Proposed Development of

Sapphire Wind Farm

Northern, New South Wales

Environmental Assessment

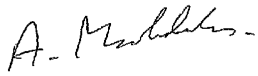
Volume 1

November 2011

Prepared for Sapphire Wind Farm Pty Ltd by Wind Prospect CWP Pty Ltd

CERTIFICATION

Submission of Environmental Assessment prepared under Part 3A of the *Environmental and Planning Assessment Act 1979*.

Application Reference	09_0093		
Document Description	Proposed development of Sapphire Wind Farm - Environmental Assessment		
Declaration	I certify that I have prepared the contents of this Environmental Assessment with the Director-General's Requirements dated 29th May 2009, and amendments dated 21st February 2011, 13th May and 16th August 2011 and that to the best of my knowledge, the information contained in the Environmental Assessment is not false or misleading.		
	Name	**Signed**	**Date**
Reviewing Manager	Adrian Maddocks		9th November 2011

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CHANGES TO GOVERNMENT DEPARTMENT NAMES

During the preparation of this Environmental Assessment, there have been changes to several Government Department names. Reference made to the former should be considered to mean the latter, and vice versa.

- Department of Environment and Climate Change and Water, which has since changed to the Department of Premier and Cabinet, specifically the Office of Environment and Heritage.
- The NSW Department of Planning, which has since changed to the Department of Planning and Infrastructure.
- The Land and Property Management Authority, which has since changed to the Department of Premier and Cabinet.
- The Department of Industry and Investment is changed to the Department of Trade and Investment, Regional Infrastructure and Services.
- The Office of Water is transferred to the Department of Primary Industries.
- The Department of Environment, Water, Heritage and the Arts is changed to Sustainability, Environment, Water, Population and Communities.
- The name of the Department of Industry and Investment is changed to the Department of Trade and Investment, Regional Infrastructure and Services.
- The Department of Primary Industries is established as a Division of the Government Service.
- The name of Transport NSW is changed to the Department of Transport.

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CHAPTER 1

Executive Summary

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1. PREFACE

The Environmental Assessment (EA) has been prepared to provide a project description, discuss all potential effects of the Sapphire Wind Farm on the existing environment and community, and discuss the measures proposed to manage and mitigate any potential adverse effects. The proposed development is for the purpose of generating electricity from wind energy.

The EA has been prepared in three volumes:

Volume 1: Main text (this volume)

Volume 2: Figures and Photomontages

Volume 3: Appendices

During the Public Exhibition phase of the assessment process the Sapphire Wind Farm EA will be available for inspection at the Glen Innes Severn and Inverell Shire Council offices and online through the New South Wales Department of Planning website, following the links to the Major Project Assessments page.

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2. INTRODUCTION

The Proponent is proposing to install, operate and maintain up to 159 wind turbines and ancillary structures on an area of the Northern Tablelands, 18 km west of Glen Innes and 28 km east of Inverell, New South Wales (NSW) (**Figure 2.1**); the proposed Sapphire Wind Farm (the Project). The wind turbines will be erected for the purpose of generating electricity from wind energy.

The Project was publicly announced in May 2009, at the commencement of detailed feasibility studies and early stages of planning. The results of public consultations and feasibility assessments are presented in this EA, as part of the Development Application (DA) for the Project.

The EA may also be used in support of subsequent applications for approval under Section 78A of the *Environmental Planning and Assessment (EP&A) Act 1979 (NSW)* associated with the lease of land for the turbine sites and associated infrastructure.

The Project will also be assessed by the Federal Department of the Environment, Water, Heritage and the Arts (DEWHA) with respect to matters of National Environmental Significance under the *Environment Protection & Biodiversity Conservation (EPBC) Act 1999*.

This EA is broad in scope, covering many topic areas. This chapter, being the Executive Summary, provides a summary of the outcomes established by the EA as a result of the assessments and consultation that took place.

2.1 The Proponent

The Project is being developed by Sapphire Wind Farm Pty Ltd (the Proponent), a wholly owned subsidiary of Wind Prospect CWP Pty Ltd (WPCWP). WPCWP is a joint venture partnership between the Wind Prospect Group and Continental Wind Partners (CWP).

The Wind Prospect Group is a progressive global organisation that is responsible for the development, construction and operation of renewable energy projects in Australia, New Zealand, United Kingdom, Hong Kong, Canada, Ireland, France and the USA. Wind Prospect has over 18 years of experience in successful development in the industry and has been involved in over 2,500 megawatt (MW) of approved wind generation (both onshore and offshore) with 380 MW under construction or in operation throughout Australia.

Continental Wind Partners were established in 2007 to finance the development of wind farms in Romania and Poland. They have since grown to be a leader in renewable energy development, expanding into the rest of Europe, Australia and New Zealand; with projects totalling over 4,500 MW. Their primary focus remains in wind energy, however they also have interests in solar, hydro, biomass and other renewable energies.

Their successful and rapid expansion is based on a proven model of co-operation with local developers. Here CWP's international expertise in the finance/banking industry and technical aspects of development are combined with the developer's own technical expertise and local knowledge. It is this collaborative partnership that ensures accelerated, professional wind development in a mutually successful manner.

3. PROJECT DESCRIPTION

The proposed Project development consists of the installation of up to 159 wind turbines, on-site electrical cable network, a combined on-site collector and switching substation, smaller collector substations, access tracks, crane hardstand areas, up to 6 permanent wind monitoring masts, and appropriate site signs. The Project is to have an installed capacity of 238 to 425 MW, depending on the model of turbine selected. Operation of the wind farm is to be carried out by a combination of remote computer control, local operations and maintenance staff.

Final turbine selection will occur through a competitive tender process pending Development Approval. The turbines used for the Project will be three-bladed, semi-variable speed, pitch regulated machines with the rotor and nacelle mounted on a reducing cylindrical steel tower. Each turbine will rise up to 157 m from the ground to the tip of the blades, with typical tower heights of between 80 and 101.5 m, and blades between 40 and 63 m in length (noting that the 101.5 m tower would have a 50.5 m blade and that a 94 m tower would be used with a 63 m blade). The wind turbines under consideration for this Project vary in terms of generation capacity from between 1.5 and 3.4 MW. Typically turbines of this magnitude begin to generate energy at wind speeds in the order of 4 metres per second (m/s) (14.4 kilometres per hour (kph)) and shut down (for safety reasons) in wind speeds greater than 25 m/s (90 kph).

Up to six permanent wind monitoring masts, up to 100 m in height, will be installed on-site. The purpose of the masts is to provide necessary information for the performance monitoring of the wind turbines. The wind monitoring masts would be of a guyed, narrow lattice or tubular steel design.

The electricity produced by each wind turbine generator would be transformed from 0.69 kilovolts (kV) up to 33 kV by a transformer generally located within or adjacent to each turbine. Underground electrical cables will be installed at a depth of approximately 0.8 to 1 m below the ground surface to conduct the electricity from the wind turbines to the collector substation. The underground electrical cables will follow site access tracks where practical.

The collector and switching substation site is expected to require approximately 2 hectares (ha) of land and will include standard grid connection infrastructure and buildings. The chosen location minimises the visual impact of the wind farm by siting the substation away from frequently used public roads, and with vegetation screening, post construction, if warranted. This also allows for the Project's internal electrical infrastructure and grid connection to have a reduced visual impact.

To harness the energy produced by the Project, it will be connected to TranGrid's 132 or 330 kV transmission network and when not generating will draw a minor amount of electricity from the local transmission network.

Project management will be carried out by the Proponent, unless commercial or other arrangements change. All Project and construction management will comply with the appropriate company's Quality Assurance System and Environmental Management System, or equivalent, ensuring that relevant procedures, statutory requirements and operational standards are met.

Project management will also be in accordance with this EA and other documents, such as Environmental Management Plans (EMP's). An outline of the measures to be addressed in the full EMP has been developed for the Project and is contained in **Chapter 20** Statement of Commitments. It will be a requirement that all actions contained within the EMP are considered and incorporated into the Construction and Operational EMP's and other environmental documentation.

4. PROJECT JUSTIFICATION

There has been growing global recognition of the need to mitigate the environmental effects associated with fossil fuel energy generation. Such thoughts have manifested into international, national and state wide commitments supporting the development of clean and sustainable energy projects.

In 2008, the Australian government ratified the Kyoto Protocol and signed up to cut greenhouse gas emissions to 108 % of the levels they were is 1990. This was a watershed decision and an important step in determining Australia's position on climate change in the international arena.

On 20 August 2009, the Federal Parliament passed the Renewable Energy Target legislation, which aims for 20 % or 45,000 GWh of Australia's electricity to be generated from renewable sources by 2020. Since then, in January, 2011 the RET was separated into the Large-scale Renewable Energy Target (LRET) and the Small-scale Renewable Energy Scheme (SRES). This change is anticipated to support a higher REC price for large scale projects, like wind farms, and provide greater certainty for the renewable energy sector. Wind energy generation is a low cost, viable renewable energy source and can be readily implemented to meet a substantial percentage of these targets.

The Project will play an important role in contributing to both the increasing local and global need for such renewable projects in tackling the issues of Global Warming and Climate Change; contributing between 1.66 % and 2.95 % of new renewable generation to meet the legislated Australian target. Moreover the Project site and size has been carefully selected using a number of factors and will displace a conservative estimate of 13,162,338 tonnes of carbon dioxide equivalents over the life of the Project.

5. PLANNING CONTEXT

The development of the Project requires:

- Project approval under Part 3A of the New South Wales (NSW) *Environmental Planning and Assessment (EP&A) Act, 1979*; and
- Consideration of the requirements of the Commonwealth's *Environment Protection and Biodiversity Conservation (EPBC) Act, 1999.*

The NSW Department of Planning issued the Project with Director-General's Requirements (DGR's) on 29th May 2009. The DGR's include key issues for the Proponent to address in the EA with a focus on impacts, management and mitigation strategies. The Project received revised DGR's on the 23rd February 2011 extending the Date of Expiration to 29th May 2012 and adding additional requirements. Finally, the Project was classified as a 'Controlled Action' under the *EPBC Act* on the

31st March 2011, which saw the Project issues with supplementary DGR's on the 13th May and 16th August 2011. The supplementary DGR's apply to the accredited assessment process.

In addition, relevant Federal, State and Local Government legislation, policy and guidelines are considered and addressed throughout the EA where appropriate.

6. STAKEHOLDER CONSULTATION

Consultation for the Project commenced in May 2009 during the early stages of planning and feasibility assessment. Consultation at this time aimed to inform the general public, neighbouring residents, statutory regulators and other stakeholders of the Project in order to identify issues that required addressing during project planning and design.

Consultation for the Project was conducted by way of letters of notification to stakeholders, face-to-face contact with neighbouring residents, a public exhibition and consultation meetings with various stakeholders. The Project website (www.sapphirewindfarm.com.au) presents an ongoing, active consultation medium for people to track the development of the Project and provide comment.

A number of consultees have responded, providing input or advice to the Project. The public exhibitions, held across two days in Glen Innes and Inverell in February 2011, were attended by over 60 local and regional residents.

7. ASSESSMENT OF KEY ISSUES

The Proponent, along with a number of specialist consultants and stakeholders, has used various methods during the feasibility and planning stages of the Project. Together, the Proponent, specialists and stakeholders have determined the baseline environmental conditions at the Project site, identified potential impacts and developed management strategies to mitigate those impacts where possible. These assessments and consultations have been consolidated into this EA, to develop an optimal wind farm design that balances environmental, social, economic and cultural needs.

This EA is structured to address the requested key issues and non-requested additional issues by the DGR's under the *EP&A Act* that have the potential to create environmental or human impacts. These are summarised in the following sections of the Executive Summary with extensive detail found within the main chapters of this **Volume 1** and associated **Volumes 2** and **3**.

8. LANDSCAPE AND VISUAL ASSESSMENT

The Proponent commissioned Green Bean Design Landscape Architects to prepare a Landscape and Visual Impact Assessment (LVIA) for the Project. The LVIA involved a comprehensive evaluation of the visual character of the landscape in which the Project would be located, and an assessment of the potential landscape and visual impacts that may result from the construction and operation of the Project, taking into account appropriate mitigation measures.

In terms of overall landscape sensitivity, the LVIA determined that each of five Landscape Character Areas within the Project viewshed had a Medium sensitivity to accommodate change, and represented a landscape that is reasonably typical of other landscape types found in surrounding areas of the New England Tablelands.

The LVIA also determined that the Project is likely to be an acceptable development within the viewshed, which in a broader context also contains built elements such as roads, agricultural industry, aircraft landing strips, communication and transmitter towers, power lines and an approved wind farm.

There are a number of potential visual effects associated with the wind farm, including glinting, which experience suggests is relatively rare and shadow flicker effects which are unlikely to be experienced at any residences. The Project will have some degree of visual influence, however it is unlikely that wind farm projects will ever conform, or be acceptable to all points of view.

Overall, the cumulative visual effect of the Project would not result in any significant 'direct', 'indirect' or 'sequential' cumulative impacts when considered against any existing or proposed projects. The Project is well suited to the scale of the landscape and is unlikely to give rise to an unacceptable cumulative visual influence.

9. NOISE ASSESSMENT

Hearing is a fundamental human sense and is used constantly for communication and awareness of the environment. Noise is generally described as being 'unwanted' or 'unfavourable' sound and, to some extent, is an individual or subjective response as what may be a sound to one person, may be regarded as noise by another.

The unique acoustic emissions from wind turbines can be a potential problem for closely located residents. Noise assessments have been carried out by SLR Pty Ltd, to predict the likely noise levels for comparison with the South Australian Environmental Protection Authority (SA EPA) *Noise Guidelines for Wind Farms* (February 2003) (SA EPA Guidelines). This document was developed to assess and manage environmental noise impacts from wind farms in South Australia and has been adopted by the NSW Department of Planning (DoP). The SA EPA have since prepared revised noise guidelines (*Wind Farms Environmental Noise Guidelines* 2009), however these are yet to be implemented in NSW and are not considered here.

Wind turbine noise has been predicted and assessed against relevant criteria prescribed by the SA EPA Guideline and World Health Organisation (WHO) goals where appropriate.

- Layout Option 1 (159 WTG's), equipped with Gamesa G87 turbines was predicted to comply with all relevant noise criteria, SA EPA Guidelines and WHO guidelines at all neighbouring dwellings.
- Layout Option 1 (159 WTG's), equipped with Vestas V90 turbines was predicted to comply with all relevant noise criteria, SA EPA Guidelines and WHO guidelines at all neighbouring dwellings except for one marginal exceedance (<0.5 dBA).
- Layout Option 2 (125 WTG's), equipped with Vestas V112 turbines was predicted to comply with all relevant noise criteria, SA EPA Guidelines and WHO guidelines at all neighbouring dwellings except for one marginal exceedance (<0.5 dBA).
- Layout Option 2 (125 WTG's), equipped with Siemens SWT 2.3-101 turbines was predicted to comply with all relevant noise criteria, SA EPA Guidelines and WHO guidelines at all

neighbouring dwellings except for one marginal exceedance (<0.5 dBA) and one medium (<3dBA) exceedance.

Exceedances will be managed post consent following final turbine selection through landowner agreements, the reduction of turbine operational noise, micrositing turbine positions or by the removal of turbines, whichever is deemed the most appropriate solution to achieve compliance.

Construction noise impact, blasting impact and vibration levels have been assessed and the 'worst case' scenarios modelled and found to be generally acceptable. Construction traffic noise impact has also been assessed and the 'worst case' maximum construction traffic generated scenario would increase existing traffic noise levels along local roads by up to 4 to 7 dBA, but due to the typically large setback of dwellings from the road network would result in a noise level that would be considered acceptable under the ECRTN.

10. FLORA AND FAUNA ASSESSMENT

Eco Logical Australia Pty Ltd (ELA) was commissioned to undertake an ecological assessment of the area proposed to be affected by the Project. The assessment methodology comprised a literature review, site reconnaissance, vegetation mapping and detailed flora and fauna surveys for the entire Site, including alternative and optional infrastructure considered as part of the EA.

Targeted surveys for threatened species were undertaken across the study area between October 2008 and January 2011. Vegetation mapping, flora quadrats and an assessment using the Biobanking methodology were also undertaken.

The study area was found to support twenty one threatened fauna species and three endangered ecological communities. Habitat exists for ten threatened flora species, however only four were found on-site, as well as one Rare or Threatened Australian Plant (RoTAP). The potential for threatened species and endangered ecological communities that can be recorded on-site include:

- BR116 Black Cypress Pine - Tumbledown Gum – Narrow-leaved Ironbark;
- BR240 White Box grassy woodland of the Nandewar and Brigalow Belt South Bioregions;
- BR153 Manna Gum – Rough-barked Apple – Yellow Box grassy woodland/open forest;
- Brown Treecreeper (*Climacteris picumnus victoriae*) (TSC Act);
- Diamond Firetail (*Stagonopleura guttata*) (TSC Act);
- Hooded Robin (*Melanodryas cucullata*) (TSC Act);
- Little Lorikeet (*Glossopsitta pusilla*) (TSC Act);
- Scarlet Robin (*Petroica boodang*) (TSC Act);
- Speckled Warbler (*Pyrrholaemus saggitatus*) (TSC Act);
- Turquoise Parrot (*Neophema pulchella*) (TSC Act);
- Regent Honeyeater (*Anthochaera phrygia*) (TSC Act & EPBC Act);
- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) (TSC Act);
- Eastern Bentwing-bat (*Miniopterus schreibersii oceansis*) (TSC Act);
- Eastern Freetail-bat (*Mormopterus norfolkensis*) (TSC Act);
- Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*) (TSC Act);
- Greater Broad-nosed Bat (*Scoteanax rueppellii*) (TSC Act);

- Eastern Cave Bat (*Vespadelus troughtoni*) (TSC Act);
- Border Thick-tailed Gecko (*Underwoodisaurus sphyrurus*) (TSC Act & EPBC Act);
- Bell's Turtle *(Elseya bell)* (TSC Act & EPBC Act);
- Collared Delma (*Delma torquate*) (EPBC Act);
- Booroolong Frog (*Litoria booroolongensis*) (TSC Act & EPBC Act) ;
- Koala (*Phascolarctos cinereus*) (TSC Act);
- Spotted-tailed Quoll (*Dasyurus maculatus*) (TSC Act & EPBC Act); and
- Squirrel Glider (*Petaurus norfolcensis*) (TSC Act).

Twelve migratory species were identified from the EPBC Act Protected Matter Search Tool however no species were recorded during the surveys.

A Referral under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) was submitted to the Department of Sustainability, Environment, Water, Population and Communities (DSEWPAC) in February 2011 addressing the likely impacts of the Project on matters of National Significance, and in particular on the Box-Gum Woodland (BGW) within the Project Site, listed as Critically Endangered under the EPBC Act. The Project was designated a Controlled Action under the *EPBC Act* on the 31st March 2011 and, subsequently, DSEWPAC provided the Proponent with supplementary Director-General's Requirements (DGR's) on the 13th May 2011, which apply to the accredited assessment process.

The Proponent has made a number of amendments to the proposed layout to minimise and avoid impacts on the ecological values of the site. Given the extensive areas of EEC vegetation types across the site area, and the requirement for turbines to be placed on ridge tops, 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, but on the other hand ensures no consolidated areas of clearing occur.

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 are summarised below:

- Access roads have 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 treeless or low tree density areas, where possible, to minimise the need for additional or excessive tree clearance;
- Where possible, turbines have been placed in woodland areas where ground layer disturbance has previously taken place (e.g. sown areas);
- Construction compounds, substations and rock crushing facilities have been located outside ecologically sensitive areas where possible;
- The Project 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;

- Access tracks and transmission line routes have been re-aligned to avoid threatened plants recorded within the study area; and
- The reticulation has been placed underground and within the road footprint where possible to allow for temporary rather than permanent disturbance. Reticulation will pass overhead across gullies and waterways to reduce impacts.

In order to protect the ecological values of the site a number of management and mitigation measures have been proposed. Given their extent, and to avoid duplication, these are outlined in **Chapter 20** Statement of Commitments together with the Project stage during which each would be implemented. A number of species-specific mitigation measures are included and it is envisaged that some of these would be implemented at both the proposed impact site and offset site with full details provided in the Construction Environmental Management Plan, Operation Environmental Management Plan, Weed Management Plan and Soil and Water Management Plan post approval.

The Proponent has explored the registration of a Biobank site as an offset option, but may still utilise other suitable methods for securing a conservation outcome depending on continued interest by landowners. Three properties have been identified where the vegetation types and condition have been verified as being in equivalent or better condition than the impact sites and combinations of any two of the properties will provide an offset area between 504 ha (Properties 1 and 2) and 569 ha (Properties 1 and 3) and meet the "like for like or better" offsetting principles with a minimum 2:1 offset ratio.

Whilst there were no confirmed records of the Border Thick-tailed Gecko in the project site, the 18.7 ha of impact to potential habitat will be offset with up to 184.65 ha of potential habitat in offset Property 3. The loss of 113.7 ha of potential foraging habitat for the Regent Honeyeater and Swift Parrot will be offsets with between 350 and 427 ha of potential foraging habitat.

11. CULTURAL HERITAGE ASSESSMENT

NSW Archaeology Pty Ltd was commissioned in June 2009 to undertake an archaeological and cultural heritage assessment comprising of a literature review and field surveys to collect data for the entire Project, including alternative and optional infrastructure locations.

The assessment identified that a number of different Aboriginal groups occupied the New England region, with the Project site attributed to the traditional terrain of the Ngarrabal. The predominant land use in the Project area is predicted to have been restricted to hunting and gathering forays and movement through the country, with the actual presence of Aboriginal groups limited due to the lack of reliable water sources found on-site. The early 1800's saw changes in the traditional land use of Aboriginal people with the introduction of European settlement.

European settlement of the area began in the late 1820's, with establishment of towns in the region occurring throughout the 1830's. Both Glen Innes and Inverell enjoyed large growth over the mid-1800's and became popular areas due to expansions in farming and mining.

In accordance with the *Interim Guidelines for Aboriginal Community Consultation* (IGACC) – *Requirements for Applicants* (NSW Department of Environment and Conservation (DEC) 2004), the required field surveys were conducted with the assistance of a number of people from the Edgerton-Kwiembal EHCAC.

The assessment report determined that the archaeological resource across the Project site is of low significance, given the nature and density of the artefact locales recorded in the area, and the low scientific significance rating they have been accorded. However, the construction of the Project will result in substantial physical impacts to any Aboriginal objects which may be located within direct impact areas irrespective of their archaeological significance. That is, any Aboriginal object situated within an area of direct impact will be comprehensively disturbed and/or destroyed during construction.

The three Aboriginal object locales recorded on-site were assessed to be of low archaeological potential and sensitivity and are therefore of low archaeological significance. Five trees were documented which were considered by the Aboriginal field assistants to be possible scarred trees. No items of Non-Indigenous heritage were located during the survey. The Project has a low likelihood of causing any impacts to items of Non-Indigenous heritage; therefore no mitigation strategies are required.

Ground disturbance will occur predominantly during the construction phase of the Project with the potential to cause direct impacts to any Aboriginal objects or Non-Indigenous items which may be present on-site. Aboriginal objects (stone artefacts) can be expected to extend in a relatively continuous, albeit very low to low density distribution across the broader landscape encompassed by the Project. Overall the proposed impacts are predicted to be discrete in nature due to the relatively small footprint of construction activities and, therefore, impacts to the archaeological resource across the landscape can be considered only partial in nature.

12. TRAFFIC AND TRANSPORT ASSESSMENT

Bega Duo Designs was commissioned to undertake a Traffic and Transport Assessment for the proposed Project. The study was conducted in accordance with the NSW Roads and Traffic Authority (RTA) *Guide to Traffic Generating Developments* and the DGR's, and provided a technical appraisal of the traffic and safety implications arising from the Project.

The assessment concluded that as a result of the Project an additional 250 vehicles per day would be expected during the construction period. This could have a significant impact on the existing road users, especially on the minor and unsealed roads, for approximately two years until construction of the Project has finished. Major impacts are expected only during the construction and decommissioning periods, with minor impacts during the operational phase.

A range of management and mitigation strategies have been proposed during the construction, operation and decommissioning phases of the Project to minimise traffic impacts, reduce community disruption and the risk of traffic incidents. In turn this will facilitate minimum disruption to existing traffic conditions.

13. AVIATION ASSESSMENT

Existing aviation activity in the locality of the Project site was identified during planning and design through consultation with the Department of Defence (DoD), Civil Aviation Safety Authority (CASA), Airservices Australia (AsA), Aerial Agricultural Association of Australia (AAAA), NSW Emergency Services, NSW Police Aviation Support Branch, NSW Rural Fire Service and the local community.

There are two aerodromes within the vicinity of the Project Study area; Glen Innes, approximately 14 km east and Inverell, approximately 30 km south west. According to the aviation hazard assessment carried out by The Ambidji Group, the Project does not impact the OLS and PANS OPS of these airfields.

CASA administers regulations for the intrusion of obstacles into aerodrome OLS and PANS OPS and obstacles 110 m above ground level outside of aerodromes. On 1 March 2011 CASA indicated that a review would be undertaken of safety issues associated with obstacles remote from an aerodrome, which will now be undertaken by Department of Infrastructure and Transport (DIT). As there is no current standard in place, it is CASA's view that the decision of the lighting of obstacles outside the vicinity of aerodromes is the responsibility of the Proponent.

The Ambidji Group recommends the Proponent consider the provision of obstacle marking and lighting as a duty of care obligation. On receipt of Development Approval for the Project, the Proponent will consult with CASA and DIT on the issue of obstacle lighting. The Proponent will be seeking a solution, which if appropriate to do so will consider the provision of obstacle marking and lighting. If CASA insist on full compliance with the requirements of the now withdrawn CASA Circulatory AC 139-18(0), the Proponent will commit to shielding provisions allowed under existing CASA guidelines.

Agricultural aerial spraying activity occurs for pest management and pasture top-dressing. Pest management spraying is unlikely to be affected by the Project. Top-dressing activity will require care by pilots applying the material to properties along the ridgelines.

Some private landing strips are present and of those known, the majority are not impacted by the Project's wind turbine locations. Those strips which are known to be impacted by the wind turbines have been discussed with the relevant associated landowners.

14. COMMUNICATION ASSESSMENT

Electromagnetic signals (or radio waves) are transmitted throughout the country as part of telecommunication systems by a wide range of operators. Such systems are used for radar, radio broadcast, television, mobile phones and mobile and fixed radio transmitters. Electromagnetic signals generally work best if a clear path exists between the transmitting and receiving locations, known as line of sight (LOS).

There is the potential for interference from any large structure, including wind turbines, which occur within or close to the signal path. Signals can be interfered with or reflected by the rotating blades of a wind turbine, which could degrade the performance of the signal (Bacon 2002). Electromagnetic emissions from generators and other machinery also have the potential to affect signals; however with modern turbine generators and strict International Electrotechnical Commission (IEC) regulations for manufacturers, there are now negligible emissions from wind turbines (Auswind 2006).

There are a few point-to-point links and omni-directional services which occur across and next to the Project. There is the potential for one link (NSW Ambulance) to be impacted by the Project, however there is expected to be minimal or no impacts on other links in the vicinity of the Project. Where the Project does cause any interference to any links, the Proponent will conduct an investigation with the afflicted parties and implement a suitable solution to the problem.

15. ELECTROMAGNETIC FIELD ASSESSMENT

Electric and magnetic fields (EMF's) are associated with a wide range of sources and occur both naturally and as a result of human activity. Naturally occurring EMF's are those associated with lightning or the Earth's magnetic field. Human induced EMF's occur wherever electricity is present, meaning we are constantly exposed to EMF's in our home and work environments.

Wind farms create EMF's from operational electrical equipment, such as transmission lines, substations and the electrical components found within the wind turbines. This equipment has the potential to produce Extremely Low Frequency (ELF) EMF's, which means the current will alternate direction between 30 and 300 times per second, or at 30 to 300 Hertz (Hz).

The measurements of electromagnetic fields can vary within a wind farm, depending on the placement of equipment such as turbines, substations and internal electrical cables. The *Interim guidelines on limits of exposure to 50/60 Hz electric and magnetic fields* (NHMRC 1989) places guidelines on exposure to both electric and magnetic fields for the public and construction industry.

The typical strategy for reducing electromagnetic fields is distance from the source. Other strategies also include burying cables and placing cables together to cancel the emitted fields. As most of the wind turbine electrical equipment is encased within the turbine, in housing at the base of the tower or located 80 to 100 m above ground level, the distance and shielding from electromagnetic fields decreases the impact from emitting sources.

Electromagnetic fields can be recorded highest at substations; however, appropriate fencing and remote placement of the substation within the landscape can greatly reduce any exposure to electromagnetic fields.

16. FIRE AND BUSHFIRE ASSESSMENT

Fire and bushfire impacts of the Project on human life and property have been assessed in accordance with the DGR's and the *Rural Fires Act 1997*.

By basing the risk management process on the AS/NZS 4360-2004 *Risk Management* (Standards Australia 2004) and the National Inquiry on Bushfire Mitigation and Management (Council of Australian Governments (COAG) 2004), an analysis and evaluation of bushfire risk and acceptable risk treatments have been undertaken.

The Project occurs in an area of low bushfire risk due to the vegetation and agricultural practices in the area. By reviewing the possible ignition sources from the wind farm and analysing bushfire risk assessments on life and property, it is possible to create mitigation and management strategies to minimise the Projects impact on fire and bushfire risk. Through implementing these strategies in a Bushfire Emergency and Evacuation Plan it is possible to increase the awareness of the procedures of bushfire emergencies, increase the preparedness of construction and maintenance staff, and facilitate orderly and safe evacuation and refuge during times of bushfire. The consideration of these mitigation and management strategies will allow the Project to decrease its impact on fire and bushfire hazards.

17. WATER ASSESSMENT

The Project falls under the Border Rivers Regulated River Water Sharing Plan and the Borders Rivers Unregulated and Alluvial Water Sources Water Sharing Plan (Draft). The area is also managed with regards to the Border Rivers – Gwydir Catchment Management Authority (CMA) Plan. Therefore, there are a number of water management targets in place including the water sharing, water quality, management of water supply and wastewater, water conservation and efficiency, and river and wetland protection and rehabilitation.

Water required for the Project, as also discussed in **Chapter 3** Project Description, will be sourced from on-site water sources, such as bores and dams, where possible or brought in from off-site suppliers as a last resort. There will be minimal impacts to groundwater and surface waters in and around the Project due to limited direct-impact activities, which will be controlled with effective mitigation actions and management strategies. Potential impacts are most likely to occur from construction activities. However, with a Soil and Water Management Plan in place, all potential impacts can be managed, resulting in minimising the extent of remediation efforts being required on-site.

18. GENERAL ENVIRONMENTAL ASSESSMENT

The General Environmental Assessment chapter addresses aspects of the proposed project beyond the key issues identified in the DGR's. In summary the following aspects are assessed in terms of the existing situation, potential impacts and, where necessary, the management and mitigation measures put in place:

- Climate;
- Air quality;
- Soils and landforms;
- Water/Riparian;
- Waste;
- Crown roads and triangulation stations;
- Responses to consultation; and
- Aspects relating to construction.

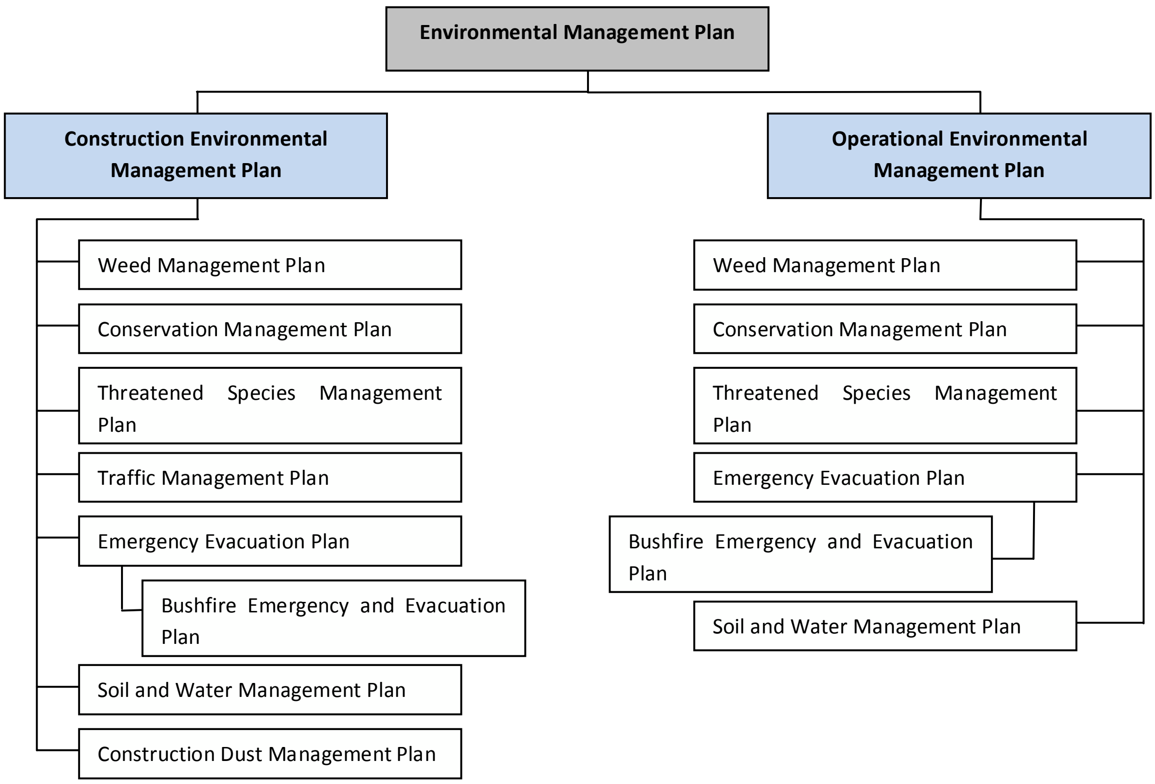
19. SOCIO-ECONOMIC ASSESSMENT

The Socio-Economic Assessment chapter addresses aspects of the proposed project beyond the key issues identified in the DGR's. In summary the following aspects are assessed in terms of the existing situation, potential impacts and, where necessary, the management and mitigation measures put in place:

- Land value;
- Mineral exploration;
- Tourism;
- Community wellbeing and community fund; and
- The local economy.

20. STATEMENT OF COMMITMENTS

The Statement of Commitments (SoC) is a review of all management and mitigation measures mentioned in previous chapters of this EA that will be managed by the Proponent. The framework for the SoC is displayed below, and comprises an Environmental Management Plan (EMP) that combines the Construction Environmental Management Plan (CEMP) and the Operational Environmental Management Plan (OEMP). Within both of these plans there are a number of sub-plans to assist in the amelioration, management and mitigation of environmental impacts from the construction and operational phases of the Project.



21. CONCLUSION

This EA has assessed the potential environmental impacts that may result from the proposed Project, a proposal incorporating up to 159 wind turbines and capable of generating between 238 to 425 MW of new renewable energy generation.

The proposal has been assessed in accordance with the *Environmental Planning and Assessment Act 1979* and taken into consideration the *Environment Protection and Biodiversity Conservation Act 1999*, along with other Federal, State and Local Government legislation, policy and guidelines.

The Project has incorporated the findings identified through the design phase, including consultation with the local community and associated stakeholders. The potential impacts of the Project have been assessed and appropriate avoidance, mitigation and management measures proposed. **Chapter 20** Statement of Commitments details all measures to which the proponent has committed to implementing during the pre-construction, construction, operation/maintenance and decommissioning phases.

Benefits of the proposal have been identified at a global, regional and local scale, including:

- Production of approximately 999,363 MWh per annum, sufficient for the average consumption of 136,899 homes (based on conservative calculations). A figure equal to 2.22 % of the 45,000 GWh Renewable Energy Target;
- Displacement of greenhouse gas emissions by approximately 899,426 tonnes of CO_2-e per annum, the equivalent of taking 224,857 cars off the roads (based on conservative calculations);
- Provision of local jobs, a Community Fund to benefit the local area in the vicinity of the Project and the injection of at least $477 million into the Australian economy; and
- Improved security of electricity supply through diversification.

The Proponent is committed to ensuring the measures proposed in developing the Project are best practice, and that they maintain the high standard set in all regions within which the Wind Prospect Group operate.

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CHAPTER 2

Introduction

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2. INTRODUCTION

2.1 The Proposal

The Proponent is proposing to install, operate and maintain up to 159 wind turbines and ancillary structures on an area of the Northern Tablelands, 18 km west of Glen Innes and 28 km east of Inverell (**Figure 2.1**); the proposed Sapphire Wind Farm.

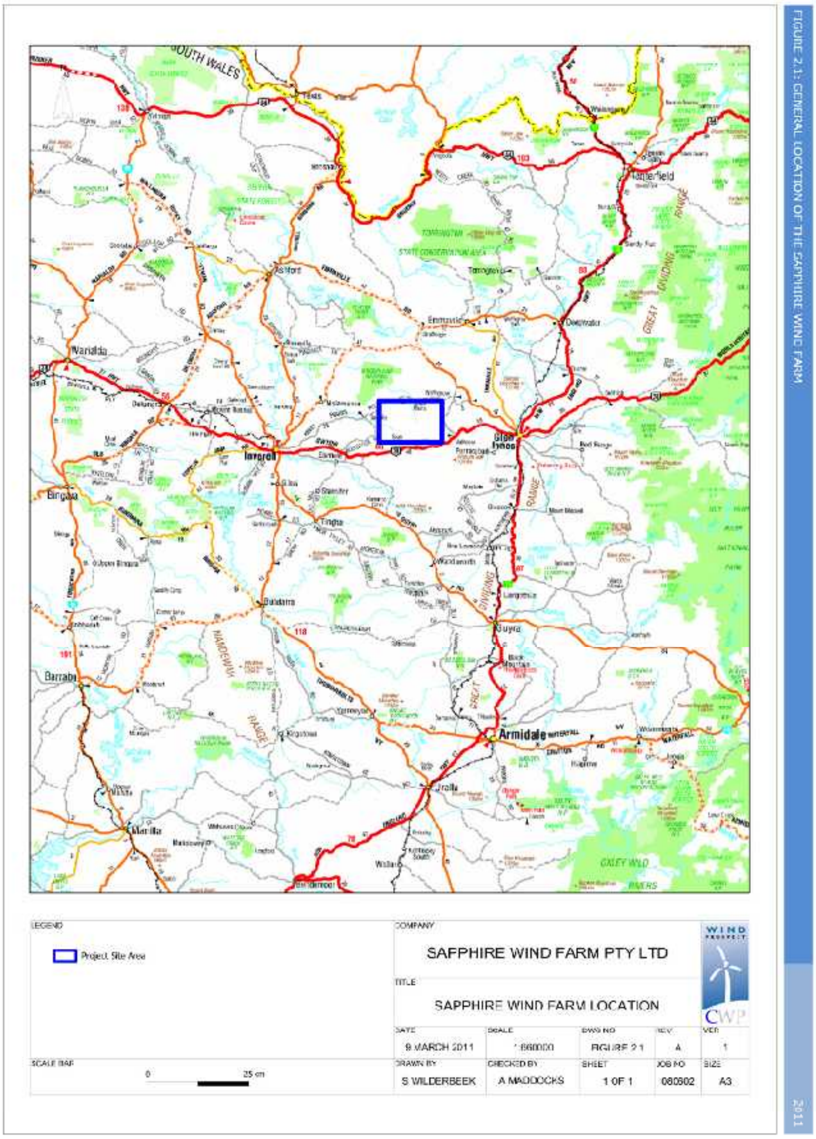

Figure 2.1 General location of the Sapphire Wind Farm
(An A3 size version of this Figure is displayed in Volume 2)

The proposed Sapphire Wind Farm (the Project) lies within the Glen Innes Severn and Inverell Shire Council boundaries, in the northern region of New South Wales (NSW). The turbines will be erected for the purpose of generating electricity from wind energy.

The Project was publicly announced in May 2009, at the commencement of detailed feasibility studies. The results of public consultations and feasibility assessments are presented in this Environmental Assessment (EA), as part of the Development Application (DA) for the Project.

The purpose of the EA is to support the DA associated with the construction and operation of the Project, including:

- Construction and operation of up to 159 turbines;
- Construction of access tracks, hardstand areas and other associated on-site infrastructure; and
- On-site electrical connections and infrastructure, including an on-site switchyard and substation.

The EA may also be used in support of subsequent applications for approval under Section 78A of the *Environmental Planning and Assessment Act 1979 (NSW)* associated with the lease of land for the turbine sites and associated infrastructure.

The Project will also be assessed by the Federal Department of the Environment, Water, Heritage and the Arts (DEWHA) with respect to matters of National Environmental Significance under the *Environment Protection & Biodiversity Conservation (EPBC) Act 1999*.

2.2 The Proponent

The Project is being developed by Sapphire Wind Farm Pty Ltd (the Proponent), a wholly owned subsidiary of Wind Prospect CWP Pty Ltd (WPCWP). WPCWP is a joint venture partnership between the Wind Prospect Group (WPG) and Continental Wind Partners (CWP).

WPG is a progressive global organisation that is responsible for the development, construction and operation of renewable energy projects in Australia, New Zealand, United Kingdom, Hong Kong, Canada, Ireland, France and the USA. WPG has over 18 years of experience in successful development in the industry and has been involved in over 2,500 megawatt (MW) of approved wind generation (both onshore and offshore) with 380 MW under construction or in operation throughout Australia.

WPG have no proceedings under a Commonwealth, State or Territory law for the protection of the environment or the conservation and sustainable use of natural resources against them and operate under the following environmental policies:

- Environmental Policy;
- Carbon Neutral Policy; and
- Project-specific Environmental Management Plans.

CWP were established in 2007 to finance the development of wind farms in Romania and Poland. They have since grown to be a leader in renewable energy development, expanding into the rest of Europe, Australia and New Zealand; with projects totalling over 4,500 MW. Their primary focus remains in wind energy, however they also have interests in solar, hydro, biomass and other renewable energies.

Their successful and rapid expansion is based on a proven model of co-operation with local developers. Here CWP's international expertise in the finance/banking industry and technical aspects of development are combined with the developers own technical expertise and local knowledge. It is this collaborative partnership that ensures accelerated, professional wind development in a mutually successful manner.

2.3 Form and Content of the Environmental Assessment

This EA has been prepared to provide a Project description, discuss all potential effects of the Project on the existing environment and community, and describe the measures proposed to mitigate any potential adverse effects.

The EA has been prepared in three volumes, and comprises:

- Volume 1 – Main Text (this volume).
- Volume 2 – Figures and Photomontages.
- Volume 3 – Appendices.

NOTE: The subject matter of this report involves the use of technical words, units and terms with which the reader may be unfamiliar. A glossary and list of unit conversion factors has been included in **Chapter 21** and reference to this may be of assistance.

An outline of the contents of **Volume 1** (this chapter) is provided below:

Chapters 1-6 provide an executive summary and description of the Project. They also outline Project justification, planning context and a summary of the public consultation process.

Chapters 7-19 contain the bulk of the EA for the Project. They describe:

- The existing physical, ecological and social environment of the region;
- Impact assessment information; and
- Impact mitigation measures.

Chapter 20 provides an outline of the Environmental Management activities relating to the Project incorporated into a Statement of Commitments.

Chapter 21-23 concludes the EA, has a glossary, abbreviations and unit conversion factors, and provides references made throughout the document.

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CHAPTER 3

Project Description

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3. PROJECT DESCRIPTION

This chapter presents a detailed description of the works associated with the construction and operation phases of the proposed Sapphire Wind Farm development, which is otherwise referred to as 'the Project' throughout this Environmental Assessment (EA).

3.1 Key Terms

For the purposes of this EA the following terminology has been used when referring to the Project.

Locality: Area encompassing all lands within a 10 km radius around the Project site.

Project site: Land within the cadastre boundaries of all properties subject to this proposal, comprising an area of 14,376 hectares (ha).

Study area: 200 metre (m) wide corridor in which the turbine footprint, roads and electrical cables will be contained, comprising an area of 1,982 ha.

Development footprint: All proposed locations of the turbines, roads, reticulation, collector substation and facilities building, comprising a maximum area of 288 ha which includes the permanent removal of 140 ha of habitat and the temporary loss of 148 ha of habitat.

Clusters: It is likely that 'Clusters' of turbines will be constructed and commissioned in stages, which is discussed in more detail later in the chapter.

3.2 Location and Site Design

The Sapphire Wind Farm is situated 28 km east of Inverell and 18 km west of Glen Innes in the north east of NSW in the Northern Tablelands. The hills are of moderate-to-high elevation (750 m to 1,100 m above sea level, Australian Height Datum (AHD)), adjacent to the Waterloo Range to the east of the Project. The nearest township is Glen Innes, which is located approximately 18 km to the east along the Gwydir Highway.

When first announced in May 2009 the Project consisted of up to 178 turbines spread over 28 different properties, with the capability to produce enough energy to supply over 170,000 average Australian households. Since being announced, the Project has been revised to take into account additional modelling of the wind speed, consultation with nearby stakeholders and the consideration of different turbine models available to the market. This has resulted in a slight reduction in the extent of the wind farm and a re-design of the turbine layouts to arrive at the two configurations presented as part of this EA. More details can be found in **Chapter 4** Project Justification and **Chapter 6** Stakeholder Consultation.

The Project now comprises a wind farm with two potential turbine layouts; one consisting of 159 wind turbines (Layout Option 1) and the other 125 wind turbines (Layout Option 2) spread over 22 different properties (the Project site). Details of the land tenure for the Project are contained within **Appendix 1**. Coordinates of each layout are detailed in **Appendix 2**. One or a combination of these layouts will be used in the construction of the Project, to be determined following final turbine selection post-consent. The worst-case impacts of both layouts are considered within this EA.

The Project will have an installed capacity of 238 to 425 MW, which is dependent on the turbine model and layout selected, and will consist of the following components:

- The installation of up to 159 wind turbines in the Kings Plains area between Glen Innes and Inverell, NSW (refer to **Figure 3.1**) with a maximum blade tip height of 157 m;
- A combined main collector and switching substation comprising cable marshalling, switchgear and transformers;
- Site operations facilities and services building;
- Underground electrical reticulation cables (up to 33 kilovolt (kV) capacity) and control cables within each of the wind turbine Clusters, potentially connecting to up to 3 cluster collector substations comprising cable marshalling, switchgear and step up transformers to 66 kV;
- Overhead electrical interconnection lines (up to 66 kV capacity) and control cables between the wind turbine Clusters and the main collector substation;
- Access roads from the public highways to the turbine locations and substation;
- Crane hardstand areas for the erection, assembly, commissioning, maintenance, recommissioning and decommissioning of the wind turbines;
- Up to six permanent wind monitoring masts;
- Temporary site office and storage compound(s) including site parking;
- 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 Project will connect to either the TransGrid 330 kV double-circuit overhead transmission line running through the Sapphire Cluster or the TransGrid 132 kV single circuit overhead transmission line running adjacent to the Gwydir Highway to the south of the Project. The export connection may require up to 2 km of 330 kV or 3.5 km of 132 kV overhead transmission line depending on which connection point is selected. These transmission lines are considered as part of this Project in the relevant sections of the following EA.

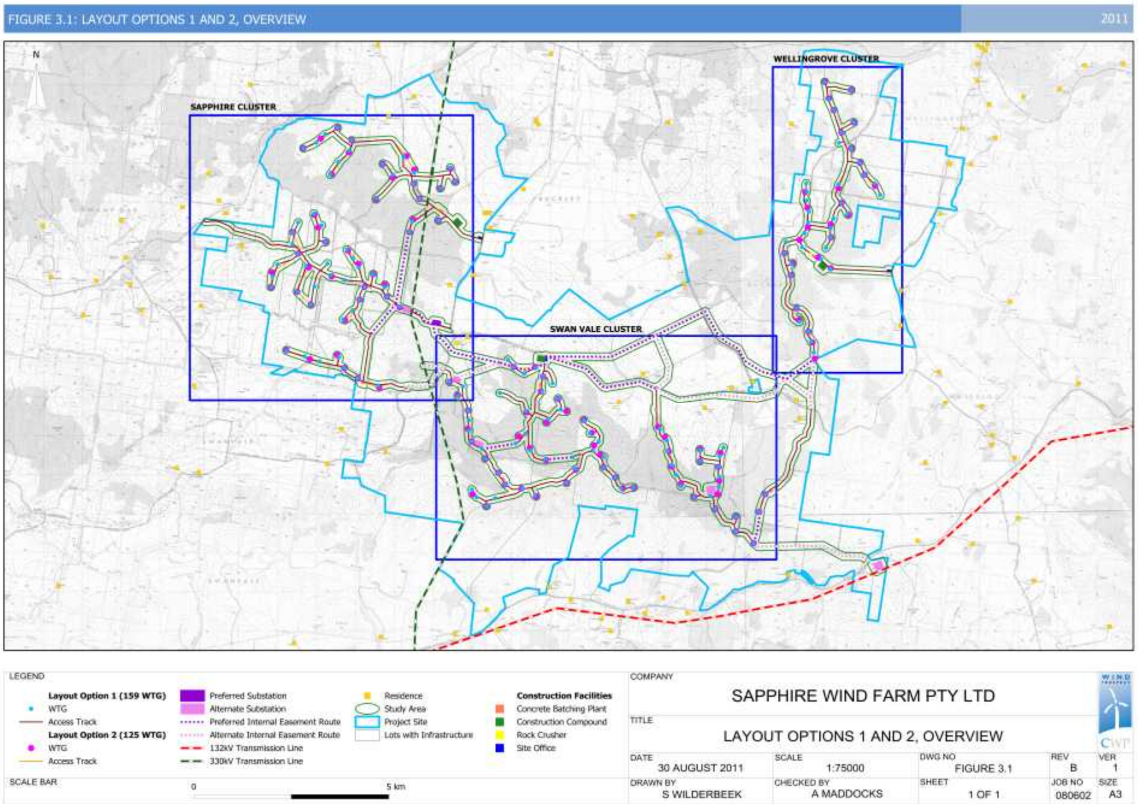

Figure 3.1 Sapphire Wind Farm, Layout Options 1 and 2, Overview

(An A3 size version of this Figure is displayed in Volume 2)

Typical dimensions of the components that comprise the Project are presented in **Table 3.1** below.

Table 3.1 Project components and approximate dimensions (based on greatest impact)

Project Component	Approximate Dimensions
Permanent	
Turbine footings (max footprint)	20 x 20 m
Turbine assembly / crane hardstand areas	50 x 25 m
Main collector and switching substation	100 x 200 m
Cluster collector substation	25 x 25 m
Facilities building	30 x 6 m
Site access: new roads [1]	78 km x 12 m
Underground cabling on-site	160 km x 1 m
Internal overhead electrical interconnection / easement [2]	10 km x 2 m / 10 km x 45 m
Permanent Monitoring Mast	100 m tall
Temporary (during construction)	
Earthworks alongside permanent infrastructure (roads/hardstands) [3]	78 x 10 m (est.)
Concrete batch plant	50 x 100 m
Rock crushing facility	50 x 60 m
Site office	40 x 100 m
Construction compound[4]	150 x 200 m

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

[2] *The estimated easement width is up to 45 m for the internal overhead transmission lines, 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.*

[3] *Construction of the internal road network will require earth works that are beyond the limits of the permanent road impact within the Study area. This is required to level areas of steep gradient to a design suitable for safely transporting Project components into position. Detailed civil designs have been prepared for Layout Option 1 (considered to have the greatest impact when compared to Layout Option 2) that include impacts associated with permanent road, hardstand and turning head areas in addition to the area considered the extent of the earth works. A thorough assessment of these impacts is included in* ***Chapter 10*** *Flora and Fauna.*

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

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 Project.

Given the scale of the Project it is likely that 'Clusters' of turbines will be constructed and commissioned in stages, which is discussed in more detail later in the chapter. Consequently, and for the benefit of stakeholder understanding, we have broken down the Project into three main Clusters (**Table 3.2**, **Figures 3.2** to **3.5**).

Table 3.2 Wind turbine Clusters

Turbine Cluster	Number of Turbines (Layout Option 1)	Number of Turbines (Layout Option 2)	General location
Sapphire	56	45	Western Cluster
Swan Vale	66	51	Southern Cluster
Wellingrove	37	29	Eastern Cluster

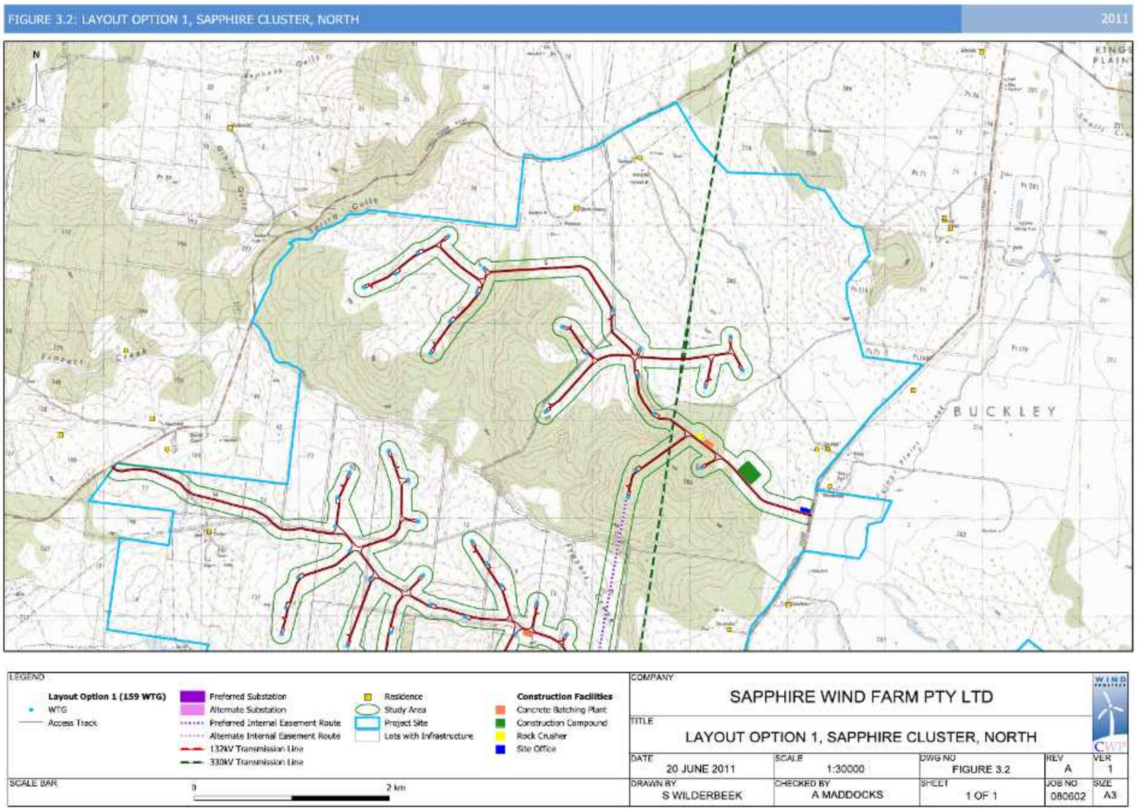

Figure 3.2 Layout Option 1, Sapphire Cluster, North

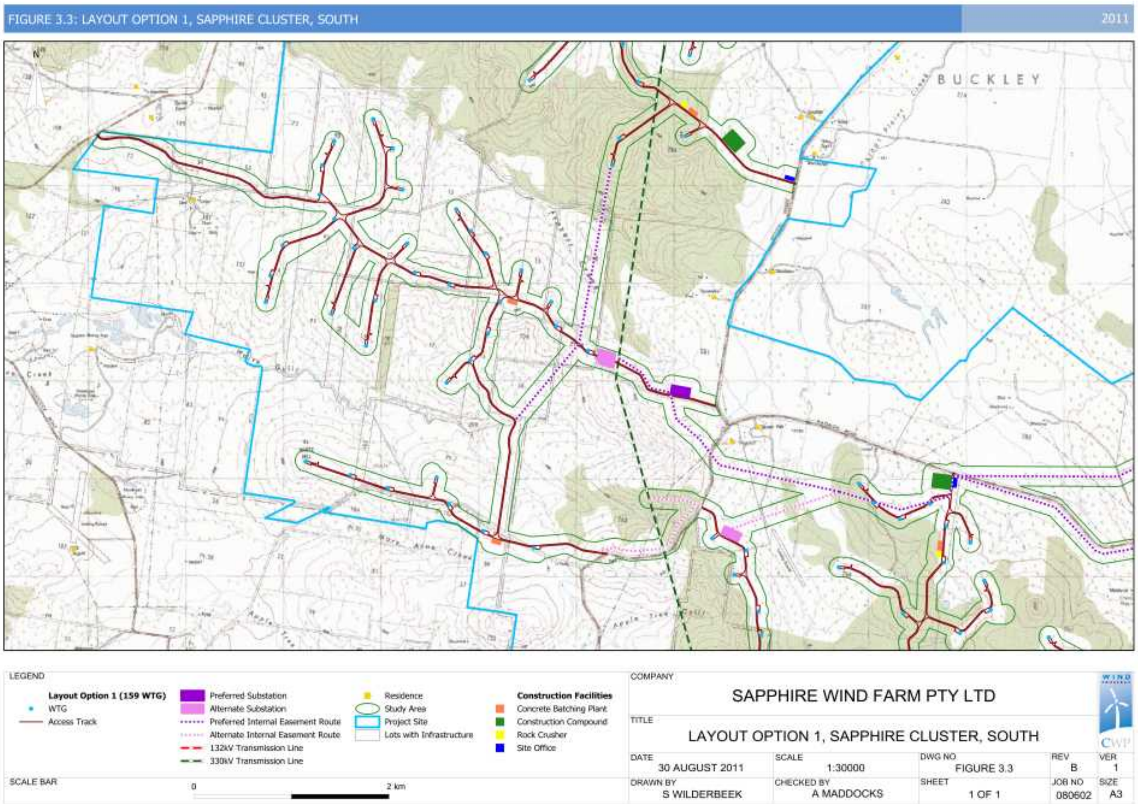

Figure 3.3 Layout Option 1, Sapphire Cluster, South

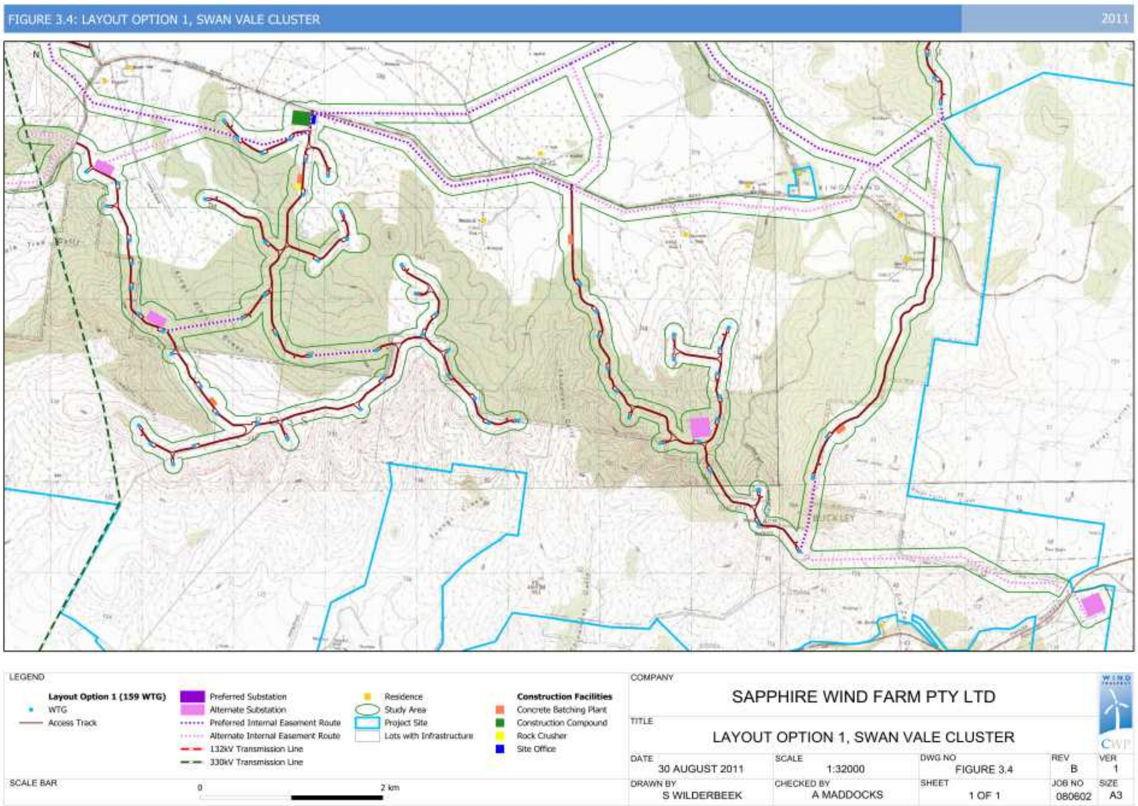

Figure 3.4 Layout Option 1, Swan Vale Cluster

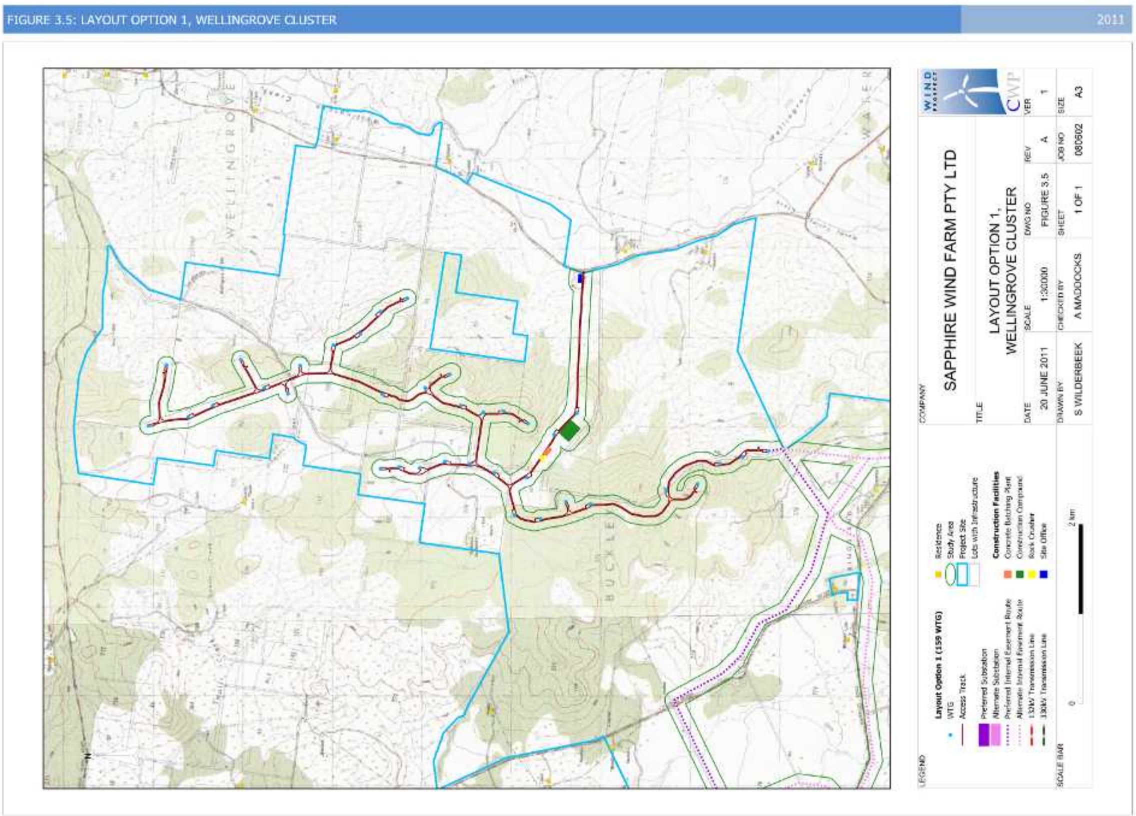

Figure 3.5 Layout Option 1, Wellingrove Cluster
(A3 size versions of these Figures are displayed in Volume 2)

3.3 Wind Farm Infrastructure

It is not yet known which model of wind turbine will be used for the Project as final turbine selection will occur through a competitive tender process pending Development Consent. However, in terms of generation capacity, the wind turbines under consideration for this Project vary in the range from 1.5 and 3.4 MW. By way of example the Suzlon S88, 2.1 MW machine (as installed at the Capital Wind Farm, east of Lake George, New South Wales (NSW)) is typical of the type of wind turbine that could be used. **Image 3.1** below displays a picture of a typical wind turbine, detailing the component parts.

Consideration will also be given to the use of different turbine sizes and manufacturers across the site to better utilise the on-site wind resource profile. For example, the use of Vestas V112 turbines for two Clusters and Siemens SWT 2.3-101 turbines for the third Cluster may result in a more productive wind farm based on the wind resource profile across the site. Turbine dimensions would still fall within the permissible turbine sizes considered in this EA.

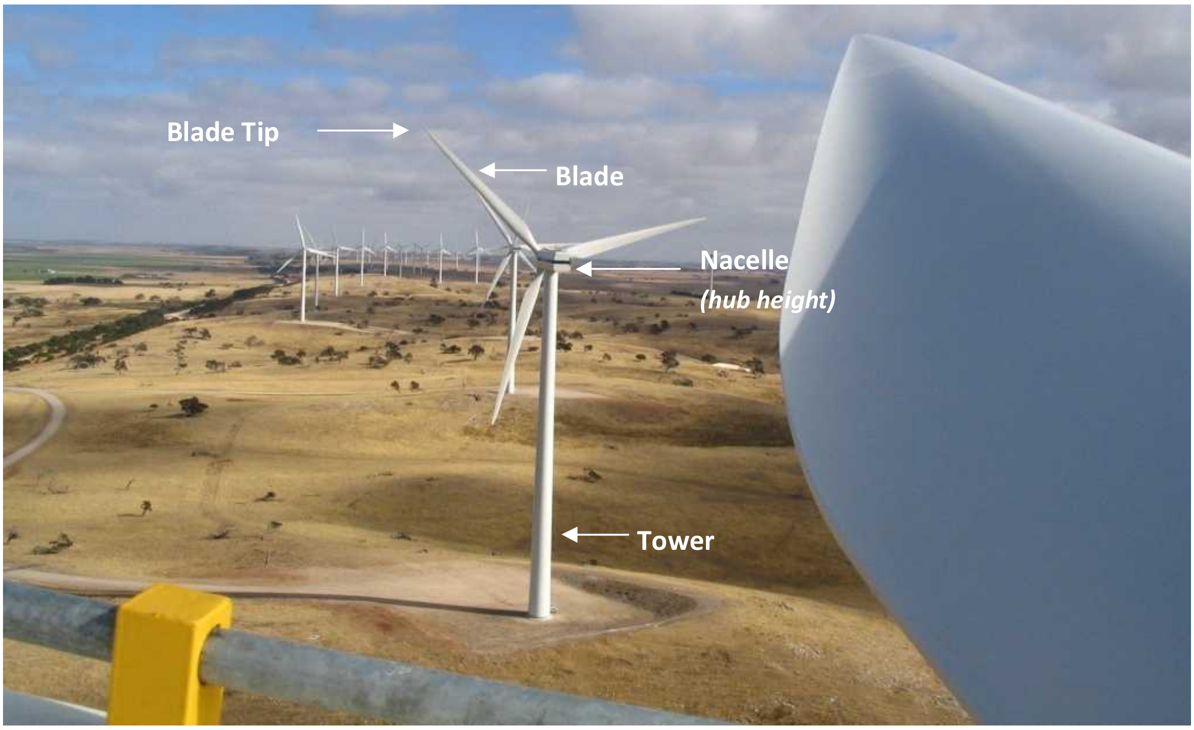

Image 3.1 Components of a wind turbine

3.3.1 *Turbine Rotor*

The potential turbines used for the Project will be three-bladed, semi-variable speed, pitch regulated machines with rotor diameters between 80 and 126 m and a swept area of 5,027 to 12,469 square metres (m^2). Typically turbines of this magnitude begin to generate energy at wind speeds in the order of 4 metres per second (m/s) (14.4 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.

3.3.2 *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 157 m. Alternative tower heights of 80, 85, 91, 93, 94 and 100 m are also under consideration however this is not an exhaustive list since new models and certified designs are continually entering the market place. The tower will typically be manufactured and transported to site in three to five sections for on-site assembly.

3.3.3 *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 157 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 5m to accommodate the wide-range of tower heights and blade lengths such new machines consist of.

3.3.4 *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.

3.3.5 *Footings*

Three types of foundation for the turbines will be considered pending geotechnical investigation of the ground conditions at the Project 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. (Refer to **Image 3.2** for an example of a gravity footing).

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. (Refer to **Image 3.2** for an example of a rock anchor footing).

Image 3.2 Typical gravity (left) and rock anchor (right) footings

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 onto 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 Project assume the use of the largest foundation footprint for all turbines, i.e. slab (gravity) foundations.

3.3.6 *Crane Hardstand and Assembly Areas*

Site access roads would have areas of hardstand (approximately 50 by 25 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 found to be unavoidable, this will be appropriately managed and carried out as described in **Chapter 20** Statement of Commitments. The 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. The 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 3.3** below shows a typical hardstand area adjacent to the wind turbine footing.

Image 3.3 Typical hardstand area adjacent to a rock anchor footing

3.3.7 *Monitoring Masts*

There are currently two temporary wind monitoring masts installed on site, one 60 m mast located in the Sapphire Cluster and one 50 m mast located in the Swan Vale Cluster, recording wind data for Project development and planning. These will remain in situ until the permanent masts are installed to replace them or they are removed once construction is complete.

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 3.4** below shows both typical tubular and lattice wind monitoring mast designs.

Image 3.4 Tubular (left) and lattice (right) wind monitoring masts

3.4 Electrical Infrastructure

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

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

3.4.1 *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 in either the nacelle, the base of the tower or close to the base of the tower on a concrete pad. **Image 3.5** below shows an example of a transformer located outside of the tower.

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

Image 3.5 Transformer adjacent to wind turbine

3.4.2 *Collector and Switching Substation*

The collector and switching substation (the "Substation") locations have been chosen to minimise access distance and electrical losses, and to reduce its visibility from surrounding public viewpoints (see **Figures 3.1** to **3.5**). The 132 kV Substation will be 1.1 km from the Adavale residence (non-involved landowner) whilst the 330 kV Substation will be 0.6 km from the Kingshill residence (involved landowner). **Table 3.3** describes the site features for each of the substation locations under consideration. Following construction, and if warranted, raised earthwork perimeters and small areas of native tree planting may be installed to screen any parts of the Substation that are visible from the surrounding country to reduce noise and visual impact. The Substation will require its own power supply from the local 11 kV or 22 kV transmission network.

Table 3.3 Preferred and optional substation locations

ID[1]	Location	Site Features
Preferred 330 kV Substation Location		
A	Western Feeder Road	An area of native vegetation (low quality) easily accessed from the Western Feeder Road, within 600m of the 330 kV transmission line and forming part of the access into the Sapphire Cluster. The nearest dwelling (associated) is 630 m away.
Optional 330 kV Substation Locations		
B	Western Feeder Road (adjacent to 330 kV transmission line)	An area of native vegetation (moderate-good quality) to be accessed from the Western Feeder Road, immediately adjacent to the 330 kV transmission line. The nearest dwelling (associated) is 1.1 km away.
C	Waterloo Road	An area of native vegetation (low quality) to the south of Waterloo Road and Western Feeder Road, just off the public roadway, 600 m east of the 330 kV transmission line. The nearest dwelling (associated) is 900 m away.
D	Within the Swan Vale Cluster	An area of native vegetation (moderate-good quality) to the south of Waterloo Road, 700 m east of the 330 kV transmission line. The nearest dwelling (associated) is 2.3 km away.
Optional 132 kV Substation Locations		
E	Within the Swan Vale Cluster	An area of native vegetation (moderate-good quality) south of Waterloo Road, 5 km north west of the 132 kV transmission line. The nearest dwelling (associated) is 2.1 km away.
F	South of the Gwydir Highway	An area of native vegetation (moderate-good quality) to the south of the Gwydir Highway, immediately adjacent to the 132 kV transmission line. The nearest dwelling (non-associated) is 1.2 km away.

[1] *The identifier matches the infrastructure lettering shown in Figure 61 of **Appendix 7**.*

The Substation will include one or two 150 or 200 megavolt ampere (MVA) transformers to step-up the voltage to 132 or 330 kV, together with ancillary equipment. It will occupy an area approximately 100 by 200 m and will be surrounded by a 3 m high security fence, surmounted by strands of barbed or razor wire, including lockable gate(s). The Substation arrangement will include an array of busbars, circuit breakers, isolators, various voltage and current transformers and a static compensator-capacitor as agreed with TransGrid. A buried earth grid will extend one metre beyond the fence on all sides. The ground surface within the Substation enclosure will be covered partly with a layer of crushed rock and partly by concrete slabs. As the transformer may contain upwards of 80,000 L of oil, provision will be made in the design for primary and secondary containment of any oil that may leak or spill from the transformers or associated components. This would involve constructed concrete bunds around each transformer and a spill oil retention basin or oil/water separator outside the Substation compound. The 2 ha area includes a provision for a 20 m buffer of land surrounding the equipment.

3.4.3 *Overhead and Underground Cables*

The electrical cables from the Wellingrove, Swan Vale and Sapphire Clusters will comprise a mix of underground or overground cabling and will connect via the cluster collector substations to either the 132 or 330 kV connection points. Where feasible, overhead transmission lines will be used to export power from each of the Clusters to the Substation (see **Figures 3.1** to **3.5**). **Image 3.6** shows a typical overhead line construction that could be implemented in this Project.

Image 3.6 Double-circuit overhead 33 kV power line

The underground cable routes will generally be between the turbines and follow the route of the internal access roads (refer to **Image 3.7** 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. Placement of these cables below ground will result in minimal visual impact.

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

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

Image 3.7 Laying underground electrical cable within road network

3.4.4 *Operation Facilities Building*

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

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

3.4.5 *Cluster Collector Substations*

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

Each cluster substation will occupy an area approximately 25 by 25 m and will be surrounded by a 3 m high security fence, surmounted by strands of barbed or razor wire. A cluster collector station would consist of up to three medium voltage transformers stepping up to 66 kV to minimise on site reticulation losses alongside other ancillary electrical assets such as transformer hardstands, environmental bunding, circuit breakers, busbars, voltage control and communication equipment.

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

3.5 Site Access Works

3.5.1 *Site Entry*

The Project locality can be reached via the Gwydir Highway between Glen Innes and Inverell, with direct access from local roads such as Waterloo Road, Polhill Road and Western Feeder Road.

Existing access roads are shown in **Figures 3.1** to **3.5** and can be classified into two broad categories:

- National Highways: Gwydir Highway, which is maintained by the Roads and Traffic Authority (RTA), would provide access from Glen Innes or Inverell to the site; and
- Local Roads: The direct access to the site is provided by local roads maintained by Glen Innes Severn or Inverell Shire Councils. The significant local roads are Waterloo Road, Polhill Road and the Western Feeder Road;

The RTA, Glen Innes Severn and Inverell Shire Councils have ongoing maintenance and improvement programmes for the roads and bridges under their control. There are no current proposals for major road improvements on the access roads under consideration.

The currently favoured access points for the three Clusters are shown in **Figures 3.1** to **3.5** and are described below:

- Wellingrove Cluster: The main access point is from Polhill Road, via Waterloo Road to the Gwydir Highway some 6.4 km away;
- Swan Vale Cluster: The main access is from Waterloo Road onto the southern ridgeline, accessed from the Gwydir Highway; and
- Sapphire Cluster: Access will be from Waterloo Road and the Western Feeder Road, depending on which section of the Cluster is to be accessed. An alternative access route is available following on from the Western Feeder onto Kings Plains Road to the north of the site, but this is not preferred.

Note: 21.2 km of the arterial road access likely to be used for construction activities are unsealed. This has implications for water usage and dust suppression and is discussed later in this chapter.

All entrances to the Project 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. Further details relating to safe access considerations are discussed in **Chapter 12**, Traffic and Transport.

3.5.2 *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.

As indicated in **Section 3.2** depending on final turbine selection and crane availability, new internal access roads will consist of either a 12 or 6 m wide design. The 12 m wide design is applicable for a track-mounted 'crawler' crane whereas the 6 m wide design is suited for a more mobile tyre-mounted crane. If a 6 m design is constructed it will incorporate passing bays up to 12 m wide located at intervals of approximately 1 km to allow for the safe passage of vehicles.

Currently crawler cranes are more common within the Australian market place and therefore the assessments undertaken within this EA are based around the greatest impact arising from a 12 m wide design for Layout Option 1. However tyre-mounted cranes are beginning to enter the market and if available will be considered for this Project.

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 Options 1 and 2 that include impacts associated with permanent road, hardstand and turning head areas in addition to the area considered the extent of the earth works. Designs have been carried out for both a 12 m and 6 m (with passing bays) road, hardstand and turning head network and a thorough assessment of these impacts is included in **Chapter 10** Flora and Fauna.

If a 12 m wide road design is considered appropriate for construction, then up to 6 m of road width will be rehabilitated after the infrastructure has been installed (post construction phase). If a 6 m road design is constructed then no rehabilitation would occur to the road after the infrastructure has been installed (post construction phase).

The 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 three Clusters are shown in **Figures 3.1** to **3.5** and described below:

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

3.5.3 *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 Project site safety regulations permit, or entrances made wider (bell-mouth) to allow manoeuvring.

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

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

3.5.4 ***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 Development 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 Project, 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 Project.

However once 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 Project site and incorporates the 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 **Section 3.8**).

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

If roads are not required for the ongoing operation and maintenance works of the Project they will be removed and rehabilitated on completion of the construction phase, and in accordance with landowner preferences and environmental controls.

3.6 Utility Services

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

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 Project 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 Project site.

3.7 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 Project area as possible. There are two existing gravel quarries located to the north of the Project on Kings Plains Road, as well as additional quarries within 10 km of the Project. Several landowners have expressed interest in allowing gravel extraction from their properties, which would require the necessary extraction permits prior to use. Both gravel and sand will be required to mix the high strength concrete to pour the wind turbine foundations. Gravel will also be required to dress the turbine sites, see **Image 3.5** above, and provide a low resistivity apron around the substations.

Water requirements will be met by sourcing water from within the Project area as long as the relevant permits can be obtained under current water control regulations. Bore water will be utilised from involved landowner properties where available, requiring the transfer of bore licensing from agricultural to temporary industrial use for construction purposes. If water cannot be sourced locally, then it will be brought to site by external water suppliers under contract to the Project. It is estimated that in the order of 13.3 ML of water would be required to produce the quantity of concrete required for gravity footings for Layout Option 1, 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 4.2 ML of water would be required if standard rock anchors were used for all footings in Layout Option 1.

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

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

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

3.8 Potential Design Layout Variations

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

As indicated in the Gullen Range Wind Farm EA, in relation to the relocation of wind turbines, the EP&A Act allows for the relocation of equipment so long as it remains broadly consistent with the proposal as outlined, otherwise an application for the modification of the Project Approval would be required.

The Department of Planning also noted in its assessment of the Gullen Range Wind Farm:

> *"… the Environmental Planning and Assessment Act 1979 permits the Proponent to make minor amendments to the project where such amendments would not be inconsistent with the approved project, or to seek the Minister's approval to modify the approval if the amendments are in fact deemed to be inconsistent."*

It is possible that wind turbines and other infrastructure may be relocated up to 100 m from the submitted layouts, subject to the provisions of the EP&A Act. In respect of the points outlined above, and the Project site-specific avoidance, mitigation and management actions described in the subsequent chapters, if it can be shown that such a repositioning and its impacts remains consistent with the approved Project, then no modification of the approval would be required.

Similarly, the constant roll-out of new turbine models by a variety of manufacturers makes it impossible to select a preferred turbine model at this stage. At the time of choosing the final turbine model, its parameters would be compared with those assessed in this report, to determine whether or not a modification would need to be sought.

3.9 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 Project site.

3.9.1 *Anticipated Project Timeline*

Approval is sought for the final positioning of up to 159 turbines and associated infrastructure within a radius of 100 m of the locations based on two preferred layouts, as indicated in **Figures 3.1** to **3.5**. The Proponent is applying for Development Consent to allow for substantial construction to begin within 5 years of the date of Consent. The actual timing of construction will principally be driven by the length of time taken to obtain other permits and authorisations, attaining Board approval/project financing for commencement and the long lead times for wind farm components. An indicative Project timeline is presented in **Table 3.4**. Staging of the development is also a consideration and some of those factors which may lead to a staged approach are discussed below in **Section 3.9.2**.

The following provides a guide to the anticipated activities subject to Development Consent for the Project.

Table 3.4 Anticipated Project timeline

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

** National Electricity Rules*

3.9.2 *Construction Staging and Considerations*

The following section provides context into aspects that could have a bearing on a staged construction process and as such the Proponent is seeking flexibility in approval conditions to allow for a staged development, subject to Development Consent.

Project scale: The Project comprises of three discrete Clusters and is estimated to be constructed over a period of 18 to 24 months. Within this time period it is anticipated that activities will occur mainly within one or two of the Project Clusters at any one time. This is subject to commercial considerations and the Conditions placed on the development following Development Consent.

The Proponent requests that the Project could be either commissioned in stages or as a whole wind farm.

3.9.3 *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 Project 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 the Proponent at that time. It is at this stage that final micro-siting of the wind turbines and site infrastructure will occur, subject to Development Consent and the Conditions placed on the development.

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 (EMP's) as outlined in **Chapter 19** Statement of Commitments (SoC). The Project EMP's 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 Project works.

3.9.4 *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 collector substation and cluster substation locations, access road areas, crane hardstand and assembly areas;
- The construction of a secure site compound, with Project owner and subcontractors field offices (portables), parking bays, and toilet facilities (temporary);
- 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 Draft 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.

3.9.5 *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 159 wind turbines, approximately six permanent wind monitoring masts, a substation/s, above and below ground cabling and temporary site facilities. Construction activity is likely to occur over a period of approximately 18 to 24 months with rehabilitation following the completion of works.

Community construction awareness programme: Prior to the commencement of the Project site construction activities, a programme of community awareness initiatives will be implemented. Information will be disseminated to the local community through local newspapers and direct mail to advise them of the nature of the construction activities, their timing and potential impacts. Contact details will be provided for individuals to gain further information or if required to express concerns or complaints.

Updates on the progress of construction works and relevant impacts will be provided during the construction period.

Site Establishment and Temporary Site Infrastructure: Site works will require the erection of temporary infrastructure such as a portable field office, toilet facilities, construction compound and parking bays (refer to **Image 3.8** below). This infrastructure will be typical of that used at construction sites; however it will not include full accommodation facilities.

Image 3.8 Typical temporary site office

Three preferred areas for the temporary site office, toilet facilities and construction compound and parking bays have been considered. One is located off Polhill Road in the Wellingrove Cluster, the second located off Waterloo Road in the Swan Vale Cluster and the third off the Western Feeder Road in the Sapphire Cluster (see **Figures 3.1** to **3.5**). The temporary site office facilities will be approximately 40 by 100 m and the construction compound approximately 150 by 200 m, with a combined area of approximately 3.4 ha. The area will be fully fenced with sufficient access to allow vehicle movement, stockpiling of materials, and office facilities. The selection criteria for identifying these locations were with respect to the following:

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

Pending 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. Post-construction, one of the temporary construction compounds will be retained as a permanent laydown area for the duration of the project.

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

Signage will be erected on the Gwydir Highway and other critical locations from the outset of construction, directing all vehicles associated with the construction site to the Project site office. Sightseeing traffic will be managed towards safe, prominent viewpoints where they may view the Project, but not in a way that would jeopardise the safety of sightseers or the progress of construction. Additional signage would be located near to the Project site, providing information about the turbines, the companies involved in the Project and essential safety information and telephone numbers. The need for a pull-off bay for sightseers' cars will also be assessed. Negotiations with the Glen Innes Severn and Inverell Shire Councils, NSW RTA and other affected parties will be initiated to determine final signage locations and the various works required.

Ancillary Construction Activities: On-site Concrete Batch Plant/Rock Crusher: Up to six concrete batching plant locations and three rock crusher locations are proposed to supply concrete and aggregate for the wind turbine foundations and access tracks. As each Cluster will be built in turn, it is unlikely that more than two of these will be operational at any time during the construction period.

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

A rock crusher would occupy an area of approximately 50 m by 60 m and consist of a tracked mobile crushing unit, conveyor belts, feeder and engine. Sufficient area will be required for the use of front-end loaders, delivery of materials and entry and exit of vehicles. **Image 3.9** below shows a typical mobile concrete batching plant facility and rock crusher.

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

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

Pending 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.

Image 3.9 Temporary on-site concrete batching plant and rock crusher

Under the *Protection of the Environment Operations Act 1997* 'Concrete Works' are considered a scheduled activity requiring a Licence from the Department of Environment and Climate Change (DECC) if the capacity of production of concrete exceeds 30,000 tonnes per year. A licence for its operation will be applied for to the DECC following Development Consent.

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 Project site. Site access points would be gated and secured, and appropriate warning signs erected.

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

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

Footing Construction: If gravity foundations are required, the construction of the foundation for each wind turbine would involve the excavation of approximately 450 m^3 of ground material to a depth of approximately 2.5 m. Shuttering and steel reinforcement would then be put in place and concrete poured to form the base in-situ. The upper surface of each base would finish approximately 0.5 to 1 m below ground level with either a central reinforced concrete plinth to support the tower, or a base steel tower section set into the concrete. Given the limited output capacity of the concrete batch plants, foundation designs can incorporate cold joints and construction joints. These can limit foundation pours to around 250 m^3, thereby allowing increased workmanship, less demand on the batching plant and a contingency plan in the event of plant breakdown, delays to material supplies or detrimental weather events (discussed below in more detail).

If rock anchor foundations are required, the construction of the foundation for each wind turbine would involve the excavation of approximately 100 m^3 of ground material to a depth of approximately 2.5 m. The rock anchor cores are drilled into the bedrock prior to concrete pour, and are up to a depth of approximately 20 m. The rock anchor tendons are grouted into place, stressed and secured once the concrete has cured sufficiently. Steel forms shuttering and steel reinforcement would then be put in place and concrete poured to form the base in-situ. The upper surface of each base would finish at ground level with either a central reinforced concrete plinth to support the tower, or a base steel tower section set into the concrete.

Prolonged cold temperatures can cause heat loss from the limestone hydration process during foundations pours. If concrete loses too much heat there is a risk of plastic cracking and loss of durability within the concrete. This can be controlled to a degree by additives to the concrete mixture. The preferred approach is to avoid pouring concrete during prolonged periods of cold weather.

With hot temperatures, the concrete can be affected by water loss through evaporation and can dry out too quickly. Additives can again control the extent of this, however pouring concrete during the evening or when the temperatures are lower is preferred. Alternatively a tent can be erected over the base area to provide protection to the concrete pour.

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;
- Placement of tape warning of the presence of electrical cables at the required depth; and

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

Collector Substation and Switchgear Compound: A location for the on-site collector and switchgear substation has been selected (**Figures 3.1** to **3.5**) for both the 132 kV and 330 kV possible connection points. The total compound area will be in the order of 100 by 200 m incorporating a 20 m Asset Protection Zone (APZ) area extending from the boundary of the installed equipment. The yard will be surfaced with compacted quarry rubble to form a hardstand area. Reinforced concrete footings will then be constructed to support electrical infrastructure and buildings. Infrastructure required within the yard includes 132 or 330 kV transformers, switchgear, power conditioning equipment and operation facilities building. **Image 3.10** below shows a typical collector and switchgear substation design during construction.

Image 3.10 Transformer foundation (foreground) and electrical substation and switchgear infrastructure (background)

Cluster Collector Substation: A cluster collector station would consist of up to three medium voltage transformers stepping up to 66 kV to minimise on site reticulation losses alongside other ancillary electrical assets such as circuit breakers, busbars, voltage control and communication equipment.

Physical footprint of the station should not exceed 25 m by 25 m and will include transformer hard stands, environmental bunding and security fencing at 2 m high.

Turbine Erection: The turbine components would be delivered to the Project 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 3.11** shows the sequential stages undertaken during the installation of a wind turbine.

Image 3.11 A range of typical turbine erection photographs

3.9.6 *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.

3.9.7 *Operation*

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

3.9.8 *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.

Should a problem occur with a wind turbine, then the on-site maintenance staff will attend to the machine to get it operational again. Depending on the situation, a turbine could be non-operational for several hours or days. Significant problems which require the replacement of major components, such as turbine blades, may require the use of cranes and ancillary equipment. This can result in a turbine being offline for several weeks whilst the appropriate equipment and materials are sourced.

3.9.9 *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 Project layout, or significant changes to the turbine technology, will be referred to the NSW Department of Planning as an amended proposal. It would also be subject to the regulations and guidelines of the day. Refurbishment requires the transportation and installation equipment and facilities, similar to that used during initial construction.

3.9.10 *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. 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 Project 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.

All decommissioning work would be the responsibility of the Project owner and is a provision within the lease arrangements with the landowners. Experience in Denmark and The Netherlands shows that sale of the scrap metal and other valuable items salvaged from the turbines and electrical components would more than meet the cost of decommissioning.

3.9.11 *Fire management*

A fire management plan is an important part of both wind farm planning and the community consultation process. All aspects of the Project will adhere to the current guidelines on bushfire protection as outlined in **Chapter 16** Fire and Bushfire.

Despite the low risk that wind farms present, fire management is a major concern within the Northern Tablelands region of NSW, and planning for fire prevention and an effective and informed response is 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 RFS to confidently plan and execute an effective response.

Appropriate fire management actions for all stages of the Project 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; and
- 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.

The RFS has been notified of the Project and further consultation will continue. Details of the Project site (such as turbines, access tracks and gate locations) will be provided to assist their internal response planning. Specific fire prevention and response measures are outlined in the Project EMP (see **Appendix 19**). Furthermore, an Emergency Response Plan will be developed in consideration of RFS guidelines and further consultation with regional and local rural fire groups, and would include agreed notification protocols, contacts and response actions.

3.10 Summary

The Project will comprise one of two potential design layouts; one consisting of up to 159 wind turbines and the other up to 125 wind turbines, both spread over 22 different properties, with a maximum blade tip height of 157 m. Consideration is also given to a 100 m micro-siting allowance and 5 m turbine height allowance, to accommodate post-consent layout changes and turbine selection considered as part of this EA.

The Project will connect into either the 330 kV TransGrid transmission line running north-south within the Sapphire Cluster or the 132 kV TransGrid transmission line running east-west to the south of the Swan Vale Cluster and the Gwydir Highway.

The Proponent requests that consideration is given to a micro-siting allowance of 100 m 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), 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, including storage areas. Land that is disturbed but is not part of the land-take for the life of the Project, will be reinstated.

Operation of the Project 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.

CHAPTER 4

Project Justification

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4. PROJECT JUSTIFICATION

There has been growing global recognition of the need to mitigate the environmental effects associated with fossil fuel energy generation. Such thoughts have manifested into international, national and state wide commitments supporting the development of clean and sustainable energy projects. The Sapphire Wind Farm will play an important role in contributing to both the increasing local and global need for such renewable projects and in tackling the issues of Global Warming and Climate Change.

4.1 Greenhouse Gas Emissions and Climate Change Science

There are naturally occurring greenhouse gases, including water vapour, carbon dioxide, nitrous oxide, methane and ozone in the atmosphere, which reflect and absorb heat from the Earth's surface. These natural greenhouse gases, in particular carbon dioxide, nitrous oxide and methane, in addition to human introduced gases such as halocarbons, chlorine- and bromine- containing substances and sulphur hexafluoride, are increasing in concentration and causing a rise in the normal levels of absorption, leading to the threat of elevated global temperatures.

Studies have found that the current rate of carbon dioxide emissions is greater than the natural rate of removal of carbon dioxide from the atmosphere (United Nation's Intergovernmental Panel on Climate Change (IPCC) 2007, pg 38). As a consequence of this increased concentration of carbon dioxide equivalent, it is predicted that the Earth will warm between 2 and 4.5 °C (IPCC 2007, pg 38). According to the David Suzuki Foundation, increased global temperatures will see changes in extreme weather patterns, shortage of water supplies, imperilled ecosystems, increase in risks on human health and potential for economic risks (David Suzuki Foundation, 2009).

The energy supply, transport and industry sectors are the primary drivers behind the rate of carbon dioxide equivalent emissions, which have increased by approximately 80 % from 1970 to 2004 (IPCC 2007, pg 36). Central to this is a heavy reliance on coal for low-cost electricity production, which is also recognised as having the highest output of carbon dioxide equivalent emissions (Garnaut 2008).

The consensus of scientific opinion as presented to world governments by the IPCC is that there is a link between humankind's actions and a variety of climate-related issues. Industrialisation and the resultant emissions of greenhouse gases from the burning of fossil fuels have created, and continue to exacerbate, a global environmental problem – Climate Change.

4.2 Global Response

The IPCC established by the World Meteorological Organisation (WMO) and the United Nations Environment Programme (UNEP) was set up in 1988 to provide a comprehensive forum in the fundamental understanding of linkages between greenhouse gas emissions and climate change.

The international consensus was summarised in the Geneva Ministerial Declaration, July 1996. This Conference of the Parties (COP2), addressing the United Nations Framework Convention on Climate Change (UNFCCC), concluded that there was a need for action from all tiers of government to avert the deleterious effects of climate change. This resulted in most participating countries to encourage renewable energy generation projects through sustainable development initiatives, in addition to complementary actions to develop energy conservation and efficiency measures.

In 1997, the Kyoto Protocol was established, which called for industrialised countries to reduce their collective emissions of greenhouse gases by 5.2 % below 1990 levels by 2008-2012. The year 2004 saw the Kyoto Protocol made legally binding in the European Union (EU) and ratified by the Russian government. This allowed for the Kyoto Protocol to establish the first binding international commitments to limit greenhouse gas emissions and an international emissions trading system to promote cost-effective reductions in 2005.

In 2008, the Australian government ratified the Kyoto Protocol and signed up to cut greenhouse gas emissions to 108 % of the levels they were is 1990. This was a watershed decision and an important step in determining Australia's position on climate change in the international arena.

4.3 Australian Greenhouse Gas Emissions and Response

Australia is the sixth highest emitter of greenhouse gas emissions in the world at 28.1 tonnes of carbon dioxide equivalent per person (Department of Climate Change (DCC) 2008). On a sectoral basis (energy supply, transport, industry and agriculture) the greatest percentage of greenhouse gas emissions are attributed to energy supply at 49 % (NSW Office of Environment and Heritage (OEH), 2008). Collectively, New South Wales (NSW), Queensland and Victoria account for over 80 % of energy supply greenhouse gas emissions throughout Australia (DCC 2009b).

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Bureau of Meteorology (BoM) published *Climate Change in Australia* (2007) based on the IPCC report *The Regional Impacts of Climate Change: An Assessment of Vulnerability* (2001). The following was concurred:

- Annual temperature increases of approximately 1.0 °C by 2030, with warming as large as 1.8 °C for some inland regions;
- Annual warming ranging from around 1.0 to 2.5 °C for the lowest assumed emission scenario, and 2.2 to 5.0 °C for the highest assumed emission scenario by 2070;
- Decreases in precipitation of 2 to 5 % in most regions, with decreases reaching 10 % in south-west regions. Later in the century the projected precipitation changes are larger and more variable, with the range of annual precipitation change being -30 to +20 % in central, eastern and northern areas in 2070;
- Global seal level rise is projected to be 18 to 59 cm by 2100, with possible addition from ice sheets of 10 to 20 cm; and
- Storm surges occurring in conditions of higher mean sea levels will enable inundation and damaging waves to penetrate further inland increasing flooding, erosion and the subsequent impacts on built infrastructure and natural ecosystems.

In 2007 the IPCC released their fourth assessment report, but again there was not sufficient information to determine the effects on Australia, so CSIRO and BoM created an update to accompany *Climate Change in Australia* and concluded:

- Concentrations of greenhouse gases are on the rise, with an unexpected increase in methane;

- Carbon sinks remove considerable amounts of anthropogenic carbon dioxide, but they are becoming less efficient;
- Sea levels are rising, with current projections of up to 80 cm by the end of the century;
- Southern Ocean acidity has increased, while salinity has decreased; and
- Rainfall in southern Australia has declined over a 30 year period, caused by changes in climate systems over the region (CSIRO and BoM 2009).

To combat these recorded and potential impacts, the Australian government and other agencies and participants in the climate change and energy sectors have come up with a number of responses in the form of Acts and policies, funds, programs and schemes.

Department of Climate Change and Energy Efficiency: In 1997, the Federal Government created the Australian Greenhouse Office (AGO) to provide a whole government approach to greenhouse issues. In March 2000, the AGO became an Executive Agency of Government and as a result the Department of Climate Change and Energy Efficiency (DCCEE) was established in December 2007. In 2007, Australia also ratified the 1997 Kyoto Protocol, making a commitment to limit greenhouse gas emissions growth. The DCCEE also developed a strategy to further reduce national emissions through the Carbon Pollution Reduction Scheme (an emissions trading scheme), the implementation of which, after being rejected by parliament twice, was deferred indefinitely. In 2010 a similar carbon pricing instrument was proposed in the form of a carbon tax, which is intended to reduce greenhouse gas emissions by making carbon pollution more expensive.

Renewable Energy Target: The Renewable Energy Target (RET) legislation was passed by Federal Parliament in August 2009, providing an expansion on the Mandatory Renewable Energy Target (MRET), aiming to acquire 20 % of Australia's electricity from renewable sources by 2020. The RET commenced with a target of 45,000 gigawatt hours (GWh) to be generated from renewable sources by 2020. After that, each year the target will remain at 45,000 GWh until 2030 when the RET will cease operation.

To meet the existing RET, each retailer must obtain a target amount of electricity in megawatt hours (MWh) from renewable energy sources in order to avoid a financial penalty. Renewable energy is obtained with Renewable Energy Certificates (REC), which are created by accredited renewable energy generators. Once a REC is bought by a retailer, it is surrendered to the government regulator. From 2001 to 2007 the largest REC generating sources were from hydro, wind and solar water heaters (Office of the Renewable Energy Regulator 2008, page 14).

In response to uncertainty in the small-scale renewable technology market, in January 2011 the RET was separated into the Large-scale Renewable Energy Target (LRET) and the Small-scale Renewable Energy Scheme (SRES). This change is anticipated to support a higher REC price for large scale projects, like wind farms, and provide greater certainty for the renewable energy sector.

Council of Australian Governments: The Council of Australian Governments (COAG), October 2008, agreed to develop a National Strategy on Energy Efficiency, to accelerate energy efficiency efforts across government levels and to help households and businesses prepare for the introduction of a future carbon price.

COAG in 2010 took original measures further, increasing residential and commercial efficiency ratings, and introducing mandatory disclosure of energy efficiency. COAG have also stressed the urgency to create a uniform scheme on renewable targets to provide consistency for investors looking to support Australia's renewable energy industry in the coming years.

Funding: The Australian Government has taken steps towards investing in a growing renewable energy industry. The Clean Energy Initiative, announced in 2009, invested $3.5 billion in clean coal projects, the Solar Flagships Program and the National Energy Efficiency Initiative. This funding was boosted by a further $650 million to establish the Renewable Energy Future Fund, the focus of which was support of new technologies.

GreenPower: GreenPower, started in 1997 to accredit and audit renewable energy retail products, now manages the program nationally. Over 900,000 residential electricity customers in Australia now purchase accredited renewable energy through the program.

4.4 Need for New Power Generation in New South Wales

According to the Australian Bureau of Statistics (ABS) between 2001 and 2006, NSW's main source of energy consumption was from black coal (53 %) and petroleum (38 %), with black coal usage increasing by 9 % over that five year period. Energy demands in NSW are also increasing, with a 1,310 GWh increase in energy demand per annum over the past ten years, and an estimated 3.8 % annual increased energy demand over the next ten years (TransGrid, 2010). It is predicted that NSW will have the largest projected growth in peak electricity demand in Australia (TransGrid 2010).

Compared to other states, NSW has a relatively unexploited wind resource, a large electricity market and an available transmission capacity, which makes it very suitable to accommodate wind power technology. Under the LRET, investors are seeking to utilise this wind resource as the demand for REC's increases.

The State Plan 2010 provides the vision for NSW for the next ten years and includes goals and the provision of direction for delivery of priorities and targets. The State Plan has set targets in line with the National LRET of 20 % renewable energy consumption by 2020. In addition, a long term goal of a 60 % cut in greenhouse gas emissions by 2050 and a return to year 2000 greenhouse gas emission levels by 2025 were detailed.

4.5 Suitability of Wind Power

4.5.1 *Evolution of Wind Technology*

The ability to harness wind power has evolved from research in the 1980s, expansion and consolidation in the 1990s, to a competitive, mature, mainstream energy supply technology in the current market. At the end of 2010, the total international capacity of wind energy was 197,000 MW, with global wind power capacity increasing by 24.1 % in 2010 (**Figure 4.1**, GWEC 2010). It is predicted that by 2020 wind power will be supplying 12 % of the global demand for electricity (Martinez *et al* 2009).

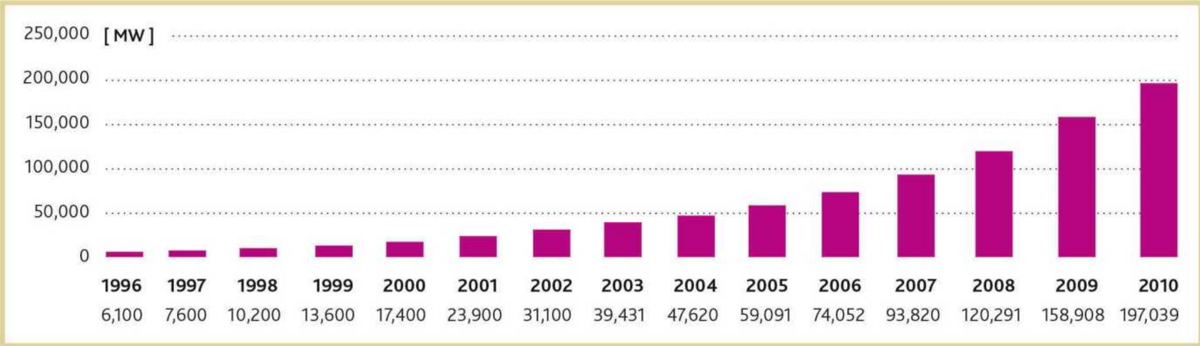


Figure 4.1 Global cumulative installed wind capacity 1996 – 2010
Source: Global Wind Energy Council (GWEC)

One of the advantages of wind technology is its high energy return on the energy invested. As seen in **Figure 4.2**, wind technology both on and offshore has a high energy return on energy invested compared to existing conventional energy sources, such as coal, and other renewable technologies. Due to high energy return from wind energy, the requirement to harness the wind more effectively has helped to drive the evolution of wind technology.

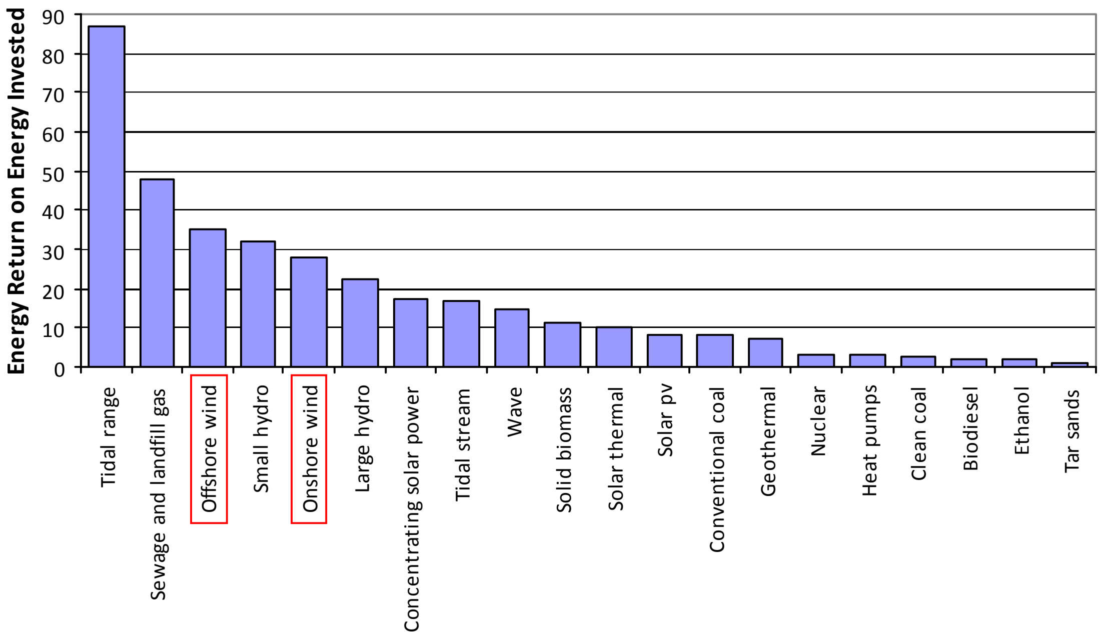


Figure 4.2 Energy return on energy invested
Source: Hughes and Anslow 2007

Wind energy is also well positioned to meet future targets and provide 12 % of the global demand for electricity by 2020, as it possesses one of the lowest production costs, uses no water during electricity production and is a mature technology acceptable to energy utilities in comparison to other renewable energy sources as seen in **Table 4.1**.

Table 4.1 Mainstream renewable energy available in the LRET

Generation Source	Technical Maturity	Water Use (L/MWh)	Cost ($/MWh)
Hydro	Mature	high	27-282
Wind	Mature	nil	75-90
Solid biomass	Research	2000 (wet)/ 700 (dry)	47-120
Solar thermal	Emerging	2000 (wet)/ 150 (dry)	120-150
Solar PV	Various	nil	400-800
Geothermal	Research	high	large range

Source: Garnaut Review, Owen Report, Gullen Range Submission Report

4.5.2 *Community Support*

Renewable Energy Precincts: There are six Renewable Energy Precincts consisting of the New England Tablelands, Upper Hunter, Central Tablelands, NSW/ACT Border Region, South Coast and Cooma-Monaro. The Renewable Energy Precincts are a community partnership initiative, designed to give local communities a stake in renewable energy development. Resources that have been created to assist the Renewable Energy Precincts include:

- Pre-Feasibility Study for a Solar Power Precinct;
- Community Attitudes to Wind Farm in NSW;
- Clean Energy Jobs in Regional NSW;
- The Wind Energy Fact Sheet;
- Estimating Greenhouse Gas Abatement from Wind Farms in NSW;
- NSW Wind Farm Greenhouse Gas Savings Tool; and
- Impact of Wind Farms on Surrounding Land Values in Australia.

Community Attitudes to Wind Farms in NSW: DECCW commissioned AMR Interactive to undertake telephone interviews to study the attitude of communities to wind farms and renewable energy across the six renewable energy precincts over May and June 2010. A total of 2,022 residences and 300 businesses were interviewed with the following key results:

- Familiarity with wind power found 59 % spontaneously named wind power as a clean energy source, with 81 % of residents regarding wind power as an acceptable source for power generation when asked specifically. 68 % of residents knew about wind farms currently operating in NSW, however only 28 % knew of planned or under construction wind farms;
- Perceptions about wind power and its benefits and impacts found 32 % of residents believed wind farms would contribute to an increase in tourism, 69 % of residents did not perceive any health concerns, and 62 % did not perceive a negative impact on the environment;
- Level of support for wind farms found 85 % of residents supported wind farms being built in NSW with 80% supporting wind farms in their local region. 79 % supported wind farms being built 10 km from their residence and 60 % at 1 to 2 km. 68 % of the residents which opposed a wind farm at 1 to 2 km saw an overall benefit for wind farms to the local region;
- Key drivers for support of a wind farm at 1 to 2 km included benefit to the local community and noise. Key drivers for opposition of a wind farm at 1 to 2 km included economic and community

benefits, perceived visual and noise impacts, concerns about health, safety and heritage values and perceptions of wind power relating to clean energy and its potential in NSW; and

- 61 % of non-farming businesses in the Renewable Energy Precincts believed there would be no impact from a wind farm and 30 % anticipated positive effects on their businesses. Farming businesses were more likely to spontaneously express concern about the location of a wind farm, nevertheless, 57 % would consider a wind farm on their property.

National Telephone Survey: The Australian Wind Energy Association commissioned the Australian Research Group Pty Ltd (ARG) to conduct a telephone survey on renewable energy, in particular wind farms in August 2003. A total of 1,027 participants were surveyed with the following results:

- 94 % thought that a target to increase the contribution of clean energy from renewable resources was a good (32 %) or very good idea (62 %). Less than 3 % considered the current target to be too high or much too high;
- A substantial majority (76 %) said that they were prepared to pay 5 % more on electricity bills for 10 % more clean energy when faced with the option of having cheap electricity at any cost;
- 88 % said they wanted the government to increase support to the renewable energy sector, compared to 26 % wanting an increase in support for the fossil fuel sector;
- For 71 %, reducing greenhouse pollution outweighed protecting industries that rely on reserves of fossil fuel; and
- 95 % supported (27 %) or strongly supported (68 %) building wind farms to meet Australia's rapidly increasing demand for electricity and 91 % agreed it was more important to build wind farms for electricity than avoid building them in rural Australia.

The survey resulted in respondents supporting clean energy from renewable resources, even with a potential increase in price. It also highlighted that it is more important to reduce greenhouse pollution rather than support the fossil fuel sector, and instead place wind farms in rural areas.

NSW Southern Tablelands Survey: Wind farm developer Epuron Pty Ltd commissioned REARK Research to conduct a random phone survey on 300 residents in the Goulburn, Crookwell and Yass region to determine community perception on wind farm developments in the Southern Tablelands, July 2007 (Epuron, 2008). The survey concluded that:

- 80 % were concerned right now with the threat of global warming and its impact on the environment, while 16 % were unconcerned;
- 89 % were in favour of wind farm projects being developed in the Southern Tablelands, while 5 % were opposed;
- 71 % favour a wind farm within 1 km of their home and 87 % support a wind farm within 25km; and
- 9 in 10 have seen a wind turbine and more than 8 in 10 have seen the Crookwell Wind Farm.

This survey showed that respondents are concerned about global warming and have seen the alternatives, such as the wind farm at Crookwell. This resulted in the majority of respondents willing to have a wind farm within 1 km of their residence.

4.5.3 *"Taralga Wind Farm" Judgement*

The 2007 Land and Environment Court hearing of the Taralga Landscape Guardians Inc. v Minister for Planning and RES Southern Cross Pty Ltd, reviewed a number of key issues relating to wind farms in rural NSW. In particular, issues relating to visual impacts on the landscape from surrounding residencies and the village of Taralga were scrutinised.

The judgement stated that wind turbines were acceptable in the landscape at Taralga, and set out steps for determining how many wind turbines would be acceptable. Based on the economic viability, visual impact from the village and the broader public interest, it was decided that the original design of 69 wind turbines of the Taralga Wind Farm was acceptable. As for any residential visual or other associated impacts with the Taralga project, it was decided that any suggested mitigation measures need to be settled by RES Southern Cross Pty Ltd and the potentially affected residence.

By comparison, the Project will have minimal impact on Glen Innes or Inverell as these towns occur outside the wind farm viewshed, as discussed in **Chapter 8** Landscape and Visual. However there have been concerns raised by individual properties on potential visual impacts as discussed in **Chapter 6** Stakeholder Consultation, and similar to the Taralga judgement, any mitigation measures will be between the Proponent and any affected landowners.

4.5.4 *Interaction with the Electricity Network*

The National Electricity Market (NEM) manages the supply and demand of the NSW market by ensuring power generation is available at each instant in time to meet the required consumption. The NEM is supported by baseload power stations, generally coal, to provide 100 % capacity at 100 % of the time. However, this is not always possible due to maintenance and failures of coal fired power stations which in NSW result in 28 days of planned maintenance per annum (Power System Planning and Development (PSPD) 2009). This requires the Australian Electricity Market Operator (AEMO) to source power from multiple energy generators to provide a secure baseload.

Despite common misconceptions that wind farms are inefficient and unreliable, they are in fact an efficient and reliable energy supplier in the NEM and can support baseload in the market. This is due to the fact that:

- Both wind farms and modern coal fired power stations are efficient in the order of 35 - 45 %;
- The NEM is strong enough to cope with output fluctuations of a wind farm;
- Wind turbines are reliable, with an availability of above 97 % which means that wind farms are able to operate for the majority of the year;
- Wind farms are in fact similar to hydro power and coal fired generators, which do not operate at 100 % capacity 100 % of the time;
- Wind is a free energy source and therefore mitigates risks to the existing electricity supply infrastructure from acts of terrorism and price risks from fossil fuels which are tied strongly to the international market; and
- Existing wind farms in NSW and Australia are providing evidence that wind energy production is clean, reliable and cost effective in meeting current market energy demands.

It is likely the Project will not result in the direct closure of any baseload or coal fired power stations, instead wind energy will become an increasing and important part of the energy mix as Australia transitions into a carbon constrained economy.

4.5.5 *Finite Resource Market*

As previously mentioned in **Section 4.4**, the dominant fuel consumption in Australia is fossil fuel combustion, through the long term usage of oil, natural gas and coal. Post-2000 prices have reached record highs compared to coal in the 1970s and oil in the 1980s. Therefore, not only are these forms of energy emitting large concentrations of carbon dioxide, they are becoming more expensive. Such costs are expected to rise further with the emergence of the emissions trading scheme in Australia and a price on carbon. New, renewable energy technologies are required to extend the limited amount of oil and natural gas and help minimise the impact on mining in remote and sensitive areas. Wind technology, with significant market growths annually, increasing support from international communities and with decreasing component costs, is one such technology.

4.5.6 *Life Cycle Assessment*

Wind turbines require energy to be spent during the manufacturing stage of its components and therefore a certain amount of carbon dioxide equivalents will be produced. In comparison to other forms of energy, such as coal and nuclear, onshore wind farms have relatively low carbon intensities, as seen in **Figure 4.3**.

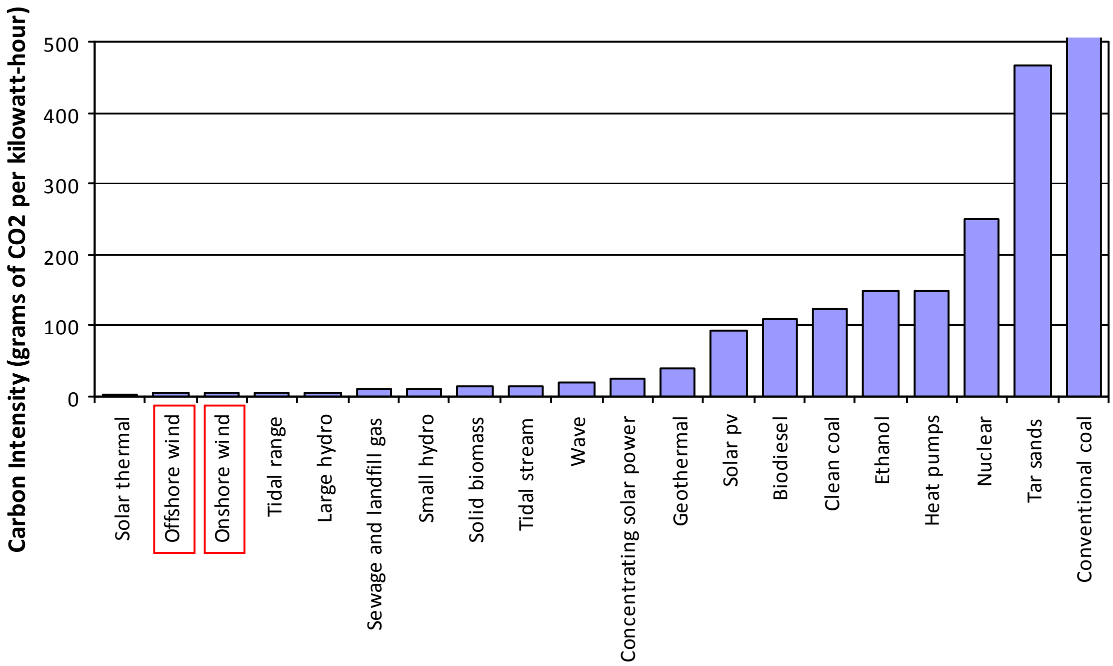
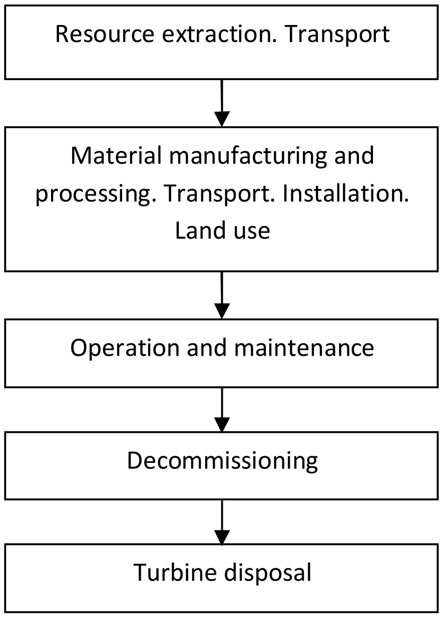


Figure 4.3 Typical industrial carbon footprints

Source: Hughes and Anslow 2007

To further analyse the carbon footprint of a wind turbine a Life Cycle Assessment (LCA) can be undertaken which identifies areas in the manufacturing and construction of the wind turbine where carbon dioxide emissions can be reduced. The main steps of the LCA for a wind turbine are displayed in **Figure 4.4**.



Note: 10 % loss in material when recycling occurs at the turbine disposal stage

Figure 4.4 Life Cycle Assessment model of a wind turbine
Source: Adapted from Martinez et al 2009

In general, the time for a wind turbine to repay the energy used in construction ranges between five to eight months (Martinez *et al* 2009; Tremeac & Meunier 2009; Elsam 2004). The time it would take for a wind turbine to repay the amount of global greenhouse gases emitted is not as widely researched, however initial studies have found it would take approximately six months (Tremeac & Meunier 2009). Of the processes involved, manufacturing has the largest impact. However it is balanced by the decommissioning and turbine disposal stages which consist of mainly recycling with its positive benefits for the environment (Martinez *et al* 2009; Tremeac & Meunier 2009).

4.6 Contribution of the Sapphire Wind Farm

4.6.1 *Land Suitability*

The proposed wind farm is consistent with the Rural Lands State Environmental Planning Policy (SEPP) as it is a development which can occur in unison with the continuing use of the land for rural purposes.

Although the proposed development temporarily reduces the available land for agriculture during construction, the long term use of the land for agricultural purposes will not be compromised during operation of the Project. In addition, the potential diversity of income gained by landowners would assist in ensuring traditional rural communities can remain on the land and continue farming during times of drought or other hardship.

The Rural Land SEPP also restricts subdivision of rural land where conflicts occur. Currently the Glenn Innes Local Environmental Plan (LEP) identifies a minimum lot size of 20 ha (clause 12[2]), while Severn LEP states a minimum lot size of 40 ha (Clause 25[3a]) and Inverell LEP identifies a minimum lot size of 200 ha (Clause 11[4a]). According to Glen Innes Severn and Inverell Shire Council's Development Application database there are no pending or approved subdivisions or building entitlements in the vicinity of the Project which will be impacted upon.

Visual and noise impacts were assessed with respect to future dwelling entitlements in lots surrounding the proposed development site boundary in **Chapter 8** Landscape and Visual and **Chapter 9** Noise. Therefore, as there are no pending developments and future impacts have been assessed in neighbouring lots, the Project is considered suitably placed in its current position.

There are two National Parks and one Nature Reserve in proximity to the Project, the Kings Plains National Park (5 km north west), Nullamanna National Park (20 km north west) and Severn River Nature Reserve (20 km north west) as shown in **Figure 4.5** below. Mount Topper State Forest is also located 30 km south west of the Project site.

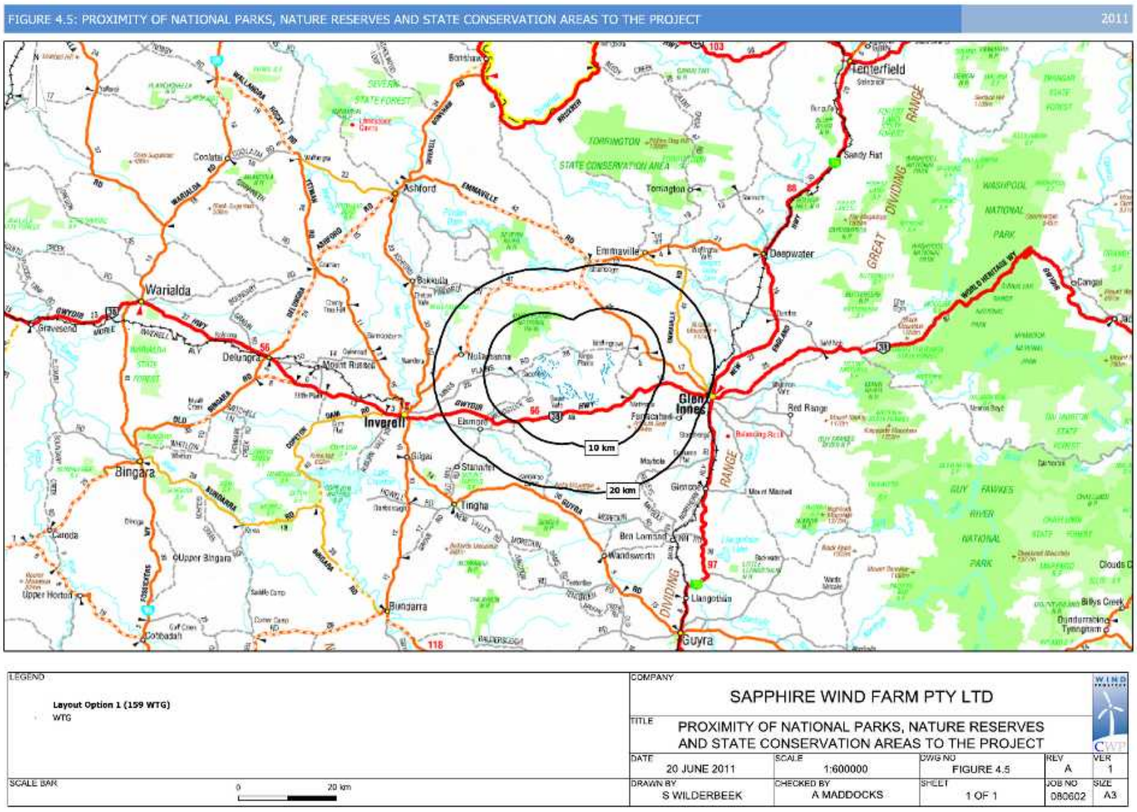


Figure 4.5 Proximity of National Parks, Nature Reserves and State Conservation Areas to the Project
(An A3 size version of this Figure is displayed in Volume 2)

Both the Kings Plains National Park and Severn River Nature Reserve are used for conservation and recreation, with tourist stops and camping areas available. The Mount Topper State Forest is being managed to control widespread invasive flora and fauna species. Through the influence of distance, vegetation and topography, the Project would unlikely be visible from camping or recreational areas within any of these regional Parks or Reserves.

The Project site overlaps with 12 mineral exploration or mining licences and applications for licences as shown in **Table 4.2** below. It is unlikely that the placement of turbines within or adjacent to mining operations (should they be economical, environmentally acceptable and approved) would result in conflict, based on the type of mining activity being undertaken in the area. Wind farms currently co-exist with mining areas in NSW, including the approved Woodlawn Wind Farm, adjacent to Veolia's Woodlawn Bioreactor near Tarago, NSW (a disused open cut mineral mine). All companies involved in the area have been contacted and their responses are summarised in **Chapter 19** Socio-Economic Assessment.

Table 4.2 Exploration and Mining Licences overlapping the Project site

Company	Title(s)	Status
Australian Gemstone Resources PL	ML 1492 EL 6982	Expires 16 Aug 2022 Expires 11 Dec 2011
DE GUNST, Steven	ELA 4332	Application 23 Jul 2011
Eastern Feeder-Holdings PL	ML 1374	Expires 13 Jul 2015
Inishowen Resources PL	EL 7374	Expired 20 Jul 2011
Jesasu PL	AL 2 AL 14	Expired 14 Mar 2011 (Renewal Sought) Expires 9 Aug 2012
Pan Gem Resources (Aust) PL	ALA 19	Application 22 Jul 1999
Parnosa PL	EL 7669	Expires 16 Dec 2012
Valbob Mining PL	EL 7796	Application 4 Jul 2013
Volcan Australia Corporation PL	EL 7301 EL 7302	Expired 23 Feb 2011 (Renewal Sought) Expired 23 Feb 2011 (Renewal Sought)

4.6.2 *Layout*

A range of factors are considered during the 'site selection' phase, which affects the suitability of an area for a wind farm, and which can potentially constrain development. These include:

- Suitable wind resource;
- Ease of connecting to and capacity of the local electricity transmission network;
- Site access and general ground conditions, including slope and geology;
- Proximity to residential properties and the nature of surrounding land uses;
- Availability of turbine sites based on a range of constraints;
- Presence (or absence) of nationally and locally significant areas with regard to environment, landscape, nature conservation, archaeology and cultural heritage; and
- Interest within the community.

Wind Resource: Numerous investigations into the wind resource potential at several locations across NSW have revealed some general principles which can be applied to assess the merit of an individual site's wind resource. Wind speeds are likely to be adequate in areas that are:

- Exposed to open water or large areas of open grassland without intervening obstructions. These areas receive a very smooth airflow with a high-energy content; and
- On significantly elevated locations, surrounded by a smooth and gently rounded landscape, thus promoting wind speed-up. The ranges that make up the Project area offer excellent speed-up due to topographical detail.

The Proponent installed one wind monitoring mast in the Sapphire Cluster in December 2008 and another in the Swan Vale Cluster in February 2011. Two Triton sonic wind profilers were also positioned on-site in October 2009 and March 2011 respectively. A Triton is an instrument based on the SODAR (SOund Detection And Ranging) principle and is able to be moved around the site on a regular basis, collecting further wind data. The recorded wind data, when modelled incorporating long term BoM data from local area, shows wind speeds that are high and consistent making a wind farm project viable in the selected location.

Land Use: As the Project is located in the agricultural area of Kings Plains, there is a low population density within and around the Project. Non-associated landowners have wind turbines further away from their dwellings than associated landowners, in order to minimise impacts as discussed in **Chapter 6** Stakeholder Consultation, **Chapter 8** Landscape and Visual and **Chapter 9** Noise.

Electricity Transmission Network: Ease of connection to and capacity within the grid can be difficult to assess, given the commercially confidential nature of certain information concerning the electricity distribution and transmission networks, coupled with the complexity and variety of connection options that may be available. However, on a broad scale, areas remote from high voltage overhead transmission lines or from existing population centres are unlikely to offer many feasible opportunities for grid connection. Together with grid connection factors, actual grid capacity and the ability for the electricity grid to absorb wind generated electricity seem to be the principal limiting factors for wind farm development in NSW.

The high voltage transmission network that the Project will connect into is either the TransGrid 330 kV double-circuit overhead transmission line running through the Sapphire Cluster or the TransGrid 132 kV double-circuit overhead transmission line running adjacent to the Gwydir Highway to the south of the Project.

Site Access and Condition: There is good road access to the Project site as discussed in **Chapter 12** Traffic and Transport, with the arterial roads intersecting with major State and Federal highways, making it a suitable site for the Project.

Community Interest: Landowners’ interests are also important in determining the location of wind turbines, as a wind farm cannot be placed on land where the landowners are resistant to the development. Neighbouring landowners are not always receptive to the placement of wind turbines and appropriate consultation was carried out during the assessment of this Project, as discussed in **Chapter 6** Stakeholder Consultation. Turbines have been moved and/or removed to accommodate the varying opinions of wind turbines, to reduce the visibility and noise impacts from some properties/communities altering the layout of the Project (see **Chapter 6** Stakeholder Consultation).

4.6.3 *Scale*

In NSW, it was common for proposed wind farms to be no greater than 50 MW, consisting of up to 20 to 25 wind turbines. Recently, larger wind farm projects have been proposed, approved and constructed as listed in **Table 4.3**. This upscaling in size is a response to the LRET and the new target emission reductions for NSW, as discussed in **Chapter 5** Planning Context. Therefore the Project, with up to 159 wind turbines, is comparable in scale to more recently proposed wind farms and is of a suitable size to contribute to Australia’s target of emissions reductions.

Table 4.3 NSW Wind Farms

Wind Farm	State of Development	Number of WTG
Capital	Constructed	67
Cullerin	Constructed	15
Blayney	Constructed	15
Crookwell	Constructed	8
Boco Rock	Approved	122
Conroy's Gap	Approved	15
Black Springs	Approved	9
Silverton	Approved (Proposed)	282 (598)
Gullen Range	Approved	84
Crookwell II	Approved	46
Glen Innes	Approved	27
Woodlawn	Approved	23
Kyoto Energy Park	Approved	34
Yass	Proposed	152
Capital II	Proposed	55
White Rock	Proposed	119
Ben Lomond	Proposed	100
Flyers Creek	Proposed	44
Crookwell 3	Proposed	30
Paling Yards	Proposed	50-60
Adjungbilly	Proposed	26
Birrema	Proposed	60-80
Collector	Proposed	60-80
Bodangora	Proposed	25-40
Rugby	Proposed	90
Rye Park	Proposed	80-110
Crudine Ridge	Proposed	70-110
Liverpool Range	Proposed	300-500
Bango	Proposed	100
Golspie	Proposed	100
Uungula	Proposed	330

Source: DPI, Major Project Register, Accessed 10/6/11

Generally, having a larger scale wind farm will result in higher energy production, leading to reduced capital costs and therefore lowering the cost per unit of energy generated. When first announced in May 2009 the Project consisted of up to 178 turbines, however due to wind speed modelling, consultation with nearby stakeholders and different turbine models now available on the market, the Project today consists of up to 159 turbines. This is still significant, and allows for economies of scale to be achieved during the procurement, construction, operation and decommissioning of the Project.

The Project is designed into three separate Clusters as described in **Chapter 3** Project Description. By having three Clusters the potential impacts from various construction activities can be reduced, including visual, noise, and traffic and transport effects, as compared to a single large development.

4.6.4 *Size of Proposed Wind Turbines*

Wind turbines come in various sizes depending on use and location. **Figure 4.6** below provides a timeline of the different styles of turbines from the 1970s to the present. It is important to note that new turbine models are constantly being developed and this chart is only representative of the increasing scale of machines over time.

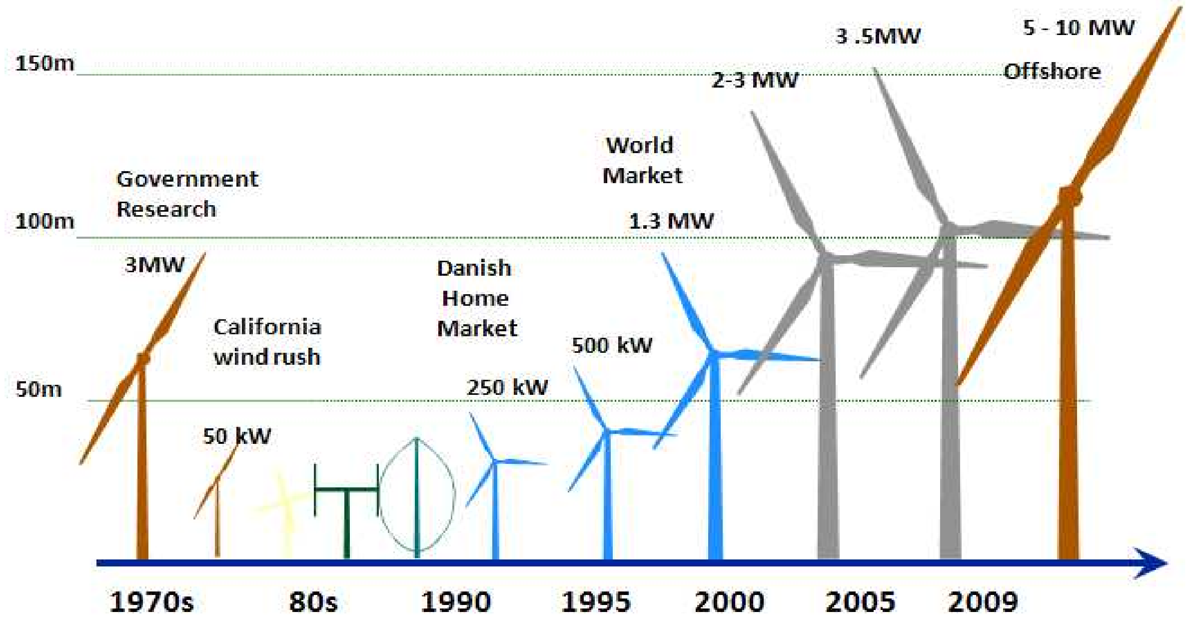


Figure 4.6 Evolution of wind turbine generators

The Great California Wind Rush in the early eighties saw the introduction of 1,000 x 55 kW wind turbines in Palm Springs, California. In 1995, 39 x 600 kW wind turbines were installed in Denmark at the Rejsby Hede Wind Farm, representing the largest wind farm in Denmark at the time. With increasing generator and turbine size, the demand for wind turbines for larger projects grew, creating momentum towards a mature world market. Offshore wind farms increasingly became of interest to countries with high population densities and restricted onshore sites. Today, with an ever-increasing demand for renewable energy sources, wind turbines continue to increase in generator size and height for both onshore and offshore installations to maximise the capacity of wind farms, and significantly improve the provision of renewable energy on a global scale.

Sapphire Wind Farm is a part of today's increasing trend towards the use of larger wind turbines that have the capacity to capture greater portions of the wind resource in NSW and deliver realistic baseload electricity generation. The Proponent will be reviewing a number of wind turbine models as discussed in **Chapter 3** Project Description, which will ultimately determine the number of turbines installed and the capacity of the Project.

4.6.5 *The NSW Wind Farm Greenhouse Gas Savings Tool*

As part of the Renewable Energy Precincts initiative the NSW Government has developed the NSW Wind Farm Greenhouse Gas Savings Tool, allowing community and industry to easily calculate the projected greenhouse gas savings from new wind farms in different Renewable Precincts across NSW.

The NSW Wind Farm Greenhouse Gas Savings Tool estimates savings by multiplying the output from a wind farm with the emissions intensity of the electricity supplied in the NEM. The emissions intensity of electricity supplied in the NEM varies according to the location and size of a new wind farm, so site specific emissions intensities must be used for different size developments within each Renewable Precinct.

The installed capacity of the Project will be dependent on the final turbine model and layout selection, however it is expected to fall into a range between 238 and 425 MW, as outlined in **Chapter 3** Project Description. As such, the NSW Wind Farm Greenhouse Gas Savings Tool has been used to estimate the greenhouse gas savings across the range of 238 and 425 MW using the New England Renewable Precinct emission savings (results in **Appendix 3**).

The estimated annual greenhouse gas savings from an installed capacity of 238 MW is 639,000 tonnes of CO_2-e. At this capacity, the Project would generate 746 GWh of electricity annually, enough to power 102,100 homes each year (NSW OEH, 2011).

Alternatively, at an installed capacity of 425 MW, an estimated 1.14 million tonnes of greenhouse gas emissions will be saved annually. At this capacity, the Project would generate 1,331 GWh of electricity, and power 182,400 homes annually (NSW OEH, 2011).

4.6.6 *Greenhouse Gas Emission Reductions*

The National Greenhouse Accounts (NGA) factors provide amounts of carbon dioxide equivalents (CO_2–e) for direct and indirect emissions. Indirect emissions are of primary consequence to this Project as they relate to the consumption of purchased electricity from the grid. These emissions are physically produced by the burning of fossil fuels (coal, natural gas, etc.) at the power station. By calculating the indirect emissions for the Project, it is possible to determine the amount of CO_2–e offset.

The megawatt hours (MWh) per year potentially produced by the Project, **based on both a conservative capacity factor and average installed capacity**, can be calculated by:

Number of turbines x capacity factor x installed wind turbine capacity (MW) x 8,760 (h/y)

159 turbines x 0.35 x 2.05 MW x 8,760 = 999,363 MWh/y (999 GWh/y)

Using the latest NSW indirect emission factor, Scope 2, from the NGA:

1 MWh produced for burning of fuels at the power station = 0.89 tonnes CO_2-e emitted

Wind energy is dispatched first into the grid, in doing so requiring less generation from fossil fuel power stations. As a result, wind generation can directly result in CO_2–e emissions savings in NSW. For example:

1 MWh produced from wind = 0.90 tonnes CO_2-e saved

Therefore the amount of CO_2-e emissions saved will be:

Predicted wind farm output per year (MWh/y) x Avoided CO_2-e emissions (tonnes/MWh)

Using the most recent figures published in the NGA Factors (2010), it is estimated that the Project will displace 899,426 tonnes of CO_2-e per annum and 17,988,520 tonnes of CO_2-e over a 20 year operational life of the Project. This means that the Project would result in an annual reduction in CO_2-e emissions equivalent to taking approximately 224,857 cars off the road permanently (based on an average unleaded petrol car that emits approximately 4.0 tonnes of CO_2-e per year (Greenfleet 2010)).

Using the calculations above as a guide, the Project consisting of 159 x 2.05 MW wind turbines at a capacity factor of 35 % would supply energy for 136,899 homes (based on an average Australian household usage at 7.3 MWh/y (NSW DECCW, 2010)).

The Project and creation of wind farms are part of an upstream solution. It is part of the solution for not only reducing the generation of carbon dioxide equivalents from coal-fired power stations, but also providing alternate electricity to users in NSW for at least 136,899 homes, reducing the pressure on the finite resources of fossil fuels.

With respect to the above calculations, higher capacity factors and therefore increased renewable generation can be achieved through:

- Increasing the hub height to capture higher wind speed;
- Selecting a wind turbine most suited to producing the greatest yield with respect to the wind resource across the Project site; and
- Allowing flexibility in the size and range of machines which can be installed at each Cluster within Project site.

Optimising the Project site in this manner would displace more of the energy that would otherwise be generated from incumbent coal-fired power stations and thereby reduce carbon dioxide equivalent emissions.

Using the conservative generation figures presented above, the Project would contribute approximately 2.22 % of the 45,000 GWh Renewable Energy Target over a 20 year operational life of the Project. Alternatively, using the NSW Wind Farm Greenhouse Gas Savings Tool, the Project would contribute between 1.66 % and 2.95 % of the 45,000 GWh Renewable Energy Target by 2020.

4.7 Summary

Increased greenhouse gases absorbing warmth from the earth are causing deleterious effects on the Earth’s climate. Through ongoing research and a better understanding of carbon emissions International, National and State Governments are realising the benefits of clean, renewable energy generation. Policy implementation is now encouraging energy generation from renewable sources in order to both reduce harmful atmospheric emissions and meet future energy demand with diverse and secure supplies.

In 2008, the Australian government ratified the Kyoto Protocol and signed up to cut greenhouse gas emissions to 108 % of the levels they were is 1990; a watershed decision and an important step in determining Australia's position on climate change in the international arena.

The RET, now LRET, legislation was passed in Federal Parliament in August 2009, and has set a target of 20 % or 45,000 GWh of Australia's electricity to be generated from renewable sources by 2020. Wind energy generation is a low cost, viable renewable energy source and can be readily implemented to meet a substantial percentage of this target.

The Project will play an important role in contributing to both the increasing local and global need for such renewable projects to tackle the issues of Global Warming and Climate Change; contributing between 1.66 % and 2.95 % (depending on the model applied) additional renewable energy generation to meet the legislated Australian target. Moreover the Project site and size has been carefully selected using a number of factors and will displace carbon dioxide equivalents by an estimated 17,988,520 tonnes over the life of the Project.

CHAPTER 5

Planning Context

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5. PLANNING CONTEXT

This chapter of the Environmental Assessment (EA) addresses any relevant statutory provisions in relation to the Sapphire Wind Farm.

The development of the Project requires:

- Project approval under Part 3A of the New South Wales (NSW) *Environmental Planning and Assessment (EP&A) Act, 1979*; and
- Consideration of the requirements of the Commonwealth's *Environment Protection and Biodiversity Conservation (EPBC) Act, 1999.*

In addition, relevant Federal, State and Local Government legislation, policy and guidelines are considered and described in the following sections.

5.1 Federal Government Legislation and Policy

5.1.1 *Environment Protection and Biodiversity Conservation Act 1999*

The EPBC Act is the central piece of environmental legislation for the Australian government. It provides the legal framework to protect and manage matters of national environmental significance, while also considering cultural values and society's economic and social needs.

Under the Act, the Proponent must conduct a Protected Matters Report to assemble technical information depending on the level of assessment. The Proponent conducted a Protected Matters Report on the 29th April 2008 using the protected matters search tool, encompassing 558 km^2, addressing the seven matters of National Environmental Significance (NES). The results of the report and the impacts on the Project are discussed in **Chapter 10** Flora and Fauna and **Appendix 11**.

The Commonwealth and NSW Government have an accredited assessment process in place for 'Controlled Actions' allowing assessments under the *EP&A Act* (Parts 3A, 4, 5) to be automatically accredited under the *EPBC Act*. A 'Controlled Action' is decided by the Commonwealth and the accredited assessment process reduces the amount of duplication that could occur in an EA for a project.

On 31th March 2011, the Federal Minister for the Environment determined that the Project would constitute a Controlled Action pursuant to Section 75F(3) of the *EP&A Act*. The Controlled Action decision enables the accredited assessment to occur under the *EPBC Act*. An accredited assessment, under the *EPBC Act*, is a written agreement between the Commonwealth and a State or Territory that allows for accreditation of State environmental processes and systems by the Commonwealth. In this context, an accredited process is one that is run by a State for which the Commonwealth agrees beforehand satisfies its own legal and/or policy requirements, thus doing away with the need for a separate process. Accredited assessments still allow the Commonwealth to decide if a proposal should go ahead after the completion of the State assessment process.

Subsequently, the Department of Sustainability, Environment, Water, Pollution and Communities (SEWPaC) have provided the Proponent with supplementary Director-General's Requirements (DGR's) on the 13th May 2011, which applies to the accredited assessment process.

The supplementary DGR's state that:

> *"The controlled action is likely to have a direct and indirect impact on matters of national environmental significance, in particular, threatened species and/or threatened ecological communities listed under sections 18 and 18A, and migratory species listed under section 20 and 20A of the EPBC Act."*

Matters relating to threatened species and communities are addressed in **Chapter 10** Flora and Fauna of this EA and in **Appendix 11**.

The Proponent was issued a further set of supplementary DGR's by the DPI 16th August 2011, which applies to the accredited assessment process. These DGR's relate to the Proponent's community consultation and stipulated more detail and transparency in the consultation process. For all consultation undertaken by the Proponent refer to **Chapter 6** Stakeholder Consultation.

The full list of DGR's are included in **Appendix 4** and **Table 5.2** below has been provided to ensure ease of reference and to demonstrate compliance with the supplementary DGR's.

5.1.2 *Civil Aviation Safety Regulations 1998*

To address the issue of wind turbine height, CASA's Manual of Standards Part 139 – Aerodromes, states that, in general, an obstacle would require obstacle lighting unless an aeronautical study assesses it as being shielded by another object or that it is of no operational significance. For wind turbines occurring outside of an aerodrome CASA released Advisory Circular *AC 139-18(0) Obstacle Marking and Lighting of Wind Farms* in July 2007 to provide advice regarding the requirements for obstacle marking and lighting of wind turbines and wind monitoring masts, under Civil Aviation Safety Regulations (CASR) Part 139 (see **Appendix 15**). In 2008 this advisory was withdrawn, and as such, CASA's statutory power to require obstacle marking and lighting only applies within the vicinity of an aerodrome (30 km). Therefore, it is CASA's view that the decision of the lighting of obstacles outside the vicinity of aerodromes is the responsibility of the Proponent, in consideration of their duty of care.

In March 2011, CASA indicated that a review would be undertaken by Department of Infrastructure and Transport (DIT) as the subject matter on obstacle marking and lighting outside of an aerodrome was raised in the DIT paper *Safeguards for Airports and the Communities around them*.

The Project will have turbines greater than 110 m in height as discussed in **Chapter 3** Project Description, so CASA and the RAAF have been informed as discussed in **Chapter 6** Stakeholder Consultation. The recommendations from CASA are discussed in **Chapter 13** Aviation.

5.1.3 *Radiocommunications Act 1992*

Part 4.1 'Standards and other technical regulation' of the *Radiocommunications Act 1992* is designed to make systems such as wind turbines efficient, flexible and responsive with regard to the interference of radio emissions. The standards also require an adequate level of immunity from electromagnetic disturbances.

As wind turbines and associated ancillary structures produce electromagnetic fields, the Project has the potential to interfere with radiocommunications as discussed in **Chapter 14** Communication Assessment.

5.1.4 *Directory of Important Wetlands in Australia*

The Directory of Important Wetlands is a database of Ramsar defined wetlands in Australia, developed by the Australian government and State and Territory nature conservation agencies.

There are no recorded Ramsar wetlands in the vicinity of the Project, as discussed in **Chapter 17** Water and **Appendix 21**.

5.1.5 *Renewable Energy Target*

The Renewable Energy Target (RET) is intended to acquire 20 % of Australia's electricity from renewable sources by 2020. The RET will commence with a target of 45,000 GWh to be generated from renewable sources by 2020. After that, each year the target will remain at 45,000 GWh until 2030 when the RET will cease operation.

Chapter 4 Project Justification discusses how the Project will help to meet the targets of the RET by producing renewable energy for Australia's electricity grid.

5.2 State Government Legislation, Policy and Guidelines

5.2.1 *Environmental Planning and Assessment Act 1979*

In NSW, wind farm developments are subject to the *EP&A Act* and relevant instruments that are created under it, including Part 3A Major Infrastructure, Section 75C 'Critical Infrastructure', Section 75I DGR's, Section 75JA Biobanking-Special Provisions and Part 1 Section 5. With regard to the provisions of Part 1 Section 5, the Project takes into consideration the following as listed in **Table 5.1**.

Table 5.1 Part 1, Section 5 and where addressed within the EA

Section 5	Chapter of EA
(a) to encourage:	
(i) the proper management, development and conservation of natural and artificial resources, including agricultural land, natural areas, forests, minerals, water, cities, towns and villages for the purpose of promoting the social and economic welfare of the community and a better environment,	**Chapter 3** to **Chapter 19**
(ii) the promotion and co-ordination of the orderly and economic use and development of land,	**Chapter 4**, **Chapter 18** and **Chapter 19**
(iii) the protection, provision and co-ordination of communication and utility services,	**Chapter 3, Chapter 4** and **Chapter 14**
(iv) the provision of land for public purposes,	n/a

Section 5	**Chapter of EA**
(v) the provision and co-ordination of community services and facilities, and	**Chapter 19**
(vi) the protection of the environment, including the protection and conservation of native animals and plants, including threatened species, populations and ecological communities, and their habitats, and	**Chapter 10**
(vii) ecologically sustainable development, and	**Chapter 4**, **Chapter 5**, **Chapter 10** and **Chapter 19**
(viii) the provision and maintenance of affordable housing, and	n/a
(b) to promote the sharing of the responsibility for environmental planning between the different levels of government in the State, and	**Chapter 5** and **Chapter 6**
(c) to provide increased opportunity for public involvement and participation in environmental planning and assessment.	**Chapter 6**

The NSW Department of Planning and Infrastructure (DoPI) is responsible for ensuring that the requirements of the *EP&A Act* and its regulations are addressed for developments where the Minister for Planning has the Approval Authority.

5.2.2 ***State Environmental Planning Policy (Major Projects) 2005***

The Major Project policy allows the NSW Government to focus on projects that are most significant and vital to the future of NSW as a whole. A proposal is classified as a Major Project depending on the location, economic importance, environmental impact or development type. The Project is classified under Schedule 1 as a Major Project, as it is part of the transport, energy and water infrastructure and under Part 24 it has “capital investment value of more than $30 million, or has a capital investment value of $5 million and is located in an environmentally sensitive area of State Significance”. Once a proposal has been classified as a Major project under section 75R of the *EP&A Act,* Parts 4 and 5 are no longer applicable, except under Division 6 and 6A of Part 4 which addresses development contributions.

A Major Project can also be classified as a critical infrastructure project under Section 75C of the *EP&A Act*, if the proposal is considered to be essential for the State for economic, environmental or social reasons.

The Critical Infrastructure provisions:

- ensure the timely and efficient delivery of essential infrastructure projects;
- allow the Government and the planning system to rapidly and readily respond to the changing needs of the State;
- provide certainty in the delivery of these projects; and
- provide for rigorous scrutiny to ensure environmental outcomes are appropriate focus on delivering outcomes essential to the NSW community.

A project that is declared to be essential to the State is the subject of a full and thorough environmental assessment by the Director-General, with particular emphasis given to ensuring the proposal goes ahead in an environmentally appropriate and sustainable manner. The environmental assessment process for Critical Infrastructure projects is the same as for any other major project. The Sapphire Wind Farm has been declared to be essential to the State and determined as Critical Infrastructure as it will be greater than 30 MW in capacity.

5.2.3 *Director-General's Requirements*

After the submission of the final Preliminary Environmental Assessment (PEA) on the 28th April, 2009, the Director-General of the DoP established requirements, the DGR's, on 29th May. These DGR's were subsequently revised and extended on the 21st February 2011. Supplementary DGR's were issued on the 31st March 2011 when the Project was declared a Controlled Action under the EPBC Act, with a secondary set of supplementary DGR's issued on the 16th August 2011. The DGR's, as listed in **Appendix 4**, include key issues for the Proponent to address in the EA with a focus on impacts, management and mitigation strategies. **Table 5.2** summarises the requirements, including those supplementary DGR's provided by DEWHA and DPI, and where each issue is addressed within the EA.

Table 5.2 Outline of DGR's as issued and where they are addressed within the EA

Director-General's Requirements	Chapter of EA
General Requirements	
Executive summary	**Chapter 1**
Detailed description of the Project	**Chapter 3**
Relevant statutory provisions	**Chapter 5**
Assessment of issues (outlined below)	**Chapters 7** to **19**
Statement of Commitments	**Chapter 20**
Conclusion justifying the Project	**Chapter 21**
Certification of the authors of the EA	**Cover and Contents**
Assessment Requirements	
Project Justification	**Chapter 4 and 5**
Assessment of key issues	**Chapter 7**
Visual	**Chapter 8**
Noise	**Chapter 9**
Flora and fauna	**Chapter 10**
Cultural heritage	**Chapter 11**
Traffic and transport	**Chapter 12**
Aviation hazard	**Chapter 13**
Communication	**Chapter 14**
Electromagnetic fields	**Chapter 15**
Fire and bushfire hazard	**Chapter 16**
Water	**Chapter 17**
General environmental assessment	**Chapter 18**
Socio-Economic	**Chapter 19**

Director-General's Requirements		Chapter of EA
Cumulative		**Chapter 7** to **19**
Consultation Requirements		
Appropriate and justified level of consultation with agencies and community		**Chapter 6**
Supplementary Director-General's Requirements 13th May 2011	**Section of Appendix 11**	**Chapter of EA**
General Information	n/a	**Chapters 1** to **5**
Description of the controlled action	**Chapter 2**	**Chapters 3** and **4**
Description of the relevant impacts of the controlled action	**Chapter 2**	**Chapters 3** and **4**
An assessment of all relevant impacts with reference to the *EPBC Act* Policy Statement 1.1 *Significant Impact Guidelines on Matter of National Environmental Significance* (2009) that the action has, will have or is likely to have on relevant migratory and threatened species and/or ecological communities listed under sections 18, 18A, 20 and 20A of the *EPBC Act*.	**Appendix K**	**Chapter 10**
Justification of the likelihood of occurrence within the proposed development envelope for each relevant threatened species and ecological community.	**Section 4.3, Appendix C**	**Chapter 10**
A description and analysis of significance of the potential inter alia, direct, indirect, cumulative and facilitative impacts, both in the short and long term, of the action to each relevant species and ecological community.	**Section 5.4 - 5.10, Appendix H, Appendix K**	**Chapter 10**
Relevant technical data or other information within the context of the proposed development site and region.	**Section 4.3, Appendix G & E, Section 5.5.1 & Section 5.5.2**	**Chapter 10** and **Appendix 21**
A statement as to whether and relevant impacts are likely to be unknown, unpredictable or irreversible.	**Section 5.5, 5.7**	**Chapter 10**
Where there is a potential habitat for EPBC Act listed species, surveys should be undertaken, or justification for why surveys are not necessary. Any surveys must be timed appropriately and undertaken for a suitable period of time by a qualified person.	**Section 5.3, Table 17**	**Chapter 10**
Proposed safeguards and mitigation measures.	**Section 5.3, Table 17**	**Chapters 10** and **20**
A description of feasible mitigation measures, changes to the controlled action or procedures, which have been proposed by the Proponent or suggested in public submissions, and which are intended to	**Section 5.3, Table 17, Appendix L**	**Chapters 5, 10** and **20**

Supplementary Director-General's Requirements 13th May 2011	Section of Appendix 11	Chapter of EA
prevent or minimise relevant impacts.		
Offsets	**Chapter 6**	**Chapter 10**
Should any residual impact exist that cannot be mitigated it may be necessary for offset measures to be considered in order to ensure the protection of matters of national environmental significance in perpetuity.	**Chapter 6**	**Chapter 10**
Other approvals and conditions	n/a	**Chapter 5**
Economic and social matters	n/a	**Chapter 19**
Environmental record of the person proposing to take the action	n/a	**Chapter 2**
Information sources	n/a	**Chapter 23**
Consultation	n/a	**Chapter 6**

Supplementary Director-General's Requirements - 16th August 2011	Chapter of EA
A comprehensive, detailed and genuine community consultation and engagement process must be undertaken. This process must ensure that the community is both informed of the proposal and is actively engaged in issues of concern to them, and is given ample opportunity to provide its views on the proposal. Sufficient information must be provided to the community so that it has a good understanding of what is being proposed and of the impacts. There should be a particular focus on those non wind farm associated community members who live in proximity to the site.	**Chapter 6**
The Environmental Assessment must clearly document and provide details and evidence of the consultation process and who was consulted with.	**Chapter 6**
All issues raised during the consultation process must be clearly identified and tabulated in the Environmental Assessment.	**Chapter 6**
The Environmental Assessment must state how the identified issues have been addressed, and how they have informed the proposal as presented in the Environmental Assessment. In particular, the Environmental Assessment must state how the community's issues have been responded to.	**Chapter 6**

Resources considered in this EA
Wind Energy Facilities draft Environmental Impact Assessment Guidelines (Planning NSW, June 2002)
Best Practice Guidelines for Implementation of Wind Energy Projects in Australia (Auswind, 2006)
Wind Farms and Landscape Values: National Assessment Framework (Australian Wind Energy Association and Australian Council of National Trust, June 2007)
Cumulative Risk for Threatened and Migratory Species (Commonwealth Department of Environment and Heritage, March 2006)
Wind Farms and Birds: Interim Standards for Risk Assessment (Auswind, July 2005)
Assessing the Impacts on Birds - protocols and Data Set Standards (Australian Wind Energy Association)
Threatened Biodiversity Survey and Assessment - Guidelines for Developments and Activities (Working Document) (DEC, 2004)
Advisory Circular 139-18(0) Obstacle Marking and Lighting of Wind Farms (Civil Aviation Safety Authority, July, 2007). Note: this advisory is currently withdrawn however a replacement has to date not been issued.
The NSW State Groundwater Quality Protection Policy (DLWC, 1998)

Resources considered in this EA
The NSW State Groundwater Dependent Ecosystems Policy (DLWC, 2002)
Department of Water and Energy's Guidelines for Controlled Activities (February 2008)
Draft Guidelines for Aboriginal Cultural Impact Assessment and Community Consultation (DEC, July 2005)
Draft Guidelines for Threatened Species Assessment (DEC, 2005)
Wind Farms - Environmental Noise Guidelines (South Australian Environment Protection Authority, 2003)
NSW Industrial Noise Policy (EPA, 2000)
Environmental Criteria for Road Traffic Noise (NSW EPA, 1999)
Environmental Noise Control Manual (EPA, 2004)
Assessing Vibration: A Technical Guideline (DECC, 2006)
Wind Farm Greenhouse Gas Savings Tool (DECCW)

5.2.4 ***State Environmental Planning Policy (Infrastructure) 2007***

The *State Environmental Planning Policy (SEPP) (Infrastructure) 2007* was developed to improve the efficiency of the existing planning system in delivering essential public infrastructure and services, by repealing 20 existing environmental planning instruments. The *SEPP Infrastructure* also overrides most other environmental planning instruments in the event of inconsistencies, excluding *SEPP (Major Projects) 2005, SEPP 14* and *SEPP 26*.

The *SEPP Infrastructure* outlines the planning processes for infrastructure projects under Part 3A, Part 4, Part 5 and exempt development. It also outlines the circumstances for the exempt development of wind monitoring masts in Clause 39(2) (a). Up to six permanent wind monitoring masts will be required for the duration of the wind farms operation, which is discussed in **Chapter 3** Project Description.

5.2.5 ***State Environmental Planning Policy (Rural Lands) 2008***

The *State Environmental Planning Policy (SEPP) (Rural Lands) 2008* main aims are to:

- Facilitate the orderly and economic use and development of rural lands for rural and related purposes;
- Identify the Rural Planning Principles and the Rural Subdivision Principles so as to assist in the proper management, development and protection of rural lands for the purpose of promoting the social, economic and environmental welfare of the State;
- Implement measures designed to reduce land use conflicts;
- Identify State significant agricultural land for the purpose of ensuring the ongoing viability of agriculture on that land, having regard to social, economic and environmental considerations; and
- Amend provisions of other environmental planning instruments relating to concessional lots in rural subdivisions.

The *Rural Lands SEPP* does not directly impact the land use suitability of the proposed development, rather the aims of the *Rural Lands SEPP* are to ensure agricultural lands are not compromised by the pressure for other land uses, especially more intensive uses. The proposed wind farm is consistent with the *Rural Lands SEPP* as it is a development which can occur in unison with the continuing use of the land for rural purposes.

A further consideration in relation to the *Rural Lands SEPP* is that it has been used as a vehicle to restrict subdivision of rural lands where conflicts occur. The *Rural Lands SEPP* does not require councils to review their minimum lot size(s) or change those lot sizes in an existing Local Environment Plan (LEP). Councils have the option to transfer the existing minimum lot size(s) currently applying in its Local Government Area (LGA) into a new LEP. The *Rural Land SEPP* does not enforce change in the local controls, with the exception of concessional lot provisions.

5.2.6 ***State Environmental Planning Policy 44 (Koala Habitat)***

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

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

Section 75R of the *EP&A Act* excludes, with respect to critical infrastructure projects, all environmental planning instruments (other than SEPPs that specifically relate to the project) and council orders under Division 2A of Part 6. An assessment under SEPP 44 is, therefore, not required. However, as a threatened species, Koala habitat has been assessed as part of the proposed development impacts in **Chapter 10** Flora and Fauna and **Appendix 11**.

5.2.7 ***National Parks and Wildlife Act 1974***

The *National Parks and Wildlife (NPW) Act 1974* outlines matters relating to flora and fauna and Aboriginal heritage. To ensure accordance with the relevant parts of the *NPW Act*, Eco Logical Australia has conducted an assessment on flora and fauna in **Appendix 11** with an overview provided in **Chapter 10** Flora and Fauna.

As the Project is classified under Part 3A of the *EP&A Act*, Part 6 approvals of the *NPW Act* are not required, unless approval for an activity which will impact on any Aboriginal objects or declared Aboriginal Places is required. As the Project has the potential to impact on Aboriginal objects or declared Aboriginal Places, the *Interim Guidelines for Aboriginal Community Consultation – Requirements for Applicants* (IGACC) has been implemented with this Project to engage interested parties for Aboriginal Assessment and Advisory Services along with NSW Archaeological Pty Ltd. The completed assessment on Aboriginal heritage is attached in **Appendix 12**, with an overview provided in **Chapter 11** Cultural Heritage.

5.2.8 *Protection of the Environment Operations Act 1997*

The *Protection of the Environment Operations (POEO) Act 1997* is administered by the Office of Environment and Heritage (OEH), Environmental Protection Authority (EPA), local councils and other public authorities. The EPA issues licences to control the air, noise, water and waste impacts of a scheduled activity. Schedule 1 of the *POEO Act* lists the activities which require a licence.

As the source of energy generation is wind power, the *POEO Act* does not require a licence for the operation of the Project. However, during the construction phase a licence is expected to be necessary for:

- Mobile concrete batch plants if the total exceeds 30,000 tonnes per year of pre-mixed concrete or concrete products; and
- Crushing, grinding or separating if the activity has the capacity to process more than 150 tonnes of materials per day or 30,000 tonnes of materials per year.

5.2.9 *Threatened Species Conservation Act 1995*

The purpose of the *Threatened Species Conservation Act 1995* is to prevent impacts, conserve and protect biological diversity and ensure ecologically sustainable development. The *Threatened Species Amendment Act 2004* further enhanced the purpose of the original Act by integrating conservation with main-stream decision making, under the *EP&A Act* on land usage and structure of the economy.

Eco Logical Australia Pty Ltd has undertaken a flora and fauna assessment to determine the significance for threatened species, presented in **Appendix 11** and summarised in **Chapter 10** Flora and Fauna.

5.2.10 *Threatened Species Conservation (Biodiversity Banking) Regulation 2008*

Biodiversity Banking (BioBanking) provides the means to address the loss of biodiversity in NSW. Landowners have the ability to establish biobank sites, which can be 'bought' by developers to secure the conservation of biodiversity in perpetuity.

BioBanking provides the means to address the loss of biodiversity from particular developments which impact upon the environment in NSW. It is a market-based scheme that provides a streamlined biodiversity assessment process for development, a rigorous and credible offsetting scheme, as well as an opportunity for rural landowners to generate income by managing land for conservation.

The Proponent undertook a Biobank assessment across the Project site to ensure the principles in the DGR's are maintained and suitable sites are located for offsetting threatened areas as discussed in **Chapter 10** Flora and Fauna and **Appendix 11**.

5.2.11 *NSW Catchment Management Authority Act 2003*

The *NSW Catchment Management Authority (CMA) Act 2003* aims to establish authorities for decision-making and provide natural resource planning at a catchment level. This is done through applying scientific and local community knowledge to achieve a fully functioning and productive landscape. Under the *CMA Act*, Catchment Management Authorities are required to prepare a Catchment Action Plan (CAP).

Chapter 17 Water and **Appendix 21** discuss how the Border Rivers-Gwydir Catchment Management Authority CAP is applicable to the Project.

5.2.12 *Native Vegetation Act 2003*

The main objects of the *Native Vegetation Act 2003* are to promote ecologically sustainable development, prevent broad scale clearing and protect and improve native vegetation.

Eco Logical Australia conducted vegetation surveys to identify species potentially affected and the total area of disturbance. The results are in **Appendix 11** and findings are summarised in **Chapter 10** Flora and Fauna.

5.2.13 *Noxious Weeds Act 1993*

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

Any weeds found on-site, as discussed in **Chapter 10** Flora and Fauna, will be managed in accordance with assigned Control Categories determined by the Act.

5.2.14 *Contaminated Land Management Amendment Act 2008*

The *Contaminated Land Management Amendment Act 2008* is the management of contaminated land, where contamination is significant enough to warrant regulation. The amendment to this Act is to allow contaminated sites to be cleaned more efficiently.

As discussed in **Chapter 18** General Environmental Assessment, if any contaminated sites are found during construction, the appropriate authorities will be notified and actions taken in accordance with the Act.

5.2.15 *NSW Rural Fire Act 1997*

The *NSW Rural Fire Act 1997* imposes obligations on the land managers to take all reasonable measures to prevent the occurrence and spread of wildfire to adjoining lands from lands under care and management. Fire management is implemented under a Bushfire Risk Management Plan (**Appendix 19**).

Chapter 16 Fire and Bushfire discusses further impacts and possible mitigation methods.

5.2.16 *Roads Act 1993*

The *Roads Act 1993* addresses authorities, functions and regulation of activities relating to the use and type of roads.

Consultation with the Roads and Traffic Authority, Glen Innes Severn Council and Inverell Shire Council, as outlined in **Chapter 6** Stakeholder Consultation, is required to determine access and necessary upgrading of access points, which could require permits under the Act. Further detail is provided in **Appendix 13**, with a summary in **Chapter 12** Traffic and Transport.

5.2.17 *Surveying Act 2002 No. 83*

Clause 24 (1) of the *Surveying Act 2002 No. 83* states that "A person must not remove, damage, destroy, displace, obliterate or deface any survey mark unless authorised to do so by the Surveyor-General". The Department of Lands has been consulted, as discussed in **Chapter 6** Stakeholder Consultation, in regards to the close proximity of turbines to any Trigonometrical Stations (TS). While the Project does not directly impact on any TS, full results are discussed in **Chapter 18** General Environmental Assessment.

5.2.18 *Water Policies and Plans*

The Project, under the DGR's, must consider the following policies and plans with regard to water usage and quality during construction/dust suppression and concrete batching plant(s) facilities:

- Water Management Act 2000;
- Water Act 1912;
- NSW Wetlands Policy;
- NSW Weir Policy;
- NSW Groundwater Quality Protection Policy;
- NSW State Groundwater Dependant Ecosystem Policy;
- Border Rivers - Gwydir Catchment Management Action (CMA) Plan;
- Border Rivers Regulated River Water Source Water Sharing Plan;
- Border Rivers Unregulated and Alluvial Water Sources Water Sharing Plan (Draft); and
- NOW Guidelines/DWE Guidelines for Controlled Activities.

This EA addresses how the Project will consider each of these policies and plans in **Chapter 17** Water, **Appendix 21** and **Chapter 18** General Environmental Assessment.

5.2.19 *Noise Regulation and Guidelines*

The SA Environment Protection Authority's *Noise Guidelines for Wind Farms 2003* provides guidelines for the predicted equivalent noise levels from wind turbines. Recorded noise levels at relevant receivers should not exceed 35 dBA or 5 dBA above background noise levels, whichever is the greater. These guidelines are formally applied in NSW and as advised in the DGR's have been used in the assessment of the Project as discussed in **Chapter 9** Noise and **Appendix 9**.

During construction the Project will be regulated by the *NSW Industrial Noise Policy 2000* and chapter 171 of the *Environmental Noise Control Manual 2004*.

5.2.20 *NSW State Plan*

The NSW State Plan aims to support jobs and boost investment and growth. To meet these aims, the Plan has a number of priorities including a *reliable electricity supply with increased use of renewable energy* and *cleaner air and progress on greenhouse gas reductions*.

The Project aligns with these priorities by supplying NSW with new renewable energy generation and by displacing the output of greenhouse gas emissions from alternate power generation sources as discussed in **Chapter 4** Project Justification.

5.2.21 *Guidelines for Wind Energy and Related Facilities*

Draft NSW Wind Energy EIA Guidelines 2002: This draft was designed to ensure early identification of issues in relation to ESD. The guidelines provide the basic requirements for a wind farm development in NSW, addressing necessary policies and regulations within the *EP&A Act*, general key issues, consultation processes and an additional guideline for an Environmental Management Plan (EMP).

Auswind's Best Practice Guidelines for the Implementation of Wind Energy Projects in Australia 2006: These guidelines were developed by a broad range of both industry and regulatory organisations and provide an outline of best practice processes for all stages of wind farm site selection, development, construction and operation. These processes ensure that Australia's wind industry provides safe, reliable, economically and environmentally sustainable energy to Australia (AusWind, 2006).

5.3 Regional and Local Government Legislation/Policy

5.3.1 *Regional Policies*

The Project falls under the Border Rivers-Gwydir CMA, within the McIntyre River Catchment. Under the DGR's, the Project must consider the Border Rivers-Gwydir Catchment Management Authority CAP to conform to the principles of an ecologically sustainable landscape. Further information is provided in **Chapter 17** Water, **Chapter 18** General Environmental Assessment and **Chapter 10** Flora and Fauna.

5.3.2 *Local Environmental Plans*

The proposed site for the Project occurs within the Glen Innes Severn and Inverell Shire Council areas, which means it is subject to three Local Environmental Plans (LEP's), as Glen Innes Severn Council is yet to amalgamate its two LEP's (Glen Innes and Severn Shire) into one. The LEP's are an established framework for development within local government areas. For the Project to be classified as a Part 3A of the *EP&A Act*, the proposed activity is required to be permissible under the relevant LEP. The Project occurs on land zoned 1 (a) Rural Zone, which does not prohibit the erection of wind turbines or farms, as land can still be predominantly used for pastoral purposes. Turbines also provide additional income, allowing maintenance of rural properties without having to use other alternative methods such as subdivision. The requirements for each LEP (the Glen Innes and Severn Shire LEP's have been considered as one) and how the proposal is addressing them are listed below in **Table 5.3**.

The DGR's also require the EA to address the suitability of the Project with respect to potential land use conflicts and future surrounding land use taking into account local and strategic land use objectives. Further detail is provided in **Chapter 4** Project Justification about mitigation methods for future potential land use conflicts.

Table 5.3 Glen Innes Severn LEP 1991, 2002 and Inverell LEP 1988

Glen Innes Severn LEP 1991, 2002	Inverell Shire LEP 1988	Relevance to Proposed Development
Planning		
To apply common and consistent requirements and procedures in the assessment of all applications. To encourage and assist effective community participation in the decision-making process.	To ensure developments make adequate provision for services that meet the needs and expectations of the community.	Addressed under the *EP&A Act,* Part 3A as Critical Infrastructure (s.75C) which excludes all environmental planning instruments (s.75R) except for SEPP's that specifically relate to the proposed development and council orders under Division 2A of Part 6 (related to enforcement).
		In preparing the environmental assessment requirements, the Director-General is to consult relevant public authorities and have regard to the need for the requirements to assess any key issues raised by those public authorities (s.75F(4)). Glen Innes Severn and Inverell Shire Councils have been consulted and provided input into the DGR's (s.75F(4)).
Agriculture		
To maintain and encourage diverse and sustainable agriculture.	To maintain the integrity of the agricultural industry, and pursue sustainable growth opportunities, to ensure productive use of rural land to preserve rural qualities.	The proposed development temporarily reduces the available land for grazing (during construction). However in the long term agricultural use would not be significantly impacted due to the limited amount of land-take required for the Project. The proposed development would provide off-farm income to land owners assisting agricultural enterprises during times of drought or other hardship (discussed in **Chapter 19** Socio-Economic).
		The proposed wind farm is consistent with the *Rural Lands SEPP* as it is a development which can occur in unison with the continuing use of the land for rural purposes.

Glen Innes Severn LEP 1991, 2002	Inverell Shire LEP 1988	Relevance to Proposed Development
Environmental Protection		
To ensure that land containing or likely to contain rare or threatened species, populations, ecological communities or habitats is protected against inappropriate clearing and development.	To protect and conserve through partnerships and the implementation of a biodiversity conservation and bushland management strategy.	This environmental assessment addresses the DGR's with regard to minimising environmental impacts and risks (see **Chapter 20** Statement of Commitments). Results demonstrate the Project will develop in a manner which minimises risks to the natural and physical environment.
Cultural Values		
To protect and conserve local cultural heritage.	To preserve and conserve local cultural heritage.	Aboriginal Cultural Heritage surveys and Non-Indigenous surveys have been conducted in accordance with the DGR's (full detail **Chapter 11** Cultural Heritage). This will protect and conserve the cultural heritage in the area. The community was contacted via a number of means as discussed in **Chapter 6** Stakeholder Consultation, including an open day, public opinion surveys, website, media releases, door to door and newsletters, to ensure that the opinions of the rural community were heard.
Residential		
To increase affordable and social housing in Glen Innes.	To ensure physical development is in accordance with community needs and expectations, adopted planning instruments and policies, and to protect, rehabilitate and manage all impacts on the natural environment.	The proposed development is located18 km west of Glen Innes and 28 km east of Inverell. There is limited rural residential development in the vicinity of the proposed development. No approved or pending development applications on neighbouring lots will be impacted by the Project (full detail **Chapter 4** Project Justification and **Chapter 18** General Environmental Assessment).
Financial		
To drive a diversified economy to improve employment opportunities, income levels and lifestyle of residents.	To cultivate market and development opportunities, to attract economic contributors.	The community will be provided with a Community Fund for the life of the Project, and there will be added benefits to the community with increased jobs and economic activity as discussed in **Chapter 19** Socio-Economic. Ratepayers will not incur any financial burdens as the Proponent will be responsible for any road upgrades and building of infrastructure required for the Project.

Glen Innes Severn LEP 1991, 2002	Inverell Shire LEP 1988	Relevance to Proposed Development
Industry		
To widen the economic base of Glen Innes in the areas of industry, commerce, agriculture and tourism. Promote emerging technology and infrastructure.	To retain, grow and attract business to maintain the vibrancy of industrial, commercial and professional services.	Increased road traffic may be generated by the development on local roads to view the Project. A viewing platform or parking bay could be constructed to account for a possible increase in tourism if Council requires it (discussed **Chapter 19** Socio-Economic). The proposal promotes an industry that would benefit the local community and wider population into the future. Due to the careful planning and proposed management of the Project there would be minimal nuisance caused by the proposed development (discussed **Chapter 4** Project Justification).

5.3.3 *Development Control Plans – Wind Power Generation*

The Proponent recognises that the Project locality occurs within two council areas which have implemented wind energy-specific Development Control Plans (DCP's):

- Glen Innes Severn Council DCP – Wind Power Generation (2008); and
- Inverell Shire Council DCP – Wind Power Generation (2009).

The DGR's require the EA to address the suitability of the Project with respect to potential land use conflicts and future surrounding land use, taking into account local and strategic land use objectives. The DCP's have been developed by each council with the aim to assist and guide potential developers seeking to carry out wind power generation developments. It is also the aim for each council that such developments are appropriately located and do not impact significantly on the health, safety and amenity of the community or the environment.

The DCP's from both councils have areas of overlap, which also correlate with the DGR's. **Table 5.4** presents the common themes from both DCP's and identifies where the EA has addressed aspects of those DCP's.

Table 5.4 Outline of DCPs and where they are addressed within the EA

Development Control Plan – Wind Power Generation	Chapter of the EA
The location of the property, boundary dimensions and site area. This information is to be accompanied by a 1:25000 scale map indicating:	**Chapters 2, 3** and **Volume 2**
The location of the proposed development.	**Chapter 2** and **Volume 2**
The route of the transmission lines to the electricity grid.	**Chapter 3** and **Volume 2**
The service road networks on and to the site.	**Chapters 3, 12** and **Appendix 13**

Development Control Plan – Wind Power Generation	Chapter of the EA
The proximity to significant features such as dwellings, environmentally sensitive land, prime agricultural land, forests, national parks, heritage items and aircraft facilities.	**Chapters 3, 4, 11, 13, Appendix 12** and **15**
A site plan(s) clearly indicating positions of the proposed wind turbines, site boundaries, native vegetation, proposed vehicular access points, existing and proposed vegetation on the site, the location and uses of all existing and proposed buildings on the site, power lines, sub-stations(s) and fences on site.	**Chapters 3, 10, Volume 2** and **Appendix 11**
Full specifications of the proposed wind turbine(s). This is to include full dimensions, wind turbine generation capacity, materials, colours and finishes.	**Chapter 3** and **Chapter 8**
A detailed land use description of the adjoining land and/or affected lands and landscapes including an assessment of any likely or foreseen impacts on these lands.	**Chapter 4**
A detailed assessment of the noise impact of the proposal, including the noise generated during construction/erection of the wind turbine(s), existing background noise data and predicted likely noise levels generated by the wind turbine(s) and the wind farm as a whole once operational for all likely noise receivers. The noise impact assessment must be undertaken in accordance with;	**Chapter 9** and **Appendix 9**
The current version of Wind Turbines – The South Australian Environment Protection Authority's Wind Farms – Environmental Noise Guidelines as determined suitable for NSW by the Department of Environment and Climate Change.	**Chapter 9** and **Appendix 9**
The Environmental Noise control Manual (EPA, 2004).	**Chapter 9** and **Appendix 9**
Any other noise assessment requirements/tool determined to be suitable by the Department of Environment and Climate Change for wind farms.	**Chapter 9** and **Appendix 9**
Details of noise mitigation measures and ongoing monitoring and management of the development must also be provided in the assessment. This must include an assessment of the feasibility, effectiveness and reliability of proposed measures and any residual impacts potentially arising after these measures have been implemented.	**Chapter 9** and **Chapter 20**
If any noise agreements with residents are proposed where noise criteria cannot be met, sufficient information must be provided to enable a clear understanding of what has been agreed and what criteria have been used to frame any such agreements.	**Chapter 6**
Visual impacts must be provided in the environmental assessment; it is to include all project components, locations and dimensions. A photographic assessment clearly demonstrating the potential visual amenity impacts of the proposal must be provided along with a clear description of visual amenity mitigation and management measures that the proponent intends to apply to apply to the development. This must include an assessment of the feasibility, effectiveness and reliability of proposed measures and any residual impacts potentially arising after these measures have been implemented. The environmental assessment must include a comprehensive assessment on the visual impacts of the proposal on the surrounding landscape and scenic character/values (including existing and approved dwellings) for a distance of at least 10 km from the wind turbine(s) taking into consideration shadow flicker and blade glinting.	**Chapters 8, 20, Volume 2** and **Appendix 7**
Any visual impact assessment should be prepared with regard to the Australian Wind Energy Association and Australian Council of National Trust's Wind Farms and	**Chapter 8, Volume 2** and **Appendix 7**

Development Control Plan – Wind Power Generation	**Chapter of the EA**
Landscape Values: Stage 1 Report – Identifying Issues, March 2005, Appendix B: Wind Farms and Landscape Values: Final Issues Paper. The use of computer assisted models/simulations, photomontages or other graphic representations are encouraged, these should also include any potentially affected dwellings.	
An evaluation of the electromagnetic radiation and/or interference from the wind turbines and/or transmission lines. This must include potential health impacts on humans and animals as well as mobile phone, television, radio and two-way reception etc.	**Chapters 14, 15, Appendix 17** and **18**
A construction program and related environmental management plan incorporating the proposed staging of the project, erosion and sediment controls, heavy vehicle movements, site access including all service roads, transmission towers, substation, underground wiring/cabling, construction stage impacts including facilities, waste disposal, staff/contractor numbers etc, weed control, farm impacts and all other works.	**Chapter 20**
An evaluation of flora and fauna impacts with specific mention of migratory species potentially impacted by the development. In the case of a proposed development being in close proximity to known habitats or rare or endangered species, early consultation with the Department of Environment and Climate Change (DECC) is highly recommended. Furthermore Auswind's publication: Wind Farms and Birds. Interim Standards for Risk Assessment (as amended) and the Department of Environment and Heritage Wind Farm Collision Risks for Birds – Cumulative Risk for Threatened and Migratory Species (as amended), should be referred to in the evaluation.	**Chapter 10** and **Appendix 11**
A decommissioning and site restoration plan and program, including the wind farm life expectancy.	**Chapter 3**
All relevant matters in any NSW Department of Planning EIA Guideline(s) and the NSW Wind Energy Handbook current at the time of application.	**All Chapters**
Demonstration that the relevant agencies issues have been addressed, for example the CASA for aviation safety, Department of Environment and Climate Change etc. The EIA must clearly describe the consultation process and the issues the relevant agencies have risen.	**Chapter 6**
The heritage significance of the subject site, nearby sites and surrounds. This includes but is not limited to indigenous and non-indigenous cultural, archaeological and built environment issues/items. Potential impacts on any such items must be addressed the EIA with proposed mitigation measures also outlined. Reference is to be made to the current version of the Inverell Shire Council Local Environmental Plan, NSW Heritage Office, the National Trust of Australia and the Australian Heritage Council. The draft NSW Heritage Office policy on Wind Farms should also be referenced.	**Chapters 11, 20** and **Appendix 12**
A post construction and commissioning monitoring program detailing, but not limiting to noise measurement reporting, shadow flicker assessments, fauna impacts surveys, traffic movements and maintenance schedules. The program will identify those issues to be addressed in a report which is to be lodged with Council on an annual basis which will be made available for public viewing. Any inconsistencies arising from the operation of the wind farm and any consent issues by Council are to be addressed in the report. Each application will be dealt with on its own merits and the requirements of the monitoring program identified as a result of the community consultation and development assessment process.	**Chapter 20**

In regards to the Planning and Environmental Controls of the DCPs, the Project has been designed in accordance with the DGR's, which incorporates the following aspects of the Project as listed in **Table 5.2**. The DCP's and DGR's are not the same and therefore the Project is not compliant with all aspects of the DCP's. In particular, the reference to a wind turbine:

> *Where visible from a non-related dwelling or immediate surrounds, the development shall not be located within 15 times the blade tip height or 2km's (whichever is the greater) of any dwelling not associated with the development or 15 times the blade tip height or 2km's (whichever is the greater) from a reasonable, practical and suitable dwelling site on any lot that has been created for the purpose of a dwelling.*

The Project has taken into consideration all associated and non-associated dwellings when designing the Project, including noise and visual studies, which can be found in **Chapter 8** Landscape and Visual and **Chapter 9** Noise. The Proponent prefers this method of assessing dwellings, compared to a 2 km set back.

5.3.4 *Northern Tablelands Draft Bushfire Risk Management Plan*

The Project will be subject to the draft Northern Tablelands Bushfire Risk Management Plan, which does not mention the proposed development site, identify it within any specific zoning, or suggest any specific recommendations for bushfire management. The Project will comply with provisions contained in the bushfire plan, and it is suggested that issues associated with the Project are incorporated into the Bushfire Risk Management Plan at its next review to ensure any concerns arising are addressed.

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CHAPTER 6

Stakeholder Consultation

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6. STAKEHOLDER CONSULTATION

6.1 Preliminary Consultation

The Proponent submitted a draft Preliminary Environmental Assessment (PEA) for the proposed Sapphire Wind Farm to the New South Wales (NSW) Department of Planning (DoP) on the 7th October 2008. The draft PEA allowed the DoP to identify key government and agency stakeholders who would provide input into the Director-General's Requirements (DGR's), and requested that they attend a Planning Focus Meeting (PFM) to discuss the Project. The PFM took place on the 19th November 2008.

A subsequent change to the Project required the submission of a revised turbine layout to the DoP on the 21st April 2009. A second PFM was considered unnecessary because of the minor modifications to the Project; however, the relevant government and agency stakeholders were re-consulted to ensure no additional issues had arisen as a result of the change. Once it was determined that there were no further issues, a final PEA was submitted to the DoP on the 28th April 2009. DGR's were subsequently issued on the 29th May 2009 which form the basis of this Environmental Assessment (EA).

6.1.1 *Planning Focus Meeting*

A PFM for the Project was held on the 19th November 2008 at the Kings Plains Castle, Kings Plains. Staff from Wind Prospect CWP was on-hand to introduce the Project, provide input to the meeting and answer any questions raised. Agency participants included:

- Dinuka McKenzie and Gina Davis (NSW DoP);
- Stephen O'Donoghue (DECCW);
- Graham Price (Glen Innes Severn Council); and
- Brett McInnes (Inverell Shire Council).

Agencies invited but which were unable to attend the PFM included:

- Department of Water and Energy (DWE);
- Department of Primary Industries (DPI);
- Civil Air Services Australia (CASA);
- Airservices Australia (AA); and
- Commonwealth Department of Defence (DoD).

Participants met in Kings Plains Castle for the PFM and then travelled to the site of the installed wind monitoring mast located within the Sapphire Cluster. From this location the participants were able to view the majority of the site, including the Sapphire and Swan Vale Clusters.

6.1.2 *Director-General's Requirements*

Following the submission of the final PEA, the DoP prepared DGR's based on advice and input received from the government and agency stakeholders listed above. The DGR's are summarised in **Table 5.2** in **Chapter 5** Planning Context indicating where each item is addressed in the EA.

In addition to the prescribed DGR's, the DoP identified a range of other parties with whom consultation would be required. These are outlined in **Section 6.3** below, together with a much broader range of individual and group stakeholders identified by the Proponent in the course of preparing this EA.

6.1.3 *Revised Director-General's Requirements*

As DGR's are valid for a period of two years, it was necessary for the Proponent to apply to the DoP on the 16th February 2011 to have the DGR's extended by a further twelve months in order to complete the EA. Revised DGR's were issued on the 23rd February 2011 to extend the Date of Expiration to the 29th May 2012. Three further requirements were added to the DGR's at the time of their re-issue, as follows:

- Reference is made to the *Wind Farm Greenhouse Gas Savings Tool* developed by DECCW;
- Consideration of the surrounding proposed wind farms (Glen Innes, White Rock and Ben Lomond) for cumulative assessment; and
- Additional detail to be provided on water supply, water quality and hydrology.

These additional requirements are also considered within this EA in their appropriate chapters.

6.1.4 *Supplement to the Director-General's Requirements*

The Project was declared a Controlled Action under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) on the 31st March 2011. The Commonwealth issued a series of supplementary requirements for the assessment of the Project in order to satisfy the Controlled Action designation. These supplementary DGR conditions are listed in **Appendix 4** and considered as part of the EA process.

Following submission of the EA to the DoP for adequacy review, further supplementary DGR's were issued on the 16th August 2011. These DGR's were issued to all wind farm projects currently in the planning system and required further clarification on the stakeholder and community consultation process undertaken for the Project. These DGR's are addressed in the following chapter.

6.2 Approach to Consultation

Public consultation for the Project commenced in May 2009 during the early stages of Project planning and feasibility assessment. Consultations at this time aimed to inform the general public, neighbouring residents, statutory regulators and other stakeholders of the Project in order to identify issues that may require addressing during Project planning and design. Extensive public consultation has taken place since the early stages of the Project and has targeted all interested and potentially affected parties. Consultation took the form of:

- Letters of notification to various stakeholders, including local, state and national groups and agencies;
- Face-to-face notification (or letter drop where necessary) of neighbouring residents within a 5 km radius of the Project;
- Newsletter (x2), Public Opinion Survey (x2), Project website, media releases and radio interviews;

- Public Exhibition Open Days held in the Library & Learning Centre, Glen Innes and Riverside Function Centre & Restaurant, Inverell; and
- Ongoing consultation meetings with various stakeholders throughout the Project planning and design stages.

The Proponent has maintained the Project website (www.sapphirewindfarm.com.au) since the Project's inception and has continued to maintain an 'open door' policy for consultation. The provision of the Project Manager's contact details has ensured that stakeholders can find out information about the Project at any stage of the development, even up to post-Construction.

6.3 Stakeholder Identification and Consultation

The stakeholders listed below in **Tables 6.1**, **6.2** and **6.3** were provided with information regarding the proposed development. They were invited to provide any comment, information or guidance in the course of the Project's development and in the preparation of this EA. Copies of the responses (where given in writing) are included in **Appendix 5** and summarised in **Section 6.4**.

6.3.1 *Key Interest Groups*

Table 6.1 List of all individual and group stakeholders directly consulted

Group	Stakeholder
Key Interest Groups	
Immediate Community	▪ Participating Landowners ▪ Neighbouring Residents
Local Aboriginal Groups	▪ Aniwan Local Aboriginal Land Council ▪ Glen Innes Local Aboriginal Land Council ▪ Kwiembal Elders Indigenous Group ▪ Ngoorabul Elders ▪ Edgerton-Kwiembal EHCAC ▪ Aboriginal Reference Group Border Rivers-Gwydir Catchment Management Authority
Local Community and Businesses	▪ Locally elected members ▪ Title holders of mineral exploration leases and mining licences within the study area # ▪ Interested people in the broader community ▪ Local Businesses ▪ Glen Innes Natural Resources Advisory Committee (GLENRAC) ▪ Gwydir and Macintyre Resources Management Committee Landcare (GWYMAC) ▪ New England Livestock Health and Pest Authority ▪ Friends of the Earth (Northern Rivers) ▪ Inverell Apex Club ▪ Ashford Lions Club ▪ Country Women's Association of NSW Evening Branch ▪ Glen Innes Chamber of Commerce ▪ Glen Innes Country Women's Association ▪ Glen Innes Leo Club ▪ Glen Innes Lioness Club ▪ Glen Innes Lions Club ▪ Glen Innes Masons ▪ Glen Innes Probus Club

Group	Stakeholder
	▪ Glen Innes Rotary Club ▪ Glen Innes View Club ▪ Inverell Chambers of Commerce ▪ Inverell Country Women's Association ▪ Inverell East Rotary Club ▪ Inverell Macintyre Lions Club ▪ Inverell Masons ▪ Inverell Mixed Probus ▪ Inverell Reconciliation Group ▪ Inverell Rotary Club ▪ Inverell View Club

 # Indicates those stakeholder groups that were identified by the DoP as key consultees and provided input into the DGR's.

Initial Consultations: Face-to-face contact was made with many neighbouring property owners during the week commencing the 11th May 2009, within approximately 5 km of the wind farm site. Approximately 79 neighbouring residences were visited. These residents were provided with information on key points of the Project proposal, Issue 1 of the Sapphire Wind Farm Newsletter (see **Appendix 6**), office contact details, a Public Opinion Survey (POS) to complete and a Frequently Asked Questions (FAQ) brochure on generic wind farm facts. In the event of the resident being absent or unavailable (i.e. 'Private Property' or 'No Trespassing' signs on gates), a package containing the aforementioned material was left at the main door, letterbox or gate.

Website Launch: In May 2009, to coincide with initial consultations, the Project website was launched (www.sapphirewindfarm.com.au) as a means of providing ongoing, up-to-date information to interested stakeholders. The website also provides a mechanism for people to provide feedback via an online Public Opinion Survey, as well as contact details for the Proponent should they wish to discuss specific issues directly.

Public Exhibition: Following almost two years of data collection, project refinement and ongoing consultation, a public exhibition was held for the proposed Sapphire Wind Farm at the Library and Learning Centre, Glen Innes and Riverside Function Centre, Inverell on the 2nd and 3rd February 2011 respectively. Residents of the Glen Innes and Inverell districts were advised of the exhibition by way of advertisements in the local newspapers (Glen Innes Examiner and Inverell Times) for the two weeks leading up to the exhibition. A press release was also issued to local media outlets, including the aforementioned newspapers, Armidale Express, Armidale Independent, Northern Daily Leader and ABC New England, inviting people to participate.

Over 60 people attended the public exhibitions in total. The exhibitions were identical, presenting details of the proposed Sapphire Wind Farm and interconnection options, including its likely appearance illustrated by means of plans and photomontages. A number of panels were displayed, containing information about the Project collected during the preparation of the EA and about wind energy in general. A DVD presentation from the British Wind Energy Association (BWEA) was also shown, outlining the key features of wind farms during planning, construction and operation. Copies of the second issue of the Sapphire Wind Farm newsletter, Frequently Asked Questions brochure and company information relating to Wind Prospect CWP were also made available. Five members of the Wind Prospect CWP team were on-hand to answer questions and explain the details of the proposed development.

Project Refinement: There have been several modifications to the Project site since the original layouts presented in the draft PEA. Prior to the submission of the final PEA, the Project layout underwent some initial modifications to the wind turbine positions to take into account updated wind modelling across the site. This resulted in the removal of several turbine groups, as presented to the NSW DoP on the 21st April 2009 in a revised layout, as shown in **Figure 6.1**.

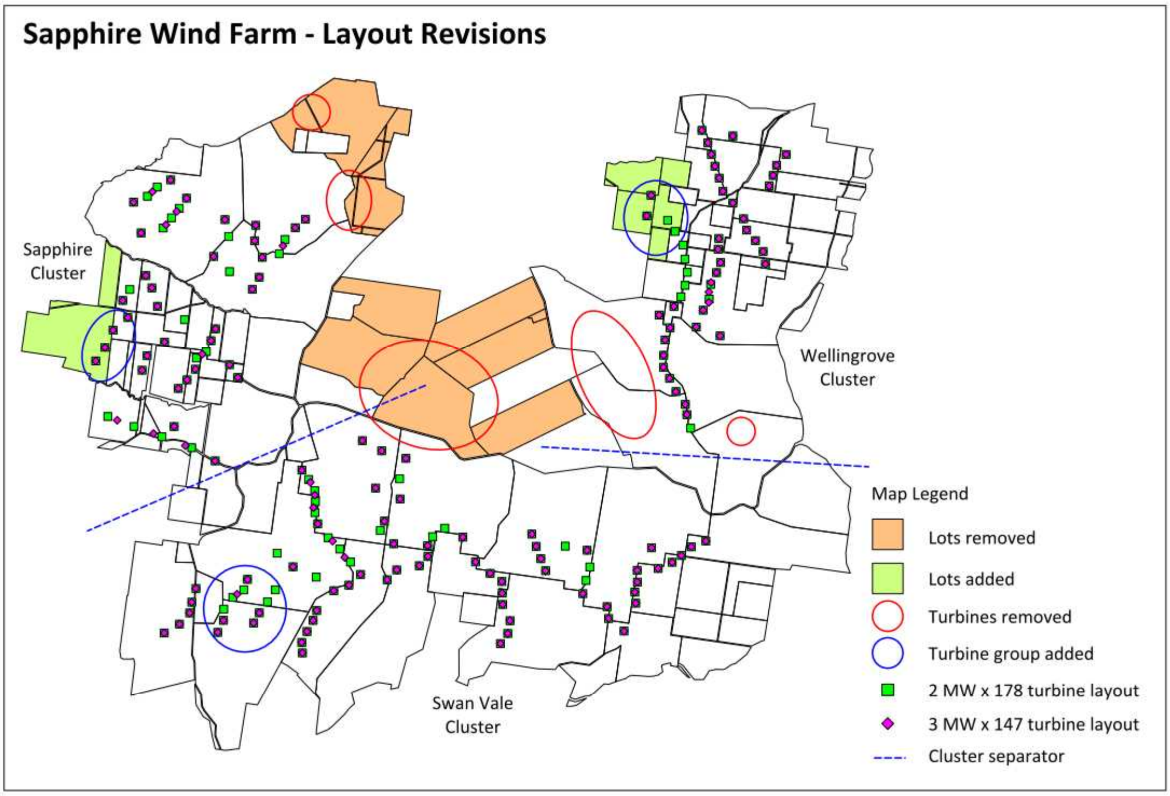

Figure 6.1 Modifications to the Project site 21st April 2009

In the time preceding the finalisation of the EA, further modifications were made to the layout based on stakeholder and community consultation, in particular with residents in the vicinity of the Project. As a result, further wind turbines were removed from the layout in order to address concerns raised about potential visual impact, noise and other issues. This reduced the maximum number of wind turbines from 178 in the original layout to 159 as currently proposed in this EA. **Figure 6.2** shows the modifications which were made to the project at the time.

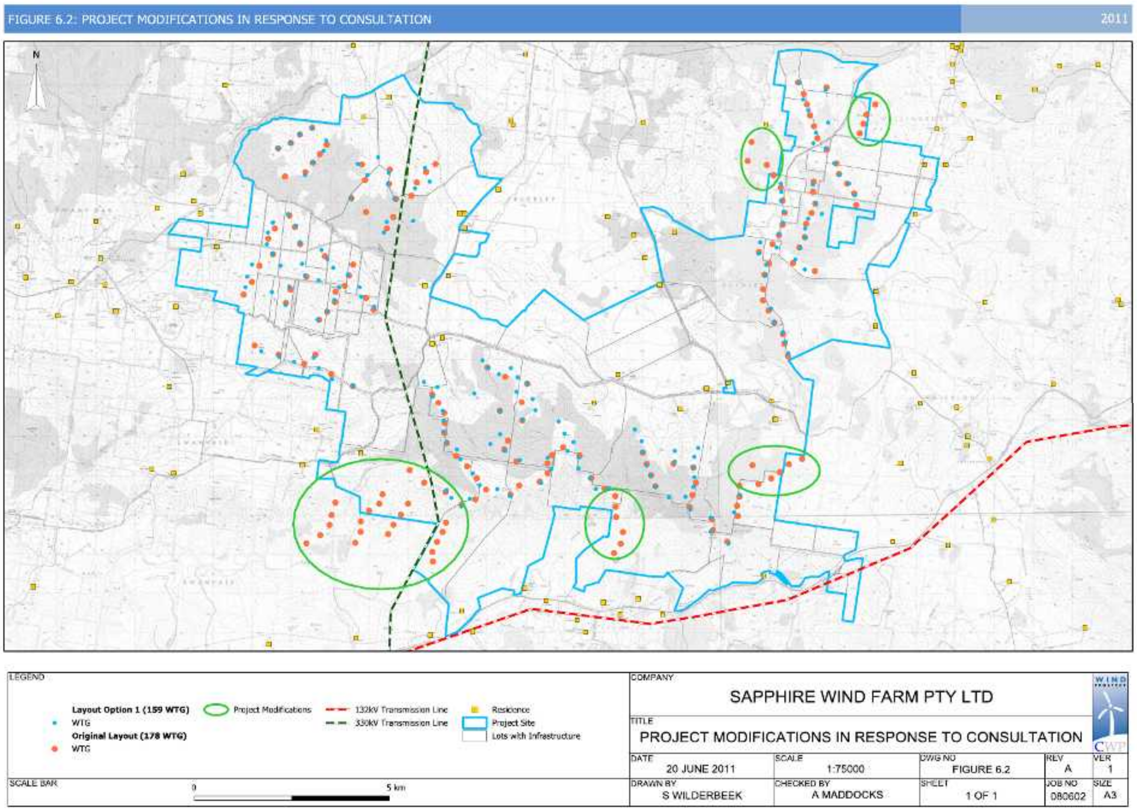

Figure 6.2 Project modifications in response to consultation
(An A3 size version of this Figure is displayed in Volume 2)

6.3.2 *Key Government Consultees*

Table 6.2 List of all Key Government Consultees

Group	Stakeholder
Key Government Consultees	
Local Councils	▪ Glen Innes Severn Council # ▪ Inverell Shire Council #
NSW Government Departments	▪ NSW Aboriginal Land Council ▪ NSW DECCW # ▪ NSW DPI # ▪ NSW DWE# ▪ NSW Office of Water (NOW) ▪ NSW Department of Lands (DoL) - Crown Lands / Native Title ▪ NSW DoL - Surveyor General ▪ NSW Roads and Traffic Authority (RTA) # ▪ NSW Rural Fire Service (RFS) – Region North # ▪ Border Rivers-Gwydir Catchment Management Authority (CMA) #
Federal Government Agencies	▪ Department of Environment, Water, Heritage and the Arts (DEWHA) ▪ DoD # ▪ CASA # ▪ AA #
Service Providers	▪ TransGrid #

 # Indicates those stakeholder groups that were identified by the DoP as key consultees and provided input into the DGR's.

6.3.3 *Other Government and Non-Government Consultees*

Table 6.3 List of all Other Government and Non Government Organisation Consultees

Group	Stakeholder
Other Government and Non Government Organisations	
Other Government and Non Government Organisations	▪ Australian Conservation Foundation ▪ World Wildlife Fund ▪ Greenpeace ▪ Planet Ark ▪ Nature Conservation Council NSW ▪ Office of the Renewable Energy Regulator ▪ Aerial Agricultural Association Australia # ▪ Glen Innes Rural Fire Service ▪ Inverell Rural Fire Service ▪ EMI Co's (inc. ACMA) ◆ NSW Government Network Radio Service ◆ NSW Police Service ◆ NSW Ambulance Service ◆ NSW State Emergency Service ◆ NSW Rural Fire Service ◆ Channel Seven ◆ PRIME ◆ NBN ◆ Australian Communications and Media Authority ◆ Channel Ten ◆ WIN (Channel 9) Television

Indicates those stakeholder groups that were identified by the DoP as key consultees and provided input into the DGR's.

A Stakeholder Consultation Plan created from the outset of the Project is summarised in **Table 6.4** below. The Plan detailed a timeline by which the dissemination of information and consultations occurred with all three stakeholder categories. Throughout this period, consultation continued with all stakeholders that expressed an ongoing interest in the Project.

Table 6.4 Key stages in the consultation process

Approx. Timing	Category / Group / Stakeholder	Nature of consultation
2008 - ongoing	Participating landowners	Initial approach, contract negotiation, ongoing development liaison
	TransGrid	Initial approach, ongoing grid connection studies, consultation on connection options
September 2008	DoP	Opinion sought and Project declared to be a Major Project under Part 3A of the *Environmental Planning and Assessment (EP&A) Act, 1979*
October 2008 - May 2009	DoP DECCW DWE NOW DPI Inverell Shire Council Glen Innes Severn Council DoD	PFM, submission of the Project Application, PEA, receipt of initial DGR's

Approx. Timing	Category / Group / Stakeholder	Nature of consultation
	CASA AA	
May 2009 - ongoing	Neighbouring Residents	Information disseminated via door-knocking and feedback sought
	Local Aboriginal Groups	Information disseminated via phone call and/or letter/email accompanied by Newsletter #1 and feedback sought
	Local Community Groups	Information disseminated via letter/email, accompanied by Newsletter #1 mail-out and feedback sought
	NSW Government Departments	Information disseminated via phone call and/or letter/email accompanied by Newsletter #1 and feedback sought
	Federal Government Departments	Information disseminated via phone call and/or letter/email and feedback sought
	Other Govt. And Non-Govt. Organisations	Information disseminated via letter/email and feedback sought
May 2009	All	Sapphire Wind Farm website launched and media release issued
May 2009	Participating landowners Inverell Shire Council Glen Innes Severn Council RTA DoL	Notification of all landowners, upon which the proposed development may occur or impact, of the Major Project Application in accordance with Clause 8F of the *Environmental Planning and Assessment Regulation 2000*
January 2011	Local Aboriginal Groups	Archaeological and cultural heritage survey participation
March 2011 - ongoing	DEWHA	Referral of proposed action with respect to the *Environment Protection and Biodiversity Conservation (EPBC) Act, 1999*.
February 2011	Key Interest Groups and Local Councils	Public Exhibition Open Day held in Glen Innes and Inverell incorporating maps, facts and figures and finding from key assessments under taken to date.
March 2011	DEWHA	Determination of 'Controlled Action' status under the EPBC Act
May 2011	DEWHA and DoP	Receipt of supplementary DGR's provided by DEWHA and DoP
June 2011	DoP and Proponent	Submission of Draft EA to DoP for adequacy review
August 2011	DoP	Receipt of further supplementary DGR's during adequacy review
September 2011	DoP and Proponent	Submission of final EA to DoP for Public Exhibition
Future		
September to October 2011	All	Public Exhibition of the EA during which submissions can be made
October 2011	Proponent	Prepares Preferred Project Report /Submissions Report in response to submission
February 2012	DoP and DEWHA	Development Consent decision

6.4 Stakeholder Response

6.4.1 *Key Interest Groups*

A number of Key Interest Group stakeholders have provided input into the Project, highlighting a broad range of issues for consideration. Such input from local groups and individuals is important during the development of the Project in order to mitigate adverse impacts to the local community as far as practical. Issues raised have been addressed where feasible to do so and have resulted in a number of modifications to the original layout as shown in **Figure 6.2**.

Other issues raised by the Key Interest Groups concerned broader aspects of the development that are considered throughout this EA, detailed below in **Table 6.5**.

Table 6.5 Summary of the broader Key Interest Group issues and where addressed within the EA

Key Interest Group	Issue Raised	Addressed
Local Aboriginal Groups	Archaeological and cultural heritage survey participation	**Chapter 11**
Neighbouring Residents and Local Community and Businesses	Visual impact	**Chapter 8**
	Noise impact	**Chapter 9**
	Economic value	**Chapters 4** and **18**
	Community fund	**Chapter 18**
	Bushfire risk	**Chapter 16**
	Greenhouse emissions	**Chapter 4**
	Dissemination of information	**Chapter 6** (this chapter)
	Communication impacts	**Chapter 14**
	Aviation impacts	**Chapter 13**

Throughout the Project planning stage Public Opinion Surveys were distributed to Key Interest Group stakeholders. In addition, a "*Have Your Say*" feature of the website provided the same functionality via a different media to capture stakeholder views, comments and concerns about the Project. The following tables show the number of responses received and their opinion on the proposed development for each question asked.

1. Do you approve of wind being used to generate renewable electricity

No Answer	1	3 %
Yes	23	72 %
No	7	22 %
No view	1	3 %
Respondents	32	

2. On hearing of our proposal, what was your initial view?

No Answer	0	0 %
I support it	22	69 %
I don't support it	6	19 %
Undecided	4	12 %
Respondents	32	

3. How close do you live to the proposed wind farm?

No Answer	0	0 %
<15km	28	52 %
>15km	26	48 %
Respondents	54	

4. Does the website provide adequate information?

Yes	7	70 %
No	3	30 %
Respondents	10	

Note: Respondents did not always answer each question posed, resulting in a range of respondent sample groups as evident above.

Whilst the number of returned surveys and questionnaires are statistically too small to determine any trend in overall positive or negative support for the wind farm development, they do provide a 'snap shot' into local community views as received.

6.4.2 *Key Government Consultees*

Various environmental stakeholders have provided advice on flora and fauna species of potential significance in the area. Such stakeholders include the DECCW, the DoPI, the DWE and the Commonwealth DEWHA. Consultation with such agencies is ongoing, with their input into the development process being critical for the appropriate environmental management of the Project site.

In addition to receiving the DGR's for the Project, the DoP also provided broader agency input used in defining assessment requirements. Again, these are summarised below with respect to the relevant chapter of the EA in which the issue is addressed. Moreover, there are a number of additional Key Government Consultees that did not have the opportunity to provide input from the outset. However, through identification and subsequent consultation, their opinions have been sought and are also summarised below.

Generally the requirements of the Key Government Consultees are more prescribed in their nature and easily captured in the general requirement, key assessment and general environmental assessment chapters of this EA.

Table 6.6 Summary of the broader Key Government Consultee issues and where addressed within the EA

Key Government Consultee	Issue Raised	Addressed
Glen Innes Severn Council	Cumulative Impact	**Chapters 7 to 19**
	Noise Impact	**Chapter 9**
	Erosion and Sedimentation Control	**Chapter 18**
	Gravel and Material Provision	**Chapter 18**
	Roads and Maintenance	**Chapters 12** and **18**
	Weed Control	**Chapter 10**
Inverell Shire Council	Weed Control	**Chapter 10**
	Bushfire Risk Management	**Chapter 16**
	Roads and Maintenance	**Chapters 12** and **18**
	Gravel and Material Provision	**Chapter 18**
	Socio-Economic Impacts	**Chapter 19**
DECC	Water	**Chapter 17**
	Air quality	**Chapter 18**
	Noise	**Chapter 9**
	Cultural Heritage	**Chapter 11**
	Waste	**Chapter 18**
	Construction Staging	**Chapters 3** and **10**
	Contaminated Land	**Chapter 18**
	Threatened Species	**Chapter 10**
	Vegetation Clearing	**Chapter 10**
DPI	Weed Control	**Chapter 10**
	Aquatic biodiversity	**Chapter 17**
	Agricultural Issues	**Chapters 3, 13** and **10**
	Waste	**Chapter 18**
	Erosion and Sedimentation Control	**Chapter 18**
DWE/NOW	Water supply	**Chapters 3** and **17**
	Water courses, riparian corridors and Groundwater Dependant Ecosystems	**Chapter 17**
DoL	Trig. Stations	**Chapter 17**
LPMA	Crown Land / Native Title	**Chapter 18**
RTA (No response)	Roads And Maintenance	**Chapter 12**
RFS (No response)	Fire And Bushfire Risk	**Chapter 16**
DoD	Aviation Hazard	**Chapter 13**
	Communication Impact	**Chapter 14**
CASA (No response)	Aviation Hazard	**Chapter 13**
AsA	Aviation Hazard	**Chapter 13**
DEWHA	Environment Protection And Biodiversity Act 1999	**Chapters 3** and **10**

Key Government Consultee	Issue Raised	Addressed
Tony Windsor MP	Visual Impact on Wellingrove	**Chapters 3, 6** and **8**
TransGrid	Grid Connection	**See below**

The Proponent will be entering into a Connection Investigation Network Agreement (CINA) with TransGrid to progress the connection of the wind farm to the grid. This process is a formal arrangement that incorporates TransGrid and the Australian Electricity Market Operator (AEMO, formerly National Electricity Market Management Company (NEMMCO)) in determining the electrical connection requirements.

6.4.3 *Other Government and Non-Government Organisations*

Consultation also occurred with a range of Other Government and Non-Government Organisations, a full list of these stakeholders is provided in **Table 6.3**, in **Section 6.3**.

The Aerial Agricultural Association of Australia (AAAA) provided a response with respect to the proposed impact from the wind farm on neighbouring airstrips. AAAA indicated that, due to internal resource constraints, the organisation was unable to provide a full assessment of the proposed impact. A thorough assessment of aviation related hazards in conjunction with the responses received from the DoD, CASA and AA can been seen in **Chapter 13** Aviation.

Some users or managers of various radio communications, telecommunication and television services have provided advice on the likely effect of the proposed wind turbines on their transmission signals. All advice received has been used in conjunction with results of electromagnetic interference studies (see **Chapter 14** Communications) to develop a compliant turbine layout or to propose mitigation measures in the event of concerns over interference from the Project.

6.5 Detailed Stakeholder Consultation

A number of detailed discussions were held with some of the stakeholders in the vicinity of the Project in order to address their concerns or matters raised in subsequent meetings. These are highlighted below.

6.5.1 *Church Communities Australia*

Church Communities Australia (CCA) operates an integrated community at the 'Danthonia' property where approximately 175 people currently reside. The site includes community facilities, school, medical centre, church and religious premises, a sign-making factory as well as other community and agricultural uses. The CCA main facilities and buildings are approximately 8 km to the west south west of the Project and the Swan Vale Cluster.

CCA were contacted in June 2009, along with other neighbouring landowners, during preparation of the LVIA report and expressed concern about the visual impact of the wind farm on their community. Photomontages were prepared and provided to CCA by the Proponent in order to illustrate the view of the wind farm from the CCA's main facilities.

Following discussions between CCA and the Proponent, CCA engaged landscape consultants Spackman Mossop Michaels to prepare a LVIA of the Wind Prospect Sapphire Wind Farm Project in August 2010. A meeting to discuss CCA's LVIA of the Project was held in September 2010, including CCA and their consultant.

Following subsequent discussions, and in order to address concerns about the visual impact on CCA, the Proponent removed 22 turbines from the south west lower ridgelines of the wind farm site (**Figure 6.2**). Revised photomontages were also prepared by the Proponent and provided to CCA in order to illustrate the difference that the removal of these turbines would make for CCA's consideration as a proactive measure to address CCA concerns.

Discussions are ongoing with CCA to ensure that they are kept up-to-date with the development and to consider any further issues they may have with the Project moving forward.

6.5.2 ***Wellingrove Community***

Wellingrove is a small community (approximately 10 houses, plus new development approvals) of residential properties 3 km to the north east of the Project. The residents expressed concern about the presence of a wind farm in the vicinity of their community not long after the Project was made public in May 2009. Initial meetings took place in June 2009 and August 2009 to better understand their concerns, with the main issue being the placement of four turbines on Wellingrove Hill to the west.

Despite the closest turbine being over 2 km from the nearest residence, the Proponent considered the visual impact of the turbines which had been highlighted. Photomontages were prepared to illustrate the views toward the proposed development from the centre of Wellingrove (Polhill Road). Based on the results of the photomontage, the Proponent opted to remove them from the Project design. This modification to the layout is shown in **Figure 6.2** earlier in this Chapter.

Photomontages of the revised layout were presented to the residents in a meeting in September 2010 showing the modifications, much to their satisfaction. The closest turbine was now approximately 3.6 km from the community.

6.5.3 ***Mineral Exploration and Mining Licence Holders***

Consultation letters and maps showing the layout of the Project were sent to all mineral exploration and mining licence holders identified in the Minview database, found on the NSW DPI website. The details of these licences and the status of communications are outlined in **Table 6.7** below.

Table 6.7: Exploration and Mining Licences overlapping the Project site

Company	Title(s)	Status	Response
Australian Gemstone Resources PL	ML 1492 EL 6982	Expires 16 Aug 2022 Expires 11 Dec 2011	Response Received
DE GUNST, Steven	ELA 4332	Application 23 Jul 2011	No Response
Eastern Feeder-Holdings PL	ML 1374	Expires 13 Jul 2015	No Response
Inishowen Resources PL	EL 7374	Expired 20 Jul 2011	No Response
Jesasu PL	AL 2 AL 14	Expired 14 Mar 2011 (Renewal Sought) Expires 9 Aug 2012	No Response
Pan Gem Resources (Aust) PL	ALA 19	Application 22 Jul 1999	Response Received
Parnosa PL	EL 7669	Expires 16 Dec 2012	No Response
Valbob Mining PL	EL 7796	Expires 4 Jul 2013	Response Received
Volcan Australia Corporation PL	EL 7301 EL 7302	Expired 23 Feb 2011 (Renewal Sought) Expired 23 Feb 2011 (Renewal Sought)	Response Received

Letters were sent out to all known mining companies in February 2009, May 2010 and again in December 2010 informing the licence holders of the Project and requesting consultation on the interaction of the Project and potential mining activity in the area. As can be seen from the table, only four licence holders responded to the repeated request for consultation. The two most recent licence applications, Valbob Mining and DE GUNST, are currently being progressed.

Where possible, the Project has avoided direct impact with any mining licence holders within the Project site. As exploration licences can be considerable in their geographic extent, it has not been possible to avoid direct impacts on such licences over the Project site. However, given there is no active mining taking place in those areas until a mining licence is granted, the development of the Project is not restricted in any way at this time. Under the NSW Mining Act 1992, Division 2, should the wind farm be built prior to the granting of a mining licence, the wind farm would constitute a 'significant improvement' over the land (Clause 23A, Schedule 1) and would therefore prevent the level of mining activity which could take place in the vicinity of the Project.

The Proponent intends on maintaining a dialogue with those mining companies which have exploration or mining licences within the Project site.

6.5.4 *TransGrid*

Recent discussions with TransGrid about the potential connection options into the local transmission network have necessitated a modification to the potential location of the 330 kV substation compound. In a meeting held in June 2011, TransGrid advised that the proposed substation location was inappropriate and suggested a more suitable location (see **Figure 6.3** below). As TransGrid would take ownership of this asset and require it to be designed to their own specification, consideration of their requirements in order to achieve a suitable connection option is crucial to the construction of the project.

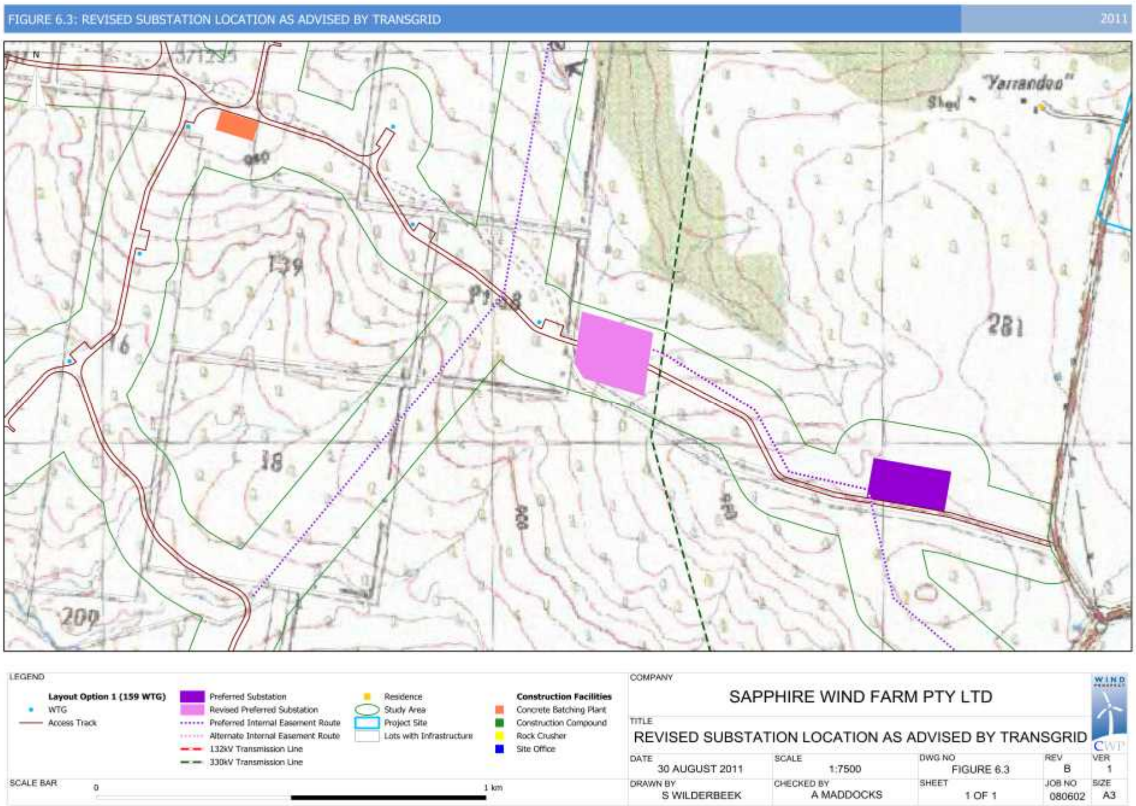

Figure 6.3 Revised substation location as advised by TransGrid

The proposed substation differs in shape and size due to slope and boundary constraints (fencelines, turbine location and 330 kV transmission line easement) in the new location. Based on a 200 m survey corridor undertaken by Eco Logical Australia, it can be seen that all of the substation fits within the survey corridor and therefore no additional surveys are required (see associated vegetation analysis and figures in **Chapter 10** Flora and Fauna).

The new substation location (2.69 ha in size) is still located within Manna Gum – Rough-barked Apple – Yellow Box grassy woodland / open forest but moves from a Low condition area to a Moderate to Good Native Pasture area. However, the revised location removes the need for a 650 m x 60 m easement (3.9 ha) of overhead 330 kV transmission line, which would pass through the same vegetation type ranging in quality from Low to Moderate to Good Native Pasture / Trees, replacing it instead with 650 m x 45 m (2.9 ha) of 66 kV transmission line. No threatened species would be impacted by the revised substation location, nor is it potential habitat for the Regent Honeyeater or Border Thick-tailed Gecko.

Similarly, no noise impact assessment has been completed, but the proposed location is now further away from the nearest residence compared to the previous location (950 m versus 1,150 m). The new location is also at a lower elevation than before (930 m versus 980 m) and better shielded by existing vegetation, which will further limit noise propagation. The lower elevation also helps reduce the visual impact of the substation from surrounding roads and residences, both associated and non-associated.

Based on the minimal impact caused by moving the substation to this new location, the Proponent does not propose to carry out any additional surveys. The change in vegetation condition from Low to Moderate to Good is offset by the reduction in transmission line corridor required to connect to the new substation location. The new location also benefits from reduced noise and visual impacts. The Proponent will recalculate the offset requirements post-consent, once the layout is known based on final turbine selection.

6.6 Summary

Consultation for the Sapphire Wind Farm proposal was conducted by way of letters of notification to stakeholders, face-to-face contact with neighbouring residents, a public exhibition and consultation meetings with various stakeholders. The Project website (www.sapphirewindfarm.com.au) presents an ongoing, active consultation medium for people to track the development of the Project and provide comment.

Stakeholders included statutory bodies, local interest groups and regional / local residents. A number of consultees responded, including local community groups, concerned about the development and provided input or advice for the Project which subsequently resulted in the modification of the Project design. In particular, consultation with Church Communities Australia and the Wellingrove residents resulted in the removal of turbines in order to reduce concerns about the Project and make it more acceptable to them.

Attempts to contact companies with exploration or mining licences resulted in limited success, despite repeated attempts to encourage consultation about the Project. The Proponent maintains an ongoing consultation process, however, and is open to future discussion about the potential interaction with mining companies operating in the Project site.

CHAPTER 7

Assessment of Key Issues

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7. ASSESSMENT OF KEY ISSUES

A number of issues require assessment in the development of a wind farm. Each issue has varying importance depending on the type and scale of the project. The classification of an issue determines the level of assessment required.

Issues are identified in a number of ways, including:

- Relevance to guidelines, strategic plans or policies produced by the New South Wales government or other governing bodies;
- Reference to other projects, especially those in similar locations;
- Association to research and reference material on wind farms; and
- Outcomes from consultations with stakeholders.

The Director-General's Requirements (DGR's), under the *Environmental Planning and Assessment Act 1979*, requires key or additional issues be identified as these issues have the potential to create environmental or human impacts. This Environmental Assessment is structured to address the requested key issues and **Table 7.1** summarises each key issue and the investigation strategies employed. **Chapters 8** to **17** provide greater detail including the methodologies, results and mitigation measures recommended by these investigations for each key issue individually. Additional issues not directly required by the DGR's are identified in **Chapter 18** General Environmental Assessment and **Chapter 19** Socio-Economic Assessment.

An assessment of cumulative environmental impacts considers the potential impact of a Project in the context of existing developments and future developments to ensure that any potential environmental impacts are not considered in isolation.

Table 7.1 Key assessment areas related to the Project and methods of investigation

Key Issue	Addressed	Investigation Strategy
Landscape and visual	**Chapter 8**	Assessment by Green Bean Design Pty Ltd, and broader stakeholder communication
Noise	**Chapter 9**	Assessment by SLR Consulting Australia Pty Ltd, and broader stakeholder communication
Flora and fauna	**Chapter 10**	Assessment by Eco Logical Australia Pty Ltd, and broader stakeholder communication
Cultural heritage	**Chapter 11**	Assessment by New South Wales Archaeological Pty Ltd, and broader stakeholder communication
Traffic and transport	**Chapter 12**	Assessment by Bega Duo Designs
Aviation	**Chapter 13**	Consultation with key government agencies, the Ambidji Group Pty Ltd and broader stakeholder communication
Communication	**Chapter 14**	Assessment by Lawrence Derrick and Associates, and broader stakeholder communication
Electromagnetic fields	**Chapter 15**	Desktop review
Fire and bushfire	**Chapter 16**	Assessment by Eco Logical Australia Pty Ltd
Water	**Chapter 17**	Consultation with key government agencies, assessment by Eco Logical Australia Pty Ltd and associated landowners
General environmental assessment	**Chapter 18**	Assessment by Eco Logical Australia Pty Ltd and desktop review
Socio-economic assessment	**Chapter 19**	Consultation with associated parties and desktop review
Cumulative	**Chapters 8** to **19**	Assessment by multiple consultants, desktop reviews and broader stakeholder consultations

CHAPTER 8

Landscape and Visual Impact Assessment

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8. LANDSCAPE AND VISUAL IMPACT ASSESSMENT

The Proponent commissioned Green Bean Design Landscape Architects (GBD) to prepare a Landscape and Visual Impact Assessment (LVIA) for the Sapphire Wind Farm. The detailed LVIA is included in **Appendix 7**. The LVIA involved a comprehensive evaluation of the visual character of the landscape in which the Project would be located, and an assessment of the potential landscape and visual impacts that may result from the construction and operation of the Project, taking into account appropriate mitigation measures. An additional update letter is also included in **Appendix 7** which considers an increased blade tip height of 157 m.

This chapter presents a summary of the LVIA methodology as well as the key results and findings arising from the assessment. The detailed results of the LVIA are included in **Appendix 7**.

The LVIA addresses the Director-General's Requirements (DGR's) for the Project assessment, as well as issues raised separately in consultation with local stakeholders and residents. GBD also reviewed the Glen Innes Severn and Inverell Shire Councils Development Control Plans (DCP) *Wind Power Generation 2008* and *2009* respectively in regards to consideration of visual assessment.

The LVIA is cognisant of the Australian Wind Energy Association and Australian Council of National Trust's publication *Wind Farms and Landscape Values National Assessment Framework* (June 2007), and encompasses the general assessment framework outlined in the National Assessment Framework. In addition to the National Assessment Framework, the LVIA has also included a review of the *National Wind Farm Development Guidelines* (Public Consultation Draft V2.4, 2010).

8.1 Method

The LVIA methodology adopted by GBD has been applied to a number of similar LVIA Part 3A Major Projects assessed and approved by the New South Wales (NSW) Department of Planning and Infrastructure (DPI), including wind farms in rural NSW.

The LVIA methodology included the following activities and assessments:

- Desktop study addressing visual character and identification of receptor locations surrounding the Project;
- Fieldwork and photography;
- Preparation of Zone of Visual Influence diagrams;
- Assessment and determination of landscape sensitivity;
- Assessment and determination of visual impact;
- Preparation of photomontages and illustrative figures; and
- Preparation of a shadow flicker assessment.

8.1.1 *Viewshed, Zone of Visual Influence and Visibility*

A core component of the LVIA is defined by the description, assessment and determination of the viewshed, zone of visual influence and visibility associated with the Project. The relationship between viewshed, zone of visual influence and visibility is outlined in **Table 8.1** and detailed in **Appendix 7.**

Table 8.1 LVIA definitions

Term	Definition	Relationship
Viewshed	An area of land surrounding and beyond the Project area which may be potentially affected by the Project.	Identifies the majority of the LVIA study area that incorporates receptors that may be subject to a degree of visual impact.
Zone of Visual Influence	A theoretical area of landscape from which the Project structures may be visible.	Determines areas within a viewshed from which the wind turbines may be visible.
Visibility	A relative determination at which a wind turbine or Cluster of wind turbines can be clearly discerned and described.	Describes the likely number and relative scale of wind turbines visible from a receptor location.

Viewshed: For the purpose of the LVIA, viewshed was defined as the area of land surrounding and beyond the Project area which may be potentially affected by the Project. The viewshed assumptions for the Project are outlined in **Table 8.2**.

Table 8.2 Viewshed descriptors

Distance from turbine	Potential Viewshed Descriptors
>20 km	Wind turbines become indistinct with increasing distance. Rotor movement may be visible, but rotor structures are usually not discernable. Wind turbines may be potentially discernable but generally indistinct within the viewshed resulting in a Low level visibility and Nil level visibility where influenced or screened by surrounding topography and vegetation.
10 to 20 km	Wind turbines are noticeable but tending to become less distinct with increasing distance. Blade movement may be visible but becomes less discernable with increasing distance. Wind turbines are potentially discernable but generally indistinct within viewshed resulting in Low level visibility.
5 to 10 km	Wind turbines are visible but tending to become less distinct depending on the overall extent of view available from the potential receptor location. Movement of blades may be discernable where visible against the skyline. Wind turbines potentially noticeable resulting in Low to Moderate level visibility.
3 to 5 km	Wind turbines are clearly visible in the landscape but tending to become less dominant with increasing distance. Movement of blades discernable. Wind turbines are potentially noticeable but less dominant within the viewshed resulting in Moderate level visibility.
1 to 3 km	Wind turbines would generally dominate the landscape in which the wind turbine is situated. Potential for high visibility depending on the category of receptor, their location, sensitivity and subject to other visibility factors. Wind turbines are potentially dominant within the viewshed resulting in Moderate to High level visibility.
<1 km	Wind turbines would dominate the landscape in which they are situated due to large scale, movement and proximity. Wind turbines would be potentially dominant and significant within viewshed resulting in High level visibility.

Zone of Visual Influence (ZVI): The ZVI diagrams are used to identify theoretical areas of the landscape from which a defined number of wind turbines, or portions of wind turbines, may be visible within the viewshed. They are useful for providing an overview as to the extent to which the Project could be visible from surrounding areas.

Nine ZVI diagrams have been prepared including:

- Layout Option 1 (159 WTG) ZVI from tip of blade;
- Layout Option 1 (159 WTG) ZVI from full face of rotor;
- Layout Option 1 (159 WTG) ZVI from whole wind turbine;
- Layout Option 2 (125 WTG) ZVI from tip of blade;
- Layout Option 2 (125 WTG) ZVI from full face of rotor;
- Layout Option 2 (125 WTG) ZVI from whole wind turbine;
- Cumulative ZVI with Layout Option 1 (159 WTG), Glen Innes Wind Farm and White Rock Wind Farm;
- Cumulative ZVI with Layout Option 1 (159 WTG) and Glen Innes Wind Farm; and
- Cumulative ZVI with Layout Option 1 (159 WTG) and White Rock Wind Farm.

Ben Lomond Wind Farm is not considered as part of the cumulative impact assessment due to the 20 km distance between the proposed projects.

The ZVI diagrams are illustrated in **Figures 8.1** to **8.4** in **Volume 2**, and **Appendix 7**. The ZVI methodology is assumed to be conservative as the screening effects of any structures and vegetation above ground level are not considered in any way. Therefore the Project may not be visible at many of the locations indicated on the ZVI diagrams due to the presence of trees or other screening elements. A summary of the ZVI analysis is included in **Appendix 7**.

Visibility: The level of wind turbine visibility within the 10 km viewshed can result from a number of factors including the distance between a receptor and the Project, static or dynamic receptor locations (e.g. residents or motorists) or the relative position of the receptor to the wind turbines. Whilst the distance between a receptor and wind turbines is a primary factor to consider when determining potential visibility, there are other issues, for example the level of tree cover and weather conditions, which may also affect the degree of visibility.

8.1.2 *Visual Absorption Capability and View Catchment*

Visual Absorption Capability (VAC) is a classification system used to describe the relative ability of the landscape to accept modifications and alterations without the loss of landscape character or deterioration of visual amenity. The VAC classification system is suitable to use on smaller ancillary structures where their scale and form is more readily absorbed by elements within the surrounding landscape. The VAC classification system, as described in **Table 8.3**, is used to determine the capability of the landscape to absorb the proposed collector and switching substation and transmission lines.

Table 8.3 Visual Absorption Capability descriptors

VAC Rating	VAC Description
High	Electrical infrastructure components would be extensively screened by surrounding vegetation and undulating landform.
Medium	Electrical infrastructure components would be visible but existing vegetation and surrounding landform would provide some screening or background to reduce visual contrast.
Low	Electrical infrastructure components would be highly visible either due to lack of screening by existing vegetation or surrounding landform (e.g. open flat farmland, cleared vegetation, or steep hillside crossing ridgeline).

For the purpose of this LVIA, the view catchment has been determined as approximately a 2 km buffer from either a substation or transmission line.

8.2 Existing Situation

For the purpose of this LVIA, landscape character was defined as *'the distinct and recognisable pattern of elements that occur consistently in a particular type of landscape'* (The Countryside Agency and Scottish Natural Heritage 2002).

The LVIA identified five Landscape Character Areas (LCA's), which generally occur within the Project viewshed and include:

- LCA 1 – Gently undulating to flat cultivated/pastoral farmland and mining areas;
- LCA 2 – Steep sided valleys and hills;
- LCA 3 – Drainage lines;
- LCA 4 – Forested hills and ridgelines; and
- LCA 5 – Rural dwellings.

The British Landscape Institute (2011) describes landscape sensitivity as '*the degree to which a particular LCA can accommodate change arising from a particular development, without detrimental effects on its character'*. The determination of landscape sensitivity primarily results from the nature and degree of perceptual factors that can influence interpretation and appreciation of the landscape, including landform, scale, land cover, human influence or modifications. A full list of the criteria against which landscape sensitivity was assessed is included in **Appendix 7**.

In terms of overall landscape sensitivity, the LVIA determined that each of the five LCA's within the Project viewshed had a Medium sensitivity to accommodate change, and represented a landscape that is reasonably typical of other landscape types found in surrounding areas, as well as landscapes within the wider regional context of the New England Tablelands.

With a Medium sensitivity to accommodate change, some characteristics of the landscape are likely to be altered by the Project development; however, the landscape is likely to have some capability to accommodate change. This capability is largely derived from the presence of predominantly large scale and open landscape character areas across portions of the Study area, together with the relatively low density of settlement and potential receptors located within the immediate and surrounding Project viewshed.

The LVIA determined that the Project is likely to be an acceptable development within the viewshed, which in a broader context also contains built elements such as roads, agricultural industry, aircraft landing strips, communication and transmitter towers, power lines, mining facilities and an approved wind farm.

8.2.1 *Perception and Public Consultation*

Individual perception is an important issue to consider in any visual impact assessment, as the attitude or opinion of an individual receptor adds significant weight to the level of potential visual impact. These attitudes or opinions of individual receptors toward wind farms can be shaped and formed through a multitude of complex social and cultural values.

It is unlikely that wind farm projects will ever conform or be acceptable to all points of view. Some receptors accept and support wind farms in response to global or local environmental issues, others support the environmental ideals of wind farm development as part of a broader renewable energy strategy, but do not consider them appropriate for their regional or local area, whereas others find the whole concept of wind farms unacceptable. A summary of the changes made to the Project throughout the site design and public consultation period is included in **Chapter 6** Stakeholder Consultation.

The Proponent conducted two separate opinion surveys during the course of 2009 to 2011 and received responses from the community. Submissions were also taken through the Project website. From a total of 20 Public Opinion Surveys received by the Proponent:

- 13 respondents supported the Project;
- 5 respondents did not support the Project; and
- 2 respondents did not answer the question.

From a total of ten Landscape Values Questionnaire received by the Proponent:

- 5 respondents considered that the Project would have either a neutral or positive impact on the landscape;
- 4 respondents considered that the Project would have a negative impact on the landscape; and
- 1 respondent did not provide an answer on what impact the Project would have on the landscape.

As discussed in **Chapter 6** Stakeholder Consultation, these returned surveys and questionnaires are statistically too small to determine an overall trend, however they do provide a ‘snap shot’ into local community attitudes.

Consultation also occurred with local stakeholders, including Church Communities Australia, which has a self-contained community at the ‘Danthonia’ property, and the Wellingrove community. Danthonia prepared their own visual impact assessment using an external consultant in order to outline their concerns about the Project’s visual impact. After consulting with each of these groups, modifications were made to the Project to address their individual concerns on visual impacts, as discussed in **Chapter 6** Stakeholder Consultation.

Whilst published research into the potential landscape and visual impacts of wind farms is limited in Australia, there are general corresponding results between those that have been carried out when compared to those carried out overseas.

In 2010, ARM Interactive on behalf of DECCW survey polled 2,022 residents across the six Renewable Energy Precincts, including the New England Tablelands. The key findings of the survey indicated that:

- 85 % of people supported the construction of wind farms in NSW and 80 % within their local region; and
- 79 % supported wind farms being built within 10 km of residences and 60 % of people surveyed supported the construction of wind turbines within 1 to 2 km from their residences. This level of support for wind farms within 1 to 2 km dropped to 54 % in the New England Precinct.

These results are reflected in other surveys including the community perception survey toward wind farms undertaken by Epuron for the Gullen Range Wind Farm Environmental Assessment in 2008. The results of the survey, which targeted a number of local populations within the Southern Tablelands, suggested that around 89 % of respondents were in favour of wind farms being developed in the Southern Tablelands, with around 71 % of respondents accepting the development of a wind farm within 1 km from their residential dwelling.

Whilst individual perception and local community attitudes toward wind farm development are an important issue, and need to be considered in terms of potential landscape and visual impacts, there is also the issue of the greater potential societal benefit provided by renewable energy projects, as discussed in **Chapter 4** Project Justification.

8.3 Potential Impacts

The potential significance of visual impact resulting from the construction and operation of the Project would result primarily from a combination of the following factors:

- The visibility or extent to which the Project structures would be visible from surrounding areas;
- The degree of visual contrast between the Project structures and capability of the surrounding landscape to visually accommodate the Project;
- The category and type of situation from which receptors may view the Project;
- The distance between receptor and Project wind turbines;
- The duration of time a receptor may view the Project from any static or dynamic view location; and
- The visual sensitivity of receptors surrounding the Project.

The criteria used to establish visibility and the significance of visual impact are detailed in **Appendix 7**. Residential and public receptor locations are presented in **Figure 8.5** and **8.6**, located in **Volume 2** and **Appendix 7**.

The LVIA identified a total of 139 residential receptors within 10 km of the Project. An assessment of each residential receptor location indicated that for Layout Option 1 (159 WTG) and Layout Option 2 (125 WTG):

- 3 of the 139 residential receptor locations were determined to have a High visual impact.
- 34 of the 139 residential receptor locations were determined to have a Moderate visual impact (this includes 16 residences determined to have Low to Moderate visual impact);
- 81 of the 139 residential receptor locations were determined to have a Low visual impact; and
- 21 of the 139 residential receptor locations were determined to have a Nil visual impact.

The LVIA also identified a total of 13 public receptors with 12 of the selected public receptor locations determined to have a Low visual impact and one to have a Nil visual impact. These public receptor locations included roads within the Project viewshed, Sinclair Lookout and Centennial Parklands and Martins Lookout, Glen Innes.

Overall the LVIA determined that residential receptors beyond 10 km of the Project would be unlikely to experience a visual impact greater than Low and would more likely be screened by a combination of undulating landform and tree cover.

It should be noted that the term 'visual impact' may not necessarily always imply or represent an individual's negative response toward the wind turbines, and that an individual's perception of wind farms can be positive, negative or neutral.

8.3.1 *Shadow Flicker*

Residential: Wind turbines can cast shadows on surrounding areas at a distance from the base of the tower due to their height. When viewed from a stationary position, the moving shadows can appear as a flicker giving rise to the phenomenon of 'shadow flicker'.

A shadow flicker assessment was prepared for both the Layout Option 1 (159 WTG) and Layout Option 2 (125 WTG) to determine and illustrate the potential impact of shadow flicker on surrounding receptor locations. As there are no guidelines published in NSW by which to assess the impact of shadow flicker, the assessment adopted the Victorian Planning Guidelines that state:

> *"The shadow flicker experienced at any dwelling in the surrounding area must not exceed 30 hours per year as a result of the operation of the wind energy facility".*

The results of the shadow flicker assessment for the Project determined that no associated or non-associated residential dwellings surrounding the Project would experience shadow flicker in excess of 30 hours per year, as displayed in **Appendix 7**.

Motorists: There are no specific guidelines to address the potential impact of wind turbine shadow flicker across roads, although there are lighting standards that address the need to minimise the adverse effects of shadow flicker caused by some roadside or overhead objects. The standards suggest that the flicker effect will be noticeable and possibly cause annoyance for motorists between 2.5 and 15 Hz (2.5 to 15 flickers per second), and that a flicker effect between 4 and 11 Hz should be avoided for longer than 20 seconds. As the potential flicker frequency for the Project is likely to be around 1 Hz, it is unlikely that the flicker effect will cause annoyance or impact on a driver's ability to operate a motor vehicle safely whilst travelling along local roads surrounding the Project.

8.3.2 *Photosensitive Epilepsy*

The Canadian Epilepsy Alliance (2008) defines photosensitivity as '*a sensitivity to flashing or flickering lights, usually of high intensity, which are pulsating in a regular pattern – and people with photosensitive epilepsy can be triggered into seizures by them*'. Both the Canadian Epilepsy Alliance (2008) and Epilepsy Action Australia (2008) estimate that less than 5 % of people with epilepsy are photosensitive.

Epilepsy Action Australia (2008) suggest that the frequency of flashing or flickering light most likely to trigger seizures occurs between 8 to 30 Hz (or flashes/flickers per second), although this may vary between individuals. It also suggests that 96 % of people with photosensitive epilepsy are sensitive to flicker between 15 to 20 Hz.

Given the low flicker frequency associated with the Project (around 1 Hz), which falls below the range suggested by Epilepsy Action Australia as a potential trigger for photosensitive epileptic seizures, it is unlikely that the Project would present a risk to people with photosensitive epilepsy.

8.3.3 *Blade Glint*

Blade glint refers to the reflection of sun from one or more rotating turbine blades. The occurrence of blade glint depends on a number of conditions, including the orientation of the nacelle, angle of the blade and angle of the sun. The reflectivity of the blades surface is influenced to some extent by the colour and age of the blade.

Blade glint can be mitigated through the use of matt coatings which, if applied correctly, will generally mitigate potential visual impacts.

8.3.4 *Electrical works*

The Project would include electrical infrastructure to collect and distribute electricity generated by the wind turbines to the existing electricity network. The proposed electrical works are discussed in **Chapter 3** Project Description.

The majority of electrical connections between the wind turbines and on-site substation would be via underground cabling, including areas along a number of the prominent ridgelines within the Project boundary. Some overhead electrical lines would be required to connect the Clusters to the collector and switching substation.

Based on the VAC classification scheme used to assess the impact of the electrical works on the landscape, the conclusion was that the electrical infrastructure associated with the Project would unlikely have a significant visual impact on the majority of surrounding view locations. Those residential receptor locations determined to have a Medium to Medium-to-High visual impact would all be associated residences, thus more accepting of the proposed electrical works. For a full list of results refer to **Appendix 7**.

8.3.5 *Night Lighting*

The Project may require obstacle marking and lighting at night time and during periods of reduced visibility. The requirement for lighting would be subject to the advice and endorsement of the Civil

Aviation Safety Authority (CASA) and Department of Infrastructure and Transport (DIT). As discussed in **Chapter 13** Aviation Assessment, CASA is currently undertaking a review on obstacle marking and lighting of wind farms.

However, with respect to duty of care, the Proponent commissioned The Ambidji Group, an independent aviation safety expert, to conduct an Aeronautical Impact Assessment and Obstacle Lighting Review to determine the risks posed to aviation activities by the Project. The Ambidji Group report, as discussed in **Chapter 13** Aviation Assessment, recommended that the Project may require lighting as duty of care or other applicable mitigation measures. The outcomes of the aviation assessment (**Appendix 15**) will be submitted to CASA and DIT for their consideration. Further discussion on the assessment process and requirement for wind turbine lighting is included within **Chapter 13** Aviation Assessment.

Epuron (2008), conducted studies in Victoria on night time lighting mounted on wind turbines and discovered that lights could be visible for a number of kilometres, however the actual intensity of the night time lighting was considered to be no greater than other sources of night time lighting, including vehicle head and tail lights. **Appendix 7** provides an illustration of the visual effect of night time lighting mounted on wind turbines at Cullerin Wind Farm, NSW. It should also be noted that after community consultation and preparation of an aviation risk assessment, night time lighting mounted on wind turbines was removed from the Cullerin Wind Farm.

A small number of existing night time light sources are present in the vicinity of the Project, including lighting associated with dispersed homesteads, vehicles travelling along local roads and night time obstacle lighting on TV transmitter masts located on Carpenter Hill, west of Glen Innes. Potential night time light sources generated by the Project could result from:

- Control and auxiliary buildings;
- Collector and switching substation;
- Wind turbines and wind monitoring masts; and
- Scheduled or emergency maintenance.

The receptor locations that could be impacted by night time lighting generally include residents and motorists. The impact of night lighting on motorists would be minimal due to the very short duration of visibility from undulating landform and direction of travel. Night lighting would be visible from some residential receptors, however topography and screening from vegetation and plantings around the dwelling could obscure night lighting.

8.3.6 *Cumulative Impacts*

An assessment of cumulative environmental impacts considers the potential impact of a proposal in the context of existing developments and future developments to ensure that any potential environmental impacts are not considered in isolation. 'Direct' cumulative visual impacts may occur where two or more winds farms have been constructed within the same locality, and could be viewed from the same view location simultaneously. 'Indirect' cumulative visual impacts may occur where two or more wind farms have been constructed within the same locality and could be viewed from the same view location but not within the same field of view. 'Sequential' cumulative visual impacts may arise as a result of multiple wind farms being observed at different locations during the course of a journey (e.g. from a vehicle travelling along a highway or from a network of local roads), which may form an impression of greater magnitude within the construct of short term memory.

The majority of wind farms within NSW, currently constructed, approved or under consideration by the DPI, are located within the general regional area of the NSW Southern Tablelands, including sites in the locality of Crookwell, Goulburn, and Yass. The DPI website identifies three wind farm developments currently approved or proposed within the same locality as the Project as listed in **Table 8.4**. The Ben Lomond Wind Farm has not been included in the cumulative assessment as the DGR's expired on the 19th February 2010 and there currently is no publically available information to suggest that the project will proceed.

Table 8.4 Other Wind Farm Developments

Wind Farm	Proponent	Status	Number of Wind Turbines
Glen Innes Wind Farm	Infigen	Approved	25
White Rock Wind Farm	Epuron	Submitted	Up to 119
Ben Lomond Wind Farm	AGL	DGR's lapsed	Up to 98

The LVIA determined that the Project would not result in significant 'direct', 'indirect' or 'sequential' cumulative impacts when compared to any existing or proposed wind farm developments, including Glen Innes Wind Farm and White Rock Wind Farm. Inter-visibility between these projects would be influenced by undulating landform and tree cover within and beyond the Project's 10 km viewshed.

8.4 Photomontages

Photomontages have been prepared to illustrate the general appearance of the Project following construction, based on a 100 m tower and 46 m blade (146 m to blade tip). Twelve locations were selected to represent a range of distances between the viewpoint and wind turbines (1.4 to 8.3 km), plus one montage showing the comparison of the 157 m blade tip height.

The photomontages represent Layout Option 1 (159 WTG) as it comprises the greater number of wind turbines and could present a worst case visual impact.

The photomontages locations, as displayed in **Figure 8.7** in **Volume 2**, included:

- Waterloo Road (adjoining non-associated residence);
- Polhill Road (adjoining non-associated residence);
- Wellingrove Community (non-associated residences);
- Kings Plains Road (road corridor);
- Eastern Feeder Road (road corridor);
- Western Feeder Road (road corridor);
- Kings Plains Road (adjoining non-associated residence);
- Spring Creek (adjoining non-associated residence);
- Danthonia Community (non-associated residences);
- Swan Vale, Gwydir Highway (non-associated residences with road corridor);

- Ilparran Road (adjoining associated residence);
- Krystal Blue (adjoining non-associated residence); and
- Krystal Blue (157 m turbine blade tip comparison).

The process used to generate the photomontages is detailed in **Appendix 7**. The photomontages are illustrated in **Figures 8.8** to **8.20** located in **Volume 2** and in **Appendix 7**. A detailed photomontage has also been created for each photomontage location with an example shown in **Figure 8.9** located in **Volume 2** and a detailed sheet for each photomontage in **Appendix 7**.

Whilst a professional photomontage provides an image that illustrates a reasonably accurate representation of a wind turbine, both in relation to its proposed location and its scale relative to the surrounding landscape, the LVIA acknowledges that large scale objects in the landscape can appear smaller in photomontage than in real life, and is partly due to the fact that a flat image does not allow the viewer to perceive any information relating to depth or distance.

8.5 Management and Mitigation

It is inevitable that wind turbines of the size proposed for the Project will have some degree of visual impact. However, a number of mitigation measures have been incorporated into the design of the Project, or form Project commitments, with the aim of minimising visual impact. These include:

- Use of a matt and/or off-white finish on the structures to reduce visual contrast between wind turbine structures and the viewing background (this is subject to final turbine selection and aviation safety requirements);
- Limit amount of advertising, signs or logos mounted on wind turbine structures, except those required for safety purposes;
- Undertake landscape planting where screening is deemed appropriate and in accordance with the outcomes of the assessment process;
- Appropriate selection where feasible of materials and colours, together with consideration of reflective properties for ancillary structures;
- Re-instate disturbed soil areas immediately after completion of construction and decommissioning which would include re-contouring and re-seeding with appropriate plant species and local materials where feasible;
- Enforce safeguards to control and minimise dust emissions during construction and decommissioning;
- Limit the height of stockpiles to minimise visibility from outside the Project;
- Minimise activities that may require night time lighting and, if necessary, use low lux (intensity) lighting designed to be mounted with the light projecting inwards to the Project site to minimise glare;
- Location of the collector and switching substation and other ancillary infrastructure sited sympathetically with the nature of the locality and away from major roads and residences where possible to mitigate visual impact;
- Tracks have been designed to follow contour lines, with minimal extent of cut and fill in track construction, revegetation of disturbed areas and use of local material to minimise colour contrast where feasible; and

- The majority of electrical connections within the Project site (i.e. cables between the WTG's) have been designed to be located underground (where possible), in order to further reduce potential visual impacts.

8.6 Summary

The LVIA established the current landscape values, predicted visual influence of the Project and other potential visual effects. A variety of methods were used in the visual assessment of the Project, such as public consultation, on-ground surveys, Zone of Visual Influence (ZVI) assessments, photomontage production and assessment of shadow flicker effects.

In terms of overall landscape sensitivity, the LVIA determined that each of the five LCA's within the Project viewshed had a Medium sensitivity to accommodate change, and represented a landscape that is reasonably typical of other landscape types found in surrounding areas of the New England Tablelands.

With a Medium sensitivity to accommodate change, some characteristics of the landscape are likely to be altered by the Project development; however, the landscape is likely to have some capability to accommodate change. This capability is largely derived from the large scale and open landscape character areas identified in this part of the New England Tablelands, together with the relatively low density of receptors located within the Project viewshed.

The LVIA determined that the Project is likely to be an acceptable development within the viewshed, which in a broader context also contains built elements such as roads, agricultural industry, aircraft landing strips, communication and transmitter towers, power lines and an approved wind farm.

There are a number of potential visual effects associated with the wind farm. The likely incidence of glinting is impossible to predict, but experience suggests that this occurs relatively rarely. Shadow flicker effects are unlikely to be experienced at any residences. Night time lighting would have the potential to be visible from surrounding receptors, however the level of visual impact would diminish over distance and when screened by landform or vegetation. The Project will have some degree of visual influence, however it is unlikely that wind farm projects will ever conform, or be acceptable to all points of view.

The potential collector and switching substation locations and transmission line options are unlikely to result in a significant visual impact for the majority of surrounding residential or public view receptors due to a combination of distance, undulating landform and tree cover.

An increase in blade tip height from 156 m to 157 m was not considered to significantly increase the the visual or cumulative effect of the Project. The comparative photomontage (PM11A) shows the difference between this specification of turbine and the original turbine used in the photomontages.

Overall, the cumulative visual effect of the Project would not result in any significant 'direct', 'indirect' or 'sequential' cumulative impacts when considered against any existing or proposed projects.

CHAPTER 9

Noise Assessment

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9. NOISE ASSESSMENT

Wind turbines emit sound, and as such wind farms need to be carefully designed to ensure they do not pose an unacceptable noise impact on neighbouring residents. The management of wind farm noise is unique from other types of noise source management due to the relationship between wind speeds and subsequent changes in background noise and turbine noise (explained further below). Given these unique characteristics, specific wind farm noise assessment guidelines have been developed. Noise assessments are carried out to predict the likely noise levels for comparison with the South Australian Environmental Protection Authority (SA EPA) *Wind Farms – Environmental Noise Guidelines* (February 2003) (SA EPA Guidelines, **Appendix 8**). This document was developed to assess and manage environmental noise impacts from wind farms in South Australia and has been adopted by the NSW Department of Planning (DoP). The SA EPA has since prepared revised noise guidelines (*Wind Farms Environmental Noise Guidelines*, 2009), however these are yet to be implemented in New South Wales (NSW) and are not considered here.

The Project is subject to the following noise related policies and plans, which have been considered as part of this assessment. These policies and plans relate to different aspects of the wind farm Project, including:

- Wind turbine generators – SA EPA *Wind Farms – Environmental Noise Guidelines* (2003);
- Electrical substation – NSW *Industrial Noise Policy* (EPA 2000);
- Site establishment and construction – *Interim Construction Noise Guidelines* (DECC 2009);
- Traffic noise – *Environmental Criteria for Road Traffic Noise* (EPA 1999); and
- Vibration – *Assessing Vibration: A Technical Guideline* (DECC 2006).

9.1 Noise Fundamentals

Hearing is a fundamental human sense and is used constantly for communication and awareness of the environment. Noise is generally described as being ‘unwanted’ or ‘unfavourable’ sound and, to some extent, is an individual or subjective response because what may be ‘sound’ to one person, may be regarded as ‘noise’ by another.

The measurement and assessment of noise has been developed steadily over the last century, taking into account human response measures such as hearing damage and other potential health effects such as stress. Complex noise measurement and analytical devices have also been developed to facilitate the assessment process.

A-weighting and ‘dBA’: The overall level of a sound is usually expressed in terms of dBA (decibels), which is measured using the ‘A-weighting’ filter incorporated in sound level meters. These filters have a frequency response corresponding approximately to that of human hearing. A person’s hearing is most sensitive to sounds at mid frequencies (typically 500 to 4,000 Hertz (Hz)) and less sensitive at lower and higher frequencies. The level of a sound in dBA is considered a good measure of the loudness of that sound. Different sources having the same dBA level generally sound about equally as loud, although the perceived loudness can also be affected by the character of the sound (e.g. the loudness of human speech and a distant motorbike may be perceived differently, although they can be of the same dBA level).

A change of up to 1 dBA in the level of a sound is difficult for most people to detect, whilst a 1 dBA to 5 dBA change corresponds to a small but noticeable change in loudness. A 10 dBA change corresponds to an approximate doubling or halving in loudness. **Table 9.1** below presents examples of typical noise levels.

Table 9.1: Typical Noise Levels

Sound Pressure Level (dBA)	Typical Sources	Subjective Evaluation
130	Threshold of pain	Intolerable
120 110	Heavy rock concert Grinding on steel	Extremely noisy
100 90	Loud car horn at 3 m Construction site with pneumatic hammering	Very noisy
80 70	Kerbside of busy street Loud radio or television	Loud
60 50	Department store General office	Moderate to quiet
40 30	Inside private office Inside bedroom	Quiet to very quiet
20	Unoccupied recording studio	Almost silent

Source: ***Appendix 9***

Further aspects associated with the phenomena of noise including statistical indices, character, frequency analysis, vibration and air-blast over pressure are discussed in the detailed Noise Impact Assessment report found in **Appendix 9**.

9.1.1 ***Turbine Noise***

There are two main sources of noise emissions from wind turbines. The first is aerodynamic noise from the rotation of the blades. Noise is generated by the blades passing through the air and passing the tower creating a 'swishing' sound, with the noise primarily arising at the tip and back edge of the rotor blade. The noise level increases with increasing wind speed, and thus rotation speed, until the rotation of the wind turbine blades is controlled (e.g. by feathering the blades) at a fixed speed.

The second source of noise is mechanical noise from the operating components of the turbine located in the nacelle. Mechanical noise has virtually disappeared from modern wind turbines, due to improved engineering, with more concern about avoiding vibrations. Technical improvements include elastically dampened fastenings and couplings of the major components in the nacelle, and a certain amount of sound insulation. The basic components themselves, including gearboxes, have developed considerably, with modern wind turbine gearboxes using 'soft' gearwheels; that is, toothed wheels with hardened surfaces and relatively ductile root material.

The noise emitted from turbines is a function of the wind speed, with higher wind speeds producing higher turbine noise levels until the rotation is modulated. However, in a similar way, background noise levels also increase with increasing wind speed, with background noise generally increasing at a greater rate than turbine noise at high wind speeds (SA EPA 2003).

9.1.2 *Substation Noise*

Transformer substations form an integral part of the Project, converting the incoming low voltage power generated by each of the wind turbines to higher voltages suitable for export to the neighbouring electricity network. A 132 kV or 330 kV substation located within or close to the site will comprise both collector and switching substation components as discussed in detail in **Chapter 3** Project Description. The collector and switching substation would consist of up to two 150 MVA or 200 MVA transformers which would 'step up' the voltage from the wind turbines for connection into the existing 132 kV or 330 kV transmission lines. The transformers emit a characteristic 'hum' which has been assessed in the context of its potential proposed locations for the purposes of this Environmental Assessment.

9.1.3 *Transmission Lines*

Transmission lines are typically silent in operation and are not normally a source of noise complaint. A slight crackling noise may be heard close to a line during some climate conditions due to the corona effect, however these are considered negligible and temporary.

9.1.4 *Background Noise*

Background noise is a feature of the ambient acoustic environment and in rural areas it is generated primarily by wind action on vegetation. The level of background noise will vary with wind speed and over a site, depending on the surrounding topography, presence of vegetation and other sources of noise present in an agricultural environment. The ambient background noise of a site forms part of the noise assessment process of a wind farm.

9.1.5 *Construction and Decommissioning*

There will be some noise emissions from the construction and decommissioning of the Project, however such emissions will be localised and temporary. Sources of emissions during construction include vehicle traffic, cement batching and possibly rock crushing and compressors.

9.1.6 *Scope of SA EPA Guidelines*

The core objective of the SA EPA Guidelines is to balance the advantage of developing wind energy projects in South Australia (and adopting States) with protecting the amenity of the surrounding community from adverse noise impacts. The Guidelines were also developed to provide guidance for acceptable levels of noise generation from wind turbines on those residents that do not have an agreement with the Project developer; that is, neighbouring landowners which are not part of the wind farm development (i.e. a relevant receiver). However, this does not exempt developers from responsibilities regarding noise amenity for participating landowners who may be affected.

The Guidelines do not provide an assessment of the potential for low frequency noise or infrasound, but it does state that after an extensive literature search, the SA EPA is not aware of any infrasound being reported at modern wind farm sites (as opposed to sites containing earlier, downwind turbine models for which infrasound was a characteristic). It should be noted that this view is also contained within the more recent 2009 SA EPA guidelines.

The guidelines require that neighbouring dwellings are part of an acoustic assessment of turbine noise. Whilst nearby dwellings (i.e. those within around 1-2 km of a wind farm) may perceive some level of turbine noise at particular wind speeds and directions, careful wind farm design and appropriate mitigation measures can ensure noise levels do not exceed guideline criteria.

9.1.7 *SA EPA Noise Criteria (February 2003)*

The SA EPA Guidelines state that:

> *"The predicted equivalent noise level ($L_{Aeq,\ 10min}$), adjusted for tonality in accordance with these guidelines, should not exceed:*
>
> - *35 dB(A); or*
> - *the background noise level by more than 5 dBA; or*
> - *whichever is the greater, at all relevant receivers for each integer wind speed from cut-in to rated power of the WTG."*

The Guidelines explicitly state that the "swish" or modulation noise from wind turbines is a fundamental characteristic. However, it specifies that tonal or annoying characteristics of turbine noise should be penalised. If characteristics such as tonality are identified, the predicted noise level is penalised by the addition of 5 dBA.

9.1.8 *World Health Organisation Guidelines*

The SA EPA Guideline criteria have been developed to minimise the impact on the amenity of those not involved with the Project (i.e. wind farm neighbours). It is recognised however, that where financial agreements exist, developers cannot absolve themselves of the responsibility of ensuring that an adverse effect on an area's amenity does not occur as a result of the operation of the Project. In light of the aforementioned requirement, the Proponent has referred to the World Health Organisation (WHO) criteria (for protection of amenity and avoidance of sleep disturbance) as published in the document *Guidelines for Community Noise*.

The criterion for Project involved residences within this assessment recognises the changed attitudinal response to noise from the wind farm for those financially involved with the Project. Furthermore, the implications of wind turbine noise have been discussed with each of the involved landowners in relation to their property. Therefore the assessment of the adopted external criteria of 45 dBA or the level provided by the SA EPA Guideline criteria, where higher, will be adopted. Effectively this becomes 45 dBA or background plus 5 dBA, whichever is the higher.

9.1.9 *New South Wales Industrial Noise Policy*

The NSW Industrial Noise Policy (INP) requirements include site selection for background measurements, description of the site and equipment used, graphing of results and amenity noise criteria during each of three periods (Day, Evening and Night).

The proposed site for the Project is in a rural area and therefore the Amenity Criteria for rural residential receivers, as detailed in Table 2.1 in the NSW INP, is applicable.

The criteria vary as a function of time of day. The Day, Evening and Night Periods are defined as,

Day Period	7:00 am - 6:00 pm
	8:00 am - 6:00 pm (Sundays and Public Holidays)
Evening Period	6:00 pm - 10:00 pm
Night Period	10:00 pm - 7:00 am
	10:00 pm - 8:00 am (Sundays and Public Holidays)

The Amenity Criteria (L_{Aeq} level) for the residential noise sensitive locations for the Project are,

Day Period	50 dBA
Evening Period	45 dBA
Night Period	40 dBA

The Intrusiveness Criterion in the INP is based on the rating background level (RBL), where the Criterion is,

L_{Aeq}, 15 min ≤ RBL + 5 dBA

This is almost identical to the SA EPA Guidelines (**Section 9.1.7**), the difference being the measurement interval (15 and 10 minute) and the determination of the background noise level (rating level, based on the 10th percentile of measured background levels, or using a line of best fit through the data points).

The INP states where the measured RBL is less than 30 dBA, then the RBL is considered to be 30 dBA.

In summary, it is evident that the non Project related residential receivers assessed under the *SA EPA Noise Guidelines for Wind Farms* will generally comply with INP amenity criteria. Furthermore, intrusiveness is covered by the SA EPA Guidelines.

9.1.10 *Other Relevant Guidelines*

Other relevant guidelines that address noise impacts relevant to the Project include the *Interim Construction Noise Guideline* (DECCW, 2009), the DECCW *Assessing Vibration: A Technical Guideline*, the DECCW *Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration* and the *NSW Environmental Criteria for Road Traffic Noise (ECRTN, 1999)*, further information on these guidelines may be found in **Appendix 9**.

Further guidance on noise measurement and prediction is contained within Australian Standard AS4959-2010 Acoustics - Measurement, prediction and assessment of noise from wind turbine generators.

9.2 Methods

The Proponent commissioned SLR Consulting Australia Pty Ltd (SLR) to conduct an acoustic assessment of the Project, and the full report can be seen in **Appendix 9**. In general the assessment procedure contains the following steps:

1. Predict and plot the L_{Aeq} 35 dBA noise level contour from the Project under reference conditions. Receivers outside the contour are considered to be within acceptable wind farm noise levels.

2. Establish the pre-existing background noise level at each of the relevant assessment receivers within the L_{Aeq} 35 dBA noise level contour through background noise monitoring.

3. Predict wind farm noise levels at all relevant assessment receivers for the wind speed range from cut-in to approximately 10 m/s.

4. Assess the acceptability of wind farm noise at each relevant assessment receiver to the established limits.

9.2.1 *Turbine Noise*

The noise propagation model used to predict wind farm noise levels at sensitive receptors has been based on ISO 9613 as implemented in the SoundPLAN computer noise model. The model predicts noise levels through spherical spreading and includes the effect of air absorption (as per ISO 9613), ground attenuation and shielding.

The noise character of Wind Turbine Generator (WTG) noise emissions has also been assessed for any special audible characteristics, such as tonality or low frequency content, which would be deemed more annoying or offensive.

Final selection of a WTG supplier is yet to be undertaken, therefore WTG models, as displayed in **Table 9.2**, were selected for each layout to represent the noisiest and quietest WTG currently available in the market that would be suited to the Project site. All WTG are three bladed, upwind, pitch-regulated and active yaw.

Table 9.2: WTG Manufacturers Data

	Layout Option 1 (159 WTG)		**Layout Option 2 (125 WTG)**	
Model	Gamesa G87	Vestas V90	Vestas V112	Siemens SWT 2.3-101
Power (MW)	2.0	2.0	3.0	2.3
Rotor Diameter (m)	87	90	112	101
Hub Height (m)	100	100	94	101.5
Standard Mode Sound Power Level, $L_{WA, ref}$ (dBA)	106.4	103.7	106.5	107

*Note: For further detail on WTG's refer to **Appendix 9**.*

The predicted noise level contours from the Project under reference conditions, for both layouts with each WTG listed in **Table 9.2**, are presented in **Appendix 9**. The worst case predicted noise contour maps for Layout Option 1 (159 WTG) and Layout Option 2 (125 WTG) are presented below in **Figure 9.1** and **Figure 9.2**.

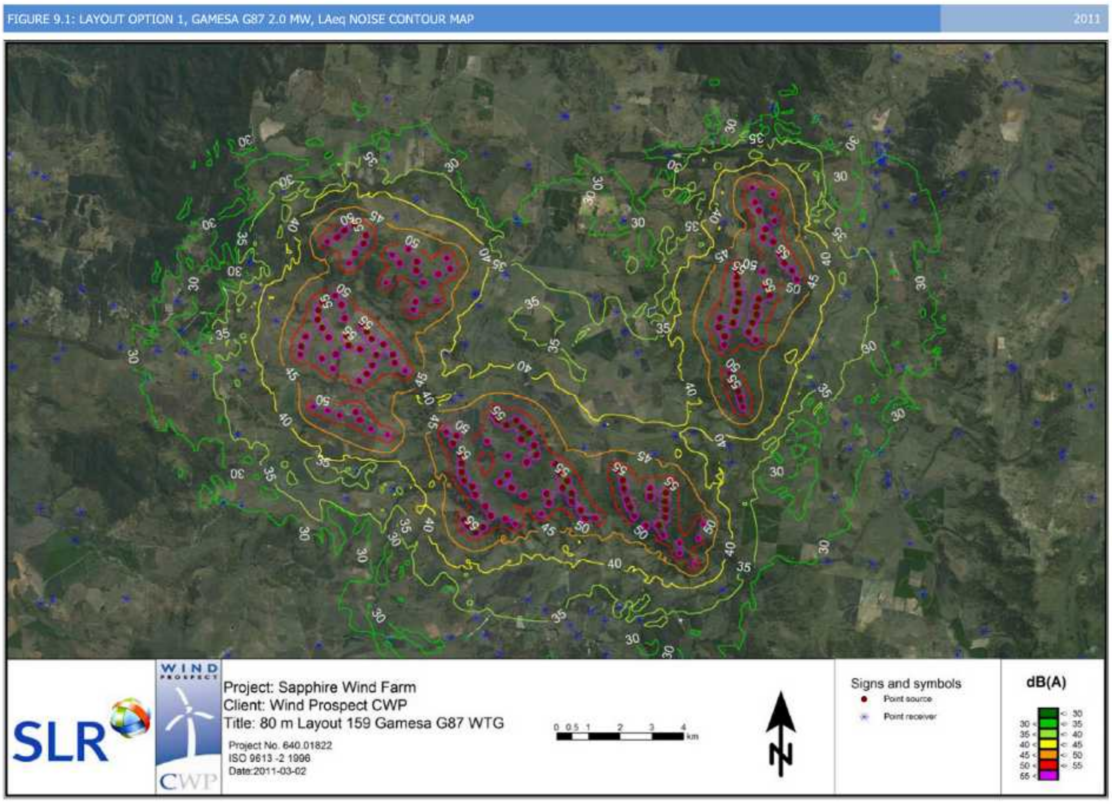

Figure 9.1 Layout Option 1, Gamesa G87 2.0 MW, L_{Aeq} Noise Contour Map

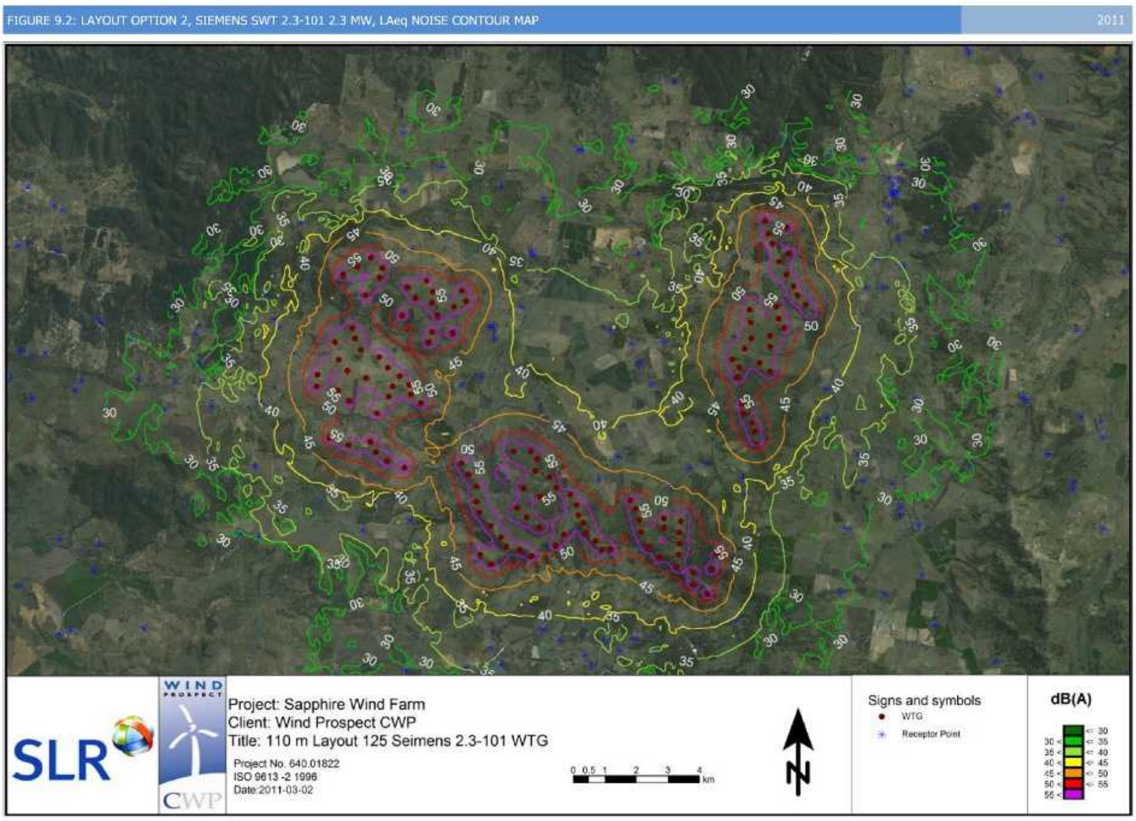

Figure 9.2 Layout Option 2, Siemens SWT 2.3-101 2.3 MW, L_{Aeq} Noise Contour Map

(A3 size versions of these Figures are displayed in Volume 2)

9.2.2 *Substation Noise*

A substation is required at the point of connection to the TransGrid-owned transmission infrastructure, the location of which has been chosen to minimise access distance and electrical losses, and to reduce its visibility from surrounding public viewpoints. For a description on the potential locations and types of substation, refer to **Chapter 3** Project Description.

Noise predictions for transformer substations have been made using CONCAWE algorithms assuming an absolute 'worst case' meteorology enhancement condition of downwind 3 m/s and Pasquill Stability Class F temperature inversion.

9.2.3 *Background Noise*

In order to establish the intrusive noise limit, background noise monitoring is required to establish the pre-existing ambient noise environment as a function of wind speed. As wind speed increases the ambient noise level at most receivers generally also increases as natural sources such as wind in trees, etc begin to dominate. The variation in background noise with wind speed is usually quite site specific and related to various physical characteristics such as topographic shielding and the extent and height of exposed vegetation.

Noise monitoring was completed for a period of approximately two weeks and correlated to synchronous wind speed and direction data at the Project monitoring mast. The captured data points were screened for validity, with data points monitored during periods of rain or where the average wind speed at the microphone position likely exceeded 5 m/s discarded from the data set. Other data points that were obviously affected by external noise sources (e.g. pond pumps, grass mowing, birds at dawn, etc) were also removed from the data set. A regression analysis of all valid data has been used to determine a line of 'best fit' from which the noise limit is established.

The local noise data was correlated to the wind speed at a reference 60 m wind monitoring mast on-site at heights of 45 m and 60 m above ground level (AGL). These values were then used to extrapolate the wind speed to the hub height of 100 m AGL using the wind profile power law. Local noise data was then correlated to the 100 m AGL extrapolated wind speed.

9.2.4 *Construction and Decommissioning Noise*

Construction: Computer noise models of typical construction scenarios were developed which included all anticipated mobile equipment for each activity operating simultaneously at full load. The four construction activities with the required equipment to complete the task included:

- Construction of access tracks with a vibrating roller;
- Establishment of WTG tower foundations and electrical substation with a rock crusher and concrete batch plant;
- Digging of trenches to accommodate underground power cables with an excavator; and
- Assembly and erection of WTG and towers with a crane.

To assess the possible worst case construction scenario for all nearby receivers, all four construction activities were modelled at each turbine location and the highest noise levels for each receiver predicted.

Blasting: Blasting may be required in some areas to clear large rock outcrops to prepare turbine foundations. The proposed wind farm site is a green field site where no previous blasting or blast monitoring has been conducted and therefore no specific site laws exist. Modelling has therefore adopted a site law derived from measurement data at a different site to give an indicative result.

Traffic Noise: Traffic generated by the Project during its construction phase has been evaluated in *Traffic and Transport Study: Proposed Sapphire Wind Farm* (March 2011) prepared by Bega Duo Designs (**Appendix 13**). Traffic generated by the Project during its operational phase will be insignificant.

Construction traffic for the Project will primarily utilise the Gwydir Highway with areas to the east accessed from Polhill Road and to the north from Kings Plains Road. Project areas to the west or centre of the Project are located along or accessed from Waterloo Road, the Eastern Feeder Road or the Western Feeder Road.

9.3 Existing Situation

The Project site incorporates up to 22 landowners, with a total of 26 dwellings existing within 2 km of the Project. All of these dwellings are inhabited, with 20 belonging to involved landowners (associated dwelling) and six to neighbouring landowners (non-associated dwelling). The nearest associated dwelling is 1 km and the nearest non-associated dwelling is 1.1 km from the nearest turbine.

The Gwydir Highway is sufficiently far away to the south of the Project site that background noise levels at most receptor locations will not be affected by road traffic noise. All properties surrounding the proposed site have an ambient background noise environment that is determined by predominantly natural sources which are largely wind influenced.

The prevailing wind directions are east and west. The district receives approximately 800 to 900 mm of rainfall annually.

9.4 Potential Impacts

9.4.1 *Impacts from Turbine Noise*

The assessment figures contained within the Noise Impact Assessment report, **Appendix 9,** depict the predicted WTG noise level curves and statistical results for each layout and WTG, as previously detailed in **Table 9.2**. **Table 9.3** below provides a summary with respect to exceedance levels on neighbouring dwellings. For further detail refer to **Appendix 9.**

Table 9.3: Predicted Noise Exceedance Levels on Neighbouring Dwellings

	Model	SA EPA Guideline	WHO Guidelines
Layout Option 1 (159 WTG)	Gamesa G87	None	None
	Vestas V90	1 marginal exceedance (<0.5 dBA)	None
Layout Option 2 (125 WTG)	Vestas V112	1 marginal exceedance (<0.5 dBA)	None
	Siemens SWT 2.3-101	1 marginal exceedance (<1 dBA) 1 medium exceedance (<3 dBA)	None

SLR's predicted noise levels at associated dwellings were well below the WHO Guidelines. For further detail refer to **Appendix 9.** Once the final turbine model has been selected, the noise assessment will be re-run to determine final noise modelling for the Project. Any remaining or additional exceedances will be resolved through landowner agreements, the reduction of turbine operational noise, micrositing turbine positions or by the removal of turbines, whichever is deemed the most appropriate solution to achieve compliance.

Predicted external noise levels will be further mitigated by shielding effects of the building and surrounding vegetation, with the anticipated internal noise levels similarly reduced by the façade of the dwelling itself. It should be noted that all predicted noise levels are considered to be conservative with the model assuming 'hard ground', average downwind propagation from all WTG's to each receiver and a well developed moderate ground based temperature inversion, a scenario which cannot be re-created in reality.

9.4.2 *Low Frequency Noise*

Low frequency noise is not clearly defined but is generally regarded to mean noise in the range of 10-200 Hz. Noise occurring at frequencies below 20 Hz is often referred to as infrasound (**Appendix 10**). The range of human hearing is 20-20,000 Hz, with 1 dB being the smallest change in noise that humans can detect. Low frequency noise is almost always present in an ambient quiet background, produced, for example, by machinery, transport, structure-borne noise and natural sources such as wind, waves and thunder.

Older models of downwind turbines have had associated problems with low frequency noise and infrasound, however this has been taken into consideration by the wind industry and large modern turbines use a well balanced upwind design which does not pose the same issues. Research has been carried out on both audible and inaudible noise from modern wind turbines in the UK, USA and Europe. Studies in Germany found that modern wind turbines emit sound at extremely low levels in the infrasound range (less than 20 Hz) which is far below the human detection threshold and far below levels which can cause any adverse human impacts (Klug 2002, in **Appendix 10**). Further, a recent study compared levels of infrasound emitted from two Australian wind farms with those emitted by waves on an Australian beach and with the Central Business District (CBD) of an Australian city. Results found that infrasound emissions from the wind farms were lower than, or on par with those found at the beach or within the CBD of Adelaide (Sonus, 2010).

The main impact of low frequency noise to humans is that of annoyance. Research to date has not shown any health effects at the levels normally associated with operational wind turbines. Furthermore, other research conducted into low frequency noise from modern wind turbines has shown that the levels of low frequency noise is below accepted thresholds and is therefore not considered to be a problem (British Wind Energy Association 2005).

9.4.3 *Temperature Inversions*

Temperature inversion is an atmospheric condition in which temperature increases with height above ground. Such conditions may increase noise levels by focussing sound wave propagation paths at a single point. Temperature inversions occurring within the lowest 50 m to 100 m of the atmosphere can affect noise levels measured on the ground. Temperature inversions are most commonly caused by radiative cooling of the ground at night leading to cooling of the air in contact with the ground. Such conditions are especially prevalent on cloudless nights with little wind.

Conventional approaches to assessing noise propagation under temperature inversion conditions require knowledge of the temperature gradient and assume that the noise source is located below the temperature inversion, typically near to the ground. The effect of temperature inversions on noise propagation from WTG’s is therefore not typical of other sources.

WTG’s for the Project are located on top of elevated ridges. The hub height (assumed acoustic centre of the WTG) is located typically on average 150 m higher than receiver locations in the surrounding area (not to be confused with the proposed maximum hub height of 100 m). It is therefore unlikely that conventional temperature inversion conditions, in the lowest 100 m of the atmosphere, would affect noise propagation from such an elevated source.

A further consideration must be that temperature inversions require little to no wind in order to minimise atmospheric mixing and hence develop. During calm conditions the WTG’s are unlikely to operate, as cut-in speed is at least 3 m/s to begin generating.

9.4.4 *Atmospheric Stability and Wind Profile Impacts*

The wind velocity at a location can be represented by a vertical profile (gradient) that generally is at a minimum at ground level and increases with altitude. The wind velocity profile is primarily determined by physical factors such as surface roughness and topographic (relief) effects, which are reasonably constant over time. However the profile can also be affected by more variable local atmospheric conditions including atmospheric stability and turbulence.

Atmospheric stability is determined by the total heat flux to the ground, primarily being the sum of incoming solar and outgoing thermal radiation and heat exchanged with the air. During clear summer days (incoming radiation dominates) air is heated from below and rises, causing significant thermal mixing, vertical air movements and turbulence. This process limits large variations in the vertical wind velocity profile.

During clear nights when outgoing radiation dominates, air is cooled from below, air density is greatest closer to the ground and minimal thermal mixing occurs. This leads to a stable atmosphere where horizontal layers of air are largely decoupled and allows for a higher wind velocity gradient.

The noise assessment methodology outlined in the SA EPA Guidelines, as with many other similar wind farm noise assessment methodologies, by necessity rely on independently verified reference sound power data available for specific wind turbines measured at a manufacturer's test site. The measurement procedure has been standardised (IEC 61400-11) to require sound power data to be measured coincidentally with reference wind speed measurements at an altitude of 10 m.

For this assessment the SA EPA Guideline methodology has been adapted to the alternative reference wind speed at a height of 100 m AGL which is more representative of hub height wind speed. Accordingly the turbine sound power level data has been amended to the appropriate 100 m AGL wind speed. This approach goes some way to alleviating the variability that changing wind profiles have with respect to a 10 m reference height.

While the proposed layouts meet the requirements of the SA EPA Guidelines in all but two locations, some uncertainty remains as to the likely noise conditions that will result under specific atmospheric conditions over time. The SA EPA Guidelines noise limits are generally set within the requirements of the WHO Guidelines that relate to health impacts, and it is highly unlikely that the remaining uncertainty could lead to such impacts. However, it is possible that under certain conditions the amenity of existing dwellings could be reduced notwithstanding compliance with SA EPA Guidelines. These conditions are likely to be variable and intermittent, and therefore not result in a long term loss in amenity.

9.4.5 ***Substation Noise Impacts***

Under the NSW Industrial Noise Policy, the current assessment of predicted noise levels from substation locations shows one of the three potential 330 kV substation locations will have acceptable noise limits, while both potential 132 kV substation locations will have acceptable noise limits, as detailed in **Appendix 9**.

It is considered that the potential substation locations that exceed minimum noise limits are still viable locations as post-consent mitigation measures will be implemented to ensure compliance. A transformer with a lower sound power level would reduce the predicted noise level to acceptable levels. Other noise attenuation mitigation measures could also be incorporated into the design of the substation, Post Approval to lessen the predicted noise impact. The actual mitigation measures required will depend on which of the 330 kV or 132 kV substation locations is selected and the type of transformer(s) used.

9.4.6 ***Transmission Lines***

Operational noise associated with the proposed transmission line is expected to be negligible as transmission lines are typically silent in operation and are not normally a source of noise complaint. There would be a small number of vehicular movements and occasional helicopter patrols during inspections and routine maintenance along the easement. These practices are generally considered acceptable across other transmission lines. In the unlikely event that complaints are received in relation to noise generation from maintenance activity, appropriate action would be taken by the Proponent to reduce any excessive noise impact.

9.4.7 *Impacts from Construction and Decommissioning*

Construction: The predicted 'worst case' construction noise impacts are, for most receiver locations, below the existing typical daytime rating background level.

Some nearby receivers may receive elevated construction noise levels when turbine foundation civil works are located nearby and should the operation of a rock crusher be necessary, however, due to the anticipated short period of localised works this would be considered satisfactory. Operation of the rock-crusher is dependent upon the geotechnical conditions of the foundation site and would be operated intermittently at most. Consideration of mitigation measures such as localised shrouding may be needed if adverse conditions are experienced if and when operating the rock crusher at the most exposed positions.

In consideration that the predicted levels represent 'worst case' construction scenarios and are within limits which would be considered acceptable, it is unlikely that general construction noise will cause any unnecessary impact.

Concrete Batching Plants: In most cases concrete batch plant noise will be below ambient background noise levels and likely be inaudible. Three receptor locations (associated dwellings) are anticipated to be greater than 10 dBA above the daytime RBL and classified as 'noise affected'. No locations are anticipated to be 'highly noise affected'.

Blasting: The closest anticipated distance between blasting and residences would be approximately 1,007 m. With a maximum instantaneous charge (MIC) of up to 90 kilograms (kg), the airblast overpressure is modelled to be below the acceptable level of 115 dB Linear for all existing residences. The anticipated blasting is likely to meet all human comfort limits and building damage assessment criteria. All other sources of vibration would be less than those above.

Traffic Noise: The projected increase in road traffic noise levels on all local roads are anticipated to meet the NSW Roads and Traffic Authority (RTA) *Environmental Criteria for Road Traffic Noise (ECRTN) 1999* target for a local road at daytime at modest setback distances. Being a rural farming community, most receptors are at much greater setback distances from their road frontage and therefore will easily meet the ECRTN requirement.

There could potentially be deliveries of equipment scheduled for out of hours, necessitated by traffic congestion considerations and safe passage of heavy vehicle convoys or especially long loads. Night-time traffic has the potential to cause sleep disturbance to residential receivers along the route. This potentially affects receivers situated closer to the road.

Preliminary calculations indicate that maximum noise levels at a residence approximately 10 m from the road as a result of a heavy vehicle passing-by would be in the range 45 to 80 dBA. Night-time background noise levels along affected routes could be below 30 dBA and as such maximum noise levels from pass-bys may have the potential for sleep disturbance. However, the Gywdir Highway is already a major route and carries significant heavy vehicles so it is unlikely Project related night-time traffic would be of any greater impact than vehicles already using the route. Mitigation measures will be implemented to deal with increased traffic noise within the Project site on quieter rural roads away from the Gwydir Highway.

9.4.8 *Cumulative Impacts*

An assessment of cumulative environmental impacts considers the potential impact of a proposal in the context of existing developments and future developments to ensure that any potential environmental impacts are not considered in isolation. A development would need to be located within approximately 2 to 3 km of the proposed wind farm in order to present a possible cumulative influence on noise. The Project area is classified as rural and residences are dispersed across the landscape. The main sources of current noise levels are from farming activities and large trucks on the roads moving stock and timber. There are two proposed wind farms in the region, White Rock Wind Farm and Ben Lomond Wind Farm, and one consented wind farm, Glen Innes Wind Farm. All developments are outside a 3 km radius and so would not interact with the Project to produce a further cumulative noise effect.

9.5 Management and Mitigation

9.5.1 *Turbine Noise*

After final turbine selection and Project refinement, additional noise modelling will be carried out, pre-construction, to ensure that the predicted noise levels are within required criteria based on the chosen WTG.

If, during operation, it is found that WTG noise impacts are non-compliant with stated criteria used for the assessment due to temperature inversion, atmospheric stability or other reasons, then an ‘adaptive management’ approach can be implemented to mitigate or remove the impact. This process could include:

- Investigating the nature of the reported impact;
- Identifying exactly what conditions or times lead to undue impacts;
- Consideration of operating WTG’s in a reduced ‘noise optimised’ mode during offending wind directions and at night-time (sector management);
- Turning off WTG’s that are identified as causing the undue impact; and
- Providing acoustic upgrades (glazing, façade, masking noise etc) to affected dwellings.

9.5.2 *Substation Noise*

If the preferred substation location is non-compliant with NSW Industrial Noise Policy the following mitigation measures would be applied as appropriate:

- The use of transformer(s) with a lower sound power level output;
- Landscaping, including raised embankments and vegetation, around the substation; and
- Providing acoustic upgrades (glazing, façade, masking noise etc) to affected dwellings.

9.5.3 *Construction and Decommissioning*

Noise emissions from construction, major maintenance or decommissioning/refurbishment work can be minimised by continued adequate maintenance of construction vehicles, and by ensuring work activities occur within recommended working hours, according to the SA EPA, where practicable (i.e. 7.00 am to 6.00 pm, Monday to Saturday and 9.00 am to 6.00 pm Sundays). Any proposed work outside of these hours will entail close consultation with the affected community. Also, any noise emissions from construction activity will be localised and temporary.

To minimise potential noise impacts associated with night-time deliveries, there will be prior notification to the affected public and restricted use of exhaust/engine brakes in built up areas.

9.6 Summary

Wind turbine noise has been predicted and assessed against relevant criteria prescribed by the SA EPA Guideline and WHO guidelines where appropriate.

Layout Option 1 (159 WTG), equipped with either Gamesa G87 or Vestas V90 WTG was predicted to comply with all relevant noise criteria, SA EPA Guideline and WHO guidelines at all neighbouring dwellings except for one marginal exceedance with the Vestas V90.

Layout Option 2 (125 WTG), equipped with either Vestas V112 or Siemens SWT 2.3-101 WTG was predicted to comply with all relevant noise criteria, SA EPA Guideline and WHO guidelines at all neighbouring dwellings except for one marginal exceedance for both WTG models and one medium exceedance for SWT 2.3-101.

Once the final turbine model has been selected, the noise assessment will be re-run to determine final noise modelling for the Project. Any exceedances will be resolved through landowner agreements, reducing turbine operational noise, micrositing turbine positions or by the removal of turbines, whichever is deemed the most appropriate course of action.

Construction noise impact has been assessed and the 'worst case' scenarios modelled were found to be generally acceptable given the temporary and limited duration. Blasting impact has been assessed and found to be acceptable. Similarly, vibration levels are anticipated to be well within the acceptable criteria.

Construction traffic noise impact has been assessed and the 'worst case' maximum construction traffic generated scenario would increase existing traffic noise levels along local roads by up to 4 to 7 dBA but due to the typically large setback of dwellings from the road network would result in a noise level that would be considered acceptable under the ECRTN.

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CHAPTER 10

Flora and Fauna Assessment

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10. FLORA AND FAUNA ASSESSMENT

Eco Logical Australia Pty Ltd (ELA) was commissioned to undertake an ecological assessment of the area proposed to be affected by the Project. The full report is available in **Appendix 11.**

This chapter draws from that report and summarises aspects of the methods used to capture data and the nature of the existing ecological features of the Project site. More pertinently an assessment of potential impacts, proposed avoidance, mitigation and management measures and an offset strategy with respect to those impacts are also summarised.

10.1 Legislative Framework

10.1.1 *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*

A Referral under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) was submitted to the Department of Sustainability, Environment, Water, Population and Communities (DSEWPAC) in February 2011 addressing the likely impacts of the Project on matters of National Significance, and in particular on the Box-Gum Woodland (BGW) within the Project Site, listed as Critically Endangered under the EPBC Act. Discussions were undertaken between the Proponent and DSEWPAC and subsequent re-design work undertaken with the view to minimise impacts on BGW wherever practicable. The Project was designated a Controlled Action under the *EPBC Act* on the 31st March 2011 due to the residual level of impact which would result from the construction of the wind farm.

Consequently, Department of Planning and Infrastructure (DoPI) has requested that the assessment for the Project under Part 3A is subject to a one-off accredited assessment process and agreed that the assessment would be subject to the general administrative steps outlined in the New South Wales (NSW) Assessment Bilateral administrative procedure. Subsequently, DSEWPAC have provided the Proponent with supplementary Director-General's Requirements (DGR's) on the 13th May 2011, which apply to the accredited assessment process.

EPBC Act Significance Assessments have been conducted for those Matters of National Environmental Significance (NES) considered to have the potential to occur within the study area. The supplementary DGR's listed additional threatened species requiring EPBC Significance Assessments, which ELA conducted and are included in **Appendix 4**. Some of these species are unlikely to be present within the study area, nevertheless, assessments have been conducted and justification provided for their absence. All impacts on other threatened flora species have been avoided through modifications to the Project layout where possible.

All matters relating to threatened species and communities are addressed in this chapter and **Appendix 11**. The full list of DGR's can be found in **Appendix 4** and **Table 5.2** in **Chapter 5** Planning Context to provide ease of reference and to demonstrate compliance with the supplementary DGR's.

10.1.2 *NSW Legislation*

The Project is also assessed under the following NSW environmental acts and plans:

- *Environmental Planning and Assessment Act 1979* (EP&A Act);

- *Threatened Species Conservation Act 1995;*
- *Fisheries Management Act 1994;*
- *Noxious Weeds Act 1993;*
- *State Environmental Planning Policy 44 (Koala Habitat);*
- *Glen Innes Severn and Inverell Shire Council's Local Environmental Plans (LEP's); and*
- *Glen Innes Severn and Inverell Shire Council's Development Control Plans (DCP's);*

10.2 Methods

To determine the nature of the existing environment and any potential impacts, ELA conducted a literature review, site reconnaissance, vegetation mapping, flora and fauna surveys and Biobanking surveys of the study area.

10.2.1 *Literature Review*

A review of all readily available literature, database records, imagery and maps pertaining to the ecology of the study area and surrounding locality provided important background information which formed the basis of future assessment work. A full reference list is available in **Appendix 11**.

10.2.2 *Site Reconnaissance*

Site reconnaissance was undertaken on 27th to 30th October 2008 prior to the detailed field surveys, to verify site access, broad vegetation types and condition, fauna habitat present on-site and to select locations for the detailed surveys. This information was then used in conjunction with the DGR's and Biobanking "species requiring survey" to determine the requirements for the detailed surveys.

10.2.3 *Vegetation Mapping*

Vegetation mapping occurred across two survey periods, December 2008 and September 2010. Vegetation boundaries were mapped using a number of tools including, aerial photographs, maps, ground-truthing, visual observations and predictions.

10.2.4 *Flora and Fauna Surveys*

Detailed flora and fauna surveys were undertaken across the study area from October 2008 to January 2011. Surveys were undertaken in accordance with Department of Environment and Conservation (DEC) *Threatened Biodiversity Survey and Assessment Guidelines Working draft* (DEC 2004), the original and supplementary DGR's (including Matters of National Environmental Significance (NES)) and "species requiring survey" as determined by the Biobanking Credit Calculator. Surveys began as full systematic surveys in Spring/Summer 2008, before Biobanking surveys were adopted from February 2009 so that Biobanking could be used to inform quantum of offsets. Survey periods were designed to target species when most detectable, active or in flower, as described in **Appendix 11**.

10.2.5 *Biobanking*

The Biobanking Assessment was undertaken in accordance with the Biobanking Assessment Methodology and Credit Calculator Operational Manual (NSW DECC 2009). The Biobanking Credit

Calculator required targeted surveys for six threatened flora and eight threatened fauna species, with an additional flora species added after it was recorded within the study area by ELA. Surveys were undertaken for nine of the species listed on the basis that potential habitat was present on-site.

10.3 Existing Situation

10.3.1 *Vegetation Types*

Six Border Rivers – Gwydir Catchment Management Authority (CMA) Revised Biometric Vegetation Types are present across the Project site and surrounding locality, as displayed in **Figure 10.1** including:

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

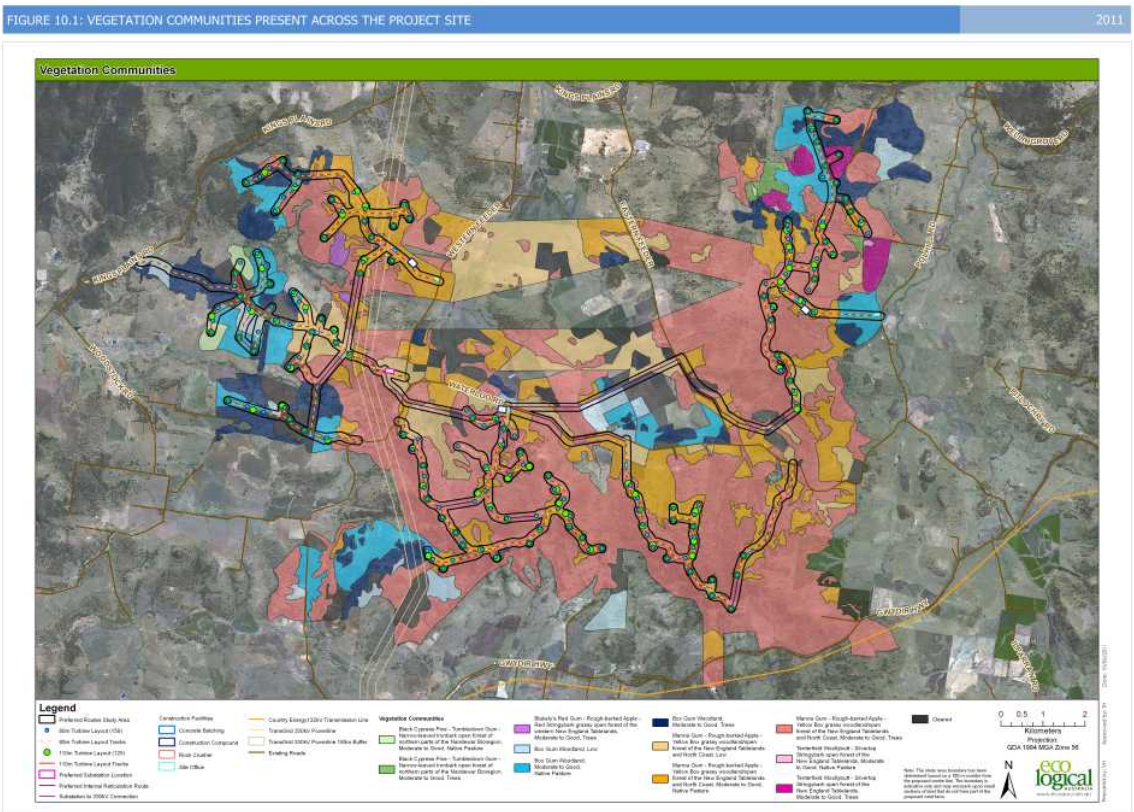

Figure 10.1 Vegetation communities present across the Project site
(An A3 size version of this Figure is displayed in Volume 2)

BR116 and BR240 (both BGW equivalent) are listed as an Endangered Ecological Community (EEC) under the New South Wales *Threatened Species Conservation Act 1995* (TSC Act) and as a Critically Endangered Ecological Community (CEEC) under the EPBC Act. BR153 (Ribbon Gum, Mountain Gum, Snow Gum Grassy Forest/ Woodland of the New England Tablelands Bioregion equivalent) is also listed as an EEC under the *TSC* Act. These three vegetation types are considered to have been cleared significantly within the Border Rivers-Gwydir CMA.

As a general rule, condition of vegetation types across the Project site will vary according to the presence or absence of grazing, period of spelling, and rainfall. Given the study area is used mainly for agricultural purposes these vegetation types are impacted by weed invasion, grazing intensity and soil disturbance to varying degrees, depending on the land use practices implemented on each property.

The densest vegetation areas were found on the steepest slopes with the project area, away from proposed wind farm infrastructure, with spurs and gentle slopes supporting lightly wooded areas. Grasslands occur over a majority of the project area, within which the majority of the project infrastructure has been sited. Further description of the vegetation types and dominant species can be found in **Appendix 11**.

10.3.2 ***Flora***

The study area possesses 394 species of vascular plants, with 278 native and 116 exotic species. Potential habitat exists for ten threatened species (**Appendix 11**), however only four were recorded across the Project site. Only one Rare or Threatened Australian Plant (RoTAP) was found. There was no regionally significant species listed by either Glen Innes Severn or Inverell Shire Councils, as both rely on the NPWS databases for their vegetation information. **Table 10.1** below provides a brief overview of flora species in the area, with full details presented in **Appendix 11**.

Table 10.1 Flora present within the study area

Category	Species
Common General flora	*Eucalyptus dealbata* (Tumbledown Gum), *E. crebra* (Narrow-leaved Ironbark), *E. blakelyi* (Blakey's Red Gum), *E. macrorhyncha* (Red Stringybark), *E. melliodora* (Yellow Box), *E. viminalis* (Ribbon/Manna Gum), *E. banksii* (Tenterfield Woollybutt), *E. subtilior, E. crebra*, *E. albens* (White Box), *Callitris endlicheri* (Black Cypress Pine), *Angophora floribunda* (Rough-barked Apple), *Aristida ramose* (Pruple Wiregrass), *Asperula conferta* (Common Woodruff), *Bothriochloa macra* (Red Grass), *Carex* inversa (Knob Sedge), *Cymbopogon refractus* (Barbed Wire Grass), Poa *sieberiana* (Snow Grass), *Calotis cuneata* (Mountain Burr-Daisy), *Desmodium varians* (Slender Tick-trefoil), *Geranium solanderi* (Native Geranium), *Themeda australis* (Kangaroo Grass) and *Wahlenbergia communis* (Tufted Bluebell).
Threatened flora	*Bothriochloa biloba* (Lobed Bluegrass), *Dichanthium setosum* (Bluegrass), *Eucalyptus mckieana* (McKie's Stringybark) and *Thesium australe* (Austral Toadflax).

Category	Species
Rare or Threatened Australian Plant flora	*Bothriochloa biloba* (Lobed Bluegrass)

Note: Not all species have a 'common name'.

Exotic Species: Four weed species listed as noxious weeds (NW) under the NSW *Noxious Weeds Act 1993* for the Glen Innes Severn and Inverell Shire LGA's were recorded within the study area and one of those species was also listed as a Weed of National Significance (WoNS).

Weeds accounted for approximately 29 % of all species recorded across the study area and often occurred in localised patches in paddocks where clearing or spraying had been undertaken. Exotic species common throughout the study area, NW and WoNS are provided in **Table 10.2**.

Table 10.2 Exotic species present within the study area

Category	Species
Common exotic species	*Bidens pilosa* (Cobbler's Pegs), *Bromus spp.*, *Centaurea solstitialis* (St Barnaby's Thistle), *Carthamus ianatus* (Saffron Thistle), *Chloris truncata* (Windmill Grass), *Cirsium vulgare* (Scotch Thistle), *Conyza bonariensis* (Flax-leaf Fleabane), *Cyclospermum leptophyllum* (Slendery Celery), *Hypochaeris radicata* (Cat's-ear), *Lolium spp.*, *Medicago spp., Paronychia brasiliana* (Chilean Whitlow Wort), *Paspalum dilatatum* (Paspalum), *Petrorhagia nanteuilii, Rosa rubiginosa* (Sweet Briar) and *Trifolium spp.*.
Noxious Weeds	*Xanthium occidentale/X. spinosum/X. spp.* (Bathurst/Noogoora/Hunter/ South American/Californian/Cockle Burr), *Rubus fruticosus* [aggregate species] (Blackberry), *Hypericum perforatum* (St. John's Wort) and *Rosa rubiginosa* (Sweet briar).
Weed of National Significance	*Rubus fruticosus* [aggregate species] (Blackberry)

Note: Not all species have a 'common name'.

10.3.3 *Fauna Habitat*

The Project site supports a diversity of habitat types including open forest, woodland, grassland, farm dams, creeks, rocky outcrops and hollow-bearing trees which provide habitat for birds, bats, mammals, frogs and reptiles, including some threatened species (see below). A summary of key habitats present is discussed in **Appendix 11**.

10.3.4 *Fauna Groups*

135 fauna species (122 native, 13 introduced) were recorded across the study area (see **Appendix 11** for full list):

- 83 bird species (including 2 introduced);
- 7 reptile species;
- 4 frog species;
- 19 terrestrial/arboreal mammal species (including 11 introduced); and
- 22 microbat species.

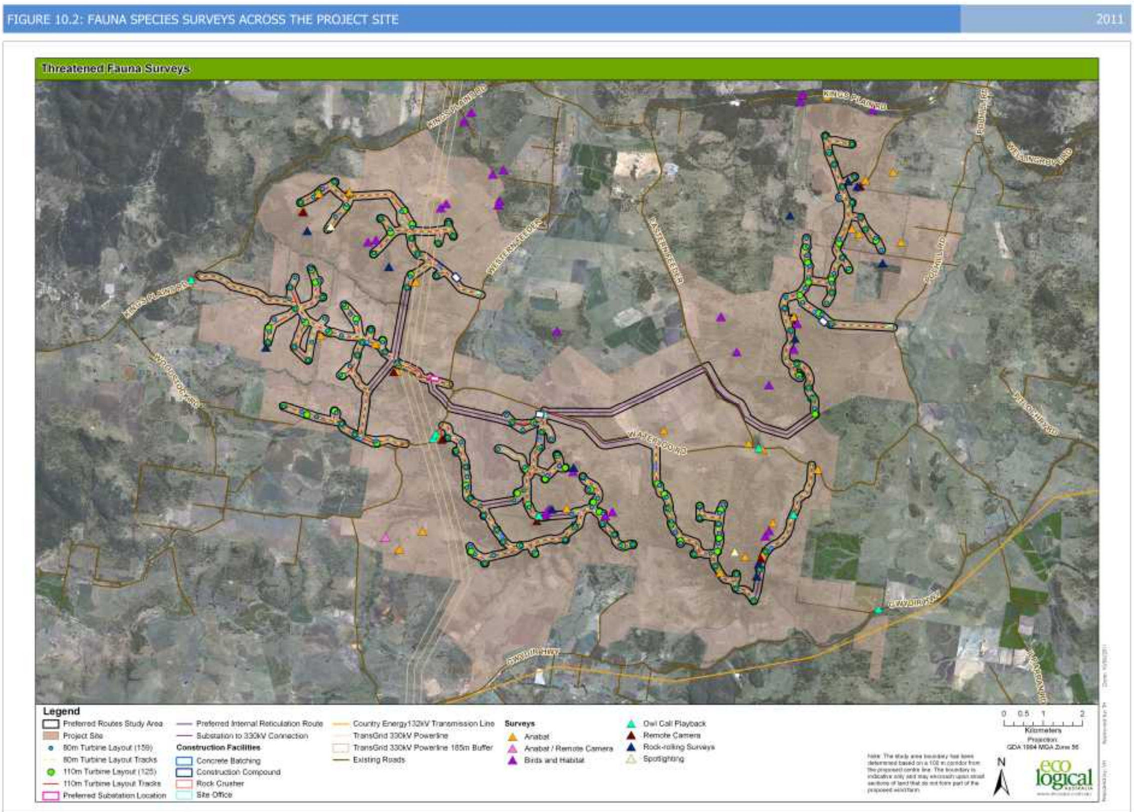

Figure 10.2 Fauna species surveys across the Project site
(An A3 size version of this Figure is displayed in Volume 2)

From these groups, a variety of threatened species have also been previously recorded within the locality. Those species previously recorded (Department of Environment, Climate Change and Water (DECCW) 2011a; Birds Australia 2009) or considered to have the potential to occur (DSWEPAC 2011) are listed in **Appendix 11** together with their conservation status and an assessment of the likelihood of occurrence. **Figure 10.2** provides the locations of each fauna survey and **Figure 10.3** provides the recorded threatened species found across the Project site.

Avifauna: A total of 83 (81 native) bird species, with seven of these species been threatened, were recorded within the Project site during surveys. The vegetation types on-site support foraging, nesting and roosting habitat with numerous hollow-bearing trees and an abundance of native flora providing extensive resources throughout all seasons. **Table 10.3** provides an overview to the species surveyed on-site. Details on the occurrence of threatened bird species are discussed in **Appendix 11** and shown in **Figure 10.3**.

Table 10.3 Avifauna species present within the study area

Category	Species
Common bird species	Noisy Miner (*Manorina melanocephala*), Musk Lorikeet (*Glossopsitta concinna*), Crimson Rosella (*Platycercus elegans*), Australia Magpie (*Gymnorhina tibicen*), Eastern Rosella (*Platycercus adscitus eximius*), Red Wattlebird (*Anthochaera carunculata*), Sulphur-crested Cockatoo (*Cacatua galerita*), Sacred Kingfisher (*Todiramphus sanctus*) and Spotted Pardalote (*Pardalotus punctatus*).

Category	Species
Nocturnal bird species	White-throated Nightjar *(Eurostopodus mystacalis)* and Tawny Frogmouth (*Podargus strigoides*).
Birds of prey	Nankeen Kestrel (*Falco cenchroides*), Wedge-tailed Eagle (*Aquila audax*), Black-shouldered Kite (*Elanus axillaris*), Brown Goshawk (*Accipiter fasiatus*) and Whistling Kite (*Haliastur sphenurus*).
Threatened bird species	Brown Treecreeper (*Climacteris picumnus victoriae*), Diamond Firetail (*Stagonopleura guttata*), Hooded Robin (*Melanodryas cucullata*), Little Lorikeet (*Glossopsitta pusilla*), Scarlet Robin (*Petroica boodang*), Speckled Warbler (*Pyrrholaemus saggitatus*) and Turquoise Parrot (*Neophema pulchella*).

Note: Not all species have a 'common name'.

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

The habitat on-site also has the potential to accommodate other threatened species, including the Regent Honeyeater (*Anthochaera phrygia*), which was last recorded north east of the study area in 1994 (DECCW 2011a). However, recent survey efforts did not record the species on-site.

For a full description of avifauna, refer to **Appendix 11**.

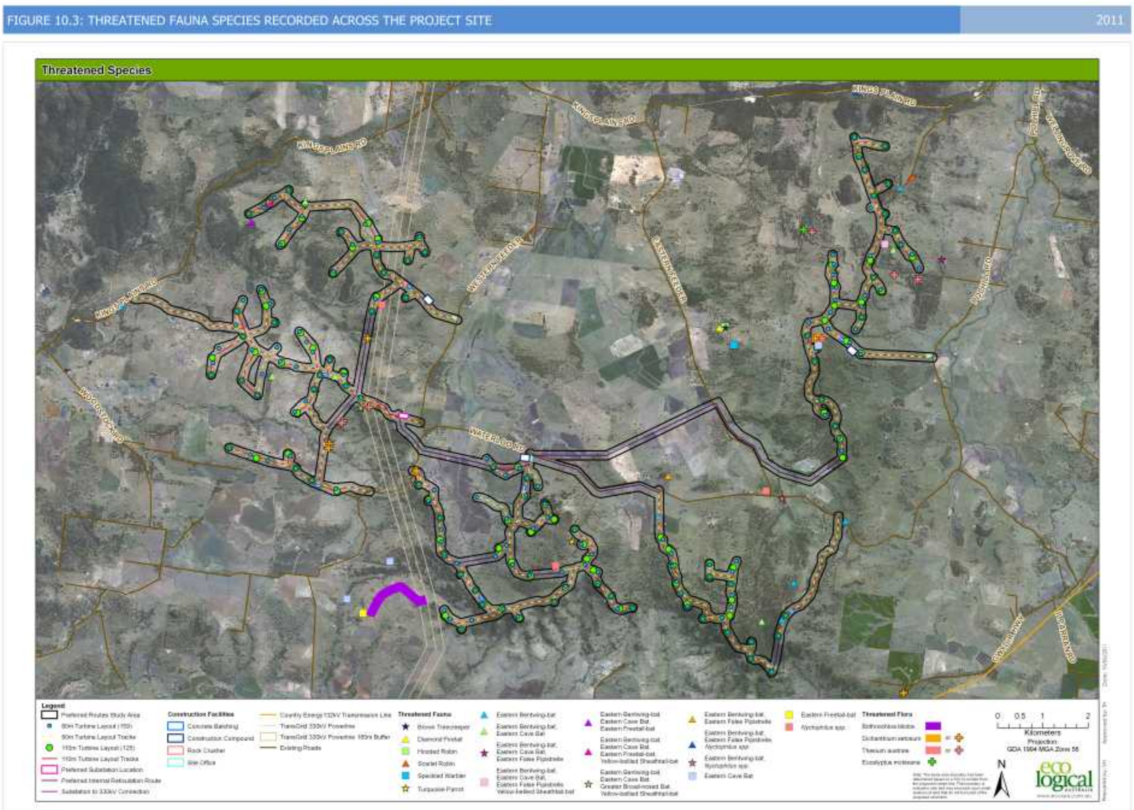

Figure 10.3 Threatened fauna species recorded across the Project site

(A3 size versions of these Figures are displayed in Volume 2)

Ground-dwelling and Arboreal Mammals: The Project site has limited habitat for ground-dwelling mammals due to grazing and limited shrub layer, although areas with tussock grasses and fallen timber provide suitable habitat for species such as the Eastern Grey Kangaroo (*Macropus robustus*) the Common Wallaroo (*Macropus robustus*) and the Red-necked Wallaby (*Macropus rufogriseus*) which were recorded within the study area.

Trees on-site provide habitat for arboreal mammals. Three threatened arboreal mammals have been historically recorded within 10 km of the Project, including the Koala (*Phascolarctos cinereus*), Spotted-tailed Quoll (*Dasyurus maculatus*) and Squirrel Glider (*Petaurus norfolcensis*) (DECCW 2011a), however none were recorded on-site during recent surveys. Koalas and Squirrel Gliders are assumed to be in the study area given the number of previous records in the locality, the presence of potential Koala feed trees and extensive Glider habitat across the project area. Targeted surveys did not identify any Spotted-tailed Quolls; with only one historical record within the locality there is some potential for this species to use the study area.

Bats: Of the 22 species of bats recorded on-site, six threatened species were identified. The hollow-bearing trees and vegetation types across the Project area provide potential roosting habitat and potential for abundant foraging for both common and the majority of threatened bat species recorded on-site (except the Eastern Bent-wing Bat and Eastern Cave Bat). No caves exist within the study area within which the Eastern Bent-wing Bat and Eastern Cave Bat would roost.

Previous to ELA survey efforts, there were no recorded threatened bat species known within the Project area (DSEWPAC 2011). **Table 10.4** lists the common and threatened species recorded on-site. For a full list refer to **Appendix 11**.

Table 10.4 Bat species present within the study area

Category	Species
Common bat species	Choloclate Wattled Bat (*Chalinolobus morio*), Gould's Wattled Bat (*Chalinolobus gouldii*), *Vespadelus spp.* and Common Bentwing-Bat (*Miniopterus schreibersii*),
Threatened bat species	Eastern False Pipistrelle (*Falsistrellus tasmaniensis*), Eastern Bentwing-bat (*Miniopterus schreibersii oceansis*), Eastern Freetail-bat (*Mormopterus norfolkensis*), Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*), Greater Broad-nosed Bat (*Scoteanax rueppellii*) and Eastern Cave Bat (*Vespadelus troughtoni*).

Note: Not all species have a 'common name'.

Amphibians: Habitat is limited across the site with ephemeral drainage lines, a small number of creeks (Kings Plains Creek and Wellingrove Creek (east of the study area boundary)) and farm dams providing potential habitat for amphibians across the study area. Only four species were identified during surveys, none of which were threatened species.

The EPBC Act listed Booroolong Frog (*Litoria booroolongensis*) had the potential to occur on-site (DSEWPAC 2011, Biobanking), however due to the lack of suitable habitat and historical data for the species no targeted surveys were undertaken by ELA. Instead an expert report was prepared assessing the likelihood of the species occurring within the Project Site, which is included in **Appendix 11**.

Reptiles: Habitat for reptiles includes woodland, grassland, drainage lines and scattered rocky outcrops with a limited amount of woody debris and leaf litter present across the site.

Three threatened species, as listed in **Appendix 11**, were listed as having the potential to occur within the study area (DECCW 2011a, DSEWPAC 2011), however ELA determined that there was only potential habitat present for the Border Thick-tailed Gecko (*Underwoodisaurus sphyrurus*), should it be present on-site. None were recorded during the site surveys.

Migratory Fauna: Twelve migratory species were identified from the EPBC Act Protected Matter Search Tool (DSEWPAC 2011), as listed in **Appendix 11**. No species were recorded during the surveys.

10.4 Potential Impacts

10.4.1 *Construction*

Vegetation Clearance: Although the Project 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 (**Figure 10.1**). The Project is comprised of 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 detailed in **Chapter 3** Project Description, two road layout options are being investigated in order to reduce the likely vegetation clearance required for the Project:

- Roads requiring a 12 m wide clearance area which will undergo revegetation back to 6 m following construction; and
- Roads requiring a 6 m wide clearance area with intermittent passing bays 12 m wide.

Both road layouts have been designed according to civil engineering requirements and with respect to minimising all unavoidable native vegetation clearance, particularly in areas containing threatened ecological communities or species. All remaining impacts have been quantified through the use of the Biobanking credit calculator (see **Section 10.4**) and in accordance with 'improve or maintain' principles.

Table 10.5 summarises the proposed vegetation clearance for each component of the Project for worst case scenario road option each layout option (12 m road including cut and fill) and **Table 10.6** lists the total area of permanent and temporary vegetation loss for each vegetation type and condition.

Table 10.5 Proposed impact areas for each layout option

Project component	Estimated impact area – 159 layout			Estimated impact area - 125 layout		
	Permanent (ha)	Temporary (ha)	Trees Only (ha)	Permanent (ha)	Temporary (ha)	Trees Only (ha)
Roads	93.72	93.11	0.00	89.60	81.69	0.00
Turbine footings and assembly	20.48	0.00	0.00	16.52	0.00	0.00
Substation	1.97	0.00	0.00	1.97	0.00	0.00
Internal overhead electrical interconnection / easement	32.17	0.00	55.67	32.23	0.00	55.23
Temporary construction facilities						
Concrete batching plants (8)	0.00	3.71	0.00	0.00	3.70	0.00
Site office (3)	0.00	1.09	0.00	0.00	1.10	0.00
Rock crushing plants (3)	0.00	0.86	0.00	0.00	0.79	0.00
Construction compounds (3)	0.00	8.80	0.00	0.00	8.72	0.00
Total						
Total study area (ha)	1,955.85					
Total site area (ha)	14,713.40					
Total development footprint	148.34	107.57	55.67	140.32	96.00	55.23

Table 10.6 Estimated clearance of each vegetation type under current Project

Revised Biometric Vegetation Type	Biobanking Condition	Ancillary Code	Area Mapped within Project Site (ha)	Area Mapped within Study Area (ha)	Estimated Impact Area – 159 Layout			Estimated Impact Area – 125 Layout		
					Permanent Clearance (ha)	Permanent Clearance – Trees Only (ha)	Temporary Clearance (ha)	Permanent Clearance (ha)	Permanent Clearance – Trees Only (ha)	Temporary Clearance (ha)
BR110	Moderate/ Good	Trees	11.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Native Pasture	62.17	12.71	0.86	0.00	0.45	0.46	0.00	0.28
BR114	Moderate/ Good	Trees	34.08	1.70	0.00	0.00	0.00	0.00	0.00	0.00
		Native Pasture	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BR116	Moderate/ Good	Trees	241.58	20.19	0.98	0.00	0.48	0.86	0.00	1.36
		Native Pasture	358.71	81.68	6.23	0.00	4.43	5.97	0.00	9.80
	Low	-	113.39	17.91	0.00	0.00	5.50	0.00	0.00	5.50
BR153	Moderate/ Good	Trees	5397.39	765.66	36.47	32.17	31.90	32.62	32.23	93.21
		Native Pasture	1703.04	499.65	33.28	0.00	56.59	32.69	0.00	88.86
	Low	-	730.15	225.48	14.30	0.00	36.15	13.68	0.00	46.88
BR227	Moderate/ Good	Trees	109.27	12.46	0.57	0.00	0.54	0.57	0.00	1.17
		Native Pasture	3.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BR240	Moderate/ Good	Trees	537.25	94.78	5.17	0.00	4.19	4.82	0.00	7.43
		Native Pasture	471.81	105.79	7.91	0.00	6.34	7.19	0.00	11.88
	Low	-	181.29	44.98	2.78	0.00	1.48	2.05	0.00	3.10
		Total	9955.20	1882.99	108.55	32.17	148.05	100.91	32.23	136.79

Threatened Ecological Communities: Under a worst case scenario (Layout Option 1), the Project would involve the permanent removal of up to 116.22 ha of BR153, in various conditions from the study area. This vegetation type is recognised as an EEC and occurs across the Project site as shown in **Figure 10.1**. Only a relatively small proportion of BR153 present within the Project site will be permanently cleared by the Project; i.e. 1.5 %. A further 124.64 ha will be temporarily cleared for roads, reticulation and construction facilities, 56.59 ha of which is comprised of modified native pasture.

The Project will also involve the permanent removal of up to 23.07 ha (Layout Option 1) of BR116 and BR240 combined, in various conditions from the study area. These vegetation types are recognised as an EEC and CEEC and occur across the Project site as shown in **Figure 10.1**. Only a relatively small proportion of BR116 and BR240 combined within the Project site will be permanently cleared by the Project; i.e. 2.4 %. A further 15.44 ha will be temporarily cleared for roads, reticulation and construction facilities.

Loss of Riparian Vegetation: The Project involves the establishment of a small number of informal creek crossings across small creeks and drainage lines. An assessment of the impacts of these crossing is included in **Chapter 17** Water. Given the landscape is highly modified and riparian vegetation primarily consists of a grassy ground layer with no over-storey, the impacts are likely to be minimal.

Flora and Fauna Habitat Removal: Habitat for a variety of threatened flora and fauna species is present across the study area, with the approximate permanent removal of 140 ha of potential habitat for a variety of species. Given the Project design is linear in structure, no large consolidated areas of clearing will occur and the proposed clearance will not isolate areas of potential habitat. Also, all threatened flora recorded on-site have been avoided through careful site design, and mitigation measures will be implemented to prevent indirect impacts.

Avifauna: There were a number of threatened birds, as listed in Table 10.3, which were recorded within the study area. Given the current amount of habitat present across the site for these species in comparison with that to be cleared (**Appendix 11**), it is considered unlikely that the proposal would result in a significant reduction in habitat for these species within the study area.

Arboreal Mammals: The Koala (*Phascolarctos cinereus*) and Squirrel Glider (*Petaurus norfolcensis*), both have a potential habitat of approximately 860 ha present within the study area, with approximately 76 ha likely to be impacted by the Project. This is unlikely to represent a significant amount of habitat removal within the Project site in the context of the amount of habitat present within the project site and given that the impact occurs over a linear area rather than in a single consolidated block.

Bats: A number of microchiropteran bats recorded within the study area have breeding habitats in the form of hollow-bearing trees. The construction of the Project will potentially remove 11.4 % of hollow-bearing trees predicted to occur across the site. This figure is only indicative as hollow bearing trees are not uniform across the site and access tracks and wind turbines have been sited to avoid hollow bearing trees where possible, therefore it is likely to be a significant over-estimate (for a complete description about the calculation on hollow-bearing trees across the Project area, refer to **Appendix 11**).

Areas of woodland and grassland across the site provide potential foraging habitat for microchiropteran bats. Of the 1,883 ha of habitat present across the site, approximately 140 ha will be permanently impacted upon. Due to the extensive areas of available habitat in the locality and the linear impact area created by the Project, it is unlikely that habitat loss would significantly impact these species within the locality of the Project.

Border Thick-tailed Gecko: While the species was not recorded during targeted surveys by ELA, the majority of the site represents marginal potential habitat with scattered isolated patches of potential habitat. The percentage of total mapped habitat impact is predicted to be 1.6 % for potential habitat and 1.2 % for marginal potential habitat.

Migratory Species: No migratory species were recorded on-site during surveys by ELA, however as such species may travel long distances, there is the ever-present potential for impacts by operational turbines should any species visit or pass through the Project site. The proposal involves the permanent removal of up to approximately 148 ha of potential habitat for migratory species. However, impacts in terms of disturbance to habitat for these species are likely to be negligible given they forage widely and the minimal amount of clearing required comparative to the amount of habitat present within the Project site.

The Regent Honeyeater (*Xanthomyza phrygia*) is likely to only use the site periodically for foraging and it is predicted that the Project will remove potentially 112 ha of foraging habitat present within the study area, which is only 1.45 % of the total area mapped.

Indirect Impacts: Indirect impacts relate to matters during the construction phase that are created as a consequence of the primary impact. A summary of the anticipated indirect impacts is provided below with further information contained within **Appendix 11** and, where indicated, the respective chapters of the Environmental Assessment (EA).

- Runoff, sedimentation and erosion (**Chapter 17** Water and **Chapter 18** General Environmental Assessment);
- Hydrological changes (**Chapter 17** Water and **Chapter 18** General Environmental Assessment);
- Edge effects/increased weed invasion;
- Wildfire (**Chapter 16** Fire and Bushfire); and
- Noise.

Weed management measures will be implemented during and post-construction to ensure the spread of weeds does not increase across the study area as a result of the Project. These will include the control of runoff that may contain seeds and the washing down of vehicles to prevent the transportation of weeds between areas when a significant weed risk has been identified. Revegetation of disturbed areas and ongoing weed management for a period of three years is also proposed.

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

Optional 132kV Transmission Line and Substation: The Project will connect to either the TransGrid 330 kV double-circuit overhead transmission line running through the Sapphire Cluster or the TransGrid 132 kV double-circuit overhead transmission line running adjacent to the Gwydir Highway to the south of the project (alternative connection).

Impacts are shown in **Table 10.7** and it is anticipated only one vegetation type, *Manna Gum – Rough-barked Apple – Yellow Box*, would be impacted. Overall impacts would be lower, however, as the size of the wind farm would be constrained by the available spare capacity of the 132 kV transmission line. Therefore, only 1/2 to 1/3 of the proposed wind farm area would be constructed, including the removal of the Sapphire Cluster, significantly reducing the environmental impacts.

Table 10.7 Estimated impacts for the 132 kV transmission line and collector substation

Vegetation Community	Impact (ha)	Credits Required (ha)	Total Credits Required	Indicative Offsets Required (ha)
External 132 kV transmission line 45 m corridor				
Manna Gum - Rough-barked Apple - Yellow Box, Moderate to Good, Trees	15.54	28.64	445	49.45 - 63.58
Collector substation				
Manna Gum - Rough-barked Apple - Yellow Box, Moderate to Good, Trees	3.98	28.64	114	12.67- 16.28

If this option were to progress, the Biobanking calculations would be re-run to determine appropriate offset requirements in order to satisfy the reduced wind farm size.

Optional 330 kV Substation Locations: The current assessment has been based on one 'preferred' substation location. However, depending on the configuration of the transmission lines and wind farm infrastructure a small number of other options may be considered (refer to **Chapter 3** Project Description and **Appendix 11**). The impacts associated with each of these options have been outlined in **Table 10.8**, including a location (Option 2) suggested by TransGrid (see **Chapter 6** Stakeholder Consultation, section 6.5.4).

It is noted that all of the proposed alternative substation locations would have a slightly greater impact than the 'preferred' substation location. Consequently, a revised offset calculation has been provided for each alternative location to account for any changes in impacts. All of the proposed substation locations have been the subject of ecological survey and, therefore, assessed for the potential presence of threatened species.

Table 10.8 Estimated impacts for the alternative 330 kV substation options

	BR513, Low	BR513, Moderate to Good, Native Pasture	BR513, Moderate to Good, Trees	Total
Credits Required/ha	**11.66**	**13.56**	**28.64**	**-**
Option 1 (Preferred)				
Impact (ha)	1.97	-	-	1.97
Option 2 (Alternative)				
Impact (ha)	2.69	-	-	2.69
Offset (credit)	31.37	-	-	31.37
Offset (ha)	3.48 – 4.48	-	-	3.48 - 4.48
Option 3				
Impact (ha)	2.00	-	-	2.00
Offset (credit)	23.32	-	-	23.32
Offset (ha)	2.59 - 3.33	-	-	2.59 - 3.33

	BR513, Low	BR513, Moderate to Good, Native Pasture	BR513, Moderate to Good, Trees	Total
Option 4				
Impact (ha)	-	-	2.00	2.00
Offset (credit)	-	-	57.28	57.28
Offset (ha)	-	-	6.36 - 8.18	6.36 - 8.18
Option 5				
Impact (ha)	-	0.01	3.98	3.99
Offset (credit)	-	0.14	113.99	114.13
Offset (ha)	-	0.02	12.67 - 16.28	12.69 - 16.30
Option 6				
Impact (ha)	-	-	3.99	3.99
Offset (credit)	-	-	114.27	114.27
Offset (ha)	-	-	12.69 - 16.32	12.69 - 16.32

*Note: Refer to Figure 12 in **Appendix 11***

10.4.2 *Operation*

Direct Impacts: Impacts on bird and bat species are likely to occur during the operational phase. Impacts include the potential for birds and bats to accidentally collide with towers and moving turbine blades. Many studies have produced literature regarding the potential impacts of wind farms on birds and bats, with most of the studies undertaken outside Australia. The impacts appear to be dependent on a number of factors including:

- Proximity to bird concentrations and location of migratory pathways (Brett Lane & Associates 2005);
- Wind farm layout, spacing between turbines and type of wind turbine used (Brett Lane & Associates 2005; Department of Environment and Heritage (DEH) tralian Greenhouse Office 2006);
- Location on the landscape, type of habitat and surrounding area, in particular proximity to forested areas and wetlands (Kevin Mills & Associates 2005; DEH Australian Greenhouse Office 2006);
- Lighting used on turbines (Brett Lane & Associates 2005) (see **Chapters 8** Landscape and Visual and **Chapter 13** Aviation for further assessment of turbine lighting); and
- Turbines located on forested ridges (Arnett 2005).

Further discussion on these subject areas in relation to the affected species as a result of the proposed Project are contained within **Appendix 11**.

Bats: Direct impacts on bat species relate predominantly to turbine collision and blade strike. There may also be some potential for barotraumas. Based on the results of literature reviews and an understanding of bat behaviour, those species considered most likely to come into contact with turbine blades or otherwise by impacted by wind turbines during the operation of the wind farm include those which forage above the canopy, are migratory or have large foraging areas and may roost in hollows across the study area. Further discussion on pertinent bat behaviour and interaction with wind turbines is contained in **Appendix 11**.

Due to the open nature of the Project site, identification of potential flyways is difficult. The open woodland environment means that bats may forage relatively unobstructed across the majority of the site and even more so in the grassland areas to the west.

A risk matrix has been prepared by ELA to assess the likelihood that bats present within the study area would be impacted by the Project as is shown in **Appendix 11**. Of the species recorded across the study area, the White-striped Freetail Bat (*Tadarida australis*), Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*), Eastern Bent-wing Bat (*Miniopterus schreibersii oceansis*) and Southern Freetail Bat (*Mormopterus sp. 4*) were the only species considered to have a high potential for strike due to roosting in hollows, their migratory nature or foraging behaviour above the canopy.

Measures to prevent bat strike wherever possible will be implemented, including ensuring wind turbines are located no closer than 30m from hollow-bearing trees following construction. However, based on the findings of past studies, it is likely that some collisions will be unavoidable even with appropriate mitigation measures (**Appendix 11**).

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. 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).

Birds: Direct impacts on bat species relate predominantly to turbine collision and blade strike and avoidance of areas where turbines are present. Few studies have been conducted in Australia or focused on agricultural landscapes, similar to those present within the study area. However, it has been suggested that the vulnerability of a species to collisions is species and habitat specific (Erickson *et al*., 2001). Of the seven recorded threatened bird species on-site, most are considered having a low likelihood of collision with turbines as they are woodland birds which forage amongst woodland areas or close to the ground. The exceptions are the Little Lorikeet (*Glossopsitta pusilla*) and Turquoise Parrot (*Neophema pulchella*), which are most at risk given their fast flight patterns and height of flight when moving between feeding areas.

Birds of prey are at risk of collision with turbines. A number of birds of prey were recorded across the study area although no nests were recorded within the study area. 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. 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 2005).

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).

A risk matrix anticipating the likelihood of collision with turbines has been prepared by ELA for those species most commonly recorded within the study area (**Table 10.9**). Factors such as the flight character, distribution across the site and whether the species is migratory have been considered when determining the likely risk. Those species considered to be at greatest risk are those that fly at high altitudes, at speed and are migratory. Based on the risk matrix, it considered unlikely that many of the species common to the study area would be likely to collide with turbines, although the risk is considered to be slightly higher for raptors and birds of prey which may collide with turbines whilst hunting prey. Passerine species, due to their fast flight patterns and sometimes high flight, may also be at risk of collision.

Table 10.9 Risk of turbine collision by bird species common throughout the study area

Common Name (*Scientific name*)	**Conservation Status**	**No. of records**	**Flight characteristics**	**Migratory**	**Distribution across site**	**Risk of collision with turbines**	**Risk of collision with overhead cables**
Brown Treecreeper (*Climacteris picumnus victoriae*)	V	1	Moderate to low	No	Woodlands	Low	Low
Hooded Robin (*Melanodryas cucullata*)	V	2	Moderate to low	No	Woodlands	Low	Low
Diamond Firetail (*Stagonopleura guttata*)	V	2	Moderate to low	No	Woodlands & grasslands	Low	Low
Little Lorikeet (*Glossopsitta pusilla*)	V	11	Fast, high-low flight depending on activity	No	Woodlands & grasslands	Moderate	Low
Turquoise Parrot (*Neophema pulchella*)	V	1	Fast, high-low flight depending on activity	No	Woodlands & grasslands	Moderate – primarily when moving between sites	Low
Scarlet Robin (*Petroica boodang*)	V	1	Moderate to low	No	Woodlands	Low	Low
Speckled Warbler (*Pyrrholaemus saggitatus*)	V	1	Moderate to low	No	Woodlands	Low	Low
Noisy Miner (*Manorina melanocephala*)	-	23	Moderate to low	No	Woodlands & grasslands	Low	Low
Musk Lorikeet (*Glossopsitta concinna*)	-	22	Fast, high – low flight depending on activity	No	Woodlands	Moderate	Low
Crimson Rosella (*Platycercus elegans*)	-	22	Fast, high – low flight depending on activity	No	Woodlands	Moderate	Low
Red Wattlebird (*Anthochaera*	-	18	Moderate to low	No	Woodlands & grasslands	Low	Low

Common Name (*Scientific name*)	Conservation Status	No. of records	Flight characteristics	Migratory	Distribution across site	Risk of collision with turbines	Risk of collision with overhead cables
carunculata)							
Australian Magpie (*Gymnorhina tibicen*)	-	18	Moderate to low	No	Woodlands & grasslands	Low	Low
Eastern Rosella (*Platycercus adscitus eximius*)	-	18	Fast, high – low flight depending on activity	No	Woodlands	Moderate	Low
Rufous Whistler (*Pachycephala rufiventris*)	-	14	Moderate to low	No	Woodlands	Low	Low
Sulphur-crested Cockatoo (*Cacatua galerita*)	-	10	Moderate to low	No	Woodlands	Low	Low
Sacred Kingfisher (*Todiramphus sanctus*)	-	10	Moderate to low	No	Woodlands	Low	Low
Nankeen Kestrel (*Falco cenchroides*)	-	2	High, soaring	Partially	Grassland	Moderate	Low
Wedge-tailed Eagle (*Aquila audax*)	-	2	High, soaring	No	Grassland	Moderate	Low
Black-shouldered Kite (*Elanus axillaris*)	-	1	High, soaring	*	Woodlands & grasslands	Moderate	Low
Brown Goshawk (*Accipiter fasciatus*)	-	1	High, soaring	**	Woodlands & grasslands	Moderate	Low
Whistling Kite (*Haliastur sphenurus*)	-	1	High, soaring	***	Woodlands & grasslands	Moderate	Low

Note: V = vulnerable

** Nomadic, populations may irrupt in response to mouse plagues in a particular area.*

*** Northern birds are sedentary, but southern birds tend to be nomadic, and immature birds move north when dispersing during the winter months.*

**** Partially migratory, but mostly resident in northern and western Australia.*

Lighting Impacts: 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 and Wildlife Service 1993) and others identifying no significant difference between turbines lit with L-864 obstruction lights and those without (Jain et al. 2007).

Indirect Impacts: Indirect impacts relate to matters during the operation phase that are created as a consequence of the primary impact. A summary of the anticipated indirect impacts, with further information contained in **Appendix 11**, includes:

- Displacement of birds;
- Predation by feral animals; and
- Wildfire (**Chapter 16** Fire and Bushfire and **Appendix 19**).

No specific studies on the displacement of non-migratory birds from wind turbines in Australia were found during this assessment. However, overseas studies, such as Devereux *et al*. (2008), on wintering farmland birds in Europe can be used. By comparing similar species, such as seed-eaters and corvids, results may be applicable to Australian farmlands. Given the extensive nature of vegetation types across the study area and available habitat, bird species are unlikely to become displaced as a result of the wind turbines such that vegetation types that once provided foraging habitat would no longer do so due to turbine avoidance behaviour.

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

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

10.4.3 *Decommissioning*

Direct and indirect impacts anticipated from the decommissioning works, as discussed in **Chapter 3** Project Description, 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.

Further impact assessments will be conducted prior to decommissioning work occurring to ensure impact assessment and management actions are up-to-date and respond to the environmental values present on-site at the time.

10.4.4 *Cumulative Impacts*

An assessment of cumulative environmental impacts considers the potential impact of the Project in the context of existing and future wind farm developments to ensure that any potential environmental impacts are not considered in isolation.

The majority of the Project site is used for agricultural purposes, specifically cropping and grazing. The protection and management of a large parcel of land as part of an offset for the impacts of the Project will assist in protecting habitat for threatened species within the locality, which may otherwise be degraded and impacted by agricultural practices.

The Project is not located within any known migratory bird pathways, however, there may be some cumulative impacts on birds and bats that forage widely over the approved Glen Innes Wind Farm and the proposed White Rock Wind Farm. Whilst some cumulative impacts of bird and bat strike from wind farms within the locality and throughout NSW as a whole are likely, the location of the Project is such that it is unlikely to substantially increase impacts on and hence loss of migratory species throughout NSW.

10.5 Avoidance, Management and Mitigation

10.5.1 *Avoidance Measures*

The Proponent has made a number of amendments to the proposed layouts to minimise and avoid impacts on the ecological values of the site. Given the extensive areas of EEC vegetation types across the site area, and the requirement for turbines to be placed on ridge tops, 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, but on the other hand ensures no consolidated areas of clearing occur.

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 are summarised below:

General:

- Access tracks have 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 treeless or low tree density areas, where possible, to minimise the need for additional or excessive tree clearance;
- Where possible, turbines have been placed in woodland areas where ground layer disturbance has previously taken place (e.g. sown areas);
- Construction compounds, substations and rock crushing facilities have been located outside ecologically sensitive areas where possible;

- The Project 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;
- Access tracks and transmission line routes have been re-aligned to avoid threatened plants recorded within the study area; and
- The reticulation has been placed underground and within the road footprint where possible to allow for temporary rather than permanent disturbance. Reticulation will pass overhead across gullies and waterways to reduce impacts.

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

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

10.5.2 *Mitigation/Recommendations*

In order to protect the ecological values of the site a number of management and mitigation measures have been proposed. Given their extent, and to avoid duplication, these are outlined in **Chapter 20** Statement of Commitments together with the Project stage during which each would be implemented, as well as **Appendix 11**. A number of species-specific mitigation measures are included and it is envisaged that some of these would be implemented at both the proposed impact site and offset site with full details provided in the Construction Environmental Management Plan, Operation Environmental Management Plan, Weed Management Plan and Soil and Water Management Plan post approval.

10.5.3 *Offset Strategy*

As the Project has undertaken a Biobank Assessment, the quickest and simplest method of meeting the offset requirements is to purchase the correct number and type of biodiversity credits from the credit register, if available. The Proponent has explored the registration of a Biobank site as an offset option, but may still utilise other suitable methods for securing a conservation outcome depending on continued interest by landowners. Another option is to purchase and manage the sites for conservation by the Proponent (or contractors acting on their behalf) through an appropriate covenant or transferred to the Minister for the Environment and gazetted as Conservation reserves (subject to agreement with the Minister for the Environment).

During the preparation of the Ecological Assessment report by ELA, preliminary ecological investigations were carried out on several properties where landowners were interested and the land was large enough, providing a “like for like” vegetation type to meet the improve or maintain outcome consistent with the credit report from the Biobank Assessment.

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. **Table 10.10** shows the level of impact on the different vegetation communities and the required offset areas based on the Biobanking methodology. **Table 10.11** shows the impact and offset for Matters of NES (EPBC Act).

Table 10.10 Comparison of impact areas and calculated offset areas

Biometric Vegetation Type	Impact Area (ha)	Proposed Offsets					Improve or Maintain Offset Target (ha)
		Property 1 Area (ha)	Property 2 Area (ha)	Property 3 Area (ha)	Total Area (ha)	Credits Generated (Est)	
Property Area		**317.00**	**223.00**	**608.62**	**1,148.62**		
Blakely's Red Gum - Yellow Box grassy open forest or woodland of the New England Tablelands	17.60	242.10	36.46	-	278.56	2,215	24-31
White Box grassy woodland of the Nandewar and Brigalow Belt South Bioregions	27.90	18.28	-	-	18.28	132	56-72
Manna Gum - Rough-barked Apple - Yellow Box grassy woodland/open forest of the New England Tablelands and North Coast	240.90	49.08	158.68	259.03	466.78	3,358	521-669
Black Cypress Pine - Tumbledown Gum - Narrow-leaved Ironbark open forest of northern parts of the Nandewar Bioregion	1.30	-	-	-	-	-	3.00
Tenterfield Woollybutt - Silvertop Stringybark open forest of the New England Tablelands	1.10	-	-	-	-	-	-
Total	**288.80**	**309.46**	**195.14**	**259.03**	**763.62**	**5,705**	**607-781**
Border Thick-tailed Gecko	18.70	-	-	184.65	184.65	1,108	41.50

Table 10.11 Offset measures for impacts to Matters of NES (EPBC Act)

EPBC Act listed Community	Condition	Impact Area (ha)	Property 1 Area (ha)	Property 2 Area (ha)	Property 3 Area (ha)	Total Area (ha) (P1+P2)	Total Area (ha) (P1+P3)	Offset: Impact Ratio (P1+2)	Offset: Impact Ratio (P1+3)
Property Area			**317**	**223**	**608.62**	**540**	**925.62**		
White-Box, Yellow Box, Blakely's Red Gum grassy woodland and Derived Native Grassland grassy woodland	Woodland	10.8	150.01	12.31	-	162.31	150.01	15.03	13.89
White-Box, Yellow Box, Blakely's Red Gum grassy woodland and Derived Native Grassland grassy woodland	Derived Native Grassland	24.9	110.37	24.15	-	134.52	110.37	5.4	4.43
Total		**35.7**	**260.38**	**36.46**		**296.84**	**260.38**	**8.31**	**7.29**
EPBC Act listed Species									
Border Thick-tailed Gecko	Potential	18.7			184.65	0	184.65	0	9.87
Swift Parrot and Regent Honeyeater (Potential Foraging Habitat)	Potential	113.7	193.85	157.06	233.15	350.91	427	3.09	3.76
Swift Parrot and Regent Honeyeater (Future Potential Foraging Habitat)	Potential	-	115.61	38.08	21.58	153.69	137.19	-	-
Spot-tailed Quoll	Potential	112.4	193.85	157.06	233.15	350.91	427	3.12	3.8
South-eastern Long-eared Bat	Potential	111.3	193.85	157.06	233.15	350.91	427	3.15	3.84
Astrotricha roddii	Potential	112.4	193.85	157.06	233.15	350.91	427	3.12	3.8
Digitaria porrecta & *Diuris pedunculata*	Potential	227.2	309.46	195.14	254.73	504.6	564.19	2.22	2.48
Picris evae	Potential	112.4	193.85	157.06	233.15	350.91	427	3.12	3.8

In particular, three properties have been identified where the vegetation types and condition have been verified as being in equivalent or better condition than the impact sites and combinations of any two of the properties will provide an offset area between 504 ha (Properties 1 and 2) and 569 ha (Properties 1 and 3) and meet the "like for like or better" offsetting principles with a minimum 2:1 offset ratio. Further details regarding these options can be found in **Appendix 11** and **Figure 10.4** shows the location of each property.

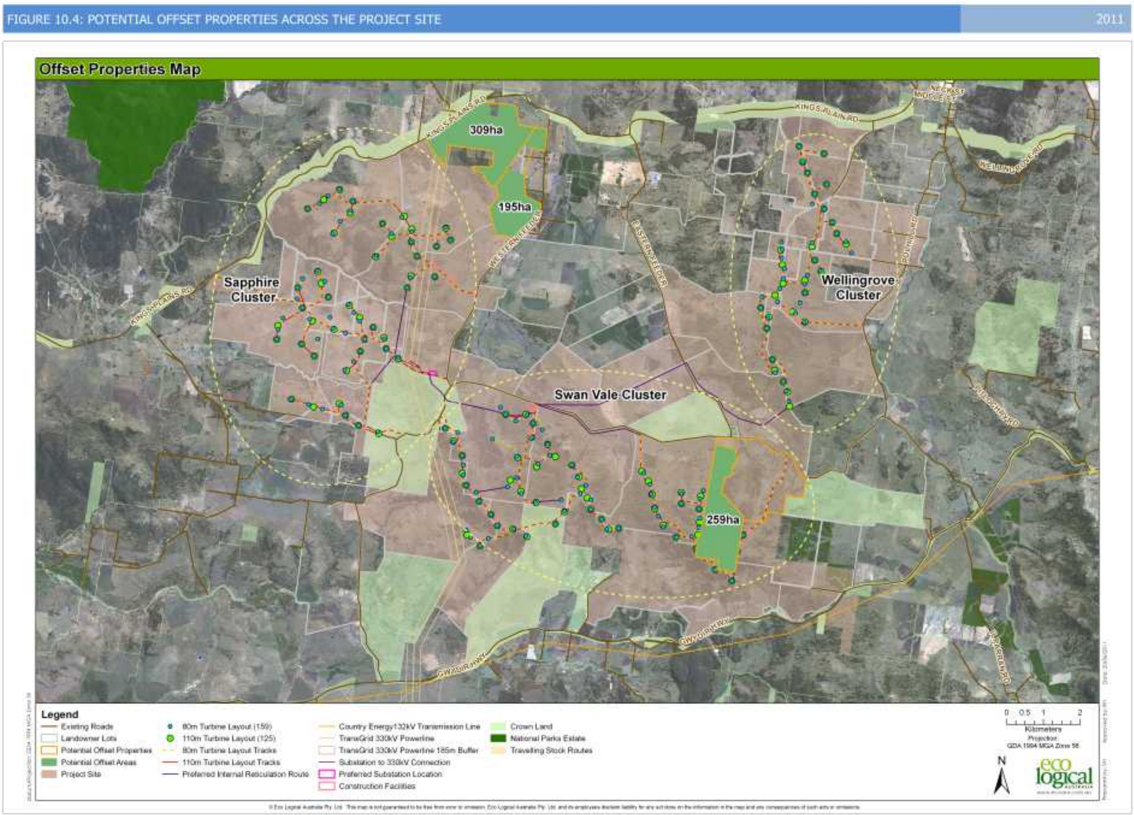

Figure 10.4 Potential offset properties across the Project site
(An A3 size version of this Figure is displayed in Volume 2)

Whilst there were no confirmed records of the Border Thick-tailed Gecko in the project site, the 18.7 ha of impact to potential habitat will be offset with up to 184.65 ha of potential habitat in offset Property 3. The loss of 113.7 ha of potential foraging habitat for the Regent Honeyeater and Swift Parrot will be offsets with between 350 and 427 ha of potential foraging habitat.

10.6 Summary

Under Part 3A of the *EP&A Act*, the Project is required to meet the principles of the 'maintain and improve' test. Whilst complete avoidance of all impacts on threatened species, their habitat and areas of native vegetation is not possible, a number of avoidance and impact minimisation measures including the modification of the layouts to avoid areas containing threatened species and communities have been implemented. Furthermore, mitigation measures will be implemented as part of the Project and will additionally reduce the potential impacts from the Project.

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

Through the suite of avoidance, mitigation and offset measures outlined in this chapter, with further detail in **Chapter 20** Statement of Commitments and **Appendix 11**, the principles of the 'maintain and improve test' are upheld.

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CHAPTER 11

Cultural Heritage Assessment

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11. CULTURAL HERITAGE ASSESSMENT

New South Wales Archaeology Pty Ltd (NSW Archaeology) was commissioned in June 2009 to undertake an archaeological and cultural heritage assessment of the proposed Project in accordance with the Director-General's Requirements (DGR's). The full report is attached in **Appendix 12**.

Both Indigenous and Non-indigenous heritage is present throughout Australia's rural landscape, and is protected in accordance with Part 6 of the National Parks and Wildlife Act 1974, which provides protection for Aboriginal Objects and Aboriginal Places. The construction of a wind farm project has the potential to cause direct impacts to any Indigenous objects (predominantly stone artefacts) or Non-Indigenous items which may be present within the study area. As such, a heritage assessment has been undertaken to identify those groups (Indigenous and Non-indigenous) with a heritage interest in the site, and to determine any heritage objects or places present within the project area in order for the Project to avoid them if necessary.

11.1 Partnership with Aboriginal Communities

In accordance with the *Interim Guidelines for Aboriginal Community Consultation* (IGACC) – *Requirements for Applicants* (NSW Department of Environment and Conservation (DEC) 2004), as discussed in **Chapter 5** Planning Context, the Proponent and NSW Archaeology actively sought to identify stakeholder groups or people wishing to be consulted about the project. Written notification about the Project, dated 12th June 2009 was sent to the following groups:

- Anaiwan Local Aboriginal Land Council (LALC);
- Glen Innes LALC;
- Native Title Services;
- DECCW;
- Inverell Shire Council; and
- Glen Innes Severn Shire Council.

Following advice received from DECCW further written notification dated 29th June 2009 was supplied to the following bodies:

- Kwiembal Elders Indigenous Group;
- Ngoorabul Elders;
- Anaiwan and Glen Innes LALC; and
- Aboriginal Reference Group Border Rivers-Gwydir Catchment Management Authority.

For a full list of groups / individuals who registered an interest in the Project, refer to **Appendix 12.**

11.2 Methods

The heritage assessment was conducted using:

- A desktop study, search of relevant databases and literature review;
- Detailed field survey;
- Analysis and discussion of results, and
- Recommendations.

For the purposes of the field survey the Project was divided into 21 Survey Units defined according to landform morphological type, accounting for approximately 2,515 ha of the Project site. The field work occurred over an eleven day period in January 2011. The survey was lead by NSW Archaeology with the assistance of a number of people from the local Aboriginal community including Liza Duncan, Vicky Duncan, Charmayne Talbot, Jeremy Duncan, Arnold Duncan, Courtney Duncan and Curtly Duncan.

Indigenous: The Project study area was surveyed to identify any Aboriginal sites or objects present, known as artefact locales, and to determine the potential impacts upon them. A predictive model was also used to determine the nature of Aboriginal occupation across the land. The degree of Aboriginal occupation is based on a number of factors and, as a result, occupation may not have been uniform across the site. By studying these factors, the predictive model can determine the type and nature of archaeological sites which might be expected to occur across the study area.

The report by NSW Archaeology was written in accordance with the DECCW *Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation* (NSW DEC 2005), which was prepared specifically for development applications assessed under *Part 3A* of the *NSW Environmental Planning and Assessment (EP&A) Act, 1979*.

Non-Indigenous: The Non-Indigenous component of this assessment has been conducted with reference to literature relating to European occupation within the area, a review of Parish maps and a field inspection aimed at locating historical items, features and potential archaeological sites. A review of the heritage database and previous archaeological investigations has also been undertaken to provide heritage context to the assessment.

For the report, NSW Archaeology consulted the NSW Department of Urban Affairs and Planning and the NSW Heritage Office, which produced guidelines for preparing archaeological and heritage assessments as set out in the *Archaeological Assessment Guidelines,* 1996 and *Heritage Assessments*, 1996.

11.3 Existing Situation

Indigenous: The assessment identified that a number of different Aboriginal groups occupied the region where the Project is proposed, with the Project site attributed to the traditional terrain of the Ngarrabal (Castlereagh Lachlan Environmental Services, 2007; Tindale, 1974). The number of archaeological studies previously conducted within the area is limited; however numerous studies have been undertaken in the broader New England region. These studies show that Aboriginal populations would have primarily functioned in small groups of variable sizes, depending on the season (Pearson, 1981). There also was the potential for groups to come together during time of plentiful food, feasting or for ceremonies (OzArk, 2009). However, the actual presence of Aboriginal groups within the study area would have been limited due to the lack of reliable water sources found on-site (McCardle, 2007; Paton, 1998).The predominant land use by Aboriginal people in the Project area is predicted to have been restricted to a limited range of activities including hunting and gathering forays conducted away from base camps and movement through the country. Such short-term activities are likely to have resulted in low to very low levels of object discard, diversity and complexity.

The early 1800's saw changes in the traditional land use of Aboriginal people with the introduction of European settlement.

Non-Indigenous: European settlement of the area began in the late 1820's, with establishment of towns in the region occurring throughout the 1830's. Inverell was settled slightly later than other towns, and was surveyed in 1858. Both Glen Innes and Inverell enjoyed large growth over the mid-1800's and became popular areas due to expansions in farming and mining. During the 1870's the town of Glen Innes was incorporated, a road to Grafton built and a hospital established. The towns of the New England District developed as centres associated with farming, dairying, mining and the railways. However it was pastoralism and mining (tin, gold and sapphire) that had the biggest impact on the establishment and growth of settlements.

Although no Non-Indigenous heritage items have previously been recorded within the project area, there is a high probability that heritage items present within the Project site will be associated with major themes such as "agriculture and pastoralism", "mining", "domestic life" and "transport and communications". For further detail on how these themes apply to the Project, refer to **Appendix 12**. These items may be present as extant and standing structures or ephemeral sites and ruins. The locations of such items are difficult to predict, although the potential generally increases on level ground adjacent to existing homesteads, good water supplies and existing or former road alignments.

11.4 Survey Results and Potential Impacts

Of the 21 Survey Units (2,515 ha) created prior to the field survey of the Study area, 1,196 ha of this area was subject to survey inspection. Ground exposures inspected were estimated to have been 7.53 ha and, of this area, archaeological visibility (the potential artefact-bearing soil profile) was estimated to have been 1.7 ha. Effective Survey Coverage has therefore been calculated at 0.07 % of the Study area, considered to be a low percentage. The low Effective Survey Coverage was a result of the thick ground surface vegetation encountered at the time of the survey due to recent heavy rainfall.

While the Effective Survey Coverage was calculated to be low, no further archaeological investigations are recommended, as the Project is expected to only cause ground disturbance in areas which are assessed, by NSW Archaeology, to have the potential to contain low to very low density of objects.

Indigenous: A total of three Indigenous object locales, SU14/L1, SU19/L1 and SU21/L1, were recorded within the assessed Survey Units as listed in **Appendix 12**. These locales, occurring in the Swan Vale and Sapphire Clusters, had very low density stone artefact distribution, resulting in low archaeological potential/sensitivity and therefore low archaeological significance. In addition to the Indigenous object locales, five trees were considered by the Aboriginal field assistants to be possible scarred trees. All Survey Units are assessed to be of low archaeological sensitivity.

Given the nature and density of the artefact locales recorded in the proposal area and the low scientific significance rating they have been accorded, unmitigated impact is considered appropriate; a strategy of impact avoidance is not warranted with respect to these locales. Indeed, with regard to the Aboriginal object locales SU14/L1 and SU19/L1, the location of the proposed impacts falls on reasonably discrete areas, which are significantly eroded due to vegetation clearance and subsequent grazing and vehicle disturbance. With regard to Aboriginal object locale SU21/L1, it is recommended that avoiding or limiting the extent of impacts to this locale, if feasible, should be given consideration.

Non-Indigenous: No items of Non-Indigenous heritage were located during the survey. The Project has a low likelihood of causing any impacts to items of Non-Indigenous heritage, therefore no mitigation strategies are required.

11.4.1 ***Cumulative Impacts***

An assessment of cumulative environmental impacts considers the potential impact of a proposal in the context of existing developments and future developments to ensure that any potential environmental impacts are not considered in isolation. Given that the impact of the Project on aspects of cultural heritage are both isolated and minimal in nature, it is anticipated that there will be no cumulative effect on cultural heritage from the introduction of the proposed development into the area.

11.5 Management and Mitigation

Desktop and on-site survey results identified three Indigenous locales, five potential scar trees and no Non-Indigenous locales. Impacts are predicted to be discrete in nature due to the relatively small development footprint within the overall Project site.

A full list of mitigation and management strategies is contained in **Section 12** of **Appendix 12**). Such strategies include:

- The Proponent, in consultation with an archaeologist, relevant Aboriginal communities and NSW Department of Premier and Cabinet (DPC), developing a Cultural Heritage Management Protocol which provides procedures to be followed for impact avoidance and accidental discovery; and
- Personnel involved in the construction and management phases of the Project trained in procedures to implement recommendations relating to cultural heritage, where necessary, to decrease impact.

The Project can continue as the Survey Units and Aboriginal Indigenous object locales recorded do not surpass scientific significance thresholds. Also no Survey Units have been identified to warrant further archaeological investigation, such as a subsurface test excavation. While the Effective Survey Coverage achieved during the field survey was low, based on consideration of the predictive model of site type applicable to the environmental context in which impacts are proposed, the archaeological potential of the proposed impact areas do not warrant further investigation.

The following mitigation and management strategies are suggested to minimise the impact on Indigenous objects and places:

- Ground disturbance impacts associated with the Project be kept to a minimum and to defined areas, to ensure minimum impact on Indigenous objects, which can be expected to extend in a relatively continuous, albeit very low to low density distribution, across the broader landscape encompassed by the Project;

- The Indigenous object locales recorded are of very low density distributions. The archaeological significance of these locales is assessed to be low. Accordingly, a management strategy of unmitigated impacts is considered to be appropriate;
- While the Indigenous stone objects recorded are very low density distributions and have low archaeological significance, it is nevertheless recommended that limiting the extent of impacts to these locales, if at all feasible, should be given consideration;
- It is recommended that additional archaeological assessments are to be carried out if any new impacts are to occur outside the study area. If a significant Indigenous object is identified, prior to impact, mitigation strategies will be implemented;
- It is recommended a strategy of avoidance of impacts be adopted in regard to the recorded trees with scars identified by the Aboriginal field assistants; and
- Impacts should not take place further north than the point 347037E 6712005N GDA in order to avoid inadvertently impacting a potential Indigenous stone arrangement site. This point is currently not proposed to be impacted upon by the Project.

Mitigation measures to account for these recommendations are presented in **Chapter 20** Statement of Commitments.

11.6 Summary

During the different phases of the Project, ground disturbance will occur with the potential to cause direct impacts to any Indigenous or Non-Indigenous locales which may be present on-site. While Indigenous objects can be expected to extend in a relatively continuous, albeit very low to low density distribution across the broader landscape encompassed by the Project, it has been proposed that due to the low archaeological significance, unmitigated impacts are considered an appropriate strategy. There were no Non-Indigenous items located within the study area.

Overall, the proposed impacts are predicted to be discrete in nature due to the relatively small footprint of construction activities and, therefore, impacts to the archaeological resource across the landscape can be considered only partial in nature.

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CHAPTER 12

Traffic and Transport Assessment

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12. TRAFFIC AND TRANSPORT ASSESSMENT

Bega Duo Designs (BDD) was commissioned to undertake a Traffic and Transport Assessment for the proposed Project (see **Appendix 13** for full report). The study was conducted in accordance with the NSW Roads and Traffic Authority (RTA) *Guide to Traffic Generating Developments* and the Director-General's Requirements (DGR's), and provides a technical appraisal of the traffic and safety implications arising from the Project. Information on internal road infrastructure is described in **Chapter 3** Project Description and preliminary designs can also be seen in **Volume 2**, **Figures 3.1** to **3.5**.

12.1 Methods

The traffic and transport assessment undertaken comprised of a desktop study, consultation and fieldwork. The desktop study involved reviewing maps of the area to identify features and revision of RTA data to establish existing traffic volumes. Consultation with the Proponent, RTA, Glen Innes Severn Council, Inverell Shire Council and heavy vehicles operators provided base Project information, advice on existing traffic conditions and possible routes for heavy vehicles during construction. Fieldwork by BDD inspected Project involved roads and undertook a traffic count in January 2011 to establish existing traffic volumes and road conditions.

This assessment developed strategies and recommendations to minimise traffic impacts throughout the life of the Project. The main focus of this assessment, however, is the construction phase, as this is likely to generate maximum traffic impacts on the existing public road network and internal access tracks, compared to other phases.

12.2 Existing Situation

To establish existing traffic conditions within the locality of the Project, BDD reviewed traffic volumes and accident records.

The Gwydir Highway, Swan Vale has the largest volume of traffic with 1,361 vehicles per day (RTA 2007). Waterloo Road has 60 vehicles per day, Western Feeder Road and Polhill Road both have less than 50 and Kings Plain Road has less than 200 vehicles per day (**Appendix 13**).

The RTA 'Crash' database has accident records over the past five years to June 2010, which include:

- Thirty six casualty accidents recorded on Gwydir Highway between Glen Innes and Inverell (67 kilometres). Four of these accidents resulted in a fatal injury. Sixty five percent of the accidents were attributed to speeding and fatigue;
- Two non-casualty accidents recorded on Kings Plain Road; and
- There were no recorded accidents on Waterloo Road.

These relatively low accident rates result from the low volumes of traffic.

12.3 Potential Impacts

A number of main and secondary roads, as discussed in **Chapter 3** Project Description and **Appendix 13**, will be used to access the Project site for construction, maintenance, refurbishment/

decommissioning and visiting purposes. The major access links will be via the Gwydir Highway, which provides access between Glen Innes and Inverell, Waterloo Road, Polhill Road, Kings Plain Road and Western Feeder Road.

12.3.1 *Construction*

Construction traffic for the installation of the Project will be present over a period of approximately two years. The traffic will consist of:

- Articulated semi-trailers (extendible and regular trailer sizes) – for transporting initial establishment equipment, materials and turbine components;
- Tipper trucks – to bring stone for the access tracks and to remove soil;
- Bulldozers – for road works on-site;
- Concrete mixers – to transport concrete from the batching plant for use on-site;
- Cranes – one small mobile crane (up to 100 tonne) for assembly of turbines on the ground and a larger mobile crane (up to 600 – 1,000 tonne, or alternatively a 300-400 tonne crawler crane) for the erection of the wind turbine; and
- Conventional 4WD vehicles and sedans – use by on-site personnel.

During the construction period the largest number of vehicle movements are likely to occur during the delivery of the wind turbine components. Each of the wind turbines will require three or four escorted, extendible trailers for the tower, up to three for the blades and one for the nacelle. Additional loads will consist of concrete, steel reinforcement, base tower sections, road stone and other construction materials being delivered to the site.

Load weights and lengths of equipment and components will vary. The heaviest loads are expected to be the 600 – 1,000 tonne crane (weighing approximately 135 tonnes) and the nacelle (weighing approximately 70 tonnes). The longest loads will be for the blades, which will have trailer lengths approximately 50 m long. As discussed in **Chapter 3** Project Description and **Appendix 13** areas will be made available on-site for semi-trailer trucks to turn around or manoeuvre.

On-site movement during the construction period will mainly consist of concrete mixers moving from the batching plants to the wind turbine bases, to pour tower footings. Each footing may contain up to 310 m^3 of concrete to be poured over an eight hour period, which would result in a rate of up to 12 concrete mixer truck trips per hour. Water carts for dust suppression may also be required, the number of trips dependant on the site conditions at the time of construction.

Traffic predictions by BDD for the Project estimate a maximum of 250 vehicles per day during peak construction period (or approximately 40 vehicles per hour). Work will overlap and be spread across clusters, and the maximum traffic volumes may, therefore, only apply at one location across the road network during any single time period. An increase in traffic volumes can impact on road safety and logistical issues. These potential impacts include (full description **Appendix 13**):

- Traffic noise and delays;
- Vehicle collisions (with stock or due to obstruction by long loads) or loss of control;
- Dust from unsealed roads (see **Chapter 18** General Environmental Assessment); and
- Road surface deterioration, particularly during wet weather.

The Project is proposed to be built in stages to minimise the above-mentioned potential impacts and limit the increase on traffic volumes.

Heavy and Over-Sized Haulage: There are a number of options for a haulage route to Glen Innes (as listed in **Appendix 13**). To minimise potential impacts the final route will take into consideration the shortest route to the Project site with appropriate carriageway and clearance, or the route that causes least disruption to local transport and commercial activities. A final route will be decided prior to construction between the Proponent, haulage contractor and road authorities and any required road modifications or upgrades designed and assessed at the time, as necessary.

Public Visits: Experience gained from operational wind farms at Hallett and Starfish Hill in South Australia, Albany and Esperance in Western Australia, Ravenshoe in Queensland, Crookwell and Blayney in New South Wales and Codrington in Victoria suggests that there will be a great deal of interest generated during the construction phase of the Project. This could be true for the Project as there are currently no operational wind farms in the area, and public awareness of wind farms is of growing interest.

12.3.2 *Operation and Maintenance*

Operational traffic will be restricted to maintenance and inspection vehicles, or other traffic use (e.g. visitors), which will make periodic visits to the site, as discussed in **Chapter 3** Project Description. Vehicles used will be standard 4WD vehicles, sedans or vans. Bulldozers/graders could be needed on an infrequent basis for maintenance of access roads during the life of the Project, which will allow for continued maintenance and inspection.

Also if a significant component of a turbine needs replacement, larger vehicles such as cranes and/or semi-trailers could be required, similar to that used during construction.

12.3.3 *Decommissioning*

The traffic and potential impacts will be similar to the construction phase of the Project. However, there will be less traffic volume as there will be no requirement for concrete mixer trucks, which in turn will reduce the potential impacts during decommissioning.

12.3.4 *Cumulative Impacts*

An assessment of cumulative environmental impacts considers the potential impact of a proposal in the context of existing developments and future developments to ensure that any potential environmental impacts are not considered in isolation. The main source of traffic within and around the Project is currently from agricultural activities and a small number of residential dwellings.

During construction, traffic levels will increase impacts however the Project is proposed to be built in stages which is intended to limit the number of roads that are impacted during the construction phase, thereby reducing cumulative impacts. During the operation phase, a small increase to existing traffic volumes can be expected resulting in a low level of cumulative impact.

The proximity of other wind farms in the area has the potential to increase the volume of traffic on roads within the vicinity of the Project. Additional traffic impacts will be limited to the Gwydir Highway which would service the Project, Glen Innes and White Rock Wind Farms. Ben Lomond is at least 20km from the Project, where impacts would be limited to the New England Highway. Cumulative impacts would only result if the construction of one or more wind farms was to occur in parallel. Impacts would be localised to main arterial routes, such as the Gwydir Highway, which should be able to accommodate the short-term increase in vehicle numbers.

12.4 Management and Mitigation

The following mitigation measures listed in this section cover the entire Project's operation, from construction through operation to decommissioning.

12.4.1 *Construction*

- Contract a licensed haulage contractor with experience in transporting heavy and over-size loads. The contractor would be responsible for obtaining all required approvals and permits from the RTA and Councils and for complying with any conditions specified in the aforementioned approvals;

- Develop a Traffic Management Plan in conjunction with the haulage contractor and road authorities to include, but not be limited to, the following:
    - Scheduling of deliveries, timing of transport, limiting the number of trips per day;
    - Undertaking community consultation before and during all haulage activities and providing a dedicated telephone contact list to enable any issues to be rapidly identified and addressed;
    - Managing the haulage process, including the erection of warning signs and/or advisory speed signs posting in advance of isolated curves, crests, narrow bridges and changes of road conditions;
    - Placing of speed limits on all roads that would be used primarily by construction traffic to reduce the likelihood of any accidents and reduce maintenance costs;
    - Designing and implementing temporary modifications to intersections and roadside furniture as appropriate;
    - Producing a Transport Code of Conduct which would be made available to all contractors and staff detailing traffic routes, behavioural requirements and speed limits;
    - Establishing procedures to monitor traffic impacts on public and internal access tracks during construction, including noise, dust nuisance and travel times, and to implement modified work methods to reduce such impacts where possible;
    - Where reconstruction or provision of a temporary crossing is required over a creek or drainage structure, the design of this structure will be discussed with the relevant authority; and
    - Reinstating pre-existing conditions after temporary modifications to the roads and pavements along the route where applicable, in consultation with the relevant authorities.
- Implement all aspects of the Traffic Management Plan in co-ordination with the Councils, RTA and property managers;
- Prepare road dilapidation reports covering pavement and drainage structures in consultation with the Councils for all of the routes before and after construction. Any damage resulting from construction traffic, except that resulting from normal wear and tear, would be repaired at the

Proponent's cost. Alternatively, the Proponent may negotiate other forms of compensation for road damage with the relevant roads authorities as appropriate; and

- Consideration for establishing a transport pool for employees from nearby towns to minimise traffic volumes.

12.4.2 *Operation and Maintenance*

- Establish a procedure to ensure the ongoing maintenance of the Project site access roads during the operation phase. This maintenance would include sedimentation and erosion control structures, where necessary.

12.4.3 *Decommissioning*

- Prepare and implement a revised Traffic Management Plan reflecting the changes in traffic volumes, during time of decommissioning.

12.5 Summary

The introduction of an additional 250 vehicles per day during the construction period could have a significant impact on the existing road users, especially on the minor and unsealed roads, for approximately two years until construction of the Project has finished. Major impacts are expected only during the construction and decommissioning periods, with minor impacts during the operational phase.

Adoption of the strategies for minimising traffic impacts outlined in this section should reduce community disruption and the risk of traffic incidents, thus facilitating minimum disruption to the existing traffic conditions.

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CHAPTER 13

Aviation Assessment

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13. AVIATION ASSESSMENT

Existing aviation activity in the locality of the Project site was identified during planning and design through consultation with the Department of Defence (DoD), Civil Aviation Safety Authority (CASA), Airservices Australia (AsA), Aerial Agricultural Association of Australia (AAAA) and the local community. This chapter presents an assessment of the aviation activity in the Project area, potential impacts from the Project and appropriate mitigation actions. This assessment includes the results of an independent Aeronautical Impact Assessment and Obstacle Lighting Review, **Appendix 15**, prepared by The Ambidji Group. An additional update letter is also included in the appendix which considers an increased blade tip height of 157 m.

13.1 Existing Situation

13.1.1 *Department of Defence*

Following the submission of the Preliminary Environmental Assessment to the Department of Planning, the DoD requested the opportunity to assess the impact of the proposed wind farm on its activities including the safety of military flying operations and the possible impact on the operation of communications, navigation aids and radars.

Advice received from the DoD is that the proposed Project will not have an impact on Defence operations, and confirms that it has no concerns at this time (**Appendix 15**). However, the DoD have noted that there is an ongoing need to obtain and maintain accurate information about tall structures so that risks associated with inadvertent collision by low flying aircraft can be reduced. The Royal Australian Air Force Aeronautical Information Service (RAAF AIS) is responsible for recording the location and height of tall structures. The information is held in a central database managed by RAAF AIS and relates to the erection, extension or dismantling of tall structures the top measurement of which is 30 m or more above ground level, within 30 km of an aerodrome, and 45 m or more above ground level elsewhere.

The wind turbines and associated meteorological masts proposed for the development will meet the above definition of a tall structure. DoD requests that the Proponent provide RAAF AIS with "as constructed" details so that the structures can be appropriately shown on aviation charts.

13.1.2 *Civil Air Operations*

CASA is concerned with two main aviation issues with respect to wind farms. The first is the protrusion of wind turbines (obstacles) into the Obstacle Limitation Services (OLS) of airfields. The OLS is essentially a defined area of airspace above and around a licensed aerodrome. The second issue is the height of turbines outside the OLS and Procedures for Air Navigation Services (PANS OPS), but still in areas of aviation activity (air traffic).

Two aerodromes in the region have OLS and PANS OPS surfaces; Glen Innes, approximately 14 km east and Inverell, approximately 30 km south west of the Project (**Figure 13.1**). The Visual Navigation Chart VNC4, Brisbane, shows an unlicensed airfield located at Inverell North which, although within 15 km of the Project, does not have instrument approach procedures.

To address the issue of wind turbine height, CASA's Manual of Standards Part 139 – Aerodromes, states that, in general, an obstacle would require obstacle lighting unless an aeronautical study assesses it as being shielded by another object or that it is of no operational significance. For wind turbines occurring outside of an aerodrome CASA released Advisory Circular *AC 139-18(0) Obstacle Marking and Lighting of Wind Farms* in July 2007 to provide advice regarding the requirements for obstacle marking and lighting of wind turbines and wind monitoring masts, under Civil Aviation Safety Regulations (CASR) Part 139 (see **Appendix 14**). In 2008 this advisory was withdrawn, and as such, CASA's statutory power to require obstacle marking and lighting only applies within the vicinity of an aerodrome (30 km). Therefore, it is CASA's view that the decision of the lighting of obstacles outside the vicinity of aerodromes is the responsibility of the Proponent, in consideration of their duty of care.

In March, 2011, CASA indicated that a review would be undertaken by Department of Infrastructure and Transport (DIT) as the subject matter on obstacle marking and lighting outside of an aerodrome was raised in the DIT paper *Safeguards for Airports and the Communities around them*.

Notwithstanding the withdrawal of the CASA Advisory Circular, in response to specific queries as to lighting standards to apply to wind farms that are remote from an aerodrome, CASA has previously advised:

- Even though a CASA assessment is not required it is important to point out the Proponent may have a duty of care to local aviators, such as aerial spraying and private flight operators, whose aeroplane landing area may be located in the vicinity of the wind farm, and who may want the wind turbines made conspicuous for night flying and during periods of low visibility;
- If the Proponent wishes to provide additional conspicuity, this may be achieved by installing obstacle lighting which meets the standards set out in the CASA Manual of Standards (MOS) Part 139 Aerodromes, Chapter 9, Section 9.4 – Obstacle lighting; and
- The Advisory Circular information (AC 139-18 (0)) is still valid as a recommendation if the Proponent wishes to do so as a risk mitigator.

The Proponent had The Ambidji Group prepare an independent Aeronautical Impact Assessment and Obstacle Lighting Review, **Appendix 15**, to determine whether the Project had an operational significance and would require obstacle lighting for the turbines.

13.1.3 ***Airservices Australia***

AsA are a government-owned corporation providing safe and environmentally sound air traffic control management and related airside services to the aviation industry. AsA provides air traffic management and aviation rescue and fire fighting services across Australia. They were consulted about the potential impact of the Project on their operations.

AsA has informed the Proponent that the Project will not affect any sector or circling altitude, or any approach at Glen Innes and Inverell aerodromes. AsA has also advised that the Project will not impact on Precision / Non-Precision Navigational Aids, HF / VHF Communications, Advanced Surface Movement Guidance and Control Systems (A SMGCS), Radar or Satellite / Links.

13.1.4 *NSW Emergency Services (Ambulance and Police) Aerial Operations*

Discussions were held with various NSW Emergency Services agencies responsible for aerial operations in the region.

Air Ambulance: Discussions with the Base Manager / Chief Pilot of CHC Helicopters revealed that careful pre-planning is conducted prior to commencing an emergency rescue operation. A complete study of topography, including known obstacles is always carried out. CHC operations manuals and safety management systems provide clear guidance to pilots with regard to the planning and conduct of flight in the vicinity of obstructions. The Chief Pilot indicated that wind farms are treated no differently from other constructed obstacles and pose no greater threat to aviation.

NSW Police Aviation Support Branch (ASB): Areas with power lines already existing in the vicinity of the Project restrict visual flight rules (VFR) operations to day light tasking only, as there is a lack of ‘cultural lighting’. As there is a 330 kV power line within the Sapphire Cluster and a 132 kV power line to the south of the Project, this previous advice would apply. Further, the ASB consider that in Visual Meteorological Conditions (VMC) the Project would be highly conspicuous.

NSW Rural Fire Service (RFS): The RFS often uses aerial fire fighting aircraft, both fixed and rotary wing, to assist ground crews in suppressing bush fires. Aircraft are regularly used in both initial attack and in ongoing fire operations in the New England area.

13.1.5 *Aerial Agricultural Association of Australia and Other Activities*

Agricultural aerial spraying is known to occur in the region for crop pest management and to top-dress pastures (nutrient application). Pest management is likely to occur annually, while top-dressing may occur every five years or so.

Information provided by the Glen Innes Severn Council indicates that there are numerous private airstrips located in the general Project site area. Specific information and contact details for seven properties with known airstrips in the vicinity of the Project site was provided to The Ambidji Group by a local aerial agricultural operator (**Figure 13.1**).

AAAA's position is that the organisation opposes wind farm developments and overhead transmission lines unless the developer has:

- Consulted in detail with local operators;
- Received independent expert advice on safety and economic impacts; and
- Considered the impacts on the aerial application industry.

Discussions were undertaken by The Ambidji Group with three local operators – G and G Agricultural, Superair Armidale and Tablelands Top Dressing Pty Ltd and an assessment completed on the potential impacts of the wind farm on agricultural aerial operations.

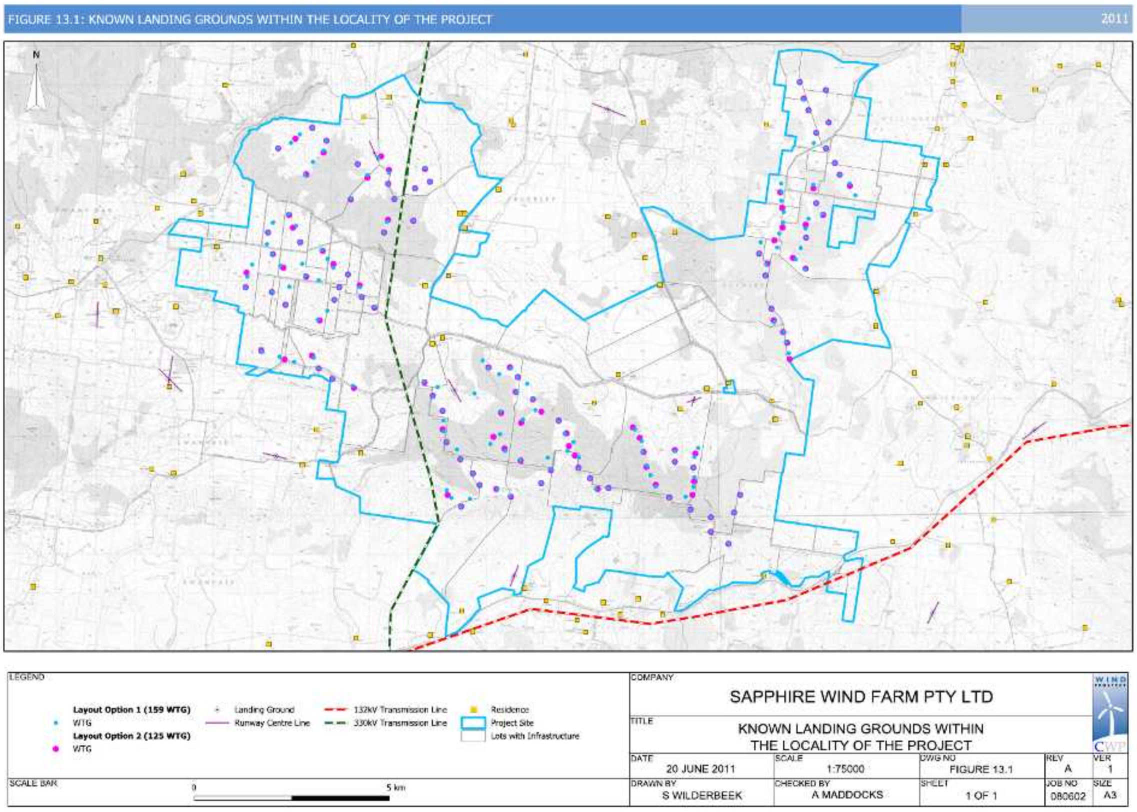

Figure 13.1 Known landing grounds within the locality of the Project
(An A3 size version of this Figure is displayed in Volume 2)

13.2 Potential Impacts

13.2.1 *Department of Defence*

Apart from the requirement to notify Department of Defence of the “Tall Structure” with “as constructed” details, the Department has advised that the Project will not impact on defence operations (**Appendix 15**).

13.2.2 *Civil Air Operations*

Tall structures have the potential to obstruct or present a safety hazard for aircraft, if sited in an OLS or in areas with high levels of air traffic. The turbine height proposed for the Project is up to 157 m. Final turbine height will depend on the model of turbine deemed to be appropriate for installation and may fall below this maximum. The OLS at Glen Innes and Inverell extend to a radius of approximately 4.5 km from the Aerodrome Reference Point (ARP). The closest point of the Project to the Glen Innes aerodrome is approximately 14 km and to the Inverell aerodrome approximately 30 km. The report undertaken by The Ambidji Group, **Appendix 15**, therefore, found there is no infringement of the OLS for either Glen Innes or Inverell Aerodromes.

This means that the Project is not likely to be assessed as an “Obstacle” or a hazard to the safety of aircraft and airport operations. However, the International Civil Aviation Organization (ICAO) which sets international standards and recommended practices, of which Australia is a member state, considers wind turbines in excess of 150 m an obstacle and as such, lighting is recommended.

Although it should be noted that ICAO Standards and Recommended Practices (SARPS) do not necessarily apply to domestic aviation activities, which is the primary concern with wind farms in Australia. The outcomes of the Aeronautical Impact Assessment and Obstacle Lighting Review will be submitted to CASA for their comment pending Development Approval.

Lighting facilities on turbines or around wind farms have the potential to have two main negative impacts. The first is the visual amenity of the Project area at night (see **Chapter 8** Landscape and Visual), both for local residences and visitors. The second impact relates to local bird and bat populations (see **Chapter 10** Flora and Fauna). Some bird and bat species are known to be attracted to some types of lights, for either navigational purposes or for feeding. This attraction may increase the probability of interaction with the wind turbine blades.

13.2.3 *Airservices Australia*

AsA has informed the Proponent that at the calculated maximum height of the highest turbine at 1,313 m AHD, the Project will not affect the PANS OPS surfaces at either Glen Innes or Inverell. The Project will not affect any sector or circling altitude, nor any approach or departure or en-route Lowest Safe Altitude (LSALT) regarding the two nearby aerodromes. They have also advised that the Project will not impact on the ATC Radar Facilities at Mount Sommerville, on the Gold Coast nor on NDB navigation aids at Glen Innes or Inverell.

13.2.4 *NSW Emergency Services (Ambulance and Police) Aerial Operations*

Air Ambulance: CHC have well-developed operation manuals and safety management systems in place in regards to activities in the vicinity of obstacles. The Chief Pilot has advised that the Project would have a minimal impact upon CHC aerial operations (**Appendix 15**). The Chief Pilot also offered the opinion that the stakeholders at greatest risk would be low time pilots of VFR aircraft operating in poor weather and not having the advantage of Instrument Flight Rules (IFR) skills and training.

NSW Police Aviation Support Branch: The Project does not pose any additional potential dangers or risks to NSW Police ASB operations (**Appendix 15**). The ASB conduct minimal operations in the area, including no IFR operations and VFR operations limited to daylight hours.

NSW Rural Fire Service: It is considered that turbines across the landscape would limit aerial fire fighting capability. Fire fighting aircraft operate at low levels and often with limited visibility due to smoke. If a bush fire was in or around a wind farm, the Service would have to wait until the fire was clear of the turbines.

13.2.5 *Aerial Agricultural Association of Australia and Other Activities*

The Project has the potential to impact on agricultural aerial spraying activities, as the turbines may potentially present physical obstacles that need to be negotiated when carrying out aerial spraying. This is likely to be more relevant to top-dressing activity, which can occur atop the ranges in the area. Pest management activities are more likely to occur over crops which are located on the lower slopes of the ranges, away from the turbines.

Mixed opinions on the impact of the Project on aerial spraying were offered during consultation. One operator commented that the Project would not impact on operations at all, while another thought that while the Project would provide a challenge, there could be a suitable "work around" to the presence of wind turbines. A third operator was clearly opposed to the Project and cited air safety as the primary reason.

The Ambidji Group and the Proponent have consulted with owners and operators at nearby airports and associated and neighbouring landowners to identify local airstrips and operations around the Project area. The Ambidji Group has created a qualitative risk assessment, as seen in **Appendix 15**, which resulted in aircraft landing area operations having a low level of risk and agricultural operations having a medium level of risk.

AAAA has previously provided guidance on this matter with respect to the Civil Aviation Authority CAAP 92:1(1), *Guidelines for Aeroplane Landing Areas* (1992) (see **Appendix 16**), with particular regard to runway splay or "clearway" distances for agricultural runways (Boco Rock Wind Farm EA, November 2009). A "clearway" is defined as an area in which there are no obstacles penetrating a slope of 2.5 % rising from the end of the runway over a width of 45 m, see **Figures 13.2** and **13.3** below.

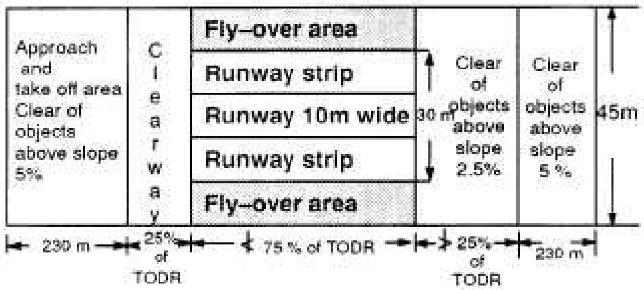

Figure 13.2 Landing ground dimensions – Agricultural Day Operations

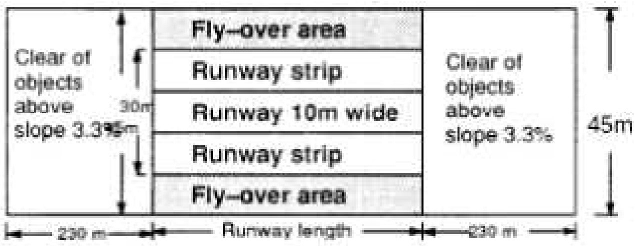

Figure 13.3 Landing ground dimensions – Agricultural Night Operations

Source: Civil Aviation Authority CAAP 92:1(1), Guidelines for Aeroplane Landing Areas (1992) ***(Appendix 16)***

Agricultural operations that involve low level flying can only occur in good conditions (high visibility) in accordance with the aviation regulations, and wind turbines can be considered to be highly visible structures. Aerial operators engaged in low level flying and agricultural operations are required to undertake a risk assessment for each flight. This would identify specific obstacle hazards such as trees and power lines. Wind turbines should be treated no differently. Therefore the operation of low flying aircraft in the vicinity of wind turbines would not represent an unacceptable risk if normal operational procedures are followed.

13.2.6 *Cumulative Impacts*

An assessment of cumulative environmental impacts considers the potential impact of a proposal in the context of consented and future developments to ensure that any potential environmental impacts are not considered in isolation. At present there is one consented wind farm (Glen Innes) and two proposed wind farms (White Rock and Ben Lomond) in proximity to the Project.

Local air operations would not be impacted by the presence of multiple wind farms, as the closest non-Project turbines are over 4 km (White Rock) and 8 km (Glen Innes). Such separation distances mean that air operations need to consider each wind farm in isolation when carrying out site-specific activities, such as agricultural spraying or pest control. As each wind farm development has to assess its potential impact on aviation activities in the area and provide mitigation measures if any impact is to occur, it is anticipated that any potential cumulative effect on aviation activities from the consented Glen Innes Wind Farm and the proposed White Rock Wind Farm and Ben Lomond Wind Farms will be covered by appropriate mitigation measures highlighted in each project's Environmental Assessment.

If obstacle lighting is a consideration, then there could be a cumulative impact if all wind farms proposed for the area are constructed and fitted with appropriate lighting. However, given there is no mandatory requirement for such lighting at this time, the consideration of cumulative impact from obstacle lighting is not required. The Proponent will consult with CASA and DIT post-consent to ensure that the wind farm meets all mandatory requirements with respect to obstacle lighting, including the consideration of cumulative impacts if necessary.

13.3 Management and Mitigation

13.3.1 *Department of Defence*

The Proponent will provide the RAAF AIS with "as constructed" details for entry on the Tall Structures Database and aviation charts.

13.3.2 *CASA Requirements*

The Proponent will provide CASA with turbine location and height details once final design positions are known and before construction commences. During construction, additional and separate notification will be required for the use of cranes (temporary obstacles) that exceed 110 m above ground level. After construction is complete, the Proponent will provide CASA with "as constructed" details.

On receipt of Development Approval for the Project, and with particular regard to the Aeronautical Impact Assessment and Obstacle Lighting Review, the Proponent will consult with CASA and DIT on the issue of obstacle lighting. The Proponent will be seeking a solution, which, if appropriate to do so, will consider the provision of obstacle marking and lighting. If CASA insist on full compliance with the requirements of the now withdrawn CASA Circulatory AC 139-18(0), the Proponent will commit to shielding provisions allowed under existing CASA guidelines. The shielding restricts the downward component of light to 5 % of nominal intensity emitted below 5° below horizontal and zero light emission below 10° below horizontal.

13.3.3 *Airservices Australia*

The Proponent will provide AsA with the location and height details of turbines with "as constructed" details.

13.3.4 *NSW Emergency Services (Ambulance and Police) Aerial Operations*

Air Ambulance: The Proponent will provide Air Ambulance with the location and height details of turbines once final turbine locations are known and before construction commences. After construction is complete, the Proponent will provide Air Ambulance with "as constructed" details.

NSW Police Aviation Support Branch: The Proponent will provide NSW ASB with the location and height details of turbines once final turbine locations are known and before construction commences. After construction is complete, the Proponent will provide NSW ASB with "as constructed" details.

NSW Rural Fire Service: The Proponent will provide NSW RFS with the location and height details of turbines once final turbine locations are known and before construction commences. After construction is complete, the Proponent will provide NSW RFS with "as constructed" details.

13.3.5 *Aerial Agricultural Association of Australia and Other Activities*

The Proponent will provide AAAA with the location and height details once final turbine locations are known and before construction commences. After construction is complete, the Proponent will provide AAAA with "as constructed" details.

Agricultural aerial spraying activities will be largely unaffected by the Project, and in relation to the assessment made in this chapter, no neighbouring properties will be unduly affected.

Appropriate information regarding the wind turbine layout and dimensions will be supplied to the RFS, if required, to assist in their planning and execution of fire response.

13.4 Summary

Wind farms have the potential to impact on aviation activity and aerodrome operations by introducing obstacles to aerial operations and interfering with aerial communication and navigation aids.

There are two aerodromes within the vicinity of the Project Study area, Glen Innes, approximately 14 km east and Inverell, approximately 30 km south west. According to the aviation hazard assessment carried out by The Ambidji Group, the Project does not impact the OLS and PANS OPS of these airfields.

CASA administers regulations for the intrusion of obstacles into aerodrome OLS and PANS OPS and obstacles 110 m above ground level outside of aerodromes. On 1 March 2011 CASA indicated that a review would be undertaken of safety issues associated with obstacles remote from an aerodrome, which will now be undertaken by Department of Infrastructure and Transport (DIT). As there is no current standard in place, it is CASA's view that the decision of the lighting of obstacles outside the vicinity of aerodromes is the responsibility of the Proponent.

The Ambidji Group recommends the Proponent consider the provision of obstacle marking and lighting as a duty of care obligation. On receipt of Development Approval for the Project, the Proponent will consult with CASA and DIT on the issue of obstacle lighting. The Proponent will be seeking a solution, which if appropriate to do so will consider the provision of obstacle marking and lighting. If CASA insist on full compliance with the requirements of the now withdrawn CASA Circulatory AC 139-18(0), the Proponent will commit to shielding provisions allowed under existing CASA guidelines.

Agricultural aerial spraying activity occurs for pest management and pasture top-dressing. Pest management spraying is unlikely to be affected by the Project. Top-dressing activity will require care by pilots applying the material to properties along the ridgelines.

Some private landing strips are present and of those known, the majority are not impacted by the Project's wind turbine locations. Those strips which are known to be impacted by the wind turbines have been discussed with the relevant associated landowners.

An increase in blade tip height to 157 m was not considered significant and had no additional impact on air safety or operations in the vicinity of the Project.

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CHAPTER 14

Communications Assessment

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14. COMMUNICATIONS ASSESSMENT

Electromagnetic signals (or radio waves) are transmitted throughout the country as part of telecommunication systems by a wide range of operators. Such systems are used for radar, radio broadcast, television, mobile phones and mobile and fixed radio transmitters. Electromagnetic signals generally work best if a clear path exists between the transmitting and receiving locations, known as line of sight (LOS).

There is the potential for interference from any large structure, including wind turbines, which occur within or close to the signal path. Signals can be interfered with or be reflected by the rotating blades of a wind turbine, which could degrade the performance of the signal (Bacon 2002). Electromagnetic emissions from generators and other machinery also have the potential to affect signals; however with modern turbine generators and strict International Electrotechnical Commission (IEC) regulations for manufacturers, there are now negligible emissions from wind turbines (Auswind 2006).

This section describes the existing radio and communication systems that operate within the vicinity of the Project, as well as general television broadcast services. It also provides an assessment of potential interference effects caused by the Project and suggested mitigation measures.

14.1 Methods

Experts have been consulted to assess the potential interference to radio-communications and TV signals in the area of the Project from electromagnetic signals. Lawrence Derrick & Associates (LDA) conducted an assessment on the potential impacts of radio-communication services (see **Appendix 17**), while Broadcasting Australia and commercial television (TV) stations were consulted regarding potential TV interference (see **Appendix 18**). Additional consultation also occurred with NSW Ambulance due to the potential impacts on a link occurring within the Project area. The following sections outline the approaches taken in measuring such interference.

14.1.1 *Radio-communication Investigations*

The Australian Communications and Media Authority (ACMA) Register of Radio-communications was reviewed by LDA to determine the location of any radio-communications links and towers within or close to the Project area. Once this was done, a corridor was created around each of the links or towers to ensure that the First Fresnel Zone (refer to **Appendix 17** for description) was not affected by any of the potential wind turbines or blades.

14.1.2 *Television Investigations*

Broadcasting Australia (managers of the National Transmission Network transmitting both ABC and SBS channels), Prime Television, NBN television and Macquarie Southern Cross Ten were approached to determine what affects the Project, in particular wind turbines, would have on any of their transmission towers or television services.

14.2 Existing Situation

14.2.1 *Radio-communications*

There are three paths with point-to-point links traversing the Project operated by TransGrid, NSW Ambulance and Soul Pattinson Telecommunications. There are also three radio sites located outside the Project boundary which have the potential to be affected, also considered by LDA.

Low power FM Broadcasting stations are located on Carpenters Hill (approximately 14 km east of the Project site), The Gap Range (approximately 22 km north of the Project Site), Kings Plains Road (approximately 23 km west of the Project Site) and Table Top Mountain (approximately 30 km west of the Project Site). These sites are all of a sufficient distance from the Project that no additional buffer zones are required.

There are other existing radio sites that occur near the boundary of the Project which are not impacted on, including:

- Department of Environment and Conservation (DECCW) Mobile Radio Base;
- Telstra Mobile Radio;
- Telstra Cellular and Point to Multipoint Bases; and
- CCA Paging Service Base.

14.2.2 *Television*

Residences in the vicinity of the Project receive television reception primarily from the Upper Namoi Main Television stations at Mount Dowe (approximately 130 km south west of the Project Site), to lower power translator stations located on Carpenters Hill, The Gap Range, Kings Plains Road and Table Top Mountain. The operators of these stations are ABC, SBS, NBN Ltd, Prime Television (Northern) Pty Ltd and Northern Rivers Television Pty Ltd. These link centre lines are all outside a 2.5 km buffer zone from the wind turbines and therefore no buffer zones are recommended by LDA.

14.2.3 *Air Services Radar*

While there is a ground to air base at Glen Innes and Non Directional Beacons in the Inverell area, there are no registered Airservices Australia (AsA) Radar facilities within LOS of the turbines. The separation distance from the Project to these sites indicates no further buffer zones are required. AsA have been notified about the Project and further detail on Aviation-related communication systems is included in **Chapter 13** Aviation.

14.2.4 *Mobile Phones*

Vodafone currently has limited 2G and 3G coverage with restricted mobile internet coverage across the Project area as seen in **Figure 14.1**. Telstra provides coverage for mobiles across the Project via Telstra Mobile satellite and has limited GSM capabilities if used in a car kit with an external antenna as seen in **Figure 14.2.**

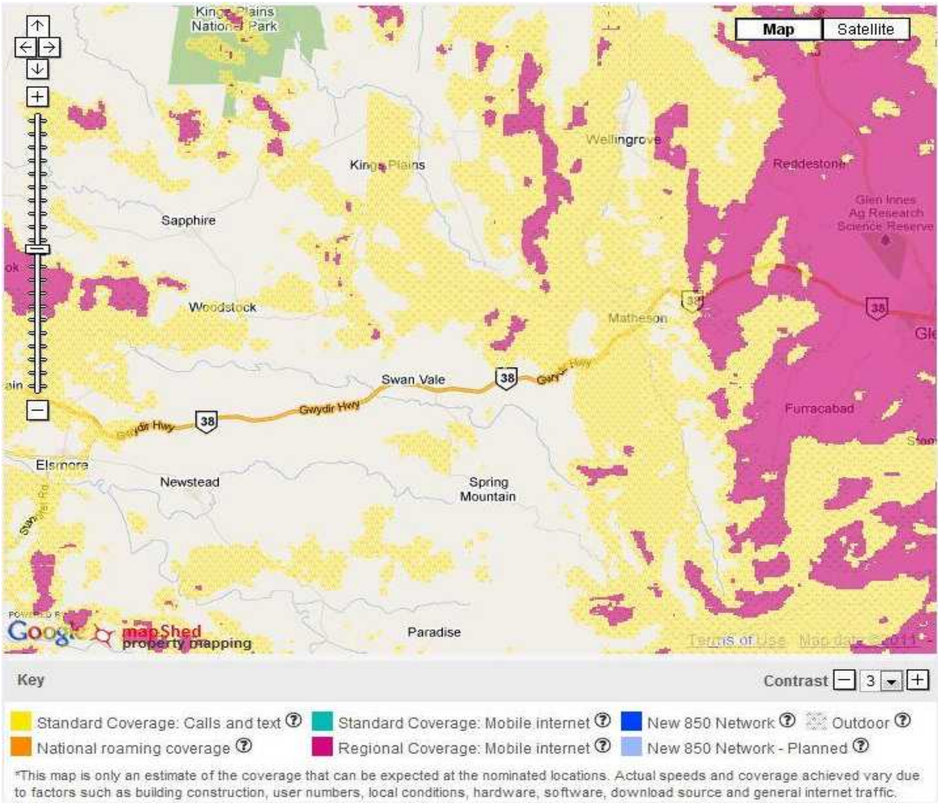

Figure 14.1 Vodafone coverage across the Project site.

Figure 14.2 Telstra coverage across the Project site.

14.3 Potential Impacts

Potential impacts on the communications services in the area vary depending on the type of signal link used and the proximity of the Project components to those links.

14.3.1 *Radiocommunications*

Point to point, or point to multipoint services require a high degree of LOS, and therefore can be easily affected by structures within the LOS pathway. As a general rule of thumb, if objects are placed outside of the First Fresnel zone (or zone of electromagnetic interference) then impacts can be avoided. LDA's assessment has suggested that the NSW Ambulance link First Fresnel zone could potentially be impacted upon by the Project's wind turbine layouts. The First Fresnel zones of other point to point radio-communication links that cross through or near the Project will not be impacted upon as seen in **Figure 14.3**.

The Proponent has been consulting with NSW Ambulance, as recommended by LDA, to determine the potential impacts of having a wind turbine within the First Fresnel zone and to determine any required mitigation measures should interference be an issue.

Also no wind turbines are located within a disruptive distance of a transmitting or communication tower, which means the Project is not expected to have any negative impacts on existing point-to-point links using such towers.

Radio Frequency broadband noise generated by power lines could be received by the radio receivers at radio repeaters or terminal sites if sites are close to the lines and if the links were operating at low frequencies. However, generally this is not an issue as transmission lines today are each built to standard specifications that reduce potential impact. Poles, towers and wires that are part of the transmission line could also physically obstruct the radio signal. However, due to the low height and limited dimension of the wires, there is minimal impact from such structures.

Amplitude Modulated (AM) and Frequency Modulated (FM) radio transmission systems are considered to be subject to negligible impacts from wind farm projects and effects only occur at very small distances from wind turbines (i.e., within 10 m) (National Research Council 2007). This will be no different at the Project site.

Mobile radio services do not require a high degree of LOS and so are less susceptible to interference by structures.

14.3.2 *Television*

Wind turbines can interfere with analogue television signals by causing the picture to flicker or 'ghost' in time with the rotation of the blades, also known as scattering or reflection.

Consultation with the three commercial broadcasters servicing Glen Innes and surrounding area has revealed that the proximity of wind turbines could potentially impact on existing TV services in the area (pers. comms NBN 2011, **Appendix 18**). The potential impact is expected to be minimal however, as the Project is well outside a 2.5 km buffer zone from the nearest TV link, as seen in **Figure 14.3**.

Broadcast Australia does not envisage any significant issues for ABC or SBS TV services due to the distance between the transmitter antenna and the wind farm, the distance between the majority of viewers in relation to the wind farm and all residences within the vicinity of the wind farm are covered by the Mount Dowe service and digital TV is available (pers. comms Broadcast Australia 2009, **Appendix 18**). Therefore the potential impact is expected to be minimal.

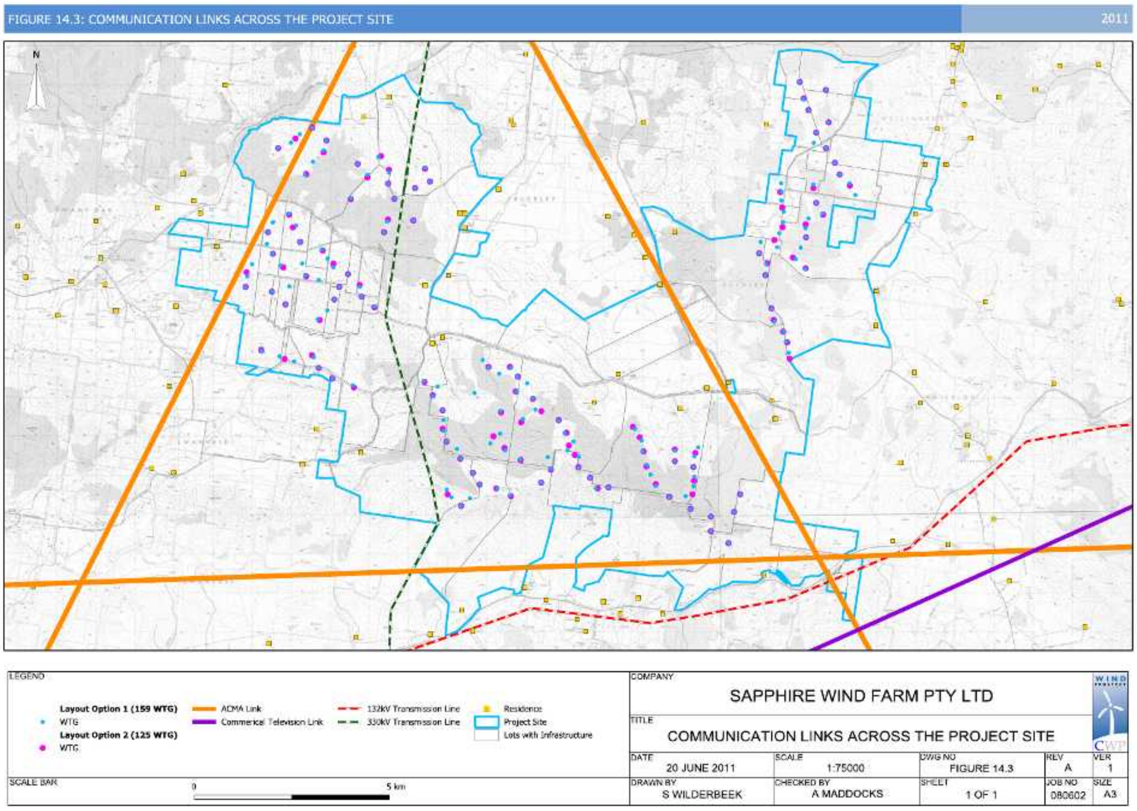

Figure 14.3 Communication links across the Project site

(An A3 size version of this Figure is displayed in Volume 2)

14.3.3 *Mobile Phones*

Mobile phone reception is mainly dependent on the position of the receiver. The position of the receiver is able to move around both natural and unnatural obstacles in the landscape and therefore wind turbines will have minimal impacts on signal quality.

14.3.4 *Cumulative Impacts*

An assessment of cumulative environmental impacts considers the potential impact of a proposal in the context of existing developments and future developments to ensure that any potential environmental impacts are not considered in isolation. As each wind farm development has to assess its potential impact on communication links in the area and provide mitigation measures if any impact is to occur, it is anticipated that any potential cumulative effect on communications links from the approved Glen Innes Wind Farm and the proposed White Rock Wind Farm and Ben Lomond Wind Farms will be covered by appropriate mitigation measures highlighted in the respective project's Environmental Assessment.

14.4 Management and Mitigation

Typical general mitigation requirements include:

- Amend planned WTG positions if necessary and feasible within the Approval Conditions, to create corridors to ensure minimal interference on links;
- A system for recording any complaints on interference, to allow for further investigations with the affected party, to reach an amicable solution;
- Use of primarily non-metallic WTG blades, to minimise disruption; and
- Where practical use equipment complying with the Electromagnetic Emission Standard AS/NZS 4251.2:1999.

Although no impacts on radio and communications are expected, except potentially on the NSW Ambulance link, typical mitigation requirements for radio-communication if impacts occur could include:

- Modifications to or relocation of existing antennae;
- Installation of a directional antennae; and
- Installation of an amplifier to boost the signal.

As it appears there will be some potential interference with the NSW Ambulance link, consultation will continue between the Proponent, LDA and NSW Ambulance to mitigate this potential impact by either relocating the link path itself or removing the wind turbine impacting on the link. This decision will be determined post development approval and mitigation implemented prior to the start of construction.

If television interference is experienced and reported by an existing receiver in the vicinity of the Project, the source and nature of the interference would be investigated by the Proponent. Should the cause of interference be attributed to the Project, then the Proponent will put suitable mitigation measures in place after consultation and agreement with the affected landowner or television broadcaster. These could include:

- Re-orientation of existing aerials to an alternative transmitter;
- Provision of a land line between the affected receiver and an antenna located in a suitable reception area;
- Provision of satellite or digital TV where available; or
- Installation of a new repeater station in a location where interference can be avoided (this is more complex for digital transmissions but also less likely due to the structure of the digital signal).

14.5 Summary

There are a few point-to-point links and omni-directional services which occur across and next to the Project. There is the potential for one link (NSW Ambulance) to be impacted by the Project, however there is expected to be minimal or no impacts on other links in the vicinity of the Project. If the Project does cause any interference to any links, the Proponent will conduct an investigation with the afflicted parties and implement a suitable solution to the problem.

CHAPTER 15

Electromagnetic Fields

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15. ELECTROMAGNETIC FIELDS

Electric and magnetic fields (EMF's) are associated with a wide range of sources and occur naturally and as a result of human activity. Naturally occurring EMF's are those associated with lightning or the Earth's magnetic field. Human caused EMF's occur wherever electricity is present, meaning we are constantly exposed to EMF's in our home and work environments.

Wind farms create EMF's from operational electrical equipment such as transmission lines, substations and the electrical components found within the wind turbines. This equipment has the potential to produce Extremely Low Frequency (ELF) EMF's, that is, the current will alternate direction between 30 and 300 times per second, or at 30 to 300 Hertz (Hz).

This chapter focuses on the theoretical health impacts and possible mitigation strategies for ELF electromagnetic fields generated by the operation of a wind farm.

15.1 Existing Situation

There are currently no Australian standards regulating exposure to ELF EMF's. The National Health and Medical Research Council (NHMRC) has issued interim guidelines on limits of exposure to 50/60 Hz electric and magnetic fields. These guidelines are aimed at preventing immediate health effects resulting from exposure to these fields, and are currently subject to a review by the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA).

The NHMRC recommended exposure limit for members of the public (24 hour exposure) is 1,000 milligauss (mG) for magnetic fields and 5 kilovolts per metre (kV/m) for electric fields. For exposure up to a few hours a day, the guidelines recommend exposure to be limited to 10,000 mG for magnetic fields, and 10 kV/m for electric fields (ARPANSA 2009).

Table 15.1 below provides typical magnetic field measurements and ranges associated with various EMF sources. Electric fields around most equipment/appliances are close to zero due to the shielding that is provided by the equipment itself. According to ARPANSA exposure levels to magnetic fields around the home are in the range of 0.1 to 2.5 mG. For homes near power lines, these levels may be as high as 5 to 10 mG (2009).

Table 15.1 EMF sources and magnetic field strength

Source	Typical measurement (mG)	Range of measurement (mG)
Television	1	0.2 to 2
Refrigerator	2	2 to 5
Kettle	3	2 to 10
Personal computer	5	2 to 20
Electric blanket	20	5 to 30
Hair dryer	25	10 to 70
Distribution power line (under the line)	10	2 to 20
Transmission power line (under the line)	20	10 to 200
Edge of easement	10	2 to 50

Note: Owing to variations in the design of electrical appliances and the loadings on transmission lines, the EMF levels may vary. The table above is based on a consistent set of measurements undertaken by power authorities in Australia using similar techniques and protocols to overseas measurements.

Source: Electricity Networks Association (2006)

15.2 Potential Impacts

ELF EMF's will be generated once the turbines and electrical infrastructure are energised (commissioned) and during the operation of the wind farm. The final configuration of the proposed Project will determine the profile and intensity of electric and magnetic fields across the Project site.

15.2.1 *Electrical Cables*

The proposed development comprises internal under and above ground electric cabling up to 132 kV and either 132 kV or 330 kV overhead electrical cabling between the switching station and the point of connection into the transmission network. Below are examples of ELF EMF's from high voltage power lines, provided to illustrate existing knowledge. The field strength from an electrical cable is dependent on load current(s), distance from the emitting source, relative phasing of circuits and spacing of conductors. Known measurements on the strength of both magnetic and electric fields are provided below:

- Measurements using a gaussmeter from underneath a 220 kV transmission line, resulted in a maximum recorded limit of 7.8 microTesla (µT) (or 78 mG) (Transpower 2009). Typical levels of magnetic field under a 330 kV high voltage transmission line range from 5 to 50 mG at a distance of 30 m from the centre of the easement (NGH Environmental 2008). Both of these measurements are in line with the range expected and presented in **Table 15.1**; and
- Similarly, electric field measurements from underneath a 220 kV transmission line, resulted in a maximum recorded limit of 3.2 kV/m (Transpower 2009) with levels of 0.07 kV/m and 0.01 kV/m recorded at 30 m and 60 m from a 115 kV power line (Hafemeister 1996).

These figures are far less than the NHMRC recommended limits for exposure of 1,000 mG and 5 kV/m. As the magnetic and electric fields emitted from the 33 kV cabling is expected to be weaker than those from transmission lines discussed above the effects from the proposed 33 kV internal electrical cabling are considered negligible.

However the strength of magnetic and electric fields can also change along a transmission line if there is an unbalanced load of energy within the line or there is line sagging due to excessive heat on the cables. Both of these effects could cause increased recordings directly underneath the transmission line, however, the effects are temporary and would not exceed the 24 hour exposure limit from the NHMRC.

15.2.2 *Substation*

Due to the function of a substation and the required components, substations have the highest variation in magnetic fields from 1 mG to 66 mG (recorded at the security fence around the substation) (Health Protection Agency 2004). Note that the recorded magnetic fields are still below the NHMRC limit of 1,000 mG.

15.2.3 *Wind Turbines*

An electromagnetic field is created in the generator and electrical equipment whilst operational. The impact of electromagnetic fields on the surrounding environment is limited by the shielding of the electrical equipment in the turbine structure or small housing unit at the base of the tower and by the height of the generator which is encased 80 to 100 m above the ground. The test results from a 1.65 MW wind turbine in Canada show a measured magnetic field in the front door of the wind turbine of 0.4 mG with typical values at a distance of 10 feet (3 m) from the wind turbine base of 0.04 mG. Furthermore it was noted that at a distance of 25 feet (7.5 m) from a wind turbine, no measurable magnetic field is expected (Windrush Energy 2004). It is anticipated that an increase in generator capacity of up to 3.3 MW would still result in magnetic field measurements below the NHMRC limit of 1,000 mG for the Project.

15.2.4 ***Receptors***

There is limited chance of the public being exposed to electric and magnetic fields from the wind farm, since the Project is wholly located on freehold land. Overhead transmission lines will run parallel to some local roads within the Project area but remain at least 10 m away and the nearest residence to a proposed substation location is approximately 900 m away. All electrical components will therefore be a suitable distance away from receptors and fall within acceptable levels of exposure.

15.2.5 ***Cumulative Impacts***

An assessment of cumulative environmental impacts considers the potential impact of a proposal in the context of existing developments and future developments to ensure that any potential environmental impacts are not considered in isolation.

Cumulative impacts need to consider the presence of existing electrical infrastructure, such as under and over ground transmission lines, substations, and transformers (pole-mounted or otherwise). At the time of submission, three other wind farm projects are proposed for the area. White Rock Wind Farm (Submitted) is approximately 4km to the south east, Glen Innes Wind Farm (Consented) is 8km to the east and Ben Lomond (DGR's Issued) is 20km to the south east of the Project. As EMF impacts are extremely localised and none of these wind farms overlap with the development footprint of the Project, no cumulative impact is anticipated.

Cumulative EMF impacts will also be created from the operation of the proposed Project within the development area. However as detailed above, in **Sections 15.1** and **15.2**, and the Management and Mitigation measures outlined below it is anticipated that the introduction of the Sapphire Wind Farm will not have a significant cumulative impact.

15.3 Management and Mitigation

To ensure there is no unnecessary exposure to electromagnetic fields the following mitigation and management measures could include:

- Burying electrical cables where feasible to shield electrical fields;
- Placing overhead transmission lines in isolated locations where possible;
- Placing wires together to cause a cancellation between the fields of electrical phases for magnetic fields;
- Placing appropriate security around emitting structures (e.g. collector and switching substations); and

- Ensuring the public, including tourists, which need to go near emitting structures are accompanied by a trained and qualified staff member.

15.4 Summary

ELF EMF's are generated from operational machinery. The measurements of electromagnetic fields can vary within a wind farm, depending on the placement of equipment such as turbines, substations and internal electrical cables.

The *Interim guidelines on limits of exposure to 50/60 Hz electric and magnetic fields* (NHMRC 1989) places guidelines on exposure to both electric and magnetic fields for the public and construction industry.

The typical strategy for reducing electromagnetic fields is distance from the source. Other strategies also include burying cables and placing cables together to cancel the fields emitted from them.

As most of the wind turbine electrical equipment is encased within the turbine, in housing at the base of the tower or located 80 to 100 m above ground level, the distance and shielding from electromagnetic fields decreases the impact from emitting sources.

Electromagnetic fields can be recorded highest at substations; however, appropriate fencing and remote placement of the substation within the landscape can greatly reduce any expose to electromagnetic fields.

CHAPTER 16

Fire and Bushfire Assessment

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16. FIRE AND BUSHFIRE ASSESSMENT

Fire and bushfire impacts of the Project on human life and property have been assessed in accordance with the Director-General's Requirements (DGR's) and the *Rural Fires Act 1997*.

In basing the risk management process on the AS/NZS ISO 31000:2009 *Risk Management – Principles and guidelines* (Standards Australia 2009), the National Inquiry on Bushfire Mitigation and Management (Council of Australian Governments (COAG) 2004) and NSW Bushfire Coordinating Committee (BFCC) Guidelines (2008), an analysis and evaluation of bushfire risk and acceptable risk treatments have been undertaken. The complete report on Bushfire Risk Assessment and Risk Treatment Options conducted by Eco Logical Australia (ELA) can be found in **Appendix 19**.

16.1 Methods

The study was conducted using:

- Desktop study;
- Field survey; and
- Analysis of results.

Information was processed according to a methodology adapted from Dovey (2004) based on vegetation type (structure and available fuel loads) and condition (level of disturbance and regeneration), which allows the vegetation on-site to be classified into different fuel types. By comparing fuel types with the slope on which vegetation grows, a bushfire hazard class can be calculated resulting in a ranking of higher or lower potential fire behaviours compared to other sites in the area.

The risk classification scheme is developed through qualitative scales of likelihood and of consequences in methodology adopted from AS/NZ ISO 31000:2009 *Risk Management – Principles and guidelines* (Standards Australia 2009) and NSW BFCC Guidelines (2008). The terminology for describing risk factors is also consistent with the bushfire risk management planning process adopted by the NSW Rural Fire Service for 'rural fire districts' of NSW. Review **Appendix 19** for an example of the qualitative scales of likelihood and consequences.

16.2 Existing Situation

The area in and around the Project site, consists predominantly of cleared plains, native pasture and large areas of Manna gum in various conditions. The Project site is surrounded by grazing and cropping farms, with the exception of Kings Plains National Park 5 km to the north west and some heavily wooded areas around Wellingrove to the north east. For more information on vegetation communities and distribution refer to **Chapter 10** Flora and Fauna.

The Project site has not been affected by a major bushfire within the last 10 years. The last major fire in the surrounding locale occurred north of the Wellingrove Cluster in 2002. On average the Northern Tablelands Bushfire Management Committee area experiences five major fires a year.

Days with a higher fire index rating occur from August to March, with the peak fire season from August to December. The days with a higher fire index rating are generally associated with strong winds from the northwest accompanied by high daytime temperatures and low humidity. Easterly winds may also adversely affect fire behaviour and hamper control efforts during this time.

Generally, fires started by lightning strikes are most common, as are accidental fires started from rural and farming activities.

The existing level of bushfire protection for life and property in the surrounding Project area is relatively good. This is due to the extensive areas of cleared grazing land combined with the compartmentalisation of the landscape by roads, both of which act as fire breaks.

16.3 Potential Impacts

16.3.1 *Bushfire Impacts*

Using methodology adapted from Dovey (2004), it can be seen that the fuel types in the Study area vary from minimal to medium. These results, in conjunction with the analysis of slope, produced **Figure 16.1**, a bushfire hazard map. The steeper slopes with good condition Manna Gum Woodland, particularly adjacent to the proposed infrastructure in the Swan Vale cluster of turbines, have a medium bushfire hazard. The rest of the Project site, dominated by grasslands and poor condition woodland on flat or gentle slopes, is a low bushfire hazard.

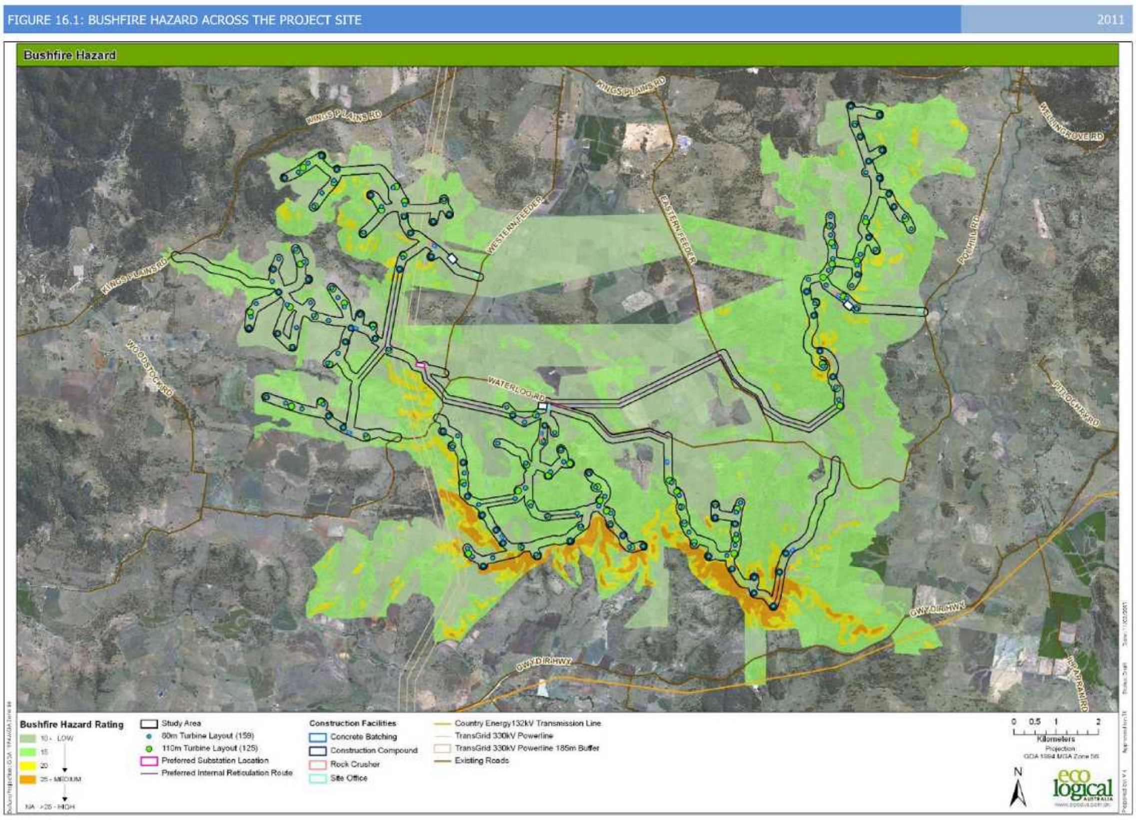

Figure 16.1 Bushfire hazard across the Project site

(An A3 size version of this Figure is displayed in Volume 2)

Applying the AS/NZS ISO 31000:2009 *Risk Management – Principles and guidelines* (Standards Australia 2009) to life (human), property (built assets) and property (stock and crops), the only category to have a rating above minor or insignificant was moderate for localised damage to stock and/or crops with short-term external assistance required to recover. For full results view **Appendix 19**.

16.3.2 *Construction and Decommissioning*

During construction and decommissioning, the use of flammable materials and ignition sources on-site increases the risk of fire.

16.3.3 *Operation*

Substations, ancillary infrastructure, wind turbines and transmission lines all have the potential to start or influence the spread of fire on-site due to the presence of electrical equipment and associated petrochemicals. Wind turbines in particular can start or influence fires from malfunctioning turbine bearings, inadequate crankcase lubrication, cable damage during rotation and electrical shorting or arching which occurs in transmission or distribution facilities (AusWEA 2001).

Fire in modern wind turbines is rare and dedicated monitoring systems (e.g. SCADA) enable turbines to be automatically shut down if ambient temperatures exceed the safe operating range, or if components overheat. Other remote alarming and maintenance procedures are required for electrical faults, which can still occur within the tower or nacelle creating a fire.

A wind turbine can influence its surrounding wind and temperature, which can ultimately impact on bushfires. However the amount of increase is approximately 0.7 °C in temperature and 0.6 m/s in wind speed at ground level (Baidya *et al*. 2004) which is negligible, considering existing vegetation is predominantly cleared pasture and grassland with low and minimal fuel loads.

Lightning strikes have the potential to occur at any wind farm location with the frequency of strikes dependent on the local climate and weather systems. Each wind turbine is built with lightning arresters to protect the turbine blades, nacelle and tower assembly. If the lightning is not grounded correctly, then minor damage can occur to the turbine, and potentially the surrounding area, starting a fire.

Underground electrical reticulation cables will be used where possible, as discussed in **Chapter 3** Project Description, which will reduce the risk of electrical fires. Where underground placement is not possible, overhead electrical interconnection lines will be used, which will have an increased risk of an electrical fire. The lines will be built, however, to appropriate specifications and routed to avoid trees and forest fragments where possible. This will reduce the maintenance required for Asset Protection Zones (APZs), which in turn will minimise the start/spread of a fire.

The transformers are located in the substation facility which will contain oil for the purpose of cooling and insulation. The substation will be built with sufficient bunding to ensure all oil is contained if a leak occurs, reducing the risk of oil spreading and potentially catching fire. The substation itself will be surrounded by gravel and concrete to minimise the spread of fire and improve the APZ.

The Project will also provide added benefit for any fire fighting operations due to the presence of new access tracks over terrain which previously had only unmade tracks. This will allow fire fighters to reduce fire response times and provide an opportunity to more easily access fires on properties within and neighbouring the Project.

16.3.4 *Cumulative Impacts*

An assessment of cumulative environmental impacts considers the potential impact of a proposal in the context of existing and future developments to ensure that any potential environmental impacts are not considered in isolation. As each wind farm development has to assess its potential impact on fires and bushfires in the area and provide mitigation measures, including a Bushfire Emergency and Evacuation Plan, it is anticipated that any potential cumulative effect to fire and bushfire from the approved Glen Innes Wind Farm and the proposed White Rock Wind Farm and Ben Lomond Wind Farms will be covered by appropriate mitigation measures highlighted in the respective project's Environmental Assessment.

16.4 Management and Mitigation

For appropriate mitigation and management strategies to be adapted to the Project, the risk analysis provided in **Appendix 19,** should be applied when assembling a management plan. This will then create a Bushfire Emergency and Evacuation Plan as shown in **Appendix 20**. The Bushfire Emergency and Evacuation Plan will become a sub-plan under the Emergency Evacuation Plan which aims to increase the awareness of the procedures during bushfire emergencies, increase the preparedness of construction and maintenance staff, and facilitate orderly and safe evacuation and refuge during times of bushfire impact.

Appropriate fire and bushfire management actions for all stages of the wind farm development (i.e. pre-construction, construction, operation and decommissioning) may include the following (a detailed list is provided in **Appendix 19**):

- Adherence to all regulations under the NSW *Rural Fires Act 1997* and the Northern Tablelands Draft Bushfire Risk Management Plans;
- The Rural Fire Service (RFS) and NSW Fire Brigade will be consulted in regard to the adequacy of bushfire prevention measures to be implemented on-site during construction, operation and decommissioning. These measures would potentially cover hot-work procedures, APZ's, safety, communication, site access and response protocols in the event of a fire originating in the Project infrastructure, or in the event of an external wildfire threatening the Project or nearby properties;
- Provide RFS with the locations of wind turbine generator (WTG) locations, ancillary infrastructure, construction work schedule, location of additional water supplies for construction, potential landing pads for fire fighting aircrafts and helicopters and access gates for fire fighting services;
- Installation of access tracks at appropriate width and vertical clearances with access suitable for all weather conditions;
- Education of construction crews and maintenance staff on the topic of bushfire risk management and risks that could be present at the Project;

- Provision of basic fire fighting equipment at each active site, including fire extinguishers, knapsacks and other equipment suitable for initial response actions with a minimum of one trained person on-site;
- Maintain provision for mobile telephone and Ultra High Frequency (UHF) radio communications;
- The collector substation will be surrounded by a gravel and concrete area, free of vegetation, to provide an APZ;
- The collector substation facility will be bunded with a capacity exceeding the volume of the transformer oil. The facility will be regularly inspected and maintained to ensure leaks do not present a fire hazard, and to ensure the bunded area is clear (including removing any rainwater);
- Placement and maintenance of APZ will occur around WTG's, transmission line easements and ancillary structures to minimise the spread of fire. Workplace health and safety protocols will be developed to minimise the risk of fire for workers in the control room and amenities;
- WTG's will be shut down if monitored components reach critical temperatures or if directed to by the RFS in the case of a nearby wildfire being declared (an all-hours contact number would be available to the RFS during the bushfire period);
- Flammable materials and ignition sources brought onto the Project site will be handled and stored as per manufacturer's instructions;
- Total fire ban days will be considered in regard to hours within which construction takes place, minimising the risk of fire and bushfire ignition; and
- Lightning protection will be installed correctly to minimise risk of malfunction.

16.5 Summary

The Project occurs in an area of low bushfire risk due to the vegetation and agricultural practices in the area. By reviewing the possible ignition sources from the wind farm and analysing bushfire risk assessments on life and property it is possible to create mitigation and management strategies to minimise the Project's impact on fire and bushfire risk. Through implementing these strategies in a Bushfire Emergency and Evacuation Plan it is possible to increase the awareness of the procedures of bushfire emergencies, increase the preparedness of construction and maintenance staff, and facilitate orderly and safe evacuation and refuge during times of bushfire. The consideration of these mitigation and management strategies will allow the Project to decrease its impact on fire and bushfire hazards.

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CHAPTER 17

Water Assessment

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17. WATER ASSESSMENT

This chapter reviews existing water conditions in accordance with relevant legislation and policies from the Director-General's Requirements (DGR's) as listed in **Chapter 5** Planning Context. The Project is subject to the following water related policies and plans, which have been considered as part of this assessment (see **Appendix 21** Riparian Assessment).

- Water Management Act 2000;
- Water Act 1912;
- NSW Wetlands Policy;
- NSW Weir Policy;
- NSW Groundwater Quality Protection Policy;
- NSW State Groundwater Dependant Ecosystem Policy;
- Border Rivers - Gwydir Catchment Management Action (CMA) Plan;
- Border Rivers Regulated River Water Source Water Sharing Plan;
- Border Rivers Unregulated and Alluvial Water Sources Water Sharing Plan (Draft); and
- NOW Guidelines/DWE Guidelines for Controlled Activities.

All these regulations provide for a number of water management targets including water sharing, water quality, management of water supply and wastewater, water conservation and efficiency, and river and wetland protection and rehabilitation. Water required for the Project, as discussed in **Chapter 3** Project Description, will be sourced from on-site water sources, such as bores and dams, where possible or brought in from off-site suppliers.

17.1 Existing Situation

The Project site lies within the MacIntyre Catchment. A number of small creeks and gullies drain from the ridges of the Project site, to the south via Swan Brook into the MacIntyre River and to the east, north and west into the Severn River catchment via one of five creeks; Kings Plains Creek, Spring Valley, Frazers Creek, Horse Gully and Wellingrove Creek. The Severn River is a principal tributary of the MacIntyre River in the Border Rivers Basin. The MacIntyre River forms part of the headwaters of the Barwon River.

17.1.1 *Groundwater Source*

The average registered water bearing zone (WBZ) of boreholes in the vicinity of the Project site is 26 m, with the highest recorded WBZ on-site at 10.9 m in the Sapphire Cluster. There are four WBZ that occur within 5 m of the surface north of Waterloo Road with the rest of the ground water tables varying between 10.4 to 56 m.

According to NOW, there is an important groundwater source under the floodplains of Kings Plains Creek and high quality groundwater in much of the fractured basalts of the hills. Most of the groundwater near Kings Plains Creek has been utilised in the past by sapphire mining companies. . Groundwater is also used for domestic and stock/agricultural purposes.

17.1.2 *Riparian/Watercourse Zone*

Most of the drainage lines in the study area are ephemeral, flow only for a short time post rainfall events and are minor tributaries draining off the ridgelines. Using the Strahler System (as detailed below), the streams on-site generally consist of:

Table 17.1 Strahler classification of streams at Sapphire Wind Farm

Stream Order	Location
1st	Near the ridges as ephemeral drainage lines with limited vegetation.
2nd	Occur across the Project site and are common in the gullies and lower elevations.
3rd or greater	Frazers Creek, Horse Gully, Kings Plains Creek and Wellingrove Creek and a number of their major tributaries.

To ensure adequate protection of these different classed steams a riparian corridor is defined, which consist of three zones, as follows:

Table 17.2 Riparian corridor zone classification

Zones	Description
Core Riparian Zone (CRZ)	The land contained within and adjacent to the channel.
Vegetated Buffer (VB)	An additional 10 m buffer on the outer edge of the CRZ that protects the environmental integrity of the CRZ from weed invasion, micro-climate changes, litter, trampling and pollution.
Asset Protection Zone (APZ)	A requirement of the NSW Rural Fire Service and is designed to protect assets (houses, buildings, etc.) from potential bushfire damage

As the study area is located on rural land, the APZ component of the riparian corridor has not been considered. **Table 17.3** provides the different CRZ widths for different stream orders. **Appendix 21** also provides a map which shows the CRZ and VB for the Project site.

Table 17.3 *Water Management Act 2000* CRZ widths

Types of Watercourses	CRZ Width
Any first order watercourse and where there is a defined channel where water flows intermittently.	10 m
Any permanent flowing first order watercourse or any second order watercourse where there is a defined channel where water flows intermittently or permanently.	20 m
Any third order watercourse or greater watercourse and where there is a defined channel where water flows intermittently or permanently. Includes estuaries, wetlands and any parts of rivers influenced by tidal waters.	20 – 40 m

17.1.3 *Wetlands*

There are a small number of freshwater wetlands found in the Border Rivers Basin, within the locality. These wetlands include River Oak Riverine Forests and Northern Montane Heaths composed of Tea-Tree Shrublands in drainage lines. The River Oak communities in the drainage lines do not occur downstream of the Project and are a widespread feature in the catchment. The Northern Montane Heaths occur in the upper reaches of neighbouring sub-catchments. The wetlands in the locality are not considered to be influenced by groundwater, instead relying upon ephemeral overland flows.

17.1.4 *Aquatic*

Most of the drainage lines in the study area are ephemeral, flow only for a short time post rainfall events and are minor tributaries draining off the ridgelines. Most of these streams surrounding the study area are considered to be first order streams, Frazers Creek and a number of its major tributaries are considered to be 3rd order or greater watercourses. No significant aquatic species are present within the Project site (see also **Chapter 10** Flora and Fauna for consideration of the Booroolong Frog (*Litoria booroolongensis*) presence in the Project site).

17.2 Potential Impacts

17.2.1 *Groundwater Source*

It is possible that construction work on the Project to intercept the groundwater table. If the wind turbine generators use a slab plus rock anchor foundation design, as discussed in **Chapter 3** Project Description, drilling could be required up to 20 m for the foundation. In the Sapphire Cluster it has been noted that the WBZ occurs at depths of 10.9 m. Should this form of foundation be utilised, appropriate measures would be taken to ensure that there was no impact on groundwater, including impact on flow rates and no contamination. For any road improvements carried out in gullies, it is unlikely that groundwater will be encountered, as work will be confined to existing ground levels.

There has been no research into groundwater directions, rates and physical and chemical characteristics at this time. Should the Project require bore water, detailed geotechnical studies will be undertaken to locate suitable bore holes, where permissible. This will be undertaken in combination with the necessary licensing requirements from the NOW and permissive occupancy rights of the affected landowners. As there are no previously identified groundwater dependent ecosystems within the Project site, impacts are predicted to be minimal.

17.2.2 *Riparian/Watercourse*

The construction phase of the Project will have the highest potential for impact on the riparian areas surrounding the development. The majority of work will occur on the ridge tops that have no or limited riparian corridors. For other work that occurs within the gullies and off the ridge tops, there is a higher likelihood for crossing riparian corridors. For a full description of construction works on-site see **Chapter 3** Project Description, however general construction activities could include excavation, trenching, concrete batching, and other earthworks. These activities can impact on surface waters by:

- Modifying surface drainage characteristics;
- Siltation from erosion and runoff;
- Siltation effects from catchment runoff; and
- Contamination of water resources.

Mitigation measures to minimise and avoid potential impacts from general construction activities and drainage line crossings are detailed below in Section 17.4.

17.2.3 *Wetlands*

The wetlands in the locality are not considered to be influenced by groundwater, instead relying upon ephemeral overland flows. The Project is not likely to influence the quantity, quality, or timing of natural flows of surface water into these wetlands. Impact on the Northern Montane Heaths, is not considered likely to occur, either directly or indirectly.

17.2.4 *Cumulative Impacts*

An assessment of cumulative environmental impacts considers the potential impact of a proposal in the context of existing developments and future developments to ensure that any potential environmental impacts are not considered in isolation. It is anticipated that there will be no cumulative effect to groundwater, riparian and watercourse corridors and wetlands from the introduction of the proposed development into the area.

17.2.5 *Aquatic*

The groundwater level data from surrounding bore holes suggests that the ridgelines are unlikely to support an ecosystem which is reliant on groundwater present at such depths. Therefore the potential impact on aquatic species is expected to be minimal, both within and external to the Project site.

17.3 Water Requirements and Sourcing

Water requirements will be met by sourcing groundwater from within the Project area 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. If water cannot be sourced locally, then it will be brought to site by external water suppliers under contract to the Project (*pers. comms*, State Water 2011).

It is estimated that in the order of 13.3 ML of water would be required to produce the quantity of concrete required for gravity footings for Layout Option 1, 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 4.2 ML of water would be required if standard rock anchors were used for all footings in Layout Option 1.

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

Based on the current regulatory provisions, if a company wishes to utilise water for dust suppression and concrete batching (both commercial/industrial purposes) from a bore licensed for stock and domestic purposes the following option is available:

17.3.1 *Purchase and Trade in Entitlement*

- The Proponent will apply to the Office of Water under the Water Act 1912 to authorise an additional purpose of industrial/commercial with a zero entitlement. This will require proof of occupancy and involve the associated landowner(s);
- The Proponent will identify the volumes of water required within an annual period and purchase this from an existing license holder with the necessary volumes and purpose. The purchase can be temporary or permanent. There are agents available which facilitate water trading who could assist. Following completion of the Project, the entitlement could then be traded once it is no longer required;
- An application for a transfer under the Water Act 1912/Water Management Act 2000 will need to be approved by the Office of Water to enable the trade to occur. This will require an assessment of the impact of the trade in accordance with relevant policy; and
- Under a Water Sharing Plan additional volumes may be able to be licensed for commercial activities in line with a controlled allocation policy.

Identification of appropriate water sources to enact this process will be determined post-consent, during the pre-construction phase of the Project once the turbine model and layout to be used have been determined. It will then be possible to calculate all necessary site water demands, the locality of proposed works, extraction points, times, volumes and rates. The necessary water licensing requirements will also be implemented, in accordance with NSW Government legislation and policy extant at the time. Should the on-site provision of water not prove feasible, then water will be sourced from commercial suppliers within the vicinity of the Project at the expense of the Proponent.

17.4 Management and Mitigation

Department of Water and Energy (DWE) have stated that any access tracks (with the exception of crossings) and all other works and disturbances should not be located in any CRZ, to ensure the integrity of the riparian corridors is not compromised. The design of the Project complies with this requirement.

All crossings will undergo detailed assessment and design post-approval, in line with the NOW *Guidelines for Controlled Activities* and NSW DPI *Why Do Fish Need to Cross the Road? Fish passage Requirements for Waterways.* There are several types of crossing which could be considered, including the use of box culverts, depending on the size of waterway and ecological habitat. All required watercourse crossings will be designed to protect and enhance water flow, water quality, stream ecology and existing riparian vegetation.

A Soil and Water Management Plan (SWMP), also discussed in **Chapter 18** General Environmental Assessment, will be prepared in line with the '*Blue Book'* (Landcom 2004) as part of the Construction Environmental Management Plan (CEMP) for the Project site, given the extent of the proposed access tracks and the nature of the soil on-site (see **Chapter 20** Statement of Commitments). The main objectives of the SWMP will be:

- To minimise soil disturbance;
- To prevent erosion events from increased surface runoff; and,

- To prevent disturbance of water resources in the area.

Specific measures that will be considered for inclusion in the SWMP include:

- All drainage from the Project is in accordance with the *Protection of the Environment Operations (POEO) Act 1997*;
- Avoid removal or disruption to naturally occurring drainage stabilisers;
- Installation of water slowing and diversion devices around construction areas, including devices to manage surface runoff from hardstand areas and surfaced access tracks;
- Design appropriate sedimentation basins to catch and treat all water from the Project site and consider utilising existing drainage paths for discharge points in respect of maintaining the natural hydrological regime and sediment movement patters, channel and bank stability, water quality and the identification of riparian buffers;
- All outlet structures are to be designed in accordance with the NOW guidelines to minimise construction and operation impacts on watercourse and riparian corridors. Considerations include, but are not limited to:
    - Any stormwater outlets should aim to be 'natural', yet provide a stable transition from a constructed drainage system to a natural flow regime outside any riparian buffers;
    - All ancillary drainage infrastructure, e.g. sediment and litter traps, should be located outside the riparian corridor. Runoff should be of an appropriate water quality and quantity before discharge into a riparian corridor or watercourse is allowed;
    - Discharge from an outlet should not cause bed or bank instability;
    - All stockpiles are to be located away from drainage lines, natural watercourses, road surfaces and trees, and are to be appropriately protected to contain sediment and runoff, e.g. sediment fencing; and
    - All water runoff that contains high silt content should be filtered and flocculated before it drains from the Project site.
- Changes to the quantity and quality of the receiving waters are to be monitored at the locations as listed in **Appendix 21** at suitable intervals (daily during construction, monthly during operation);
- Regular inspection, maintenance and cleaning of water quality and sedimentation control devices;
- If erosion is detected as a result of inadequate maintenance of drainage control devices, the relevant Environmental Manager shall be alerted and remedial action is to occur immediately, to ensure no re-occurrence of the event;
- Water management strategy to minimise water quality impacts and to maximise capture and reuse of water on-site;
- Incorporate permit/approval requirements for work within creek and riparian zones and application of the following guidelines:
    - *Managing Urban Stormwater: Soils and Construction* , 4th Edition (Landcom 2004);
    - *Managing Urban Stormwater: Soils and Construction*, Volume 2C Unsealed Roads, DECC;
    - *Guidelines for Controlled Activities,* NOW;

  - *Guidelines for Planning, construction and Maintenance of Tracks* (NSW LWC 1994); and
  - *Why Do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings*, NSW DPI (Fairfull & Witheridge 2003).
- The full suite of erosion controls and sediment controls are to be determined during the preparation of the SWMP;
- During operation the Operational Environmental Management Plan (OEMP) should monitor the following:
  - A regular inspection program for all facilities, tracks and watercourse crossings and rehabilitation sites;
  - Vehicles management e.g. restrict traffic to defined roads, including any wet weather crossing requirements;
  - Materials management e.g. control of maintenance activities and spill kits;
  - Wastewater management; and
  - Appropriate containment of refuse, rubbish etc.
- During decommissioning provide a management plan that incorporates mitigation measures that protect surface and groundwater sources.

Specific measures in the SWMP in relation to the design of access tracks would include:

- All roads have a sufficient cross-fall gradient to allow all runoff to be collected and treated;
- All watercourse crossings to be designed in accordance with the NOW guidelines and ensure that they do not adversely impact on the hydraulic regime of the watercourse;
- All watercourse crossing are designed and constructed in accordance with DPI guidelines to minimise any impact on the aquatic environment;
- The design and construction footprint and the extent of disturbances proposed within the riparian zone should be minimised;
- Maintain existing or natural hydraulic, hydrologic, geomorphic and ecological functions of the watercourse; and
- Stabilise and rehabilitate all disturbed areas in order to restore the integrity of the riparian corridor.

Specific measures in the SWMP in relation to hydrology would include:

- The establishment and operation of the concrete batching plant(s) facilities must be in accordance with the Environment Protection Authority's *Guidelines for the Concrete Batching Industry and the Environment Protection Licence* issued by DECCW;
- Concrete and cement-carrying vehicles should be washed out in appropriate wash-down facilities off-site;
- Management of hazardous material, waste and sewage;
- Wastewater produced from temporary on-site toilets during construction will be stored and trucked off-site;
- All hazardous materials are to be properly classified and stored away from flood prone areas and drainage lines. Appropriate spill kits and fire protection are to be provided on-site during construction;

- All hazardous materials are to be stored and transported appropriately in accordance with relevant DECCW and Workcover guidelines and regulations, to avoid release into the environment; and
- Any on-site refuelling must occur in an area greater than 100 m from the nearest drainage line and ensure correct practices are implemented, including:
    - Refuelling is to be carried out in a specified bunded area, according to regulatory requirements; and
    - Use of drip trays and spill mats.

Preparation of a detailed SWMP and CEMP can only be undertaken following final turbine selection, through a competitive tendering process after Consent has been granted. Once the turbine model and layout configuration are known, the detailed design work can commence which would include the preparation of these Plans.

17.5 Summary

The Project is not expected to significantly affect the watercourses or riparian vegetation within the site, the general locality and downstream due to limited activities within these areas and effective mitigation actions and management. Potential impacts could occur from construction activities and the extraction of groundwater for construction purposes.

There is the possibility for interception with the groundwater table if rock anchor turbine footings or sourcing of water from boreholes are required. If either of these eventuates, further investigations will be conducted post approval and in-line with applications guidelines and policies. No impacts on wetlands or groundwater dependent ecosystems are expected.

A SWMP will be prepared post approval and will be incorporated into the CEMP which will address all potential impacts, with the aim of minimising the risk of remediation efforts being required on-site.

The sourcing of water for construction activities will be undertaken using appropriate regulatory licences to access bore water, as outlined previously. Should it not prove possible to obtain water from within the Project site, then water will be purchased from local commercial suppliers and brought to site at the Proponent's expense.

CHAPTER 18

General Environmental Assessment

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18. GENERAL ENVIRONMENTAL ASSESSMENT

This chapter, in addition to **Chapter 19** Socio-Economic Assessment, addresses aspects of the proposed Project beyond the key issues identified in the Director-General's Requirements (DGR's). In summary the following chapter contains sections on climate, air quality, soils and landforms, waste, responses to consultation and aspects relating to construction.

18.1 Climate

On the Northern Tablelands of NSW, the climate is regarded as a cool temperate highlands region. Rainfall conditions across the Tablelands are relatively high, with a marked summer incidence and a 200 day frost interval (April to October) (DPI 2010).

A summary of climate data from Swan Vale (Numeralla) (Station No 56128, elevation 970 m) and the Glen Innes Agricultural Research Station (Station No 56013, elevation 1060 m) from the Bureau of Meteorology (BoM) is presented in **Table 18.1**.

Table 18.1 Annual weather conditions

Weather Conditions	Measurements	
	Swan Vale (Numerella)	Glen Innes Agricultural Research Station
Annual mean rainfall	849.9 mm	843.7 mm
Highest mean monthly rainfall	115.6 mm (December)	109.8 mm (December)
Lowest mean monthly rainfall	38.0 mm (April)	40.6 mm (April)
Annual mean minimum/maximum temperature	n/a	7.3 °C / 19.5 °C
Highest mean monthly maximum temperature	n/a	25.3 °C (January)
Lowest mean monthly minimum temperature	n/a	0.6 °C (July)

Source: BoM 2010

The Inverell Station (Station No 56242, elevation 582m) is the closest station that records the annual mean average of clear, cloudy and rainy days, which included 131 clear days, 86 cloudy days and 72 rainy days (BoM 2010).

18.2 Air Quality

18.2.1 *Existing Situation*

Air quality in the New England Tablelands, according to Glen Innes Severn Council's State of the Environment Report and the Inverell Shire Council's State of the Environment Report is generally considered to be good, as the area has a small and diffuse population with a lack of major industries. The area also has regular rainfall patterns, which act to remove particulates from the atmosphere, promoting vegetation cover and reducing dust generation (Glen Innes 2009). However, air quality can be affected by smoke on a seasonal basis via the use of solid fuel heaters during the colder autumn and winter months and occasional fire hazard reduction programs. Also in regional areas, fine particle dust pollution from uncovered and ploughed paddocks can become an air quality issue (Inverell 2009).

The Project site would not be expected to experience air quality issues from industry as it is located in a rural / agricultural setting. Low residential density means particulate emissions from wood heaters is not a significant issue. However, air quality could be affected by occasional bush fires, fuel reduction burns and dust particle generation from agricultural activity, development sites and unsealed roads during dry conditions.

18.2.2 *Potential Impacts*

The majority of potential impacts to air quality from the Project will occur during the construction phase. Dust particles and other emissions can be released from a range of activities, including:

- Clearing of vegetation;
- Open exposed areas;
- Stockpiles;
- Excavation works;
- Mobile concrete batching plants;
- Rock crushing;
- Processing and handling of material;
- Construction activities;
- Transfer points;
- Loading and unloading of material; and
- Haulage activities along unsealed roads.

SLR Consulting Australia Pty Ltd conducted a qualitative air assessment for the construction of the Project to determine if a PM10 study was required. As described in **Appendix 22** the predicted PM_{10} daily emissions will be 11 kg and the total daily dust will be 38 kg. These are quantities that can be appropriately managed in accordance with the Construction Dust Management Plan (CDMP). This plan will be implemented and dust deposition gauges installed near Mobile Resource sites to monitor dust emissions and ensure emissions do not exceed 4 grams per metre squared per month, in accordance with NSW Department of Environment and Climate Change and Water (DECCW) guidelines.

Cumulative Impacts: An assessment of cumulative environmental impacts considers the potential impact of a proposal in the context of existing developments and future developments to ensure that any potential environmental impacts are not considered in isolation. Other activities in the locality that have the potential to generate dust emissions include mining activities, the approved Glen Innes Wind Farm and the proposed White Rock Wind Farm. As both the Glen Innes and White Rock Wind Farms are proposed to be smaller than the Sapphire Wind Farm, the anticipated level of dust generation will be less. Given the amount of dust estimated to be generated from the Project in addition to these other activities, it is not anticipated to create a significant level of cumulative impact.

18.2.3 *Management and Mitigation*

The majority of work will not occur near residential areas. However, to ensure appropriate mitigation measures are utilised for dust and other emissions, a CDMP will be included in the Construction Environmental Management Plan and Operational Environmental Management Plan. Mitigation methods could include:

- During excavation topsoil will be stockpiled. After excavation topsoil will be replaced for seeding/fertilising and excess subsoil will be disposed of in an appropriate manner. If any excavation occurs on steep slopes the topsoil will need to be stabilised;
- Any stockpiled material will be covered with plastic and seeded or otherwise bound to reduce dust. Dust levels at stockpile sites would be visually monitored. Dust suppression (e.g. water sprays) would be implemented if required;
- During dry and windy conditions a water cart or alternative non-chemical dust suppression would be available and applied to work areas; and
- If blasting is required, Australia New Zealand Environment and Conservation Council guidelines for control of blasting impacts will be followed.

18.3 Soils and Landforms

18.3.1 *Existing Situation*

Eco Logical Australia prepared a Soils Assessment for the Project, **Appendix 23**. **Figure 18.1** presents the dominant underlying geology of the site as an unnamed unit of Basalt Flows, with a small distribution of Emmaville Volcanics found in the Sapphire and Wellingrove Clusters (Department Mineral Resources NSW 2003). An unnamed unit (comprised of Quaternary alluvial, residual or colluvial deposits of sand, silt, clay and gravel) is found in the central portion of the Swan Vale Cluster, extending northward. The main geological domain surrounding the site is Tertiary basalts (Lea et al. 1977) with outcrops of Palaeozoic Volcanics (granite) and alluvial sediments along water courses in the valleys.

Soil characteristics for the Project site are based on soil mapping published in the 1970’s using the Great Soil Groups classification, as no recent soil landscape mapping has been published for the Glen Innes locality (Lea et al. 1977a; Lea et al. 1977b). These soils include predominantly chocolate-Prairie soils in the Wellingrove Cluster, Black Earth-Euchrozem soils in the Sapphire Cluster and Black Earth-Prairie soils in the valleys and major drainage lines.

Associated landowners were also consulted to determine if there were any known contamination sites on their land. Many landowners indicated that whilst potentially contaminating activities (e.g. sheep dips, fuel storage, and herbicide spraying) occur on-site, these activities do not take place on ridge top locations that will be disturbed by the proposed development.

FIGURE 18.1: GEOLOGY UNITS ACROSS THE PROJECT SITE 2011

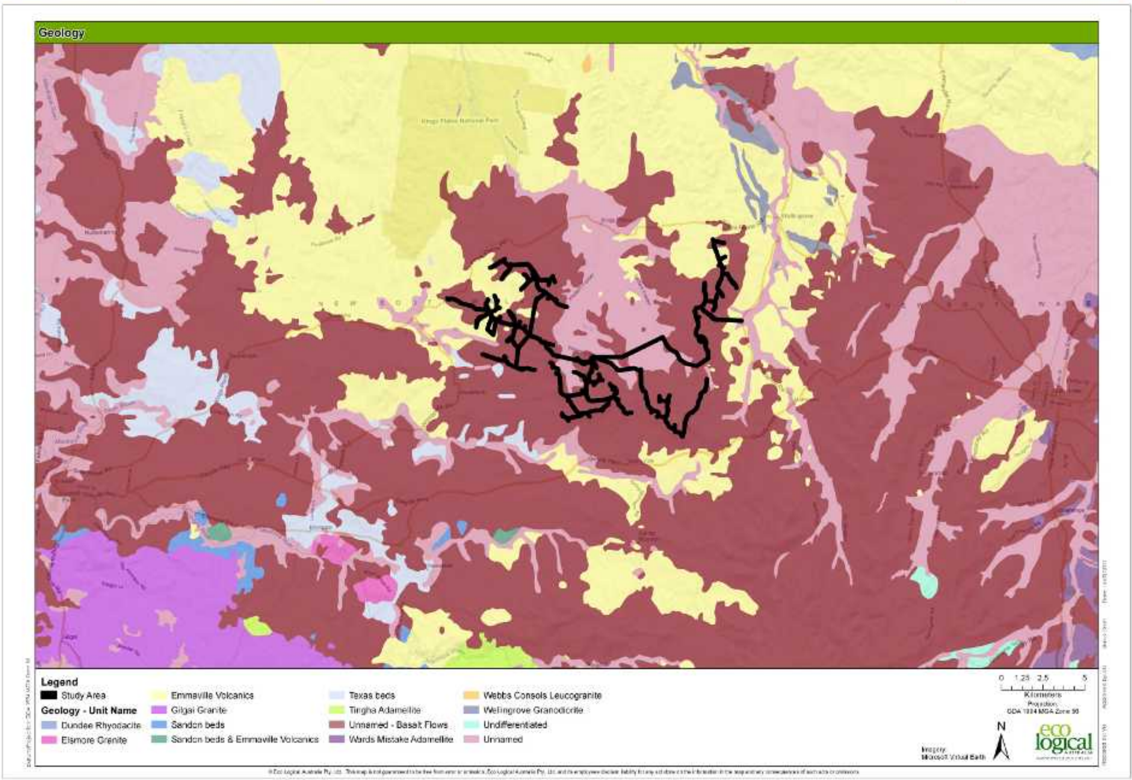

Figure 18.1 Geology units across the Project site

(An A3 size version of this Figure is displayed in Volume 2)

According to the Glen Innes Severn Council Annual Report 2008 to 2009 the council area has an estimated constant soil erosions rate of 52 t $km^{-2}a^{-1}$ (Gale & Haworth 2004). Based on the Australian Soil Classification, the erosion potential across the site for different soil groups is:

- Chocolate-Prairie soils: moderate to high depending on slope and ground cover;
- Black Earth-Euchrozem soils: low to moderate depending on slope and ground cover; and
- Black Earth-Prairie soils: low, however it can increase on cleared slopes.

18.3.2 *Potential Impacts*

The majority of potential impacts will occur during construction and will therefore be limited to the timeframe of construction activity on the Project site. These impacts could include soil compaction, erosion and contamination. The degree of these impacts will be determined by the characteristics of the soil (see **Appendix 23**) found across the Project site.

As the area experiences low levels of rainfall, there are expected to be minimal impacts from water erosion. However, any exposed soils will have higher susceptibility to water or wind erosion and will need to be considered appropriately during the construction phase.

Cumulative Impacts: The approved Glen Innes Wind Farm and the proposed White Rock Wind Farm are a sufficient distance from the Project site to ensure cumulative impacts will not occur. Construction activity is localised to specific clusters and turbine locations over the construction timeframe, therefore the likelihood of cumulative impacts is considered to be low given the distance between projects. It is therefore anticipated that there will be no cumulative effect to soil and landforms from the introduction of the proposed development into the area.

18.3.3 *Management and Mitigation*

A number of management actions will be implemented to manage surface runoff, exposed soil surfaces and contamination to surrounding soil. These methods will be included in the Soil Water Management Plan (SWMP) and will include:

- Procedures for personnel to manage suspected contaminated soils during earthwork construction;
- Planning for erosion and sediment control concurrently with engineering design, prior to any works commencing;
- Stabilisation of disturbed soil surfaces as soon as practicable after works have ceased in the area;
- All stockpiles covered to prevent the loss of material during wind and rain events. Where practicable stockpiles should be placed in areas sheltered from the wind; and
- Progressive rehabilitation of disturbed lands as soon as practically possible.

The SWMP should consider *Guidelines for planning, construction and maintenance of tracks* (NSW Department of Land and Water Conservation 1994) and *Managing Urban Stormwater: Soils and Construction, 4th Edition* (Landcom 2004) when designing, constructing and maintaining the Project. The SWMP will require detailed geotechnical investigations, which will take place post consent.

Also to minimise soil compaction at the Project site, the SWMP will have specific measures for stock management, including:

- Management of stock access during periods of vegetation and soil disturbances; and
- Removal of stock access from construction areas for entire construction periods to allow for regeneration, subject to landowner participation.

18.4 Waste

During the construction of a wind farm there are a variety of wastes produced, including:

- Cleared vegetation;
- Packaging material;
- Building materials;
- Domestic wastes;
- On-site toilets; and
- Chemicals.

Under the NSW DECCW Waste Classification Guidelines there will be liquid waste and general solid waste (non-putrescibles) produced. All waste will be disposed of in line with Council and NSW DECCW guidelines.

To handle the waste on-site from packaging and building materials and domestic waste there will be both skip bins and recycling bins. Vegetation will be mulched and used on-site where feasible, otherwise the rest can be burnt on-site with permission from Council, provided as firewood to landowners or taken to the Glen Innes Village landfill sites. The on-site toilets will either be drained by a septic tank or be an enclosed unit. All chemicals and oils will be treated as contaminated waste at the Glen Innes Village or suitable landfill. Any disposal of unsuitable excavated material will require development consent from the appropriate authorities. For full details on mitigation and management see **Chapter 20** Statement of Commitments.

Cumulative Impacts: The approved Glen Innes Wind Farm and the proposed White Rock Wind Farm will both have in place mitigation and management measures to minimise and dispose of waste correctly. Also, post construction the Project will produce minimal waste materials, similar to the other wind farms, and it is therefore anticipated that there will be no cumulative waste production from the introduction of the proposed development into the area.

18.5 Response to Consultation

18.5.1 *Trigonometrical Stations*

The Department of Lands (DoL) were asked to provide advice on the proximity of the proposed wind farm to the Wellingrove and Matheson Trigonometrical Stations (TS) within the Project site. These TS are located 1.0 km and 70 m respectively from the proposed wind turbine locations. When DoL was originally consulted in 2009, the wind turbines were initially closer to each TS, which caused the DoL to ask that these wind turbines be moved further away (**Appendix 24**). Following changes in the Layout Options, this request has been met.

The DoL also indicated that neither of the TS are located on Trigonometrical Reserves and so the Surveyor General cannot insist on any additional conditions for construction. However it was requested that during the construction phase, care is taken not to disturb or damage these TS's or the adjacent witness marks. Fines apply under current legislation should the TS locations be disturbed, damaged or destroyed and the Proponent would be required to reinstate them. The Proponent has therefore committed to avoid disturbing / damaging the TS's and adjacent witness marks.

18.5.2 *Crown Roads and Crown Land*

The DoL were also asked to provide input on aspects of the Project that may affect Crown Roads and Land (**Appendix 24**). As such a number of Crown Roads that are both held and not held under Enclosure Permits have been identified. Pending Development Approval, applications will be lodged with the DoL to close and transfer the affected Crown Roads to the adjoining landowners. To expedite the process the Proponent, in consultation with the adjoining landowners, intends to submit letters of intent to close the affected Crown Roads in readiness for the process to commence should Approval be granted.

18.5.3 *Native Title*

In consultations with the DoL advice was sought as to whether Native Title existed across any of the landholdings affected by the Project. The Land and Property Management Authority (LPMA) have confirmed that Native Title is extinguished over all lands affected by the proposed Sapphire Wind

Farm. However there are two lots that occur adjacent to the site (Lots 287 / 288 of DP 750076) that have incomplete Land Claims (9799 and 9800 respectively).

18.6 Construction

Eco Logical Australia Pty Ltd (ELA) (2009) conducted a risk analysing in accordance with Australia Standard 4360: *2004 Risk management* and Handbook HB 203:2006 *Environmental risk management – principles and processes* to provide a framework to analyse the activities, products and services relating to pre-construction, construction and operation stages of a wind farm, which meets the requirements listed in the DGR's. **Chapter 3** Project Description provides an overview of these activities and **Chapter 20** Statement of Commitments determines the management, mitigation and monitoring for the Project.

18.6.1 *Management and Mitigation*

To ensure all potential impacts during pre-construction, construction and operational stages are mitigated and managed a number of Management Plans will be created, based on the risk analysis done by ELA (2009). **Chapter 20** Statement of Commitments lists each activity, the impact it will have and possible risk treatment. Below is an overview of each necessary Management Plan and the main high residual risks which should be addressed.

Construction Environmental Management Plan: The Construction Environmental Management Plan (CEMP) will be developed prior to pre-construction and used to address environmental impacts identified by the risk analysis process in both the pre-construction and construction stages. The CEMP will consist of and address the following:

- A Soil and Water Management Plan (SWMP) in accordance with Landcom (2004), Managing Urban Stormwater: Soils and Construction, 4th Edition:
    - Soil erosion and sediment management;
    - Contaminated soil disturbance;
    - Water quality monitoring procedure for earthworks occurring in or adjacent to riparian areas;
    - Water management strategy to minimise water quality impacts and to maximise capture and reuse of water within the site; and
    - Incorporate permit/approval requirements for work within creek and riparian zones in accordance with NSW Office of Water (NOW) and NSW DECCW.
- A Construction Dust Management Plan (CDMP) as listed in **Appendix 22**;
- Manage site security and uncontrolled access via a lockable chain link fence around the temporary site facilities to minimise acts of vandalism and arson;
- Obtain necessary licenses and permits from NOW, Department of Primary Industries (DPI) and NSW DECCW;
- Manage disturbance to 'no go' areas by flagging, fencing and including details on hard copy and electronic construction plans;
- Designate environmental management responsibility to key personnel;
- Transport of oil (80,000 L for collector substation transformer and 1,000 L per wind turbine generator transformer) will be via purpose built vehicles/tankers in accordance with the Australian Dangerous Goods Code and will be fitted with emergency spill equipment. Oil will be

transferred to transformers by qualified personnel, who have training in emergency spill response. Spill control equipment will be available at the point of use;

- Incorporate licensing requirements for the concrete batching plants into the CEMP, including speed limits, portable spill kits, and management of concrete slurry;
- Use of fire mitigation and management strategies discussed in **Chapter 16** Fire and Bushfire;
- Use local water supplies, where possible, in written agreement with local landowner;
- Community consultation strategy for the duration of the construction period, to keep community informed of progress/delays and to maintain a method for receiving and addressing community feedback; and
- A number of other mitigation measures are outlined in **Chapter 20** Statement of Commitments.

Operational Environmental Management Plan: An Operational Environmental Management Plan (OEMP) will be developed prior to the completion of construction activities in order to address the broad range of the environmental impacts identified in this risk analysis. The OEMP may be combined with the CEMP for the development. The OEMP will also need to address additional mitigation measures outlined in **Chapter 20** Statement of Commitments.

CHAPTER 19

Socio-Economic Assessment

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19. SOCIO-ECONOMIC ASSESSMENT

This chapter, in addition to **Chapter 18** General Environmental Assessment, addresses aspects of the proposed Project beyond the key issues identified in the Director-General's Requirements (DGR's). In summary the following chapter contains sections on land value, mineral exploration, tourism, community wellbeing, the Community Fund and the local economy.

19.1 Land Value

As with any property and land holding there are many factors which can influence perceived and actual property values, including prevailing and permitted land uses, economic conditions, access/proximity to markets/workplaces and lifestyle considerations. In most agricultural areas the main determinant of property and land values is the productivity of the land for agricultural or livestock purposes.

It is a commonly held misbelief that wind farms can affect property and land values, and as such there have been a number of studies conducted to determine the significance, if any, of wind farms on land values. These studies, however, have predominantly concluded it is not possible to isolate the sole effect of wind farms on property and land values due to the myriad of factors (as outlined in the first paragraph) influencing value. By comparing the positive and negative impacts of the construction and operational stages of a wind farm to existing knowledge on what causes changes in property values, it is possible to predict the relationship between wind farms and property values.

Henderson and Horning Property Consultants (H&HPC 2006) conducted a study covering a fifteen year period into the relationship between wind farms and property/land values by assessing local property values around the operating Crookwell 1 Wind Farm in the NSW Southern Tablelands. The study also reviewed other overseas wind farms to compare with the Australian market. The United Kingdom perceptual study conducted by the Royal Institute of Chartered Surveyors (RICS 2004) concluded that the main negative impacts were visual impact, fear of blight (see **Section 19.1.1** below) and proximity of a property to a wind turbine. The conclusions from H&HPC relevant to this Project are:

- That agricultural productive capacity of the land subject to the wind farm and the surrounding property is not in any measured way affected by the wind farm;
- The associated property has additional revenue and benefits from the lease agreement, improved roads, erosion control and passive wind protection for stock from the substation and turbine towers;
- The future development of the land under existing planning controls would continue as zoned 1(a) Rural Zone;
- The wind farm development has the potential to slow down the shift of productive agricultural land to rural residential use in the short to medium term;
- There was no measurable reduction in values of properties that have a line of sight to the Crookwell 1 wind farm; and
- Soils, improvements and access to services are more important drivers of property values than visual impacts.

In a straw poll conducted by Nuridin (2009), she spoke with the Real Estate Institute of Australia and several other real estate agents operating in locations with wind farms to see if wind farms did influence property/land values. All interviewed agents replied that “there is no indication of any depreciation in the value of properties hosting wind farms, or those adjacent to, or in sight of turbines” (Nuridin 2009). In fact according to some agents the Albany the wind farm is used as a marketing tool and in Ararat the wind farm has caused the town to prosper (Nuridin 2009).

The NSW Valuer General released a report summarising the impact of wind farms on land values in Australia, analysing impacts of eight wind farms across NSW and Victoria (NSW Valuer General, 2009). This report found that wind farms do not appear to negatively affect property values across varying land uses, including rural, rural residential and residential. Results suggested that a property’s underlying land use may affect the property’s sensitivity to price impacts. There were no evident reductions in sale price for rural or residential properties located in nearby townships with views of the wind farm. Due to the remoteness of the wind farms, only a small number of samples were available for inclusion, limiting the conclusions that could be drawn, and highlighting the need for future studies.

The value of land suitable for subdivision could also be affected; however, as discussed in **Chapter 4** Project Justification, there are no subdivision applications or approvals for the Project site, so this is not considered relevant to the Sapphire Wind Farm. Subdivision applications which have been approved by the Inverell Shire Council near the Project will not be directly impacted upon. Moreover Council planning controls are set to limit the properties which can subdivide in the future. Conversely, due to the additional revenue from hosting wind turbines to associated landowners, subdivision is less likely to occur in the short to medium term and the land will continue to be used for sheep and cattle grazing. Some surrounding landowners have raised the concern that construction and operation of the wind farm will decrease the number of potential buyers within the market, which in turn could diminish property values. As already discussed, there are many factors that influence an individual’s decision when purchasing a property and the presence of a wind farm may or may not have an influence on this decision. For example, a potential buyer may seek a life-style with a green energy aesthetic or have no issue with wind turbines.

It should be noted that the Project cannot be developed without some risk of property value impacts during the construction and operational phases, as personal perceptions and tastes will likely come into play. Due to the difficulty in assessing the real impacts on property values there are no suggested mitigation methods to apply. However as the Community Wellbeing and Local Economy (**Sections 18.4** and **18.5**) can be positively affected by the Project, such effects can be considered to contribute to the mitigation of any loss of property value that may occur.

19.1.1 ***The Concept of “Blight”***

Compensation for “blight”, relating to the loss of future property value or from loss of amenity, was scrutinised in the Land and Environment Court in the case of Taralga Landscape Guardians Inc v Minister for Planning and RES Southern Cross Pty Ltd, 2007. The Taralga Landscape Guardians Inc sought compensation in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991* New South Wales (NSW). However the proposition presented a number of insurmountable hurdles according to Chief Judge, Justice Preston.

The Taralga Wind Farm was proposed by a private developer on land where the development was permitted. The Chief Judge summarised that if the concept of blight and compensation were to be applied to the Taralga project, then any otherwise compliant private project which had some impact in lowering the amenity of another property would be exposed to a claim. The Chief Judge went further in saying that:

> *"Creating such a right to compensation would not merely strike at the basis of the conventional framework of land use planning, but would also be contrary to the relevant objective of the Act, in s 5(a)(ii), for 'the promotion and co-ordination of the orderly and economic use and development of land'".*

The resulting decision from the Taralga judgement is relevant to the Sapphire Wind Farm, as the Proponent has leased the land for a permitted land use.

19.2 Mineral Exploration

19.2.1 *Existing Situation*

The proposed Project is located in the New England Fold Belt, along the spines of the ridges surrounding the Kings Plains district. The main geological domain surrounding the site is Tertiary basalts (Lea et al. 1977a) with outcrops of Palaeozoic Volcanics (granite) and alluvial sediments along water courses in the valleys.

There are no mineral drill holes or metallic mineral deposits recorded on-site. There are 8 companies which hold mineral titles across the site, who are shown in **Table 19.1** below.

Table 19.1 Exploration and Mining Licences overlapping the Project site

Company	Title(s)	Minerals Listed
Australian Gemstone Resources PL	ML 1492 EL 6982	Sapphire. Diamond, corundum, ruby and sapphire.
DE GUNST, Steven	ELA 4332	Diamond, corundum, ruby and sapphire.
Eastern Feeder-Holdings PL	ML 1374	Diamond, corundum and sapphire.
Inishowen Resources PL	EL 7374	Diamond, corundum, ruby and sapphire.
Jesasu PL	AL 2 AL 14	Corundum, Zircon, Sapphire. Diamond, corundum and sapphire.
Pan Gem Resources (Aust) PL	ALA 19	Corundum and sapphire.
Parnosa PL	EL 7669	Diamond, corundum, ruby and sapphire.
Valbob Mining PL	EL 7796	Elemental minerals (metallics).
Volcan Australia Corporation PL	EL 7301 EL 7302	Metallic minerals and non-metallic minerals. Metallic minerals and non-metallic minerals.

There are no metallic mineral sites currently being mined within the Project site. There are numerous industrial mineral sites surrounding the Project, however most are not operating, with the exception of five: NC and ML Campbell, TJ McCormack, DB and KF Wilson, DR and GD Burnham and one unnamed company extracting sapphire and corundum (DPI 2011).

19.2.2 *Potential Impacts*

The Project has potential to inhibit any current or future exploration of the area for mineral resources during the construction and operation phases. To determine the degree of potential impact, the Proponent contacted each involved mining company, as discussed in **Chapter 6** Stakeholder Consultation and provided each company with information relating to the proposed Project.

During the operation of the Project mineral exploration can still occur around the wind turbines and associated infrastructure, and the upgrading of roads can assist in the matter. There will be a limit on the proximity such activity can occur to a wind turbine, to prevent any instability in ground conditions leading to turbine failure.

Volcan has advised that the locations of the proposed wind turbines do not appear to adversely impact their licences and that they have no objections to the proposed Project. Other companies failed to respond to consultation despite repeated attempts to contact them.

Cumulative Impacts: The level of mining activity within the area is relatively small-scale, localised sapphire and gemstone mining which has no direct impact on the Project. The proposed White Rock Wind Farm and consented Glen Innes Wind Farm are distinctly separate from the Project. No exploration or mining licences tend to overlap multiple projects, but where broad-scale exploration licences exist it is impossible to predict where mining activity may take place. Therefore there are no anticipated cumulative impacts likely to occur from mining operations.

19.2.3 *Management and Mitigation*

The Proponent will continue to liaise with relevant mining companies and provide updates of any modifications to the Project design that arise prior and during the construction of the Project.

19.3 Tourism

Wind farms appear to be generating great public interest, as experienced in many regions of Australia, including the Esperance and Albany Wind Farms in the southern region of Western Australia, Windy Hill Wind Farm near Ravenshoe, Queensland, Lake Bonney Wind Farm near Tantanoola, South Australia and Capital Wind Farm near Bungendore, Canberra. Tourists are able to drive around these wind farms, and even walk up to a turbine at the Albany Wind Farm. Wind farms are even appearing on top destination lists with the Albany Wind Farm, Western Australia voted number 16 out of 20 for Western Australia's Top 20 Tourist Destinations and it is believed that more than 100,000 vehicles visit the wind farm annually (MAP Marketing 2008; Verve Energy 2008).

With the potential for increased traffic from visitors to the wind farm, other economic opportunities exist through activities such as wind farm tours, souvenirs, food and drink, accommodation, etc. which could form the basis of a wind tourism industry. Similarly, increased visitor numbers attracted by the wind farm could result in increased exposure to other local attractions and amenities.

Glen Innes Severn Council regularly holds events and venues, including:

- Gourmet in the Glen NSW Wine and Food Festival 2008;
- New England Regional Wine Show 2008;

- Land of the Beardies Festival 2008;
- International Women's Day 2009;
- Minerama Fossicking and Gem Show 2009;
- Seniors Week 2009;
- Youth Week Celebrations 2009;
- Art Gallery – Victorian Fire Fund Appeal;
- Australian Celtic Festival;
- Mosman Friendship;
- Grafton to Inverell Cycle Classic 2008;
- Glen Innes Show 2009; and
- Australia Day 2009.

The Inverell Shire Council Annual Report (2009-2010) lists agri-tourism and eco-tourism amongst Council's economic development objectives. Inverell Shire Council regularly holds events and venues including:

- Youth Council Committee;
- Sapphire City Festival;
- Opera in the Paddock Sapphire;
- City Floral Festival; and
- Tom Roberts Festival.

The Project will have the potential to increase visitor numbers to both councils, as demonstrated with other wind farms in Australia. However, as the Project occurs on private land, tourists will only be able to access the wind farm area from public roads. If increased traffic is recorded within the area, a parking/stopping bay to provide a vantage point for the wind farm could be considered by the Proponent, subject to the suitability and availability of land.

According to the Glen Innes Tourism Development and Marketing Plan 2010 to 2015, their mission is "to build on the economic value that tourism can provide our community for both current and future generations". The Project will help meet this mission by assisting the "Tourism Product Development", which is "the establishment of experiences, attractions and tourism infrastructure for their LGA".

19.4 Community Wellbeing and Community Fund

19.4.1 *Existing Situation*

Both the Inverell Shire and Glen Innes Severn Councils have in place Strategic Plans to provide information on aspiration goals for each community, including each council's mission and purpose. As a part of Inverell Shire Council's community aspirations, their aim is to end up a community that is "healthy, educated and sustainable" (2009b). To reach this destination two of their strategies, which the Project will be able to assist with are, "Reduce the consumption of non renewable resources" and "Facilitate the provision of opportunities for residents to gain employment". Glen Innes Severn Council's vision is to "lead a confident, inclusive community that is resilient and proud of its spirit and collective achievements, heritage and environment" (2011). The Project will assist this vision by helping council meet its strategic outcome of a Prospering Community where "jobs are created, industry and commercial ventures are encouraged".

19.4.2 *Potential Impacts*

Community wellbeing will be positively influenced by the Project during the construction and operation phases in a number of ways, including:

- A short term increase in population during construction due to the incoming work force;
- A potential increase in population during operation due to increased money in the economy, which supplies infrastructure;
- A small increase in full-time employment during operation for a select skilled workforce;
- With increased money in the economy and increased population, the potential for improved tertiary study; and
- The upgrade of roads to accommodate heavy vehicles during construction.

There will also be an increase in the number of jobs available in the area during the construction of the Project. At the Snowtown (Stage 1) Wind Farm in South Australia, which has 47 wind turbines and an installed capacity of 98.7 MW, there was an average of 55 to 65 workers on-site each week. Overall it is estimated that there were 130 people hired directly over the construction of the Project, including contracted companies (*pers. comms*, Campbell 2009). The Sapphire Wind Farm will have more wind turbines and a greater installed capacity, which could result in more people hired during the construction phase of the Project.

Cumulative Impacts: It is anticipated that the approved Glen Innes Wind Farm and the proposed White Rock Wind Farm will not have an adverse cumulative effect to community wellbeing from the introduction of the proposed development into the area. Instead these wind farms will provide additional jobs and resources into the surrounding Councils and will help both Councils reach their aspirations and visions.

19.4.3 *Management and Mitigation*

The Proponent is committed to providing a Community Fund to benefit the local area in the vicinity of the Project. The purpose of the fund is to support community groups, programmes and activities that community values or requires support for. Such programmes have been successfully established for Wind Prospect developments in South Australia and the United Kingdom.

The Proponent is proposing to contribute $2,500 per wind turbine into a Community Fund as each stage of the Project commences commercial operation, as outlined in **Section 3.9.2**. Contributions will continue annually for the lifetime of the Project until such date that the Project ceases operation and is decommissioned. Based on the two layout options proposed for the Project this could total $312,500 to $397,500 per annum, equating to $6.25m to $7.95m over an estimated 20 year Project life.

Possible options for the structure and administration of the Community Fund include, but are not limited to:

- The fund split equally between the two Councils;

- The fund managed by a publicly-elected group;
- Funding to sporting clubs, infrastructure, education, etc;
- Funding to local environment and cultural heritage projects; and/or
- Variable funding to groups based on their proximity to the Project.

With the addition of the Community Fund and other secondary effects from the construction and operation of the Project, both Councils and surrounding towns are expected to experience an overall increase in community wellbeing.

Cumulative Impacts: There is the possibility of a significant income into the council areas to support community-based projects from the combination of Community Funds also provided by White Rock Wind Farm and Glen Innes Wind Farm. As each wind farm is built, the opportunity exists for funding to be combined into a single pool of monies to enable more substantial community projects to be realised.

19.5 Local Economy

19.5.1 *Existing Situation*

As previously discussed the Project occurs across two Councils, Glen Innes Severn and Inverell Shire, so any existing or potential impacts will be localised within these Council areas. **Tables 19.2** and **19.3** show comparative employment figures for a range of industries in both councils for 2009. Glen Innes Severn's main industries include agriculture, retail trade, health and community and the tourism/service industry. The main industries in the Inverell Shire Council include agriculture, meat and meat product manufacturing and education.

Table 19.2 Most common industries of employment for Glen Innes Severn Council (2009).

Industry	Glen Innes Severn (%)
Agriculture	41.9 %
Tourism/Services	32.0 %
Retail trade	14.0 %
Health and Community Services	12.1 %

Source: Adapted from Glen Innes Severn Council SoE 2009

Table 19.3 Most common industries of employment for Inverell Shire Council (2009).

Industry	Inverell (%)
Agriculture	12.7 %
Education	6.0 %
Meat and Meat Product Manufacturing	5.3 %
Residential Care Services	3.4 %
Supermarket and Grocery Stores	3.0 %

Source: Adapted from Inverell Shire Council SoE 2009a

19.5.2 *Potential Impacts*

Of all the stages of a wind farm development, the construction and decommissioning stages of the Project will generate the largest economic gain for the greatest number of people and businesses in both Council areas. This is due to the hiring of a large temporary work force over approximately two years of construction and later one year of decommissioning. Employment opportunities would involve concreting, earthworks, steel works and electrical cabling during construction, with demolition and removal during decommissioning. Indirect employment opportunities would involve food industries, fuel, accommodation and other services that contractors coming to the area would require. Where possible the Proponent will source from local companies (as has commonly been the case with other wind farm developments around Australia), which is likely to include the utilisation of nearby quarries during construction.

There will be some short-term impacts during construction, such as modified grazing activities of associated landowners. However, all associated landowners will be compensated for any potential impacts and therefore localised negative economic impacts will be minimised.

During the operation of the wind farm there would be a small number of permanent jobs available. The Community Fund as discussed above and in **Chapter 4** Project Justification would also provide financial benefits and improved equity to the surrounding communities, improving the existing economic situation.

Cumulative Impacts: The approved Glen Innes Wind Farm and the proposed White Rock Wind Farm will not have an adverse cumulative effect to the local economy from the introduction of the proposed development into the area. Instead these wind farms will provide additional jobs and utilise existing resources in the surrounding area where feasible.

19.5.3 *Management and Mitigation*

To ensure that the local Councils benefit from the construction of the Project, local contractors will be used where feasible. This will involve the Proponent liaising with local industry representatives to utilise the full potential of local resources. A number of local businesses have already made themselves and their services known to the Proponent.

CHAPTER 20

Statement of Commitments

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20. STATEMENT OF COMMITMENTS

The Statement of Commitments (SoC) is a review of all management and mitigation measures mentioned in previous chapters of this Environmental Assessment (EA) that will be managed by the Proponent. The framework for the SoC is displayed in **Figure 20.1**, and comprises an Environmental Management Plan (EMP) that combines the Construction Environmental Management Plan (CEMP) and the Operational Environmental Management Plan (OEMP). Within these plans there are a number of sub-plans to assist in the amelioration, management and mitigation of environmental impacts from the construction and operational phases of the Project.

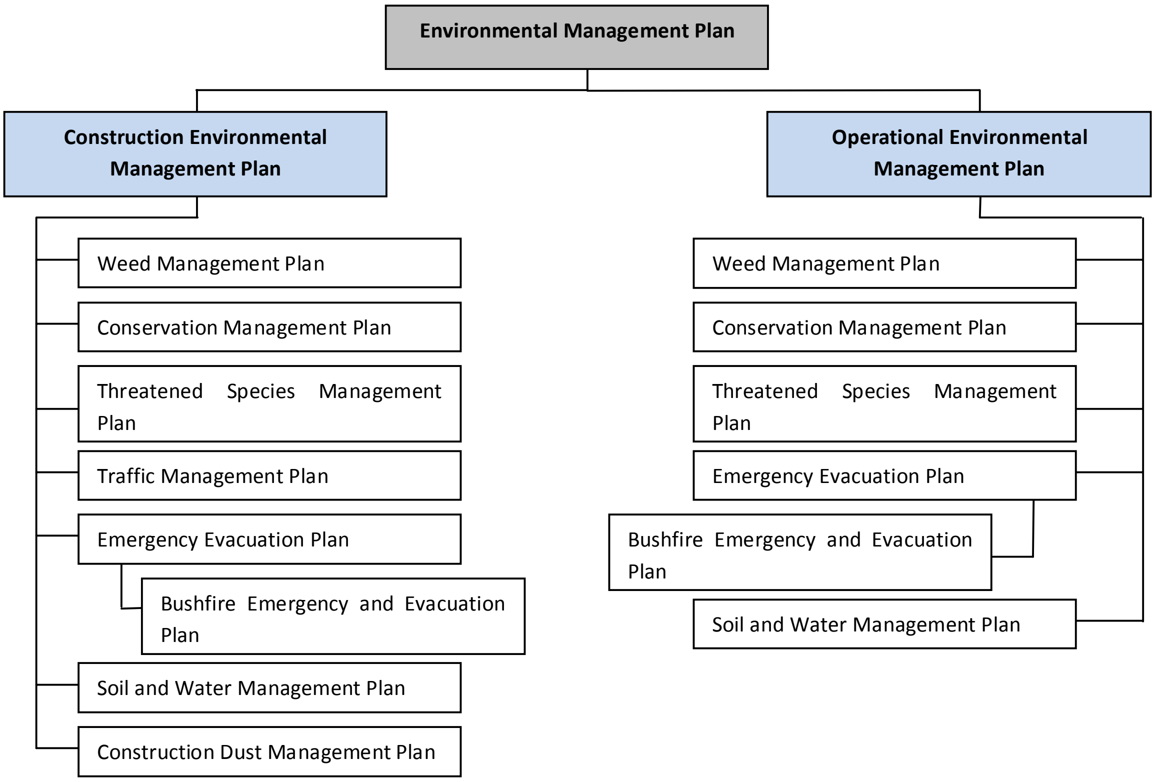

Figure 20.1 Environmental Management Plan framework

20.1 Management Plans

The following section provides an overview of each of the plans and how each relates to the overall scheme of ameliorating, mitigating and managing identified environmental impacts in this EA during the construction and operational phases of the Project.

CEMP: The main aim of the CEMP will be to ameliorate, mitigate and manage any identified environmental impacts during the construction phase of the Project. This will be done through controlling, training and monitoring measures. The CEMP will cover a number of other plans, creating a working environmental plan during construction.

OEMP: The main aim of the OEMP will be to ameliorate, mitigate and manage any identified environmental impacts during the operation phase of the Project. This will be done by combining, where feasible, with the CEMP and adding additional mitigation and management strategies for operational environmental impacts. The OEMP will cover a number of other plans, creating a working environmental plan during operation.

Weed Management Plan: The main aim of this plan will be to stop the spread of weeds during both the construction and operation phase of the Project. This will involve areas of the Project that will have soil disturbance and vegetation clearance, vehicle and machinery movement between sites, importation of soil, rocks and revegetation. By implementing a Weed Management Plan within both the CEMP and OEMP, the spread of weeds can be mitigated and managed.

Conservation Management Plan: The main aim of this plan is to limit vegetation clearance/disturbance during the construction phase of the Project and monitor fauna during the operational phase of the Project. This plan will involve the movement of vehicles and machinery between sites, damage to surrounding tree roots, vegetation clearance, smothering of vegetation by dust particles, accidental capture/death or injury to fauna and temporary removal of fauna habitat. By implementing the Conservation Management Plan within both the CEMP and OEMP, vegetation clearance/disturbance and the impact on fauna can be ameliorated, mitigated and managed.

Threatened Species Management Plan: The main aim of this plan is to limit the amount of accidental injury to and/or death of threatened species located within the Project site mainly during the construction phase, but also during any maintenance throughout the operational phase. By implementing the Threatened Species Management Plan within the CEMP and OEMP, accidental injury to and/or death of threatened species can be ameliorated, mitigated and managed.

Cultural Heritage Management Protocol: The main aim of this protocol is to limit the impact on Cultural Heritage items found during the construction and operational phase of the Project. By implementing the Cultural Heritage Management Protocol within the CEMP and OEMP the impact on Cultural Heritage items can be ameliorated, mitigated and managed.

Traffic Management Plan: The main aim of this plan is to minimise risk from increased traffic on the roads in the Project site during the construction phase of the Project. This plan will involve the movement of vehicles and machinery between sites and the haulage process. By implementing the Traffic Management Plan within the CEMP the impact of increased traffic on the roads can be ameliorated, mitigated and managed.

Emergency Evacuation Plan: The main aim of this plan is to provide an effective and suitable emergency evacuation plan for use on-site during the construction and operational phase of the Project. The EEP will consist of planned activities that will occur during construction and maintenance, and in the event of a fire or bushfire in the vicinity of the Project site. By implementing the Emergency Evacuation Plan within the CEMP and OEMP all emergency evacuations will be carried out in an effective and suitable manner decreasing the risk of injury and damage.

Bushfire Emergency and Evacuation Plan: The main aim of this plan is to provide planned and orderly evacuation procedures to construction and maintenance employees, visitors and landowners in the event of a bushfire impacting the Project site during the construction and operational phases of the Project. This plan will be a sub-plan under the Emergency Evacuation Plan. By implementing the Bushfire Emergency and Evacuation Plan within the CEMP and OEMP the plan will be able to provide orderly instructions to all impacted persons decreasing the risk of injury.

Soil and Water Management Plan: The main aims of this plan are to minimise loss of water quality and changes in the hydraulic regime during the construction and operational phases of the Project. This plan will encompass soil disturbance, erosion events from surface run-off and disturbance of water resources in the Project site. By implementing the Soil and Water Management Plan within the CEMP and OEMP, water quality and hydraulic regimes will be ameliorated, mitigated and managed.

Construction Dust Management Plan: The main aim of this plan is to minimise the generation and spread of dust during the construction phase of the Project. This plan will involve vehicle and machinery movement and activities on dry and windy days. By implementing the Construction Dust Management Plan within the CEMP, dust generation will be able to be mitigated and managed.

20.2 Draft Statement of Commitments

In accordance with the Director-General's Requirements (DGR's) and Part 3A reforms of the *Environmental Planning and Assessment (EP&A) Act, 1979* the SoC details measures for environmental mitigation, management and monitoring for the Project. Mitigation, management and monitoring measures have been developed by the Proponent and consultants reports for a range of environmental issues as discussed in **Chapters 8** to **19** for the Pre-Construction (PC), Construction (C), Operation/Maintenance (OM) and Refurbishment/Decommissioning (RD) as displayed in **Table 20.1**. Each mitigation task is defined by an impact, objective, the party responsible for the task and when the task is required during the Project. To enable ease of referencing to chapters the SoC mitigation tasks have been split into the associated chapters.

	Impact	Objective	Mitigation Task	By	Stages PC	C	OM	RD
Landscape and Visual								
001	Impact to receptors	Minimise view of infrastructure	Use of a matt and/or off-white finish on the structures to reduce visual contrast between wind turbine generator (WTG) structures and the viewing background (this is subject to final turbine selection).	Proponent	✓	✓		✓
002	Impact to receptors	Minimise view of infrastructure	Tracks have been designed to follow contour lines, with minimal extent of cut-and-fill in track construction, revegetation of disturbed areas and use of local material to minimise colour contrast where feasible.	Proponent in consultation with road engineers	✓	✓		✓
003	Impact to receptors	Minimise view of infrastructure	Location of the collector and switching substation and other ancillary infrastructure sited sympathetically with the nature of the locality and away from major roads and residences where possible to mitigate visual impact.	Proponent	✓	✓		✓
004	Impact to receptors	Minimise view of infrastructure	The majority of electrical connections within the Project site (i.e. cables between the WTG's) have been designed to be located underground where possible, in order to further reduce potential visual impacts.	Proponent	✓	✓		✓
005	Impact to receptors	Minimise view of infrastructure	Undertake landscape planting where screening is deemed appropriate and in accordance with the outcomes of the assessment process.	Proponent in consultation with affected receptor		✓	✓	✓
006	Impact to receptors	Minimise view of construction	Re-instate disturbed soil areas immediately after completion of construction and decommissioning which would include re-contouring and re-seeding with appropriate plant species and local materials where feasible.	Proponent		✓		✓
007	Impact to receptors	Minimise view of construction	Enforce safeguards to control and minimise dust emissions during construction and decommissioning.	Proponent		✓		✓
008	Impact to receptors	Minimise view of construction	Minimise activities that may require night time lighting and, if necessary, use low lux (intensity) lighting designed to be mounted with the light projecting inwards to the Project site to minimise glare.	Proponent		✓		✓

	Impact	Objective	Mitigation Task	By	Stages			
					PC	C	OM	RD
009	Impact to receptors	Minimise view of construction	Limit the amount of advertising, signs or logos mounted on wind turbine structures, except those required for safety purposes.	Proponent				
010	Impact to receptors	Minimise view of construction	Appropriate selection, where feasible, of materials and colours, together with consideration of reflective properties for ancillary structures.	Proponent				
011	Impact to receptors	Minimise view of construction	Limit the height of stockpiles to minimise visibility from outside the Project.	Proponent				
Noise								
012	Impact on receptors	Compliance	After final turbine selection and Project refinement, additional noise modelling will be carried out to ensure that the predicted noise levels are within required criteria based on the chosen WTG.	Proponent in consultation with noise consultant and landowners	✓			
013	Operational noise exceedance	Compliance	If WTG noise impacts are non-compliant with stated criteria used for the assessment due to temperature inversion, atmospheric stability or other reasons, then an ‘adaptive management’ approach can be implemented to mitigate or remove the impact. This process could include: • Investigating the nature of the reported impact; • Indentifying exactly what conditions or times lead to undue impacts; • Consideration of operating WTG’s in a reduced ‘noise optimised’ mode during offending wind directions and at night-time (sector management); • Turing off WTG’s that are identified as causing the undue impact; and • Providing acoustic upgrades (glazing, façade, masking noise etc) to affected dwellings.	Proponent			✓	
014	Construction noise exceedance	Minimisation	Ensure work activities occur within recommended working hours, according to the SA EPA, where practicable (i.e. 7.00 am to 6.00 pm, weekdays and 8.00 am to 1.00 pm on Saturdays). Any proposed work outside of these hours will entail close consultation with the affected community.	Proponent in consultation with EPA		✓		✓

	Impact	Objective	Mitigation Task	By	Stages			
					PC	C	OM	RD
015	Construction noise exceedance	Minimisation	Prior notification to the affected public and restricted use of exhaust/engine brakes in built up areas for night-time deliveries.	Proponent		✓		✓
016	Construction noise exceedance	Minimisation	Continued adequate maintenance of construction vehicles.	Proponent		✓		✓
017	Construction noise exceedance	Minimisation	Noise emissions from construction activity will be localised and temporary.	Proponent		✓		✓
018	Substation noise exceedance	Compliance	If the preferred substation location is non-compliant with the NSW Industrial Noise Policy, mitigation measures would be applied as appropriate, including; • The use of transformer(s) with a lower sound power level output; • Landscaping, including raised embankments and vegetation, around the substation; and • Providing acoustic upgrades (glazing, façade, masking noise etc) to affected dwellings.	Proponent				
Flora and Fauna								
019	Spread of weeds	Minimise spread	Development of a **Weed Management Plan**, which provides: • From soil disturbance and vegetation clearance, piling of soil which may contain exotic species at least 50 m from any water source, or areas of native vegetation; • Where a specific weed risk has been identified, all machinery, equipment and vehicles are to be washed down before entering and leaving the Project site; • Topsoil that is limited in weeds harvested to salvage the native soil seed bank and then used to reintroduce the seed bank into disturbed areas, or soil areas depleted by past land use such as intensive grazing; • All on-site staff and contractors educated on noxious weeds present at the Project site and ways to prevent spread; • Revegetation with locally native endemic species characteristic of the	Proponent in consultation with ecologist and associated landowners		✓	✓	✓

	Impact	Objective	Mitigation Task	By	Stages PC	C	OM	RD
			cleared vegetation type; • Control of perennial weed grasses within the disturbance zone for 3 to 5 years after construction; • Management of stock access during periods of vegetation and soil disturbance in coordination with landowners; and • Imported soil and rubble to be certified as fee of weeds and weed seeds.					
020	Loss of biodiversity value	Minimise impact	Development of a **Conservation Management Plan**, which provides: • All vehicles are to remain within the extent of the earth works designed specifically for the Project to minimise vegetation disturbance; • Care to be taken when working in close proximity to trees to prevent damage to roots; • A pre-clearance protocol to be designed to identify how hollow-bearing fauna will be surveyed for and managed during clearing; • An ecologist to be present on-site during clearing to capture and re-release fauna (where appropriate) • All logs and large rocks removed from within the proposed development area are to be redistributed following the completion of works in temporary clearance areas or adjacent areas to supplement habitat; • On completion, the cable route to be fenced (with landowner agreement) to allow controlled revegetation with locally endemic species (eg. *Austrostipa spp.*); • Where possible, trenches to be dug at least 15 m away from the base of trees and outside drip lines; • Minimisation of dust during construction to be undertaken via the use of water carts. Disturbance areas to be staged, and sufficient, available local water supplies are to be ensured for the construction period; • A 30 m buffer between all threatened plants and access roads and construction areas is to be maintained; • All areas to be fenced off to prevent breaches of construction	Proponent in consultation with ecologist and DECCW	✓	✓	✓	✓

	Impact	Objective	Mitigation Task	By	Stages PC	C	OM	RD
			boundaries; • Suitable fencing to be erected along trenches to prevent fauna falling in; • Daily checking of trenches by the Environmental Compliance Manager to ensure any captured fauna will be released according to the **Construction Environmental Management Plan** (**CEMP)** or **Threatened Species Management Plan** (**TSMP**) *(Note: this will not be carried out during the operation phase)*; • Pre-clearance surveys undertaken to determine if roosts, nests or dens present in any trees proposed for clearing; • Bird and bat strike 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 DECCW and other departments/agencies as required. Such a programme could include adaptive management whereby significant impacts are dealt with by using an adaptive approach; • Should WTG's require lighting, select lighting that minimises the likelihood of attracting insects and hence foraging bats, subject to CASA requirements; and • ‘Corridors’ or wide separation distances between groups of WTG’s to be maintained.					
021	Loss of biodiversity value	Minimise impact	An offset package which will be secured through the Biodiversity Banking and Offsets Scheme (BioBanking).	Proponent in consultation with ecologist, DECCW, DEWHA and associated landowners	✓			

	Impact	Objective	Mitigation Task	By	Stages PC	C	OM	RD
022	Loss of biodiversity value	Minimise impact	Upon final turbine selection and layout design, the offset requirements will be recalculated to ensure that the existing offset package is adequate for the level of impact.	Proponent in consultation with ecologist, DECCW, DEWHA and associated landowners	✓			
Cultural Heritage								
023	Loss of cultural heritage items	Minimise impact	Development of a Cultural Heritage Management Protocol, which provides procedures to be followed for impact avoidance and accidental discovery.	Proponent in consultation with an archaeologist, relevant Aboriginal communities and DECCW	✓	✓		✓
024	Loss of cultural heritage items	Minimise impact	Personnel involved in the construction and management phases of the Project trained in procedures to implement recommendations relating to cultural heritage, where necessary, to decrease impact.	Proponent in consultation with archaeologist	✓	✓	✓	✓
025	Loss of Aboriginal heritage items	Minimise impact	Impacts should not take place further north than the point 347037e 6712005n GDA in order to avoid inadvertently impacting a potential Indigenous stone arrangement site. This point is currently not proposed to be impacted upon by the Project.	Proponent	✓	✓	✓	✓
026	Loss of Aboriginal heritage items	Minimise impact	A strategy of avoidance of impacts to be adopted in regard to the recorded trees with scars identified by the Aboriginal field assistants.	Proponent in consultation with archaeologist	✓	✓	✓	✓
027	Loss of Aboriginal heritage items	Minimise impact	Additional archaeological assessments are to be carried out if any new impacts are to occur outside the study area. If a significant Indigenous object is identified, prior to impact, mitigation strategies will be implemented.	Proponent in consultation with archaeologist				

	Impact	Objective	Mitigation Task	By	Stages			
					PC	C	OM	RD
028	Loss of Aboriginal heritage items	Minimise impact	While the Indigenous stone objects recorded are very low density distributions and have low archaeological significance, nevertheless, limiting the extent of impacts to these locales, if at all feasible, should be consideration.	Proponent in consultation with archaeologist				
029	Loss of Aboriginal heritage items	Minimise impact	Ground disturbance impacts associated with the Project be kept to a minimum and to defined areas, to ensure minimum impact to Aboriginal objects (stone artefacts), which can be expected to extend in a relatively continuous, albeit very low to low density distribution, across the broader landscape encompassed by the Project.	Proponent in consultation with archaeologist		✓		✓
Traffic and Transport								
030	Safety and asset protection	Minimise risk	Contract a licensed haulage contractor with experience in transporting heavy and over-size loads, to be responsible for obtaining all required approvals and permits from the RTA and Councils and for complying with any conditions specified in the aforementioned approvals.	Proponent in consultation with RTA and councils	✓			
031	Safety and asset protection	Minimise risk	Development of a **Traffic Management Plan**, to include, but not be limited to: • Scheduling of deliveries, timing of transport, limiting the number of trips per day; • Undertaking community consultation before and during all haulage activities and providing a dedicated telephone contacts list to enable any issues to be rapidly identified and addressed; • Managing the haulage process, including the erection of warning signs and/or advisory speed signs posting in advance of isolated curves, crests, narrow bridges and changes of road conditions; • Placing of speed limits on all roads that would be used primarily by construction traffic to reduce the likelihood of any accidents and reduce maintenance costs; • Designing and implementing temporary modifications to intersections and roadside furniture as appropriate; • Producing a Transport Code of Conduct which would be made	Proponent in consultation with licensed haulage contractor and road authorities	✓	✓		✓

	Impact	Objective	Mitigation Task	By	Stages PC	C	OM	RD
			available to all contractors and staff detailing traffic routes, behavioural requirements and speed limits; • Establishing procedures to monitor traffic impacts on public and internal access tracks during construction, including noise, dust nuisance and travel times, and to implement modified work methods to reduce such impacts where possible; • Reinstating pre-existing conditions after temporary modifications to the roads and pavements along the route, where applicable, in consultation with relevant authorities; and • Where reconstruction or provision of a temporary crossing is required over a creek or drainage structure, the design of this structure will be discussed with the relevant authority.					
032	Safety and asset protection	Minimise risk	Implement all aspects of the **Traffic Management Plan** in co-ordination with the Councils, RTA and property managers.	Proponent in consultation with licensed haulage contractor and road authorities		✓		✓
033	Safety and asset protection	Minimise risk	Prepare road dilapidation reports covering pavement and drainage structures, in consultation with the Councils, for all of the routes before and after construction. Any damage resulting from construction traffic, except that resulting from normal wear and tear, would be repaired at the Proponent's cost. Alternatively, the Proponent may negotiate other forms of compensation for road damage with the relevant roads authorities as appropriate.	Proponent in consultation with council and road authorities	✓	✓		✓
034	Safety and asset protection	Minimise risk	Consideration for establishing a transport pool for employees from nearby towns to minimise traffic volumes.	Proponent	✓			
035	Safety and asset protection	Minimise risk	Establish a procedure to ensure the ongoing maintenance of the Project site internal access roads during the operation phase. This maintenance would include sedimentation and erosion control structures, where necessary.	Proponent			✓	

	Impact	Objective	Mitigation Task	By	Stages PC	C	OM	RD
036	Safety and asset protection	Minimise risk	Prepare and implement a revised **Traffic Management Plan** reflecting change in traffic volumes, during time of decommissioning.	Proponent in consultation with council and road authorities				✓
Aviation Assessment								
037	Creation of hazard	Minimise risk	The Proponent will provide the RAAF AIS, CASA, AsA, AAAA, NSW Emergency Services, NSW Police ASB and NSW RFS with the final turbine locations and dimensions prior to construction. After construction is complete, the Proponent will provide RAAF AIS, CASA, AsA, AAAA, NSW Emergency Services, NSW Police ASB and NSW RFS with the "as constructed" details.	Proponent	✓	✓	✓	✓
038	Creation of hazard	Minimise risk	The Proponent will provide CASA with notification of any cranes (temporary obstacles) that exceed 110 m above ground level.	Proponent	✓	✓		✓
039	Creation of hazard	Minimise risk	Appropriate information regarding the WTG layout and dimensions will be supplied to the Rural Fire Service, if required, to assist in their planning and execution of fire response.	Proponent	✓	✓		✓
040	Creation of hazard	Minimise risk	On receipt of Development Approval for the Project, and with particular regard to the Aeronautical Impact Assessment and Obstacle Lighting Review, the Proponent will consult with CASA and DIT on the issue of obstacle lighting.	Proponent in consultation with CASA	✓			
041	Impact to nearby properties	Minimise impact	If lighting is required, the Proponent will commit to shielding provisions allowed under existing CASA guidelines. Shielding restricts the downward component of light to 5 % of nominal intensity emitted below 5 ° below horizontal and zero light emission below 10 ° below horizontal.	Proponent in consultation with CASA	✓			

	Impact	Objective	Mitigation Task	By	Stages PC	C	OM	RD
Communication								
042	Deterioration of signal strength	Minimise deterioration	Amend planned WTG positions if necessary and feasible within the Approval Conditions, to create corridors to ensure minimal interference on links.	Proponent	✓			
043	Deterioration of signal strength	Minimise deterioration	Use of primarily non-metallic WTG blades, to minimise disruption.	Proponent	✓	✓		✓
044	Deterioration of signal strength	Minimise deterioration	Where practical, use equipment complying with the Electromagnetic Emission Standard AS/NZS 4251.2:1999.	Proponent	✓	✓		✓
045	Deterioration of signal strength	Minimise deterioration	A system for recording any complaints on interference, to allow for further investigations with the affected party, to reach an amicable solution.	Proponent			✓	✓
046	Deterioration of signal strength	Minimise deterioration	General mitigation methods for radio-communication include: • Modifications to or relocation of existing antennae; • Installation of a directional antennae; and • Installation of an amplifier to boost the signal.	Proponent			✓	✓
047	Deterioration of signal strength	Minimise deterioration	If television interference is experienced and reported by an existing receiver in the vicinity of the Project, the source and nature of the interference would be investigated by the Proponent. Should the cause of interference be attributed to the Project, then the Proponent will put suitable mitigation measures in place after consultation and agreement with the effected landowner or television broadcaster. These could include: • Re-orientation of existing aerials to an alternative transmitter; • Provision of a land line between the affected receiver and an antenna located in a suitable reception area; • Provision of satellite or digital TV where available; and • Installation of a new repeater station n a location where interference can be avoided (this is more complex for digital but also less likely to	Proponent			✓	✓

	Impact	Objective	Mitigation Task	By	Stages PC	C	OM	RD
			be required for digital television).					
048	Deterioration of signal strength	Minimise deterioration	Mitigate for any potential impacts on the NSW Ambulance link (ACMA Link ID's 6863-6864) prior to construction.	Proponent	✓			
Electromagnet Fields								
049	Exposure to EMF's	Minimise exposure	Bury electrical cables where feasible to shield electrical fields.	Proponent		✓		✓
050	Exposure to EMF's	Minimise exposure	Place wires together to cause a cancellation between the fields of electrical phases for magnetic fields.	Proponent		✓		✓
051	Exposure to EMF's	Minimise exposure	Place appropriate security around emitting structures (e.g. collector and switching substation).	Proponent	✓			
052	Exposure to EMF's	Minimise exposure	Placing overhead powerlines in isolated locations where possible.	Proponent	✓			
053	Exposure to EMF's	Minimise exposure	Ensure the public, including tourists, that need to go near emitting structures are accompanied by a trained and qualified staff member.	Proponent			✓	✓
Fire and Bushfire								
054	Increase risk of fire ignition or spread	Minimise risk	Adherence to all regulations under the NSW Rural Fires Act 1997 and the Draft Northern Tablelands Bushfire Risk Management Plans.	Proponent in consultation with relevant authorities	✓	✓	✓	✓

	Impact	Objective	Mitigation Task	By	Stages PC	C	OM	RD
055	Increase risk of fire ignition or spread	Minimise risk	The Rural Fire Service (RFS) and NSW Fire Brigade will be consulted in regard to the adequacy of bushfire prevention measures to be implemented on-site during construction, operation and decommissioning. These measures would potentially cover hot-work procedures, asset protection zones (APZ's), safety, communication, site access and response protocols in the event of a fire originating in the Project infrastructure, or in the event of an external wildfire threatening the Project or nearby properties.	Proponent in consultation with RFS and NSW Fire Brigade	✓	✓	✓	✓
056	Increase risk of fire ignition or spread	Minimise risk	Provide RFS with the locations of individual WTG locations, ancillary infrastructure, construction work schedule, location of additional water supplies for construction, potential landing pads for fire fighting aircrafts and helicopters and access gates for fire fighting services.	Proponent	✓	✓	✓	✓
057	Increase risk of fire ignition or spread	Minimise risk	Installation of access tracks at appropriate width and vertical clearances with access suitable for all weather conditions.	Proponent	✓	✓		✓
058	Increase risk of fire ignition or spread	Minimise risk	Education of construction crews and maintenance staff on the topic of bushfire risk management and risks that could be present at the Project.	Proponent		✓	✓	✓
059	Increase risk of fire ignition or spread	Minimise risk	Provision of basic fire fighting equipment at each active site, including fire extinguishers, knapsacks and other equipment suitable for initial response actions with a minimum of one trained person on-site.	Proponent		✓	✓	✓
060	Increase risk of fire ignition or spread	Minimise risk	Maintain provision for mobile telephone and UHF radio communications.	Proponent in consultation with RFS and NSW Fire Brigade		✓	✓	✓
061	Increase risk of fire ignition or spread	Minimise risk	The collector substation will be surrounded by a gravel and concrete area, free of vegetation, to provide an APZ.	Proponent	✓	✓		✓

	Impact	Objective	Mitigation Task	By	Stages PC	C	OM	RD
062	Increase risk of fire ignition or spread	Minimise risk	The collector substation facility will be bunded with a capacity exceeding the volume of the transformer oil. The facility will be regularly inspected and maintained to ensure leaks do not present a fire hazard, and to ensure the bunded area is clear (including removing any rainwater).	Proponent	✓	✓	✓	✓
063	Increase risk of fire ignition or spread	Minimise risk	Placement and maintenance of APZ will occur around WTG's, transmission line easements and ancillary structures to minimise the spread of fire. Workplace health and safety protocols will be developed to minimise the risk of fire for workers in the control room and amenities.	Proponent	✓	✓	✓	✓
064	Increase risk of fire ignition or spread	Minimise risk	WTG's will be shut down if monitored components reach critical temperatures or if directed to by the RFS in the case of a nearby wildfire being declared (an all-hours contact number would be available to the RFS during the bushfire period).	Proponent in consultation with the RFS			✓	
065	Increase risk of fire ignition or spread	Minimise risk	Flammable materials and ignition sources brought onto the Project site will be handled and stored as per manufacturer's instructions.	Proponent		✓	✓	✓
066	Increase risk of fire ignition or spread	Minimise risk	Lightening protection will be installed correctly to minimise risk of malfunction.	Proponent		✓		✓
067	Increase risk of fire ignition or spread	Minimise risk	Total fire ban days will be considered in regard to hours within which construction takes place, minimising the risk of fire and bushfire ignition.	Proponent				
Water								
068	Loss of integrity to riparian corridor	Minimise loss	Any access tracks (with the exception of crossings) and all other works and disturbances should not be located in any riparian corridors.	Proponent in consultation with DWE	✓	✓		✓

	Impact	Objective	Mitigation Task	By	Stages PC	C	OM	RD
069	Loss of integrity to riparian corridor	Minimise loss	DWE guidelines for river crossing designs, based on the Strahler Stream Order Categorisation to minimise environmental impact, will be followed in the design and upgrade of existing roads and river crossings.	Proponent in consultation with DWE	✓	✓		✓
070	Impact on watercourses	Minimise impact	All crossings will undergo detailed assessment and design post-approval, in line with the NOW *Guidelines for Controlled Activities* and NSW *DPI Why Do Fish Need to Cross the Road? Fish passage Requirements for Waterways.*	Proponent in consultation with DWE	✓	✓		
071	Impact on watercourses	Minimise impact	All required watercourse crossings will be designed to protect and enhance water flow, water quality, stream ecology and existing riparian vegetation.	Proponent in consultation with DWE	✓	✓		
072	Loss of water quality and change to hydraulic regime	Minimise loss and impact on adjacent watercourses	Development of a **Soil and Water Management Plan** (**SWMP**), to minimise soil disturbance, prevent erosion from surface runoff and to prevent disturbance of water resources in the area. Including: • All drainage from the Project is in accordance with the *Protection of the Environment Operations (POEO) Act 1997*; • Avoid removal or disruption to naturally occurring drainage stabilisers; • Installation of water slowing and diversion devices around construction areas, including devices to manage surface runoff from hardstand areas and surfaced access tracks; • Design appropriate sedimentation basins to catch and treat all water from the Project site and consider utilising existing drainage paths for discharge points in respect of maintaining the natural hydrological regime and sediment movement patters, channel and bank stability, water quality and the identification of riparian buffers; • All outlet structures are to be designed in accordance with the NOW guidelines to minimise construction and operation impacts on watercourse and riparian corridors. Considerations include, but are	Proponent in reference to Landcom 2004	✓	✓	✓	✓

Impact	Objective	Mitigation Task	By	Stages PC	C	OM	RD
		not limited to: ○ Any stormwater outlets should aim to be 'natural', yet provide a stable transition from a constructed drainage system to a natural flow regime outside any riparian buffers; ○ All ancillary drainage infrastructure, e.g. sediment and litter traps, should be located outside the riparian corridor. Runoff should be of an appropriate water quality and quantity before discharge into a riparian corridor or watercourse is allowed; ○ Discharge from an outlet should not cause bed or bank instability; ○ All stockpiles are to be located away from drainage lines, natural watercourses, road surfaces and trees, and are to be appropriately protected to contain sediment and runoff, e.g. sediment fencing; and ○ All water runoff that contains high silt content should be filtered and flocculated before it drains from the Project site. • Changes to the quantity and quality of the receiving waters are to be monitored at the locations as listed in **Appendix 21** at suitable intervals (daily during construction, monthly during operation); • Regular inspection, maintenance and cleaning of water quality and sedimentation control devices; • If erosion is detected as a result of inadequate maintenance of drainage control devices, the relevant Environmental Manager shall be alerted and remedial action is to occur immediately, to ensure no re-occurrence of the event; • Water management strategy to minimise water quality impacts and to maximise capture and reuse of water on-site;					

Impact	Objective	Mitigation Task	By	Stages PC	C	OM	RD
		• Incorporate permit/approval requirements for work within creek and riparian zones and application of the following guidelines: ○ *Managing Urban Stormwater: Soils and Construction* , 4th Edition (Landcom 2004); ○ *Managing Urban Stormwater: Soils and Construction*, Volume 2C Unsealed Roads, DECC; ○ *Guidelines for Controlled Activities,* NOW; ○ *Guidelines for Planning, construction and Maintenance of Tracks* (NSW LWC 1994); and ○ *Why Do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings*, NSW DPI (Fairfull & Witheridge 2003). • The full suite of erosion controls and sediment controls are to be determined during the preparation of the SWMP; • During operation the Operational Environmental Management Plan (OEMP) should monitor the following: ○ A regular inspection program for all facilities, tracks and watercourse crossings and rehabilitation sites; ○ Vehicles management e.g. restrict traffic to defined roads, including any wet weather crossing requirements; ○ Materials management e.g. control of maintenance activities and spill kits; ○ Wastewater management; and ○ Appropriate containment of refuse, rubbish etc. • During decommissioning provide a management plan that incorporates mitigation measures that protect surface and groundwater sources.					

	Impact	Objective	Mitigation Task	By	Stages PC	C	OM	RD
073	Loss of water quality and change to hydraulic regime	Minimise loss and impact on adjacent watercourses	In particular the **SWMP** provides specific measures for access tracks: • All roads have a sufficient cross-fall gradient to allow all runoff to be collected and treated; • All watercourse crossings to be designed in accordance with the NOW guidelines and ensure that they do not adversely impact on the hydraulic regime of the watercourse; • All watercourse crossing are designed and constructed in accordance with DPI guidelines to minimise any impact on the aquatic environment; • The design and construction footprint and the extent of disturbances proposed within the riparian zone should be minimised; • Maintain existing or natural hydraulic, hydrologic, geomorphic and ecological functions of the watercourse; and • Stabilise and rehabilitate all disturbed areas in order to restore the integrity of the riparian corridor.	Proponent in reference to Landcom 2004	✓	✓	✓	✓
074	Loss of water quality and change to hydraulic regime	Minimise loss and impact on adjacent watercourses	In particular the **SWMP** provides specific measures for hydrology: • The establishment and operation of the concrete batching plant(s) facilities must be in accordance with the Environment Protection Authority's Guidelines for the Concrete Batching Industry and the Environment Protection Licence issued by DECCW; • Concrete and cement-carrying vehicles should be washed out in appropriate wash-down facilities off-site; • Management of hazardous material, waste and sewage; • Wastewater produced from temporary on-site toilets during construction will be stored and trucked off-site; • All hazardous materials are to be properly classified and stored away from flood prone areas and drainage lines. Appropriate spill kits and fire protection are to be provided on-site during construction; • All hazardous materials are to be stored and transported appropriately in accordance with relevant DECCW and Workcover guidelines and regulations, to avoid release into the environment; and	Proponent in reference to Landcom 2004	✓	✓	✓	✓

	Impact	Objective	Mitigation Task	By	Stages PC	C	OM	RD
			• Any on-site refuelling must occur in an area greater than 100 m from the nearest drainage line and ensure correct practices are implemented, including: ○ Refuelling is to be carried out in a specified bunded area, according to regulatory requirements; and ○ Use of drip trays and spill mats.					
075	Loss of water quality and change to hydraulic regime	Minimise loss and impact on adjacent watercourses	Mitigate for any impacts on groundwater as a result of the construction or operation of the wind farm, including impact on flow rates and no contamination. Ensure that there are no lasting impacts on groundwater following decommissioning.	Proponent in consultation with Landcom 2004		✓	✓	✓
076	Loss of water quality and change to hydraulic regime	Minimise impact on groundwater	Carry out a groundwater investigation prior to any blasting on-site (if required) to ensure that there is no adverse impact on groundwater for users or dependent ecosystems. If the investigation highlights areas of concern, then appropriate mitigation or alternative methods will be used.	Proponent in consultation with NOW	✓	✓		
077	Supply of water for construction	Obtain water for construction	Calculate all necessary water demands once final layout and turbine selection have been determined. Identify appropriate water sources for the required volume of water, including the locality of proposed works, extraction points, times, volumes and rates. Obtain the necessary water licensing permits required at the time of extraction.	Proponent in consultation with NOW	✓	✓		
078	Supply of water for construction	Obtain water for construction	Should the on-site provision of water be insufficient, water will be sourced from commercial suppliers as required.	Proponent	✓	✓		
Air Quality								
079	Deterioration of air quality	Minimise impact	During excavation topsoil will be stockpiled. After excavation topsoil will be replaced for seeding and excess subsoil will be disposed of in an appropriate manner. If any excavation occurs on steep slopes the topsoil may need to be stabilised.	Proponent		✓		✓

	Impact	Objective	Mitigation Task	By	Stages			
					PC	C	OM	RD
080	Deterioration of air quality	Minimise impact	Any stockpiled material will be covered with plastic, seeded or otherwise bound to reduce dust. Dust levels at stockpile sites would be visually monitored. Dust suppression (e.g. water sprays) would be implemented if required.	Proponent		✓		✓
081	Deterioration of air quality	Minimise impact	During dry and windy conditions a water cart or alternative (non-chemical) dust suppression would be available and applied to work areas.	Proponent		✓		✓
082	Deterioration of air quality	Minimise impact	If blasting is required, Australian New Zealand Environment and Conservation Council guidelines for control of blasting impacts will be followed.	Proponent in consultation with ANZECC		✓		✓
Soil and Landforms								
083	Disturbance to existing land formations	Minimise disturbance	The **SWMP** provides specific measures for soil: • Procedure for personnel to manage suspected contaminated soils disturbed during earthworks; • All vehicles to remain on formed road or tracks designed specifically for the Project construction or operation; • All disturbed soil surfaces should be stabilised as soon as practicable after works have ceased in the area; • All stockpiles should be covered to prevent the loss of material during high wind and rain events. Where practicable stockpiles should be placed in areas sheltered from the wind; • Planning for erosion and sediment control concurrently with engineering design, prior to any works commencing; • Progressive rehabilitation of disturbed land as soon as practicable; • Jute matting or similar to be used to stabilise the soil and prevent weed invasion; • Implementation of management measures to prevent sediment and runoff entering watercourses; • Regular monitoring of erosion and sedimentation control devices including cleaning and repairing, particularly after periods of heavy rain;	Proponent	✓	✓		✓

	Impact	Objective	Mitigation Task	By	Stages			
					PC	C	OM	RD
			• A buffer of 30 m to be left between and proposed construction area and access tracks and threatened plant populations; and • Where possible, construction to be undertaken outside of summer in areas in close proximity to threatened plants to minimise impact.					
084	Soil compaction	Minimise impact	The **SWMP** will have specific measures for stock management: • Management of stock access during periods of vegetation and soil disturbances; • Removal of stock access from construction areas for entire construction periods to allow for regeneration – subject to landowner participation; and • Before remediation works, grazing to be removed and the grass sward allowed time to recover and minimise areas of bare soil.	Proponent in consultation with associated landowners		✓		✓
Waste								
085	Waste generation	Minimise waste and maximise recycling	Provision of skip bins and recycling bins on-site to handle packaging materials and domestic waste.	Proponent		✓	✓	✓
086	Waste generation	Minimise waste and maximise recycling	Mulch vegetation and use on-site where feasible, otherwise burn on-site with permission from council, provide firewood to landowners or take to Glen Innes Village or other local landfill.	Proponent		✓		✓
087	Waste generation	Appropriate disposal of waste	On-site toilets will either be drained by a septic tank or be an enclosed unit.	Proponent		✓	✓	✓
088	Waste generation	Appropriate disposal of waste	All chemicals and oils will be treated as contaminated waste at the Glen Innes Village or other local landfill.	Proponent		✓	✓	✓
089	Waste generation	Appropriate disposal of waste	Any disposal of unsuitable excavated material will require development consent from Glen Innes or Inverell Shire Council, unless it is virgin excavated natural material, then it can be disposed of at the Glen Innes Village or other local landfill.	Proponent		✓		✓

	Impact	Objective	Mitigation Task	By	Stages			
					PC	C	OM	RD
Crown Roads and Trigonometrical Stations								
090	Damage to Trigonometrical Stations	Avoid damage	Commitment to avoid disturbing and damaging the Trigonometrical Station's and adjacent witness marks.	Proponent		✓		✓
091	Council roads	Liaison with council	Development approvals for a number of Crown Roads that are both held and not held under Enclosure Permits will be lodged with the DoL to close discrete sections of Project affected Crown Roads, and transfer them to adjoining landowners.	Proponent in consultation with Council	✓	✓		✓
Construction								
092	Environmental	Minimise impact	Micro-site on-site infrastructure within a 100 m radius of the proposed Project infrastructure with respect to: • Minimising impacts to ecologically sensitive habitats and species, as listed in **Chapter 10** Flora and Fauna; • Avoid impacting on hollow-bearing trees where possible; and • Avoid impacting on identified Aboriginal scarred trees.	Proponent in consultation with relevant consultant	✓	✓		✓
093	Environmental	Minimise impact	Access roads have been designed along current tracks and roads present within the study area where possible to avoid additional vegetation clearance for access.	Proponent	✓			
094	Environmental	Minimise impact	The reticulation has been placed underground and within the road footprint where possible to allow for temporary rather than permanent disturbance.	Proponent	✓			
095	Environmental	Minimise impact	Electrical cables occurring across significant gullies and waterways will be strung overhead.	Proponent	✓			
096	Environmental	Minimise impact	The boundaries of the construction site to be clearly marked to prevent construction works breaching the boundaries.	Proponent		✓		✓

	Impact	Objective	Mitigation Task	By	Stages PC	C	OM	RD
097	Environmental	Minimise impact	Development of a **Construction Environmental Management Plan** (**CEMP**), which provides: • A **SWMP** in accordance with Landcom (2004) *Managing Urban Stormwater: Soils and Construction*, 4th Edition; • A **Construction Dust Management Plan** (**CDMP**) as listed in **Appendix 22**; • Manage site security and uncontrolled access via a lockable chain link fence around the temporary site facilities to minimise acts of vandalism and arson; • Obtain necessary licenses and permits from NOW, DPI and NSW DECCW; • Manage disturbance to 'no go' areas by flagging, fencing and including details on hard copy and electronic construction plans; • Designate environmental management responsibility to key personnel; • Transport of oil (80,000 L for collector substation transformer and 1,000 L per WTG transformers) will be via purpose built vehicles/ tankers in accordance with the Australian Dangerous Goods Code and will be fitted with emergency spill equipment. Oil will be transferred to transformers by qualified personnel, who have training in emergency spill response. Spill control equipment will be available at the point of use; • Incorporate licensing requirements for the concrete batching plants into the **CEMP**, including speed limits, portable spill kits, and management of concrete slurry; • Use of fire mitigation and management strategies discussed in **Chapter 16** Fire and Bushfire; • Use local water supplies, where possible, in written agreement with local landowner; and • Community consultation strategy for the duration of the construction period, to keep community informed of progress/delays and to maintain a method for receiving and addressing community	Proponent	✓	✓		✓

	Impact	Objective	Mitigation Task	By	Stages PC	C	OM	RD
			feedback.					
098	Environmental	Minimise impact	Development of an **Operational Environmental Management Plan** (**OEMP**), which can be combined with the **CEMP** and additions added for operation of the Project.	Proponent			✓	
099	Decommissioning	Manage process	A Decommissioning Plan will be prepared at the end of the wind farm's life detailing the process of decommissioning, the components to be removed and those to be left in situ.	Proponent				✓
100	None	Minimise risk	Provide a finalised turbine layout and infrastructure map, including turbine co-ordinates, to all stakeholders following completion of the construction of the wind farm.	Proponent			✓	
Mineral Exploration								
101	Future land use for mineral exploration	Minimise impact	Liaise with relevant mining companies and provide updates of any modifications to the Project design that arise during the construction of the Project.	Proponent		✓		
102	Future land use for mineral exploration	Minimise impact	At the time of decommissioning, communicate with associated landowners and mineral title holders that may wish to retain roads.	Proponent				✓
Tourism								
103	Future tourism	Manage increase	Consideration of a parking or stopping bay if required.	Proponent in consultation with councils and landowners			✓	

	Impact	Objective	Mitigation Task	By	Stages PC	C	OM	RD
Community Wellbeing								
104	Affect on local area	Maximise positive effect of proposal	Contributions of $2,500 per wind turbine into a Community Fund as each stage of the Project commences commercial operation will be established in close cooperation with the Glen Innes Severn and Inverell Shire Councils to provide funding for local community interest groups and activities.	Proponent in consultations with councils and community	✓		✓	✓
Economic								
105	Affect on local area	Maximise positive effect of proposal	Local contractors will be used where it is feasible, which will allow the Proponent to utilise the full potential of local resources.	Proponent in consultation with local industry representatives	✓	✓		✓

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CHAPTER 21

Conclusion

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21. CONCLUSION

This Environmental Assessment (EA) has assessed the potential environmental impacts that may result from the proposed Sapphire Wind Farm (the Project), a proposal incorporating up to 159 wind turbines and capable of generating in the order of 238 - 425 MW of new renewable energy generation.

The Project has been assessed in accordance with the *Environmental Planning and Assessment Act 1979* and taken into consideration the *Environment Protection and Biodiversity Conservation Act 1999*, along with other Federal, State and Local Government legislation, policy and guidelines.

The Project has incorporated the findings identified through the design phase, including consultation with the local community and associated stakeholders. The potential impacts of the Project have been assessed and appropriate avoidance, mitigation and management measures proposed. **Chapter 19** Statement of Commitments details all measures to which the proponent has committed to implementing during the pre-construction, construction, operation/maintenance and decommissioning phases.

Benefits of the proposal have been identified at a global, regional and local scale, including:

- Production of approximately 999,363 MWh per annum, sufficient for the average consumption of 136,899 homes (based on conservative calculations). A figure equal to 2.22 % of the 45,000 GWh Renewable Energy Target;
- Displacement of greenhouse gas emissions by approximately 899,426 tonnes of CO_2-e per annum, the equivalent of taking 224,857 cars off the roads (based on conservative calculations);
- Provision of local jobs, a Community Fund to benefit the local area in the vicinity of the Project and the injection of at least $477 million into the Australian economy; and
- Improved security of electricity supply through diversification.

The Proponent is committed to ensuring the measures proposed in developing the Project are best practice, and that they maintain the high standard set in all regions within which Wind Prospect CWP operate.

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CHAPTER 22

Abbreviations and Glossary

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22. ABBREVIATIONS AND GLOSSARY

Abbreviations

AsA	Airservices Australia
AAAA	Aerial Agricultural Association of Australia
ABS	Australian Bureau of Statistics
ACMA	Australian Communications and Media Authority
AEMO	Australian Electricity Market Operator
AGL	Above ground level
AGO	Australian Greenhouse Office
AIS	Aeronautical Information Service
ALC	Aboriginal Land Claim
AM	Amplitude Modulated
APZ	Asset Protection Zone
ARG	Australian Research Group Pty Ltd
ARPANSA	Australian Radiation Protection and Nuclear Safety Agency
A-SMGCS	Advanced Surface Movement Guidance and Control Systems
ASB	Aviation Support Branch
AusWEA	Australian Wind Energy Association
Auswind	Australia Wind Energy Association
BFCC	Bushfire Coordinating Committee
BGW	Box-Gum Woodland
BLWF	Ben Lomond Wind Farm
BioBanking	Biodiversity Banking
BoM	Bureau of Meteorology
BWEA	British Wind Energy Association
CAAP	Civil Aviation Advisory Publication
CAP	Catchment Action Plan
CASA	Civil Aviation Safety Authority
CASR	Civil Aviation Safety Regulations
CCA	Church Communities Australia
CEEC	Critically Endangered Ecological Community
CEMP	Construction Environmental Management Plan
CINA	Connection Investigation Network Agreement
CMA	Catchment Management Authority
CMA Act	Catchment Management Authority Act 2003
CO2	Carbon dioxide
CO2 -e	Carbon dioxide equivalent
COAG	Council of Australian Governments
COP2	Conference of the Parties
CPRS	Carbon Pollution Reduction Scheme
CRZ	Core riparian zone
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DA	Development Application
DACR	Defence (Area Control) Regulations
DCC	Department of Climate Change
DCCEE	Department of Climate Change and Energy Efficiency

DCP	Development Control Plan
DEC	Department of Environment and Conservation
DECC	Department of Environment and Climate Change
DEH	Department of the Environment and Heritage
DSEWPAC	Department of Sustainability, Environment, Water, Population and Communities
DEWHA	Department of the Environment, Water, Heritage and the Arts
DGR's	Director General's Requirements
DIT	Department of Infrastructure and Technology
DLWC	Department of Land and Water Conservation
DoD	Department of Defence
DoL	Department of Lands
DoP	Department of Planning
DPC	Department of Premier and Cabinet
DPI	Department of Primary Industries
DPoI	Department of Planning and Infrastructure
DWE	Department of Water and Energy
EA	Environmental Assessment
ECRTN	Environmental Criteria for Road Traffic Noise
EEC	Endangered Ecological Community
EIA	Environmental Impact Assessment
ELF	Extremely Low Frequency
EMF's	Electric and magnetic fields
EMP	Environmental Management Plan
EP&A Act	Environmental Planning and Assessment Act, 1979
EPA	Environment Protection Authority
EPBC	Environment Protection and Biodiversity Conservation Act, 1999
ESD	Ecologically Sustainable Development
EU	European Union
FM	Frequency Modulated
GIWF	Glen Innes Wind Farm
GWEC	Global Wind Energy Council
HF	High Frequency
IEC	International Electrotechnical Commission
IGACC	Interim Guidelines for Aboriginal Community Consultation
INP	Industrial Noise Policy
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organisation for Standardisation
LCA	Life Cycle Assessment/Landscape Character Areas
LEP	Local Environmental Plan
LGA	Local Government Area
LOS	Line of Sight
LPMA	Land and Property Management Authority
LSALT	Lowest Safe Altitude
LRET	Large-scale Renewable Energy Target
LVIA	Landscape and Visual Impact Assessment

MIC	Maximum instantaneous charge
MRET	Mandatory Renewable Energy Target
NEM	National Electricity Market
NEMMCO	National Electricity Market Management Company
NES	National Environmental Significance
NER	National Electricity Rules
NGA	National Greenhouse Accounts
NHMRC	National Health and Medical Research Council
NOW	NSW Office of Water
NPS	NSW Police Service
NPW Act	National Parks and Wildlife Act 1974
NPWS	National Parks and Wildlife Service
NSW	New South Wales
NW	Noxious Weeds Act 1993
OEMP	Operational Environmental Management Plan
OLS	Obstacle Limitation Surface
PANS OPS	Procedures for Air Navigation Services
PEA	Preliminary Environmental Assessment
PFM	Planning Focus Meeting
PM10	Particles effectively less than 10µm diameter
POEO Act	Protection of the Environment Operations Act 1997
PSPD	Power System Planning and Development
RAAF	Royal Australian Air Force
RBL	Rating background level
REC	Renewable Energy Certificates
REF	Review of Environmental Factors
RET	Renewable Energy Target
RFS	Rural Fire Service
RoTAP	Rare or Threatened Australian Plant
RTA	Roads and Traffic Authority (NSW)
SA EPA	South Australian Environmental Protection Authority
SEPP	State Environmental Planning Policy
SES	State Emergency Service
SoC	Statement of Commitments
SoE	State of the Environment Report
SRES	Small-scale Renewable Energy Scheme
SWMP	Soil and Water Management Plan
TS	Trigonometrical Stations
TSC Act	Threatened Species Conservation Act
TV	Television
UHF	Ultra high frequency
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
VAC	Visual Absorption Capability

VFR	Visual Flight Rules
VHF	Very High Frequency
WBZ	Water Bearing Zones
WHO	World Health Organisation
WM Act	Water Management Act 2000
WMO	World Meteorological Organisation
WoNS	Weed of National Significance
WRWF	White Rock Wind Farm
WSP	Water Sharing Plan
WTG	Wind Turbine Generator
ZVI	Zone of Visual Influence

Units

°	degree
°C	degree Celsius
dBA	decibels (A range)
GWh	gigawatt hour
h	hour
ha	hectare
Hz	hertz
kg	kilogram
km	kilometre
kph	kilometres per hour
kV	kilovolt
kV/m	kilovolts per metre
kW	kilowatt
L	litre
m	metre
m^2	square metres
m^3	cubic metres
mG	milligauss
mm	millimetre
m^3/h	cubic metres per hour
mHz	mega hertz
ML	mega litre
m/s	metre per second
MVA	megavolt Ampere
MW	megawatt
MWh	megawatt hour
MWh/y	megawatt hours per year
rpm	revolutions per minute
y	year
µT	microTesla

Glossary

Ambient noise	The all-encompassing noise associated with a given environment. It is the composite of sounds from many sources, both near and far.
Artefact locale	The exact location of where the artefact was found within the Project site.
Asset Protection Zone	Is land cleared of vegetation, designed to protect assets (houses, buildings, etc.) from potential bushfire damage.
Ben Lomond Wind Farm	A proposed 98 turbine wind farm project 20km to the south east of the Project. DGR's expired on the 19 February 2010.
Biodiversity	First coined in 1998 as a contraction of biological diversity; diversity traditionally referring to species richness and species abundance. Biodiversity has been defined subsequently as encompassing biological variety at a genetic, species and ecosystem scales (DASETT 1992). The maintenance of biodiversity, at all levels, is acknowledged internationally as a high conservation priority, and is protected by the International Convention of Biological Diversity 1992.
Biodiversity Banking	The Biodiversity Banking and Offset Scheme (Biobanking) has been established by the NSW DECC to help address loss of biodiversity and threatened species.
Bund	An earthwork or wall to contain and control spillages, normally associated with fuelling and chemical storage facilities.
Buried earth grid	Refers to physically connecting a part of an electrical system to the ground, carried out as a safety measure, be means of a conductor embedded in the earth.
Capacity factor	Factor used to account for variation in wind speeds at the site and minor electrical losses when determining the electricity output of a wind farm compared to its installed capacity.
Clusters	Is a group of wind turbines which are likely to be constructed and commissioned in one stage.
Construction Environmental Management Plan	An element of an Environmental Management Plan that addresses the control, training and monitoring measures to be implemented during the construction phase of a project in order to avoid, minimise or ameliorate potentially adverse impacts identified during environmental assessments.
Crown Land	Land that is owned and managed by State Government. Crown land accounts for over half of all land in NSW and includes Crown lands held under lease, licence or permit, community managed reserves, lands retained in public ownership for environmental or travelling stock route purposes, land within the Crown public roads network, and other unallocated lands.

Cumulative Impact	Refers to the accumulation of impacts at a locality from a range of developments of similar or different type over time.
dBA	The noise level in decibels, obtained using the 'A' weighted network of a noise level meter as specified in Australian Standards AS 1259-1990 Noise Level Meters. The 'A' weighting is designed to adjust the noise level (very approximately) in line with human hearing.
Development Footprint	The impact area from all proposed infrastructure related to the Project.
Ecologically Sustainable Development	Using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained and the total quality of life, now and in the future can be increased. Incorporates four key principles: the precautionary principle; inter-generational equity; conservation of biological diversity and ecological integrity; improved valuation and pricing of environmental resources.
Effective Survey Coverage	A percentage estimate of the proportion of the Survey Unit which provided the potential to view archaeological material.
Endangered Ecological Community	A community listed under Schedule 1, Part 3 of the NSW *Threatened Species Conservation Act 1995*.
Environment	The physical, biological, cultural, economic and social characteristics of an area, region or site.
Environmental Assessment	For a development that constitutes a Major Project under the State Environmental Planning Policy - Major Project, prepared pursuant to the *Environmental Planning and Assessment Act 1979*.
Environmental Management Plan	The control, training and monitoring measures to be implemented during the design, construction and operation phases of a project in order to avoid, minimise or ameliorate potentially adverse impacts, identified during environmental (being socio-economic, cultural, physical, biological) assessments.
Fauna	Animals
Flora	Plants
Fresnel Zone	In optics and radio communications the Fresnel zone is an elliptical region surrounding the line of sight path between transmitting and receiver antennas which must be obstruction free for a microwave radio link to work without interference.
Geophysical	Relating to the physics of the earth and its atmosphere.
Geotechnical	Relating to the application of technology to engineering problems caused by geophysical factors.
Glen Innes Wind Farm	A proposed 25 turbine wind farm project 8km to the east of the Project. Consent granted 2 October 2009 (appeal upheld 18 August 2010).

Grid With reference to electricity, the electrical transmission and distribution network.

Groundwater All water which is below the surface of the ground in the saturation zone and in direct contact with the ground of the soil.

Hydrology Surface water and groundwater and their interaction with earth materials.

Indigenous objects and sites A place where physical remains or modification of the natural environment indicate the past and 'traditional' activities by Aboriginal people. Site types include artefact scatters, isolated artefacts, burials, shell middens, scarred trees, quarries and contact sites.

Installed capacity The maximum electrical output of wind turbines installed in a wind farm.

LA_{eq} The A-weighted equivalent continuous sound level. It is defined as the steady sound level that contains the same amount of acoustical energy as a given time-varying sound over the same measurement interval. Can be loosely thought of as the 'average'.

Locality Area encompassing all lands within a 10 km radius around the Project site.

Monitoring The checking of impacts of a proposal or an existing activity in order to improve or evaluate environmental management practices; To check the efficiency and effectiveness of the environmental impact assessment process; To determine if the requirements of environmental legislation and associated regulations are being met.

Operational Environmental Management Plan An element of an Environmental Management Plan that addresses the control, training and monitoring measures to be implemented during the operational phase of a project in order to avoid, minimise or ameliorate potentially adverse impacts identified during environmental assessments.

Peak Demand The greatest demand for electricity in a stated period of time, such as the greatest demand during a week or a year.

Photomontages A composite image combining two or more photographs.

Precautionary Principle The precautionary principle states that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

Procedures for Air Navigation Services Allows aircraft to conduct an instrument approach to airports in poor weather conditions, by using a published Instrument Approach and Departure Procedures which apply varying minimum altitude requirements above terrain.

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

Proponent	In relation to an activity, means the person proposing to carry out the activity.
Ramsar	Australia is contracting party to the Ramsar Convention on wetlands. This obliges us to designate and protect wetlands of international significance.
Riparian	Relating to the banks of a natural course of water.
Risk	Likelihood of a specific undesirable event occurring within a specified period or in specified circumstances. Listed as a frequency or probability.
Risk Assessment	A process used to determine whether people and the environment are at risk (e.g. health and safety) from exposure to hazardous substances used or produced (mainly in an industrial or work place) so that appropriate control measures or management practices can be introduced to prevent or minimise the risk.
Rotor	The assembly of blades and hub that is used to intercept the wind, producing rotational energy.
SCADA	Supervisory Control and Data Acquisition system. The term implies that there are two activities that are necessary: The acquisition of data (from a wind farm) and subsequent transfer to some central location, and the control of some process or equipment from this central location.
Soil profile	A vertical section of soil, which allows for the examination of soil structure.
Statement of Commitments	Is a document on how the proponent proposes to manage the Project to minimise and where possible, avoid impacts.
Study Area	200 m wide corridor in which the turbine footprint, roads and reticulation will be contained.
Survey Unit	Area defined according to landform morphological type for cultural heritage field surveys.
Topsoil	The upper layer of soil, usually containing more organic material and nutrients than the subsoil beneath it.
Transformer	A device consisting of two or more insulated coils of wire wound around a magnetic material such as iron, used to convert one AC voltage to another or to electrically isolate the individual circuits. Usually used to increase generation voltage to transmission voltage.
Visibility	Measure of extent to which particular aspects of a development may be visible from surrounding areas.
Visual Catchment	The area from which the proposed wind farm would be potentially visible.
Weed	Naturalised, non-indigenous plant species which may be noxious weeds (or agriculture), environmental weeds or any other generally undesirable introduced species.

Wetlands	Areas largely inundated with water, yet offering elevated land as a habitat for wildlife, notably waterfowl. Can be landlocked.
White Rock Wind Farm	A proposed up to 119 turbine wind farm project 4km to the south east of the Project. DGR's issued 13 October 2010.
Wind	The movement of air, caused by heating of the atmosphere, land and sea. Usually measured as metres per second, knots or kilometres per hour.
Wind Monitoring Mast	A guyed, narrow lattice or tubular steel design mast, in this case up to 100 m in height, with anemometers and wind vanes attached at different heights on the mast, to monitor and record the wind's characteristics.
Wind Turbine Generator	Electrical generators rotated by the movement of wind over blades that feed power into the mains electricity grid.

CHAPTER 23

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