

## **APPENDIX 12**

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**Crudine Ridge Wind Farm Part 3A Ecological Assessment**

**Eco Logical Australia Pty Ltd**





# CRUDINE RIDGE WIND FARM

## Part 3A Ecological Assessment

Prepared for  
**Wind Prospect CWP**

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## Abbreviations

ABBREVIATION	DESCRIPTION
AHD	Australian Height Datum
APZ	Asset Protection Zone
BAMCCOM	Biobanking Assessment Methodology and Credit Calculator Operational Manual
BGW	Box Gum Woodland
BPBGRS	Broad-leaved Peppermint-Brittle Gum - Red Stringybark dry open forest
BOP	Biodiversity Offset Package
BOS	Biodiversity Offset Strategy
Box-Gum Woodland	White Box-Yellow Box-Blakely's Red Gum grassy woodland and derived native grassland
BRC	Bathurst Regional Council
CEEC	Critically Endangered Ecological Community
CEMP	Construction Environment Management Plan
CMA	Catchment Management Authority
CRWF	Crudine Ridge Wind Farm
DGR	Director-General's Requirement
DECCW	Department of Climate Change and Water (formerly OEH)
DNG	Derived Native Grassland
DoPI	NSW Department of Planning and Infrastructure (formerly Department of Planning)
DSEWPAC	Department of Sustainability, Environment, Water, Population and Communities
EA Report	Environmental Assessment Report
EEC	Endangered Ecological Community
EMP	Environmental Management Plans
ELA	Eco Logical Australia Pty Ltd
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
EP&A Act	<i>Environmental Planning and Assessment Act 1979</i>
FM Act	<i>Fisheries Management Act 1994</i>

ABBREVIATION	DESCRIPTION
GIS	Geographic Information Systems
GPS	Global Positioning System
HBT	Hollow-bearing Tree
LEP	Local Environmental Plan
LGA	Local Government Area
LRET	Large-scale Renewable Energy Target
NPW Act	NSW <i>National Parks and Wildlife Act 1975</i>
NOW	NSW Office of Water
NW Act	<i>Noxious Weeds Act 1993</i>
MNES	Matters of National Environmental Significance
MCS	Main collector substation
ML	Mega Litres
MRET	Mandatory Renewable Energy Target
OEH	NSW Office of Environment and Heritage
PMST	Protected Matters Search Tool
RBG	Royal Botanic Gardens
RBVTs	Revised BioMetric Vegetation Types
RET	Renewable Energy Target
RFS	Rural Fire Service
RSSGRLLB	Red Stringybark-Scribbly Gum-Red Box-Long-leaved Box shrub-tussock grass open forest
RMS	Roads and Maritime Services
SEPPs	State Environmental Planning Policies
SCS	Secondary collector substation
SRES	Small-scale Renewable Energy Scheme
SS	Switching station
SSD	State Significant Development
TSC Act	<i>Threatened Species Conservation Act 1995</i>
TSR	Travelling Stock Reserve
WBBRGYB	White Box-Blakely's Red Gum-Yellow Box grassy woodland
WONS	Weed of National Significance
WTG	Wet Tussock Grassland

# Executive Summary

Wind Prospect CWP Pty Ltd on behalf of Crudine Ridge Wind Farm Pty Ltd is proposing to develop and build a wind energy facility known as Crudine Ridge Wind Farm (CRWF) (the proposal) on Crudine Ridge, part of the Great Dividing Range in the central tablelands.

The proposal is located approximately 45 km south of Mudgee, 45 km north of Bathurst, and 60 km northeast of Orange, New South Wales (NSW) (**Figure 1**). The ridge line is of moderate-to-high elevation (890 m to 1,000 m above sea level, Australian Height Datum (AHD)). The nearest locality is Pyramul, which is approximately 5 km to the north west along Aarons Pass and Pyramul roads.

The proposal comprises a wind farm with two potential turbine layouts; one consisting of up to 106 wind turbines (Layout Option A) and the other up to 77 wind turbines (Layout Option B), together with ancillary structures, including the external overhead line, spread over 17 different properties (the project site). One or a combination of these layouts will be adopted in the construction of CRWF, to be determined following final turbine selection post-consent.

The proposal comprises the wind turbines, 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, a main and secondary collector substation and a switching station as well as a facilities building and temporary/compound facilities during the construction phase (**Figure 2**).

This ecological assessment addresses the requirements of Part 3A of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) and related NSW and Commonwealth 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 'maintain or improve' requirement included in the DGRs. Surveys and assessments were made regarding threatened species, populations and ecological communities (or their potential habitat) listed under the NSW *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* and *State Environmental Planning Policy 44* (Koala Habitat) were also considered.

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 the likely 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 ELA ecologists from November 2008 to October 2011, with a site reconnaissance undertaken in October 2008. Surveys included vegetation and biometric vegetation

type and condition mapping, supplemented by additional vegetation transects, and targeted searches for threatened flora and fauna considered likely to occur or with potential habitat (Appendix C). 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, motion activated 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).

Throughout the 2008 / 2009 surveys the conditions during the survey period were generally warm to hot, with the initial surveys being conducted during a period of light to moderate rainfall. Heavy rainfall, and in some cases minor flooding, occurred during the 2011 survey period followed by a flush of vegetation growth.

The prolonged drought being experienced throughout the central tablelands in 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 January 2009 surveys and March 2011 following a change in prevailing weather patterns and increasing rainfall over this period.

## Results

Four Central West Catchment Management Authority (CMA) Revised Biometric Vegetation Types (RBVTs) were mapped throughout the study area and project site and include:

- CW117: Broad-leaved Peppermint - Brittle Gum - Red Stringybark dry open forest on the South Eastern Highlands (BPBGRS)
- CW176: Red Stringybark - Scribbly Gum - Red Box - Long-leaved Box shrub - tussock grass open forest of the NSW South Western Slopes Bioregion (RSSGRBLLB)
- CW206: Wet tussock grasslands of cold air drainage areas of the tablelands (WTG)
- CW209: White Box – Blakely’s Red Gum - Yellow Box grassy woodland of the NSW South Western Slopes Bioregion (WBBRGYB)

White Box – Blakely’s Red Gum - Yellow Box grassy woodland of the NSW South Western Slopes Bioregion correlates to the Endangered Ecological Community (EEC) *White Box Yellow Box Blakely’s Red Gum Woodland* listed under the TSC Act and the Critically Endangered Ecological Community (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 244 species of vascular plants were recorded across the study area. Of these 161 (66 %) are native and 83 (34 %) are exotic species.

One endangered flora species (under both the TSC Act and EPBC Act), *Swainsona recta*, was recorded in September and October 2011 within WBBRGYB (wooded areas), and there is the potential for this species to inhabit pasture areas of this community and also areas of RSSGRBLLB.

Thirty six *Swainsona recta* were recorded across five locations, 31 of which were recorded within the proposed powerline easement (**Figure 10**). It is possible that more individuals are present in this area but may not have been detected as not all recorded individuals were in flower and detection of non-

flowering individuals is difficult. Where necessary, poles will be aligned to ensure no impacts to *Swainsona recta*, thereby avoiding the loss of all recorded individuals of this species.

Threatened flora for which potential habitat was observed but were not recorded during the surveys are:

- *Bothriochloa biloba* (Lobed Blue Grass);
- *Eucalyptus cannonii* (Capertee Stringybark);
- *Eucalyptus robertsonii* subsp. *hemisphaerica* (Robertson Peppermint);
- *Prasophyllum* sp. *Wybong* (*C. Phelps* ORG 5269) (A Leek Orchid);
- *Swainsona sericea* (Silky Swainson-pea); and
- *Thesium australe* (Austral Toadflax).

The study area supports a diversity of fauna habitat types in woodland and grassland comprising tussock grasses, farm dams, creeks, rocky outcrops, fallen timber, stags, leaf litter, hollow-bearing trees, defoliating bark, winter-flowering eucalypts and koala feed trees.

Ninety three bird species were recorded within the project site during the surveys, including three nocturnal species and an additional three species identified to genus level only.

Six threatened bird species (TSC Act only) were recorded across the project site. These are listed below and their locations shown in **Figure 7**.

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

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

- *Anthochaera phrygia* (Regent Honeyeater);
- *Burhinus grallarius* (Bush Stone-curlew);
- *Callocephalon fimbriatum* (Gang Gang Cockatoo);
- *Circus assimilis* (Spotted Harrier);
- *Daphoenositta chrysoptera* (Varied Sittella);
- *Hieraaetus morphnoides* (Little Eagle);

- *Lathamus discolor* (Swift Parrot);
- *Melithreptus gularis gularis* (Black-chinned Honeyeater);
- *Ninox connivens* (Barking Owl);
- *Ninox strenua* (Powerful Owl);
- *Petroica phoenicea* (Flame Robin); and
- *Polytelis swainsonii* (Superb Parrot);

*Merops ornatus* (Rainbow Bee-eater), an EPBC migratory species, was recorded twice within the project site during the surveys; although one record was incidental and location details were not recorded. The second record for the species was within the Pyramul Cluster in RSSGRBLLB (pasture).

Those migratory species for which there is potential habitat within the study area are listed below.

- *Anthochaera phrygia* (Regent Honeyeater);
- *Ardea alba* (Great Egret);
- *Ardea ibis* (Cattle Egret);
- *Hirundapus caudacutus* (White-throated Needle-tail);
- *Lathamus discolor* (Swift Parrot);
- *Merops ornatus* (Rainbow Bee-eater); and
- *Myiagra cyanoleuca* (Satin Flycatcher).

Habitat within the study area for ground-dwelling mammals is limited as there was no or a very limited shrub layer, and the ground layer in many areas is grazed in places (at times, heavily). No threatened ground-dwelling mammals were recorded.

*Phascolarctos cinereus* (Koala) and evidence of Koalas (calls, scats, scratches, skulls) were recorded 18 times during field survey, with two records inside the study area, 14 records inside the project site (outside of the study area) and two records outside of the project site.

Potential habitat is present for additional threatened species, *Dasyurus maculatus* (Spotted-tailed Quoll) and *Petaurus norfolcensis* (Squirrel Glider).

Habitat for microchiropteran bats (microbats) is present across the project site and study area, and at least 13 species of microchiropteran bats were recorded foraging across these areas. Five additional species may have been recorded, but two were identified to the genus level only while three species were not identified with certainty in anabat analyses.

Six threatened bat species were recorded across the study area:

- *Chalinolobus dwyeri* (Large-eared Pied Bat);

- *Chalinolobus picatus* (Little Pied Bat);
- *Miniopterus orianae oceanensis* (Eastern Bentwing-bat);
- *Saccolaimus flaviventris* (Yellow-bellied Sheathtail-bat);
- *Vespadelus troughtoni* (Eastern Cave Bat); and
- *Nyctophilus corbeni* (syn *N. timoriensis*) (Greater (Eastern) Long-eared Bat) (assumed based on inconclusive calls).

Habitat for amphibians is limited across the project site and study area. 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 predicted species) and has been previously recorded (twice) south of Crudine off Turondale Road approximately 2.5 km south of the intersection with Hill End Road (1990s, 1994; BRC 2011). 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 given the lack of suitable habitat.

Habitat across the site for reptiles includes woodland and grassland areas and scattered rocky outcrops. Woody debris is common throughout much of the area and provides potential habitat. Leaf litter is limited and confined to the wooded areas, although where this was present it also provides habitat for reptiles. Drainage lines and farm dams are also likely to provide habitat for reptiles. Potential habitat was present for one of these species, *Aprasia parapulchella* (Pink-tailed Worm-lizard) although this species was not recorded during the surveys.

### 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 powerline 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 the 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 have been outlined in accordance with each phase of the project (i.e. construction, operation and decommissioning) and cumulative impacts considered.

### Direct Impacts

Whilst it is not possible to completely avoid placing turbines in any areas supporting woodland or native vegetation, as this would impact upon the project feasibility, a number of amendments have been made to minimise impacts in these areas. The need for a linear alignment of turbines along ridgelines to maximise the function, capacity and economic feasibility of the wind farm limits alternative areas to which turbines can be moved to avoid impacts.

All unavoidable native vegetation clearance has been minimised and it is proposed that all remaining impacts be offset in accordance with a quantitative assessment using 'maintain or improve' principles as determined by the use of the Biobanking credit calculator.

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 has been assessed which includes the Layout A (106 turbines), and a 6 m clearance area for roads (with 12 m passing bays). 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 71.64 ha of habitat and 31.58 ha of temporary habitat loss. This includes tree clearing, mainly in areas of pasture with scattered trees (7.77 ha), for overhead electrical infrastructure.

This clearance comprises the permanent removal of 3.69 ha of remnant woodland, 60.11 ha of derived grassland/native pasture, and 0.07 ha of low condition vegetation (predominantly exotic with some native species present). It will also require 31.58 ha of temporary clearance of vegetation comprising 1.65 ha of remnant woodland and 9.93 ha of derived grassland.

A total of 5.27 ha of the Threatened Ecological Community (TEC) BGW would be permanently impacted by the proposal and 0.11 ha temporarily impacted. This represents 0.83 % of BGW within the project site and 2.17 % of BGW within the study area. This includes 4.42 ha of BGW (trees only) for the installation of the external overhead line, which represents just 0.67% of BGW present within the project site.

As a worst-case scenario, the proposal involves the permanent removal of up to 71.37 ha of potential habitat for a variety of flora and fauna species, including 9.97 ha of woodland, 61.03 ha of native pasture and 0.37 ha of low condition vegetation. Additionally, 31.58 ha of temporary clearance is proposed, including 1.65 ha of woodland and 29.93 ha of native pasture. This includes tree clearing from vegetation in various conditions for the provision of overhead electrical infrastructure.

Approximately 19,963 hollow-bearing trees (HBT) are estimated to be present across the study area and, as a worst-case scenario, it is estimated that up to 920 HBTs (4.61 %) may be removed for the proposal. The distribution of HBT across the study area is not uniform and, therefore, this estimate is indicative only and likely to be an over estimate as roads and turbines have been sited to avoid HBTs.

Direct impacts to ecological values may also occur during the operation phase of the project. There are several aspects to consider when assessing the potential impact of turbines on bats and birds, including lighting, tower height and barotrauma. The risk of bats and birds colliding with turbines 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, *Tadarida australis* (White-striped Freetail-bat) and *Saccolaimus flaviventris* (Yellow-bellied Sheath-tail-bat) were the only migratory, tree roosting species recorded within the study area and, therefore, are considered at the greatest risk of collision. However, the collision risk is also considered high for the *Mormopterus* sp. 4 (Southern Freetail Bat) as this species can forage up to 12 km from roosts and is known to forage above the canopy (Churchill 2008). Given that the *Miniopterus orianae oceanensis* (Eastern Bentwing-bat) is also a migratory species and is known to be attracted to lighting, this species was also considered to be slightly more at risk (moderate risk) than many of the other bat species. The fact that *Mormopterus* sp. 3 (Inland Freetail Bat) forages above the canopy also increases the risk (moderate risk) for this species.

## 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, site avoidance during migration, disruption of dispersal pathways, predation by feral animals, 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.

## Offsets

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

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. A number of land owners have expressed interest in entering into an appropriate conservation covenant and a further five properties have been identified that are currently for sale that are able to meet the offset requirements for the project (i.e. they are of an appropriate size, have the same or higher conservation value vegetation types and thus meet the "*like for like or better*" offset principle). None of the properties are currently required under any existing legislative requirement to be actively managed for biodiversity conservation and thus also meet the "additionality" offset principle. The ability to secure an appropriate offset for the project is readily achievable. The biodiversity values of each property are discussed in more detail in Section 6.5.

In addition, there are a number of Travelling Stock Reserves (TSRs) adjacent to the project site that have high biodiversity values and limited funds for their management. These stock reserves are currently managed by the Central North Livestock Health and Pest Authority and may be transferred back to the Department of Lands. Should it not be possible to secure a large enough privately owned offset property, a financial contribution to enhance the biodiversity management of these lands may also be made.

Based on the worst-case scenario, a total of 4,271 ecosystem credits are required to offset the impacts to three vegetation types. An impact of 0.1 ha occurs to WTG, however, as this impact is too small to be assessed using the Biobanking methodology it was added to the WBBRGYB vegetation type.

The OEH Credit Converter was used to estimate the area of offset required to meet the calculated offset requirements. The OEH credit converter assumes that offset site will generate 9.3 credits per hectare, thus the area of offset required to meet a "Tier 2 No Net Loss" outcome is estimated to be 459 ha. A Tier 3 "Mitigated Loss" outcome (an offset ratio of at least 2:1) would require a minimum offset area of 206.2 ha (Appendix I).

Based on the offset calculations conducted using the OEH Credit Converter, an offset of between 206-460 ha is required to meet a Tier 2 or Tier 3 offset consistent with the Interim Offset Policy. A Tier 1 offset cannot be met due to impacts to red flag areas. The offset is also to include approximately 50 ha of Yellow-bellied Sheathtail-bat habitat, which can be obtained from within the same offset site as the vegetation, or an alternative site should that be required.

The Biobanking Credit report also indicates that the offsets can be secured in a range of similar vegetation types, with a mixture of CMA subregions also able to provide any potential offset.

There are five (5) properties for sale and three properties whose owners are interested in entering into in perpetuity conservation covenants in the vicinity of the project site (**Figure 12** and **Table 31**). Each of these properties is capable of meeting a Tier 2 or 3 offset outcome for the project in area of offset and vegetation type and condition. Preliminary vegetation mapping has been undertaken on three of these properties confirming the targeted vegetation types, area and condition states (**Figure 13**, **Figure 14**, and **Figure 15**).

Following project approval, and prior to construction works commencing, Wind Prospect will enter into negotiations to purchase one or more of these properties and/or enter into a legally binding, in perpetuity conservation covenant with the relevant land owner to meet either a Tier 2 or Tier 3 offset. The final offset property, if purchased, will either be transferred to the NSW Minister for the Environment as an addition to the public reserve network together with a resource package to establish and manage the new reserve in perpetuity, or, if not suitable as an addition to the national reserve network, will have a conservation covenant registered on title (eg. Conservation Agreement under the *National Parks and Wildlife Act 1974*, Trust Agreement under the *Nature Conservation Trust Act 2001* or Property Vegetation Plan under the *Native Vegetation Act 2003*).

Should property purchases and/or covenanting not meet a minimum Tier 3 offset outcome, Wind Prospect will contribute funding to the Central North Livestock Health and Pest Authority/Department of Lands for the duration of the project to assist in the biodiversity management of a Travelling Stock Reserve (TSRs) adjacent to the project site. These funds may be used to undertake ecological assessments of the biodiversity values of the TSRs, prepare plans of management and / or undertake weed and pest animal control activities enhancing local biodiversity values.

Impacts to EPBC listed communities and species (potential habitat) will also be offset through the land purchase and / or conservation agreements with interested landowners. Given the impacts to MNES (

**Table 34**) the offset range of 206 - 460 ha and vegetation types described above for NSW offset requirements are considered sufficient to meet all federal offset requirements, if required.

The offset will include:

- An appropriate offset for impact on 3 ha of EPBC listed White-Box, Yellow Box, Blakely's Red Gum grassy woodland and Derived Native Grassland grassy woodland;
- Offsets for various EPBC listed fauna species identified as having **potential** habitat (but not recorded during targeted surveys) impacted by the proposed wind farm, such as Swift Parrot and Regent Honeyeater (impact of 14.3 ha), Large-eared Pied Bat, Greater (eastern) Long-eared Bat, Superb Parrot, Satin Flycatcher and Spotted-tailed Quoll (impact of 9.6 ha) and Grey-headed Flying-fox (impact of 17.82 ha);
- Offsets for various EPBC listed flora species identified as having **potential** habitat (but not recorded during targeted surveys) impacted by the proposed wind farm, such as *Prasophyllum*

sp. Wybong, *Bothriochloa biloba* and *Thesium australe* (impact of 103.1 ha), *Eucalyptus cannonii* (impact of 97.7 ha) and *Eucalyptus robertsonii* subsp. *hemisphaerica* (impact of 0.21 ha).

While further inspection may update and refine the vegetation types on site, any conservation agreement will be designed to meet the NSW offset requirements described above for both vegetation types and the Yellow-bellied Sheath-tail-bat habitat.

# 1 Introduction

Wind Prospect CWP Pty Ltd on behalf of Crudine Ridge Wind Farm Pty Ltd is proposing to develop and build a wind energy facility known as Crudine Ridge Wind Farm (CRWF) (the proposal) on Crudine Ridge, part of the Great Dividing Range in the northern central tablelands. The proposal will be assessed under Part 3A of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act).

The proposed project is located approximately 45 km south of Mudgee, 45 km north of Bathurst, and 60 km northeast of Orange, New South Wales (NSW) (**Figure 1**). The ridge line is of moderate-to-high elevation (890 m to 1,000 m above sea level, Australian Height Datum (AHD)). The nearest locality is Pyramul, which is approximately 5 km to the north west along Aarons Pass and Pyramul roads.

The Project comprises a wind farm with two potential turbine layouts; one consisting of up to 106 wind turbines (Layout Option A) and the other up to 77 wind turbines (Layout Option B), together with ancillary structures, including the external overhead line, spread over 17 different properties (the Project site). One or a combination of these layouts will be used in the construction of the CRWF, to be determined following final turbine selection post-consent.

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, a main and secondary collector substation and a switching station as well as a facilities building and temporary/compound facilities during the construction phase (**Figure 2**).

Crudine Ridge 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 Renewable Energy Target (RET) of 20% by 2020. Crudine Ridge Wind Farm will potentially supply up to 69,300 households with energy and displace approximately 437,500 tonnes of CO<sub>2</sub>-e per annum. The wind farm will have an installed capacity of up to 165 megawatts (MW). A single or double circuit 132 kV external overhead line will be constructed between the main collector substation and switching station for energy export into the grid. The 132 kV overhead transmission line will be up to 30 m in height comprising of two cross arms with insulators with an average span length of 250 m.

## REPORT STRUCTURE

This EA report is structured in 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 will be assessed including 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 calculated offset requirements, 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 CRWF project including turbines, roads, reticulation, substations 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 subject to this proposal, comprising an area of 5,697 hectares (ha) (of which 4,164.85 ha of the vegetation has been mapped).

**Locality:** The broader location of the Crudine Ridge Wind Farm represented in **Figure 1**. For the purposes of database searches, the locality is defined as a 10 km radius of the project site.

**Study area / development envelope:** 200 metre (m) wide corridor in which the turbine footprint, roads and electrical cables will be contained, comprising an area of 1663.93 ha (all of which has been mapped). It was the area subject to intensive survey effort and is the area in which changes to the proposed layout may occur. Where the boundary of the study area appears in 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:** All proposed locations of the turbines, roads, reticulation, collector substations, facilities building, network switching station and compound, comprising a maximum area of 105.93 ha, of which 71.6 ha is considered permanent infrastructure (**Table 1**). ‘Development footprint’ is used in this report as an alternative to ‘subject site’ as defined by DEC (2004).

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

ATTRIBUTE		AREA IN HECTARES
Project Site (amount that has been mapped)		4164.85
Study Area / Development Envelope		1663.93
Development Footprint	Layout A	105.93*
	Layout B	103.68

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

**Turbine layouts:** One or a combination of the two layout options will be adopted when constructing the Project, which will be determined following final turbine selection post-consent. The worst-case impacts of both layouts are considered within this ecological assessment report.

- **Layout A** - consisting of up to 106 wind turbines
- **Layout B** - consisting of up to 77 wind turbines

**Clusters:** The Project comprises two ‘Clusters’ of wind turbines (**Table 2**).

The Pyramul Cluster generally incorporates the north of the Project, with the Sallys Flat Cluster incorporating the south of the Project (**Figure 2**). It is possible one Cluster may be constructed and commissioned prior to the other, or each Cluster may be partially constructed in stages.

**Table 2: Turbine clusters**

TURBINE CLUSTERS	LAYOUT A	LAYOUT B	GENERAL LOCATION
Pyramul	58	42	Northern cluster
Sallys Flat	48	35	Southern cluster

**Direct impacts:** Those that directly affect individuals or ecological communities and their associated habitats. They include, but are not limited to, loss of individuals or ecological communities, and removal of suitable habitat. Direct impacts associated with the proposal are limited to the **development footprint** and are summarised in Section 5.4

**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, injury as a result of turbine strike, 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 wind farm is located west of the Castlereagh Highway approximately 45 km south of Mudgee, 45 km north of Bathurst, and 60 km northeast of Orange, New South Wales. The turbines extend over an approximately 25 km span north-south and 8km span east-west (**Table 3**).

The project site is on rural land within the Mid-Western Regional and Bathurst Regional Council areas and includes 17 privately owned properties. The predominant current land use is broad acre grazing of sheep and cattle.

The closest major road to the project site is the Castlereagh Highway, located to the east. Roads of significance surrounding the study area and project site are Hill End Road, Sallys Flat Road, and Aarons Pass Road on the southern, western and northern sides, respectively, and Crudine Road on the eastern side (**Figure 1**).

**Table 3: Site location details**

LATITUDE (S)			LONGITUDE (E)		
Degrees	Minutes	Seconds	Degrees	Minutes	Seconds
32	52	48.490	149	34	57.299
32	52	48.490	149	48	46.364
33	1	56.273	149	48	46.364
33	1	56.273	149	34	57.299

### 1.1.2 Rivers, Creeks and Watercourses

The study area is within the administrative catchment of the Central West Catchment Management Authority (CMA). Lying within the Macquarie-Bogan Catchment (**Figure 4**), the study area drains via a number of smaller creeks into Pyramul Creek in the north (eventually draining into the Macquarie River) and to Crudine River to the south (which drains first into the Turon River and then into the Macquarie River). Some smaller creeks cross the study area, including Salters Creek, Long Gully Creek, Tunnabidgee Creek, Sugarloaf Creek, Cherry Tree Gully, Cowflat Gully, and Bombandi Creek. The waterways within the locality are ephemeral, typified by low-flows and dry creek-beds. Some farm dams occur within the locality, and Lake Windemere, a major dam, is present to the north of the study area. 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 Crudine Ridge Wind Farm proposal is located along the spines of the Great Dividing Range in the northern central tablelands. The landscape is dominated by undulating to steep hills and ridge-lines running roughly north to south. Four Mitchell Landscapes (DECC 2008a) have been mapped for the study area: Ophir – Hargraves Plateau across the majority of the study area where the turbines are located and Mount Horrible Plateau, Cope Hills Granite and Capertee Plateau in the north east where the external overhead lines are located (**Figure 5**).

#### *Geology*

The study area is within the Hill End – Ngunnawal geological province, which over the study area is comprised of two subprovinces: the Hill End and Capertee Subprovinces. The Hill End Subprovince is present over the majority of the study area and is divided into seven geological formations. These formations are generally composed of metamorphic, clastic and volcanoclastic rocks, although some felsic rock is also present. The Capertee Subprovince is present only in the north eastern arm of the study area where the external overhead lines are proposed, and is divided into two geological formations, generally comprised of clastic and felsic rocks.

Characteristic terrain of the Hill End subprovince includes steep rolling hills and undulating low hills, with exposed bedrock occurring on all slopes. Characteristic terrain of the Capertee Subprovince includes strongly folded and steeply dipping terrain, which may vary from rugged to undulating or rolling terrain (Geoscience Australia 2011).

### *Soils*

The most common soils arising from the Hill End Subprovince are soloths and yellow solodic soils on footslopes and drainage lines, and shallow red podzolic soils and shallow soils on the upper slopes and on steep terrain. Discontinuous alluvium can also be found along drainage lines in the Hill End Subprovince (Murphy and Lawrie 1998). The typical soil types in the Capertee Subprovince include non-calcic brown soils on mid-slope positions, and deeper, medium textured and moderately to highly fertile soils where the terrain is more undulating. Non-calcic Brown Soils and Euchrozems dominate drainage lines (Murphy and Lawrie 1998).

In terms of soil landscapes, those that occur in the project site are the Burrendong, Mullion Creek, Mookerawa and Aaron's Pass units (Murphy and Lawrie 1998). The study area lies mostly on the Mookerawa and Mullion Creek units.

#### **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*

The district has been home to the Wiradjuri people for thousands of years. At the beginning of the nineteenth century, the Wiradjuri linguistic group occupied the land from south of the Murrumbidgee to north of the Lachlan as far as the upper reaches of the Macquarie River. Small clans or related family groups moved around regularly within fairly discrete territories following seasonal and ritual patterns. The rivers contributed to food supplies, and many meeting places and sites of special significance were located along them. There are (or were) relatively large numbers of carved trees associated with important sites, especially burial places (Kass 2003).

European settlers began to occupy the area in the early 1810s seeking suitable land for grazing, with Bathurst the first European settlement established west of the Blue Mountains. European settlers soon spread out over the district, bringing cattle and sheep, and began to farm crops such as wheat and barley. The Bathurst area grew the first hops, used to make beer, in Australia (Central Tablelands Landcare 2008).

Cattle and sheep grazing, and cropping, were the main land use of the region in the early days of European settlement. However, following the discovery of gold in the early 1850s, gold became the major industry in the area. Gold fields in the region were established in Ophir, Hill End, Sofala, Trunkey Creek, Cargo, Rockley, Gulgong, Windeyer and Lucknow. Over the next few decades, gold brought an influx of people to the district, leading to an expansion of the agricultural sector as farmers and businesses had a large new market to supply with food and commodities (Central Tablelands Landcare 2008).

Today, pastoralism (mainly sheep and cattle) and agriculture continue to be dominant industries in the region, despite the increased prominence of other industries (mining, tourism and industry) that have emerged in the area, particularly the eastern areas of the Central Tableland (Kass 2003).

#### *Transmission Line*

The proposal will connect to the TransGrid 132 kV transmission line which is approximately 15 km east of the site. The transmission line easement has been placed along a current access track to minimise disturbance although some slashing of vegetation will be required.

#### *Mining*

The focus of nineteenth and twentieth century mining in the region has been on gold, coal, copper and shale oil. However, significant deposits of silver, lead, zinc, molybdenum (at Mt Tennyson near Bathurst) and diamonds (on the Cudgegong) have also been exploited in the region (Kass 2003). Today, mining in the region includes coal mining, with coal mines in Ulan and Wilpinjong (near Mudgee) located to the north of the study area, and Chandos Colliery in Kandos located to the east of the study area. The study area itself does not impact on any mining 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, viticulture, and sheep and cattle grazing (Kass 2003).

### **1.1.6 Surrounding Reserves**

Several lots within the locality are owned and managed by the NSW Department of Primary Industries (DPI).

A number of areas reserved under the NSW *National Parks and Wildlife Act 1974* (NPW Act) lie within the Mid-Western Regional and Bathurst Regional LGAs.

These areas include:

- Durrigere CCA Zone 3 State Conservation Area;
- Goodiman CCA Zone 3 State Conservation Area;
- Yarrobil CCA Zone 1 National Park;
- Munghorn Gap Nature Reserve;
- Goulburn River National Park;
- Avisford Nature Reserve;
- Hill End Historic Site;
- Winburndale Nature Reserve;
- Wambool Nature Reserve;
- Wollemi National Park;

- Eusdale Nature Reserve;
- Copperhannia Nature Reserve; and
- Abercrombie Karst Conservation Reserve.

Hill End Historic Site and Avisford Nature Reserve are the nearest conservation areas, approximately 15 km to the west and 19 km to the north respectively of the study area at its nearest points, although the nearest large conservation area is Winburndale Nature Reserve, approximately 26 km to the south of the study area.

Other major areas reserved under the NPW Act which lie just outside of the Mid-Western Regional and Bathurst Regional LGAs (to the west) include Wollemi and Blue Mountains National Parks.

#### *Avisford Nature Reserve*

Avisford Nature Reserve is located on the Central Tablelands, approximately 5 km south west of Mudgee. The reserve covers 2,576 ha and occurs as three fragmented blocks extending north-west to south-east, with the blocks separated by portions of freehold and leasehold lands. It was dedicated as a Nature Reserve in 1985, with the Avisford State Forest portion added in 1987 (NPWS 2006).

The reserve has not been subjected to any substantial logging activity and only low levels of sustained grazing. As a result, Avisford Nature Reserve remains one of the most significant natural areas in the Mudgee district and provides refuge for native plant and animal communities that have been largely depleted elsewhere by agricultural land clearing (NPWS 2006).

Avisford Nature Reserve protects areas of relatively high ridgeland typified by steep sloping gullies and hills. The highest point of the range reaches 982 m above sea level. The ridgeland support open forest and woodland communities characterised by stringybark and box gums. Variations occur according to soils and topography.

Avisford Nature Reserve supports a number of threatened species including *Eucalyptus cannonii* (Capertee stringybark), *Pyrrholaemus sagittatus* (Speckled Warbler), *Climacteris picumnus victoriae* (Brown Treecreeper (eastern subspecies)), *Melanodryas cucullata* (Hooded Robin (southeastern subspecies)), *Calyptorhynchus lathami* (Glossy Black Cockatoo), *Ninox strenua* (Powerful Owl), and *Phascolarctos cinereus* (Koala). The reserve may support the endangered *Petrogale penicillata* (Brush-tailed Rock Wallaby and evidence has been found for the species in the reserve. A diversity of birds are supported by the reserve, with various honeyeaters frequently recorded (NPWS 2006).

#### *Winburndale Nature Reserve*

Winburndale Nature Reserve is located on the central tablelands, approximately 30 km north east of Bathurst. The reserve covers 10,718 ha. It was dedicated as a Nature Reserve in 1967, with additional portions added to the reserve between 1972 and 2004 (NPWS 2007).

The reserve encompasses a ridge system which is characterised by spectacular conglomerate cliff lines, that run north south through the reserve from Eskdale Gulf for 15 km. The reserve contains remnant natural vegetation and ranges in elevation from 790 m along the reserve's western boundary to its highest point of 1266 m which occurs in the south-western part of the reserve.

The reserve is significant on both a Regional and State level because it is the only area within the Central West (apart from Mount Canobolas State Conservation Area) that contains sub alpine (montane) vegetation associations which are poorly represented in the central tablelands. The dominant montane association consists of a sub-alpine woodland comprising a canopy of *Eucalyptus pauciflora* (Snow Gum) and *E. dalrympleana* (Mountain Gum) and an understorey of *Poa sieberana* (Snow Grass), and occurs on the high elevated plateaus. The majority of the reserve contains dry open woodlands, which are dominated by a canopy of *Eucalyptus macrorhyncha* (Red Stringybark) and *E. rossii* (Western Scribbly Gum). Other vegetation communities present include *Callitris endlicheri* (Black Cypress Pine) woodlands, heath communities dominated by *Calytrix tetragona* (Fringe Myrtle), and *Casuarina cunninghamiana* (River Oak) forests (NPWS 2007).

Threatened flora and fauna supported in Winburndale Nature Reserve include *Eucalyptus cannonii* (Capertee Stringybark), *Derwentia blakelyi* (Derwentia), *Paralucia spinifera* (Purple (Bathurst) Copper Butterfly), Glossy Black Cockatoo, *Callocephalon fimbriatum* (Gang Gang Cockatoo), *Ninox connivens* (Barking Owl), Powerful Owl, Brown Treecreeper, Speckled Warbler, *Stagonopleura guttata* (Diamond Firetail), *Petaurus australis* (Yellow Bellied Glider), and *Petaurus norfolcensis* (Squirrel Glider). The reserve may support *Dasyurus maculatus* (Spotted tailed Quoll) and Koala (NPWS 2007).

#### *Environmentally Sensitive Land*

The Mid-Western Regional and Bathurst Regional LGAs have a number of areas that are protected and not suitable for development. These include National Parks, Nature Reserves, State Forests and wilderness areas. Through their Local Planning Instruments, Councils have 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 with climate data is Mudgee (George Street, Station No. 062021, elevation 454 m) which is located approximately 40 kilometres to the north of the study area. Climate data for Mudgee are summarised below.

**Table 4: Climate data for Mudgee, 40 km north of the project site (Bureau of Meteorology 2011a)**

AVERAGE WEATHER CONDITIONS	MEASUREMENTS
Annual rainfall	675.5 mm
Highest monthly rainfall	67.6 mm (January)
Lowest monthly rainfall	44.2 mm (April)
Annual minimum / maximum temperature	8.3° C / 23.0° C
Highest mean monthly temperature	15.5° C to 31.0° C (January)
Lowest mean monthly temperature	1.3° C to 14.4° C (July)

## 2 Description of Project

This chapter presents a description of the works associated with the construction and operation phases of the proposed Crudine Ridge Wind Farm development, which is otherwise referred to as ‘the proposal’.

### 2.1 SITE DESIGN

The proposal comprises a wind farm with two potential turbine layouts; one consisting of up to 106 wind turbines (Layout Option A) and the other up to 77 wind turbines (Layout Option B), together with ancillary structures spread over 17 different properties (the project site). One or a combination of these layouts will be adopted when constructing the proposal. This will be determined following final turbine selection post-consent. The worst-case impacts of both layouts are considered within this ecological assessment report.

The proposal will have an installed capacity of approximately 165 MW, which is dependent on the final turbine model and layout selected, and will consist of the following components:

- The installation of up to 106 wind turbines (Layout Option A) or up to 77 wind turbines (Layout Option B) in the Pyramul area between Mudgee and Bathurst, NSW (**Figure 2**) with a maximum blade tip height of 160 m +/- 5 m;
- A main collector substation (MCS) comprising cable marshalling, switchgear, high voltage transformers and associated protection and communications assets;
- A secondary collector substation (SCS) to be located within the Sallys Flat Cluster comprising cable marshalling, switchgear and medium voltage transformers;
- Site compound and lay down area (part temporary, part permanent), including site operations facilities and services buildings;
- Underground electrical interconnection lines (up to 132 kilovolt (kV)) and control cables within each of the wind turbine Clusters, connecting to the main and secondary collector substations;
- Internal overhead electrical interconnection lines (up to 132 kV double circuit) and control cables between the main and secondary collector substations;
- A switching station (SS) to be located at the point of connection adjacent to the existing TransGrid owned 132 kV line, east of the study area;
- External overhead electrical interconnection lines (up to 132 kV double circuit) and associated communications cables between the main collector substation and the SS;
- Access roads from the public roads to the turbine locations and substations;
- Crane hardstand areas for the erection, assembly, commissioning, maintenance, recommissioning and decommissioning of the wind turbines;
- Up to six permanent wind monitoring masts;

- 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.

The proposal will connect to the TransGrid 132 kV overhead transmission line 15 km east of the Crudine ridgeline. This connecting transmission line is considered as part of this proposal in the relevant sections of the following EA.

Typical dimensions of the components that comprise the proposal are presented in **Table 5** below.

**Table 5: Proposal components and approximate dimensions (based on greatest impact)**

PROPOSAL COMPONENT	APPROXIMATE DIMENSIONS
<b><i>Permanent</i></b>	
Turbine footings (max footprint)	20 x 20 m
Turbine assembly / crane hardstand areas	30 x 50 m
Main collector substation	150 x 150 m
Secondary collector substation	25 x 25 m
Site compound ( <i>the extent of permanent section retained within temporary compound</i> )	75 x 75 m
Site facilities and services building	6 x 30 m
Site access: new roads	6 x 50 km
Underground cabling on-site	1 x 100 km
Internal overhead electrical interconnection / easement <sup>1</sup>	2 m x 15 km / 45 m x 15 km
Switching station	75 x 100 m
External overhead electrical interconnection / easement <sup>1</sup>	2 m x 15 km / 45 m x 15 km
Wind monitoring masts	5 x 5 m
<b><i>Temporary (during construction)</i></b>	
Earthworks alongside permanent infrastructure (roads/hardstands) <sup>2</sup>	10 m x 50 km (est.)
Concrete batch plant	50 x 100 m
Rock crushing facility	50 x 100 m
Site compound and office	150 x 200 m

<sup>1</sup> 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.

<sup>2</sup> 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 both Layout Options that include impacts associated with permanent road, hardstand and turning head areas in addition to the area considered the extent of the earth works.

Details of each of the component parts of the development are described in the following sections and in the accompanying figures. An outline of the construction and operational phases of the development are also provided, along with a timeframe detailing the proposed stages of activity pending Development Consent.

The Layout Options have been designed with respect to a number of technical, environmental and social factors and more detailed site assessments. Each layout ensures optimum, undisturbed use of the measured and predicted wind resource, after accommodating constraints, for the range of turbines currently being considered for the proposal.

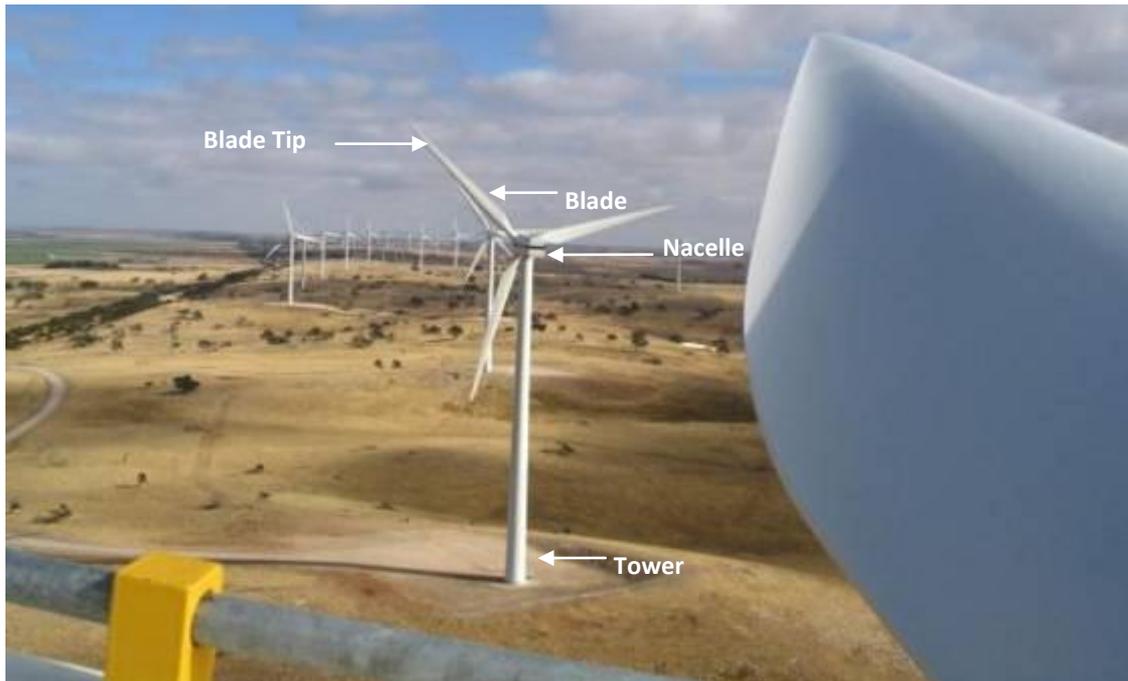
Given the scale of the proposal it is likely that two main 'Clusters' of turbines will be constructed and commissioned in stages, being Pyramul and Sallys Flat (**Table 6, Figure 2**).

**Table 6: Wind Turbine Clusters**

TURBINE CLUSTER	MAXIMUM NUMBER OF TURBINES (LAYOUT OPTION A)	MAXIMUM NUMBER OF TURBINES (LAYOUT OPTION B)	GENERAL LOCATION
Pyramul	58	42	Northern Cluster
Sallys Flat	48	35	Southern Cluster

## 2.2 WIND FARM INFRASTRUCTURE

It is not yet known which model of wind turbine will be used for the proposal as final turbine selection will occur through a competitive tender process pending Development Consent. However, in terms of generation capacity, the wind turbines currently available in the market place that are considered suitable for this proposal vary in the range from 1.5 and 3.4 MW. For example, the Suzlon S88, 2.1 MW machine (as installed at the Capital Wind Farm, east of Lake George, New South Wales (NSW)) is typical of the type of wind turbine that could be used. Image 1 below displays a picture of a typical wind turbine and the component parts are discussed below.



**Image 1: Component Parts of a wind turbine**  
 Photo courtesy: Wind Prospect CWP

### 2.2.1 Turbine Rotor

The turbines most likely to be used for the proposal will be three-bladed, semi-variable speed, pitch regulated machines with rotor diameters between 74 and 126 m and a swept area of 4,300 to 12,470 square metres (m<sup>2</sup>). Typically turbines of this magnitude begin to generate energy at wind speeds in the order of 3.5 metres per second (m/s) (12.6 kilometres per hour (kph)) and shut down (for safety reasons) in wind speeds greater than 25 m/s (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.

### 2.2.2 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 160 m. Similarly, the longest blade length under consideration is 63 m, however, it is important to note that the tower height suitable for this wind turbine is 94 m and, therefore, also falls within the maximum proposed blade tip height of 160 m. Alternative tower heights between 80 and 100 m are also under consideration however, this is not exhaustive 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 and assembled on site.

### 2.2.3 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 160 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 potential changes to tower heights and blade lengths of new machines.

#### 2.2.4 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 (model dependant), 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.

#### 2.2.5 Footings

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

- Slab (gravity) foundations would involve the excavation of approximately 450 cubic metres ( $m^3$ ) of ground material to a depth of approximately 2.5 m. Approximately 200  $m^3$  would, if suitable, be used as backfill around the turbine base. Remaining excavation material will be used for the on-site road infrastructure, where necessary. 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 300  $m^3$  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: 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. Impact assessments undertaken for the proposal assume the use of the largest foundation footprint for all turbines, i.e. slab (gravity) foundations.

**2.2.6 Crane Hardstand and Assembly Areas**

Site access roads would have areas of hardstand (approximately 30 by 50 m) adjacent to each wind turbine for use during component assembly and by cranes during installation. The clearing of 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 as described in accordance with the Environmental Management Plan. Roads would be surfaced with local stone to required load-bearing specifications. The nature and colour of surface stone would be selected to minimise visual impact prior to construction. Roads and hardstand areas would be maintained throughout the operational life of the project 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

### 2.2.7 Monitoring Masts

There are currently two temporary wind monitoring masts installed, one 60 m mast located in the Pyramul Cluster and one 100 m mast located in the Sallys Flat Cluster, recording wind data for project development and planning.

Up to six permanent wind monitoring masts, up to 100 m high, are proposed to be installed on-site. Locations for these masts are yet to be determined and will be influenced by the final wind turbine selection, but may include the locations of the existing temporary monitoring masts. These permanent masts will 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: Tubular (left) and lattice (right) wind monitoring masts**  
Photo Courtesy: Wind Prospect CWP

Permanent met masts will require low voltage cable connection for power and also a communications cable to be laid. The trench required for this will be much smaller than for the cables between turbines. The connection would come directly from the closest turbine.

## 2.3 ELECTRICAL INFRASTRUCTURE

The electrical works, including those incorporated in the wind turbine structures, will involve:

- Up to 106 wind turbine generator transformers (Layout Option A) or up to 77 wind turbine generator transformers (Layout Option B);
- The establishment of a 150 by 150 m main collector substation with 132 kV step up transformers, circuit breakers and isolators;
- The establishment of a 25 by 25 m secondary collector substation with up to 132 kV transformers and isolators;
- Approximately 100 km of up to 132 kV entrenched underground cables;

- Approximately 100 km of underground control cables;
- Approximately 15 km of up to 132 kV double circuit overhead electrical interconnection lines;
- The establishment of a 75 x 100 m switching station with 132 kV circuit breakers, isolators, metering, protections and communications assets;
- Approximately 15 km of up to 132 kV double circuit overhead transmission lines; and
- Establishment of a 6 x 30 m operation facilities building to house control and communications equipment.

### 2.3.1 Generator Transformer

The wind turbine generators typically produce electricity at nominally 0.69 kV which is stepped up 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) underground reticulation cables that link to the main or secondary collector substations.

### 2.3.2 Main Collector Substation

The main collector substation (MCS) locations have been chosen to minimise access distance and electrical losses, and to reduce its visibility from surrounding public viewpoints. Three locations have been identified for the MCS which are at a minimum distance of 3 km from any surrounding residences. Following construction, and if warranted, raised earthwork perimeters and small areas of native tree planting may be installed to screen any parts of the MCS that are visible from the surrounding country to reduce noise and visual impact. Emergency backup power for the MCS will be supplied by a diesel generator and batteries onsite to maintain network communications and protections capability.

The MCS will include up to two transformers with capacities ranging between 80 megavolt ampere (MVA) or alternatively a single 180 MVA transformer to step-up the voltage to 132 kV, together with ancillary equipment. It will occupy an area approximately 150 by 150 m and will be surrounded by a 3m high security fence, surmounted by strands of barbed or razor wire. The MCS 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 MCS 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 MCS compound. The 2.25 ha area includes a provision for a 20 m buffer of land surrounding the equipment.

### 2.3.3 Switching Station

The switching station (SS) locations have equally been chosen to minimise access distance and electrical losses, and to reduce its visibility from surrounding public viewpoints. Four locations have been identified for the SS which are at a minimum distance of 850 m from any surrounding residences. The fourth option was added to the proposal after the field surveys had been undertaken, although the development footprint still falls within the study area and the vegetation types and conditions do not change from those of the nearby SS option (see **Figure 2**).

Following construction, and if warranted, raised earthwork perimeters and small areas of native tree planting may be installed to screen any parts of the SS that are visible from the surrounding country to reduce noise and visual impact. The SS will require its own power supply from the local 11 kV distribution network, which is located within 400 m to 2 km from the proposed SS locations.

The SS will occupy an area approximately 75 m by 100 m and will be surrounded by a 3 m high security fence, surmounted by strands of barbed or razor wire. The SS arrangement will include an array of busbars, circuit breakers, isolators, various voltage and current transformers as agreed with TransGrid. A buried earth grid will extend one metre beyond the fence on all sides. The ground surface within the SS enclosure will be covered partly with a layer of crushed rock and partly by concrete slabs. The 0.75 ha area includes a provision for a 15 m buffer of land surrounding the equipment required by TransGrid.

The SS will most likely require a communications tower to provide communications redundancy which is expected to be up to 20 m in height depending on geographic conditions. Twenty-four hour lighting will need to be incorporated into the design of the SS. TransGrid requires lighting for operational safety reasons and will only be used intermittently for operational and emergency maintenance reasons.

The design of the SS will be developed in conjunction with TransGrid and comply with relevant technical, electrical and planning standards. As the SS will be owned and operated by TransGrid the operational period is likely to be beyond the timeframe of the project. The SS will provide switching capability on TransGrid's 132 kV transmission line and could potentially increase network reliability and security of supply in the region and, therefore, TransGrid may wish to retain the SS beyond the operational life of the project.

### 2.3.4 Overhead and Underground Cables

The electrical cables from the Pyramul and Sallys Flat Clusters will comprise a mix of underground and overground cabling and will connect either directly to the MCS or via the SCS. Where feasible, an internal overhead transmission line will be used to export power from the Sallys Flat Cluster to the MCS.



**Image 6: Typical overhead line construction that could be implemented in this proposal**  
**Photo Courtesy: Wind Prospect CWP**

The underground cable routes will generally be between the turbines and follow the route of the internal access roads (see Image 7 below). 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.

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.

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

A double circuit internal overhead transmission line of voltage up to 132 kV may be constructed for connection between the SCS and the MCS to minimise internal reticulation losses. The 132 kV overhead transmission line will be up to 30 m in height comprising of two cross arms with insulators with an average span length of 250 m. Above ground control cables would also be strung from the poles of the internal overhead line located between the SCS and MCS.

A single or double circuit 132 kV external transmission line will be constructed between the MCS and SS for energy export into the grid. The 132 kV overhead transmission line will be up to 30 m in height comprising of two cross arms with insulators with an average span length of 250 m.



**Image 7: Laying underground electrical cable within the road network**  
Photo Courtesy: Wind Prospect CWP

### **2.3.5 Operation Facilities Building**

A facilities building approximately 6 m x 30 m will be constructed at the same location as the MCS. 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 MCS. 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 or composting toilet system, which complies with Council requirements, will be installed to treat the small amount of waste water produced.

### **2.3.6 Secondary Collector Substation**

The secondary collector substation (SCS) location has been chosen to minimise access distance and electrical losses, and to reduce its visibility from surrounding public viewpoints. The SCS will occupy an area approximately 25 m x 25 m and will be surrounded by a 3 m high security fence, surmounted by strands of barbed or razor wire. The SCS would consist of up to three medium voltage transformers stepping up to 132 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.

## **2.4 SITE ACCESS WORKS**

### **2.4.1 Site Entry**

The site locality can be reached via several local roads leading from the Castlereagh Highway between Mudgee and Ilford.

Existing access roads are shown in **Figure 1**, and can be classified into two broad categories:

- Classified Highways: Castlereagh Highway (HW 18) and Hill End Road (MR 216), which is maintained by the Roads and Maritime Services (RMS); and
- Local Roads: The direct access to the site is provided by local roads maintained by Mid-Western Regional or Bathurst Regional Councils. The significant local roads are Windeyer Road, Pyramul Road and Aarons Pass Road for access from the north to the project site. Turondale Road for access to the south of the project site. Bombandi Road and Crudine Road for access to the external overhead line and SS.

The RMS, Mid-Western Regional and Bathurst Regional Councils have ongoing maintenance and improvement programs for the roads and bridges under their control. The favoured access point for over-size and over-mass vehicles (primarily those vehicles carrying wind turbine and electrical components) is from the north; comprising entry from the Castlereagh Highway onto Hill End Road north of Mudgee, and travelling south to the site via Windeyer Road, Pyramul Road, and Aarons Pass Road.

Other roads in the locality may also be used both by over-size/over-mass vehicles, but primarily for normal loads such as tip-trucks, concrete agitator trucks (if required) and light vehicle transport both during construction and operation.

All entrances to the site from the existing arterial roads will be designed to allow long vehicles to safely exit from or re-enter without disrupting traffic. Further consultation will be undertaken with Council and the RTA to confirm the final design.

#### 2.4.2 On-site Access Roads

Other access consists of new on-site roads between turbines, also comprising hardstand and turning head areas. The on-site roads will follow existing farm tracks where possible 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.

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 A and Layout Option B that include impacts associated with permanent road, hardstand and turning head areas in addition to the area considered the extent of the earth works.

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.

The required on-site access for the site are shown in **Figure 2** and described below:

- Pyramul Cluster: Approximately 30 km of new internal on-site access track will be required; and
- Sally's Flat Cluster: Approximately 20 km of new internal on-site access track will be required.

### 2.4.3 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 site safety regulations permit, or entrances made wider (bell-mouth) to allow manoeuvring.

Hardstand areas equal 30 m x 50 m with additional area equal to 20 m x 20 m to accommodate the turbine foundation, and roads up to 6 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.

### 2.4.4 Ancillary Roads and Remediation

Generally in the pre-approval phase of a wind farm a development is designed at a high level with respect to basic civil engineering design parameters, primarily because the final infrastructure design can change during the consenting process and the cost of undertaking detailed civil design, high definition contour surveys and geotechnical surveys is prohibitive without the security of Consent. Sites are therefore designed to the best knowledge that is available at the time, whilst incorporating avoidance, mitigation and management measures determined by means of the key assessments undertaken prior to submission to the relevant authority. However, with regard to the proposal, detailed civil designs have been undertaken with respect to the project components that create the greatest impact (the roads, hardstands, cut and fill and turning head areas) to provide accurate information in the assessment of the proposal.

Once all required approvals are obtained, activities are undertaken to reach financial close. Key to this is the selection of a preferred wind turbine supplier and construction contractor which in turn will have specific requirements for road design. For example, each turbine is uniquely different requiring bespoke turning radii, access and exit gradients and crane requirements. As such, it is not until the surveyor of the construction contractor traverses the entire site and incorporates the various conditions of approval, that detailed design of the roads and hardstands can be submitted to the turbine supplier for approval. In consideration of the above it is important that some flexibility in design is maintained during the consenting process (refer to the section on Potential Layout Design Variations below).

Some additional roads or tracks may also be required for construction of the internal and external overhead line and for access to erosion control sites. The erosion control sites will benefit from the use of excess rock excavated from turbine/pole 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 they will be removed and rehabilitated on completion of the construction phase, and in accordance with landowner preferences and environmental controls.

## 2.5 UTILITY SERVICES

The proposal will be connected to TranGrid's 132 kV transmission network and when not generating will draw a minor amount of electricity from the grid. Backup and emergency power at the MCS will be supplied by onsite batteries and a diesel generator. Auxiliary power at the SS will be supplied by a local 11 kV distribution line.

A telephone connection to the proposed operation facilities building involving multiple telephone lines will also be provided to enable remote monitoring and control of the project.

Mobile telephone coverage is available on most of the ridgelines and plateaus with limited service available on the valley floor. Although the proposal will not rely on this form of communication, it can be assumed that members of the construction, operation and maintenance teams will communicate using both mobile telephones and radios.

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. The Proponent will be responsible for the removal of all other wastes from the site.

## 2.6 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 sand will be sourced locally and as close to the site as possible. There are two previously used gravel quarries located within the site; one at the northern entrance to the site off Aarons Pass Road and one at the southern entrance off Hill End Road, as well as additional quarries within 25 km of the site. These on-site quarries may be further utilised (subject to necessary permits) and have also been identified as preferred locations for any on-site concrete batching and rock crushing facilities. In addition, 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 (see Image 5), and provide a low resistivity apron around the substations.

Water requirements will be met by sourcing water from within the locality as long as a zero share licence can be obtained under the current water sharing plan. Where available, groundwater will be purchased from involved or adjacent landowner properties who hold groundwater licences and have unused allocations. The use of regulated surface water allocations from the nearby Windermere Dam may also be an option. This source is controlled by State Water and its use would be subject to further discussions post consent. If water cannot be sourced locally, then it will be brought to site by external water suppliers under contract to the project. It is estimated that in the order of 8.9 mega litres (ML) of water would be required to produce the quantity of concrete required for gravity footings for Layout Option A, and as such can be considered the maximum amount of water required for use in concrete batching. By way of comparison, it is estimated that only 2.8 ML of water would be required if standard rock anchors were used for all footings in Layout Option A.

In addition, a further 11.7 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 unsealed arterial roads. These activities are not embargoed and as such require the Proponent to apply for a permit to the NSW Office of Water (NOW). This will be undertaken pending Consent.

Road base material will be required for construction of access roads to turbine sites and the substations. Part of the road base requirement may be sourced from material extracted from turbine footings with the remainder sourced on-site (subject to permitting) or imported to the 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 proposal 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 (CEMP).

## 2.7 POTENTIAL LAYOUT DESIGN VARIATIONS

Alterations may be required to the proposed 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, unforeseen environmental constraints, constructability/cost-reduction and pre-construction engineering investigations can impact on the final design and affected area of the proposal.

## 2.8 WIND FARM DEVELOPMENT PHASES – DEVELOPMENT CONSENT TO OPERATION

The following section provides a brief description of the detailed design, pre-construction and construction works, operation/maintenance and refurbishment/decommissioning work required at the site.

### 2.8.1 Anticipated Project Time Frames

Approval is sought for the final positioning of up to 106 wind turbines and associated infrastructure within a radius of 100 m of the locations based on two preferred layouts, as indicated in **Figure 2**. Wind Prospect CWP anticipates that substantial construction will commence in the next 18 months, although it may take up to five years before construction commences. 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 in **Table 7**.

**Table 7: Anticipated project timeline**

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

\* = National Electricity Rules

**2.8.2 Construction Staging and Considerations**

The following section provides context into aspects that could have a bearing on a staggered construction process.

**Project scale:** the proposal comprises two Clusters which are expected to be constructed over a period of 12 to 24 months. Within this timeframe it is anticipated that activities will occur mainly within one of the Clusters at any one time. Depending on various commercial considerations, the two clusters may be commissioned separately, or together.

**2.8.3 Detailed Design and Contract Development**

Once all required permits and approvals have been obtained and tenders for the design and construction have been awarded the proposal design can be finalised. This stage takes account of updated wind resource monitoring, revised energy modelling and the latest equipment and technology that is available to Wind Prospect CWP at that time. It is at this stage that final micro-sitting of the wind turbines and site infrastructure will occur.

Project environmental commitments, including undertakings arising from the impact assessment, consent conditions and any licensing conditions will be compiled and used to prepare the project Environmental Management Plans (EMPs). The project EMPs would also be incorporated into the contract specifications for the required construction works and equipment supply to ensure compliance and achieve the project environmental objectives.

Tenders will be issued using the abovementioned specifications and each tenderer’s record of performance will be reviewed as part of the selection process to ensure that they are able to achieve the required specification of works.

The Contractor will also be required to produce a Contractor Environmental Management Plan to address its component of the proposed works.

#### 2.8.4 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;
- Detailed contour surveys;
- Upgrading the surfaces of local roads and access roads where required;
- Widening the junctions or corners of local roads, entrance/access points 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, the substation locations, access road areas, crane hardstand and assembly areas;
- The construction of a secure site compound, with owner and subcontractors field offices (portables), parking bays, and toilet facilities (temporary). A 75 x 75 m area is to be retained permanently;
- Erection of signage on roads;
- Enabling works for the locating of a mobile concrete batching plant (temporary, if required);
- Enabling works for the locating of a rock crushing plant (temporary, if required);
- Environmental survey and refinement (if necessary) of the EMP in line with the SoC, Health and Safety Plan, Traffic Management Plan and any other documentation as required under the Development Consent;
- Survey of critical land 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.

#### 2.8.5 Construction Works

Construction activities include activities that cross over with pre-construction works and comprise site establishment, earth works for access roads, footings and crane hardstand areas, erection of up to 106 wind turbines, approximately six permanent wind monitoring masts, substations, above and below ground cabling and site compound. Construction activity is likely to occur over a period of approximately 12 to 24 months with rehabilitation following the completion of works.

**Site Establishment and Compound:** Site works will require the erection of temporary infrastructure such as portable field office toilet facilities and parking bays, within the temporary construction compound. This infrastructure will be typical of that used at construction sites; however, it will not include full accommodation facilities.



**Image 8: Typical temporary site office**  
**Photo Courtesy: Wind Prospect CWP**

Five preferred areas for the construction compound have been considered. Three are located in the north of the Pyramul Cluster, off Aarons Pass Road, the fourth located in the south of the Sallys Flat Cluster off Hill End Road (see **Figure 2**). The temporary site office facilities will be approximately 40 by 100 m located within the construction compound approximately 150 x 200 m, a combined area of approximately 3 ha. The area will be fully fenced with sufficient access to allow vehicle movement, stockpiling of materials, and office facilities. An area approximately 75 x 75 m will be retained for permanent use during the life of the project.

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 both Clusters;
- Minimising ecological impacts through avoidance of Threatened Ecological Communities (TECs), 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 Development Consent, a construction contractor will be appointed to the proposal. If alternative locations for these facilities are sought then the same selection criteria will be considered to determine suitable locations. Post-construction, approximately a 75 x 75 m of the selected construction compound will be retained as a permanent laydown area for the duration of the project.

**On-site Concrete Batch Plant/Rock Crusher:** Two concrete batching plant and rock crusher locations are proposed to supply concrete and aggregate for the wind turbine foundations and access tracks.

An on-site batching plant facility would occupy an area of approximately 50 m x 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<sup>3</sup>/h).

A rock crusher would occupy an area of approximately 50 m x 100 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. Image 9 below shows a typical mobile concrete batching plant facility and rock crusher.



**Image 9: Temporary on-site concrete batching plant and rock crusher**  
**Photo Courtesy: Wind Prospect CWP**

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

- Minimising ecological impacts through 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 Development Consent, 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.

**Site Access Roads and Crane Hardstand/Assembly Areas:** Site access roads and crane hardstand/assembly 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 all of the 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 6 m to allow for passing construction traffic, large mobile cranes, and other long and wide loads. The crane hardstand and assembly areas will be sized at approximately 30 m x 50 m.

**Footing Construction:** If gravity foundations are required, the construction of the foundation for each wind turbine would involve the excavation of approximately 450 m<sup>3</sup> of ground material to a depth of approximately 2.5 m. If rock anchor foundations are required, the construction of the foundation for each wind turbine would involve the excavation of approximately 100 m<sup>3</sup> of ground material to a depth of approximately 2.5 m.

**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 marked with warning tape and backfilled once the cables were in-situ.

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

- 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 up to 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;
- Backfilling and compaction of previously excavated material in layers by use of a vibration plate compactor, all in accordance with Engineering Specifications; and
- Placement of tape warning of the presence of electrical cables at the required depth.

On completion, the cable route may be marked with small marker posts and the surrounding vegetation will be allowed to regrow.

**Main Collector Substation:** Three locations for the MCS have been selected (**Figure 2**) with a total compound area of 150 by 150 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 kV transformers, switchgear, power conditioning equipment and operation facilities building. Image 10 below shows a typical substation design during construction.



**Image 10: Transformer foundation (foreground) and electrical substation and switchgear infrastructure (background).**

**Photo Courtesy: Wind Prospect CWP**

**Secondary Collector Substation:** The SCS will consist of up to three medium voltage transformers stepping up to a maximum of 132 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 x 25 m and will include transformer hard stands, environmental bunding and security fencing at 3 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 to 1,000 tonne crane together with the small mobile crane, would be required to erect the turbines once ground assembly is complete. Erection is likely to take approximately 2 to 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 11 shows the sequential stages undertaken during the installation of a wind turbine.



**Image 11: A range of typical turbine construction photographs.**  
 Photo courtesy: Wind Prospect CWP

**Internal and External Overhead Powerlines:**

Construction of the proposed internal and external powerlines require the following works to be undertaken in accordance with an appropriate CEMP:

- Site establishment including the provision of access;
- Centreline surveying and service location;
- Excavation and power pole erection; and
- Conductor and earth wire installation (including pilot wire).

The majority of the proposed transmission line locations can be readily accessed during construction via cleared agricultural land, following negotiations with landholders. In some cases, track creation or enhancement may be required where access cannot be gained or is not considered adequate to support machinery utilised during the construction of the line. A number of creek crossings may also be required to support the required machinery. Crossings not required for future maintenance activities will be decommissioned following the completion of construction works.

Existing access tracks will be utilised where possible. Where it is not possible, access tracks will preferably be restricted to the proposed transmission line corridor and will connect with existing tracks or public roads at the most convenient locations. Upgrading of the existing access tracks will be necessary to allow access by low-loaders to the SS site and other construction plant and equipment to the remainder of the line route.

Minimal clearing will be required for the construction of both the internal and external powerline. Any native vegetation removed will be chipped and mulched for use on-site. Shrub and grass understorey species will be maintained where practicable to reduce the risk of soil erosion.

**Switching Station:** The SS will be designed and constructed in line with TransGrid requirements and any other relevant technical, electrical and planning standards.

The following earthworks would occur during construction of the proposed SS:

- Cut and fill works to create a stable hardstand platform;
- Digging of trenches and footings for the switching station infrastructure; and
- Construction of concrete foundations for the control/switch room building and establishment of pads for the installation of electrical infrastructure.

On-site trafficked areas would be limited to areas at the site entrance and surrounding the switch room and control building. The infrastructure compound area would be finished with coarse gravel and pebble material. The remainder of the site would be retained as grassland with landscaped planting as necessary.

TransGrid requires the provision for night lighting for operational safety reasons that is not low-intensity. This is would only be used intermittently for operational and emergency maintenance reasons.

Landscaping would be undertaken to limit the potential visual impacts of the proposed SS. Landscaping would involve planting of locally endemic species planted in copses to break up the visibility of the compound area. A minimum cleared buffer of four metres from the compound fence is required to meet public safety requirements.

### 2.8.6 Commissioning

Pre-commissioning checks will be carried out on the high voltage electrical equipment prior to connection to the TransGrid transmission network. When the project electrical system has been energised, the wind turbines will be commissioned and put into service.

### 2.8.7 Operation

Once operational, the facility would be monitored both by on-site staff and through remote monitoring. Aspects of the 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 co-ordination. 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.

### 2.8.8 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.

Management of regrowth vegetation will be necessary within the powerline corridors to reduce the threat of combustible material to the line and to allow access for maintenance vehicles. This will be undertaken using mechanical, hand clearing and chemical clearing methods prior to construction activities commencing and as part of ongoing maintenance activities.

### 2.8.9 Refurbishment

After approximately 20 to 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 project for a further 20 to 25 years.

Any material change to the proposed layout, or significant changes to the turbine technology, will be referred to the relevant NSW planning authority at that time as an amended proposal. It would also be subject to the regulations and guidelines of the day. Refurbishment requires the transportation and installation equipment and facilities, similar to that used during initial construction.

### 2.8.10 Decommissioning

At the end of the operational life of the Project, the turbines and all above ground infrastructure will be dismantled and removed from the site. This includes all the interconnection and substation infrastructure, but may exclude the SS. 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 crusher 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 as close as possible 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 would be left in the ground and only recovered if economically and environmentally viable. Terminal connections would be cut back to below ploughing levels.

### 2.8.11 Fire Management

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

Despite the low risk that wind farms present, fire management is a major concern within the region, and planning for fire prevention and an effective and informed response is of paramount importance. 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 Rural Fire Service (RFS) to confidently plan and execute an effective response.

Appropriate fire management actions for all stages of the proposed development (i.e. pre-construction, construction, operation and decommissioning) include:

- Adherence to all regulations;
- Installation of access tracks at least 4 m wide and with appropriate vertical clearance and suitability for all weather conditions;
- Provision of appropriate fire-fighting equipment at each active site, including fire extinguishers, knapsacks and other equipment suitable for initial response actions;
- Maintaining provision for mobile telephone and UHF radio communications;
- Provision of on-site 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;
- Consideration of total fire ban days in regard to hours within which construction takes place;
- Providing the 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; and
  - Location of potential landing pads for fire-fighting aircraft or helicopters.

## 2.9 SUMMARY

The proposal will comprise one of two potential design layouts; one consisting of up to 106 wind turbines and the other up to 77 wind turbines and ancillary structures, both spread over 17 different properties, with a maximum blade tip height of 160 m. The proposal will connect into the 132 kV TransGrid transmission line running north-south approximately 15 km east of the Crudine ridgeline.

The Proponent requests that consideration is given to a 200 m micro-siting allowance and 5 m turbine height allowance during the detailed design phase, and that the Project, if necessary, can be built and commissioned in stages. Pre-construction works involve final site surveys (for heritage and ecology, if

necessary), geotechnical investigations and preparation activities. Construction works involve the grading and surfacing of access tracks and turbine footprints, and the installation of the project and connection infrastructure as well as temporary works facilities. Land that is disturbed but is not part of the land-take for the life of the project, will be reinstated.

Operation of the site is controlled remotely, with the majority of site visits required being that by maintenance staff. At the end of the term of the project the facility may either be refurbished or decommissioned. Decommissioning will involve the removal of all above-ground infrastructure and the reinstatement of the ground to a pre-construction condition.

## 3 Planning and Assessment Framework

### 3.1 COMMONWEALTH LEGISLATION

Crudine Ridge 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 proposal will provide an important contribution to the Federal Government's Renewable Energy Target (RET) of 20 % by 2020.

The RET scheme, implemented in August 2009, expanded on the previous Mandatory Renewable Energy Target (MRET), which began in 2001. In June 2010, the Parliament passed legislation to separate the RET into two parts, which commenced on 1 January 2011: the Large-scale Renewable Energy Target (LRET) and the Small-scale Renewable Energy Scheme (SRES). Legislation included:

- *Renewable Energy (Electricity) Act 2000;*
- *Renewable Energy (Electricity) (Small Scale Technology Shortfall Charge) Act 2010;*
- *Renewable Energy (Electricity) (Charge) Act 2000;* and
- *Renewable Energy (Electricity) Regulations 2001.*

The legislation above was amended by the Commonwealth Parliament on 24 June 2010:

- *Renewable Energy (Electricity) Amendment Act 2010;*
- *Renewable Energy (Electricity) (Charge) Amendment Act 2010;* and
- *Renewable Energy (Electricity) (Small Scale Technology Shortfall Charge) Act 2010.*

The changes to the previous MRET provide greater certainty for households, large-scale renewable energy projects and installers of small-scale renewable energy systems. Combined, the new LRET and SRES are expected to deliver more renewable energy than the previous 45,000 gigawatt-hour target in 2020.

#### **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;
- Commonwealth marine areas;
- Nuclear actions; and
- Great Barrier Reef Marine Park.

In addition, the EPBC Act confers jurisdiction over actions that have a significant impact on the environment:

- Where the actions affect, or are taken on, Commonwealth land;
- Are carried out by a Commonwealth agency (even if that significant impact is not on one of the eight Matters of 'National Environmental Significance').

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.

A Referral under the EPBC Act was submitted to Department of Sustainability, Environment, Water, Population and Communities (DSEWPAC) in November 2011 for the likely impacts of the proposal on BGW, *Swainsona recta* and potential habitat for threatened and migratory species. All direct 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 29 February 2012 (EPBC Ref: 2011/6206).

EPBC Act Significance Assessments have been conducted for those Matters of NES considered to have the potential to occur within the study area.

In March 2012, the Commonwealth and NSW Governments signed an agreement which allows the proposal to be assessed through an accredited assessment process under Part 3A of the NSW EP&A Act.

Initial DGRs for the proposal were issued in 2008 and revised DGRs were also issued on 23 February 2011. As a consequence of the accredited assessment process, supplementary DGRs were prepared in consultation with DSEWPAC and issued in March 2012.

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 list a number of threatened species for which DSEWPAC require 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 *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.

Although the *Environmental Planning and Assessment Amendment (Part 3A Repeal) Act 2011* commenced on 1 October 2011, Part 3A continues to apply to certain projects subject to the transitional provisions identified in Schedule 6A of the Act. These include those projects for which DGRs were issued before October 2011 and a current major project declaration remains in force. This is the case for the Crudine Ridge Wind Farm.

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 CWP Pty Ltd. On 7 March 2011, supplementary DGRs were issued to Wind Prospect CWP Pty Ltd. Bathurst and Mid-Western Regional Council, 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.

A summary of the DGRs for the Crudine Wind Farm are included in 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 October 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 Minister 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 OEH Interim Policy on assessing and offsetting biodiversity impacts of Part 3A, State Significant Development and State Significant Infrastructure (OEH 2011d) were investigated, including application of the Biobanking Assessment Methodology (BAM) to "inform" the quantum of offsets required in accordance with the Principles for Biodiversity Offsets in NSW.

#### *Biobanking*

Biobanking is a voluntary market-based scheme that provides a streamlined biodiversity assessment process for developments, 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 'maintain or improve' 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 for the proposal to provide guidance on the size/area of the offset requirements in accordance with the ‘maintain or improve’ requirement included in the project’s DGRs.

### **3.2.2 Threatened Species Conservation Act 1995**

The *Threatened Species Conservation Act 1995* (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.

### **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, excluding whales, mammals, reptiles, birds, amphibians, or other 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* (NW Act) 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 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 Mid-Western and Bathurst Regional LGAs (the Mid-Western Regional LGA includes the former Mudgee LGA, which is listed under SEPP 44).

Koalas have previously been recorded within the locality and there were a number of records of this species within the project site and study area (**Figure 9**). Schedule 2 of SEPP 44 includes a list of Koala feed tree species. The study area did not support any of the Koala feed tree species listed; however, Koala scats were found at the bases of *Eucalyptus macrorhyncha* (Red Stringbark), *E. rossii* (Inland Scribbly Gum), *E. goniocalyx* (Long-leaved Box / Bundy), and *E. polyanthemos* (Red Box) 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 the Koala is listed as a threatened species, Koala habitat has been assessed as part of the proposed development impacts.

### 3.4 LOCAL GOVERNMENT PLANS

The Crudine Ridge Wind Farm falls within the Mid-Western and Bathurst Regional Council areas. The proposal is to be assessed under the former Part 3A of the EP&A Act and, therefore, DoPI are the consent authority. Bathurst Regional Council provided input, noting that they hold an extensive list of threatened flora and fauna gleaned from actual studies throughout the LGA.

The wind farm site is currently zoned 1(a) Rural under the Mid-Western Regional Interim Local Environmental Plan (LEP) 2008 and the majority of the wind farm within the Bathurst LGA is zoned 1(e) Outer Rural Zone under Bathurst Regional (Interim) LEP 2005.

The Mid-Western Regional and Bathurst Regional LEPs neither prohibit the development, nor allow it without development consent; therefore, it is permissible once development consent has been granted.

## 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 EA report. 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) (OEH 2011a);
- Department of Sustainability, Environment, Water, Population and Communities (DSEWPAC) Online search for Matters of National Environmental Significance (Accessed June 2011);
- Bathurst Regional Council Threatened Species Records (BRC 2011);
- Royal Botanic Gardens Flora Database Records (approximately an 8x10 km square) (RBG 2011);
- Birds Australia New Atlas database 1998-present (approximately 10 km radius) (2011);
- 250k Statewide geology for NSW (DMR 2003);
- Soil Landscapes of Bathurst 1:250 000 Sheet (Kovac and Lawrie 1990);
- Soil Landscapes of Dubbo 1:250 000 Sheet (Murphy and Lawrie 1998);
- Mitchell Landscapes of NSW (DECC 2008a);
- Native Vegetation in the Central West Catchment (DEC 2006a);
- Tunnabidgee, Ilford and Sofala 1:100 000 map sheets (Geoscience Australia 1998); and
- Recovery Plans for listed threatened species (if available).

The *Roadside Management Guidelines* (Mid-Western Regional Council 2011a) and *Roadside Vegetation Assessment Report* (Mid-Western Regional Council 2010) documents were made available by Mid-Western Regional Council and a review conducted. Although these documents address a number of threatened species and communities, only a small portion of species listed were applicable to Crudine.

The assessment of likelihood for threatened and migratory species identified from the database searches to occur or to have the potential to occur within the locality was assessed. 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

A reconnaissance was undertaken by ELA ecologists in October 2008 to plan the required field work, with field surveys undertaken from November 2008 to October 2011. Surveys included vegetation and biometric vegetation type and condition mapping, supplemented by additional vegetation transects, and targeted searches for threatened flora and fauna considered likely to occur or with potential habitat (Appendix C). 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 8**.

**Table 8: Eco Logical Australia field team**

STAFF MEMBER	QUALIFICATIONS
Elizabeth Norris	Master of Science, Macquarie University, Sydney Bachelor of Science, Macquarie University, Sydney
Bruce Mullins	Master of Science, University of Technology, Sydney Bachelor of Science, University of Technology, Sydney
Tammy Haslehurst	Bachelor of Environmental Science (Hons), Macquarie University, Sydney
Lachlan Copeland	Research PhD in plant systematics, University of New England Bachelor of Natural Resources (Hons), University of New England
Daniel Magdi	Bachelor of Landscape Management and Conservation, University of Western Sydney, Sydney
Enhua Lee	PhD in Ecology and Wildlife Management, University of NSW, Sydney Bachelor of Advanced Science (Hons), University of NSW, Sydney
Lachlan Sutherland	Bachelor of Applied Science (Environmental Science) (Honours), Charles Sturt University, Wagga Wagga.
Matthew Dowle	PhD candidate (Biological Sciences and Wildlife Management), Macquarie University, Sydney Bachelor of Advanced Science (Hons), University of NSW, Sydney
Danielle Bennett	Bachelor of Animal Science, University of Western Sydney, Sydney
Vivian Hamilton	Bachelor of Environmental Management, Macquarie University, Sydney

#### 4.2.1 Survey Conditions

Weather conditions for each survey period are summarised below in **Table 9**.

Weather conditions were obtained from two weather stations. Rainfall data was obtained from Ilford, Warrangunyah (station 62031), approximately 7.2 km from Crudine (2008 – 2011), temperature data was collected from Mudgee Airport AWS (station 062101), approximately 41.4 km from Crudine (2008 – 2011) and wind speed from Mudgee (station 062101) (Bureau of Meteorology 2011a).

Throughout the 2008 / 2009 surveys the conditions during the survey period were generally warm to hot, with the initial surveys being conducted during a period of light to moderate rainfall events. Heavy rainfall, and in some cases minor flooding occurred during the survey period and a flush of vegetation growth occurred during 2011 survey period. This flush was dominated by native grasses including *Austrodanthonia racemosa* var. *racemosa*, *Austrostipa scabra*, *Aristida racemosa* and *Bothriochloa* spp.

During each survey period wind patterns were highly variable with light to moderate winds experienced on many days. In some instances, strong winds were experienced although this was not common.

The prolonged drought being experienced throughout the central tablelands throughout 2008 / 2009 is likely to have influenced the findings of this study. The change in vegetation condition was particularly noticeable between the January 2009 surveys and March 2011 surveys following a change in prevailing weather patterns resulting in increasing rainfall over this period.

**Table 9: Summary of Survey Conditions (averages, with the exception of rainfall which is total)**

SURVEY PERIOD	MAXIMUM TEMPERATURE (°C)	RAINFALL (mm)	MAXIMUM WIND GUST SPEED (KM/HR)	NOTABLE WEATHER CONDITIONS
27-29 October 2008	30.7	0	44.3	Fine and warm with light to moderate winds. Air temperature at 3pm was between 24-29°C
17-20 Nov 2008	24.6	48	53.6	Cool to mild days. Overcast and raining. Highest rainfall at 30.4mm on 19/11/2011
24-27 Nov 2008	29.2	0	42.5	Cool to mild days, overcast and raining. Highest amount of precipitation (0.8mm) recorded at 9am 24/11/2008.
19-23 Jan 2009	33.9	5.5	44.3	Generally fine but with occasional scattered showers. Warm to hot temperatures, light to moderate winds.

SURVEY PERIOD	MAXIMUM TEMPERATURE (°C)	RAINFALL (mm)	MAXIMUM WIND GUST SPEED (KM/HR)	NOTABLE WEATHER CONDITIONS
2-5 Mar 2011	25.8	3.4	38.8	Fine, mild to warm temperatures, light to moderate winds. Highest amount of precipitation (3.4mm) occurred on 3/03/2011
15-18 Mar 2011	27.9	11	36.5	The highest wind gust speed for the month occurred during survey period (52 km/h on the 15/03/2011). The highest amount of rain for the month also fell during the survey period (8.6 mm on the 16 March; the total amount of rain for the month was 32.6 mm).
18-20 Apr 2011	22.9	0	19.7	Fine, mild to warm temperatures. The lowest wind gust speed for the month occurred during survey period (17 km/h on the 20/04/2011).
Remote Cameras: 17-24 Nov 2008	25.5	64.4	72.4	Cool to mild days, overcast and with rain periods. The highest relative humidity was recorded at 98% on 19/11/08 and 20/11/2008.
Remote Cameras: 24 Nov-20 Dec 2008	32.4	108.5	68.4	Cool to mild days, overcast and with rain periods. The lowest maximum wind gust speed (at 33.5km/h) during the survey period occurred several times (4 <sup>th</sup> , 11 <sup>th</sup> , 12 <sup>th</sup> & 17 <sup>th</sup> Dec 2008).
Remote Cameras: 19Jan-6 Feb 2009	39.1	12.3	72.4	Generally fine but with occasional scattered showers. Warm to hot temperatures. Highest relative humidity (73%) recorded on the 22/01/2009

Source: BOM 2011a

#### 4.2.2 Site Reconnaissance

A site reconnaissance was undertaken from 27 – 29 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 correspondence with OEH and the Biobanking Assessments “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 six survey periods as a consequence of changes to the proposed layout which shifted vegetation plots outside of the study area; October 2008, November 2008, January 2009, March 2011 (2 survey periods), and April 2011. 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 recorded using a GPS and mapped onto an aerial photograph. 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 and 9.3, 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 1:10,000. 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 (BAM) 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). Further details on the Biobanking methodology, with respect to vegetation mapping and flora and fauna survey, is provided in Sections 4.2.5.

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, a degree of professional judgement / expert opinion has been used in this mapping.

#### *Biometric Condition Assessment*

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

Ancillary Codes were also assigned to each of the Vegetation Zones to create the Threatened Species Sub-zones.

#### *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 ha 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. CW209) from the Biobanking quadrats and traverses of the study area 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 November 2008 to October 2011 in accordance with the former Department of Environment and Conservation’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.

Detailed surveys for fauna were not conducted within the entire length of the power line easement due to the limited fauna habitat in this area, particularly in comparison to the remainder of the study area. The power line easement is comprised primarily of pasture with scattered trees. Some sections of the power line easement are located along existing tracks (see **Figure 1**), and in these areas no additional clearance for an access track will be required.

Given the size of the study area, a strategic approach to survey locations was applied. Detailed fauna surveys were conducted across other parts of the study area that support similar and / or better quality habitat than that within the proposed power line easement. It was determined that the results obtained from surveys in other areas of similar habitat would provide a good indication of the species likely to be present in areas proposed for the power line easement. Given it is more difficult to make assumptions and extrapolate the distribution of threatened flora the undertaking of targeted surveys for flora in the proposed power line easement were considered necessary and therefore were undertaken.

#### *Survey Effort & Timing*

**Table 10** outlines the survey effort undertaken across the study area and the timing of each survey. Surveys for *Litoria booroolongensis* (Booroolong Frog) were not conducted as no suitable habitat (i.e. rocky creeks/streams) existed within the study area.

Consultation with OEH was undertaken to determine the most appropriate survey timing and methodology for conducting surveys for the Regent Honeyeater. A repeated surveys approach during the optimal survey period (spring to early summer) was recommended given the use of the site by this species is likely to be sporadic and driven by flowering events and patterns throughout the locality and region. Details of the survey effort for this species are included below in **Table 10**.

**Table 10: Survey effort and timing**

TARGET SPECIES	SAMPLING TECHNIQUE	SURVEY PERIOD	SURVEY EFFORT
<b>Endangered Ecological Communities</b>			
White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Vegetation validation and quadrats	27 – 29 October 2008 17 – 20 November 2008 19 – 23 January 2009 2 – 5 March 2011 15 – 18 March 2011 18 – 20 April 2011	Vegetation validation and mapping  7 Biobanking plots (20 m x 20 m and 50 m x 20 m plots)
<b>Threatened Flora</b>			
Threatened Flora Requiring Survey	Seasonal and systematic searches (random meander transects) across all areas of potential habitat within a 200 m wide corridor.	17 – 20 November 2008 19 – 23 January 2009 2 – 5 March 2011 15 – 18 March 2011 18 – 20 April 2011 27-28 September 2011 11-13 <sup>th</sup> October 2011	27 Biobanking plots 40 transects 65 spot surveys
<b>Threatened Fauna</b>			
Booroolong Frog ( <i>Litoria booroologensis</i> )	Surveys not conducted as no suitable habitat was present. Opportunistic observations of frog species were made.		
Pink-tailed Legless Lizard ( <i>Aprasia parapulchella</i> )	Rock rolling	17 – 20 November 2008 26 November 2008	Surveys at 10 sites (in potential habitat) <ul style="list-style-type: none"> <li>At 7 sites, 500 rocks rolled per location</li> <li>At 3 sites, 1000 rocks rolled per location</li> </ul>
Threatened Birds	Diurnal bird surveys Incidental observations	17 – 19 November 2008 24 – 27 November 2008 20 – 21 January 2009 23 January 2009	50 diurnal bird surveys at 14 sites – 34.83 person hours
	Call playback (Bush Stone-curlew)	24 – 27 November 2008	5 call playback nights <b>Total: 5 nights at 2 sites</b>
	Regent Honeyeater	17 – 19 November 2008 24 – 27 November 2008 20 – 21 January 2009 23 January 2009	50 diurnal bird surveys at 14 sites – 34.83 person hours

TARGET SPECIES	SAMPLING TECHNIQUE	SURVEY PERIOD	SURVEY EFFORT
Mammals	Scat searches (Koala)	17 – 20 November 2008	Searches at 6 locations (5 sites) 6 person hours (searches for 2 minutes per tree and 30 trees per location)
	Spotlighting	17 November 2008 21 – 22 January 2009	8 person hours 2 person hours
	IR camera (Spotted-tailed Quoll)	17 – 24 November 2008 24 Nov – 20 Dec 2008 19 Jan – 6 Feb 2009	14 trap nights (as 2 traps) 54 trap nights (as 2 traps) 38 trap nights (as 2 traps) <b>Total: 106 nights at 6 locations (4 sites)</b>
	Tree-mounted Elliott trapping (Brush-tailed Phascogale, Squirrel Glider)	23 – 27 November 2008	40 trap nights (as 10 traps)
	Call playback (Koala)	17 November 2008 21 January 2009	2 call playback nights (2 sites) 1 call playback night (1 site) <b>Total: 3 nights at 3 sites</b>
Owls	Call playback (Powerful Owl)	24 – 27 November 2008 21 – 22 January 2009 16 – 17 March 2011 11 – 13 October 2011	9 call playback nights (3 sites) 2 call playback nights (2 sites) 2 call playback nights (2 sites) 2 call playback nights (2 sites) <b>Total: 15 nights at 3 sites</b>
	Call playback (Barking Owl)	17 November 2008 24 – 27 November 2008 21 – 22 January 2009 27 – 29 September 2011 11 – 13 October 2011	1 call playback night (1 site) 6 call playback nights (2 sites) 2 call playback nights (1 site) 1 call playback night (1 site) 2 call playback nights (1 site) <b>Total: 12 nights at 2 sites</b>
	Spotlighting	17 November 2008 24 – 27 November 2008 21 – 22 January 2009 16 – 17 March 2011	3.2 person hours 4 person hours 2 person hours 4 person hours
Microbats	Anabat Detection	17 November 2008 24 – 27 November 2008 19 – 20 January 2009 3 March 2011	2 anabat nights (as 2 anabats) 8 anabat nights (as 2 anabats) 4 anabat nights (as 2 anabats) 2 anabat nights (as 2 anabats)

TARGET SPECIES	SAMPLING TECHNIQUE	SURVEY PERIOD	SURVEY EFFORT
	Harp Trapping	17 November 2008 24 – 27 November 2008 3 March 2011	2 trap nights (as 2 traps) 8 trap nights (as 2 traps) 2 trap nights (as 2 traps)

### 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), 17 biometric vegetation condition plots were randomly placed across the vegetation zones in the study area in accordance with the minimum number of plots required (**Table 4** of the BAMCCOM).

Ten additional biometric vegetation condition plots were also undertaken within the project site but outside of the study area (changes to the proposed layout meant that plots were no longer within the study area). **Figure 6** shows the location of each of the biometric vegetation condition plots throughout the study area and project site.

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.

### Targeted Flora Surveys

Seasonal and systematic searches (random meander / transects) across all areas of potential habitat for threatened species within a 200 m wide corridor were undertaken. Surveys were conducted during the flowering period for all target species unless conspicuous when not in flower. All surveys were conducted by experienced botanists and consultation with the Sydney Royal Botanic Gardens was undertaken regarding appropriate survey times for the majority of species.

Confirmation that *Swainsona recta* individuals were in flower at nearby reference sites was obtained prior to undertaking targeted surveys for this species to increase the likelihood of detection. For targeted *Prasophyllum* sp. *Wybong* (Leek Orchid) surveys, a relevant expert (Dr Lachlan Copeland, Senior Botanist, Eco Logical Australia, 2011) was consulted prior to undertaking targeted searches to confirm appropriate survey timing based on historical flowering dates for this species at the Ilford Cemetery .

Survey for *Eucalyptus cannonii* was undertaken over a number of seasons and timed such that fruiting material of *Eucalyptus cannonii* could be collected to differentiate this species from the closely related *Eucalyptus macrorhyncha*. The botanist conducting the surveys has had previous experience with *Eucalyptus cannonii* and has found this species at other sites in the past.

### Flora Traverses and Spot Surveys

Besides biometric vegetation condition plots, 35 vegetation transects were conducted (9 in the study area and 26 in the project site outside of the study area; **Figure 6**). These transects were conducted to search for threatened species, but also to assist in verifying vegetation communities in the study area and project site. Along each traverse, all species encountered were recorded.

Spot surveys were also conducted around proposed turbines locations to check for the presence of

threatened flora species. In total, 65 spot surveys were conducted at the turbine locations as positioned in the original 2008 layout.

#### *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 5.4.5 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 important to note that this data is extrapolated as an estimate.

### **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 and details of the methodology implemented for the biobanking plots is included in Appendix K.

#### *Biobanking Target Species*

The Biobanking Credit Calculator requires targeted survey for ten threatened flora and five threatened fauna species (**Table 11**). Whilst a number of other threatened species have the potential to occur within the study area, ecosystem species do not require survey under the Biobanking methodology (i.e. species for which presence is assumed if a certain ecosystem type is present) nor are those species identified as not requiring survey based on the habitat requirements for each species compared to those habitat types present on site.

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).

*Goodenia macbarronii* (Narrow Goodenia) was identified by the Biobanking Tool as a species requiring survey. However, this species has now been delisted from the TSC Act and, as such, was not considered a target species. In addition, surveys were not undertaken for *Litoria booroolongensis* (Booroolong Frog) as potential habitat for this species was not present at the site.

*Prasophyllum* sp. *Wybong* (Leek Orchid) was included in the targeted threatened flora surveys due to it's listed under Commonwealth legislation. Dr Lachlan Copeland (Senior Botanist, Eco Logical Australia, 2011) was consulted prior to undertaking surveys for this species to determine appropriate survey timing.

Table 11: Biobanking Species Requiring Survey

SCIENTIFIC NAME	COMMON NAME
<b>Flora</b>	
<i>Acacia ausfeldii</i>	Ausfeld's Wattle
<i>Eucalyptus alligatrix</i> subsp. <i>miscella</i>	
** <i>Eucalyptus cannonii</i>	Capertee Stringybark
<i>Eucalyptus robertsonii</i> subsp. <i>hemisphaerica</i>	Robertson's Peppermint
* <i>Goodenia macbarronii</i>	Narrow Goodenia
<i>Grevillea divaricata</i>	
<i>Persoonia marginata</i>	Clandulla Geebung
<i>Swainsona recta</i>	Small Purple-pea
<i>Swainsona sericea</i>	Silky Swainson-pea
<i>Zieria obcordata</i>	
<b>Fauna</b>	
<i>Callocephalon fimbriatum</i>	Gang-gang Cockatoo
<i>Circus assimilis</i>	Spotted Harrier
<i>Hieraaetus morphnoides</i>	Little Eagle
<i>Litoria booroolongensis</i>	Booroolong Frog
<i>Phascogale tapoatafa</i>	Brush-tailed Phascogale

\*Delisted from TSC Act

\*\* *E. cannonii* is delineated from *E. macrorhyncha* by checking the fruiting material of a number of individuals. The presence / absence of *E. cannonii* was determined by experienced botanists.

#### 4.2.6 Calculating Impacts on Pasture Areas

Calculating tree clearing in pasture areas was based on the area of canopy cover compared to native pasture within selected polygons. In pastures, trees are randomly scattered, with actual tree numbers per hectare varying markedly. Therefore, the average canopy cover in pastures was calculated by averaging the canopy covers from areas that were deemed relatively densely, moderately and sparsely treed. Samples were taken from an number of sections of the impact area. ELA calculated that an average of 5 % of pasture areas comprised trees.

#### 4.2.7 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 have 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 October 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 seeks to describe the assemblage of 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, difficulty was experienced identifying some flora species as specimens lacked key distinguishing features. Flora species 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 activities such as grazing and other permitted landuse. Therefore, this 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 uploaded to ArcGIS Geographic Information System (GIS). 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

Four Central West CMA RBVTs were mapped throughout the study area and project site (**Figure 8**). These are outlined in **Table 12** along with their TSC and EPBC Act EEC equivalents.

**Table 12: Revised Biometric Vegetation Types and EEC Equivalent**

REVISED BIOMETRIC VEGETATION TYPE	ABBREVIATION	TSC ACT EEC	EPBC ACT CEEC
CW117: Broad-leaved Peppermint - Brittle Gum - Red Stringybark dry open forest on the South Eastern Highlands	BPBGRS	Not listed	Not listed
CW176: Red Stringybark - Scribbly Gum - Red Box - Long-leaved Box shrub - tussock grass open forest of the NSW South Western Slopes Bioregion (Benson 290)	RSSGRBLLB	Not listed	Not listed
CW206: Wet tussock grasslands of cold air drainage areas of the tablelands	WTG	Not listed	Not listed
CW209: White Box – Blakely's Red Gum - Yellow Box grassy woodland of the NSW South Western Slopes Bioregion (Benson 282)	WBBRGYB	Box Gum Woodland	Box-Gum Woodland

A brief description of each of the RBVTs found within the study area is provided below. Given the study area is used for agricultural purposes these vegetation types are impacted to varying degrees by weed invasion, grazing, minor cropping and soil disturbance depending on the land use practices on each property.

#### Conservation Significance

*BPBRRS* 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 Central West CMA (OEH 2008).

*CW176: Red Stringybark - Scribbly Gum - Red Box - Long-leaved Box shrub - tussock grass open forest of the NSW South Western Slopes Bioregion (Benson 290) (RSSGRBLLB)*

*RSSGRBLLB* is the dominant vegetation community present in the study area, occurring within both the Sallys Flat and Pyramul Clusters, although it has not been recorded in the area where the external overhead line is proposed. It occurs as open forest to woodland and grassland where trees have been cleared, and is associated with metamorphic and clastic rock (phyllite and siltstone, respectively).

Much of this community within this RBVT in the study area has been historically cleared for grazing especially where rock outcropping is minimal. However, the groundcover is in moderate to good condition with native species dominating the cover in these areas at the time of assessment.

Where trees are present, *RSSGRBLLB* is dominated by *Eucalyptus macrorhyncha*, *E. polyanthemos* (Red Box), *E. goniocalyx* (Long-leaved Box) and *E. rossii* (Inland Scribbly Gum), with *E. mannifera* occurring less frequently. The mid-storey is sparse, and where present, is comprised of regenerating *Eucalyptus* species, *Acacia dealbata* (Silver Wattle), *Indigofera australis* (Australian Indigo), and *Cassinia arcuata* (Sifton Bush). A variety of native herbs and grasses are present in the ground layer and include species such as *Joycea pallida* (Silvertop Wallaby Grass), *Bothriochloa decipiens* (Red Grass), *Microlaena stipoides*, *Austrodanthonia* sp., *Austrostipa scabra*, *Lomandra filiformis* subsp. *filiformis* (Wattle Mat-rush), *Hypericum gramineum*, *Cymbonotus lawsonianus*, *Euchiton sphaericus*, *Juncus usitatus*, *Wahlenbergia* sp., *Gonocarpus* sp., *Asperula conferta* (Common Woodruff), *Geranium* sp., *Veronica plebeia* (Trailing Speedwell), *Hydrocotyle pedunculatus*, *Goodenia hederacea* subsp. *hederacea* (Forest Goodenia) and *Oxalis perennans*.

### Conservation Status

*CW117: Broad-leaved Peppermint – Brittle Gum – Red Stringybark dry open forest on the South Eastern Tablelands* (BPBRRS)

Within the study area, *BPBRRS* is present only in the northern tip of the Pyramul Cluster along the ridgelines extending towards Toolamanang. It occurs as open forest to woodland, or as grassland where the canopy has been historically cleared. It is associated with shallow soils on volcanoclastic rock, which is present only in the northern part of the Pyramul Cluster and the area where the external overhead line is proposed.

Clearing and grazing were substantial within this RBVT in the study area. However, the groundcover is in reasonable condition with native species comprising more than 50 % cover in these areas at the time of assessment.

Where trees are present, *BPBRRS* is dominated by *Eucalyptus dives* (Broad-leaved Peppermint), *E. mannifera* (Brittle Gum), and *E. macrorhyncha* (Red Stringybark). Species in the mid-storey include *Cassinia arcuata* (Sifton Bush), *Acacia dealbata* (Silver Wattle), *Olearia elliptica* (Sticky daisy bush) and *Pteridium esculentum* (Bracken). A variety of native herbs and grasses are present in the ground layer and include *Cymbonotus lawsonianus* (Bear's-ear), *Euchiton sphaericus*, *Austrostipa scabra* (Speargrass), *Eragrostis* sp., *Bothriochloa* sp., *Austrodanthonia racemosa* var. *racemosa*, *Panicum effusum*, *Dichelachne micrantha* (Shorthair Plumegrass), *Sporobolus creber* (Western Rat-tail Grass), *Hypericum gramineum* (Small St. John's Wort), *Wahlenbergia communis* (Tufted Bluebell), *Lagenophora gracilis* (Slender Lagenophora), and *Microlaena stipoides* var. *stipoides* (Weeping Grass).

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

It is estimated that 85% of this vegetation type has been cleared within the Central West CMA (OEH 2008).

*CW206: Wet tussock grasslands of cold air drainage areas of the tablelands* (WTG)

Within the study area, *WTG* is present in gentle valleys or swales in open country between 850 m and 950 m elevation on metamorphic and clastic rock (phyllite and siltstone, respectively). It occurs as grassland only.

While few species are present in this community, the percentage cover of native species was high. Native species recorded include *Juncus* sp., *Euchiton sphaericus*, *Haloragis heterophylla* (Rough Raspwort), *Austrodanthonia* sp., *Eragrostis parviflora* (Weeping Lovegrass), *Panicum* sp., *Microlaena stipoides*, *Carex appressa* (Tall Sedge), *Elymus scaber*, and *Poa labillardierei* (Tussock Grass).

### Conservation Status

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

It is estimated that 95% of this vegetation type has been cleared within the Central West CMA (OEH 2008).

*CW209: White Box – Blakely's Red Gum - Yellow Box grassy woodland of the NSW South Western Slopes Bioregion (Benson 282) (WBBRGYB)*

Within the study area, WBBRGYB is present in lower lying, gently sloping and undulating land below 900 m elevation. It occurs in both the Sallys Flat and Pyramul Clusters, but is most common in the eastern arm of the study area where the external overhead lines are proposed, mainly on clastic (siltstone), volcanoclastic, and felsic rock (rhyolite), but also to a lesser extent on metamorphic rock (siltstone). The structure of the community is open grassy woodland, grassland and pasture.

Much of this community within this RBVT in the study area has been historically cleared for grazing. Small patches of remnant woodland in the study area are found in the Pyramul Cluster, and outside of the study area but within the project site in both the Sallys Flat and Pyramul Clusters. A larger patch of remnant woodland is present in the study area and project site along the eastern arm of the study area where the external overhead lines are proposed. All other areas where this RBVT is present in the study area and project site had been previously cleared. In the majority of grassland areas, the groundcover is in moderate to good condition, with native species comprising greater than 50 % cover at the time of assessment. However, in some areas near the eastern extremity of the study area, the groundcover is dominated by exotic species, with native species comprising less than 50 % cover, especially where pastures have been oversown with *Phalaris* spp..

Where trees are present, WBBRGYB is dominated by *Eucalyptus blakelyi* (Blakely's Red Gum) and *E. melliodora* (Yellow Box), although *E. polyanthemos*, *E. bridgesiana* (Apple Box), and *E. macrorhyncha* also occur. The mid-storey comprises regenerating *Eucalyptus* species, *Acacia dealbata*, *Cassinia arcuata*, *Pultenaea microphylla*, *Lissanthe strigosa* (Peach Heath) and *Melichrus urceolatus* (Urn-heath). A variety of native herbs and grasses are present in the ground layer and include species such as *Bothriochloa macra*, *Bothriochloa decipiens*, *Euchiton sphaericus*, *Geranium* sp., *Themeda australis* (Kangaroo Grass), *Aristida* sp. *Austrodanthonia* sp., *Cheilanthes sieberi* subsp. *sieberi* (Mulga Fern), *Desmodium varians* (Slender Tick-trefoil), *Dichelachne micrantha*, *Goodenia hederacea* subsp. *hederacea*, *Hypericum gramineum*, *Sporobolus creber* and *Wahlenbergia* sp.

### Conservation Status

WBBRGYB equates 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).

It is estimated that 85% of this vegetation type has been cleared within the Central West CMA (OEH 2008).

#### **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 2009) (**Figure 8**).

Ancillary Codes of 'PASTURE' (grassland areas) and 'TREES' (wooded areas) have also been assigned to each of the RBVTs to create Vegetation Zones, except WTG which did not support trees.

BPBGRS supported trees but given the total impact area is less than 0.25 ha; treed areas were merged into pasture areas resulting in one vegetation zone for the community. Areas of pasture were those areas that had a tree canopy cover of less than 5%.

**Table 13: Vegetation zones within the study area**

REVISED BIOMETRIC VEGETATION TYPE	BIOBANKING CONDITION (LOW OR MODERATE/GOOD)	VEGETATION ZONE
CW117: WBBRGYB	CW117_Moderate/Good	CW117_Moderate/Good_PASTURE
CW176: RSSGRLLB	CW176_Moderate/Good	CW176_Moderate/Good_TREES
		CW176_Moderate/Good_PASTURE
CW206: WTG	CW206_Moderate/Good	NA
CW209: WBBRGYB	CW209_Moderate/Good	CW209_Moderate/Good_TREES
		CW209_Moderate/Good_PASTURE
	CW209_Low	CW209_Low_TREES
		CW209_Low_PASTURE

### 4.3.3 Flora

#### General Flora

A total of 244 species of vascular plants were recorded across the study area. Of these 161 (66 %) are native and 83 are exotic species. A list of all species recorded across the study area is included in Appendix D by Revised Biometric Vegetation type.

Weeds accounted for approximately 34 % of all species recorded across the study area and often occur in localised patches in paddocks, such as in sheep camps. Exotic species common throughout the study area included *Carthamus lanatus* (Saffron Thistle), *Conyza bonariensis* (Flaxleaf Fleabane), *Hypochaeris radicata* (Catsear), *Acetosella vulgaris* (Sorrel), *Paronychia brasiliiana* (Chilean Whitlow Wort), *Centaurium* sp., *Cirsium vulgare* (Spear Thistle), *Hypericum perforatum* (St John's Wort), *Trifolium dubium*, *Eleusine tristachya* (Goose Grass), *Tolpis umbellata* (Yellow Hawkweed), *Vulpia* sp., *Hypochaeris glabra* (Smooth Catsear), *Medicago* sp., *Bromus catharticus* (Prairie Grass), *Lolium* sp. and *Phalaris aquatica* (Phalaris).

#### Threatened Flora

A number of threatened species are known to occur or have the potential to occur within the locality. Database searches of the locality were undertaken and the results are included in Appendix C (OEH 2011a, RBG 2011, 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.

One threatened flora species, *Swainsona recta*, was recorded in the north of the study area. *Swainsona recta* is a slender, erect perennial herb growing to 30 cm tall. It was recorded historically from places such as Carcoar, Culcairn and Wagga Wagga where it is probably now extinct. Populations still exist in the Queanbeyan and Wellington-Mudgee areas. Over 80% of the southern population grows on a railway easement. It is also known from the ACT and a single population of four plants near Chiltern in Victoria (OEH 2011b).

Prior to European settlement, *Swainsona recta* was associated with the grassy understorey of woodlands and open-forests dominated by *Eucalyptus blakelyi*, *E. melliodora*, *E. rubida* and *E. goniocalyx* (OEH 2011b). The species now occurs in open woodland dominated by one or more of the following: *Callitris endichleri*, *C. glaucophylla*, *Eucalyptus blakelyi*, *E. bridgesiana*, *E. dives*, *E. melliodora*, *E. microcarpa*, *E. nortonii* and *E. polyanthemus*, with grassy understorey dominated by *Themeda triandra*, *Poa sieberiana* var. *sieberiana* or *Austrostipa* spp. Plants die back in summer, surviving as rootstocks until they shoot again in autumn. The species flowers throughout spring, with a peak in October, and seeds ripen at the end of the year. Individual plants have been known to live for up to 20 years. The species is generally tolerant of fire, which also enhances germination by breaking the seed coat and reduces competition from other species (OEH 2011b).

The species was not recorded during field surveys conducted during October and November 2008, January 2009, and March and April 2011 but was recorded in September and October 2011. It has not been previously recorded in the locality. All individuals were recorded within White Box – Blakely's Red Gum – Yellow Box grassy woodland (wooded areas) although there is also the potential for this species to inhabit the pasture areas of this community and areas of Red Stringybark – Scribbly Gum – Red Box – Long-leaved Box shrub – tussock grass open forest.

Thirty six *Swainsona recta* were recorded across five locations, thirty one of which were recorded within the proposed powerline easement (**Figure 10**). It is possible that more individuals are present in this area but may not have been detected as not all recorded individuals were in flower and detection of non-flowering individuals is often difficult. The number and locations of individuals is outlined below.

The five locations where the species was recorded are as follows:

- 24 individuals on the lower slope east of the current access track;
- Seven individuals near an existing powerpole and within the proposed easement east of the current access track;
- Two individuals in a small area on the western west side of road, small area;
- Two individuals in a small area on the western west side of road (south of the two aforementioned individuals), small area; and
- One individual on the western side of road, small area.

Where necessary, poles will be aligned to ensure no impacts, thereby avoiding the loss of all recorded individuals of this species.

Threatened flora for which potential habitat was observed included:

- *Bothriochloa biloba* (Lobed Blue Grass);
- *Eucalyptus cannonii* (Capertee Stringybark);
- *Eucalyptus robertsonii* subsp. *hemisphaerica* (Robertson Peppermint);
- *Prasophyllum* sp. *Wybong* (*C. Phelps* ORG 5269) (A Leek Orchid);
- *Swainsona recta* (Mountain Swainson-pea);
- *Swainsona sericea* (Silky Swainson-pea); and
- *Thesium australe* (Austral Toadflax).

*Eucalyptus cannonii* has been previously recorded in the locality, mostly to the east of the study area, with the closest record located off the Castlereagh Highway, approximately 1.7 km away including two records from the Roadside Vegetation in the Rylstone Shire, NSW central tablelands and central western slopes (Mid-Western Regional Council 2001) made available by Mid-Western Regional Council. Remaining records of the species have been recorded north toward Lake Windamere (two records), and south east in the Ilford area (three records), and east around the Clandulla area (two records in Clandulla State Forest and one record at Charbon Colliery) (OEH 2011a, RBG 2011).

*Eucalyptus robertsonii* subsp. *hemisphaerica* has been previously recorded to the north of the study area in the Carcalgong area (OEH 2011a).

There are no records for *Bothriochloa biloba* and to date, this species has not been recorded in the central tablelands.

There are also no records for *Prasophyllum* sp. *Wybong* (*C. Phelps* ORG 5269) or *Thesium australe* in the locality, although one of the known populations of *Prasophyllum* sp. *Wybong* (*C. Phelps* ORG 5269) is at Ilford, to the east of the study area.

#### *ROTAP and Regionally Significant Flora*

One ROTAP listed species was recorded within the study area, *Discaria pubescens* (Hairy Anchor Plant). This species is widespread but uncommon along the tablelands and western slopes in woodland and forest often in rocky situations. It is listed as 3RCa under the ROTAP coding system (3 = range more than 100 km but in small populations, R = rare but with no current identifiable threat, Ca = occurs within proclaimed reserves and the known population exceeds 1000 plants) (ANPS 2012).

Another ROTAP species, *Eucalyptus elliptica* Blakely & McKie (Bendemeer White Gum) was identified approximately 11.5 km east of the project site within the Mid-Western Regional LGA (Mid-Western Regional Council 2011b). This species is listed as 3KC under the ROTAP coding system (3 = range more than 100 km but in small populations, K = poorly known species suspected of being at risk, C = species known to occur within a proclaimed reserve) (ANPS 2012). This was the only other ROTAP species identified in proximity to the project site.

Both Bathurst Regional Council and Mid-Western Regional Council were contacted to enquire whether regionally significant species lists have been issued for either local government area. No regionally significant species lists exist for the study area. Both Bathurst Regional Council and Mid-Western Regional Council rely on the OEH databases for their vegetation information.

*Noxious Weeds*

Five weed species or species groups (listed as noxious weeds under the NSW *Noxious Weeds Act 1993* (NW Act) for the Mid-Western Regional and Bathurst Regional LGAs (DID 2011) and three Weed of National Significance (WONS) were recorded within the study area and project site. 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	MID_WESTERN REGIONAL LGA	BATHURST REGIONAL LGA	NW ACT CLASS	WONS
Blackberry <i>Rubus fruticosus</i> aggregate species	x	x	4	x
Serrated Tussock <i>Nassella trichotoma</i>	X	x	4	x
St. John's Wort <i>Hypericum perforatum</i>	x	x	4	-
Sweet Briar <i>Rosa rubiginosa</i>	x	x	4	-
Willow species <i>Salix</i> sp.	x	x	5	x

**Note:**

WONS = Weeds of National Significance

NW Act = *Noxious Weeds Act 1993*

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.

Class 5: the requirements in the *Noxious Weeds Act 1993* for a notifiable weed must be complied with.

**4.3.4 Fauna and Fauna Habitat**

The project site supports a diversity of fauna habitat types including woodland, grassland, farm dams, ephemeral creeks, rocky outcrops and hollow-bearing trees. A total of 136 fauna species (including six introduced species) were recorded throughout the project site during the field surveys (Appendix E). Up to eight additional species may have been recorded, but these were not identified to the species level or with certainty. The fauna recorded were spilt over the following fauna groups:

- 11 reptile species;
- Five frog species;
- At least 93 bird species (three additional species may have been present which were identified to the genus level only) of which one is introduced;
- 14 mammals (non-bat) of which five are introduced; and
- At least 13 microbat species (five additional species may have been present. Two species were identified to the genus level only, and three species were not identified with certainty in anabat analyses).

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

*Fauna Habitat*

Fauna habitat within the project site and study area fall into one of three broad habitat types, namely; open forest, woodland and grassland. These provide habitat for a variety of fauna including woodland 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 support 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. The understorey of the woodland areas comprises a variable cover dominated by grass species. 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	REVISED BIOMETRIC VEGETATION TYPES / SPECIES	SPECIES
Hollow-bearing trees	RSSGRBLLB, WBBRGYB	Arboreal mammals, microchiropteran bats, hollow-dependent birds (including owls), and reptiles
Stags	BPBGRS, RSSGRBLLB, WBBRGYB	Birds and reptiles
Rocky outcrops	RSSGRBLLB, WTG, BPBGRS, WBBRGYB	Small ground dwelling mammals, reptiles
Dams, watercourses and ephemeral drainages	RSSGRBLLB, WTG, WBBRGYB	Amphibians, birds, reptiles, mammals, microchiropteran bats
Autumn / winter-flowering eucalypts	<i>Eucalyptus blakelyi</i> (Blakely's Red Gum), <i>E. albens</i> (White Box), <i>E. goniocalyx</i> (Long-leaved Box), <i>E. macrorhyncha</i> (Red Stringybark)	Nectivorous birds and microchiropteran bats
Tussock grasses	RSSGRBLLB, WTG, BPBGRS, WBBRGYB	Birds, frogs, reptiles and bats
Fallen timber	RSSGRBLLB, BPBGRS, WBBRGYB	Reptiles, small mammals, frogs and birds
Leaf litter	RSSGRBLLB, BPBGRS, WBBRGYB	Reptiles, small mammals and birds
Defoliating bark	RSSGRBLLB, WBBRGYB	Small mammals and reptiles

HABITAT FEATURES	REVISED BIOMETRIC VEGETATION TYPES / SPECIES	SPECIES
Koala Feed Trees	<i>Eucalyptus macrorhyncha</i> (Red Stringbark), <i>E. rossii</i> (Inland Scribbly Gum), <i>E. goniocalyx</i> (Long-leaved Box / Bundy), and <i>E. polyanthemos</i> (Red Box)	Koala

**Note:** BPBGRS = Broad-leaved Peppermint – Brittle Gum – Red Stringybark dry open forest on the South Eastern Highlands, RSSGRBLLB = Red Stringybark – Scribbly Gum – Red Box – Long-leaved Box shrub – tussock grass open forest of the NSW South Western Slopes Bioregion (Benson 290), WSG = Wet tussock grasslands of cold air drainage areas of the tablelands, and WBBRGYB = White Box – Blakely’s Red Gum – Yellow Box grassy woodland of the NSW South Western Slopes Bioregion (Benson 282).

Tree Hollows

Tree hollows are common throughout remnant woodland areas (RSSGRBLLB, BLPBGRS, WBBRGYB) and amongst scattered trees across the landscape and, therefore, potential habitat for hollow-dependant species is abundant. However, there is little evidence of widespread recruitment in the landscape and, therefore, the protection of hollow-bearing trees (HBT) and measures to encourage / promote recruitment are important in order to retain these faunal assemblages. Some recruitment is evident in areas of WBBRGYB. An abundance of scattered hollow-bearing logs is also present and provides habitat for a variety of fauna.

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 all hollow-bearing trees across the site. However, plot data (20 m x 50 m) collected as part of the Biobanking assessment was used to estimate the number of hollows per hectare 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 HBTs likely to be impacted is, therefore, likely to be significantly less than shown in **Table 16**.

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

REVISED BIOMETRIC VEGETATION TYPE	AVERAGE NUMBER OF HBT WITHIN 0.1 ha	ESTIMATED NUMBER OF HBT PER HECTARE	AMOUNT OF VEGETATION TYPE WITHIN STUDY AREA (ha)	ESTIMATED MAXIMUM NUMBER OF HBT PRESENT WITHIN THE STUDY AREA	IMPACT AREA (ha)	ESTIMATED NUMBER OF HBT TO BE REMOVED	PERCENT CLEARED
Broad-leaved Peppermint-Brittle Gum - Red Stringybark dry open forest on the southeastern highlands, Moderate to Good, Pasture**	0.00	0.00	1.20	0.00	1.20	0.00	0.00
Broad-leaved Peppermint-Brittle Gum - Red Stringybark dry open forest on the southeastern highlands, Moderate to Good, Trees	NA	0.00	5.49	0.00	0.01	0.00	0.00
Red Stringybark-Scribbly Gum-Red Box-Long-leaved Box shrub-tussock grass open forest, Moderate to Good, Pasture**	0.43	4.30	1,067.68	4,591.02	89.86	386.40	8.42
Red Stringybark-Scribbly Gum-Red Box-Long-leaved Box shrub-tussock grass open forest, Moderate to Good, Trees	7.60	76.00	200.08	15,206.08	6.63	503.88	3.31
Wet tussock grasslands of cold air drainage areas of the tablelands, Moderate to Good	0.00	0.00	15.98	0.00	0.14	0.00	0.00
White Box-Blakelys Red Gum-Yellow Box grassy woodland, Low, Pasture**	0.00	0.00	51.80	0.00	0.34	0.00	0.00
White Box-Blakelys Red Gum-Yellow Box grassy woodland, Moderate to Good, Pasture**	0.00	0.00	178.88	0.00	2.02	0.00	0.00
White Box-Blakelys Red Gum-Yellow Box grassy woodland, Moderate to Good, Trees	1.00	10.00	16.60	166	2.99	29.9	0.00
<b>Total</b>				<b>19,963.10</b>	<b>103.19</b>	<b>920.18</b>	<b>4.61</b>

**Note:**

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

Table includes only those vegetation types impacted by the proposal. \*\* It is likely that HBT within pasture areas could be avoided.

## Corridors and Movement Pathways

### *Local*

The historic land use of the locality 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. In several areas, particularly on the valley flats, soil has been tilled for a variety of crops, including oats. 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 vegetation corridors are somewhat fragmented, consisting of dense native vegetation on the steepest slopes of the ranges, and lightly wooded areas on spurs and gentle slopes where access for livestock is available. The extent of 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 slope decreases, tree cover becomes sparser.

The main fauna corridor through the study area occurs along Crudine Ridge, which generally runs south-west to north-east through the study area. The most densely wooded areas occur on the eastern (south east facing) slopes of Crudine Ridge, although in the Pyramul Cluster, densely wooded areas also occur on the plateaus and western slopes. Outside the study area, the corridor connects with northern ranges heading towards Toolamanang and Avisford, and eventually Mudgee, and with western, southern and eastern ranges via the riparian areas along the Turon and Crudine Rivers.

### *Regional Corridors*

In large sections of the Central West region, especially where broad-acre farming is prevalent, roadside reserves and Travelling Stock Routes and Reserves (TSRs) provide the main habitat corridors across the landscape (Molino Stewart 2010).

### *Fauna Groups*

A variety of threatened fauna species that have been recorded within the locality (BRC 2011, Birds Australia 2009, OEH 2011a) 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 project site.

### Avifauna

Ninety three bird species were recorded within the project site during the surveys, with an additional three species identified to genus level only and include three nocturnal species. Species recorded are listed in Appendix E. Common species include *Corvus coronoides* (Australian Raven), *Gymnorhina tibicen* (Australian Magpie), *Coracina novaehollandiae* (Black-faced Cuckoo-shrike), *Platycercus elegans* (Crimson Rosella), *Platycercus adscitus eximius* (Eastern Rosella), *Rhipidura albiscapa* (Grey Fantail), *Dacelo novaeguineae* (Laughing Kookaburra), *Philemon corniculatus* (Noisy Friarbird), *Strepera graculina* (Pied Currawong), *Anthochaera carunculata* (Red Wattlebird), *Pardalotus punctatus* (Spotted Pardalote), *Cormobates leucophaeus* (White-throated Treecreeper), *Rhipidura leucophrys* (Willy Wagtail), *Lichenostomus chrysops* (Yellow-faced Honeyeater), and *Acanthiza chrysorrhoa* (Yellow-rumped Thornbill).

The project site supports foraging, nesting and roosting habitat for a variety of bird species. Nesting habitat for hollow-dependent species is abundant in areas of RSSGRBLLB, BLPBGRS, and

WBBRGYB. These and grassland areas, also provide extensive foraging habitat for some bird species. Habitat for wetland birds across the site is largely limited to farm dams and the ephemeral drainage lines across the study area and project site. Most farm dams held water during the survey period, although their habitat value for waterbirds is limited.

Three nocturnal bird species were recorded during field survey: *Aegotheles cristatus* (Australian Owlet-nightjar), *Ninox boobook* (Southern Boobook) and *Podargus strigoides* (Tawny Frogmouth). Birds of prey were also recorded including *Falco cenchroides* (Nankeen Kestrel), *Aquila audax* (Wedge-tailed Eagle), *Elanus axillaris* (Black-shouldered Kite), and *Falco berigora* (Brown Falcon). Waterbirds recorded include *Tachybaptus novaehollandiae* (Australasian Grebe), *Chenonetta jubata* (Australian Wood Duck), *Fulica atra* (Eurasian Coot), *Anas superciliosa* (Pacific Black Duck), and *Threskiornis spinicollis* (Straw-necked Ibis).

Six threatened bird species were recorded across the project site. These are listed below and their locations shown in **Figure 7**.

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

### **Brown Treecreeper**

The Brown Treecreeper has been recorded on ten occasions in the locality: twice in the Lower Pyramul area off Doughertys Junction Road and Sallys Flat Road to west of the study area (Birds Australia 2011a), seven times to the south of the study area, south of Crudine (five records) and north of Sofala (two records) along Turondale Road and Sofala Road, respectively (Birds Australia 2011a, BRC 2011, OEH 2011a), and once near Charbon to the east of the study area (OEH 2011a).

The species was recorded three times during the survey period: once in the study area within the Sallys Flat Cluster, and twice in the project site (within both the Sallys Flat and Pyramul Clusters). All records were made within RSSGRBLLB (trees).

### **Little Lorikeet**

Prior to this assessment, no records for the Little Lorikeet have submitted to Birds Australia or OEH for the locality. Further, no sightings have been recorded by Bathurst Regional Council for the locality.

The Little Lorikeet was recorded just outside a wooded area in the Sallys Flat Cluster during field survey. It was also recorded in the project site, outside of the study area, within the RSSGRBLLB (pasture).

### **Hooded Robin**

The Hooded Robin has been recorded on six occasions in the locality: twice in the Lower Pyramul area off Doughertys Junction Road to the west of the study area (1999; Birds Australia 2011a), once in the Crudine area on Crudine Road approximately 6 km north from the intersection with Hill End Road (2002; BRC 2011, OEH 2011a), once on Turondale Road approximately 2.5 km south of the intersection with Hill End Road (2008; BRC 2011), and twice approximately 2.5 km to the west of Turondale Road, approximately 4 km south of the intersection with Hill End Road (1978 and 1980; BRC 2011).

The Hooded Robin was recorded on five occasions during field surveys: once in the study area within the Sallys Flat Cluster, and four times in the project site (once in the area between the Sallys Flat and Pyramul Clusters, and three times in the Pyramul Cluster). The species was recorded within wooded areas comprised of RSSGRBLLB (trees), and WBBRGYB (trees).

### **Scarlet Robin**

The Scarlet Robin has been recorded on numerous occasions in the locality, with 25 records for the species on the “Wiruna” property on Old Ilford Road, near Razorback (south east of the study area; Birds Australia 2011a), one record in the Lower Pyramul area off Doughertys Junction Road (west of the study area; Birds Australia 2011a), and one record from Charbon Colliery (to the east of the study area; Birds Australia 2011a). Another record of the Scarlet Robin was recorded within the northeast corner of the project site with several additional recorded to the north-west and north-west of the project site (OEH 2011a).

The Scarlet Robin was recorded on three occasions outside of the study area but within the project site during field surveys. The records were all from within RSSGRBLLB (pasture) in the Pyramul Cluster.

### **Speckled Warbler**

The Speckled Warbler has been recorded on four occasions in three areas within the locality. In one of the areas, south of the Crudine area on Turondale Road approximately 2.5 km south of the intersection with Hill End Road, the species has been recorded twice (1992 and 2008; BRC 2011). In the remaining two areas, both in the Sofala / Upper Turon area to the south of the study area (on Sofala Road approximately 3 km south of the intersection with Hill End Road and Upper Turon Road approximately 5 km east of the intersection with Hill End Road), the species has been recorded once each in 2000 and once in 2006 (Birds Australia 2011a).

During the field surveys, the Speckled Warbler was recorded on three occasions: twice in the study area and once in the project site within the Pyramul Cluster. The species was recorded within RSSGRBLLB (trees and pasture).

### **Diamond Firetail**

The Diamond Firetail has been recorded on numerous occasions to the west of the study area in the Lower Pyramul area off Doughertys Junction Road and at the junction of Doughertys Junction Road and Sallys Flat Road (10 records in 1998, 1999, 2000 and 2001; Birds Australia 2011a), and to the south east of the study area on the “Wiruna” property on Old Ilford Road, near Razorback (five records in 2006, 2008, 2009 and 2010; Birds Australia 2011a). It has also been recorded on six occasions to the south of the study area: twice in the Sofala area (2005 and 2006; Birds Australia 2011a), as well as four times (3 locations) in the Crudine area on and off Turondale Road (1979, 1978, 1992, 1995; BRC 2011).

The Diamond Firetail was recorded on 10 occasions during field survey. However, the species was recorded in the study area on only two occasions (within the Sallys Flat Cluster). Remaining records of the species were made in the project site (three in the Pyramul Cluster, and four in the Sallys Flat Cluster) and just outside the project site on Crudine Road (one record), approximately 300m from where it intersects with Hill End Road. Where the species was recorded in the study area or project site, it was recorded within RSSGRBLLB (trees and pasture), and WBBRGYB (trees).

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

- *Anthochaera phrygia* (Regent Honeyeater);
- *Burhinus grallarius* (Bush Stone-curlew);
- *Callocephalon fimbriatum* (Gang Gang Cockatoo);
- *Circus assimilis* (Spotted Harrier);
- *Daphoenositta chrysoptera* (Varied Sittella);
- *Hieraaetus morphnoides* (Little Eagle);
- *Lathamus discolor* (Swift Parrot);
- *Melithreptus gularis gularis* (Black-chinned Honeyeater);
- *Ninox connivens* (Barking Owl);
- *Ninox strenua* (Powerful Owl);
- *Petroica phoenicea* (Flame Robin); and
- *Polytelis swainsonii* (Superb Parrot).

None of these species were recorded within the study area or project site during the surveys. However, Regent Honeyeater, Gang Gang Cockatoo, Spotted Harrier, Varied Sittella, Little Eagle, Swift Parrot, Black-chinned Honeyeater, Barking Owl, Powerful Owl, and Flame Robin have been recorded in the locality:

- Regent Honeyeater: one record (1996) to the north of the study area at upper Meroo (OEH 2011a), two records south of the study area near Crudine on Turondale Road approximately 2.5 km and just over 4 km south of the intersection with Hill End Road (1999 and 2003; BRC 2011), and four records to the north east or east of the study area at Lake Windamere (two records made in 1970 and 2003), Clandulla State Forest (one record made in 1993), and Ilford (one record made in 2004) (OEH 2011a).
- Gang Gang Cockatoo: one record (2002) to the south of the study area near Crudine on Turondale Road approximately 2.5 km south of the intersection with Hill End Road (BRC 2011), and two records (2007 and 2009) to the south east of the study area, near Razorback (Birds Australia 2011a);
- Varied Sittella: two records (both in 2002) to the south east of the study area, near Razorback (Birds Australia 2011a), and one record (2009) to the south of the study area near Crudine on Turondale Road approximately 2.5 km south of the intersection with Hill End Road (Birds

Australia 2011a);

- Little Eagle: one record (2003) to the east of the study area at Aarons Pass off the Castlereagh Highway (OEH 2011a), and two records (1999 and 2000) to the west of the study area in the Lower Pyramul area, off Doughertys Junction Road (Birds Australia 2011a);
- Swift Parrot: one record (2002) to the south of the study area near Crudine on Turondale Road approximately 2.5 km south of the intersection with Hill End Road (BRC 2011);
- Black-chinned Honeyeater: one record (1972) to the south of the study area at Sofala (OEH 2011a), and one record to the south of the study area near Crudine on Turondale Road approximately 2.5 km south of the intersection with Hill End Road (1992; BRC 2011);
- Barking Owl: one record (2002) to the south of the study area near Crudine on Turondale Road approximately 2.5 km south of the intersection with Hill End Road (BRC 2011) and one record (1997) at Green Gully Road at the northern limit of the study area (OEH 2011a);
- Powerful Owl: one record (2002) approximately 12 km south east of the study area, near Razorback (Birds Australia 2011a) and another record located at Green Gully Road less than 15km north of the study area (OEH 2011a); and
- Flame Robin: one record (2006) approximately 12 km south east of the study area, near Razorback (Birds Australia 2011a).

There are no database records in the locality for the Bush Stone-curlew, Spotted Harrier or Superb Parrot although potential habitat is present and, therefore, surveys for these species were undertaken. No individuals of these species were recorded during the surveys.

Areas of potential habitat for the Regent Honeyeater are shown in **Figure 11**. Crudine Ridge is not a core breeding location for this species, although one of the core breeding locations for the species, the Capertee Valley, is located only 40 km away, to the south east of the study area. As such, and given the transitory nature of the Regent Honeyeater, Crudine Ridge could be used periodically for foraging and to a lesser extent breeding as this species is known to breed in Mistletoe which is present across the study area.

#### *Migratory Birds*

A total of ten listed migratory bird species were identified from the EPBC Act Protected Matters Search Tool (PMST) (DSEWPAC 2011a) and Atlas records. Those species for which there is potential habitat within the study area are listed below.

- *Anthochaera phrygia* (Regent Honeyeater);
- *Ardea alba* (Great Egret);
- *Ardea ibis* (Cattle Egret);
- *Hirundapus caudacutus* (White-throated Needletail);
- *Lathamus discolor* (Swift Parrot);
- *Merops ornatus* (Rainbow Bee-eater); and
- *Myiagra cyanoleuca* (Satin Flycatcher).

Other than Regent Honeyeater and Swift Parrot (see above Avifauna section), two species, Rainbow Bee-eater and White-throated Needletail, have been previously recorded in the locality. Rainbow Bee-eater has been recorded on seven occasions in two locations in the locality: six times in the Lower Pyramul area to west of the study area, and once to the south of the study area in the Sofala area (on Sofala Road, approximately 3 km south from the intersection with Hill End Road; Birds Australia 2011a). White-throated Needletail has been recorded on three occasions in one location within 10 km of the site south east of the study area at “Wiruna” property on Old Ilford Road, near Razorback (Birds Australia 2011a).

Rainbow Bee-eater was recorded twice within the project site during the surveys, although one record was incidental and location details were not recorded. The second record for the species was within the Pyramul Cluster in RSSGRBLLB (pasture).

#### Ground-dwelling and Arboreal Mammals

Habitat within the study area for ground-dwelling mammals is limited as there was no or a very limited shrub layer, and the ground layer in many areas is grazed in places (at times, heavily). However, in those areas where woodland is present and grazing less intense, tussock grasses and fallen timber / logs provide nesting and sheltering resources for ground-dwelling mammals. Ground-dwelling mammals recorded include *Tachyglossus aculeatus* (Short-beaked Echidna) and *Macropus giganteus* (Eastern Grey Kangaroo), *Wallabia bicolor* (Swamp Wallaby), *Macropus rufogriseus* (Red-necked Wallaby). No smaller ground-dwelling mammals were recorded, although no trapping for small mammals was specifically conducted as surveys were focused at recording the presence threatened species considered likely to occur (Appendix C).

Five introduced mammals were recorded within the study area and project site: *Vulpes vulpes* (European Red Fox), *Capra hircus* (Goat), *Sus scrofa* (Pig), *Oryctolagus cuniculus* (European Rabbit) and *Ovis aries* (Sheep).

Trees in the project site provide habitat for arboreal mammals. Arboreal mammals recorded were *Petaurus breviceps* (Sugar Glider), *Pseudocheirus peregrines* (Common Ringtail possum), *Trichosurus vulpecular* (Common Brushtail Possum) and the threatened species, *Phascolarctos cinereus* (Koala).

The Koala has been previously recorded in the locality. There are 41 records for the species dating from 1949, spread around the study area, primarily to the west and north.

Koalas and evidence of Koalas (calls, scats, scratches, skulls) were recorded 18 times during field survey, with two records made inside the study area, 14 records made inside the project site (outside of the study area) and two records made outside of the project site. In terms of locations within the turbine clusters for those records within the study area or project site, most of the records were made within the Sallys Flat Cluster (one within the study area and five within the project site), with only a few records made within the Pyramul Cluster (one within the study area and two within the project site). Seven records were made in the project site between the Sallys Flat and Pyramul Clusters. Records were made within RSSGRBLLB (trees).

Potential habitat is present for additional threatened species, *Dasyurus maculatus* (Spotted-tailed Quoll) and *Petaurus norfolcensis* (Squirrel Glider). Spotted-tailed Quoll has been previously recorded in the locality in the Crudine area (one record in 2003; BRC 2011, OEH 2011a), Sofala area (one record in 2004; OEH 2011a) and at Lake Windamere (one record in 1996; OEH 2011a). Squirrel Glider has not been previously recorded in the locality. Despite surveys for these species, no individuals were recorded during field surveys. Brush-tailed Phascogale was listed as having the potential to occur

within the study area (DSEWPAC 2011a, Biobanking predicted species) although no previous records have occurred within the locality. Based on the assessment of the habitat within the study area, it was considered that there was the potential for this species to occur within the study area.

#### Megachiropteran and Microchiropteran Bats

Habitat for microchiropteran bats (microbats) is present across the project site and study area, and at least 13 species of microchiropteran bats were recorded foraging across these areas. Five additional species may have been recorded, but two were identified to the genus level only while three species were not identified with certainty in anabat analyses. Bat activity was common across the site with an average of 54.38 calls per night (definite calls only). This number would be lower if the small number of high volume call nights (e.g. 289 calls on 25/11/08 and 150 calls on 19/01/09) were removed from the data when calculating the average.

Appendix F lists those species recorded across the study area during surveys and their preferred flight heights. *Chalinolobus gouldii* (Gould's Wattled Bat), *Vespadelus vulturnus* (Little Forest Bat), *Chalinolobus morio* (Chocolate Wattled Bat), and *Tadarida australis* (White-striped Freetail Bat) were the most commonly recorded species in anabat surveys, with Little Forest Bat the species most commonly caught in harp traps.

Only three threatened bat species, *Miniopterus orianae oceanensis* (Eastern Bentwing Bat), *Falsistrellus tasmaniensis* (Eastern False Pipistrelle) and *Pteropus poliocephalus* (Grey-headed Flying-fox) have previously been recorded within the locality. The Eastern Bentwing Bat and Eastern False Pipistrelle were recorded in 2006 to the east of the study area approximately 14 km away, in a limestone mine at Kandos (OEH 2011a). The Grey-headed Flying-fox was recorded in 2003 to the south of the study area near Crudine on Turondale Road approximately 2.5 km south of the intersection with Hill End Road (BRC 2011). *Nyctophilus corbeni* (syn. *N. timoriensis*) (Greater Long-eared Bat) and *Chalinolobus dwyeri* (Large-eared Pied Bat) were listed as species with the potential to occur within the locality under the EPBC Protected Matters Search Tool (DSEWPAC 2011a). However, there were no records for these species in the locality.

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

- *Chalinolobus dwyeri* (Large-eared Pied Bat);
- *Chalinolobus picatus* (Little Pied Bat);
- *Miniopterus orianae oceanensis* (Eastern Bentwing-bat);
- *Saccolaimus flaviventris* (Yellow-bellied Sheath-tail-bat);
- *Vespadelus troughtoni* (Eastern Cave Bat); and
- *Nyctophilus corbeni* (*N. timoriensis*) (Greater (Eastern) Long-eared Bat) (assumed presence due to indistinguishable call).

Of the species, only two microbats, Little Pied Bat and Eastern Bentwing Bat, were detected with certainty. Remaining species were detected with lower categories of confidence: Large-eared Pied Bat was assigned a "probable" detection while Yellow-bellied Sheath-tail Bat and Eastern Cave Bat were

assigned a “possible” detection in anabat analysis. A “probable” detection is defined as a detection with a low probability of confusion with species of similar calls. A “possible” detection is defined as a detection with a medium to high probability of confusion with species with similar calls. The calls of the three *Nyctophilus* species, namely *N. geoffroyi*, *N. gouldi* or *N. corbeni*, are difficult to tell apart, and in the anabat analyses, were identified as *Nyctophilus* spp. For this reason, it has been assumed that *Nyctophilus corbeni* is present at the site at the site as a precautionary measure for the assessment of impacts.

Eastern Bentwing Bat was recorded at six locations, mostly within the project site, with one location falling within the study area (within the Sallys Flat Cluster). A total of 52 definite calls were identified for the species. In terms of the turbine clusters, two locations where the species was detected fell within the Sallys Flat Cluster, three locations fell within the Pyramul Cluster, while one location fell between the Sallys Flat and Pyramul Clusters. The majority of records were made within RSSGRBLLB (trees and pasture), although the record made within the study area (Sallys Flat Cluster) was made within WTG.

Eastern Cave Bat was recorded at two locations within project site, within the Sallys Flat Cluster and between the Sallys Flat and Pyramul Clusters. Only two possible calls were recorded for the species, one at each location recorded, with records made within RSSGRBLLB (trees).

Little Pied Bat, Yellow-bellied Sheathtail Bat and Large-eared Pied Bat were each recorded at one location in the project site. In terms of the turbine clusters, Little Pied Bat and Yellow-bellied Sheathtail Bat were recorded in the Pyramul Cluster. Large-eared Pied Bat was recorded in the Sallys Flat Cluster. The number of calls for each species over the field survey included: one definite call for Little Pied Bat, two possible calls for Yellow-bellied Sheathtail Bat, and one probable call for Large-eared Pied Bat. The vegetation community in which Little Pied Bat, Large-eared Pied Bat, and Yellow-bellied Sheathtail Bat were recorded was RSSGRBLLB (trees and pasture).

The hollow-bearing trees across the study area provide potential roosting habitat for the majority of the threatened bats (with the exception of Eastern Bentwing-bat, Large-eared Pied Bat and Eastern Cave Bat) and potential foraging habitat was abundant across the study area. Areas of habitat include flyways, tracks, woodland, grassland, ephemeral watercourses and farm dams and hollow-bearing trees. No caves were recorded within the study area which the Eastern Bentwing-bat, Large-eared Pied Bat or Eastern Cave Bat require for roosting. However, a cave is known to be present on an unaffected property to the south of the site but the extent of caves throughout the locality is unknown.

### Amphibians

Habitat for amphibians is limited across the project site and study area, although ephemeral drainage lines, including Salters Creek, Long Gully, Tunnabidgee Creek, Sugarloaf Creek, Cowflat Gully, and Bombandi Creek, and farm dams provided potential habitat for amphibians across the project site and study area. Incidental records of five species were made by identifying calls heard during nocturnal surveys: *Crinia signifera* (Common Eastern Froglet), *Litoria latopalmata* (Broad-palmed Frog), *Litoria peroni* (Peron’s Tree Frog), *Limnodynastes tasmaniensis* (Spotted Marsh Frog) and *Uperoleia laevisgata* (Smooth Toadlet).

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 predicted species) and has been previously recorded (twice) south of Crudine off Turondale Road approximately 2.5 km south of the intersection with Hill End Road (1990s, 1994; BRC 2011). 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.

### Reptiles

Habitat across the site for reptiles includes woodland and grassland areas and scattered rocky outcrops. Woody debris is common throughout much of the area and provides habitat. Leaf litter is limited and confined to the wooded areas, although where this was present it also provides habitat for reptiles. The drainage lines and farm dams are also likely to provide habitat for reptiles, with *Chelodina longicollis* (Eastern Snake-necked Turtle) recorded in these areas. Other reptiles recorded across the project site and study area include two snakes *Ramphotyphlops* sp. (Blind Snake) and *Pseudechis porphyriacus* (Red-bellied Black Snake), one gecko *Diplodactylus vittatus* (Eastern Stone Gecko), four skinks *Ctenotus taeniolatus* (Copper-tailed Skink), *Egernia cunninghami* (Cunningham's Skink), *Acritoscincus platynotum* (Red-throated Skink), and *Trachydosaurus rugosus* (Shingleback), two dragons, *Pogona barbata* (Eastern Bearded Dragon) and *Amphibolurus muricatus* (Jacky Lizard), and one goanna *Varanus varius* (Lace Monitor).

Three threatened reptile species were listed on the database searches as having the potential to occur within the study area (OEH 2011a, DSEWPAC 2011a). However, potential habitat was only present for one of these species, the Pink-tailed Worm-lizard (*Aprasia parapulchella*). There are no existing records for the species within the project site. However, the species has been recorded in the locality and just beyond 10 km from the study area, with the closest records to the south and south west of the site at Sofala and off Box Ridge Road approximately 11 km away (dates unknown; BRC 2011).

### *SEPP 44 Koala Habitat*

The Koala has been recorded in the locality as well as in the project site and study area (see mammal section above). While no Koala feed trees listed under Schedule 2 of SEPP 44 were present in the project site and study area, signs of Koala were found on *Eucalyptus macrorhyncha* (Red Stringbark), *E. rossii* (Inland Scribbly Gum), *E. goniocalyx* (Long-leaved Box / Bundy), and *E. polyanthemos* (Red Box) (diameter at breast height between 19cm and 80 cm) present across the project site within RSSGRBLLB. The species is also likely to use the vegetation communities, BLPBGRS and WBBRGYB, given the presence of *E. macrorhyncha* in BLPBGRS and past records of Koala in WBBRGYB in the Central West CMA (OEH 2011b). 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 area covered by RSSGRBLLB, BLPBGRS and WBBRGYB has been used in considering impacts on the Koala under the TSC 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 Crudine River being the closest large river, present directly adjacent to the study area under the external overhead powerlines at its closest point and approximately 4 km away from the study area at its furthest point.

Smaller creeks running through the study area include:

- Salters Creek;
- Long Gully;
- Tunnabidgee Creek;

- Johnathon's Flat Creek;
- Sugarloaf Creek;
- Cherry Tree Gully;
- Cowflat Gully; and
- Bombandi Creek.

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

- Buckleys Creek (south);
- Green Valley Creek (west);
- Stinking Water Creek (north west);
- Merrigans Gully (south east);
- Conns Creek (north east); and
- Tabrabucca Creek (east).

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 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 2008c). Based on the results of the ecological assessment, a number of amendments to the proposed layout were made to minimise and avoid impacts of the proposal on the ecological values of the site.

Given the presence of an EEC and threatened species 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 and hollow loss;
- 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;
- 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;
- Construction compounds, substations and rock crushing facilities have been located outside ecologically sensitive areas, where possible;
- Corridors or wide separation distances will be maintained between groups of turbines;
- The proposal has been aligned so as to have the minimum impact possible on BGW with disturbance occurring only for the installation of the external overhead powerline where only the canopy will be removed, ensuring the understorey remains;
- Where necessary, poles will be aligned within the powerline easement to ensure there are no impacts on *Swainsona recta*, thereby avoiding the loss of all recorded individuals of this species. Realignment of the powerline corridor further east or west was considered although this was likely to result in greater impacts on potential habitat for this species as additional clearance areas would be needed to provide access for construction and maintenance. In the current location, the external overhead line runs along an existing easement and access road or pasture areas and, therefore, impacts to native vegetation have been minimised. Furthermore, provided stringent mitigation measures are implemented during construction, it is unlikely that the proposal would have a detrimental impact on the population with many of the recorded individuals present in a current powerline easement.
- 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 except where roads are required to cross creeks. In these areas the reticulation will form part of the clearing for the road crossing the creek.

#### *Construction Facilities*

Three main collector substations, one secondary collector substations, five site compound locations (one option will be selected), two rock crushing batching plant, four switching stations have been identified. The fourth switching substation option was added to the proposal after the field surveys had been undertaken, however, the development footprint still falls within the study area and, therefore, was covered by the surveyed area. The substation location perceived to have the greatest impact has been used for the impact calculations. The location of each construction facility has been selected with operation requirements and environmental constraints in mind and, where possible, those in previously disturbed areas will be selected (**Figure 2** and **Figure 3**).

### 5.3 MITIGATION MEASURES

In order to protect the ecological values of the site a number of management and mitigation measures have been recommended and will be included in the Statement of Commitments. These are outlined in **Table 17** together with the project stage during which each should be implemented have been included. 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.

The Mid-Western Regional Council *Roadside Management Guidelines* (Mid-Western Regional Council 2011a) have been reviewed and those management measures applicable to the proposed works at the project site have been included in the mitigation table below. Mitigation measures, with regards to *Swainson recta*, were formulated in consultation with John Briggs from OEH.

Whilst the likelihood of bird and bat species being struck cannot be accurately predicted, a commitment to monitoring strike across CRWF has been made. This will include the preparation of a bird and bat monitoring program prior to operation of the wind farm that, in consultation with OEH and SEWPAC, will identify the frequency of monitoring and reporting, the thresholds at which impacts are considered unacceptable and the adaptive management approaches which are acceptable.

Given the construction timeframes for the proposal and that mitigation and management measures for bird and bat strike are dynamic and change as more is learnt about the impacts of wind farms, it is proposed that the frequency of reporting strike data is determined during the preparation of the monitoring program in consultation with OEH and SEWPAC. In addition, the adaptive management measures that would be implemented should strike thresholds be reached will be negotiated with OEH and SEWPAC at such time that significant strike is detected to allow for a more tailored and species specific approach to mitigation. This will facilitate the development of a strategy that best targets the issue, and can be developed in response to data collected from other wind farms also if available.

The potential benefits of monitoring the Capertee Valley Regent Honeyeater population, in an attempt to determine if the CRWF has any detrimental impacts on breeding, was investigated. Monitoring of the Capertee Valley population currently takes place annually in August, September and October and this has been occurring for the past 10 years and regent Honeyeater co-ordinators have been doing additional monitoring at other times. However, it is believed that it would be almost impossible for the Capertee monitoring to pick up if the wind farm was having any impacts on breeding for the following reasons (pers comm. Dean Ingwersen):

- There are so many variables that contribute to good and bad breeding and this varies between seasons. It would be difficult to determine the cause.
- The population is so small therefore it would be difficult to show with any confidence any impacts to breeding.
- Based on past research it is suggested that approximately 120 years of data would be needed to show with confidence any impacts on breeding etc as there is so much 'noise' in the data - Clarke, R.H., Oliver, D, Boulton, R., Cassey, P. and Clarke, M. (2003) "Assessing programs for monitoring threatened species – a tale of three honeyeaters (Meliphagidae)". *Wildlife Research* 30 (5), p. 427-435.

It is believed that monitoring impacts on the wind farm site would be much more informative than attempting to use the results from monitoring in the Capertee Valley (pers comm. Dean Ingwersen) and therefore monitoring the impacts of the proposal on the Regent Honeyeater will be incorporated into the overall wind farm monitoring program.

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	
<b>Spread of weeds</b>											
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	
Spread of weeds through topsoil removal	All	<p>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.</p> <p>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.</p>				✓		✓	\$50,000	Moderate	

IMPACT	RELEVANT SPECIES / GUILD	MITIGATION MEASURE	TIMEFRAME	DETAILED DESIGN	PRE-CONSTRUCTION	DURING CONSTRUCTION	OPERATION	DECOMMISSIONING	COST ESTIMATE	PREDICTED EFFECTIVENESS OF MEASURE
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 locally native coloniser such as <i>Austrostipa</i> spp. be used.			✓	✓		✓	\$500,000	High
	All	Weed management measures implemented to control perennial weed grasses.	Three years following construction. A review will then be undertaken to determine if further weed management is required.			✓	✓	✓	\$40,000	High
	All	Management of stock access during periods of vegetation and soil disturbance to prevent weed spread.				✓		✓	NA	Moderate
<b>Sedimentation, Erosion and Runoff</b>										
Sedimentation, and soil erosion	All	Before any remediation works that will further disturb the soil, grazing will be removed, where practical, in consultation with the landowner 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	Where practicable stockpiles should be covered to minimise 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

IMPACT	RELEVANT SPECIES / GUILD	MITIGATION MEASURE	TIMEFRAME	DETAILED DESIGN	PRE-CONSTRUCTION	DURING CONSTRUCTION	OPERATION	DECOMMISSIONING	COST ESTIMATE	PREDICTED EFFECTIVENESS OF MEASURE
		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 minimise 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 minimise sediment and runoff entering the watercourse in accordance with SWMP.				✓		✓	\$50,000 (part of SWMP implementation)	High
<b>Vegetation Clearance / Disturbance</b>										
Removal of vegetation	All	Native vegetation will be chipped and mulched for on-site use. Shrub and grass species, < 3 m in height, will be maintained where practicable during the powerline construction.			✓	✓			NA	Moderate
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 temporarily fenced (with landowner agreement) to allow the controlled revegetation with locally endemic species (e.g. <i>Austrostipa</i> 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
Removal of potential habitat and/or vegetative corridors		Tree clearance will be avoided wherever possible and where required will occur in a linear fashion, rather than in one consolidated block. Regeneration of some cleared areas will occur.			✓	✓			NA	High
<b>Fauna</b>										
Temporary removal of fauna habitat / dead wood	Ground-dwelling species Pink-tailed Worm-lizard	All logs and large rocks (15 cm diameter – 70 cm diameter) 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 be 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.				✓		✓	\$150,000 (assumed salary for 2 year construction period)	High
Disturbance to nests of threatened species	Bush Stone-curlew	A qualified ecologist will search potential nesting locations (i.e. in open areas) during breeding season prior to any construction works or vehicle movement in open areas.  Surveys for Bush Stone-curlew nests will be conducted in conjunction with surveys for hollow-dependant fauna.  Full details of mitigation measures for the Bush Stone-curlew will be outlined in the CEMP.			✓				\$150,000 (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	A buffer of 30 m will be maintained between all turbines and hollow-bearing trees (where practical)		✓	✓	✓			NA	High
		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
		Environmental Compliance Manager or field officer qualified and license to handle fauna, on site during clearing to capture and re-release fauna (where appropriate)				✓			\$150,000 (assumes salary for 2 years of construction)	High
Death and injury through bird and bat strike	Microbats	<p>Preparation and implementation of a bird and bat monitoring program prior to operation of the wind farm that, in consultation with OEH and SEWPAC, will identify the frequency of monitoring and reporting, the thresholds at which impacts are considered unacceptable and the adaptive management approaches which are acceptable.</p> <p>An adaptive management approach will be undertaken whereby the following may be undertaken should any turbines be identified as having a high incidence of strike during monitoring.</p> <p><b>Step 1</b> – feather the relevant turbine (s) to reduce strike or change the wind speed trigger at which the rotors begin turning</p> <p><b>Step 2</b> – based on further monitoring, if the measures in Step 1 do not reduce incidence, the relevant turbines may be temporarily shutdown during high risk periods.</p>	Prior to construction	✓		✓		NA	Moderate to High	

IMPACT	RELEVANT SPECIES / GUILD	MITIGATION MEASURE	TIMEFRAME	DETAILED DESIGN	PRE-CONSTRUCTION	DURING CONSTRUCTION	OPERATION	DECOMMISSIONING	COST ESTIMATE	PREDICTED EFFECTIVENESS OF MEASURE
	Birds	Setting back turbines from cliff edges or positioning turbines on the prevailing leeward side of ridges is recommended to reduce the hazard posed to soaring raptors using rising winds on steep slopes. A setback of at least 50 m from the cliff edge has been implemented for Crudine Ridge Wind Farm.		✓					NA	Moderate
	Birds and bats	Should turbines 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. (see adaptive approach above under death and injury through strike).					✓	\$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

Flora

IMPACT	RELEVANT SPECIES / GUILD	MITIGATION MEASURE	TIMEFRAME	DETAILED DESIGN	PRE-CONSTRUCTION	DURING CONSTRUCTION	OPERATION	DECOMMISSIONING	COST ESTIMATE	PREDICTED EFFECTIVENESS OF MEASURE
Accidental trampling during construction	Swainsona recta*	Pre-clearance surveys will be undertaken during the flowering season (Spring) for <i>Swainsona recta</i> in areas of potential habitat within the powerline easement impact area. This will ensure all individuals are identified and flagged for fencing during construction. Survey will only be undertaken when individuals on site are in flower. Should new individuals be identified, poles will be shifted to avoid any direct impacts. Populations or known individuals of <i>Swainsona recta</i> should be clearly marked / delineated in the field prior to construction work. Temporarily fence the area to prevent access. Fencing around the individuals incorporating a 5 m buffer from the outer most plants when erecting the fencing is recommended.	Prior to the commencement of construction works		✓				\$30,000 – pre-clearance surveys \$12,000 / km - fencing	High
Erosion and weed invasion		All disturbed soil surfaces shall be stabilised as soon as practicable after works have ceased in the area and areas rehabilitated and managed to prevent weed invasion.				✓			\$250,000	Moderate to High
Smothering of vegetation by dust		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.		✓		✓			\$250,000	Moderate
Revegetation	All	Rehabilitation of internal access roads that are not required following construction on completion of the construction phase. Landscaping around the main and secondary collector substations will use native plant where appropriate.				✓			\$500,000	High
<b>Soils</b>										
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

IMPACT	RELEVANT SPECIES / GUILD	MITIGATION MEASURE	TIMEFRAME	DETAILED DESIGN	PRE-CONSTRUCTION	DURING CONSTRUCTION	OPERATION	DECOMMISSIONING	COST ESTIMATE	PREDICTED EFFECTIVENESS OF MEASURE
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.
<b>Fire</b>										
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
		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

IMPACT	RELEVANT SPECIES / GUILD	MITIGATION MEASURE	TIMEFRAME	DETAILED DESIGN	PRE-CONSTRUCTION	DURING CONSTRUCTION	OPERATION	DECOMMISSIONING	COST ESTIMATE	PREDICTED EFFECTIVENESS OF MEASURE
		Providing the Rural Fire Service (RFS) with: <ul style="list-style-type: none"> <li>• A construction works schedule</li> <li>• Maps of final turbine layout and identification information for individual turbine sites</li> <li>• Access road plans and locations of access gates</li> <li>• Security information such as location of locked gates and restricted access areas</li> <li>• Location of any additional water supplies installed for construction activities</li> <li>• Location of potential landing pads for fire-fighting aircraft or helicopters</li> </ul>			✓				NA	High
<b>Hazardous Materials</b>										
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
<b>Others</b>										
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.

\* Mitigation and management measures for *Swainsona recta* were determined following consideration of the species Draft Recovery Plan and consultation with species expert (John Briggs; OEH, 2012)

## 5.4 DIRECT IMPACTS - CONSTRUCTION

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 trenching to install underground reticulation which can then be filled and revegetated. Measures will then be implemented to prevent weed invasion and erosion once installed.

### 5.4.1 Vegetation Clearance

**Table 18** summarises the proposed vegetation clearance for each component of the proposal for each turbine layout option. Roads will be 6 m wide with intermittent passing bays 12 m wide. The most feasible turbine layout will be determined during the detailed design phase of the proposal and will depend on final turbine selection and crane availability. **Table 18** lists the total area of permanent and temporary vegetation loss for each vegetation type and condition.

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 'maintain or improve' principles as determined by the use of the Biobanking credit calculator. The results of the Biobank credit calculations is included in a stand-alone report (Appendix I) and summarised in the proposed offset strategy (Section 6).

As a worst case scenario, the proposal involves the permanent removal of 71.64 ha of habitat and 31.58 ha of temporary habitat loss. This includes the clearing of trees, mainly in areas of pasture with scattered trees (7.77 ha), for provision of overhead electrical infrastructure.

This clearance comprises the permanent removal of 3.69 ha of remnant woodland, 60.11 ha of derived grassland/native pasture, and 0.07 ha of low condition vegetation (predominantly exotic with some native species present). It will also require 31.58 ha of temporary clearance of vegetation comprised of 1.65 ha of remnant woodland and 9.93 ha of derived grassland.

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

PROJECT COMPONENT	ESTIMATED IMPACT AREA (ha) – LAYOUT A (6 m ROAD)			ESTIMATED IMPACT AREA (ha) – LAYOUT B (6 m ROAD)		
	PERMANENT (ha)	TEMPORARY (ha)	TREES ONLY (ha)	PERMANENT (ha)	TEMPORARY (ha)	TREES ONLY (ha)
Roads, crane hardstands and passing bays	39.98			37.34		
Turbine footings	20.70			15.04		
Main collector substation (3) (one will be selected – worst case included here)	2.38			2.38		
Secondary collector substation	0.06			0.06		
Internal overhead electrical interconnection / easement			2.70			2.70
External overhead electrical interconnection / easement			6.01			6.00
11kV electrical interconnection / easement to switching station			0.08			0.08
<b>Temporary construction facilities</b>						
Site compounds (5) (one option will be selected – worst case included here)	0.56	2.52		0.56	2.52	

PROJECT COMPONENT	ESTIMATED IMPACT AREA (ha) – LAYOUT A (6 m ROAD)			ESTIMATED IMPACT AREA (ha) – LAYOUT B (6 m ROAD)		
	PERMANENT (ha)	TEMPORARY (ha)	TREES ONLY (ha)	PERMANENT (ha)	TEMPORARY (ha)	TREES ONLY (ha)
Rock crushing batching plants (2) (one option will be selected – worst case included here)		1.92			1.91	
Switching stations (3) (one will be selected – worst case included here)	0.76			0.76		
Cut and fill		28.24			34.33	
<b>Total</b>						
Study area (ha)	<b>1,663.80</b>					
Project site area (ha)	<b>5,697.00</b>					
Project site area – mapped (ha)	<b>4,164.85</b>					
Total development footprint (ha)	<b>64.52</b>	<b>32.68</b>	<b>8.71</b>	<b>56.22</b>	<b>38.76</b>	<b>8.70</b>

**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 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	BIOMETRIC CONDITION	ANCILLARY CODE	MAPPED WITHIN PROJECT SITE (ha)	MAPPED WITHIN STUDY AREA (ha)	ESTIMATED IMPACT AREA – LAYOUT A			ESTIMATED IMPACT AREA – LAYOUT B		
					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)
Broad-leaved Peppermint-Brittle Gum - Red Stringybark dry open forest on the southeastern highlands	Moderate to Good	Pasture	19.80	10.04	0.81	0.00	0.39	0.78	0.00	0.66
Broad-leaved Peppermint-Brittle Gum - Red Stringybark dry open forest on the southeastern highlands	Moderate to Good	Trees	20.44	5.49	0.00	0.00	0.01	0.03	0.00	0.08
Red Stringybark-Scribbly Gum-Red Box-Long-leaved Box shrub-tussock grass open forest	Moderate to Good	Pasture	2,190.19	1067.68	58.46	1.99	29.41	49.97	1.97	34.46
Red Stringybark-Scribbly Gum-Red Box-Long-leaved Box shrub-tussock grass open forest	Moderate to Good	Trees	1032.37	200.08	3.69	1.30	1.64	3.86	1.31	1.95
Wet tussock grasslands of cold air drainage areas of the tablelands	Moderate to Good	-	29.71	15.98	0.06	0.06	0.02	0.06	0.06	0.05
White Box-Blakelys Red Gum-Yellow Box grassy woodland	Low	Pasture	98.18	51.80	0.07	0.27	0.00	0.07	0.27	0.00
White Box-Blakelys Red Gum-Yellow Box grassy woodland	Low	Trees	0.81	1.06	0.00	0.03	0.00	0.00	0.03	0.00
White Box-Blakelys Red Gum-	Moderate	Pasture	482.51	178.88	0.78	1.13	0.11	0.78	1.13	0.11

REVISED BIOMETRIC VEGETATION TYPE	BIOMETRIC CONDITION	ANCILLARY CODE	MAPPED WITHIN PROJECT SITE (ha)	MAPPED WITHIN STUDY AREA (ha)	ESTIMATED IMPACT AREA – LAYOUT A			ESTIMATED IMPACT AREA – LAYOUT B		
					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)
Yellow Box grassy woodland	to Good									
White Box-Blakelys Red Gum-Yellow Box grassy woodland,	Moderate to Good	Trees	2.77	1.75	0.00	0.00	0.00	0.08	0.00	0.12
White Box-Blakelys Red Gum-Yellow Box grassy woodland,	Moderate to Good	Trees (EPBC)	65.74	14.85	0.00	2.99	0.00	0.00	2.99	0.00
Disturbed terrain	Low	-	21.95	11.96	0.24	0.01	0.10	0.24	0.01	0.36
Exotic pasture	Low	-	200.54	104.36	0.41	0.93	1.00	0.35	0.93	0.97
<b>Total</b>			<b>4,164.85</b>	<b>1,663.93</b>	<b>64.52</b>	<b>8.71</b>	<b>32.68</b>	<b>56.22</b>	<b>8.70</b>	<b>38.76</b>

**Note:** All calculations are based on a worst case scenario (i.e. 6 m road layout with cut and fill). BPBGRS = Broad-leaved Peppermint-Brittle Gum - Red Stringybark dry open forest, RSSGRBLLB = Red Stringybark-Scribbly Gum-Red Box-Long-leaved Box shrub-tussock grass open forest, WBBRGYB = White Box-Blakely's Red Gum-Yellow Box grassy woodland, WTG = Wet Tussock Grassland of cold air drainage areas.

#### 5.4.2 Impacts to Critically Endangered Ecological Communities (CEECs)

*CW209: White Box – Blakely's Red Gum - Yellow Box grassy woodland of the NSW South Western Slopes Bioregion (WBBRGYB)*

Areas of the Endangered Ecological Community (EEC) *White Box Yellow Box Blakely's Red Gum Woodland* listed under the TSC Act and the Critically Endangered Ecological Community (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)), are primarily in the north of the site, with smaller areas present in the south west outside the study area. Areas of Low condition BGW are characteristic of the TSC Act defined community. However, areas mapped as Moderate/Good condition only reflect the EPBC Act listed BGW community. Low condition areas do not retain sufficient integrity to be considered the CEEC under the EPBC Act. Furthermore, none of the derived grassland / pasture areas that met the EPBC Act criteria fall within the proposed impact area.

Where possible, clearing of BGW has been avoided. A total of 5.27 ha of BGW would be permanently impacted by the proposal and 0.11 ha temporarily impacted. This represents 0.83 % of the BGW within the project site and 2.17 % of the BGW within the study area.

This total includes the permanent clearing of small areas to place the poles for the powerline (generally estimated to be a permanent impact of about 5% of the area) and permanent clearance for 664.59 m of tracks within the powerline easement. The majority of this area is pasture with small sections on open woodland. The 4 m of clearing required for the access tracks will not be required along the full length as where the proposed track location runs along a current access track, further clearing will not be required. Some shrubs and groundcover may be slashed as part the easement establishment, but this impact will be short term as, the area will be left to regenerate following construction and there will be no further removal of species or topsoil.

The proposal will disturb 4.42 ha of BGW (trees cleared only) for the installation of the external overhead line, which represents just 0.67% of BGW present within the project site (**Table 19**). Even without the canopy layer, this area will still represent BGW and the patch will remain relatively intact and this disturbance will not fragment the community.

Permanent clearance for part of the access track network is also proposed (0.85 ha). Where the proposed access track passes through a section of BGW in the north of the site, the track follows a current access track and, therefore, the increase in fragmentation from widening the road will be minimal. In other areas, the tree cover is wide spread and, therefore, fragmentation likely to be minimal.

#### 5.4.3 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 *Swainsona recta* was recorded within the study area, all individuals have been avoided and mitigation measures will be implemented to prevent indirect impacts. Appropriate mitigation measures for *Swainsona recta* were developed following consultation with John Briggs (OEH, 2012) and consideration of the species Draft Recovery Plan. **Table 20** outlines the amount of potential habitat likely to be impacted by the proposal for *Swainsona recta* under each layout option. Likely impacts on habitat for other threatened species not recorded within the study area but for which potential habitat is present are included in **Table 21**.

Table 20: Population estimates for *Swainsona recta*

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)	LAYOUT A WITH 6 m ROADS		LAYOUT B WITH 6 m ROADS	
						AMOUNT OF POTENTIAL HABITAT IMPACTED (ha)			
						PERMANENT	TEMPORARY	PERMANENT	TEMPORARY
<i>Swainsona recta</i>	WBBRGYB*	36	0	551.02	195.48	4.90	0.11	4.98	0.23

**Note:** \* Low condition vegetation not included

WBBRGYB = White-Box - Blakely's Red Gum – Yellow Box grassy woodland

Table 21: Potential habitat for threatened flora and likely impacts (reflecting Layout A)

SPECIES	HABITAT WITHIN STUDY AREA	HABITAT MAPPED IN PROJECT SITE (ha)	MAPPED WITHIN STUDY AREA (ha)	AMOUNT OF HABITAT TO BE PERMANENTLY IMPACTED (ha)	AMOUNT OF HABITAT TO BE TEMPORARILY IMPACTED (ha)
<i>Prasophyllum</i> sp. Wybong	BPBGRS, RSSGRB, WBBRGYB	3,912.81	1,531.63	71.52	31.56
<i>Bothriochloa biloba</i>	BPBGRS, RSSGRB, WBBRGYB	3,912.81	1,531.63	71.52	31.56
<i>Thesium australe</i>	BPBGRS, RSSGRBLLB, WBBRGYB	3,912.81	1,531.63	71.52	31.56
<i>Eucalyptus cannonii</i>	BPBGRS, RSSGRBLLB	3,262.80	1,283.29	66.25	31.45

SPECIES	HABITAT WITHIN STUDY AREA	HABITAT MAPPED IN PROJECT SITE (ha)	MAPPED WITHIN STUDY AREA (ha)	AMOUNT OF HABITAT TO BE PERMANENTLY IMPACTED (ha)	AMOUNT OF HABITAT TO BE TEMPORARILY IMPACTED (ha)
<i>Eucalyptus robertsonii</i>	BPBGRS, RSSGRBLLB	40.24	15.53	0.81	0.40
<i>Swainsona sericea</i>	WBBRGYB, RSSGRBLLB	551.02	195.48	4.90	0.11

**Note:** BPBGRS = Broad-leaved Peppermint-Brittle Gum - Red Stringybark dry open forest, RSSGRBLLB = Red Stringybark-Scribbly Gum-Red Box-Long-leaved Box shrub-tussock grass open forest, WBBRGYB = White Box-Blakely's Red Gum-Yellow Box grassy woodland

#### 5.4.4 Loss of riparian vegetation

The proposal involves the establishment of a 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.

#### 5.4.5 Loss of fauna habitat

As a worst-case scenario, the proposal involves the permanent removal of up to approximately 71.64 ha of potential habitat for a variety of species, including 7.98 ha of woodland and 63.29 ha of native pasture and 0.37 ha of low condition vegetation. Additionally, 31.58 ha of temporary clearance is proposed, including 1.65 ha of woodland and 29.93 ha of native pasture. 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, involves narrow clearance corridors 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 or areas of potential habitat for fauna. Where the proposed access track passes through a section of BGW in the north of the site, the track follows a current access track and, therefore, the increase in fragmentation from widening the road will be minimal. In other areas, the tree cover is wide spread (i.e. the average space between trees is greater than the width of the access roads) and, therefore, fragmentation in terms of habitat use by fauna is likely to be minimal.

Approximately 19,963 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 920 HBTs (4.61 %) may be removed for the proposal. The distribution of HBT across the study area is 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.

#### **5.4.6 Loss of threatened fauna habitat**

##### *Birds*

The following threatened birds were recorded within the study area:

- Brown Treecreeper;
- Little Lorikeet;
- Hooded Robin;
- Scarlet Robin;
- Speckled Warbler; and
- Diamond Firetail.

**Table 22** 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. Furthermore, areas of consolidated woodland have been avoided in the majority of instances and, therefore, consolidated areas would not become fragmented, thereby impacting bird habitat use.

**Table 22: Likely impacts to habitat for threatened birds recorded at the site (reflecting Layout A)**

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)	BREEDING HABITAT		FORAGING HABITAT	
					AMOUNT OF HABITAT TO BE PERMANENTLY IMPACTED (HA)	AMOUNT OF HABITAT TO BE TEMPORARILY IMPACTED (HA)	AMOUNT OF HABITAT TO BE PERMANENTLY IMPACTED (HA)	AMOUNT OF HABITAT TO BE TEMPORARILY IMPACTED (HA)
Brown Treecreeper	BPBGRS, RSSGRBLLB, WBBRGYB (includes pasture areas)	3,912.81	223.23	1,531.63	8.01	1.65	71.63	31.56
Hooded Robin	BPBGRS, RSSGRBLLB, WBBRGYB (includes pasture areas)	3,912.81	223.23	1,531.63	8.01	1.65	71.63	31.56
Scarlet Robin	BPBGRS, RSSGRBLLB, WBBRGYB (includes pasture areas)	3,912.81	223.23	1,531.63	8.01	1.65	71.63	31.56
Diamond Firetail	BPBGRS, RSSGRBLLB, WBBRGYB (includes pasture areas)	3,912.81	223.23	1,531.63	8.01	1.65	71.63	31.56

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)	BREEDING HABITAT		FORAGING HABITAT	
					AMOUNT OF HABITAT TO BE PERMANENTLY IMPACTED (HA)	AMOUNT OF HABITAT TO BE TEMPORARILY IMPACTED (HA)	AMOUNT OF HABITAT TO BE PERMANENTLY IMPACTED (HA)	AMOUNT OF HABITAT TO BE TEMPORARILY IMPACTED (HA)
Little Lorikeet	BPBGRS, RSSGRBLLB, WBBRGYB (including trees in pasture)	1,261.66	288.65		11.19	3.15	11.19	3.15
Speckled Warbler	BPBGRS, RSSGRBLLB, WBBRGYB	1,121.32	222.17		7.98	1.65	7.98	1.65

**Note:** BPBGRS = Broad-leaved Peppermint-Brittle Gum - Red Stringybark dry open forest, RSSGRBLLB = Red Stringybark-Scribbly Gum-Red Box-Long-leaved Box shrub-tussock grass open forest, WBBRGYB = White Box-Blakely's Red Gum-Yellow Box grassy woodland

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

- Regent Honeyeater;
- Bush Stone-curlew;
- Gang Gang Cockatoo;
- Varied Sittella;
- Little Eagle;
- Swift Parrot;
- Black-chinned Honeyeater;
- Barking Owl;
- Powerful Owl;
- Spotted Harrier
- Flame Robin; and
- Superb Parrot.

**Table 23** outlines the amount of habitat present within the study area and the amount likely to be impacted for these additional species. 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. Furthermore, areas of consolidated woodland have been avoided in the majority of instances and, therefore, consolidated areas would not become fragmented, thereby impacting bird habitat use.

Preferred breeding habitat is not present within the study area for the Swift Parrot, Regent Honeyeater nor Gang Gang Cockatoo as these species either congregate in specific breeding areas of which none are located at Crudine or preferred habitat features are not present at Crudine.

### **Regent Honeyeater**

The Regent Honeyeater primarily inhabits temperate woodlands and open forests of the inland slopes of south-east Australia, particularly Box-Ironbark woodland and riparian forests of River She-oak. There are three known key breeding regions: Chiltern-Albury in north-east Victoria; Capertee Valley, NSW; and the Bundarra-Barraba region, NSW. In NSW the distribution is very patchy and mainly confined to the two main breeding areas and surrounding fragmented woodlands, although other lesser used breeding sites also occur. The species is known to make large-scale nomadic movements across the landscape, which is thought to coincide with the flowering times of different eucalypt species on which they feed (OEH 2011b, DSEWPAC 2011b).

The species was not observed on site through fauna surveys (which included targeted surveys for threatened bird species) in November 2008, January 2009 and opportunistically during flora surveys in March and April 2011 and September and October 2011. There are no existing records for this species within the project site.

The project site lies approximately 40 km to the west of the Capertee Valley, and approximately 55 km

to the south west of the lesser used Mudgee – Wollar region breeding area (Scientific Committee Final Determinations 2011). The Regent Honeyeater mainly nests in mature eucalypts and she-oaks in Box-Ironbark and other temperate woodlands and riparian gallery forest dominated by River She-oak (OEH 2011b). The study area and project site has limited BGW and no riparian gallery forest. However, this species may also breed in Mistletoe (pers comm. Damon Oliver, OEH) and therefore potential breeding habitat, although not preferred, is present within the study area.

The proposal will permanently remove 11.19 ha and temporarily remove 3.15 ha of potential habitat within the study area. Vegetation removal will be linear in nature rather than in one consolidated block and the loss of potential habitat for this species represents just 1.14% of the potential habitat within the Project site. The main wooded corridor, which runs through the Project site, along the eastern slopes of Crudine Ridge will be largely retained, thereby ensuring an abundance of habitat is still available for this species.

### Swift Parrot

The Swift Parrot is a highly mobile species which is endemic to south-eastern Australia. The Swift Parrot breeds in Tasmania during spring and summer, migrating in the autumn and winter months to south-eastern Australia from Victoria and the eastern parts of South Australia to south-east Queensland. In NSW this species mostly occurs on the coast and south-west slopes (DSEWPAC 2011b).

On the mainland this species occurs in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations (OEH 2011b). Favoured feed trees include winter flowering species such as Swamp Mahogany, Spotted Gum, Red Bloodwood, Mugga Ironbark, and White Box. Commonly used lerp infested trees include *E. microcarpa* (Inland Grey Box) and *E. moluccana* and *E. pilularis* (Blackbutt). Swift Parrots also use insect-infested trees, which in the Crudine Ridge area, include Red Box Yellow Box, and Blakely's Red Gum (pers comm. Chris Tzaros, Birds Australia, July 2011).

Fauna surveys were conducted during spring and summer, when this species is not on the mainland. No individuals were observed opportunistically during flora surveys in April 2011, when they are present on the mainland and there are no existing records for this species within the Project site. The species has been previously recorded in the locality (in 2002) to the south of the study area near Crudine on Turondale Road approximately 2.5 km south of the intersection with Hill End Road (BRC 2011). There is potential for the species to use the project site during their time on the mainland due to the presence of eucalyptus species which are prone to insect infestation (Red Box Yellow Box, and Blakely's Red Gum). Blakely's Red Gum is also winter-flowering, as is Long-leaved Box, although the latter is not a prolific flowerer and is thus less likely to be used by the Swift Parrot (pers comm. Chris Tzaros, Birds Australia, July 2011).

The proposal will permanently remove 11.19 ha and temporarily remove 3.15 ha of potential foraging habitat for the Swift Parrot, which represents a small area of the available habitat within the Project site (1.14%). Tree clearance will be avoided wherever possible and the number of trees being removed will be minimal with respect to the area of available foraging habitat present within the study area. Vegetation removal will occur in a linear and dispersed fashion, rather than in one consolidated block, ensuring that a sufficient distribution of potential habitat remains.

### **Gang Gang Cockatoo**

The project site is unlikely to provide preferred breeding habitat for the Gang Gang Cockatoo as this species is known to favour old growth attributes for nesting and roosting (OEH 2011b). The proposal will permanently remove 7.98 ha of potential habitat and temporarily impact 1.65 ha of potential habitat for this species. Given the extent of potential habitat across the project site, the impact on potential habitat is minimal.

**Table 23: Likely impacts on potential habitat for birds (reflecting Layout A)**

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)	BREEDING HABITAT		FORAGING HABITAT	
					AMOUNT OF HABITAT TO BE PERMANENTLY IMPACTED (HA)	AMOUNT OF HABITAT TO BE TEMPORARILY IMPACTED (HA)	AMOUNT OF HABITAT TO BE PERMANENTLY IMPACTED (HA)	AMOUNT OF HABITAT TO BE TEMPORARILY IMPACTED (HA)
<b>WOODLAND BIRDS</b>								
Black-chinned Honeyeater;	BPBGRS, RSSGRBLLB, WBBRGYB (includes trees in pasture areas)	1,261.66	223.23	288.65	8.01	1.65	11.19	3.15
Bush Stone-curlew	BPBGRS, RSSGRBLLB, WBBRGYB (includes pasture areas)	3,942.52	1,547.61		71.64		31.58	
Flame Robin	BPBGRS, RSSGRBLLB, WBBRGYB (includes pasture areas)	3,912.81	223.23	1,531.63	8.01	1.65	71.63	31.56
Gang Gang Cockatoo	BPBGRS, RSSGRBLLB, WBBRGYB	1121.32	0.00	222.17	0.00	0.00	7.98	1.65

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)	BREEDING HABITAT		FORAGING HABITAT	
					AMOUNT OF HABITAT TO BE PERMANENTLY IMPACTED (HA)	AMOUNT OF HABITAT TO BE TEMPORARILY IMPACTED (HA)	AMOUNT OF HABITAT TO BE PERMANENTLY IMPACTED (HA)	AMOUNT OF HABITAT TO BE TEMPORARILY IMPACTED (HA)
Little Eagle	BPBGRS, RSSGRBLLB, WTG, WBBRGYB (includes pasture areas)	3,942.52	223.23	1,547.61	8.01	1.65	71.64	31.58
Regent Honeyeater	BPBGRS, RSSGRBLLB, WBBRGYB (include s trees in pasture areas)	1,261.66	0.00	288.65	11.19	3.15	11.19	3.15
Spotted Harrier	BPBGRS, RSSGRBLLB, WTG, WBBRGYB (includes pasture areas)	3,942.52	223.23	1547.61	8.01	1.65	71.64	31.58
Superb Parrot	BPBGRS, RSSGRBLLB, WBBRGYB	1,121.32	222.17		7.98	1.65	7.98	1.65

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)	BREEDING HABITAT		FORAGING HABITAT	
					AMOUNT OF HABITAT TO BE PERMANENTLY IMPACTED (HA)	AMOUNT OF HABITAT TO BE TEMPORARILY IMPACTED (HA)	AMOUNT OF HABITAT TO BE PERMANENTLY IMPACTED (HA)	AMOUNT OF HABITAT TO BE TEMPORARILY IMPACTED (HA)
Swift Parrot	BPBGRS, RSSGRBLLB, WBBRGYB (includes trees in pasture areas)	1,261.66	0.00	288.65	0.00	0.00	11.19	3.15
Varied Sittella	BPBGRS, RSSGRBLLB, WBBRGYB	1,121.32	222.17		7.98	1.65	7.98	1.65
<b>OWLS</b>								
Barking Owl	BPBGRS, RSSGRBLLB, WTG, WBBRGYB (includes pasture areas)	3,942.52	223.23	1547.61	8.01	1.65	71.64	31.58
Powerful Owl	BPBGRS, RSSGRBLLB, WTG, WBBRGYB (includes pasture areas)	3,942.52	223.23	1,547.61	8.01	1.65	71.64	31.58

**Note:** BPBGRS = Broad-leaved Peppermint-Brittle Gum - Red Stringybark dry open forest, RSSGRBLLB = Red Stringybark-Scribbly Gum-Red Box-Long-leaved Box shrub-tussock grass open forest, WBBRGYB = White Box-Blakely's Red Gum-Yellow Box grassy woodland, WTG = Wet Tussock Grassland of cold air drainage areas

### Migratory Birds

There are six listed migratory species (excluding the Regent Honeyeater and Swift Parrot as they are covered above) which have the potential to occur within the project site. Only one species, Rainbow Bee-eater, is known to occur and was recorded during field surveys. The majority of these species may use the site in a transient manner and those for which the site provides potential habitat include:

- Great Egret;
- Cattle Egret;
- White-throated Needletail;
- Rainbow Bee-eater; and
- Satin Flycatcher.

A summary of the likely impacts of the proposal on habitat for these threatened species is included below in **Table 24**.

**Table 24: Likely impacts to potential habitat for migratory birds (reflecting Layout A)**

SPECIES	HABITAT WITHIN STUDY AREA	PROJECT SITE	STUDY AREA	AMOUNT OF HABITAT TO BE PERMANENTLY IMPACTED (HA)	AMOUNT OF HABITAT TO BE TEMPORARILY IMPACTED (HA)
Rainbow Bee-eater	BPBGRS, RSSGRBLLB, WTG, WBBRGYB (includes pasture areas)	3,942.52	1,547.61	71.64	31.58
Great Egret	WTG	29.71	15.98	0.12	0.02
Cattle Egret	BPBGRS, RSSGRBLLB, WTG, WBBRGYB (includes pasture areas)	2,722.21	1,272.58	63.29	29.93
Satin Flycatcher	BPBGRS, RSSGRBLLB, WBBRGYB	1,121.32	222.17	7.98	1.65
White-throated Needletail	BPBGRS, RSSGRBLLB, WTG, WBBRGYB (includes pasture areas)	3,942.52	1,547.61	71.64	31.58

**Note:** BPBGRS = Broad-leaved Peppermint-Brittle Gum - Red Stringybark dry open forest, RSSGRBLLB = Red Stringybark-Scribbly Gum-Red Box-Long-leaved Box shrub-tussock grass open forest, WBBRGYB = White Box-Blakely's Red Gum-Yellow Box grassy woodland, WTG = Wet Tussock Grassland of cold air drainage areas

## Mammals

### Ground-dwelling and Arboreal Mammals

The study area provides potential habitat for three threatened mammal species (excluding bats). Koalas and evidence of Koalas (calls, scats, scratches, skulls) were recorded 18 times during field survey, with two records made within the study area, 14 records made within the project site (outside of the study area) and two records made outside of the project site. Most of the records were made within the Sallys Flat Cluster, with only a few records made within the Pyramul Cluster. There are also a number of historical records of Koalas throughout the locality. Potential habitat is also present for the Spotted-tailed Quoll and Squirrel Glider although these species have not been recorded at the site. **Table 25** outlines the likely impacts of the proposal on habitat for these species.

**Table 25: Likely impacts to potential habitat for mammals (reflecting Layout A)**

SPECIES	HABITAT WITHIN STUDY AREA	PROJECT SITE	STUDY AREA	AMOUNT OF HABITAT TO BE PERMANENTLY IMPACTED (HA)	AMOUNT OF HABITAT TO BE TEMPORARILY IMPACTED (HA)
Koala	BPBGRS, RSSGRBLLB, WBBRGYB (includes trees in pasture areas)	1,261.66	288.65	11.19	3.15
Spotted-tailed Quoll	BPBGRS, RSSGRBLLB, WBBRGYB	1,121.32	222.17	7.98	1.65
Squirrel Glider	RSSGRBLLB, WBBRGYB	1,100.88	216.68	7.98	1.64

**Note:** BPBGRS = Broad-leaved Peppermint-Brittle Gum - Red Stringybark dry open forest, RSSGRBLLB = Red Stringybark-Scribbly Gum-Red Box-Long-leaved Box shrub-tussock grass open forest, WBBRGYB = White Box-Blakely's Red Gum-Yellow Box grassy woodland, WTG = Wet Tussock Grassland of cold air drainage areas

### Megachiropteran and 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 19,963 HBT are estimated to be present across the study area and it is anticipated that up to 920 HBT (4.61%) 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 and in pasture areas micro-siting can ensure HBTs are avoided.

Areas of woodland and grassland provide potential foraging habitat for microchiropteran bat species. Of the 1,547.61 ha of habitat present across the study area (including woodland and grassland), up to approximately 71.64 ha of this will be permanently removed and 31.58 ha will be temporarily cleared. Combined, the proposed 103.22 ha of impact represents 6.67 % of the fauna habitat within the study

area and approximately 2.62 % 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. 3,942.52 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.

- Up to six threatened bat species (including one assumed species) were recorded across the study area during the survey period. Of these species, only two, Little Pied Bat and Eastern Bentwing-bat, were detected with certainty. Remaining species were detected with lower degrees of confidence; 'probable' or 'possible' detection. Nevertheless, a precautionary approach has been taken and these species have been included in the list below of species for which the study area provides habitat and the anticipated impacts to habitat outlined in

**Table 27.** The Grey-headed Flying-fox also has the potential to utilise the study area although no potential camp sites for roosting are present and, therefore, impacts on this species would entail foraging habitat only.

- Large-eared Pied Bat;
- Little Pied Bat;
- Greater Long-eared Bat (assumed presence);
- Eastern Bentwing-bat;
- Yellow-bellied Sheath-tail-bat; and
- Eastern Cave Bat.

*Reptiles*

The study area supports potential habitat for the Pink-tailed Worm-lizard. Targeted surveys for this species were undertaken although none were recorded within the study area.

**Table 26** outlines the likely impacts on potential habitat. To reduce impacts, rocks that are of a suitable size to provide potential habitat for this species will be relocated to adjacent areas during construction.

**Table 26: Likely impacts to potential habitat for the Pink-tailed Worm-lizard**

SPECIES	HABITAT WITHIN STUDY AREA	PROJECT SITE	STUDY AREA	AMOUNT OF HABITAT TO BE PERMANENTLY IMPACTED (HA)	AMOUNT OF HABITAT TO BE TEMPORARILY IMPACTED (HA)
Pink-tailed Worm-lizard	BPBGRS, RSSGRBLLB, WBBRGYB (includes pasture areas)	3,813.82	1,478.77	71.15	31.56

Table 27: Likely impacts on habitat for microchiropteran and megechiropteran bats (reflecting Layout A)

SPECIES	HABITAT WITHIN STUDY AREA	HOLLOW-BEARING TREES IMPACTED	PROJECT SITE BREEDING	PROJECT SITE FORAGING	STUDY AREA BREEDING	STUDY AREA FORAGING	TOTAL PERMANENT BREEDING	TOTAL TEMPORARY BREEDING	TOTAL PERMANENT FORAGING	TOTAL TEMPORARY FORAGING
Eastern Bentwing-bat*	BPBGRS, RSSGRBLLB, WTG, WBBRGYB (includes pasture areas)	533.78 <sup>#</sup>	0.00	3,942.52	0.00	1547.61	NA	NA	71.64	31.58
Eastern Cave Bat	BPBGRS, RSSGRBLLB, WBBRGYB	NA	NA	1,121.32	NA	222.17	NA	NA	7.98	1.65
Greater Long-eared Bat	BPBGRS, RSSGRBLLB, WBBRGYB	533.78	1,121.32	1,121.32	222.17	222.17	7.98	1.65	7.98	1.65
Grey-headed Flying-fox	BPBGRS, RSSGRBLLB, WBBRGYB (includes pasture areas)	NA	NA	1,261.66	NA	288.65	NA	NA	11.19	3.15
Large-eared Pied Bat	BPBGRS, RSSGRBLLB, WBBRGYB	533.78	1,121.32	1,121.32	222.17	222.17	7.98	1.65	7.98	1.65
Little Pied Bat	BPBGRS, RSSGRBLLB, WBBRGYB	533.78	1,121.32	1,121.32	222.17	222.17	7.98	1.65	7.98	1.65

Yellow-bellied Sheath-tail-bat	BPBGRS, RSSGRBLLB, WTG, WBBRGYB (includes pasture areas)	533.78 <sup>#</sup>	3,942.52	3,942.52	1,547.61	1,547.61	71.64	31.58	71.64	31.58
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**Note:** \* may use HBT for roosting but not preferred

<sup>#</sup> assumes impacts to HBTs in pasture can be avoided therefore not included in number removed

BPBGRS = Broad-leaved Peppermint-Brittle Gum - Red Stringybark dry open forest, RSSGRBLLB = Red Stringybark-Scribbly Gum-Red Box-Long-leaved Box shrub-tussock grass open forest, WBBRGYB = White Box-Blakely's Red Gum-Yellow Box grassy woodland, WTG = Wet Tussock Grassland of cold air drainage areas

## 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) including:
  - cluster rather than linear layout (Drewitt & Langston 2008)
  - orientation of turbines (i.e. turbines in rows parallel to the main direction of migratory species flight, rather than incepting main flight path) (Drewitt & Langston 2008)
- 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 including height of turbine (Brett Lane & Associates 2005, Barclay *et al.* 2007)
- Lighting used on turbine (Brett Lane & Associates 2005)
- Turbines located on forested ridges (Arnett 2005)
- Land use close to turbines (Drewitt & Langston 2008)
- Seasonal increases in energy demand associated with breeding or preparing for hibernation in some species leading to seasonal increases in foraging time, feeding areas or flight time in search of a mate (Cyrán & Barclay 2009)
- Distribution of bat prey items (Cyrán & Barclay 2009)

### 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). 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

Based on studies in the United States it appears that collision mortality is most significant for tree-dwelling, migratory species (Kuvlesky *et al.* 2007, Baerwald *et al.* 2009, Cyran & Barclay 2009). Resident populations of bats appear to be less vulnerable to collision, as few bat fatalities have included resident bats at a number of wind farms in the United States (Kuvlesky *et al.* 2007). Other 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). Studies in the northern hemisphere have shown that most fatalities occur during late summer through autumn each year and tend to peak during that period that coincides with the autumn migration. It has been suggested that migrating bats fly higher above the ground than other bats and that high-flying migrants are less likely to echolocate and, therefore, detect spinning turbines. However, few data exists for assessing whether migrating bats are less likely to echolocate (Cyran & Barclay 2009).

The cause of fatality at wind farms may not be the same for all species. For example, a study was conducted by Cyran and Barclay (2009) that assessed the patterns in bat fatality data in North America and Europe and found that *Pipistrellus subflavus* and *Pipistrellus pipistrellus* roost in trees but are not considered migratory in areas where they collide with turbines and the cave dwelling-bat *Tadarida brasiliensis* might account for the most fatalities in some site in southern North America.

Very little is known about the extent of collision by Australian bats with wind turbines and limited studies have been undertaken. However, monitoring surveys conducted between 2000 – 2003 at the Codrington Wind Farm (14 turbines) recorded only two individuals of White-striped Freetail Bat killed by collision, and at the Toora Wind Farm (12 turbines) six White-striped Freetail Bats and one Chocolate Wattled Bat were killed, which equates to 0.04 and 0.14 bats deaths/turbine/year at Codrington and Toora respectively (Richards 2005). A study conducted at Buffalo Ridge, Minnesota, that was constructed in three phases that total 354 turbines found that bat fatalities ranged from 0.07 / year at Phase 1 to 2.04 / year at Phase 3. Furthermore, the timing of mortalities and other factors suggested that most mortality involved migrant rather than resident breeding bats (Johnson *et al.* 2003).

Given the small size of the Australian wind farms studied above in comparison to the proposed Crudine Ridge Wind Farm, it is anticipated fatality numbers may be slightly higher at Crudine given the increase number of turbines and are more likely to be in the range of those found for the Buffalo Ridge Wind Farm. However, impacts from the Crudine Ridge Wind Farm may be slightly lower given the site is not located in any known bat migratory paths.

The general consensus appears to be that the highest bat fatalities occur on nights when wind speed is low ( $< 6 \text{ m s}^{-1}$ ), 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. Nevertheless, mitigation measures that should be considered to minimise bat fatalities include:

- Changing the wind-speed trigger at which the turbine rotors begin turning or alter the blade angles to reduce rotor speed. Baerwald *et al.* 2009 found that by altering when the turbine rotors begin in low winds, blades were near motionless in low wind speeds, which resulted in a significant reduction in fatalities. Changing the wind-speed trigger reduced fatalities by 60 % and altering the blade angle reduced fatalities by 57.5 %. Further, Arnett *et al.* 2009 reported on studies that showed that changing turbine 'cut-in speed' from the normal 3.5-4 m/s to 5.5 m/s resulted in at least a 50 % reduction in bat fatalities compared to normal operating turbines.
- Turning off turbines during low conditions or before and after storm fronts and during high risk periods (2 hours after dusk) may substantially reduce bat fatality (Arnett *et al.* 2008). It is important to note that this mitigation measure may not be feasible given the potential loss in productivity and site-specific studies would need to be conducting to determine the effectiveness of this mitigation measure.

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). This hypothesis is supported by the study conducted by Horn *et al.* (2008) which involved the use of thermal infrared cameras to assess the flight behaviour of bats at wind turbines in the USA. The study found that bats approached both rotating and non-rotating blades and investigated various parts of the turbines with repeated fly-bys. Whilst it is unknown why bats may investigate moving blades, this behaviour increases the probability of a collision. This study also indicated that in many cases bats successfully avoid moving turbine blades (Horn *et al.* 2008). Based on the findings of Horn *et al.* (2008) it should be acknowledged that despite the implementation of mitigation measures, not all fatalities are avoidable or can be mitigated against as bats have been found to naturally approach turbines.

A correlation between the time of day and bat activity around turbines is also evident with most of the bat activity occurring in the first 2 hours after sunset (Horn *et al.* 2008). Therefore, it may be possible that changes to turbine speeds, including switching off turbines, during this high activity time may assist in reducing fatalities.

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. 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.

### 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

It is acknowledged that there is insufficient information and specific past research to determine the exact likelihood of turbine strike. However, professional judgement has been used based on habitat requirements and behaviour of the species to determine the likelihood of collisions. Based on an assessment of bat behaviour, those species like to be at most risk of turbine strike at Crudine Ridge Wind Farm are those where turbines are located close to hollows that may be used for roosting and that forage above the canopy (Appendix F). *Tadarida australis* (White-striped Freetail-bat) and *Saccolaimus flaviventris* (Yellow-bellied Sheath-tail-bat) were the only migratory, tree roosting species recorded within the study area and, therefore, are considered at the greatest risk of collision. However, the collision risk is also considered high for the *Mormopterus* sp. 4 (Southern Freetail Bat) as this species can forage up to 12 km from roosts and is known to forage above the canopy (Churchill 2008). Given that the *Miniopterus orianae oceanensis* (Eastern Bentwing-bat) is also a migratory species and is known to be attracted to lighting, this species was also considered to be slightly more at risk (moderate risk) than many of the other bat species. The fact that *Mormopterus* sp. 3 (Inland Freetail Bat) forages above the canopy also increases the risk (moderate risk) for this species. Other species that are considered to have a moderate potential of strike due to their foraging activities either occurring within or above the canopy and / or their migratory nature are identified in Appendix F.

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.

Bat activity was monitored across the study area over a number of seasons throughout 2008, 2009 and 2011 via anabat detection and harp trapping. Gould's Wattled Bat, Little Forest Bat, Chocolate Wattled Bat and White-striped Freetail Bat were the most commonly recorded species in anabat surveys, with Little Forest Bat the most commonly caught species in harp traps.

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 across the northern, southern and central parts of the study area.

The collision risk rating assigned to Gould's Wattled Bat was moderate as this species uses tree hollows for roosting and has a fast flight (up to 36 km/hr), forages up to 15 km from roost sites, will pass through open paddocks and can may also be attracted to lighting. This species was recorded in at all anabat locations across the study area and was trapped in harp traps within southern section of the Sallys Flat Cluster and the southern part of the Pyramul Cluster.

The Little Forest was commonly recorded across all harp trap and anabat sites. The risk of collision with turbines for this species is thought to be a low as it is not migratory, flies below the canopy and does not forage far from roost sites.

One Chocolate Wattled Bat was recorded in the southern part of the Sally Flat Cluster and calls for this species were recorded across all anabat sites. The likelihood of this species colliding with turbines is considered moderate as the species does not migrate, they forage in the open zone between the top of the understorey and canopy although they forage up to 5 km from roost sites and have fast, direct flight (speeds of up to 28 km/hr).

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 will be implemented. However, based on the findings of past studies, it is likely that some collisions will be unavoidable even with mitigation measures.

### 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 / displacement. 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;
- species that flock and fly above the canopy (Kevin Mills & Associates 2005); and
- species with weak-powered flight that rely heavily on wind and thermal updrafts for flying and lifting (de Lucas *et al.* 2008).

### Collision

Migratory birds have also been said to be at greatest risk of collision during take-off and descent, including during migration stopovers, as their flight paths take them through the height range of the rotor swept area (Drewitt & Langston 2008). Most northern hemisphere research indicates that passerines, particularly nocturnal migrants, suffer the most collision fatalities at wind farms regardless of what type of habitat the wind farm was constructed in (Kuvlesky *et al.* 2007). 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. However, the probability of collision is thought to be related to factors such as:

- species-specific factors (eg. behaviour, migration patterns) (de Lucas *et al.* 2008);
- turbine height (de Lucas *et al.* 2008);
- elevation above sea level (de Lucas *et al.* 2008);
- topographic factors (de Lucas *et al.* 2008);
- abundance of prey (Drewitt & Langston 2008);
- topographic bottlenecks (eg. mountain passes) (Drewitt & Langston 2008);
- migration staging areas (Drewitt & Langston 2008); and
- near breeding or wintering concentrations (eg. wetlands) (Drewitt & Langston 2008).

It has also been suggested that birds fly lower in strong headwinds or low cloud ceiling, thus bringing them into the zone occupied by wind turbines (Drewitt & Langston 2008). De Lucas *et al.* (2008) analysed large-bird fatality data from 10 years of sampling at two wind farms in Spain and found no clear relationship between species mortality and species abundance.

Collision mortality estimates vary from site to site throughout the United States, but generally collision fatalities are not thought to be substantial enough to impact bird populations because few birds collide with turbines (Kuvlesky *et al.* 2007). Most research on wind farm collision mortality has taken place over the last 20 years in Europe and the United States, with the results indicating the bird collisions range from 0 collisions/turbine/year up to >30 collisions/turbine/year. The variation is due to numerous factors such as locating a wind farm in a bird migratory route, in habitats frequented by birds or constructing turbines in linear strings rather than clusters will increase collision rates (Kuvlesky *et al.* 2007). Drewitt & Langston (2008) found the lowest collision rates to be associated with grasslands and moorland sites, while the highest were associated with mountain ridges and wetlands.

Although collision mortality may have an insignificant impact on passerine populations, collisions between raptors and wind turbines may have an impact on raptor populations because raptors have longer life spans than passerines and consequently lower reproductive productivity (Drewitt & Langston 2008, Kuvlesky *et al.* 2007).

Despite such discrepancies, there is a degree of consensus that raptors may be more vulnerable to

collision than several other bird groups. This may be due to generally lower displacement or avoidance effects, although several other factors are considered influential. For example, hunting raptors may become so fixed on a prey item that they fail to see turbine blades. Weather and topography are increasingly highlighted as being influential in raptor collision risk. More research into weather and topography influences on the home range of resident raptors will allow for safer micro-siting of turbines (Madders & Whitfield 2006).

This concern is justified, as substantial raptor collisions have occurred at wind farms (eg. Altamont Pass Wind Resources Area (APWRA) in California, where collision mortality rates 0.15 – 0.24 birds/turbine/year). At this same location, Smallwood and Thelander (2005) estimated that between 570 and 835 raptors are killed annually at APWRA yielding an estimate of 0.1062 birds/year/turbine (Kuvlesky *et al.* 2007).

Conversely, de Lucas *et al.* (2008) conducted a study of raptor mortality over a 10 year period across two wind farms and found that mortality rates were relatively low with 0.04 and 0.07 birds per turbine per year for the two wind farms. Several other studies in the United States, Spain and Scotland recorded no raptor mortalities or mortality rates so low, that the impacts on raptor populations was not significant. Therefore, it appears that raptor collision mortality is more of a concern when wind turbines are constructed at inappropriate locations (eg. migration routes), where large concentrations of raptors occur (eg. APWRA), or where turbines are constructed in unsuitable locations within the wind farm, such as slopes of hills, draws, or ridges that frequently used by foraging raptors (Kuvlesky *et al.* 2007).

Mitigation measures that should be considered to minimise bat fatalities include:

- Temporary shutdown or feathering of turbines during periods of particularly high bird activity especially in migration bottlenecks, such as mountain passes, migration staging areas and near breeding or wintering concentrations, including wetlands (Drewitt & Langston 2008). It is important to note that this mitigation measure may not be feasible given the potential loss in productivity and site-specific studies would need to be conducting to determine the effectiveness of this mitigation measure. This measure may be implemented at the Crudine Ridge Wind Farm if deemed necessary.
- Setting back turbines from cliff edges or positioning turbines on the prevailing leeward side of ridges is recommended to reduce the hazard posed to soaring raptors using rising winds on steep slopes (Drewitt & Langston 2008). A setback of at least 50 m from the cliff edge has been implemented for Crudine Ridge Wind Farm.

### *Displacement*

The construction and operation of wind farms is thought in some cases to lead to displacement of bird species or changes in the way in which species utilise a site. Disturbance from wind farms can include operation of the turbine rotors, human and machine noise during site construction activities, maintenance and repair work, vibration and increased access following the establishment of site access tracks. Noise and visual disturbance may displace birds into less suitable habitat and this may reduce their ability to survive and reproduce (Madders & Whitfield 2006). For wind farms, the wind speed controls directly the sound power level of turbines as well as the propagation mechanisms. Wind turbines have two potential sources of noise: the turbine blades passing through the air as the hub rotates, and the gearbox and generator in the nacelle (Ziliani 2011).

Displacement has been suggested to occur potentially up to 500 m around construction sites with some disruption up to 1 km, depending on line of visibility (Madders 2004 cited in Bright *et al.* 2006).

Preliminary results at Argyll and Northern Ireland sites suggest foraging may be little affected, but local displacement of nesting attempts may occur in the order of 2-300 m around turbines (Madders & Whitfield 2006). Curlews were found to have a large avoidance distance of 800m, which suggests that breeding populations of this species may be particularly vulnerable to displacement (Pearce-Higgins *et al.* 2009).

Other studies in USA, however, have not noted any displacement effects due to the operation of wind farms (Madders & Whitfield 2006) and based on a 10 year study, de Lucas *et al.* (2008) found no indication of change in mortality rates, suggesting that there were no long-term temporal changes in birds reactions to wind farms (eg. habituation). However, the response is likely to be species specific and dependant on whether the site is providing foraging or nesting habitat and the proximity of turbines to these areas.

Based on the aforementioned studies there is the potential for some bird species to be displaced as a consequence of the proposed wind farm. Some may habituate and others may make permanent transitions to adjacent areas. Extensive areas of potential habitat are present adjacent to the site for those species recorded within the study area and it is likely that if disturbed, they would utilise this habitat. Those species for which displacement is likely to have the greatest impact are territorial species with large home ranges they may be pushed into a neighbouring territory by disturbance.

#### *Risk Matrix - Birds*

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. It is acknowledged that there is insufficient information and specific past research to determine the exact likelihood of turbine strike. However, professional judgement has been used based on habitat requirements and behaviour of the species to determine the likelihood of collisions.

Of those species recorded on site, the Little Lorikeet, Crimson Rosella (*Platycercus elegans*) and Eastern Rosella (*Platycercus adscitus eximius*) are at the most risk given their fast, flight patterns and that they may fly at height particularly when moving between feeding areas (Appendix G). The White-throated Needletail is also a greater risk than some species as this species is migratory and forages up to 'cloud level,' on updraughts and sometimes in whirlwinds. Raptors were also identified as at moderate risk of collision given their height flight patterns and large home ranges and the fact that species such as *Falco berigora* (Brown Falcon) and *Aquila audax* (Wedge-tailed Eagle) soar and glide increases their likelihood of collision. A small number of other species were considered at moderate risk and included those species that are migratory in response to local changes (see Appendix G).

#### *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).

There are historical records of the Regent Honeyeater within the locality and, therefore, it is possible that this species may utilise the study area and possibly in response to changes in the availability of food resources or as a stopover during migration. Therefore, at this time there is a risk of collision.

During the operational phase of the wind farm, Regent Honeyeaters may collide with the moving turbines or change their migratory paths to avoid the turbines. Species most at risk of collisions with wind turbines are those that fly at high altitudes, at speed and are migratory.

Consultation with OEH was undertaken regarding the likelihood of Regent Honeyeaters using the site and colliding with turbines. It was acknowledged that little is known about the height at which they fly or the distance with which they would cover if they were undertaking a long foraging foray throughout a day from the breeding area. The Regent Honeyeater is an arboreal species which forages mainly in the crowns of flowering trees (DSEWPAC 2011b), therefore while foraging within woodland areas within the study area, collision with turbines is unlikely. However, this species is known to fly at heights of approximately 50 m or slightly above when moving in groups and may also be at risk when . This species is considered most at risk when moving between woodland patches.

Consultation with Dean Ingwersen (Birds Australia) was also undertaken regarding the likelihood that the Regent Honeyeater would breed and / or forage across CRWF and the likely impacts on breeding. The Capertee Valley and including Mudgee to Wollar are known to be the key breeding areas for this species, as is Chiltern. However, there is the potential for this species to breed throughout its entire range. Although it is considered unlikely that this species would breed in the immediate vicinity of CRWF, this cannot be completely ruled out. Last season this species was recorded breeding in Moruya and Armidale as well as the aforementioned key breeding areas (pers comm. Dean Ingwersen, Birds Australia).

During breeding the Regent Honeyeater forages within approximately 2 km of the nest. Regent Honeyeaters are thought to be most at risk during migration, outside the breeding season (between August and November) although this is speculative in the absence of detailed information and studies. There has been minimal tracking of foraging and migration heights for this species and therefore the risk of strike cannot be accurately predicted (pers comm. Dean Ingwersen, Birds Australia).

No one really knows how high above the canopy they fly when migrating. Information on this is not available and to date people have used information from studies on other honeyeaters (eg. yellow-faced and white-naped) to infer what the Regent Honeyeater is likely to do. During local movements they are suspected to fly about 10 – 15 m above the canopy but when migrating are estimated to fly at a height of about 50 m above the canopy (pers comm. Dean Ingwersen, Bird Australia).

Suggestions have also been made that honeyeaters fly at or just above canopy height whilst foraging and move from ridge to ridge at a height between 5 m and 50 m above the canopy (pers comm. David Geering, OEH). Therefore, there is a risk that these species may also be struck by wind turbines when moving between foraging areas, particularly in areas where White Box are present and when there is an abundant flowering event. The assessments of likely impacts for this proposal have been based on the assumption that this species would fly 50 m above the canopy when migrating.

The likelihood that honeyeaters would actively avoid the wind farm is also unknown. In the absence of sufficient studies or information, the likelihood of the Regent Honeyeater being struck cannot be accurately predicted. A commitment to monitoring strike across CRWF has been made. This will include the preparation of a bird and bat monitoring program prior to operation of the wind farm that, in consultation with OEH and SEWPAC, will identify the frequency of monitoring and reporting, the thresholds at which impacts are considered unacceptable and the adaptive management approaches which are acceptable.

Dean Ingwersen (Birds Australia) suggested that the presence of the CRWF is unlikely to have a significant impact on the breeding activities of the Regent Honeyeater although he noted that it is not possible to give a definitive answer as there is not enough known about the movement patterns of this species to say which areas they use the most.

Swift Parrots are known to collide with opaque/transparent objects that they do not perceive to be barriers, such as wire netting fences, windows and cars (OEH 2011b). Mortality, primarily through collision with artificial objects, is listed as one of two key threats to the species under the Swift Parrot Recovery Plan (Swift Parrot Recovery Team 2001). As wind turbines are solid, opaque structures, they are less likely to confuse Swift Parrots, and the risk of collision is much less. Swift Parrots tend to move within the height of trees in which they are feeding, although less frequent migration between sites may be higher. A study of the cumulative impacts of collision with turbines on the overall population of Swift Parrot, was determined to be very small (Smales 2005).

The Rainbow Bee-eater is a migratory species that has been recorded at the site. This species breeds through most of its range but southern populations are known to move north during winter before returning to summer breeding areas. Populations of this species at the site would be at risk of collision with turbines during take-off for migration.

The White-throated Needletail is a highly aerial species that has been recorded within the study area. This species arrives in Australia from its breeding grounds in the northern hemisphere in spring and return to Asia to breed around mid-May. Populations of this species at the site would be at risk of collision with turbines during take-off and landing for migration and would also be at risk during foraging as they are known to forage at heights up to 'cloud level' and usually in areas of updraught, on the edges of low pressure systems or the smoke of bushfires and occasionally in whirlwinds (DSEWPAC 2011b).

The majority of other species are migratory in response to local changes and, therefore, at lower risk of collision (see Appendix G). Bird strike will be monitored during the operation of the wind farm and an adaptive management approach implemented whereby additional measures are investigated should significant bird strike at certain turbines be recorded.

#### 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 *Podargus strigoides* (Tawny Frogmouth), *Ninox boobook* (Southern Boobook) and *Aegotheles cristatus* (Australian Owlet-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.

## 5.6 SUMMARY OF DIRECT IMPACTS

- Layout A is likely to have the greatest impacts. Therefore, based on this layout, approximately:
  - 0.81 ha permanent and 0.40 ha of temporary removal of BPBGRS
  - 65.44 ha permanent and 31.05 ha of temporary removal of RSSGRBLLB
  - 0.12 ha permanent and 0.02 ha of temporary removal of WTG
  - 5.27 ha permanent and 0.11 ha of temporary removal of WBBRGYB
- Removal of up to approximately 71.64 ha of potential habitat for a variety of species and 31.58 ha of temporary clearance based on Layout A (with 6 m clearance for roads);
- Approximately 19,963 HBTs are estimated to be present across the study area and it is anticipated that up to 920 HBTs (4.61 %) may be removed for the proposal;
- Of the species recorded across the study area, White-striped Freetail Bat, Yellow-bellied Sheath-tail-bat and Southern Freetail Bat were the species considered to have a high potential for collisions with turbines. Given the Eastern Bentwing-bat is also a migratory species and is known to be attracted to lighting, this species was also considered to be slightly more at risk; and
- There is moderate potential for collisions by birds of prey, raptors, migratory species and passerines across the study area.

## 5.7 INDIRECT IMPACTS - CONSTRUCTION

### 5.7.1 Runoff, sedimentation and erosion

The study area is located upslope of a number of ephemeral creeks and tributaries and a number pass through or occur adjacent to the study area. The Crudine River also lays downslope of the study area. Crossing across a small number of drainage lines is proposed. 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) will be prepared and implemented to prevent such occurrences. Measures to prevent pollutants from being transported from the site into the creek will 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 the recorded threatened plants in the powerline easement. Dust, if uncontrolled, could impact on the viability of nearby plants. For this reason, it has been recommended that a water cart be present during construction to reduce dust. Given that widening of the current access track in proximity to the recorded *Swainsona recta* is not proposed, impacts from dust on this species are likely to be minimal.

### 5.7.2 Hydrological changes

The proposal involves the establishment of multiple 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 (if any) 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 in already disturbed areas, wherever possible, 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 and movement of

vehicles throughout the site.

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 three years is also required. Six metre wide roads with 12 m passing bays have been proposed 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 Cudgegong Draft Bushfire Risk Management Plan and consultation with Garry Barrett of the Cudgegong Rural Fire District Office, the site and surrounds have not been affected by a large bushfire within the last 10-15 years. The Crudine Ridge Wind Farm location has experienced very little fire history due to the dominance of grazing and cropping in the area. Based on past fire history, there is no clear indication of the portion of the project site that is thought to be the most likely to experience a large bushfire (ELA 2011b).

The Cudgegong Bushfire Management Committee area has approximately 150 - 200 bush fires per year, of which approximately 3 - 5 can be considered to be major fires, but the occurrence of these are not uniformly spread across the landscape, and no major fires have occurred at or immediately surrounding the site for many years. The ignition source of such fires is similar to other rural environments of NSW with fires commonly started by lightning strikes and as accidental fires started from rural and farming activities (ELA 2011b).

The vegetation within the site is considered to be within the ‘high,’ ‘medium,’ ‘lower’ and ‘negligible’ fuel groups depending on the vegetation type (structure and available fuel loads) and condition (level of disturbance and regeneration), as discussed in **Table 28** (ELA 2011b).

**Table 28: Description of the four fuel groups adapted from Dovey (1994) (ELA 2011b)**

FUEL GROUP	CHARACTERISTICS OF EACH FUEL GROUP	RELEVANCE TO CRUDINE
High	Continuous fuels, higher quantity, available to burn during average seasons ( <i>higher fire intensity expected</i> ).	Only present in isolated pockets along the eastern and northern extremities of the site. Also likely to be present further to the north, north east and south east of the site where there are more extensive areas of Open Forest.
Medium	Less continuous fuels, medium level quantity, available to burn during average seasons but may be less often than high ( <i>medium or high fire intensity expected</i> ).	Present at the site in the form of intact and good condition Woodland, and highly disturbed / modified Open Forest areas.
Lower	Possibly discontinuous fuels, low-medium fuel quantity, moister fuels unlikely to contribute to high intensity fires in average season, fuel structure facilitates easier control ( <i>fire intensities may range from low-high and generally regarded as easier to control</i> ).	Present at the site in the form of poor condition Woodland and Native Grasslands.

FUEL GROUP	CHARACTERISTICS OF EACH FUEL GROUP	RELEVANCE TO CRUDINE
Minimal	Unlikely to burn or always burn within controllable limits.	Present at the site in the form of pasture grass.

Based on the information provided in the fire weather and fire hazard analysis, likely fire behaviour can be predicted. It is a combination of undesirable fire weather (i.e. hot and dry westerly winds during summer) and the potential for a grassfire to spread towards farm assets in the surrounding area. A grass fire under the influence of wind may travel fast, reaching assets before fire fighters can attend the scene (ELA 2011b).

The existing level of bushfire protection for life and property in the surrounding area is relatively good due to the existence of vast areas of cleared grazing lands combined with the compartmentalisation of the landscape by roads. Grazing land and roads provide breaks and control lines for fast spreading grass fires (ELA 2011b).

The project site and surrounding area can be accessed by the immediate and surrounding road network, providing acceptable response times for local volunteer NSW Rural Fire Service fire fighters. A volunteer RFS brigade is located at the Crudine township (ELA 2011b).

The site is covered by the Cudgong Draft Bushfire Risk Management Plan which provides a platform to manage bushfire risk across the districts (ELA 2011b).

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. Noise levels across the wind farm will also vary depending on the wind direction and distance of habitat from wind farm infrastructure. Some species, and particularly when breeding, have been noted as sensitive to noise disturbance (eg. nesting owls). However, habituation or limited disturbance has been noted in other species. Therefore, it is difficult to generalise about the likely impacts of noise from the wind farm on fauna and in the absence of detailed studies on individual species and wind farms, it is anticipated that the greatest disturbance would take place during construction and the noise may displace some fauna. However, for the majority of species the impact is likely to be short term.

## 5.8 INDIRECT IMPACTS - OPERATION

### 5.8.1 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 (controlled 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 (*Alauda arvensis*) 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 rural 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.

### 5.8.2 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 farms may displace bird species due to avoidance behavioural patterns. Given that the majority of the species utilising the project site are not migratory and that habitat for all species is extensive throughout the project site and locality, it is unlikely that turbine avoidance would displace any populations or species such that their habitat requirements would no longer be met.

### 5.8.3 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 *Vulpes vulpes* (Red Fox), are unlikely to be increased beyond current levels or increase the carrying capacity of resident Red 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.

### 5.8.4 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*.

## 5.9 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.

### 5.10 CUMULATIVE IMPACTS

There are currently four other wind farms in operation or proposed for the Central Western Slopes in proximity to the proposed Crudine Ridge Wind Farm (Wind Farms in NSW, unpublished website 2012).

- **Blayney Wind Farm** (15 turbines) is situated between Carcoar Dama and Mount Macquarie and was constructed in 2000. Blayney Wind Farm is located 63 km to the south west of Hill End and 70 km from the proposed Crudine Ridge Wind Farm (Wind Farms in NSW, unpublished website 2012).
- **Black Springs Wind Farm** (9 turbines) has been approved with conditions and is located near Oberon, about 50 km south of Bathurst and 96 km from Hill End and 93 km from the proposed Crudine Ridge Wind Farm.
- **Flyers Creek Wind Farm** (up to 44 turbines) is to be situated 20 km south of Orange, 60 km from Hill End and 70 km from the proposed Crudine Ridge Wind Farm. An application for the construction of this wind farm is currently under review by the Department of Planning.
- **Uungala Wind Farm** (up to 250 turbines) is situated 40 km to the north west. An application for construction is in the early stages of development, DGR's have been issued and site assessments will commence in the second half of 2012.

The majority of the locality is used for agricultural purposes. The protection and management of a large parcel of land (or several parcels 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, which may otherwise be degraded and impacted by agricultural practices.

The Crudine Ridge Wind Farm is not located within any known key migratory bird pathways. However it is possible that some species, particularly the Regent Honeyeater, may pass across and use CRWF particularly during flowering events. Migratory honeyeaters are likely to frequent the area when winter flowering eucalypts (primarily White Box, *Eucalyptus albens*) are in heavy flower. This may not occur every year.

The cumulative impact of CRWF and the surrounding wind farms on the Regent Honeyeater is difficult to determine. Although there is some distance between CRWF and most of the other proposed wind farms, Uungala is the nearest proposed wind farm and has a large number of proposed turbines. There is the potential for honeyeaters to be struck across the both wind farms when moving between foraging areas or migrating.

Dean Ingwersen (Birds Australia) suggested that the presence of the CRWF is unlikely to have a significant impact on the breeding activities of the Regent Honeyeater although he noted that it is not possible to give a definitive answers as there is not enough known about the movement patterns of this species to say which areas they use the most.

There is also the potential for bat species with large home ranges (eg. Eastern Bentwing-bat) to be struck across both CRWF and Uungala. There are gaps in the understanding of the Eastern Bentwing-bat, the height at which they fly and the impact of other wind farms on this and other bat species. This

species can travel up to 65 km in one night and, therefore, may cross more than one wind farm in a foraging event.

Whilst the likelihood of the species being struck cannot be accurately predicted, a commitment to monitoring strike across CRWF has been made. This will include the preparation of a bird and bat monitoring program prior to operation of the wind farm that, in consultation with OEH and SEWPAC, will identify the frequency of monitoring and reporting, the thresholds at which impacts are considered unacceptable and the adaptive management approaches which are acceptable.

Likely cumulative impacts associated with multiple wind farms being present within the region are likely to be restricted to highly mobile species and potentially the cumulative loss of vegetation communities present across numerous wind farms. The vegetation clearing associated with the wind farms constitutes a very small proportion of existing vegetation and available woodland habitat in the region.

Cumulative impacts from Crudine Ridge Wind Farm and the other wind farms in the area have been assessed as low with the exception of Ungala which is approximately 40 km from CRWF and has a large number of proposed turbines. The large size of this wind farm will increase the risk of cumulative impacts on mobile species (i.e. some bats and migratory birds) when both CRWF and Ungala are in operation.. Impacts on migratory and mobile species are expected to be lower as the proposed 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. However, the presence of a key breeding area for the Regent Honeyeater nearby means that the risk of collision and cumulative impacts on this species is likely to be higher, particularly given their movement is driven by flowering events.

#### 5.11 ADDITIONAL SWITCHING STATION

A fourth switching station option was added to the proposal after the field surveys had been undertaken. However, the development footprint still falls within the study area and the vegetation types and conditions do not change from those of the nearby substation option. Furthermore, impacts have been calculated based on the substation anticipated to have the greatest impact on ecological values and this did not change with the addition of the fourth substation.

## 6 Offset Requirements, Strategy & Proposed Package

### 6.1 INTRODUCTION

The DGRs for the Crudine Wind Farm require the proponent to “*demonstrate how the project (with incorporation of all proposed measures to avoid, mitigate and/or offset impacts) achieves a biodiversity outcome consistent with ‘maintain or improve’ principles. Sufficient details must be provided to demonstrate the availability of viable and achievable options to offset the impacts of the project and to secure these measures in perpetuity*” (DoP&I 2010).

The measures to avoid and mitigate the impacts of the project are outlined in Section 5.2 and 5.3 of this report. This section provides a detailed description of the proposed offset strategy which addresses ‘maintain or improve’ principles as required by the DGRs and the OEH’s Interim Offset Policy for Major Projects (OEH 2011). In summary the proposed Biodiversity Offset Package (BOP) provides for:

- A ‘maintain or improve’ quantification of the impacts of the project using the Biobanking Assessment Methodology;
- A covenanted or transferred offset property/properties which provide for in perpetuity protection on title where existing biodiversity values would be enhanced to meet the calculated offset requirement; and
- In perpetuity biodiversity management of this/these property.

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 and CoA 2011)**

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.

Recently the Commonwealth Government has released a consultation draft of the environmental offsets policy under the EPBC Act (CoA 2011), which includes much of the information above but also some key additions and changes relating to offsets policy. The policy focuses on providing high-quality conservation outcomes for matters of NES while also allowing proponents more flexibility to find and secure offsets. The consultation draft of the policy has four main aims, including:

1. Ensuring the efficient, effective, transparent, proportionate, scientifically robust and reasonable use of offsets under the EPBC Act;
2. Providing proponents, the community and other jurisdictions with greater certainty and guidance on how offsets are determined and applied under the EPBC Act;

3. Delivering improved environmental outcomes by consistently applying offsets policy;
4. Explaining the Government’s position on a range of issues, including:
  - a) When it is appropriate to consider offsets as part of a project;
  - b) The appropriate nature and scale of offsets;
  - c) The use of market-based instruments for the delivery of offsets.

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 have investigated the availability of potential offset sites in the vicinity of the Project area. There are a range of mechanisms available that meet the offsetting principals. These are illustrated in **Image 12**. 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 OEH’s preferred offset mechanism.

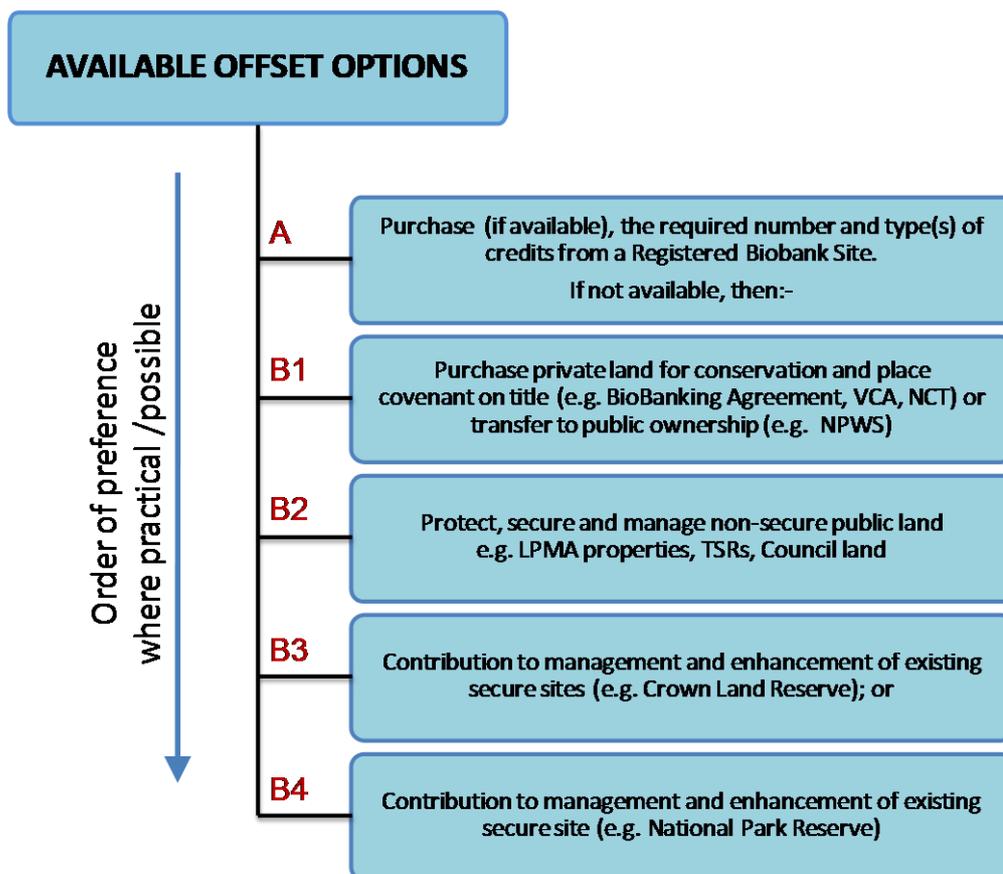


Image 12: Available Offsetting Principals in order of preference

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. A number of land owners have expressed interest in entering into an appropriate conservation covenant and a further five properties currently for sale are able to meet the offset requirements for the project (i.e. they are of an appropriate size, have the same or higher conservation value vegetation types and thus meet the “*like for like or better*” offset principle) and are not currently required under any existing legislative requirement to be actively managed for biodiversity conservation and thus also meet the “additionality” offset principle. The ability to secure an appropriate offset for the project is readily achievable. The biodiversity values of each of these properties is discussed in more detail in Section 6.5.

In addition, there are a number of Travelling Stock Reserves (TSRs) adjacent to the project site that have high biodiversity values and limited funds for their management. These stock reserves are currently managed by the Central North Livestock Health and Pest Authority and maybe transferred back to the Department of Lands. Should it not be possible to secure a large enough privately owned offset property, a financial contribution to enhance the biodiversity management of these lands may also be made.

#### 6.4 OFFSET REQUIREMENT TO MEET MAINTAIN OR IMPROVE CONSERVATION OUTCOME

Other than the Biobanking Assessment Methodology (BAM), there is no standardised quantitative method of assessing whether a proposal meets the ‘maintain or improve’ standard specified in the DGRs. Accordingly, an indicative Biobanking Assessment has been conducted for the proposal to inform the “quantum” of biodiversity offsets required to meet an ‘maintain or improve’ outcome in accordance with the OEH interim policy on Biodiversity Offsets for Part 3A and Major Projects (OEH 2011c) (Appendix I).

The OEH Interim Policy specifically acknowledges that proposals assessed under Part 3A of the EP&A Act do not have to meet the ‘maintain or improve’ standard which is required under the Biobanking Scheme. The approach taken by Wind Prospect CWP is consistent with this policy. The BAM has been used to inform the quantum of offset required, and whilst it is OEHs preference that a Tier 1 ‘maintain or improve’ 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 biobank impact assessment undertaken represents the ‘worst case’ scenario, in terms of ecological impact, resulting from the various wind farm options. The assessment has assumed that the maximum number of turbines (106 turbines) will be selected, a 6 m wide road design with cut and fill areas and intermittent 12 m passing bays, and has included all hardstand areas around turbines and parallel to roads. The biodiversity impact of the wind farm may actually be less than calculated in this report should the final design option use only 77 turbines.

A summary of the credits required to offset the impact of the proposal is provided in **Table 29**. A full credit assessment report is provided in Appendix I.

#### 6.4.1 Ecosystem Credits Required at the Offset Site

When using the BAM (and the ‘maintain or improve’ 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 generate 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 thus providing a target “range”. 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 106 turbine option.

Based on this scenario, a total of 4,271 ecosystem credits are required to offset the impacts to three vegetation types. An impact of 0.1 ha occurs to WTG, however, as this impact is too small to be assessed using the Biobanking methodology it was added to the WBBRGYB vegetation type.

The OEH Credit Converter was used to estimate the area of offset required to meet the calculated offset requirements. The OEH credit converter assumes that offset site will generate 9.3 credits per hectare, thus the area of offset required to meet a “Tier 2 No Net Loss” outcome is estimated to be 459 ha. **Table 29** provides a breakdown of the offset requirements per Biometric vegetation type. A Tier 3 “Mitigated Loss” outcome (an offset ratio of at least 2:1) would require a minimum offset area of 206.2 ha (Appendix I). A Tier 1 offset cannot be achieved due to impacts to “red flag” vegetation communities.

The Biobanking Credit report also indicates that the offsets can be secured in a range of similar vegetation types, with a mixture of CMA subregions also able to provide any potential offset.

#### 6.4.2 Species Credits Required at the 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 48 ha of potential habitat for the Yellow-bellied Sheath-tail-bat is required to offset the 13.05 ha of potential habitat being impacted. Under Biobanking these credits can be obtained from the same offset site as the ecosystem credits, or a different offset site should that be required (**Table 30** and Appendix I). Where possible Wind Prospect CWP will aim to secure the offset from the same site.

**Table 29: Ecosystem Credit requirements for Layout A**

VEGETATION TYPE	CONDITION	TOTAL IMPACT (HA)	CREDITS REQUIRED	CREDITS/ HA	ESTIMATED NO. CREDITS GENERATED / HA- AT BIOBANK SITE	OFFSET REQUIRED (HA)
Broad-leaved Peppermint - Brittle Gum - Red Stringybark dry open forest on the South Eastern Highlands	DNG	1.2	20	16.7	9.3	2.15
Red Stringybark - Scribbly Gum - Red Box - Long-leaved Box shrub - tussock grass open forest the NSW South Western Slopes Bioregion (Benson 290)	DNG	89.9	3979	41.2	9.3	427.87
	Woodland	6.6				
White Box - Blakely's Red Gum - Yellow Box grassy woodland of the NSW South Western Slopes Bioregion (Benson 282)	DNG	2.4	271	50.3	9.3	29.18
	Woodland	3.0				
<b>Total</b>	<b>N/A</b>	<b>103.1</b>	<b>4270</b>	<b>41.4</b>	<b>9.3</b>	<b>459.2</b>

**Note:** DNG = Derived Native Grassland

**Table 30: Estimated Yellow-bellied Sheath-tail-bat Species Credit Offset for Layout A**

HABITAT TYPE	AREA IMPACTED (HA)	CREDITS REQUIRED	AVERAGE NO. CREDITS GENERATED/HA	OFFSET REQUIRED (HA)
Potential	13.05	290	6	48

## 6.5 PROPOSED OFFSET PACKAGE

Based on the offset calculations conducted using the OEH Credit Converter, an offset of between 206-460 ha is required to meet a Tier 3 or Tier 2 offset consistent with the Interim Offset Policy. A Tier 1 offset cannot be met due to impacts to red flag areas. The offset is also to include approximately 50 ha of Yellow-bellied Sheath-tail-bat habitat, which can be obtained from within the same offset site as the vegetation, or an alternative site should that be required.

Due to the area of each vegetation type being impacted, the offset is to predominantly consist of the RSSGRBLLB vegetation type (193 - 427 ha). However, the offset will also be required to contain examples of the other vegetation types on site, most notably the WBBRGYB, which requires an offset of between 10.8 ha - 29.1 ha.

Five (5) properties have been identified for sale and three properties whose owners are interested in entering into in perpetuity conservation covenants in the vicinity of the project site (**Figure 12** and **Table 31**). Each of these properties is capable of meeting a Tier 3 or 2 offset outcome for the project in area of offset and vegetation type and condition. Preliminary vegetation mapping has been undertaken on three of these properties confirming the targeted vegetation types, area and condition states (**Figure 13**, **Figure 14**, and **Figure 15**).

Following project approval, and prior to construction works commencing, Wind Prospect CWP will enter into negotiations to purchase one or more of these properties and/or enter into a legally binding, in perpetuity conservation covenant with the relevant land owner to meet either a Tier 3 or Tier 2 offset. The final offset property, if purchased, will either be transferred to the NSW Minister for the Environment as an addition to the public reserve network together with a resource package to establish and manage the new reserve in perpetuity, or if not suitable as an addition to the national reserve network will have an a conservation covenant registered on title as below.

The owners of properties not purchased will enter into a legally binding conservation covenants (Conservation Agreement under the *National Parks and Wildlife Act 1974*, Trust Agreement under the *Nature Conservation Trust Act 2001* or Property Vegetation Plan under the *Native Vegetation Act 2003*). The covenant (and an associated biodiversity management plan) will be prepared to require in perpetuity management of the offset area. Wind Prospect will establish a Trust Fund guaranteeing annual payments to the land owner in line with management cost estimates outlined in the management plan and its periodic review. An annual management plan implementation report will be prepared and submitted to the NSW DoP&I outlining the management actions and results implemented over the previous 12 months triggering payments for the subsequent 12 months.

The OEH has advised that the properties for sale in the Capertee Valley would be acceptable for land transfer and dedication to the recently established adjacent Capertee National Park (subject to an agreeable resource package) (Tim Hager, OEH Hurstville pers.comm.) OEH will advise whether properties in the Hill End area are suitable for reservation (Peter Christie, OEH Dubbo, pers.comm.).

Should property purchases and/or covenanting not meet a minimum Tier 3 offset outcome, Wind Prospect will contribute to the Central North Livestock Health and Pest Authority/Department of Lands for the duration of the project to assist in the biodiversity management of a Travelling Stock Reserve (TSRs) adjacent to the project site. These funds may be used to undertake ecological assessments of the biodiversity values of the TSRs, prepare plans of management and / or undertake weed and pest animal control activities enhancing local biodiversity values.

Impacts to EPBC listed communities and species (potential habitat) will also be offset through the land

purchase and / or conservation agreements with interested landowners. Given the impacts to MNES (

**Table 34)** the offset range of 206 ha - 460 ha and vegetation types described above for NSW offset requirements are considered sufficient to meet all federal offset requirements, if required. The offset will include:

- An appropriate offset for impact on 3 ha of EPBC listed Box-Gum Woodland;
- Offsets for various EPBC listed fauna species identified as having **potential** habitat (but not recorded during targeted surveys) impacted by the proposed wind farm, such as Swift Parrot and Regent Honeyeater (impact of 14.3 ha), Large-eared Pied Bat, Greater (eastern) Long-eared Bat, Superb Parrot, Satin Flycatcher and Spotted-tailed Quoll (impact of 9.6 ha) and Grey-headed Flying-fox (impact of 17.82 ha);
- Offsets for various EPBC listed flora species identified as having **potential** habitat (but not recorded during targeted surveys) impacted by the proposed wind farm, such as *Prasophyllum* sp. Wybong, *Bothriochloa biloba* and *Thesium australe* (impact of 103.1 ha), *Eucalyptus cannonii* (impact of 97.7 ha) and *Eucalyptus robertsonii* subsp. hemisphaerica (impact of 0.21 ha).

While further inspection may update and refine the vegetation types on site, any conservation agreement will be designed to meet the NSW offset requirements described above for both vegetation types and the Yellow-bellied Sheath-tail-bat habitat.

**Table 31: Areas of mapped vegetation on potential offset properties**

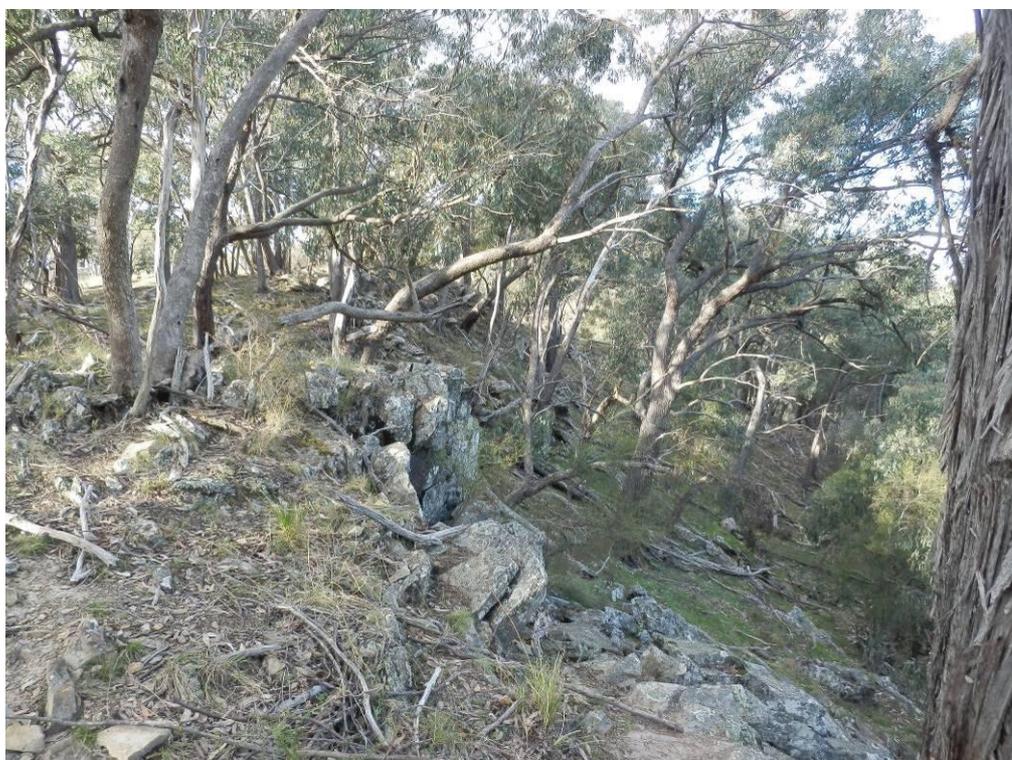
VEGETATION COMMUNITIES (BIOMETRIC TYPES)	TEC EQUIVALENT	IMPACT (HA)	OFFSET TARGET (HA) (TIER 3 - TIER 2)	PROPERTIES FOR SALE				LANDOWNERS INTERESTED IN CONSERVATION COVENANTS		
				S1	S2	S3	S4	C1	C2	C3
Broad-leaved Peppermint - Brittle Gum - Red Stringybark dry open forest on the South Eastern Highlands	Not listed	1.20	2.15-2.4	0	0	0	0	0	0	
Red Stringybark-Scribbly Gum-Red Box-Long-leaved Box shrub-tussock grass open forest, Moderate to Good, Pasture	Not listed	89.90	193-427		248			1		
Red Stringybark-Scribbly Gum-Red Box-Long-leaved Box shrub-tussock grass open forest, Moderate to Good, Trees	Not listed	6.60			323			31		
White Box-Blakelys Red Gum-Yellow Box grassy woodland, Moderate to Good, Pasture	Not listed	2.40	10.8-29.1	18.32	210			156		
White Box-Blakelys Red Gum-Yellow Box grassy woodland, Moderate to Good, Trees	White Box - Yellow Box - Blakely's Red Gum grassy woodland and derived native grasslands	3.00		51.77	74			47		
Blakely's Red Gum - Yellow Box - Rough-barked Apple grassy woodland of the Capertee Valley, Sydney Basin (woodland)	White Box - Yellow Box - Blakely's Red Gum grassy woodland and derived native grasslands					67	290		107	

VEGETATION COMMUNITIES (BIOMETRIC TYPES)	TEC EQUIVALENT	IMPACT (HA)	OFFSET TARGET (HA) (TIER 3 - TIER 2)	PROPERTIES FOR SALE				LANDOWNERS INTERESTED IN CONSERVATION COVENANTS		
				S1	S2	S3	S4	C1	C2	C3
Blakely's Red Gum - Yellow Box - Rough-barked Apple grassy woodland of the Capertee Valley, Sydney Basin (derived grassland)	White Box - Yellow Box - Blakely's Red Gum grassy woodland and derived native grasslands					56	46		???	
White Box - Narrow-leaved Ironbark grassy woodland of the Capertee Valley, Sydney Basin	White Box - Yellow Box - Blakely's Red Gum grassy woodland and derived native grasslands								160	
Grey Box - grass tree - spinifex woodland on limestone hills of the western Hunter and Capertee Valleys, Sydney Basin	White Box - Yellow Box - Blakely's Red Gum grassy woodland and derived native grasslands								1	
Grey Gum - Narrow-leaved Stringybark - Inland Scribbly Gum shrubby open forest of the western Capertee Valley, Sydney Basin	Not listed					200	81		24	
Blue-leaved Ironbark - pine shrubby open forest on hills in the Capertee Valley, Sydney Basin	Not listed					55	0			
River Oak open forest of major streams, Sydney Basin and South East Corner	Not listed					2	2			
Grey Myrtle - Lilly Pilly dry rainforest in dry	Not listed								1	

VEGETATION COMMUNITIES (BIOMETRIC TYPES)	TEC EQUIVALENT	IMPACT (HA)	OFFSET TARGET (HA) (TIER 3 - TIER 2)	PROPERTIES FOR SALE				LANDOWNERS INTERESTED IN CONSERVATION COVENANTS		
				S1	S2	S3	S4	C1	C2	C3
gullies, Sydney Basin and South East Corner										
Inland Scribbly Gum - Grey Gum - Narrow-leaved Ironbark shrubby open forest on hills of western Capertee Valley, Sydney Basin	Not listed								30	
Cleared	N/A			10.62	0			0	350	
<b>Total</b>		<b>103.10</b>	<b>206-460</b>	<b>80.71</b>	<b>855</b>	<b>380</b>	<b>419</b>	<b>234</b>	<b>673</b>	<b>195</b>



**Image 13: Derived native grassland on potential offset property C1**



**Image 14: Remnant Red Stringybark-Scribbly Gum-Red Box-Long-leaved Box shrub-tussock grass open forest grassland on potential offset property C1**



**Image 15: Remnant Box Gum Woodland on property S1 with *Swainsona recta* habitat**



**Image 16: Remnant Red Stringybark-Scribbly Gum-Red Box-Long-leaved Box shrub-tussock grass open forest grassland on property S2**



**Image 17: Remnant Red Stringybark-Scribbly Gum-Red Box-Long-leaved Box shrub-tussock grass open forest grassland on property S2**

**Table 31** provides a summary of the area and condition of each vegetation type impacted and the target offset area to achieve a minimum Tier 3 offset (2:1 ratio) or a Tier 2 offset (full BAM calculated offset area). Depending on the final combination of properties that form the offset package, the proportion of woodland to Derived Native Grassland (DNG) vegetation condition sates will vary however, existing woodland areas will be targeted in the selection process and DNG areas progressively rehabilitated through removal of grazing and natural regeneration or assisted (tree planting) regeneration. The offset ratio for impacts to WBBRGYB will be up to 5.36:1 and for RSSGRBLLB will be up to 4.4:1.

**Table 30** indicates that an offset target of 48 ha of suitable habitat will achieve an offset ratio of 3.68:1 for the Yellow-bellied Sheath-tail Bat, although this offset ratio is likely to be significantly exceeded by the targets for woodland vegetation types.

**Table 34** provides a summary for each Matter of National Environmental Significance impacted by condition and the corresponding offset ratios. Again, depending on the final combination of properties that form the offset package, the proportion of woodland to DNG vegetation condition sates will vary however, existing woodland areas will be targeted in the selection process and DNG areas progressively rehabilitated through removal of grazing and natural regeneration or assisted (tree planting) regeneration. The offset ratio for impacts to EPBC Act listed Box-Gum Woodland will be up to 7.3:1 and is likely to be higher than this given the proportion of woodland on the identified offset properties.

Whilst there were no confirmed records of Swift Parrot, Regent Honey-eater, Grey-headed Flying-fox,

Large-eared Pied Bat, Greater Long-eared Bat, Superb Parrot, Satin Flycatcher, Spotted-tailed Quoll, White-throated Needle-tail, Rainbow Bee-eater, Cattle Egret or Great Egret, potential habitat exists, there are previous records in the region and the species may use habitat on site from time to time. The proportion of potential habitat impacted and the likely offset ratio for each of these species is included in

**Table 34.**

Areas of potential habitat impacted, and offset ratios of potential habitat for *Bothriochloa biloba*, *Eucalyptus cannonii*, *E. robertsonii* subsp. *hemisphaerica*, *Prasophyllum* sp. Wybong, and *Thesium australe* are also shown in

**Table 34.**

**Table 32: Offset outcomes for overall impacts to biodiversity values (NSW) – ecosystem credits**

BIOMETRIC VEGETATION TYPE	CONDITION	IMPACT			TIER 3-2 OFFSET TARGET (HA)	OFFSET : IMPACT RATIO
		IMPACT AREA (HA)	CREDITS REQUIRED	AVERAGE CREDITS REQUIRED /HA		
Broad-leaved Peppermint - Brittle Gum - Red Stringybark dry open forest on the South Eastern Highlands	DNG	1.2	20	16.7	2.15-2.4	2:1
<b>Sub-total</b>		<b>1.2</b>	<b>20</b>	<b>16.7</b>	<b>2.15-2.4</b>	<b>2:1</b>
Red Stringybark - Scribbly Gum - Red Box - Long-leaved Box shrub - tussock grass open forest the NSW South Western Slopes Bioregion (Benson 290)	DNG	89.9	3,560	39.6	180-383	2-4.26:1
Red Stringybark - Scribbly Gum - Red Box - Long-leaved Box shrub - tussock grass open forest the NSW South Western Slopes Bioregion (Benson 290)	Woodland	6.6	419	63.5	13-45	2-6.8:1
<b>Sub-total</b>		<b>96.5</b>	<b>3,979</b>	<b>41.2</b>	<b>193-428</b>	<b>2-4.4:1</b>
White Box - Blakely's Red Gum - Yellow Box grassy woodland of the NSW South Western Slopes Bioregion (Benson 282)	Low Pasture	0.3	7	22.8	0.6-0.75	2-2.5:1

BIOMETRIC VEGETATION TYPE	CONDITION	IMPACT			TIER 3-2 OFFSET TARGET (HA)	OFFSET : IMPACT RATIO
		IMPACT AREA (HA)	CREDITS REQUIRED	AVERAGE CREDITS REQUIRED /HA		
White Box - Blakely's Red Gum - Yellow Box grassy woodland of the NSW South Western Slopes Bioregion (Benson 282)	DNG	2.1	58	27.6	4.2-6.2	2-2.95:1
White Box - Blakely's Red Gum - Yellow Box grassy woodland of the NSW South Western Slopes Bioregion (Benson 282)	Woodland	3	207	68.8	6-22	2-7.3:1
<b>Sub-total</b>		<b>5.4</b>	<b>271</b>	<b>50.3</b>	<b>10.8—28.95</b>	<b>2-5.36:1</b>
<b>Total</b>		<b>103.1</b>	<b>4,270</b>	<b>41.4</b>	<b>206-459</b>	<b>2-4.45:1</b>

**Note:** Pasture = Derived Native Grassland

**Table 33: Offset measures for overall impacts to biodiversity values (NSW) – species credits**

BIOMETRIC VEGETATION TYPE	CONDITION	IMPACT			TIER 1 OFFSET TARGET (HA)	OFFSET : IMPACT RATIO
		IMPACT AREA (HA)	CREDITS REQUIRED	CREDITS REQUIRED /HA		
Yellow-bellied Sheath-tail-bat	Potential	13.05	290	22.2	48	3.68:1

**Table 34: Offset measures for impacts to Matters of NES (EPBC Act)**

MATTERS OF NES	CONDITION	IMPACT AREA (HA)	TIER 3-2 OFFSET TARGET (HA)	OFFSET: IMPACT RATIO
White Box grassy woodland of the Nandewar and Brigalow Belt South Bioregions	Woodland	3.0	6 - 22	2 - 7.3#
<b>Total</b>		<b>3.0</b>	<b>6 - 22</b>	<b>2 - 7.3#</b>
<b>EPBC Act listed Species</b>				
<b>Swift Parrot and Regent Honeyeater (Potential Habitat)*</b>				
Broad-leaved Peppermint-Brittle Gum - Red Stringybark dry open forest on the southeastern highlands	DNG	0.06	2.15 – 2.4	30.71 - 34.2
Broad-leaved Peppermint-Brittle Gum - Red Stringybark dry open forest on the southeastern highlands	Woodland	0.01		
Red Stringybark - Scribbly Gum - Red Box - Long-leaved Box shrub - tussock grass open forest the NSW South Western Slopes Bioregion	DNG	4.49	193 - 427	17.3 – 38.4
Red Stringybark - Scribbly Gum - Red Box - Long-leaved Box shrub - tussock grass open forest the NSW South Western Slopes Bioregion	Woodland	6.63		
White Box-Blakely's Red Gum-Yellow Box grassy woodland	DNG	0.12	10.8 - 29.1	3.44 – 9.27
White Box-Blakely's Red Gum-Yellow Box grassy woodland	Woodland	3.02		
<b>Total</b>		<b>14.33</b>	<b>205 – 458.5</b>	<b>14.3 – 31.9:1</b>
<b>Large-eared Pied Bat, Greater (eastern) Long-eared Bat, Superb Parrot, Satin Flycatcher and Spotted-tailed Quoll (Potential foraging habitat)</b>				

MATTERS OF NES	CONDITION	IMPACT AREA (HA)	TIER 3-2 OFFSET TARGET (HA)	OFFSET: IMPACT RATIO
Broad-leaved Peppermint-Brittle Gum - Red Stringybark dry open forest on the southeastern highlands	DNG	0.01	2.15 – 2.4	215 - 240
Red Stringybark - Scribbly Gum - Red Box - Long-leaved Box shrub - tussock grass open forest the NSW South Western Slopes Bioregion	Woodland	6.63	193 - 427	29.1 – 64.4
White Box-Blakelys Red Gum-Yellow Box grassy woodland	Woodland	3.00	6 - 22	2 – 7.3
<b>Total</b>		<b>9.64</b>	<b>201.15 – 451.4</b>	<b>20.8 – 46.8</b>
<b>Grey-headed Flying-fox (Potential foraging habitat)</b>				
Broad-leaved Peppermint-Brittle Gum - Red Stringybark dry open forest on the southeastern highlands	DNG	1.2	2.15 – 2.4	1.77 – 1.98
Broad-leaved Peppermint-Brittle Gum - Red Stringybark dry open forest on the southeastern highlands	Woodland	0.01		
Red Stringybark - Scribbly Gum - Red Box - Long-leaved Box shrub - tussock grass open forest the NSW South Western Slopes Bioregion	DNG	4.49	193 -427	17.3 -38.4
Red Stringybark - Scribbly Gum - Red Box - Long-leaved Box shrub - tussock grass open forest the NSW South Western Slopes Bioregion	Woodland	6.63		
White Box-Blakely's Red Gum-Yellow Box grassy woodland,	DNG	2.47	10.8 – 29.1	1.96 – 5.3
White Box-Blakely's Red Gum-Yellow Box grassy woodland,	Woodland	3.02		
<b>Total</b>		<b>17.82</b>	<b>205.95 - 458.5</b>	<b>11.56 - 25.73</b>
<b><i>Prasophyllum sp. Wybong, Bothriochloa biloba and Thesium australe</i> (Potential habitat)</b>				
Broad-leaved Peppermint-Brittle Gum - Red Stringybark dry open forest on the southeastern highlands	DNG	1.2	2.15 – 2.4	1.77 – 1.98

MATTERS OF NES	CONDITION	IMPACT AREA (HA)	TIER 3-2 OFFSET TARGET (HA)	OFFSET: IMPACT RATIO
Broad-leaved Peppermint-Brittle Gum - Red Stringybark dry open forest on the southeastern highlands	Woodland	0.01		
Red Stringybark - Scribbly Gum - Red Box - Long-leaved Box shrub - tussock grass open forest the NSW South Western Slopes Bioregion	DNG	89.86	193 - 427	2.0 – 4.43
Red Stringybark - Scribbly Gum - Red Box - Long-leaved Box shrub - tussock grass open forest the NSW South Western Slopes Bioregion	Woodland	6.63		
White Box-Blakely's Red Gum-Yellow Box grassy woodland,	DNG	2.36	10.8 – 29.1	2.0 – 5.41
White Box-Blakely's Red Gum-Yellow Box grassy woodland,	Woodland	3.02		
<b>Total</b>		<b>103.08</b>	<b>205.95-458.5</b>	<b>2.0 – 4.45</b>
<b><i>Eucalyptus cannonii</i> (Potential habitat)</b>				
Broad-leaved Peppermint-Brittle Gum - Red Stringybark dry open forest on the southeastern highlands	DNG	1.2	2.15 – 2.4	1.77 – 1.98
Broad-leaved Peppermint-Brittle Gum - Red Stringybark dry open forest on the southeastern highlands	Woodland	0.01		
Red Stringybark - Scribbly Gum - Red Box - Long-leaved Box shrub - tussock grass open forest the NSW South Western Slopes Bioregion	DNG	89.86	193 -427	2.0 – 4.43
Red Stringybark - Scribbly Gum - Red Box - Long-leaved Box shrub - tussock grass open forest the NSW South Western Slopes Bioregion	Woodland	6.63		
<b>Total</b>		<b>97.70</b>	<b>195.15 – 429.4</b>	<b>2.0 – 4.4</b>
<b><i>Eucalyptus robertsonii subsp. hemisphaerica</i> (Potential Habitat)</b>				
Broad-leaved Peppermint-Brittle Gum - Red Stringybark dry open forest on the southeastern highlands	DNG	1.2	2.15 – 2.4	1.77 – 1.98

MATTERS OF NES	CONDITION	IMPACT AREA (HA)	TIER 3-2 OFFSET TARGET (HA)	OFFSET: IMPACT RATIO
Broad-leaved Peppermint-Brittle Gum - Red Stringybark dry open forest on the southeastern highlands	Woodland	0.01		
<b>Total</b>		<b>1.21</b>	<b>2.15 – 2.4</b>	<b>10.20 – 11.43</b>
<b>Great Egret (Potential Habitat)**</b>				
Wet Tussock Grassland	Grassland	0.14		
<b>Total</b>		<b>0.14</b>		
<b>Cattle Egret (Potential Habitat)**</b>				
Broad-leaved Peppermint-Brittle Gum - Red Stringybark dry open forest on the southeastern highlands	DNG	1.2		
Red Stringybark - Scribbly Gum - Red Box - Long-leaved Box shrub - tussock grass open forest the NSW South Western Slopes Bioregion	DNG	89.86		
Wet Tussock Grassland	Grassland	0.14		
White Box-Blakelys Red Gum-Yellow Box grassy woodland	DNG	2.02		
<b>Total</b>		<b>93.22</b>		
<b>White-throated Needletail and Rainbow Bee-eater (Potential Habitat)</b>				
Broad-leaved Peppermint-Brittle Gum - Red Stringybark dry open forest on the southeastern highlands	DNG	0.39	2.15 – 2.4	1.77 – 1.98
Broad-leaved Peppermint-Brittle Gum - Red Stringybark dry open forest on the southeastern highlands	Woodland	0.01		

MATTERS OF NES	CONDITION	IMPACT AREA (HA)	TIER 3-2 OFFSET TARGET (HA)	OFFSET: IMPACT RATIO
Red Stringybark - Scribbly Gum - Red Box - Long-leaved Box shrub - tussock grass open forest the NSW South Western Slopes Bioregion	DNG	29.41	193 - 427	17.3 -38.4
Red Stringybark - Scribbly Gum - Red Box - Long-leaved Box shrub - tussock grass open forest the NSW South Western Slopes Bioregion	Woodland	1.64		
Wet Tussock Grassland	Grassland	0.02		
White Box-Blakelys Red Gum-Yellow Box grassy woodland	DNG	0.11		
<b>Total</b>		<b>31.58</b>	<b>195.15 – 429.4</b>	<b>6.18 – 13.60</b>

**Note:**

# proportion of “woodland” White Box grassy woodland of the Nandewar and Brigalow Belt South Bioregions in final offset area is likely to be significantly higher as these areas will be preferentially targeted.

\* Whilst Swift Parrot and Regent Honeyeater will utilise scattered paddock trees 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.

\*\*Impacts to grassland and derived grassland potential habitat for Great and Cattle Egrets is provided in the region of the proposed Wind Farm by ongoing rural activities. DNG is the proposed offset areas is proposed to be rehabilitated as woodland providing additional habitat for higher conservations status woodland species

DNG = Derived Native Grassland

## 6.6 OFFSET REQUIREMENT TO MEET MAINTAIN OR IMPROVE CONSERVATION OUTCOME

### 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:

- Vegetation on the proposed offset properties is generally of equal or better condition than 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 package 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 proposed offset package has been informed through a biometric calculation (use of Biobanking Assessment Methodology) that considers the structure, function and compositional elements of biodiversity (Principle 9 offsets must be quantifiable);
- The offset properties will either be purchased and transferred to the NSW Minister for the Environment as additions to the national parks estate (subject to acceptance by the Minister) or have Conservation Covenants registered in perpetuity on title and conservation 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 made to secure the proposed offsets prior to any construction occurring and will form part of the conditions of approval (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 areas are supplementary (Principle 12) and have not been used to offset other impacts or received any other funding for which obligations have not already been met; and
- The proposed offsets will be enforceable through development consent conditions (Principle 13 Offsets must be enforceable through development conditions).

### 6.6.2 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 (Box-Gum Woodland) and suitable habitat for the threatened fauna species where potential habitat may be impacted (Swift Parrot, Regent Honey-eater, Grey-headed Flying-fox, Large-eared Pied Bat, Greater Long-eared Bat, Superb Parrot, Satin Flycatcher, Spotted-tailed Quoll, White-throated

Needletail, Rainbow Bee-eater, Cattle Egret or Great Egret Border Thick-tailed Gecko habitat) and suitable habitat for the threatened flora species where potential habitat may be impacted (*Bothriochloa biloba*, *Eucalyptus cannonii*, *E. robertsonii* subsp. *hemisphaerica*, *Prasophyllum* sp. Wybong, and *Thesium australe*) (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 package 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 (Principle 5);
- The offset area is within the vicinity of the project site but will not be directly or indirectly impacted by the proposal other than offset property S1 (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 (206 - 460 ha) is estimated to be in the range \$1.0 M - \$2.53 M to secure the land and provide for in perpetuity conservation land management. This is based on land value of between \$2,000 and \$2,500 per hectare and in perpetuity management costs of up to \$3,000 per ha. The social and economic opportunity costs of securing the offset package is the loss of 206-460 productive agricultural land.

## 7 Conclusion

Under Part 3A of the EP&A Act, the DGRs require this EA report to provide details of the measures to avoid, mitigate or offset impacts consistent with the principles for offsets in NSW and the ‘maintain or improve’ test. The Crudine Ridge 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. 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 central tablelands through *in perpetuity* protection of large, viable offset areas.

The suite of avoidance, mitigation and offset measures will be consistent with ‘maintain or improve’ principles.

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