed in some parts of the site. In the absence of fire, grazing can be an important form of disturbance to prevent the accumulation of biomass that may not be favourable to some native flora species. Grazing will be periodically removed during construction, but should be reintroduced post-construction. Rotational periods of grazing and spelling help to foster healthy native pastures in the absence of fire.

The risk of fire with wind farms is inherently low (CFA 2007). A low risk is associated with malfunctioning turbine bearings, inadequate crankcase lubrication, cable damage during rotation, electrical shorting or arcing occurring in transmission and distribution facilities (CFA 2007). The location of wind turbines away from tall vegetation in the study area minimises the risk of fire. It is unlikely that the proposal will significantly affect the fire regime such that high intensity fire would have a detrimental impact on *Diuris pedunculata* potential habitat. The proposed access roads will increase the accessibility across the site should a fire occur.

The study area is primarily located on ridge tops and, therefore, is largely not affected by the surrounding streams. Conversely, the proposal is not likely to significantly affect flooding or flow regimes for the study area. There may be a small and localised increase in run-off in areas where the ground within the construction area will be compacted, gravelled or concreted. Soil erosion and run-off control measures will be implemented as part of the mitigation measures undertaken for the proposal.

The proposal is considered unlikely to contribute to increasing feral animal activity across the project site and instead is likely to assist with the management of these species through the proposed mitigation measures to be implemented within the study area and on the proposed offset sites.

How is the proposal likely to affect habitat connectivity?

No populations have been recorded within the study area during the current survey.

Furthermore, the proposal is unlikely to impact upon habitat connectivity for *Diuris pedunculata* due to the availability of at least 1581.91 ha of potential habitat within the study area, and 8856.66 ha of potential habitat mapped within the project site that will not be cleared. Some existing vegetation corridors will be subject to disturbance within the study area. However, this is likely to consist of 100 m or 80 m turbine layout nodes, with only a 12 m access road joining these nodes. The corridors are already subject to some fragmentation from historic land uses (agriculture) and the development footprint has avoided the most intact sections of these vegetation corridors throughout the project site.

How is the proposal likely to affect critical habitat?

This species is not included on the Register of Critical Habitat in NSW.

Eucalyptus mckieana **(McKie's Stringybark)**

Eucalyptus mckieana is a medium sized eucalypt with red-brown fibrous bark and is confined to the rain shadow on the western side of the northern tablelands of NSW between Bendemeer in NSW and Stanthorpe in southern Queensland. *Eucalyptus mckieana* is most commonly found on gently sloping or flat site, on poor sandy loams, forming a grassy open forest in association with a suite of other eucalypt species (DECCW 2011a).

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Vegetation surveys and targeted surveys were undertaken across the development footprint in areas of suitable habitat during October, November and December 2008, April and May 2009, September, October and December 2010, and January 2011. The existing records of *Eucalyptus mckieana* are located on the Hollingworth property outside the north-east quadrant of the study area. During the design phase of the Sapphire Wind Farm, this area was previously considered for inclusion into the turbine corridor. However, the final design has excluded this area from the development footprint, and thus these ten trees will not be affected by the development.

Potential habitat for *Eucalyptus mckieana* exists within the Black Cypress Pine – Tumbledown Gum – Narrow-leaved Ironbark open forest community within the study area. The total area of potential habitat for *Eucalyptus mckieana* within the study area is 12.71 ha. An 80m turbine layout with 12 m roads would result in a permanent loss of 0.86 ha and a temporary impact to 0.54 ha of potential habitat. A 100m turbine layout with 12 m roads would also result in a permanent loss of 0.46 ha and a temporary impact to 0.28 ha of potential habitat.

No individuals were recorded within the proposed impact area. A large portion of the study area does not support suitable habitat for this species and that the history of clearing and grazing within the study area has eliminated viable seed from the seed bank in areas of potential habitat. The species is able to resprout from epicormic growth post-fire (DECCW 2011b). However, the development is unlikely to change the fire regime within the area. Given its location and history of disturbance, the proposed development is considered unlikely to affect the lifecycle of *Eucalyptus mckieana*.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

Vegetation will be removed in linear strips (for turbines, access tracks and the associated ancillary structures required for the running of the wind farm). As a worst case scenario, the area of vegetation to be cleared consists of a permanent loss of 0.86 ha and a temporary impact to 0.54 ha of potential habitat, totalling 1.31 ha.

This loss of potential habitat is contiguous with similar vegetation mapped within the study area (amounting to 12.71 ha) and mapped within the project site (amounting to 73.71 ha). The amount of potential habitat proposed to be impacted represents 10.3 % of the potential habitat mapped within the study area, but only 1.8 % of potential habitat mapped within the project site. For these reasons, the proposal is unlikely to substantially reduce the amount of potential habitat for this species present in the project site.

Nonetheless, control measures will be implemented to ensure that impacts to habitat for the threatened species are minimised. Measures to avoid the spread of weeds will be implemented from pre-construction works, throughout construction and operation until decommissioning, thereby reducing potential impacts of the proposal to potential habitat for this species.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

No - the known distribution of *Eucalyptus mckieana* extends further south to Bendemeer (just north of Tamworth) and into south-eastern Queensland and therefore the study area does not constitute the limit of its distribution (DECCW 2011b).

How is the proposal likely to affect current disturbance regimes?

Information regarding the response of *Eucalyptus mckieana* to fire is sparse, however, it is known to resprout from epicormic growth post-fire (DECCW 2011b). However, the risk of fire with wind farms is inherently low (CFA 2007). A low risk is associated with malfunctioning turbine bearings, inadequate crankcase lubrication, cable damage during rotation, electrical shorting or arcing occurring in transmission and distribution facilities (CFA 2007). The location of wind turbines away from tall vegetation in the study area minimises the risk of fire. It is unlikely that the proposal will significantly affect change the existing fire regime in the study area.

The development footprint is primarily located on ridge tops and, therefore, is not affected by the flood regime of surrounding streams. Conversely, the proposal is not likely to significantly affect flooding or flow regimes for the study area. There may be a small and localised increase in run-off in areas where the ground within the construction area will be compacted, gravelled or concreted.

The site is grazed primarily by sheep and cattle. Due to extended drought, stocking rates were not heavy at the time of survey. Grazing pressure and management varies across the landscape, and the proposal is considered unlikely to exacerbate over-grazing at the site, but may, in fact, contribute to a more sustainable grazing regime through the mitigation and offset measures proposed in some parts of the site. In the absence of fire, grazing can be an important form of disturbance to prevent the accumulation of biomass that may not be favourable to some native flora species. Grazing will be periodically removed during construction, but should be reintroduced post-construction. Rotational periods of grazing and spelling help to foster healthy native pastures in the absence of fire.

Threats to *Eucalyptus mckieana* from feral animals is limited to occasional grazing pressure on recruiting individuals from European Rabbits. No evidence of this was identified within the study area, however the proposal is considered unlikely to contribute to increasing feral animal activity across the project site and instead is likely to assist with the management of these species through the proposed mitigation measures to be implemented within the study area and on the proposed offset sites.

How is the proposal likely to affect habitat connectivity?

The proposal is unlikely to impact upon habitat connectivity for *Eucalyptus mckieana*, given the limited numbers of individuals present within the project site and the small amounts of potential habitat within the study area and to be impacted. Furthermore, the proposal is unlikely to impact upon habitat connectivity for the *Eucalyptus mckieana* due to the availability of at least 12.71 ha of potential habitat within the study area, and 73.71 ha of potential habitat mapped within the project site that will not be cleared. Some existing vegetation corridors will be subject to disturbance within the study area. However, this is likely to consist of 100 m or 80 m turbine layout nodes, with only a 12 m access road joining these nodes. The corridors are already subject to some fragmentation from historic land uses (agriculture) and the development footprint has avoided the most intact sections of these vegetation corridors throughout the project site.

How is the proposal likely to affect critical habitat?

Not applicable - critical habitat cannot be declared for vulnerable species.

***Eucalyptus nicholii (*Narrow-leaved Black Peppermint)**

Eucalyptus nicholii is a tree growing to 15-20 m tall with thick, fibrous, grey to grey-brown, longitudinally furrowed rough bark over its trunk and branches. Adult foliage is dull greenish grey and narrowly lanceolate, with flowers in clusters of seven. (DECCW 2011b).

The species is confined to the New England Tablelands of NSW, where it occurs largely on private property from north of Tenterfield to Nundle (DECCW 2011b). It occurs in grassy or sclerophyll woodland communities and within the study area is associated with the Blakely's Red Gum – Rough-barked Apple – Red Stringybark grassy open forest, Blakely's Red Gum – Yellow Box grassy open forest, Manna Gum – Rough-barked Apple – Yellow Box grassy woodland/open forest, Tenterfield Woollybutt - Silvertop Stringybark open forest and White Box grassy woodland communities.

Eucalyptus nicholii is listed as Vulnerable under the TSC Act.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

There is potential for *Eucalyptus nicholii* to occur within areas of woodland and derived grassland. Vegetation surveys and target surveys were conducted across the proposed development footprint in suitable habitat during October, November and December 2008, April & May 2009, and September, October and December 2010, and January 2011. No individuals were recorded during the surveys.

The total area of potential habitat for *Eucalyptus nicholii* within the study area is 1581.91 ha. An 80m turbine layout with 12 m roads would result in a permanent loss of 122.78 ha and a temporary impact to 104.47 ha of potential habitat. A 100m turbine layout with 12 m roads would result in a permanent loss of 116.95 ha and a temporary impact to 213.71 ha of potential habitat.

Information regarding the lifecycle of *Eucalyptus nicholii* is sparse. No individuals were recorded within the study area. The species prefers a fire interval between 10 and 25 years (DECCW 2011b), however the development is unlikely to change the fire regime within the area. Given the lack of records and history of disturbance, the proposed development is considered unlikely to affect the lifecycle of *Eucalyptus nicholii*.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

Vegetation will be removed in linear strips (for turbines, access tracks and the associated ancillary structures required for the running of the wind farm). As a worst case scenario, the area of vegetation to be cleared consists of a permanent loss of 122.78 ha and a temporary impact to 104.47 ha of potential habitat, totalling 227.25 ha.

This loss of potential habitat is contiguous with similar vegetation mapped within the study area (amounting to 1581.91 ha) and mapped within the project site (amounting to 8856.66 ha). The amount of potential habitat proposed to be impacted represents 14.4 % of the potential habitat mapped within the study area, but only 2.6 % of potential habitat mapped within the project site. Furthermore, only a fraction of the potential habitat mapped within the study area is likely to consistently support the low levels of disturbance and high species richness characteristic of habitat for this species. For these reasons, the proposal is unlikely to substantially reduce the amount of potential habitat for this species present in the project site.

Nonetheless, control measures will be implemented to ensure that impacts to habitat for the threatened species are minimised. Measures to avoid the spread of weeds will be implemented from pre-construction works, throughout construction and operation until decommissioning, thereby reducing potential impacts of the proposal to potential habitat for this species.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

No - the *Eucalyptus nicholii* is confined to the NSW northern tablelands with approximately ranging from Nundle (south-east of Tamworth) to north of Tenterfield. The study area falls within this range, and therefore is not at limit of its distribution (DECCW 2011b).

How is the proposal likely to affect current disturbance regimes?

Current disturbances at the site include cattle and sheep grazing, soil disturbance and grazing by feral animals including the European Rabbit and European Hare, and periods of drought and rainfall consistent with the southern oscillation index and resultant cycles of drought (El Niño) and wetter periods (La Niña). There have been no major fire events on the site in the last decade.

The site is grazed primarily by sheep and cattle. Due to extended drought, stocking rates were not heavy at the time of survey. Grazing pressure and management varies across the landscape, and the proposal is considered unlikely to exacerbate over-grazing at the site, but may, in fact, contribute to a more sustainable grazing regime through the mitigation measures proposed in some parts of the site. In the absence of fire, grazing can be an important form of disturbance to prevent the accumulation of biomass that may not be favourable to some native flora species. Grazing will be periodically removed during construction, but should be reintroduced post-construction. Rotational periods of grazing and spelling help to foster healthy native pastures in the absence of fire.

The risk of fire with wind farms is inherently low (CFA 2007). A low risk is associated with malfunctioning turbine bearings, inadequate crankcase lubrication, cable damage during rotation, electrical shorting or arcing occurring in transmission and distribution facilities (CFA 2007). The location of wind turbines away from tall vegetation in the study area minimises the risk of fire. The existing fire regime within the study area is not expected to change as a result of the proposed development and, therefore, is considered unlikely to have a deleterious impact on *Eucalyptus nicholii*. The proposed access roads will increase the accessibility across the site should a fire occur.

The study area is primarily located on ridge tops and, therefore, is largely not affected by the surrounding streams. Conversely, the proposal is not likely to significantly affect flooding or flow regimes for the study area. There may be a small and localised increase in run-off in areas where the ground within the construction area will be compacted, gravelled or concreted. Soil erosion and run-off control measures will be implemented as part of the mitigation measures undertaken for the proposal.

Grazing by feral animals such as the European Rabbit and European Hare can reduce natural recruitment of eucalypt feed trees. The proposal is considered unlikely to contribute to increasing feral animal activity across the project site and instead is likely to assist with the management of these species through the proposed mitigation measures to be implemented within the study area and on the proposed offset sites.

How is the proposal likely to affect habitat connectivity?

No individuals were recorded within the study area during the surveys. Furthermore, the proposal is unlikely to impact upon habitat connectivity for *Eucalyptus nicholii* due to the availability of at least 1581.91 ha of potential habitat within the study area, and 8856.66 ha of potential habitat mapped within the project site that will not be cleared. Some existing vegetation corridors will be subject to disturbance within the study area. However, this is likely to consist of 100 m or 80 m turbine layout nodes, with only a 12 m access road joining these nodes. The corridors are already subject to some fragmentation from historic land uses (agriculture) and the development footprint has avoided the most intact sections of these vegetation corridors throughout the project site.

How is the proposal likely to affect critical habitat?

Not applicable - critical habitat cannot be declared for vulnerable species.

***Picris evae* (Hawkweed)**

Picris evae is an erect annual herb growing 1.3–1.7 m high, with linear, variable, stalkless leaves, sparsely covered with split-ended hairs (that mostly grow around the base of the plant) and small yellow flower heads (DECCW 2011b).

Picris evae has been recorded across the northern tablelands from Oxley Park near Tamworth, to Elsmore (east of Inverell) and it's distribution extends into south-east Queensland (DECCW 2011b).

Picris evae occurs in sclerophyll open woodland with a grassy understorey composed of *Dichanthium* spp.. Associated canopy species include *Eucalyptus melliodora*, *E. crebra*, *E. populnea*, *E. albens*, *Angophora subvelutina*, *Allocasuarina torulosa*, and *Casuarina cunninghamiana* (Holzapfel, 1994), and within the study area is associated with the Black Cypress Pine – Tumbledown Gum – Narrow-leaved Ironbark open forest, Blakely's Red Gum – Rough-barked Apple – Red Stringybark grassy open forest, Blakely's Red Gum – Yellow Box grassy open forest, Manna Gum – Rough-barked Apple – Yellow Box grassy woodland/open forest, Tenterfield Woollybutt - Silvertop Stringybark open forest and White Box grassy woodland communities.

Picris evae is listed as a Vulnerable species under the TSC Act.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

There is potential for *Picris evae* to occur within areas of woodland and derived grassland. Vegetation surveys and targeted surveys were conducted across the proposed development footprint in potential habitat during October-December 2008, September-October and December 2010 and January 2011, during the species' known flowering period. The species was not recorded during the current surveys.

The total area of potential habitat for *Picris evae* within the study area is 894.79 ha. An 80 m turbine layout with 12 m roads would result in a permanent loss of 75.36 ha and a temporary impact to 37.11 ha of potential habitat.

Information regarding the lifecycle of *Picris evae* is sparse. The proposal is unlikely to form a barrier to the dispersal of *Picris evae* throughout the landscape, as the primary means of dispersal are likely to be wind and animal vectors. The movement of animals, particularly stock, may be temporarily disrupted during the construction period, however, stock are likely to return following construction. Wind patterns at ground level are unlikely to be affected by the proposed development. Given the current extent of the population and the narrow linear nature of the proposal, the dispersal of seeds of this species is unlikely to be impeded by the proposal.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

Vegetation will be removed in linear strips (for turbines, access tracks and the associated ancillary structures required for the running of the wind farm). As a worst case scenario, the area of vegetation to be cleared consists of a permanent loss of 75.36 ha and a temporary impact to 37.11 ha of potential habitat, totalling 112.47 ha.

This loss of potential habitat is contiguous with similar vegetation mapped within the study area (amounting to 894.79 ha) and mapped within the project site (amounting to 6331.11 ha). The amount of potential habitat proposed to be impacted represents 12.6 % of the potential habitat mapped within the study area, but only 1.78 % of potential habitat mapped within the project site. Furthermore, only a fraction of the potential habitat mapped within the study area is likely to consistently support the low levels of disturbance and high species richness characteristic of habitat for this species. For these reasons, the proposal is unlikely to substantially reduce the amount of potential habitat for this species present in the project site.

Nonetheless, control measures will be implemented to ensure that impacts to habitat for the threatened species are minimised. Measures to avoid the spread of weeds will be implemented from pre-construction works, throughout construction and operation until decommissioning, thereby reducing potential impacts of the proposal to potential habitat for this species.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The known distribution of *Picris evae* ranges from near Tamworth across the northern tablelands and into south-east Queensland, and therefore the potential habitat within the study area does not lie at the limit of its distribution (DECCW 2011b).

How is the proposal likely to affect current disturbance regimes?

The main identified threats to *Picris evae* are weed invasion, inappropriate fire regimes, habitat fragmentation and clearing of vegetation for cropping and grazing (DECCW 2011b).

Current disturbances at the site include cattle and sheep grazing, soil disturbance and grazing by feral animals including the European Rabbit and European Hare, and periods of drought and rainfall consistent with the southern oscillation index and resultant cycles of drought (El Niño) and wetter periods (La Niña). There have been no major fire events on the site in the last decade.

The site is grazed primarily by sheep and cattle. Due to extended drought, stocking rates were not heavy at the time of survey. Grazing pressure and management varies across the landscape, and the proposal is considered unlikely to exacerbate over-grazing at the site, but may, in fact, contribute to a more sustainable grazing regime through the mitigation measures proposed in some parts of the site. In the absence of fire, grazing can be an important form of disturbance to prevent the accumulation of biomass that may not be favourable to some native flora species. Grazing will be periodically removed during construction, but should be reintroduced post-construction. Rotational periods of grazing and spelling help to foster healthy native pastures in the absence of fire.

The risk of fire with wind farms is inherently low (CFA 2007). A low risk is associated with malfunctioning turbine bearings, inadequate crankcase lubrication, cable damage during rotation, electrical shorting or arcing occurring in transmission and distribution facilities (CFA 2007). The location of wind turbines away from tall vegetation in the study area minimises the risk of fire. There is insufficient information available regarding the preferred fire regime for *Picris evae*, however, the existing fire regime within the study area is not expected to change as a result of the proposed development and, therefore, is considered unlikely to have a deleterious impact on *Picris evae*.

The study area is primarily located on ridge tops and, therefore, is largely not affected by the surrounding streams. Conversely, the proposal is not likely to significantly affect flooding or flow regimes for the study area. There may be a small and localised increase in run-off in areas where the ground within the construction area will be compacted, gravelled or concreted. Soil erosion and run-off control measures will be implemented as part of the mitigation measures undertaken for the proposal.

The proposal is considered unlikely to contribute to increasing feral animal activity across the project site and instead is likely to assist with the management of these species through the proposed mitigation measures to be implemented within the study area and on the proposed offset sites.

How is the proposal likely to affect habitat connectivity?

The linear construction area will not bisect any existing populations of *Picris evae*. Furthermore, the proposal is unlikely to impact upon habitat connectivity for the *Picris evae* due to the availability of at least 897.79 ha of potential habitat within the study area, and 6331.11 ha of potential habitat mapped within the project site that will not be cleared. Some existing vegetation corridors will be subject to disturbance within the study area. However, this is likely to consist of 100 m or 80 m turbine layout nodes, with only a 12 m access road joining these nodes. The corridors are already subject to some fragmentation from historic land uses (agriculture) and the development footprint has avoided the most intact sections of these vegetation corridors throughout the project site.

How is the proposal likely to affect critical habitat?

Not applicable - critical habitat cannot be declared for vulnerable species.

***Thesium australe* (Austral Toadflax)**

Thesium australe is a small, straggling herb to 40 cm tall and is found in very small populations and within NSW is scattered throughout the east of the state, from the northern to southern tablelands. *Thesium australe* occurs in grassland or grassy woodland, often in damp sites in association with Kangaroo Grass (*Themeda australis*) (DECCW 2011b).

Within the study area, the species is associated with the Blakely's Red Gum – Rough-barked Apple – Red Stringybark grassy open forest, Blakely's Red Gum – Yellow Box grassy open forest, Manna Gum – Rough-barked Apple – Yellow Box grassy woodland/open forest, Tenterfield Woollybutt - Silvertop Stringybark open forest and White Box grassy woodland communities.

Thesium australe is listed as Vulnerable under the TSC Act.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

There is potential for *Thesium australe* to occur within areas of woodland and derived grassland. Vegetation surveys and target surveys were conducted across the proposed study area in suitable habitat during October, November and December 2008, September, October and December 2010, and January 2011, during the species' known flowering period. The surveys found two populations of *Thesium australe*: at the edge of the access track corridor between Turbine 44b and the TransGrid powerline in the Sapphire cluster and in the centre of the Wellingrove cluster, totalling 7350 individuals.

The total area of potential habitat for *Thesium australe* within the study area is 1581.91 ha. An 80 m turbine layout with 12 m roads would result in a permanent loss of 122.78 ha and a temporary impact to 104.47 ha of potential habitat. A 100 m turbine layout with 12 m roads would result in a permanent loss of 116.95 ha and a temporary impact to 213.71 ha of potential habitat.

Within the Sapphire cluster, the existing *Thesium australe* population is largely separated from the proposed access route by a stock fence and there is an associated change in vegetation condition. The proposed access route location will avoid areas of known plants and is located in the vegetation in poorer condition outside the stock fence. The periphery of the Sapphire cluster population approaches the edge of the access corridor. Therefore, during the detailed design phase of the project, the access road will need to be located against the northern edge of the proposed access corridor. This will provide the largest possible buffer to the *Thesium australe* population, specifically a 30 m buffer will be maintained between all individual *Thesium australe* plants of this population and any construction areas or access tracks.

Little is known of dormancy, the persistence of seedbanks, associated pollinators, or germination mechanisms for this species. *Thesium australe* is considered to be a biennial, however glasshouse studies suggest plants could live up to three years from germination (DSE 2003). It is generally observed in association with *Themeda triandra* (Kangaroo Grass), as species upon which it is hemiparasitic (DSE 2003). *Thesium australe* has been observed to germinate well post-fire, however adequate regeneration can be expected without fire, as least where the grassland is lightly grazed (DSE 2003).

Information on dispersal mechanisms is sparse. However, given the current extent of the population and the narrow linear nature of the proposal, the dispersal of seeds of this species is unlikely to be impeded by the proposal. Detrimental impacts on the lifecycle of *Thesium australe* are not anticipated.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

Vegetation will be removed in linear strips (for turbines, access tracks and the associated ancillary structures required for the running of the wind farm). As a worst case scenario, the area of vegetation to be cleared consists of a permanent loss of 122.78 ha and a temporary impact to 104.47 ha of potential habitat, totalling 227.25 ha.

This loss of potential habitat is contiguous with similar vegetation mapped within the study area (amounting to 1581.91 ha) and mapped within the project site (amounting to 8856.66 ha). The amount of potential habitat proposed to be impacted represents 14.4 % of the potential habitat mapped within the study area, but only 2.6 % of potential habitat mapped within the project site. Furthermore, only a fraction of the potential habitat mapped within the study area is likely to consistently support the low levels of disturbance and high species richness characteristic of habitat for this species. For these reasons, the proposal is unlikely to substantially reduce the amount of potential habitat for this species present in the project site.

Nonetheless, control measures will be implemented to ensure that impacts to habitat for the threatened species are minimised. Measures to avoid the spread of weeds will be implemented from pre-construction works, throughout construction and operation until decommissioning, thereby reducing potential impacts of the proposal to potential habitat for this species.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The known distribution of the *Thesium australe* extends to eastern Victoria and south-eastern Queensland and therefore the study area does not constitute the limit of its distribution (DECCW 2011b).

How is the proposal likely to affect current disturbance regimes?

The site is grazed primarily by sheep and cattle. Due to extended drought, stocking rates were not heavy at the time of survey. Grazing pressure and management varies across the landscape, and the proposal is considered unlikely to exacerbate over-grazing at the site, but may, in fact, contribute to a more sustainable grazing regime through the mitigation measures proposed in some parts of the site. In the absence of fire, grazing can be an important form of disturbance to prevent the accumulation of biomass that may not be favourable to some native flora species. Grazing will be periodically removed during construction, but should be reintroduced post-construction. Rotational periods of grazing and spelling help to foster healthy native pastures in the absence of fire.

Preliminary observations of a population of *Thesium australe* showed the apparent stimulation of germination by fire. The risk of fire with wind farms is inherently low (CFA 2007). A low risk is associated with malfunctioning turbine bearings, inadequate crankcase lubrication, cable damage during rotation, electrical shorting or arcing occurring in transmission and distribution facilities (CFA 2007). The location of wind turbines away from tall vegetation in the study area minimises the risk of fire. It is unlikely that the proposal will significantly affect the fire regime such that it would have a detrimental impact on the *Thesium australe*.

The study area is primarily located on ridge tops and, therefore, is largely not affected by the surrounding streams. Conversely, the proposal is not likely to significantly affect flooding or flow regimes for the study area. There may be a small and localised increase in run-off in areas where the ground within the construction area will be compacted, gravelled or concreted. Soil erosion and run-off control measures will be implemented as part of the mitigation measures undertaken for the proposal.

Feral animals can have a detrimental impact on threatened species and their habitat. In the case of threatened flora, grazing by feral animals such as the European Rabbit and European Hare can result in the species being precluded from a site. The proposal is considered unlikely to contribute to increasing feral animal activity across the project site and instead is likely to assist with the management of these species through the proposed mitigation measures to be implemented within the study area and on the proposed offset sites.

How is the proposal likely to affect habitat connectivity?

The linear construction area will not bisect any existing populations of *Thesium australe*. Furthermore, the proposal is unlikely to impact upon habitat connectivity for the *Thesium australe* due to the availability of at least 1581.91 ha of potential habitat within the study area, and 8856.66 ha of potential habitat mapped within the project site that will not be cleared. Some existing vegetation corridors will be subject to disturbance within the study area, however, this is likely to consist of 100 m or 80 m turbine layout nodes, with only a 12 m access road joining these nodes. The corridors are already subject to some fragmentation from historic land uses (agriculture) and the development footprint has avoided the most intact sections of these vegetation corridors throughout the project site.

How is the proposal likely to affect critical habitat?

Not applicable - critical habitat cannot be declared for Vulnerable species.

FAUNA

Birds

***Anthochaera phrygia* (Regent Honeyeater)**

Regent Honeyeater is a striking black and yellow honeyeater with a curved bill and a wingspan of 30 cm. Adults are 20 - 24 cm long, and have a characteristic patch of dark pink or cream-coloured facial-skin around the eye. The call is a soft metallic bell-like song, and birds are most vocal in the non-breeding season (November to July) (DECCW 2011b). Preferred habitat is temperate woodland and open forest of the inland slopes of south-east Australia (DECCW 2011b).

The range of Regent Honeyeater has contracted dramatically in the last 30 years, to between north-east Victoria and south-east Queensland. Only three known key breeding populations remain, at Chiltern (NE Vic), Capertee Valley (NSW central highlands), and Bundarra-Barraba (NSW north-western slopes). The distribution is patchy, and mainly confined to breeding areas and surrounding patchy woodlands, however on occasional years flocks are recorded foraging in coastal woodlands and forests (DECCW 2011b).

Regent Honeyeater is listed as an Endangered species under the EPBC Act. It is also listed as a Migratory species under the EPBC Act, and is included in the Japan-Australia Migratory Bird Agreement (JAMBA).

There were no records of Regent Honeyeater on the Birds Australia data search (2009) although there is a historical record on the DECCW database (1968), approximately 1 km to the south of the site and a more recent record (1994) along Wellingrove Road, 7 km to the north east of the study area. It is worth noting that the Birds Australia survey effort in the area is considerable with a number of survey records having been submitted over many years.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Regent Honeyeater was not recorded at the site but has the potential to occur. Potential habitat in the study area is shown in Figure 9. There is an historical record (1968) of the Regent Honeyeater to the south of the site and a more recent record (1994) along Wellingrove Road to the north east of the study area (DECCW 2011b).

The proposal may affect the lifecycle of the Regent Honeyeater through changes to foraging behavior resulting from removal of foraging habitat and changes to migration through accidental strike with the turbines during operation of the wind farm.

There are three major breeding areas for the Regent Honeyeater, Bundarra-Barraba, Capertee Valley and north-east Victoria (DECCW 2011b). Sapphire is not a breeding site for this species and given the transitory and migratory nature of this species, it is likely to only be used periodically for foraging. The Regent Honeyeater primarily feeds on nectar from box and ironbark eucalypts and occasionally from banksias and mistletoes (NPWS 1995). As such it is reliant on locally abundant nectar sources with different flowering times to provide a reliable supply of nectar (Environment Australia 2000).

The total area of potential foraging habitat for Regent Honeyeater within the study area is 894.79 ha. Assuming the highest level of impact (the 80m turbine layout), 112.47 ha of foraging habitat will be cleared. This represents 12.6 % of the habitat present within the study area and less than 1.45 % of the available habitat mapped (7,764.84 ha).

During the operational phase of the wind farm, there is a risk that Regent Honeyeaters will accidentally collide with the moving turbines. Much literature has been produced regarding potential impacts of wind farms on birds although most of the studies have been undertaken overseas. The impacts appear to be dependent on a number of factors including proximity to wetlands, migratory pathways, proximity to bird concentrations and forested areas. These issues have been addressed in the layout design to minimise the risk of bird strike where possible. Bird strike will be monitored during the operation of the wind farm and an adaptive management approach implemented whereby additional measures are implemented should significant bird and bat strike at certain turbines be recorded.

Given that breeding habitat will not be impacted, a detrimental impact on the lifecycle of Regent Honeyeater is not anticipated. An offset will be prepared in accordance with the Biobanking tool to compensate for the loss of foraging habitat and accident strike by the turbines will be monitored.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

Regent Honeyeater is a threatened species, listed as Endangered under the TSC Act. It is a highly mobile species and forages on nectar from eucalypts such as the Mugga Ironbark, White Box and Yellow Box, and Blakely's Red Gum on which they are reliant, particularly favouring those trees on the wettest, most fertile soils, such as along creek flats and broad river valleys.

The study area at Sapphire is mostly confined to the ridges of the locality with limited direct impact on waterways. The waterways within the locality are generally typified by low-flows and dry creek-beds. Given the location of the vegetation to be cleared, this would not be consistent with the preferred foraging habitat along the wettest, most fertile soils of river valleys.

Foraging habitat to be removed for Regent Honeyeater is comprised of linear strips (for turbines, access tracks and the associated ancillary structures required for the running of the wind farm). As a worst case scenario, the area of vegetation to be cleared consists of a loss of 112.47 ha of potential foraging habitat. The amount of potential habitat proposed to be impacted represents 12.6 % of the potential habitat mapped within the study area, but 1.45% of the total potential habitat mapped within the locality. For these reasons, the proposal is unlikely to substantially reduce the amount of potential habitat for this species present.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The distribution of Regent Honeyeater originally encompassed a vast area within 300 km of the coast from Brisbane to Adelaide. Presently, the Regent Honeyeater is no longer found in South Australia and records from Queensland are now uncommon. The remaining population in Victoria and NSW is patchy, with little information available on the movement patterns of this highly mobile species. The reduction in the range of Regent Honeyeater is considered to have resulted from expanding agriculture and the clearing of 85 % of the box-ironbark woodlands, which were once extensively distributed across inland eastern Australia (DSEWPC 2011b). The proposed wind farm site is within the known range of the species and not at the limit of the species distribution.

How is the proposal likely to affect current disturbance regimes?

Current disturbances at the site include cattle and sheep grazing, soil disturbance and grazing by feral animals including the European Rabbit and European Hare, and periods of drought and rainfall consistent with the southern oscillation index and resultant cycles of drought (El Niño) and wetter periods (La Niña). There have been no major fire events on the site in the last decade.

The site is grazed primarily by sheep and cattle. Due to extended drought, stocking rates were not high at the time of survey. Grazing pressure and management varies across the landscape, and the proposal is considered unlikely to exacerbate over-grazing at the site, but may, in fact, contribute to a more sustainable grazing regime through the mitigation measures proposed in some parts of the site. In the absence of fire, grazing can be an important form of disturbance to prevent the accumulation of biomass that may not be favourable to some native flora species. Grazing will be periodically removed during construction, but should be reintroduced post-construction. Rotational periods of grazing and spelling help to foster healthy native pastures in the absence of fire. A spell in grazing may result in the increased regeneration of eucalypt feed trees for the Regent Honeyeater.

The risk of fire with wind farms is inherently low (CFA 2007). A low risk is associated with malfunctioning turbine bearings, inadequate crankcase lubrication, cable damage during rotation, electrical shorting or arcing occurring in transmission and distribution facilities (CFA 2007). The location of wind turbines away from tall vegetation in the study area minimises the risk of fire. It is unlikely that the proposal will significantly affect the fire regime such that high intensity fire would have a detrimental impact on the Regent Honeyeater foraging habitat. The proposed access roads will increase the accessibility across the site should a fire occur.

The study area is primarily located on ridge tops and, therefore, is largely not affected by the surrounding streams. Conversely, the proposal is not likely to significantly affect flooding or flow regimes for the study area. There may be a small and localised increase in run-off in areas where the ground within the construction area will be compacted, gravelled or concreted. Soil erosion and run-off control measures will be implemented as part of the mitigation measures undertaken for the proposal.

Grazing by feral animals such as the European Rabbit and European Hare can reduce natural recruitment of eucalypt feed trees. The proposal is considered unlikely to contribute to increasing feral animal activity across the project site and instead is likely to assist with the management of these species through the proposed mitigation measures to be implemented within the study area and on the proposed offset sites.

How is the proposal likely to affect habitat connectivity?

Vegetation will be removed in linear strips (for turbines, access tracks and the associated ancillary structures required for the running of the wind farm). Habitat to be removed for the Regent Honeyeater is comprised of 112.47 ha of potential woodland foraging habitat, which represents 12.6 % of the habitat for this species throughout the study area. The area of vegetation to be cleared is contiguous with other examples of the same vegetation communities in a similar condition mapped within the locality (amounting to 7,764.84 ha), and therefore the proposal is unlikely to substantially reduce the amount of habitat for this species present.

How is the proposal likely to affect critical habitat?

Critical habitat for the Regent Honeyeater has not been declared.

***Circus assimilis* (Spotted Harrier)**

The Spotted Harrier occurs throughout the Australian mainland, except in densely forested or wooded habitats of the coast, escarpment and ranges, and rarely in Tasmania. It occurs in grassy open woodland including acacia and mallee remnants, inland riparian woodland, grassland and shrub steppe. It is found most commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands (DECCW 2011b).

The Spotted Harrier is listed as Vulnerable under the TSC Act.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Spotted Harrier was not recorded at the site. However, the species is known to occur in the Glenn Innes-Guyra Basalts CMA subregion and has the potential to occur at the site given the presence of timbered habitats across the site. The proposal may affect the lifecycle of the Spotted Harrier through a reduction in habitat that may be used for both hunting and nesting, and the potential for casualties from accidental strike with the turbines.

In terms of foraging habitat, the Spotted Harrier preys on terrestrial mammals (e.g. bandicoots, bettongs, and rodents), birds and reptiles, occasionally insects and rarely carrion (DECCW 2011b). During nesting, the Spotted Harrier builds a stick nest in a tree and lays eggs in spring (or sometimes autumn), with young remaining in the nest for several months (DECCW 2011b).

In terms of habitat loss, based on the highest level of impact (80m turbine layout), the proposal will permanently impact 140.72 ha of woodland and pasture and temporarily impact 148.05 ha of the study area.

A risk matrix anticipating the likelihood of bird collision with turbines has been prepared for those species most commonly recorded within the study area. While this risk matrix did not include the Spotted Harrier, the results showed that species considered to be at greatest risk are those that fly at high altitudes, at speed and are migratory. So while the species is not known at the study site, should it utilise the site, the risk of collision with the turbines is considered likely to be moderate as raptors and birds of prey are known to sometimes collide with turbines whilst hunting prey.

Given this species has not been recorded foraging or breeding at the site, the proposal is considered unlikely to affect the lifecycle of this species.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The Spotted Harrier is listed as a threatened species in NSW. Potential habitat to be removed for Spotted Harrier is comprised of linear strips (for turbines, access tracks and the associated ancillary structures required for the running of the wind farm). As a worst case scenario, the area of vegetation to be cleared consists of a permanent loss of 140.72 ha and a temporary impact to 148.05 ha of potential habitat, totalling 288.77 ha.

This loss of potential habitat is contiguous with other examples of the same vegetation communities in a similar condition mapped within the study area (amounting to 1882.99 ha) and mapped within the project site (amounting to 9955.20 ha). The amount of potential habitat proposed to be impacted represents 15.3 % of the potential habitat mapped within the study area, but only 2.9 % of potential habitat mapped within the project site. For these reasons, the proposal is unlikely to substantially reduce the amount of potential habitat for this species present in the project site.

Given that vegetation removal is to occur is a narrow linear corridor, rather than one consolidated stand, it is unlikely that the proposed vegetation clearance would impact on this species such that foraging and breeding resources would become limited in the study area.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The Spotted Harrier occurs throughout the Australian mainland, except in densely forested or wooded habitats of the coast, escarpment and ranges. Individuals disperse widely in NSW and comprise a single population. Therefore, the Spotted Harrier at Sapphire is not at the limit of its known distribution.

How is the proposal likely to affect current disturbance regimes?

Current disturbances at the site include cattle and sheep grazing, soil disturbance and grazing by feral animals including the European Rabbit and European Hare, and periods of drought and rainfall consistent with the southern oscillation index and resultant cycles of drought (El Niño) and wetter periods (La Niña). There has been no major fire event in the last decade.

The site is grazed primarily by sheep and cattle and grazing pressure and management varies across the landscape. The proposal is considered unlikely to exacerbate over-grazing at the site, but may, in fact, contribute to a more sustainable grazing regime through the mitigation measures proposed in some parts of the site. In the absence of fire, grazing can be an important form of disturbance to prevent the accumulation of biomass that may not be favourable to some native flora species. Grazing will be periodically removed during construction, but should be reintroduced post-construction. Rotational periods of grazing and spelling help to foster healthy native pastures in the absence of fire.

Grazing by feral animals such as the European Rabbit and European Hare can reduce natural recruitment of eucalypt feed trees. The proposal is considered unlikely to contribute to increasing feral animal activity across the project site and instead is likely to assist with the management of these species through the proposed mitigation measures to be implemented within the study area and on the proposed offset sites. No adverse impacts to potential Spotted Harrier habitat is expected to result from a reduction in grazing pressure from livestock and feral animals.

The study area is primarily located on ridge tops and, therefore, is largely not affected by the surrounding streams. Conversely, the proposal is not likely to significantly affect flooding or flow regimes for the study area. There may be a small and localised increase in run-off in areas where the ground within the construction area will be compacted, gravelled or concreted. Soil erosion and run-off control measures will be implemented as part of the mitigation measures undertaken for the proposal.

The risk of fire with wind farms is inherently low (CFA 2007). The location of wind turbines away from tall vegetation in the study area minimises the risk of fire. It is unlikely that the proposal will significantly affect the fire regime such that high intensity fire would have a detrimental impact on Spotted Harrier foraging and nesting habitat. The proposed access roads will increase the accessibility across the site should a fire occur.

Therefore, changes to the current disturbance regime as a result of the proposal that may impact the Spotted Harrier are not considered likely.

How is the proposal likely to affect habitat connectivity?

The woodland and open forest areas of the study area have naturally large canopy gaps and a very open understorey. Given the linear nature of the proposal and that tree clearance has been minimised it is considered unlikely that the proposal would create barriers to movement of the Spotted Harrier, which is a highly mobile species.

How is the proposal likely to affect critical habitat?

Not applicable - critical habitat cannot be declared for vulnerable species.

***Climacteris picumnus victoriae* (Brown Treecreeper)**

The eastern subspecies of Brown Treecreeper lives in eastern NSW in dry eucalypt woodlands and forests through the western slopes of NSW and in coastal areas with drier open woodlands such as the Snowy River Valley, Cumberland Plain, Hunter Valley and parts of the Richmond and Clarence Valleys (DECCW 2011b).

Brown Treecreeper is listed as Vulnerable under the TSC Act.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

The Brown Treecreeper has potential habitat within the study area in areas of Black Cypress Pine - Tumbledown Gum-Narrow-leaved Ironbark open forest, Blakely's Red-gum - Rough-barked Apple – Red Stringybark grassy open forest, Blakely's Red-gum – Yellow Box grassy open forest/woodland, Manna Gum – Rough-barked Apple – Yellow Box grassy woodland/open forest, Tenterfield Woollybutt – Silvertop Stringybark open forest and White Box grassy woodland. This potential habitat represents 894.79 ha of the study area, however only a fragment of this will be disturbed by the development footprint. The proposal will require 75.36 ha of permanent habitat loss and 37.11 ha of temporary loss.

Despite the presence of potential habitat, the Brown Treecreeper has not been recorded within the development footprint. Diurnal bird surveys and opportunistic surveys were conducted across the study area in suitable habitat during October, November and December 2008; April and May 2009; September and October 2010 and January 2011. The Brown Treecreeper was recorded in a patch of woodland 800 m east of the Eastern Feeder road, within two kilometres of the Wellingrove cluster. The Brown Treecreeper is a sedentary species, present year-round at most nesting sites, with a home range averaging 4.4 ha.

The Brown Treecreeper may nest and forage within the areas of potential habitat, however tree clearance for the proposal will be avoided wherever possible and the amount of trees being removed will be minimal with respect to the amount of potential habitat present for this species within the study area.

The Brown Treecreeper is considered to forage in terrestrial and arboreal habitats in equal measures, on a diet of ants and other invertebrates. Given it's preference for foraging within vegetated areas or close to the ground, the risk of the Brown Treecreeper colliding with turbines is considered low (DECCW 2011b). Therefore, the proposal is considered unlikely to affect the lifecycle of this species should it be present at the site.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

Vegetation will be removed in linear strips (for turbines, access tracks and the associated ancillary structures required for the running of the wind farm). As a worst case scenario, the area of vegetation to be cleared consists of a permanent loss of 75.36 ha and a temporary impact to 37.11 ha of potential habitat, totalling 112.47 ha.

This loss of potential habitat is contiguous with other examples of the same vegetation communities in a similar condition mapped within the study area (amounting to 894.79 ha) and mapped within the project site (amounting to 6331.11 ha). The amount of potential habitat proposed to be impacted represents

12.6 % of the potential habitat mapped within the study area, but only 1.8 % of potential habitat mapped within the project site. For these reasons, the proposal is unlikely to substantially reduce the amount of potential habitat for this species present within the project site.

The removal of habitat trees, including trees with hollows, will be avoided where possible. However, a pre-clearance protocol will be developed and implemented to survey for hollow-bearing fauna and determine if nests are present in any trees proposed for clearing.

The areas of woodland habitat present across the study area, comparative to the area of habitat to be removed is very small. Furthermore, vegetation removal is to occur is a narrow linear corridor, rather than one consolidated stand. Therefore, it is unlikely that the proposed vegetation clearance would impact on this species such that foraging and nesting resources would become limited within the study area.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The Brown Treecreeper is endemic to eastern Australia and occurs in eucalypt forests and woodlands of inland plains as far west as Narrabri, and slopes of the Great Dividing Range from the northern tablelands to south-east Queensland as far north as the Fitzroy River (DECCW 2011b). The Brown Treecreeper it not at the limit of it's distribution at Sapphire.

How is the proposal likely to affect current disturbance regimes?

The fire regime of the study area is not expected to change as a result of the proposal, as the risk of fire with wind farms is inherently low (CFA 2007). A low risk is associated with malfunctioning turbine bearings, inadequate crankcase lubrication, cable damage during rotation, electrical shorting or arcing occurring in transmission and distribution facilities (CFA 2007). Furthermore, a number of mitigation measures will be implemented during construction to prevent accidental fires.

The site is grazed primarily by sheep, and cattle are present in some areas. Over-grazing from stock changes the vegetation structure of the understorey, which may reduce the availability of invertebrate taxa as a food source for Brown Treecreeper. Grazing pressure and management varies across the landscape, and the proposal is considered unlikely to exacerbate over-grazing at the site. It may, in fact, contribute to a more sustainable grazing regime through the mitigation and offset measures proposed in some parts of the site. In the absence of fire, grazing can be an important form of disturbance to prevent the accumulation of biomass that may not be favourable to some native flora species. Grazing will be periodically removed during construction, but should be reintroduced post-construction. Rotational periods of grazing and spelling help to foster healthy native pastures in the absence of fire.

Feral animals can also have a detrimental impact on Brown Treecreeper through predation by species such as feral Cats and the European Red Fox. The proposal is considered unlikely to contribute to increasing feral animal activity across the project site and instead is likely to assist with the management of these species through the proposed mitigation measures to be implemented within the study area and on the proposed offset sites.

How is the proposal likely to affect habitat connectivity?

The woodland and open forest areas of the study area have naturally large canopy gaps and a very open understorey. Given the linear nature of the proposal, that this species is highly mobile and that tree clearance has been minimised, it is considered unlikely that the proposal would create barriers to movement of this species throughout the project site. Furthermore, given the flight characteristics of this species, it is considered unlikely that they would collide with turbines and hence turbines are unlikely to restrict movement across the project site.

How is the proposal likely to affect critical habitat?

Not applicable - critical habitat cannot be declared for vulnerable species.

***Daphoenositta chrysoptera* (Varied Sittella)**

The Varied Sittella is a small songbird, endemic and widespread in mainland Australia and found in eucalypt woodlands and forests throughout their range. They prefer rough-barked trees like stringybarks and ironbarks or mature trees with hollows or dead branches, mallee and Acacia woodland (DECCW 2011b). They feed on arthropods found within the crevices of rough or decorticating bark, dead branches, standing dead trees and small branches and twigs in the tree canopy (DECCW 2011b). The Varied Sittella's population size in NSW is uncertain but is believed to have undergone a moderate reduction over the past several decades (DECCW 2011b).

Varied Sittella tend to forage in groups, flying into the tree canopy and working down the branches and the trunk, probing through the bark in search of insects (Pizzey & Knight 2003). To breed, a well camouflaged cup-like nest is constructed to resemble a bulge in the upright fork of a eucalypt, *Casuarina* or *Melaleuca* tree (Pizzey & Knight 2003).

Varied Sittella is listed as Vulnerable under the TSC Act.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Varied Sittella was not recorded at the site although it has been recorded within the Kings Plains National Park to the northwest of the site (DECCW 2011a). Potential habitat within the study area includes open eucalypt woodlands that may be used for foraging or nesting. The proposal could affect the lifecycle of the Varied Sittella through clearing of potential foraging and breeding habitat and casualties caused by accidental collision with the turbines.

The area of woodland within the study area that could form potential habitat for the Varied Sittella is 894.79 ha. Assuming the highest degree of impact (the 80m turbine layout), the proposal requires permanent removal of 75.36 ha (8.42 %) of woodland habitat and the temporary loss of 37.11 ha of woodland habitat. Given this is a relatively small impact comparative to the amount of habitat within the study area, the proposal is considered unlikely to adversely affect the lifecycle of this species should it be present at the site.

The likelihood of the Varied Sittella colliding with the turbine likely to be low given that other woodland birds such as the Brown Treecreeper were considered to have a low risk in the bird collision matrix.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The Varied Sittella is a threatened species in NSW. The viability of Varied Sittella populations is sensitive to habitat isolation and simplification, including reductions in tree species diversity, tree canopy cover, shrub cover, ground cover, logs, fallen branches and litter (DECCW 2011b). Other threats to the Varied Sittella include the dominance of Noisy Miners in woodland patches, habitat degradation through small-scale clearing for fencelines and road verges, rural tree decline, loss of paddock trees and connectivity, 'tidying up' on farms, and firewood collection (DECCW 2011b)

While the species has not been recorded at the site, potential habitat will be impacted through the permanent removal of 75.36 ha of woodland or 8.2 % of woodland within the study area (894.79 ha). A further 37.11 ha or woodland will be temporarily cleared. This clearance represents 1.8% of the woodland habitat mapped within the project site. An offset will be prepared in accordance with the quantum calculated using the Biobanking tool to compensate for the loss of habitat. Habitat features including dead trees will be retained where possible within the study area and fallen logs will be relocated to adjacent areas where they can continue to be used by fauna. For these reasons, the proposal is unlikely to substantially reduce the amount of potential habitat for this species present in the project site.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The Varied Sittella is sedentary and inhabits most of mainland Australia except the treeless deserts and open grasslands. Distribution in NSW is nearly continuous from the coast to the far west (DECCW 2011b). Therefore, the Sapphire site is not at the limit of the Varied Sittella's known distribution.

How is the proposal likely to affect current disturbance regimes?

Current disturbances at the site include cattle and sheep grazing, soil disturbance and grazing by feral animals including the European Rabbit and European Hare, and periods of drought and rainfall consistent with the southern oscillation index and resultant cycles of drought (El Niño) and wetter periods (La Niña). There have been no major fire events on the site in the last decade.

A high intensity fire would result in a temporary loss of foraging habitat for the Varied Sittella and place the species at greater risk from predation by raptors during breeding. However the risk of fire with wind farms is inherently low (CFA 2007). The location of wind turbines away from tall vegetation in the study area minimises the risk of fire. It is unlikely that the proposal will significantly affect the fire regime such that high intensity fire would have a detrimental impact on Varied Sittella habitat. The proposed access roads will increase the accessibility across the site should a fire occur.

The site is grazed primarily by sheep, and cattle are present in some areas. Over-grazing from stock changes the vegetation structure of the understorey and will limit regeneration of woodland trees, which may reduce the availability of insects as a food source for Varied Sittella. A more open understorey also encourages the presence of Noisy Minors which out compete the Varied Sittella. Grazing pressure and management varies across the landscape, and the proposal is considered unlikely to exacerbate over-grazing at the site. It may, in fact, contribute to a more sustainable grazing regime through the mitigation and offset measures proposed in some parts of the site. In the absence of fire, grazing can be an important form of disturbance to prevent the accumulation of biomass that may not be favourable to some native flora species. Grazing will be periodically removed during construction, but should be reintroduced post-construction. Rotational periods of grazing and spelling help to foster healthy native pastures in the absence of fire.

Therefore, changes to the current disturbance regime that may impact the Varied Sittella is not considered likely given the environmental management and mitigation measures proposed.

How is the proposal likely to affect habitat connectivity?

The apparent reduction in numbers of Varied Sittella has been attributed to declining habitat. The sedentary nature of the Varied Sittella makes cleared land a potential barrier to movement (DECCW 2011b). The proposed development will result in the permanent loss of up to 75.36 ha of woodland habitat and temporary removal of 37.11 ha of woodland. This represents 12.6 % of potential habitat within the study area, and 1.8 % of potential habitat mapped within the project site. The woodland and open forest areas of the study area have naturally large canopy gaps and a very open understorey. Given that vegetation removal is to occur as a narrow linear corridor, rather than one consolidated stand, it is unlikely that the proposal would create barriers to movement of Varied Sittella between woodland areas. Furthermore, given the flight characteristics of this species, it is considered unlikely that they would collide with turbines and hence turbines are unlikely to restrict movement across the project site.

How is the proposal likely to affect critical habitat?

Not applicable - critical habitat cannot be declared for vulnerable species.

***Glossopsitta pusilla* (Little Lorikeet)**

This species is gregarious, travelling and feeding in small flocks (<10 individuals). The species roosts in treetops, most typically selecting small hollows (<3 cm) in the limb or trunk of smooth-barked eucalypts high above the ground (2–15 m). These nest sites are often used repeatedly for decades, suggesting that preferred sites are limited. Nesting season extends from May to September. In years when flowering is prolific, Little Lorikeet pairs can breed twice, producing 3-4 young per attempt, however the survival rate of fledglings is not known (DECCW 2011b).

In NSW, the range of the Little Lorikeet extends from the coast to the western slopes of the Great Dividind Range, along the full length of the eastern seaboard.

The Little Lorikeet is a threatened species, listed as Vulnerable under the TSC Act.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

The Little Lorikeet is a highly mobile species with fast, high-low flight depending on activity. The species feeds mostly on nectar and pollen and forages primarily in open eucalypt woodland. They also utilise other trees such as *Angophora* spp. and *Melaleuca* spp., and productive riparian habitats are particularly preferred. Isolated flowering trees in open country, (e.g. paddock trees and roadside remnants) also help sustain viable populations of the species.

The Little Lorikeet has been recorded flying over the study area and potential habitat is present within areas of Black Cypress Pine - Tumbledown Gum - Narrow-leaved Ironbark open forest, Blakely's Red-gum - Rough-barked Apple – Red Stringybark grassy open forest, Blakely's Red-gum – Yellow Box grassy open forest/woodland, Manna Gum – Rough-barked Apple – Yellow Box grassy woodland/open forest, Tenterfield Woollybutt – Silvertop Stringybark open forest, White Box grassy woodland and associated derived grassland. This potential habitat represents 1594.62 ha of the study area and the proposal will require 123.64 ha of permanent potential habitat loss and 104.92 ha of temporary removal of potential habitat. This loss represents 14.3% of potential habitat within the study area and only 2.6% of potential habitat mapped within the project site.

Although the proposal will result in the removal of 228.56 ha of potential nesting and foraging habitat for this species, vegetation clearance is linear in nature and therefore will not result in large consolidated patches of vegetation clearance. Furthermore, tree clearance has been avoided wherever possible. Therefore, it is considered unlikely that the clearance of small sections of grassy understorey cleared for roads and turbines would impact upon the lifecycle of the species. Lastly, extensive areas of potential habitat exist within the project site (8930.37 ha).

A risk matrix anticipating the likelihood of collision with turbines and risk of collision with overhead power lines has been prepared for those species most commonly recorded within the study area including the Little Lorikeet. The Little Lorikeet was found to have a moderate risk of collision with turbines and a low risk of collision with overhead power lines. Wind turbines are solid, opaque structures and the risks posed by moving rotors are generally within the height range of between 30 and 120 metres above the ground. It is thus considered unlikely that the types of collision situations that the Little Lorikeet could encounter would be from moving about a location in the course of routine foraging generally do so within the height of the trees in which they feed.

Therefore, the proposal is unlikely to have a negative impact on the lifecycle of the Little Lorikeet.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

Little Lorikeets nest typically in limb or trunk of smooth-barked eucalypts and riparian trees such as *Allocasuarina* species and nest sites are often used repeatedly for decades suggesting that preferred sites are limited. The study area supports a large proportion of hollow bearing trees which are common throughout woodland areas. However, the proposal has been designed such that tree removal has been minimised wherever possible and will be further minimised during the detailed design phase. All turbines have been placed at least 30 m from hollow-bearing trees.

Vegetation will be removed in linear strips (for turbines, access tracks and the associated ancillary structures required for the running of the wind farm). As a worst case scenario, the area of vegetation to be cleared consists of a permanent loss of 123.64 ha and a temporary impact to 104.92 ha of potential habitat, totalling 228.56 ha.

This loss of potential habitat is contiguous with other examples of the same vegetation communities in a similar condition mapped within the study area (amounting to 1,594.62 ha) and mapped within the project site (amounting to 8,930.37 ha). The amount of potential habitat proposed to be impacted represents 14.3 % of the potential habitat mapped within the study area and only 2.6 % of potential habitat mapped within the project site.

Where the removal of habitat trees is required, a pre-clearance protocol will be developed and implemented to survey for hollow-bearing fauna and determine if roosts or nests are present in any trees proposed for clearing. An ecologist will be present during clearing to capture and re-release individuals (where appropriate).

Given that vegetation removal is to occur is a narrow linear corridor, rather than one consolidated stand, it is unlikely that the proposed vegetation clearance would impact on this species such that foraging and roosting resources would become limited in the study area.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The Little Lorikeet is distributed widely across the coastal and Great Divide regions of eastern Australia from Cape York to South Australia. NSW provides a large portion of the species' core habitat, with lorikeets found westward as far as Dubbo and Albury (DECWW 2011b). Although found throughout the inland slopes, the study area approaches the western limit of the species' distribution.

How is the proposal likely to affect current disturbance regimes?

Current disturbances at the site include cattle and sheep grazing, soil disturbance and grazing by feral animals including the European Rabbit and European Hare, and periods of drought and rainfall consistent with the southern oscillation index and resultant cycles of drought (El Niño) and wetter periods (La Niña). There have been no major fire events on the site in the last decade.

Fire regimes that impact foraging habitat are of most relevance to the Little Lorikeet. The risk of fire with wind farms is inherently low (CFA 2007). The location of wind turbines away from tall vegetation in the study area minimises the risk of fire. It is unlikely that the proposal will significantly affect the fire regime such that high intensity fire would have a detrimental impact on Little Lorikeet foraging habitat. The proposed access roads will increase the accessibility across the site should a fire occur.

Therefore, significant changes to the current disturbance regime that may impact the Little Lorikeet are unlikely.

How is the proposal likely to affect habitat connectivity?

The landscape within the study area is one of open woodland, and turbine corridors have been deliberately focussed in areas of vegetation that have already undergone some historical clearing (for agricultural uses). Therefore the narrow and linear nature of the proposal is considered unlikely to result in fragmentation of habitat or create barriers to movement for this highly mobile species.

How is the proposal likely to affect critical habitat?

Not applicable – critical habitat has not been declared for this species.

Hieraaetus morphnoides **(Little Eagle)**

The Little Eagle is a medium-sized bird of prey that is found throughout the Australian mainland excepting the most densely forested parts of the Dividing Range escarpment. It occurs as a single population throughout NSW. Habitat consists of open eucalypt forest, woodland or open woodland. Sheoak or acacia woodlands and riparian woodlands of interior NSW are also used (DECCW 2011b).

The Little Eagle nests in tall living trees within a remnant patch, where pairs build a large stick nest in winter. Breeding occurs during the spring and young fledge in early summer. It preys on birds, reptiles and mammals, occasionally adding large insects and carrion (DECCW 2011b).

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Little Eagle was not recorded at the site. However, the species is known to occur in the Glen Innes-Guyra Basalts CMA subregion and has the potential to occur at the site given the presence of timbered habitats. The proposal may affect the lifecycle of the Little Eagle through a reduction in habitat that may be used for both hunting and nesting, and the potential for casualties from accidental strike with the turbines. In terms of foraging habitat, the Little Eagle preys on birds, reptiles, mammals and occasionally large insects and carrion (DECCW 2011b).

While this risk matrix did not include the Little Eagle, the results showed that species considered to be at greatest risk are those that fly at high altitudes, at speed and are migratory. While the species is not known at the study site, should it utilise the site, the risk of collision with the turbines is considered likely to be moderate as raptors and birds of prey are known to sometimes collide with turbines whilst hunting prey.

Given this species has not been recorded foraging or breeding at the site, the proposal is considered unlikely to affect the lifecycle of this species.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The Little Eagle is listed as a threatened species in NSW. Potential breeding and foraging habitat removal is comprised of linear strips (for turbines, access tracks and the associated ancillary structures required for the running of the wind farm). As a worst case scenario, the area of vegetation to be cleared consists of a permanent loss of 140.72 ha and a temporary impact to 148.05 ha of potential habitat. This loss of potential habitat is contiguous with other examples of the same vegetation communities in a similar condition mapped within the study area (amounting to 1,882.99 ha) and mapped within the project site (amounting to 9,955.20 ha). The amount of potential habitat proposed to be impacted represents 15.3 % of the potential habitat mapped within the study area and only 2.9 % of potential habitat mapped within the project site.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The Little Eagles is found throughout the Australian mainland excepting the most densely forested parts of the Dividing Range escarpment. It occurs as a single population throughout NSW. Therefore, the Little Eagle is not at the limit of its known distribution at Sapphire.

How is the proposal likely to affect current disturbance regimes?

Current disturbances at the site include cattle and sheep grazing, soil disturbance and grazing by feral animals including the European Rabbit and European Hare, and periods of drought and rainfall consistent with the southern oscillation index and resultant cycles of drought (El Niño) and wetter periods (La Niña). There has been no major fire event in the last decade.

The site is grazed primarily by sheep and cattle and grazing pressure and management varies across the landscape. The proposal is considered unlikely to exacerbate over-grazing at the site, but may, in fact, contribute to a more sustainable grazing regime through the mitigation measures proposed in some parts of the site. In the absence of fire, grazing can be an important form of disturbance to prevent the accumulation of biomass that may not be favourable to some native flora species. Grazing will be periodically removed during construction, but should be reintroduced post-construction. Rotational periods of grazing and spelling help to foster healthy native pastures in the absence of fire.

Grazing by feral animals such as the European Rabbit and European Hare can reduce natural recruitment of eucalypt feed trees. Threats to the Little Eagle include secondary poisoning from rabbit baiting. Site management including the rabbit control should consider alternatives to poisoning for the control of rabbits to avoid inadvertently poisoning higher food chain species like the Little Eagle.

The proposal is considered unlikely to contribute to increasing feral animal activity across the project site and instead is likely to assist with the management of these species through the proposed mitigation measures to be implemented within the study area and on the proposed offset sites. No adverse impacts to potential Little Eagle habitat is expected to result from a reduction in grazing pressure from livestock and feral animals.

The risk of fire with wind farms is inherently low (CFA 2007). The location of wind turbines away from tall vegetation in the study area minimises the risk of fire. It is unlikely that the proposal will significantly affect the fire regime such that high intensity fire would have a detrimental impact on Little Eagle foraging and nesting habitat. The proposed access roads will increase the accessibility across the site should a fire occur.

Therefore, significant changes to the current disturbance regime that may impact the Little Eagle are unlikely.

How is the proposal likely to affect habitat connectivity?

The woodland and open forest areas of the study area have naturally large canopy gaps and a very open understorey. Given the linear nature of the proposal and that tree clearance has been minimised, it is considered unlikely that the proposal would create barriers to movement of the Little Eagle, which is a highly mobile species.

How is the proposal likely to affect critical habitat?

Not applicable - critical habitat cannot be declared for vulnerable species.

***Lathamus discolor* (Swift Parrot)**

The Swift Parrot breeds in Tasmania between September and January and migrates to the mainland in autumn, where it forages on profuse flowering eucalypts (Blakers *et al.* 1984; Schodde and Tidemann 1986). Hence on the mainland, autumn and winter flowering eucalypts are an important food source for this species and include *Eucalyptus robusta* Swamp Mahogany, *Corymbia maculata* Spotted Gum, *C. gummifera* Red Bloodwood, *E. sideroxylon* Mugga Ironbark, and *E. albens* White Box.

Another food source is lerp, a carbohydrate exudate of insects that feed on eucalypt phloem through leaf surfaces (Smales 2005). Commonly used lerp infested trees include *E. microcarpa* Inland Grey Box, *E. moluccana* Grey Box and *E. pilularis* Blackbutt.

These resources may be very localised, eruptive and highly variable from one year to another. As a consequence, Swift Parrots appear to be very mobile, even nomadic, during the course of a given winter and their mainland distribution may differ considerably between years (Smales 2005).

In NSW, the Swift Parrot mostly occurs on the coast and south west slopes, but its range extends from Victoria and the eastern parts of South Australia to south-east Queensland (DECCW 2011b). The population estimates in 2005 estimated fewer than 2000 birds remaining (Smales 2005).

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Swift Parrot was not recorded at the site and there are no database records for the species within a 10 km radius of the study area. The species is predicted to occur in the Glenn Innes-Guyra Basalts CMA subregion and has the potential to occur at the site given the presence of winter-flowering eucalypts including *Eucalyptus blakelyi* Blakely's Red Gum, *E. laevopinea* Silvertop Stringybark, *E. albens*, *E. dealbata* Tumbledown Red Gum and *E. crebra* Narrow-leaved Ironbark.

As the species is a summer breeding migrant to Tasmania, the site at Sapphire would only be used for foraging. Therefore, the lifecycle of the Swift Parrot is only likely to be affected through a reduction in foraging habitat, and the potential for casualties from accidental strike with the turbines.

In terms of foraging habitat, the study area contains 1594.62 ha of potential habitat for Swift Parrot in the form of vegetation communities containing autumn/winter flowering eucalypts. Of this amount, 123.64 ha (7.8 % of study area) will be permanently cleared and 104.92 ha (6.6 % of study area) will be temporarily cleared within the study area.

A risk matrix anticipating the likelihood of collision with turbines has been prepared for those species most commonly recorded within the study area. While this risk matrix did not include the Swift Parrot, the results for other parrots (eg. Turquoise Parrot and Little Lorikeet) was moderate and is likely to be similar for the Swift Parrot. However, the Swift Parrot is a migratory species and therefore it likely to be at a slightly greater risk that the other parrots. Swift Parrots moving about a location in the course of routine foraging generally do so within the height of the trees in which they feed. Less frequent movements between sites, between feeding and roosting areas and on migration may be higher (Smales 2005).

A study of the cumulative impacts of collision with turbines on the overall population of Swift Parrots, predicted by the modelling for all current and presently proposed wind farms within the species' range are very small. Results for the range of avoidance rates modelled equate to slightly more or less than one parrot killed due to wind turbine collisions every ten years (Smales 2005).

Under the Swift Parrot Recovery Plan (Swift Parrot Recovery Team 2001) the two key threats to the species are loss of habitat and mortality, primarily through collision with artificial objects. One of the recovery actions for the species listed in the Swift Parrot Recovery Plan 2001-2005 is to reduce the incidence of swift parrot collisions with manmade structures including chain-link fences, windows and vehicles. Most likely these collisions occur principally where birds can see through glass or mesh without perceiving them to be barriers (Smales 2005).

Wind turbines are solid, opaque structures and the risks posed by moving rotors are generally within the height range of between 30 and 120 metres above the ground. It is thus considered unlikely that the types of collision situations that the parrot presently encounters in urban environments will exist at wind farms (Smales 2005).

Therefore, the proposed wind farm at Sapphire is unlikely to have a negative impact on the lifecycle of the Swift Parrot. The clearing of potential foraging habitat is low and the risk of collision with the turbines is limited.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The Swift Parrot is listed as a threatened species in NSW. Vegetation will be removed in linear strips (for turbines, access tracks and the associated ancillary structures required for the running of the wind farm). The study area contains 1594.62 ha of potential habitat for Swift Parrot in the form of vegetation communities containing autumn/winter flowering eucalypts. Of this amount, 123.64 ha (7.8 % of study area) will be permanently cleared and 104.92 ha (6.6 % of study area) will be temporarily cleared within the study area.

Given that vegetation removal is to occur is a narrow linear corridor, rather than one consolidated stand, it is unlikely that the proposed vegetation clearance would impact on this species such that foraging and roosting resources would become limited in the study area.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

In NSW, the Swift Parrot mostly occurs on the coast and south west slopes, but its range extends from Victoria and the eastern parts of South Australia to south-east Queensland (DECCW 2011b). Therefore, Sapphire is not at the limit of the Swift Parrot's known distribution.

How is the proposal likely to affect current disturbance regimes?

Current disturbances at the site include cattle and sheep grazing, soil disturbance and grazing by feral animals including the European Rabbit and European Hare, and periods of drought and rainfall consistent with the southern oscillation index and resultant cycles of drought (El Niño) and wetter periods (La Niña). There have been no major fire events on the site in the last decade.

Fire regimes that impact foraging habitat are of most relevance to the Swift Parrot. The risk of fire with wind farms is inherently low (CFA 2007). The location of wind turbines away from tall vegetation in the study area minimises the risk of fire. It is unlikely that the proposal will significantly affect the fire regime such that high intensity fire would have a detrimental impact on Swift Parrot foraging habitat. The proposed access roads will increase the accessibility across the site should a fire occur.

Therefore, significant changes to the current disturbance regime that may impact the Swift Parrot are unlikely.

How is the proposal likely to affect habitat connectivity?

The woodland and open forest areas of the study area have naturally large canopy gaps and a very open understorey. Given the linear nature of the proposal and that tree clearance has been minimised it is considered unlikely that the proposal would create barriers to movement of the Swift Parrot, which is a highly mobile nomadic species.

How is the proposal likely to affect critical habitat?

Critical habitat for the Swift Parrot has not been declared.

Furthermore, the most important habitat for overwintering Swift Parrots is probably the Box-Ironbark Forests of central Victoria and southern NSW, where it feeds on the profusely-flowering Red Ironbarks *E. tricarpa* (central Victoria), *E. sideroxylon* (north eastern Victoria) and other flowering eucalypts.

Lophoictinia isura **(Square-tailed Kite)**
The Square-tailed Kite is a medium-sized raptor that ranges along coastal and subcoastal areas from south-western to northern Australia, Queensland, NSW and Victoria. In NSW, scattered records of the species throughout the state indicate that the species is a regular resident in the north, north-east and along the major west-flowing river systems. It is a summer breeding migrant to the south-east, including the NSW south coast, arriving in September and leaving by March (DECCW 2011b). Breeding is from July to February, with nest sites generally located along or near watercourses, in a fork or on large horizontal limbs.

Found in a variety of timbered habitats including dry woodlands and open forests, it shows a particular preference for timbered watercourses. The Square-tailed Kite 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 (DECCW 2011b). The species appears to occupy large hunting ranges of more than 100 km^2.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Square-tailed Kite was not recorded at the site. There are no database records for the Square-tailed Kite within a 10 km radius of the study area (DECCW 2011a). However, the species is known to occur in the Glenn Innes-Guyra Basalts CMA subregion and has the potential to occur at the site given the presence of timbered habitats. However, the species preference for timbered watercourses is poorly represented on the site, as the riparian areas primarily consist of a grassy groundlayer with no overstorey.

As the species is a summer breeding migrant to the south–east, the site at Sapphire is unlikely to be used for breeding. Therefore, the lifecycle of the Square-tailed Kite is only likely to be affected through a reduction in foraging and roosting habitat, and the potential for casualties from accidental strike with the turbines.

In terms of foraging habitat, the Square-tailed Kite soars over forest and woodland canopy in search of passerines nestlings which forms its main food source (Pizzey and Knight, 2003), and insects in the tree canopy, picking most prey items from the outer foliage (DECCW 2011b). In terms of habitat loss based on the highest level of impact (80m turbine layout), the proposal will require 140.72 ha of permanent vegetation clearing and 148.05 ha of temporary loss, representing 15.3% of the potential habitat mapped within the study area (1882.99 ha) and only 2.9% of potential habitat mapped within the project site (9955.20 ha).

A risk matrix anticipating the likelihood of collision with turbines has been prepared for those species most commonly recorded within the study area. While this risk matrix did not include the Square-tailed Kite, the results showed that species considered to be at greatest risk are those that fly at high altitudes, at speed and are migratory. While the species is not known at the study site, should it utilize the site, the risk of collision with the turbines is considered to be slightly higher as the raptor may collide with turbines whilst hunting prey.

Given the poor condition of preferred riparian habitat and the absence of records for the species within the study area, the proposal is considered unlikely to affect the lifecycle of this species.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The Square-tailed Kite is listed as a threatened species in NSW. Vegetation will be removed in linear strips (for turbines, access tracks and the associated ancillary structures required for the running of the wind farm). The proposal will affect potential habitat for the species through 140.72 ha of permanent vegetation clearing and 148.05 ha of temporary clearing. This loss of potential habitat is contiguous with other examples of the same vegetation communities in a similar condition mapped within the study area (amounting to 1882.99 ha) and mapped within the project site (amounting to 9955.20 ha). The amount of potential habitat proposed to be impacted represents 15.3 % of the potential habitat mapped within the study area and only 2.9 % of potential habitat mapped within the project site.

Given that vegetation removal is to occur is a narrow linear corridor, rather than one consolidated stand, it is unlikely that the proposed vegetation clearance would impact on this species such that foraging and roosting resources would become limited in the study area.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The Square-tailed Kite ranges along coastal and subcoastal areas from south-western to northern Australia, Queensland, NSW and Victoria. In NSW, scattered records of the species throughout the state indicate that the species is a regular resident in the north, north-east and along the major west-flowing river systems. (DECCW 2011b). Therefore, the Square-tailed Kite is not at the limit of its known distribution at Sapphire.

How is the proposal likely to affect current disturbance regimes?

Current disturbances at the site include cattle and sheep grazing, soil disturbance and grazing by feral animals including the European Rabbit and European Hare, and periods of drought and rainfall consistent with the southern oscillation index and resultant cycles of drought (El Niño) and wetter periods (La Niña). There have been no major fire events on the site in the last decade.

The site is grazed primarily by sheep and cattle and grazing pressure and management varies across the landscape. The proposal is considered unlikely to exacerbate over-grazing at the site, but may, in fact, contribute to a more sustainable grazing regime through the mitigation measures proposed in some parts of the site. In the absence of fire, grazing can be an important form of disturbance to prevent the accumulation of biomass that may not be favourable to some native flora species. Grazing will be periodically removed during construction, but should be reintroduced post-construction. Rotational periods of grazing and spelling help to foster healthy native pastures in the absence of fire.

Grazing by feral animals such as the European Rabbit and European Hare can reduce natural recruitment of eucalypt feed trees. The proposal is considered unlikely to contribute to increasing feral animal activity across the project site and instead is likely to assist with the management of these species through the proposed mitigation measures to be implemented within the study area and on the proposed offset sites. No adverse impacts to potential Square-tailed Kite habitat is expected to result from a reduction in grazing pressure from livestock and feral animals.

The risk of fire with wind farms is inherently low (CFA 2007). The location of wind turbines away from tall vegetation in the study area minimises the risk of fire. It is unlikely that the proposal will significantly affect the fire regime such that high intensity fire would have a detrimental impact on Square-tailed Kite foraging and roosting habitat. The proposed access roads will increase the accessibility across the site should a fire occur.

Therefore, significant changes to the current disturbance regime that may impact the Square-tailed Kite are unlikely.

How is the proposal likely to affect habitat connectivity?

The woodland and open forest areas of the study area have naturally large canopy gaps and a very open understorey. Given the linear nature of the proposal and that tree clearance has been minimised, it is considered unlikely that the proposal would create barriers to movement of the Square-tailed Kite, which is a highly mobile species with large hunting ranges of more than 100 km^2.

How is the proposal likely to affect critical habitat?

Not applicable - critical habitat cannot be declared for vulnerable species.

***Melanodryas cucullata cucullata* (Hooded Robin)**

The south-eastern form of the Hooded Robin is found from Brisbane to Adelaide throughout much of inland NSW, with the exception of the north-west. The species is widespread, found across Australia, except for the driest deserts and the wetter coastal areas - northern and eastern coastal Queensland and Tasmania. This species prefers lightly wooded country, usually open eucalypt woodland, acacia scrub and mallee, often in or near clearings or open areas. Structurally diverse habitats featuring mature eucalypts, saplings, some small shrubs and a ground layer of moderately tall native grasses are required (DECCW 2011b).

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Diurnal bird surveys and opportunistic surveys were conducted across the proposed study area, in areas of suitable habitat during October, November and December 2008; April and May 2009; September and October 2010, and January 2011. Individuals were recorded 800 m east of the Eastern Feeder road and less than two kilometres west of the Wellingrove cluster.

There is potential for the Hooded Robin to occur within the study area with potential habitat within the study area in areas of Black Cypress Pine - Tumbledown Gum-Narrow-leaved Ironbark open forest, Blakely's Red-gum - Rough-barked Apple – Red Stringybark grassy open forest, Blakely's Red-gum – Yellow Box grassy open forest/woodland, Manna Gum – Rough-barked Apple – Yellow Box grassy woodland/open forest, Tenterfield Woollybutt – Silvertop Stringybark open forest and White Box grassy woodland. However, the structural diversity of a large proportion of this habitat is limited. The proposal will require 75.36 ha of permanent habitat loss and 37.11 ha of temporary loss. This potential habitat represents 12.6 % of the study area (894.79 ha) and 1.8% of the project site (6,331.11 ha).

The territorial range of Hooded Robin increases from 10 ha during the breeding season to 30 ha in the non-breeding season, and although the proposal will result in the loss of up to 112.47 ha of potential habitat, these will be distributed throughout the linear development footprint, and not one consolidated area of vegetation. Thus, the removal of any areas of potential habitat may result in the reduction of a territorial range and is unlikely to affect the entire territory. Furthermore, given tree clearance has been avoided wherever possible, it is considered unlikely that the clearance of small sections of grassy understorey for roads and turbines would impact upon the lifecycle of the species.

The Hooded Robin is considered unlikely to fly at height as it is a woodland foraging species that nests below 6 m high, and therefore turbine strike where turbines occur throughout open parts of woodland is unlikely. Although flight heights may increase between woodland patches, given the home range of this species, that the most consolidated patches of structurally-diverse woodland are on the Mt Buckley range and are large enough to cover the entire home range for this species, the potential for this species being struck by turbines due to movement between woodland patches is considered low. Therefore the proposal is considered unlikely to affect the lifecycle of this species should it be present at the site.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

Vegetation will be removed in linear strips (for turbines, access tracks and the associated ancillary structures required for the running of the wind farm). As a worst case scenario, the area of vegetation to be cleared consists of a permanent loss of 75.36 ha and a temporary impact to 37.11 ha of potential habitat, totalling 112.47 ha.

Given the areas of woodland habitat present across the study area, comparatively the area of habitat to be removed is very small, and that vegetation removal is to occur is a narrow linear corridor, rather than one consolidated stand, it is unlikely that the proposed vegetation clearance would impact on this species such that foraging and nesting resources would become limited in the study area.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The Hooded Robin is widespread, found across Australia, except for the driest deserts and the wetter coastal areas - northern and eastern coastal Queensland and Tasmania. (DECCW 2011b). This species in not at the limit of its distribution within the project site.

How is the proposal likely to affect current disturbance regimes?

The fire regime of the study area is not expected to change as a result of the proposal, as the risk of fire with wind farms is inherently low (CFA 2007). A low risk is associated with malfunctioning turbine bearings, inadequate crankcase lubrication, cable damage during rotation, electrical shorting or arcing occurring in transmission and distribution facilities (CFA 2007). Furthermore, a number of mitigation measures will be implemented during construction to prevent accidental fires.

The site is grazed primarily by sheep, and cattle are present in some areas. Over-grazing from stock changes the vegetation structure of the understorey, which may reduce the availability of invertebrate taxa as a food source for Hooded Robin. Grazing pressure and management varies across the landscape, and the proposal is considered unlikely to exacerbate over-grazing at the site, but may, in fact, contribute to a more sustainable grazing regime through the mitigation and offset measures proposed in some parts of the site. In the absence of fire, grazing can be an important form of disturbance to prevent the accumulation of biomass that may not be favourable to some native flora species. Grazing will be periodically removed during construction, but should be reintroduced post-construction. Rotational periods of grazing and spelling help to foster healthy native pastures in the absence of fire.

Feral animals can have a detrimental impact on Hooded Robin habitat. In the case of grasslands and grassy woodlands, grazing by feral animals such as the European Rabbit can result in loss of species diversity and tussock structure which in turn impacts the presence of insects as a food source for Hooded Robin.

Feral animals can also have a detrimental impact on Hooded Robin through predation by species such as feral Cats and the European Red Fox. The proposal is considered unlikely to contribute to increasing feral animal activity across the project site and instead is likely to assist with the management of these species through the proposed mitigation measures to be implemented within the study area and on the proposed offset sites.

How is the proposal likely to affect habitat connectivity?

The woodland and open forest areas of the study area have naturally large canopy gaps and a very open understorey however the Hooded Robin has a preference for foraging and nesting within the most