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Glen Innes Wind Farm
Visual Impact Assessment
Glen Innes Wind Power

September 2008
Reference 25766-003
Revision 3

Connell Wagner

Document Control

Document ID: C:\A Jeff files\25766 Glen Innes\03 GIWF EA Final Chapters Sept 08\Appendices\C Visual Assessment\08_10_GIWF_ea_Appendix C_Visual Impact Assessment.doc

Rev No	Date	Revision Details	Typist	Author	Verifier	Approver
0	24/10/2007	Draft Report	CW	JB/KD	PW	CF
1	May 2008	Final Draft Report	KD	JB/KD	PW	LK
2	July 2008	Final Draft Report	KD	JB/KD	PW	LK
3	September 2008	Final Report	KD	JB/KD	PW	CV

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PLATES (appended)

APPENDICES

1. Introduction

The proposed Glen Innes Wind Farm comprising up to 27 wind turbines will be located on the Waterloo Range about 12 km to the west of Glen Innes and approximately 50 km to the east of Inverell (Figure 1). This report provides a review of the visibility of the proposed development and factors affecting its visual impact. The aim of the report is to provide objective information to assist the community and the consent authority to understand the visual characteristics of the proposal sufficient to form their own opinion on the likely visual impacts of the proposal. It forms part of the Environmental Assessment for the project.

The Director-General of the Department of Planning NSW (DoP) has issued the requirements for the matters to be addressed by the Glen Innes Wind Farm Environmental Assessment including the requirements for a visual impact assessment. The requirements specified that the visual impact is required to be illustrated with photomontages of the turbine installations taken from strategic vantage points up to a distance of 10 km. The assessment is also required to have detailed and concise descriptions of management measures to be put in place to mitigate the visual impact on the surrounding community.

This report addresses the Director-Generals' requirements relating to visual impact assessment. It includes a landscape analysis, a detailed description of the assessment methodology and provides an assessment of the visual impact at key locations around the wind farm in addition to material that can be used by others to make their own judgement of the visual impact of the project. These materials include:

- A view field analysis prepared using a Geographic Information System (GIS)
- A series of photomontages from selected representative vantage points
- A description of factors to be considered by the visual impact assessment
- A review of the wind farm visibility from key vantage points
- Options for mitigating visual impact.

Visual impact is a key issue in the planning process for wind farms. Due to the significance of visual impact assessment for wind farms and a perceived subjectivity in assessment methods applied, the Wind Energy Association (Auswind) and the Australian Council of National Trusts (ACNT) have undertaken a joint project entitled: "*The Wind Farms and Landscape Values – National Assessment Methodology project"*. The objective of the project is to provide a sound and transparent framework for:

- Identifying and assessing landscape values
- Assessing the potential impacts of wind farms on landscape values
- Site impact assessment and mitigation
- Community consultation procedures

Stage 1 of the Landscape Values project was released in 2005 and has been followed by a draft "National Assessment Framework" on 9th February 2007 and a "Foundation Report" issued on 5th March 2007. These draft documents were released for public comment for a period to 5th April 2007. The National Assessment Framework (NAF) was finalised in 30th June 2007, and has subsequently been used to address the visual elements of the Glen Innes Wind Farm.

A Guideline for Landscape and Visual Assessment methodologies for wind energy projects based on the NSW Department of Planning EIA Guidelines for Wind Energy Facilities is provided in Appendix B.

1.1 Project overview

The proposed development consists of up to 27 wind turbines, each with a capacity of between 2 and 3 megawatts (MW) depending on the turbine to be selected. The wind farm's total generation capacity will be in the range from 54 to 81 megawatts. This is a moderate sized wind farm by world standards.

The wind turbines will be interconnected by 33,000 volt underground cables and connected to a 33,000/(66,000 or 132,000) volt substation at the northern end of the wind farm adjacent to the existing 66,000 volt Glen Innes to Inverell line to which the wind farm will be connected. It is possible that this line may be upgraded to 132,000 volts by TransGrid and the wind farm may be connected at this voltage.

This assessment is based on an advanced stage of project planning and reflects the impacts relevant to the proposed layout and equipment specification. However, the actual model of turbine to be used and the number to be installed is yet to be confirmed. The final form of the installed wind farm will be subject to the outcome of equipment tenders and any conditions of the planning approval process. Consideration has been given during planning and assessment to potential variations in the wind farm design and associated variations in visual impact. The proposed layout involving 27 turbine sites represents the maximum development that will occur at the site and a lesser number may be installed.

The proposed layout consists of a general north-south group of turbines on an elevated ridge of the Great Dividing Range referred to as Waterloo Range. The distribution of turbines (Figure 2) can be considered as several clusters that are described in Table 1.1 below. It can be seen that the Southern group of turbines are at higher elevations than turbines in the northern group located closer to Gwydir Highway.

Table 1.1 – Wind farm general arrangement

Group	No. of turbines		Location in Wind Farm	Level of footings (m)	Features
Northern Group	9	(33%)	Northern	1160 to 1200	Single ridge
Central-eastern Group	4	(15%)	South-eastern	1240	Two distinct knolls
Central-western Group	8	(30%)	South-western	1160 to 1220	Single ridgeline and a knoll
Southern Group	6	(22%)	South	1160 to 1275	Several discrete knolls and ridges
Total	27	(100%)			

The ridges on which the turbines will be located have elevations varying from about 1,160 metres to 1,275 metres. The turbine sites will be 200 to 300 metres above the floor of the Wellingrove valley to the west of the site and 100 to 200 metres above the Reddestone and Furracabad valleys to the east of the site.

The wind farm's visual characteristics are outlined in Section 2.1. The turbines proposed for the site are large structures that, depending on the model selected, could have a height of up to 130 metres to the top of the area swept by the turbine blades. When located on elevated ridges, they are prominent features in the landscape and would be visible from parts of Glen Innes some 12 km to the east of the wind farm.

The turbine layout allows for a minimum spacing between turbines within each group or row of approximately 230 metres. The layout reflects the arrangement of ridges and the predominant easterly

and westerly wind direction. The number of turbines installed and individual locations of turbines may vary, depending on the outcome of tenders for equipment supply, design and construction considerations and development consent conditions.

Ancillary works are shown on Figure 2 and include:

- New access tracks and upgraded existing tracks
- A 33,000 volt to 66,000 (or 132,000) volt substation and a facilities building
- Underground power and control cables between turbines
- Permanent and temporary wind monitoring masts
- Temporary construction site office

Generator transformers may be located close to the base of the wind turbine towers or within the nacelles of the turbines (Figure 3).

The visual impact of most of the ancillary works will be significantly less than that of the wind turbines, because they are low level aspects of the development and mostly will not be visible from public roads in the areas around the site. Nevertheless, each of the ancillary works will be designed to minimise visual impact. Visual aspects of the ancillary works are discussed in Section 8.

The wind farm will be connected to the electricity grid via a 33,000/ (66,000 or 132,000) volt substation located adjacent to an existing Country Energy 66,000 volt or upgraded 132,000 volt transmission line. The visual impact of the substation is also addressed by this report.

2. Summary of Visual Characteristics

The five key characteristics affecting visual amenity that need to be considered in the planning stages of a wind power development (Arkesteijn & Westra, 1991) are:

- the number of turbines
- the size and colour of the turbines and their supporting structures
- the number of blades on each turbine
- the turbine placement pattern
- the landscape character

This section of the report reviews the physical aspects of the wind farm, the landscape character and the visual elements that may affect the community's acceptance of the development.

2.1 Wind farm visual characteristics

The wind farm involves the turbines, electrical connection works and access tracks. Of these, the wind turbines will be the most visible facilities. The key wind farm characteristics affecting visual impact are shown in Table 2.1 below. Wind turbine structures will have the general form shown in Figure 3.

Table 2.1 – Wind farm components and key visual characteristics

Wind Farm component	Visual characteristic
Tower and hub height	• Steel tubular supporting towers • 80 metre hub height • Tower 4.5 metres at base and 2.5 metres at top
Turbine	• Three bladed • Rotor diameter of between 88 and 100 metres (up to 49 metre blades)
Turbine rotation (rpm)	• Up to 18 revolutions per minute
Colour	• Matt white colour or similar light neutral colour
Generator transformer	• located near the base of each turbine – green (or within the nacelle)
Electrical works	
Electrical connection	• Underground power and control cables will connect the wind turbines within each group
Substation and grid connection components	
Substation	• About 30 metres by 70 metres with a number of small buildings • Height of structures mostly less than 10 metres
Connection to existing 66,000 (or 132,000) volt overhead line	• The connection may have a short section of overhead 66,000 or 132,000 volt power line between the substation and the existing overhead line • Several wood or concrete poles could be used to support the conductors
Access works	
Site entrance	• Signposted, gate adjacent the Gwydir Highway during construction
Site access tracks	• Up to 8 metres wide and unsealed predominantly between the turbines with several access tracks leading up onto the ridges where the turbines will be located

The actual wind farm equipment details will be confirmed by a tender process. For this assessment, the dimensions of a 3MW 100 metre diameter wind turbine have been used.

The turbines will have three blades and the literature suggests that this number of blades is more visually balanced than turbines with only two blades (Arkesteijn & Westra, 1991). It is proposed that the turbines be finished in a matt white or similar light neutral colour. Documented experience of wind farms also suggests that finishing the turbines in a pale unobtrusive colour gives the most acceptable result (Gipe, 1995).

The substation will occupy an area of about 70 metres by 30 metres. Its component elements will mostly have a height less than 10 metres and can be effectively screened by the combination of its siting and by trees. Additional screening through planting of trees could be undertaken if required, subject to adequate clearances being maintained. One or two pole structures may be required adjacent to the substation as part of the grid connection.

Access tracks are at ground level and most will not be visible from surrounding viewpoints. Where necessary, their visibility can mostly be mitigated by positioning of the tracks, suitable earthwork formation and revegetation to minimise visibility.

2.2 Wind farm layout

The placement of the turbines as shown in Figure 2 has been designed to utilise turbine sites that maximise the energy produced from the wind farm and included consideration of the following aspects:

- Selection of sites that have high energy potential to maximise generated output
- Site suitability for the type of turbines to be installed
- Spacing of turbines so that the disturbance of air flow has minimal affect on adjacent turbines
- Selection of tower heights which provide optimal utilisation of the wind energy regime within the constraints of feasible construction at the remote locations
- Capacity of the existing transmission infrastructure
- Provision of sufficient distance to existing residences to ensure acceptable noise criteria are not exceeded and to reduce visual impact and shadow flicker effect at the residences.

Some sites offering high energy have been excluded from the wind farm due to difficult access, ecological considerations or proximity to residences.

The layout will only be finalised after planning consent has been obtained, contracts for equipment supply and construction have been awarded and detailed pre-construction wind monitoring is complete. Any significant issues arising during the agency and community review of the environmental impact assessment are likely to be addressed by mitigation measures incorporated in association with developing the final layout.

2.3 Visual aspects of the wind farm

The wind turbines will have a height of up to 130 metres, measured to the highest point of the area swept by the blades. At such heights, some people may compare the turbine structures to tall buildings. However, the wind turbines differ from bulky structures such as buildings in that the supporting towers are only 2.5 to 4.5 metres wide. Also, the turbine blades are relatively slender structures that have a maximum width of 3.5 metres near the hub and taper to the tip. When viewed from the side the blades have a very thin profile and present very little of the blade surface. Due to their height, the turbine structures will nevertheless be visible from a considerable distance.

It is likely that many viewpoints will only provide partial views of the wind farm with parts of it being concealed by topography and/or woodland. At other locations the aspect will mean that views are away from the wind farm and at such locations the development may be associated with a minor visual impact.

In general, the moderate size of the properties where the wind farm is located and the low settlement density of some surrounding areas, means that the bulk of public views of the wind farm will be distant views.

The closest neighbouring residence is 0.96 kilometres from the nearest turbine, however other occupied neighbouring residences are at distances greater than 1.3 kilometres. Given the size of the turbines, their scale in the landscape can be significant for the closest residences. The closest public road to a wind turbine is West Furracabad Road at a distance of 1.2 kilometres. The Gwydir Highway also passes close to the northern end of the wind farm but due to topography and woodland vegetation there will be limited close views of the wind farm. Parts of the wind farm will also be visible at many points along local roads to the east and west of the wind farm. Most of the local roads have low traffic volumes.

The Gwydir Highway will also provide mostly partial views of the wind farm, with many points along the Highway having trees and/or topography providing partial or complete screening. However, several sections will have more expansive views of the wind farm from distances of more than two kilometres.

Where the wind farm is visible, the varying topographic heights of the turbines within each group may avoid the appearance of a geometric layout with the turbine positions following the contours of the land.

In addition, the effect of turbines trailing out of sight along a ridge line or being partially screened by topography can introduce an element of 'depth' to some views. Visual impact studies indicate this to be a preferred visual outcome. The spacing of the turbines can also affect the visual impact. The minimum spacing used is in excess of 200 m.

The rotation of the turbine blades will add an element of movement in the view and could invoke varying responses including visual attraction or annoyance. It may also increase visibility. The three bladed wind turbines rotating in random phase should avoid introducing unnecessary geometry into the rural landscape. The relatively slow rotation speed of the turbines, up to 18 revolutions per minute, may not be unduly disturbing to most people. Observers at the Crookwell Wind Farm in the Southern Tablelands of NSW have expressed surprise at the slow rotation speed, which in that case is of the order of 28 revolutions per minute.

A further aspect of wind farms is the novelty aspect. The Glen Innes Wind Farm will be visible from the Gwydir Highway as well as being part of some distant views from Glen Innes. As wind turbines are still a relatively new type of electricity generation in New South Wales, the wind farm will represent an additional point of interest for many locals, visitors and travellers passing through the region.

2.4 Landscape character

Hull and Revell (1989) define landscape and scenes as follows:

Landscape – "the outdoor environment, natural or built, which can be directly perceived by a person visiting and using that environment."

Scene – "A scene is the subset of a landscape which is viewed from one location (vantage point) looking in one direction …".

Scenes may be further classified as close, distant, panoramic or corridor views. In the case of distant views, it is less easy to distinguish the detail of the objects in the scene. Corridor views are those which are constrained by lateral features.

Landscape descriptors can include physical (natural and cultural) and artistic or psychological descriptors. The physical elements of the landscape (natural and cultural) of the proposed wind farm locality are described in the following two sections, while Section 2.5 discusses the subjective elements of landscape preference.

2.4.1 Natural features of the landscape

The landscape of the Glen Innes area is comprised of typical New England Tablelands rural land with hilly topography, green pastures and intermittent areas of woodland being distinctive features of the landscape.

The Waterloo Range (part of the Great Dividing Range) on which the wind farm is located has its highest point within the project area at approximately 1,275 metres. Waterloo Range is visible from Glen Innes about 12 kilometres to the east and also contrasts with the flatter terrain where Glen Innes is located at an elevation of about 1,050 metres as well as the Severn River valley to the north of the wind farm site. Both the Waterloo Range and the adjacent plains are distinct features of the local landscape.

The landscape of the wind farm site comprises mostly cleared pastoral land with areas of remnant woodlands adjacent to parts of the wind farm. Mature trees both dead and alive are scattered through the landscape. Areas of remnant woodland can relate to areas of steep slopes, poor soils or simply different priorities of the owners of the land. There are extensive areas of wooded land to the west of the site on the steeper slopes above Wellingrove Creek. The tracts of woodland close to the wind farm will not be affected significantly by the development and they will still be present in views after the wind farm has been installed.

There are few outcropping rock features in the mostly basalt terrain. As far as possible, rock features will be avoided or, if disturbed, relocated nearby to preserve habitat for reptiles. The retention of these rock features can also serve to maintain the appearance of the location.

Watercourses on the upper slopes of the range are intermittent. Drainage from the site is to the creeks to the east and west of the site. Disturbance of watercourses will be minimised.

Overall there is a high proportion of vegetation in most views, varying from cleared paddocks with varying degrees of exotic grass and some native grass to patches of remnant woodlands.

2.4.2 Cultural features of the landscape

Cultural elements of the existing landscape for the purpose of this assessment include the built features such as local roads, residences, farm buildings, fences, overhead power lines, trig stations and communications facilities. In general, these features are scattered through the landscapes and are a minor part of the rural scenes.

The farming of the land can be regarded as a cultural element, with the generally cleared grazing paddocks that exist over much of the site having been created over the last 150 years of farming in the area.

Residences and farm buildings (e.g. shearing sheds and barns) are scattered throughout the rural land at varying densities mostly in lower, more sheltered locations. The ridges on which the turbines are

located have been chosen because they have suitable wind energy resources and also because they are free from residential settlement. In some places, generally closer to Glen Innes, there are clusters of small acreage farms with residences, however Council has indicated that this trend is unlikely to be permitted in the vicinity of the wind farm site.

Some residences in this New England Tablelands Region are surrounded by trees as a means to protect the residence from winds. While the visibility of the residences may be reduced in these cases, they are identifiable as such in the extensively cleared landscape. Fencing is a common visual element of the landscape, while exotic trees and shrubs are associated with some of the residences and rural buildings.

Roads in the vicinity of the wind farm include:

- the sealed Gwydir Highway about 1 kilometre north of the wind farm away at its closest point
- the unsealed Illparran Road in Wellingrove Valley to the west of the project area
- the unsealed West Furracabad, Cherry Tree and Hillside Roads to the east of the wind farm
- the unsealed former highway alignment on top of Waterloo Range
- the unsealed Rose Hill Road to the north-east of the site
- minor property access tracks which are common in the area
- the New England Highway is about 12 km to the east of the wind farm site

Traffic volumes on the Gwydir Highway have been assessed as around 4,272 vehicles per day. The volume of traffic on the local roads surrounding the site appears to be low. No rail lines pass close to the site.

An existing generally east west trending 66,000 volt transmission line comprising wood pole structures passes to the north of the wind farm and is generally on the southern side of the Gwydir Highway. It is likely that this line will be upgraded to 132,000 volts over the next few years. This will involve minor change to its appearance. Lower voltage lines distribute electricity to rural settlements.

The wind farm site will be partially visible from the Glen Innes Township some 12 kilometres east of the wind farm. However, tree screening, topography or aspect of the viewpoint within the town will limit many views of the wind farm.

There are few public places such as community halls or churches close to the wind farm apart from Matheson Church to the north-west of the site.

The proposed wind farm will be an additional cultural element in the landscape. Some viewers would describe it as an industrial element of the landscape while many others would see it as an expression of sustainable energy generation. The viewer's association of the development with these aspects will affect their personal acceptance of the wind farm.

Sinclair Lookout is located on the southern side of the Gwydir Highway and at the top of the slope into Wellingrove Creek valley. While the lookout is close to the northern end of the wind farm the aspect of the lookout is generally to the west toward Inverell and away from the wind farm. Nevertheless, the northernmost turbines will be at close distance to the south of the lookout and visible from it.

2.4.3 Types of views and landscape elements

Overall, the landscape character comprises pastoral scenes with moderate size properties scattered throughout the area. Components of the views in the wind farm locality are primarily grass-covered paddocks, scattered trees, occasional rural residences, farm buildings and associated fencing and tracks.

Ridges forming the Great Dividing Range are significant visual features within the broader locality. The ridges also obstruct the extent of views from many potential viewpoints. Viewpoints may in places also be constrained by vegetation. Topography, vegetation and aspect may provide partial or full screening of the wind farm from some viewpoints.

The main landscape elements present at the wind farm locality are shown in Table 2.2 below and are complemented by landscape images in the accompanying photomontages (Viewpoints 1 to 10).

Table 2.2 – Representative local landscape elements

Ref Plate	Landscape element	Main features present in the landscape	Representative view
1	Pastoral scene on Waterloo Range	Elevated above surrounding rural lands. Extensively cleared but with large areas of remnant woodland mainly on the steeper slopes that flank the more gently sloping pastoral lands.	
2	Pastoral scene within West Furracabad Valley	Flat rural grassland between moderate size hills. Extensive clearing is evident. Scattered rural residential development is spread through the valley at a low density. Cultural features include roads, fencing, power lines and sheds	
3	Pastoral scene in Reddestone Creek Valley	Flat narrow valley, mostly cleared, some willows along creekline and a low density of rural residences. The heavily cleared lowland contrasts with the wooded slopes that flank Waterloo Range and nearby hills.	
4	Rural scene Wellingrove Valley viewed from Waterloo Range	Narrow valley with slopes to the east and the west rising some 200 to 300 metres above the valley. The valley floor has been extensively cleared. Significant areas of remnant woodland occur on slopes. Scattered rural residences are present mainly on the lowland areas and roads, fences and buildings are evident.	

5	Wellingrove Valley view toward Waterloo Range	View of Waterloo Range above rural lands in Wellingrove Valley. Gwydir Highway in foreground. Remnant woodland evident on slopes in contrast to heavily cleared area of valley floor. Poplar trees are evident in places along the Highway. There is a low level of rural residential development in this landscape.	
6	Rural settlement (West Furracabad Valley shown)	The western part of Furracabad Valley includes isolated residences but in some places two or more may be in close proximity. Establishment of trees around residences is common in rural areas that are at times subject to strong winds. Extensive clearing is a feature of the valley.	
7	Hilly range to the south west of the wind farm	A significant elevated topographic feature occurs to the south of the wind farm. It is characterized by steeper slopes and lesser development in terms of clearing and rural residences than for the valley floor. The density of rural settlement is low within Wellingrove Valley but clearing has been extensive.	
8	Furracabad grassland with elevated land to the south	This view from Mayvona shows the cleared grassland in the southern Furracabad Valley with the Lombardy residence in mid distance and the elevated ranges to the south between the wind farm and Ben Lomond localities. The view is from close to the wind farm but away from it.	
9	Residence in rural setting	This view is from Hillside Road toward Highfields residence situated amongst the trees. The former residence is visible at the right of the photo. Turbine site 18 is located on the hill behind the Highfields residence.	
10	Urban area in rural setting	The view from Martins Lookout to the east of Glen Innes includes the urban areas in the foreground, Furracabad Valley in the mid distance and Waterloo Range in the background. Within Glen Innes itself views of the surrounding landscape are screened by built structures and trees	

In addition to the representation of landscape elements provided in Table 2.2, the appended photomontages for representative Viewpoints 1 to 10 also include a range of elements of rural scenes together with the proposed wind turbines. The representative viewpoints have been selected for their maximum visual exposure of the wind farm and many locations where views of the wind farm were constrained (by either topography or trees) were not chosen for the production of photomontages.

2.5 Subjective aspects of landscape preference

The preceding sections have described the visual aspects of the turbines, the layout of the wind farm and the main natural and cultural features of the landscape. A viewer's perception of these natural and cultural elements and the values assigned to them is more difficult to define than the physical aspects of the scene and it is likely that a variety of responses will be obtained from those potentially affected by the development.

2.5.1 Aspects affecting viewing experiences

Aspects which singularly, or in combination, may affect a viewer's response to the development include:

- the viewer's relationship to the area, e.g. resident or visitor
- in the case of a local resident, proximity to the wind farm and extent of change arising from the development
- the viewer's experience, values or attachment to the character of the existing view
- the viewer's preference for the status quo
- impressions/associations invoked in the viewer by the development
- the perceived extent of change to an existing view and contrast with the existing landscape
- any uncertainty in the mind of the viewer as to actual impact when implemented
- the viewer's response to sense of movement in the landscape

The above aspects, and perhaps others, may influence how a viewer perceives various scenes and their acceptance, like or dislike of the scene. A variety of responses are possible and it is unlikely that there will be a consistent response.

2.5.2 Consultation with landowners and landscape values

It is possible that some people within the visual catchment may feel a degree of concern regarding the impact on their longer term enjoyment of the locality. Such concern is likely to be heightened by any uncertainty regarding the extent of actual impact. It may also vary between individuals based on each person's association with the local landscape and the values that they attach to the current landscape.

With the above consideration in mind, Glen Innes Wind Power has undertaken consultation with the community and has provided details of the proposed development and contact details to enable further discussion with interested or concerned locals.

The initial consultation was carried out by visiting many of the neighbours to the development and explaining details of the proposed development to the community. The impression gained from the initial consultation was that many neighbours are generally supportive of wind energy developments while others have expressed concerns regarding proximity of the development. As far as possible, Glen Innes Wind Power has modified the wind farm layout to mitigate visual impacts with the aim of addressing concerns raised by some neighbours however the scope to vary the array is limited by practical considerations in achieving a viable wind farm project.

Further consultation was undertaken in December 2007 at Open Days held in Glen Innes where representative photomontages were available together with other project information.

Involvement in the visual assessment for a range of wind farm sites has shown that the wide range of responses is obtained from neighbours to wind farm developments. A general response is that those involved in working the land are often ambivalent about wind farm developments as they appear to regard them as a practical utilisation of the land in addition to the traditional purposes. Those neighbours that have rural residential as their primary purpose for the land appear to have more wide ranging responses including criticism of the wind farm developments as imposing large unfamiliar structures into the rural landscapes. Concerns regarding the development may also be exacerbated by anxiety in respect of land values and in these cases it can be difficult to distinguish the primary source of concern.

No other wind farms have been constructed in the New England Tableland and so the Glen Innes Wind Farm will be the first of this type of development in the region. Neighbours that have not visited other locations with wind farms can only assess the impact of a wind farm in the rural landscape based on media coverage, which can provide various approaches to the issue. Neighbours to other wind farm developments have commented that they were less concerned by the wind farm development at their location once they had viewed other operating wind farm sites.

This report provides a description of the potential visual impacts of the wind farm on neighbouring residences and aims to assist stakeholders by providing a basis for potential viewers, including local residents, to reach their own conclusions as to the potential visual impacts of the proposed development, using realistic representations of the wind farm in the form of photomontages. It also aims to provide a relative ranking of visibility of the wind farm from the selected viewpoints and a description of the changes to the scenes at those viewpoints.

2.5.3 NSW experience

The prior establishment of a wind farm on a grazing property at Crookwell provides a useful local reference to gauge community reaction to such installations. In that instance, the broader community has been supportive of the development, and has mostly indicated very positive responses since construction of the wind farm.

A quote in the Crookwell Gazette, May 12, 1998 reads as follows, " *They are simply stunning and beautiful white structures which blend well into the natural environment*. "

On the other hand, the owner of an adjoining property was quoted (Sydney Morning Herald, 25th August, 1998) as saying the wind turbines are "*a desecration of beautiful country*".

Another letter from a Crookwell local (26th August 1998) in the Sydney Morning Herald included the following statement, " *And I have yet to meet anyone who has seen the new wind farm – both locals and visitors – who have not remarked on the beauty and elegance of the structures"*.

In the case of the Blayney Wind Farm constructed in 1999 there was a broad acceptance of the wind farm development by the Blayney community. However, instances of anxiety and opposition were encountered from neighbours to the development. Correspondence with those neighbours following the installation of the wind farm has indicated a significant reduction in the neighbours' concerns.

It is recognised that there are differences between the setting and scale of the Glen Innes Wind Farm development and the Crookwell and Blayney wind farms and residents in these areas may have different values. Indeed, as noted above, differences were found in the Crookwell area, with some neighbours expressing support and others voicing concern about the development.

In the case of the Gunning Wind Farm, for which consent was gained in November 2004, there was general community support but some objection from immediate neighbours. That wind farm has not yet been built and the reaction to the constructed wind farm is not available.

From the above examples, it can be seen that widely differing views can be held regarding the acceptability or otherwise of the visual impact of a wind farm. On this basis it serves little purpose to make categorical assertions regarding the likely visual impact of the development. Rather, the likely spectrum of opinion reinforces the approach of providing realistic impressions of the completed wind farm to enable the Consent Authority and other interested parties to make their own assessments of visual impact.

2.5.4 Lake Bonney experience

Lake Bonney Wind Farm comprises of 99 wind turbines and is currently Australia's largest constructed wind farm. The site is within an area used for grazing and contains scattered rural residences. Minor opposition was received to the development application and the project appears to have achieved broad community acceptance, despite its scale.

2.5.5 Association with environmentally friendly technology

The overall strong community support received from the Crookwell, Blayney, Gunning and Lake Bonney communities may be related to the fact that wind farms utilise an environmentally friendly energy source while allowing continuity of existing land use. In short, many people have embraced the notion of ecologically sustainable development and are likely to form a positive mental association with the wind turbine structures. However, not all of the people resident in the local area can be expected to have this outlook and some may prefer the existing rural vistas without imposition of the wind turbines.

2.5.6 Visual Absorption Capability

Details have also been sought by the approval authority as to the 'visual absorption capability' of the Glen Innes landscape in respect of the proposed wind farm development. In broad terms 'visual absorption capability' has been described as "*the landscape's ability to accept alteration without diminishment of visual quality (or creation of visual contrast)*" (*URS Corporation, 2006*). In this respect 'visual contrast' involves a project's consistency with the visual elements of form, line, colour and texture already established in the landscape and is indicated to inversely correlate with 'visual absorption capability'. It could be said that the scale and form of the wind turbines contrast with the rural scenes and as such there would be a low visual absorption capability for wind farms.

A range of other terms have been used in the same reference article to assist visual analysis. These terms include visual quality, viewer sensitivity, landscape visibility, viewer exposure, visual impact susceptibility, visual contrast, project dominance and view impairment. Those terms and their usage in the reference article are outlined below in the context of the proposed wind farm development.

'Visual quality' is a measure of the overall impression or appeal of an area as determined by particular landscape characteristics such as magnitude or shape of landforms, particular features of interest such as rock forms or particular colour associations, water features and vegetation patterns as well as public values. The area surrounding the wind farm contains many pastoral scenes with varying degrees of elevated ridges and mixtures of cleared land and remnant woodland. The scenes unquestionably present a pleasant rural setting.

'Viewer sensitivity' is a term used to express the level of concern or interest of viewers of the landscape and be closely associated with the viewer's expectation for the area. Viewer sensitivity is a measure of the importance placed on a given landscape based on the human perceptions of the intrinsic beauty or character of the landforms and elements of the landscape. Some variance in sensitivity is evident within the local population with some resisting change and others less concerned.

'Landscape visibility' describes the ability of a landscape to be observed from a particular viewpoint and can be a function of distance, degree of detail, seasonal or diurnal variations and presence or absence of screening features such as landforms, vegetation or weather conditions. The following sections provide a detailed review of the visibility of the project in the local landscapes. The hilly country means that the extent of views will vary from place to place and visual impacts will vary across the locality.

'Viewer exposure' describes the degree to which a range of viewers are exposed to the landscape. It takes into account the number of viewers, the duration of view and proximity of viewers to the subject landscape. Where a landscape is remote and receives few visitors it can be described as having a low viewer exposure. In most cases neighbours to the wind farm will reside in areas where there is limited visitation apart form the local rural residents. As such the potentially impacted landscapes could be said to have low exposure. However, from the point of view of residents in these areas they may view their personal exposure to the local landscape as high.

'Project dominance' refers to the project's relationship to other visible landscape components in terms of vertical and horizontal extent. Terms that have been used to describe a project's scale and spatial relationship to the existing landscape are subordinate, co-dominant or dominant. The nature of wind farm developments with tall wind turbine structures installed on elevated ridges leads to them having a degree of vertical dominance. However, in a lateral sense, the turbines can be considered as slender structures that comprise a minor part of panorama views. The actual degree of lateral dominance will depend on the spacing of turbines, the orientation of the array relative to the wind farm and essentially the 'density' of turbines within a particular part of the landscape. Due to the moderate scale of the wind farm and it being spread along 8.5 kilometres of the Waterloo Range it can be said to be distributed through parts of the landscape rather than concentrated in the landscape.

'View impairment' refers to the extent to which a project's scale and position results in the blockage of higher quality visual elements by lower quality elements. As mentioned above, it is a feature of wind turbine structures that even though having a prominence in the landscape their structures are slender and they do not obscure the main elements of rural landscapes. As such prominence seems to better characterise the position of turbines in landscapes rather than dominance.

Based on consideration of the above visual factors, the topographic variations at the wind farm locality and the available landscape views, the 'visual absorption capability' of the individual landscapes appears to vary from place to place. The application of that term appears to have been originally applied for forestry projects that involved a different form of visual impact to that posed by wind farm development. The term appears to be less suited to the assessment of wind farm projects where the turbines are by nature prominent and the proportion being naturally obscured by topography or vegetation is generally more consequential than managed. The Foundation Report of the Wind Farms and Landscape Values Study briefly touched on the landscape's visual absorption capability but the term does not appear to be mentioned further in the associated National Assessment Framework Report.

In general, all rural landscapes are considered to have a degree of attractiveness and even those subject to overgrazing can exhibit character and beauty for some viewers. Wind farm developments are by their nature most likely to be located in rural areas on ridges where they will be prominent features in otherwise pastoral landscapes as is the case for the proposal on Waterloo Range. To a large extent the turbines add a new element in the landscape without significantly obscuring existing elements. The Glen Innes wind farm landscapes have low viewer exposure and have not been recognised under any planning scheme or heritage register as a zone of special visual significance. To limit wind farm developments in such landscapes throughout NSW would significantly reduce opportunities for the development of this form of renewable energy more broadly.

3. Methodology

The methodology adopted for this review of the visual impact of the proposed development includes both an assessment of the wind farm's visibility and an overview of subjective aspects. The review entailed the following steps:

- Determination of visibility criteria (Section 4)
- Identification of the wind farm's visual catchment (Section 5)
- Compilation of a list of assessment sites (Section 5.1 and Table 5.1)
- Photography at assessment sites (Section 6.1)
- Computer modelling of topography and generation of perspective views of the wind farm (Section 6.2)
- Photomontage compilation (Section 6.3)
- Review of photomontages against the visibility criteria (Section 7)
- Review of indicative visibility for a range of viewpoints including residences surrounding the wind farm
- Review of potential visual impact of the wind farm on residences surrounding the wind farm (Section 7.3)
- Review of visual aspects of ancillary works (Section 8)
- Identification of options to mitigate the project's visual impact.

More detailed descriptions of these stages are provided in the following sections.

Shadow flicker analysis has been assessed separately and is reported in Appendix D.

4. Visibility Assessment Criteria

In order to facilitate objective assessment of visibility, a set of key assessment criteria was developed. The key criteria against which the visibility of the proposed development was assessed are:

- the distance from the wind farm
- the spatial extent of the wind farm (view field angle)
- the number of visible turbines

The **distance** of each assessment site from the closest turbine was used as a principal factor to rank visual prominence, which decreases with distance. Scenic impact has also been shown to decrease rapidly with distance in a reciprocal relationship (Hull and Bishop, 1988). Distance can also be used to classify whether the wind farm would be viewed in the:

- foreground (0 to 1 km), the zone of greatest reduction in scenic impact with distance
- mid-ground (1 to 3 km)
- background (more than 3 km)

The Glen Innes Wind Farm development is spread over approximately 8.5 kilometres from north to south with eastern and western central groups. Accordingly, in some views the closest turbines may be in the mid-ground or foreground, while the more distant turbines are in the background. In this situation, it is the closest turbines that are regarded to have the most visual impact. In some cases, topography and/or trees may obscure the more distant turbines.

Neighbouring residences are all set back at least one kilometre or more from the wind farm. There are no close public viewpoints apart from Sinclair Lookout and short sections of local roads that are located in the foreground.

The **view field angle** can be described as the angle subtended by the visible wind farm at the observer's location. This angle varies for different viewpoints and is influenced by the distance from the wind farm, the number of turbines, the layout and its orientation relative to the viewer and the effect of intervening topography. In some cases, only part of the wind farm will be visible. The angle between the left and right hand edge of the view field of the visible wind farm defines the affected proportion of the viewpoint. A person normally sees about 100^{o} at any point and can easily see a much broader field by scanning from side to side.

As noted above, the angle subtended by the wind farm is, in part, dependent on distance in that, as the distance from the wind farm increases the view field angle for the same width of wind farm will decrease. For a layout such as the Glen Innes Wind Farm, the greatest angular decrease in the view field with distance occurs from 0 to 1 kilometre. Beyond about 3 kilometres there is a lesser decrease in the view angle as distance increases.

The **number of visible turbines** for the foreground, mid-ground and background was determined for each assessment site from inspection of photomontages (Viewpoints 1 to 10) and review of layouts relevant to the viewpoints and is shown in Table 7.1.

Although not specifically taken into account in ranking the visibility of the wind farm, the number of visible turbines is also likely to contribute to overall visibility. To some extent it can affect the view field angle and has indirectly affected the visibility ranking described below.

4.1 Visibility ranking

The above factors have been used to assign a simple relative ranking of the visibility of scenes into three classes, high, moderate and low, as described below and shown graphically in Figure 4. For the purpose of this assessment the following descriptors were adopted.

High Visibility: Scenes having high visibility include viewpoints within 1 kilometre and viewpoints up to 3 kilometres depending on the wind farm view field angle

Low Visibility: Low visibility is assigned to all viewpoints beyond 5 kilometres and viewpoints between 3 and 5 kilometres depending on the wind farm view field angle. It should be noted, however, that low visibility does not necessarily correspond to low visual impact.

Moderate Visibility: This classification is applied to viewpoints intermediate between the low and high classes

While the above classification scheme is somewhat arbitrary, it does serve to rank visibility for the respective viewpoints and enable comparison between them. It is stressed that visibility rankings do not represent the visual impact which, as indicated in Section 2.5, is subject to a range of other considerations. Similarly, the visibility ranking does not indicate whether the visibility is adverse or favourable.

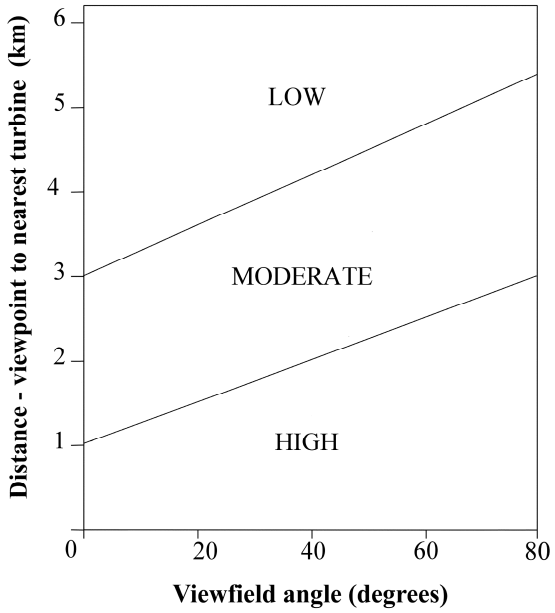

Figure 4 – Classification of wind farm visibility

4.2 Backdrop of the wind farm views

Whether the wind turbines are seen against the sky or land features can also be relevant to the assessment of visual impact. Most views of the wind farm will have a background of sky. In clear weather, the turbines are likely to be more clearly defined against the blue sky, whereas they may be less noticeable with a backdrop of clouds. The photomontages in this assessment have been enhanced to make the turbines more prominent.

5. Visual Catchment and Assessment Sites

The visual catchment of a wind farm is the area of surrounding land from which the wind turbines may be wholly or partly visible. Areas not included in the visual catchment are those where the view of the wind farm is obscured by topography, vegetation, human made structures or even just distance (Robotham & Quillesh).

The wind farm will be visible at distances of 10 to 20 kilometres in some directions. The view of the wind farm across Furracabad Valley from Glen Innes is largely unimpeded while topography is a limiting factor in other directions, particularly to the south as described in the following sections. Visual impacts decrease with distance and this assessment has been predominantly focussed on distances of 10 kilometres or less.

For this study, the approximate visual catchment of the wind farm was computed using a Geographic Information System (GIS) and digital topographic data that was sourced from commercially available map sheet data for the Stonehenge and Glen Innes 1:25,000 map sheets. Various representations of the visual catchment are shown in Figures 5 to 11.

Because data on the heights of vegetation was not readily available over the study area, its affect on viewfield extent has not been used for the computation of the visual catchment. The result of the GIS derived visual catchment computation shown in Figures 5 to 11 are therefore conservative with the actual areas from which the wind farm would be visible being less than shown in the figures.

The representation of the wind farm's visual catchment shown in Figure 5 shows the catchment for areas to Glen Innes and beyond. Figure 6 shows the visual catchment for the wind farm locality in more detail than in Figure 5. The shaded areas in Figures 5 and 6 represent locations where part or all of the wind farm may be visible.

Due to the difference between the location of the groups of turbines, differences in the elevation of turbines and topographic variations across the locality, the visibility of the respective turbine groups varies for different viewpoints. Figures 7 to 10 provide a further break down of the visual catchment for individual turbine groups distinguishing which turbines can be seen from different viewpoints. In addition, Figure 11 represents the wind farms zones of visual influence, which demonstrates the number of turbine tips visible in the area surrounding the wind farm.

As mentioned above the visual catchments shown in Figures 5 to 10 and the zones of visual influence shown in Figure 11 are conservative and due to screening by trees that are not recognized by the computer system the visual catchments will be more restricted than shown in Figures 5 to 11.

5.1 Selection of representative viewpoints for visibility assessment

Within the wind farm's visual catchment ten specific sites were identified from which the visibility of the wind farm was assessed and for which photomontages were prepared. All include views of the wind turbines. The basis for the selection of the ten assessment sites was to include representative views of the various turbine groups from various directions at locations where the public would be able to view the wind farm. All the selected viewpoints are on public roads surrounding the site, some of which are close to private residences and are generally representative of the views from those residences. The distance of the viewpoints varies from 1.8 kilometres (Viewpoint 8), the closest public viewpoint for the wind farm, to 11.6 kilometres (Viewpoint 10).

The viewpoints were also selected as far as possible to provide a clear view of the wind farm. Locations that were affected by tree and/or topography screening, although a common characteristic,

were generally avoided. Photomontages were prepared at key locations around the proposed wind farm to provide representative views of the wind farm. These viewpoints for the photomontages are located nearby one or more residences. Photomontages were not prepared for specific residences as often tree screens around the residences would limit views of the wind farm and because locations nearby on public roads were generally representative of the views from the residences. The photomontages for the locations nearest to such residences should enable the respective residents to visualise the changes arising from development of the wind farm relative to their property. Table 7.2 identifies the closest photomontage to each resident within 3 kilometres of the wind farm.

The locations of the ten viewpoints are shown in Figures 5 and 6 and are listed in Table 5.1.

Only two viewpoints are beyond the range of 5 kilometres from the nearest turbine. Due to spacing between the turbines and lateral extent of the wind farm there may be a distance of up to 5 kilometres or more between the nearest turbine and the most distant turbine. The visual impact from more distant viewpoints is regarded as being less significant.

Viewing experiences from the nominated locations are generally representative of a range of viewpoints surrounding the locality where the representative viewpoint was obtained.

Table 5.1 – Details of viewpoint assessment sites

Ref	Viewpoint Location (see also Figure 5)			View details			
	Easting AMG m	Northing AMG m	Description of Location	Distance to nearest turbine (km)	Direction of view	Turbine Group in view Y = 'Yes'	
						Northern	Southern
1	363342	6702166	Jenkins Road adjacent to Caloola Property	3.2	North East	Y	Y
2	362975	6704375	Intersection of Waterloo Road and Camerons Road	2.7	East / North East	Y	Y
3	361365	6708813	Intersection of Gwydir Highway and Waterloo Road	3.6	East / South East	Y	Y
4	368017	6712417	Gwydir Highway, adjacent to "Rosefields"	3.7	South West	Y	Y
5	371079	6711791	Gwydir Highway	6.3	South West	Y	Y
6	370618	6707880	West Furracabad Road	3.1	West	Y	Y
7	371223	6704422	Intersection of Furracabad Road and Haymarket Road	3.4	West / North West	Y	Y
8	369193	6703614	Intersection of Hillside Road and Cherry Tree Road	1.8	North West	N	Y
9	370164	6700071	Haymarket Road	3.7	North West	Y	Y
10	379100	6709775	Martins Lookout, Glen Innes	11.6	West	Y	Y

The Glen Innes Township is approximately 10 kilometres east of the closest turbine location and is visible from the crest of Waterloo Range. Accordingly, there will be views of the wind farm from Glen Innes but the extent of the wind farm that is visible from various viewpoints within Glen Innes will vary. The wind farm's visibility from Glen Innes viewpoints will depend on the aspect of the particular

viewpoint, its elevation, screening features in the vicinity of the viewpoint and the nature of the intervening topography that can provide partial or complete screening of views to the wind farm.

Inverell is about 50 kilometres to the west of the wind farm. Due to the distance involved and topographic features the wind farm is unlikely to be visible from Inverell.

Figure 5 shows the location of the wind farm together with lines representing distance from the nearest turbine in five kilometre intervals. The lines shown on Figure 5 provide assistance to residents to gauge the distance to their respective points of interest and to select viewpoints at similar distance for comparison purposes.

5.2 Review of visibility from areas surrounding the wind farm

In addition to the computation of the visual catchment shown in Figure 5, the following provides a commentary on potential wind farm visibility from the various directions from which it may be viewed.

More detail of the visual features of each turbine group is provided in Section 5.3 and discussion of visibility and visual impact of the wind farm is provided in Section 7. A discussion of the views from the representative viewpoints and potential views of the site from other points such as residences and public places is also included. Due to the distribution of turbines in separate groups, the discussion in Section 7 refers to the visual features of the turbine groups as appropriate.

5.2.1 Views to the site from the south

The visual catchment to the south of the wind farm is limited by the extension of the Waterloo Range to the south. The southern extent of the wind farm also has scattered vegetation, which assists in screening the farm. There are no major roadways running along ranges to the immediate south of the wind farm.

The closest neighbours will have views of the wind farm from all other angles of views, except the south. Viewpoints from the south west (Viewpoint 1) and south east (Viewpoint 8 and 9) illustrate the visual impact of the turbine groups on the few neighbouring residences to the south of the wind farm. Due to the lack of neighbours to the south of the wind farm and screening provided by topography and trees, no photomontages have been prepared from due south of the wind farm.

5.2.2 Views to the site from the east

The low level expanse of the plain to the east of the wind farm means that views of the wind farm will be obtained from Glen Innes Township, the Gwydir Highway and a number of residences to the east.

There are a range of residences to the east of the wind farm however the density of the rural settlement is generally low and most residences are at least two kilometres from the site. Two of the residences to the east are wind farmers.

The wind farm will be visible from the Gwydir Highway on approach to the Waterloo Range as well as some of the local roads such as West Furracabad Road, East Furracabad Road, Haymarket Road and Cherry Tree Road.

Photomontages have been produced for viewpoints from the West Furracabad and Gwydir Highways (Viewpoint 4, 5 and 6). From these viewpoints, many of the turbines are visible, with those on the eastern ridges of the wind farm site being clearly visible while some further to the west are partly screened by topography.

5.2.3 Views to the site from the north

The wind farm will be partly visible at locations to the north as indicated in Figure 5. Inspections of the area to the north indicate that it is sparsely settled and that topography, together with screening by trees will in many places limit views of the wind farm and for these locations the visual impact will be low. However, the single residence on top of Waterloo Range, Wattle Vale is slightly less than two kilometres to the north of the wind farm and will have views to the northernmost turbines.

5.2.4 Views to the site from the north-east

Due to the large elevated features of the Waterloo Range in comparison to the low lying lands where Glen Innes is located some parts of the town will have direct views of the wind farm.

There will be partial views of the wind farm from vehicles on the Gwydir Highway travelling west. There are also a number of residences, some of which may have views of the wind farm. Two photomontages have been prepared for locations along the Gwydir Highway with south west views toward the wind farm (Viewpoints 4 and 5). These viewpoints are 3.7 and 6.3 kilometres east of the wind farm respectively.

5.2.5 Views to the site from the northwest

There are a number of residences to the north west of the site and the Matheson Church and former post office site. The remaining area is sparsely populated by rural settlements. The wind farm will be visible from parts of this area and some of the residences in the immediate vicinity. Viewpoint 3 illustrates the view from this area at a distance of approximately 3.6 kilometres from the nearest turbine.

Further north west of this vantage point the visibility of the wind farm will be reduced due to distance, the topography of the area and some heavily vegetated hill tops.

There will be views to the wind farm from along the Gwydir Highway and Waterloo Road to the north west of the wind farm.

5.2.6 Views to the site from the west

The extent of the visual catchment to the west is predominantly along Wellingrove River Valley with the ridge line on the western side of the valley limiting the extent of the visual catchment to the west. The western slope of the Waterloo Range is fairly steep and without rural settlement. However a range of residences are scattered through the valley with some at the base of the western slope of Waterloo Range. Viewpoint 2 illustrates the view from the west towards the middle section of the wind farm from a distance of about 2.7 kilometres from the nearest turbine.

5.2.7 Views to the site from public roads

The wind farm will be visible from the Gwydir Highway, Waterloo Road, West Furracabad Road and some of other local roads further from the site. The wind farm may also be visible form some roadways in the township of Glen Innes but only as distant views.

5.3 Visual features of each turbine group and surrounding viewpoints

This section provides a description of the visual features of the southern and northern turbine groups and the substation. It also identifies the main viewpoints in relation to these groups.

Northern Group
The northern group of 9 turbines is the closest part of the wind farm to the Gwydir Highway and will be the most prominent feature seen by travellers on the highway. There are limited partial views of the wind farm from the Gwydir Highway where it crosses Waterloo Range.

The density of rural settlement around the northern group is low with the three closest neighbouring residences being at about two kilometres from the wind farm.

Photomontages for Viewpoints 3, 4 and 5 provide views with the Northern Group closest to the viewpoint. The visual catchment for the northern group of turbines is shown in Figure 7.

Central-Eastern Group
The central-eastern turbine group of 4 proposed turbines (10, 20B, 21B and 22B) will be visible to residences within the Furracabad Valley. Figure 9 shows the visual catchment of these four turbines. The proposed turbines are about 1 kilometre from two vacant residences, Hillside and Mayvona. These residences will have views of the closer turbines but topography will limit views of some of the turbines on the western ridge.

Photomontages for Viewpoints 7, 8 and 9 provide views of the Central-eastern turbine group. The closest, Viewpoint 8 is from the intersection of West Furracabad and Hillside Roads. While the viewpoint is set further back from the wind farm than the closest residences, it presents a broader view of the wind farm than will be obtained from the closer locations.

Central-Western Group
The central-western group consists of 8 proposed turbines (10B to 14B) that are mostly more than two kilometres from neighbouring residences except for Glengyle and Illparran which are 1 to 1.5 kilometres from the nearest wind turbine. Figure 8 shows the visual catchment for this group of turbines. Viewpoints 1 and 2 provide the closest viewpoints of the central-western turbine group.

Southern Group
The southern group comprises 6 turbines (15 to 19) on several elevated peaks and ridges. The closest turbine to an occupied residence (Highfields) is Turbine 18 at 0.96 kilometres from the residence. The visual catchment of the southern group of turbines is shown in Figure 10. Screening by topography and trees will limit the views to the more distant southern and western turbine groups for some locations in the southern group's visual catchment

Viewpoints 1, 2, 6, 7, 8 and 9 provide views of the southern part of the wind farm.

5.3.1 The substation site

The substation is a relatively low feature that will have limited visibility from surrounding areas. Its location at the northern end of the wind farm has been selected to be close to the existing 66,000 volt overhead transmission line. Its actual location at the northern end of the wind farm is set back from the edges of the ridge and screening of trees will minimise its visibility. The substation is expected to represent a minor visual impact.

5.4 Factors which may restrict the visibility of the wind farm

The wind farm will be visible to varying degrees from many locations during the day. Topography and large trees will provide the main factors restricting visibility of the wind farm from specific viewpoints. The aspect of the viewpoint will also affect the visibility of the wind farm. Viewpoints on slopes facing away from the wind farm would be expected to have lesser visual impact from the development than viewpoints facing the wind farm site.

At certain times weather conditions involving low cloud, fog and heavy rain may limit daytime views of the wind turbine structures. Visibility of the wind farm will be at a maximum on fine sunny days with blue skies and a clear dust free atmosphere. Considerable effort was made to obtain photos that show these conditions so that the photomontages would represent the wind farm at a time when it is most visible.

Other factors such as the colour finish of the turbine components and the tower can also affect the visibility of the structures but their influence will vary with the weather conditions or the backdrop to views of the wind farm as the degree of contrast fluctuates.

Depending on requirements of the Civil Aviation Safety Authority it may be necessary to have lighting on the turbine structures. If so, the wind farm lighting will be visible at night when not screened by cloud cover. The issue the visibility of aircraft safety lighting is discussed in greater detail in Section 7.4.

Apart from removing turbines from the layout, the proponent's main options to reduce wind farm visibility include provision of screening at viewpoints and colour finish for the turbines.

6. Photomontages

To assist the assessment of visual impact at each of the selected assessment sites photographic representations (photomontages) of the modified landscape were prepared (Viewpoints 1 to 10).

The use of pictures as surrogates for real landscape has been criticised in that photographs are less complex, less multi-dimensional and offer less interaction than do real scenes (Abello *et al.,* 1986). However, the use of photomontages derived from on-site landscape photographs can be valid if viewers rank pictures in approximately the same way as they rank the actual scenes. A number of researchers have reported high correlations between photo-based judgements and on-site judgements of scenic beauty (Hetherington *et al.*, 1993).

Given the variable topography around the wind farm site, viewing experiences at different locations can be quite variable. The photomontages serve to indicate the proportion of the wind farm that will be visible and also the relationship of the proposed wind turbines to the landscape features with which the local residents are familiar.

The preparation of these photomontages involved photography and computer modelling to integrate the wind farm structures with the photographic image of the landscape. The process of photomontage preparation is described in more detail in the following sections.

6.1 Photographs

A series of colour photographs was taken at each of about 15 locations surrounding the wind farm. Of these ten viewpoints were selected to provide representative views of the wind farm site. The photographs were taken to achieve a perspective of sizes as realistic to the eye as possible. This required consideration of both the camera focal length and the width of the field of view. For a negative size of 35 mm, a focal length of 65 mm gives the most realistic representation of distance and size (Tindal and Garrad). Others suggest that focal length is not critical. Nevertheless, the purpose of this assessment photographs used to prepare the photomontages have been taken using a consistent focal length of 65mm.

While a 100 degree view is indicated to be the most natural to the eye (Robotham & Quillesh), a viewer is able to scan a wider field of view. Accordingly, at most sites a series of photos was taken and then joined together to gain a field of view that extended beyond the wind farm site. Fewer photographs were required for the more distant viewpoints where the wind farm occupied only a narrow view field or where intervening topography or vegetation limited the view to the wind farm.

A Nikon F65 single lens reflex camera with Nikon AF Nikkor 28 to 80 mm zoom lens was used to take the photographs. The 65 mm setting was marked on the lens case and maintained for each photo. Kodak 100 Film was used for most of the photography. A tripod with two spirit levels was also used to obtain the series of photos to ensure that each series of photos was in a horizontal plane.

A series of visits to the locality was required to obtain photographic images for all locations that displayed suitable, relatively clear sky weather conditions. Despite the number of visits to the locality not all of the photography was obtained for clear sky conditions and a degree of cloud cover is evident in some photography. While this situation is typical of the weather conditions experienced for the locality, the visibility of turbines can vary with the nature of the background conditions. The graphical production of the photomontages has generally involved some highlighting of the turbines in the material provided in the Environmental Assessment to assist the recognition of the turbine structures.

6.2 Computer modelling and perspective views

The 'Windfarmer' software program was used to produce a three dimensional model of the wind farm site. The model was then used to generate perspective views of the proposed wind farm based on the horizontal and vertical position of each turbine with respect to each of the viewpoints.

In all of these views, the turbines were shown generally facing the viewer in order to show the maximum visual impact. In practice, the turbines will predominantly face east or west into the predominant wind directions.

The resultant perspective views from each of the selected viewing points provide realistic representations of the turbines in relation to topography. However the combination of the perspective views with the photography requires checks to ensure that scale and positioning of the turbines is realistic.

6.3 Production of the photomontages

To illustrate the appearance of the wind farm from specific locations the photos and computer generated perspective views were combined to create photomontages.

The computer model generated scaled graphical displays of the wind turbines to allow their incorporation into the photo images for each of the selected viewpoints. Production of the resultant photomontages has aimed to provide an accurate simulation of the appearance and scale of the wind farm on the existing landscape. While considerable effort has been made to ensure the photomontages are realistic representations for the respective viewpoints the process incorporates a number of steps that may each reduce the precision of the final result. The presence of existing monitoring towers or other identifiable features within the photographs used to compile the views provides important reference points against which the modelled turbine location and scale within the photomontage can be reviewed and where necessary, adjustments made.

Following any adjustments to the photomontages they are expected to provide realistic representations of the general form of the installed wind farm. It is also possible that the final position of turbines may vary slightly relative to those shown in the photomontage and that a lesser number of turbines may be installed.

As part of the process, the landscape photos were scanned into a computer for production of photomontages for each of the selected ten visual assessment sites as shown in Viewpoints 1 to 10 (Tables 5.1 and 7.1 and Figure 5). The photomontages have been printed at a scale suitable for incorporation in the Environmental Assessment document. The aim has been to represent as realistically as possible the actual view seen by the human eye at the various viewpoints. In the case of Viewpoints 3 and 8 it has been necessary to provide the full span of the photomontage in two parts due to the view angle covered at these locations. The collection of photomontages portrays viewing experiences from the ten sites around the wind farm and forms a key resource for visual impact assessment of the project.

Due to limitations of the equipment used to produce the photomontages, it can be difficult to precisely match the colours on the computer generated images with those on the original photographs. These differences were not considered to be such as to prevent an effective visual assessment and, in some instances, the visibility of the turbines has been accentuated due to increased contrast against the sky.

7. Visibility Assessment Results and Impact Assessment

An assessment of the likely visibility of the proposed development and visual impact for the local community is provided in the following sections. Section 7.1 provides the assessment of visibility undertaken for each of the ten representative viewpoints shown in Figures 5 and 6. In addition, Section 7.2 contains an indicative visibility assessment from about 35 residences surrounding the wind farm site as well as several other relevant locations.

7.1 Visibility assessment for the ten representative viewpoints

The assessment of the ten representative viewpoints was based on:

- review of relevant photomontages for each location
- assessment of the visibility of the wind farm from each of the viewpoints based on the proportion of wind farm that may be visible from the viewpoint
- observation of factors that may reduce the visibility (e.g. topographic features, tree screening and aspect)
- reference to GIS based view field analysis that takes into account the height of the turbines and topographic screening

The key visibility criteria and the resulting visibility classifications (based on the assessment criteria in Section 4) are shown in Table 7.1. A turbine is regarded as 'visible' even if it is only partially visible. In addition, the number of turbines in various distance ranges (1-3 km, 3-5 km and >5 km) from the viewpoint are shown. The viewpoints are located 1.8 to 11.6 kilometres from the nearest turbine with seven at distances of 2.5 to 4 kilometres. It can be seen that only Viewpoints 2 and 8 have turbines in the range less than 3 kilometres, which for visual impact studies is generally regarded as mid-ground. Highfields is the closest occupied residence to the wind farm but a photomontage was not prepared for this location due to the substantive screening provided by the mature trees surrounding the residence.

Of the ten sites assessed, two are ranked as having high visibility, six as moderate visibility and two as low visibility. Visibility of the substation is regarded as low due to the low height of its structures and screening by trees from many viewpoints. Neither the substation nor ancillary features such as roads have been included in the visibility classification as these aspects will be located to reduce their visibility from surrounding areas.

Martin's Lookout to the east of Glen Innes (Viewpoint 10 at about 11.6km from the wind farm) was assessed as being subject to low visibility. It can be seen for the respective Viewpoint that due to the effects of distance (and to some extent topographic screening) visibility from Viewpoint 10 is low. However, the turbines will nevertheless be discernible in the landscape when weather conditions permit.

There are limited trees on the ridges where the wind farm is located and therefore little to reduce or soften views of the proposed structures. Visibility of the proposed structures in these cases will therefore relate to the contrast provided by the background scene. Many views of the wind farm will be from a lower elevation and the backdrop to the turbines is likely to be the sky. There are few elevated viewpoints that could contain portions of the turbines in front of more distant ridges. In such cases, even though the wind turbines are noticeable features they will not significantly mask the scenes but rather they may impact upon the character of the scenery.

At many residences trees close to the residence are likely to reduce the portion of the wind farm that is visible. However, in such cases, more expansive views of the proposed development may be available at short distances from the residences and from beyond tree stands surrounding the residence.

Section 7.2 and 7.3 provide an indicative guide to visibility considerations and impacts for residences and public places surrounding the wind farm site. In addition, Figure 11 provides an indication of the number of turbine tips visible in the areas surrounding the wind farm.

Table 7.1 – Visibility assessment results for the ten representative viewpoints

		Number of visible turbines			Visibility criteria		
Ref No.	Viewpoint Location (see also Figure 5)	Mid-ground	Background		Distance to Nearest Turbine	View Angle	Visibility Class
		1 – 3 km	3 - 5 km	> 5 km	km	degrees	
1	Jenkins Road, adjacent to Caloola Property	0	16	11	3.2	74	M
2	Intersection of Waterloo Road and Camerons Road	2	19	6	2.7	107	H
3	Intersection of Gwydir Highway and Waterloo Road	0	10	17	3.6	73	M
4	Gwydir Highway, adjacent to "Rosefields"	0	5	21	3.7	67	M
5	Gwydir Highway	0	0	24	6.3	62	L
6	West Furracabad Road	0	8	9	3.1	63	M
7	Intersection of East Furracabad Road and Haymarket Road	0	13	12	3.4	82	M
8	Intersection of Hillside Road and Cherry Tree Road	10	5	0	1.8	98	H
9	Haymarket Road	0	5	11	3.7	39	M
10	Martins Lookout, Glen Innes	0	0	27	11.6	35	L
		Substation – Low visibility due to low height and tree screening					

7.2 Other potential viewing points

The visibility of the Glen Innes Wind Farm is demonstrated in the photomontages that have been prepared for the ten representative viewpoints surrounding the wind farm. Section 5.2 also provides a review of the general visibility of the wind farm when viewed from each of the localities in each direction around the wind farm.

In addition, specific viewpoints have been assessed for the potential visibility of the wind farm. Table 7.2 provides a listing of indicative visibility parameters, predominantly for the main residences that occur within about three kilometres of the wind farm. Residences beyond three kilometres that will have a lesser visual impact have not been included in Table 7.2. Neighbouring residences may also use Figure 11 as a guide to the potential visibility of the wind farm.

In preparing Table 7.2, the visibility parameters for each viewpoint have been estimated and should be regarded as indicative only. In some cases, the actual residences have not been visited and the

assessment is based on a review of the local terrain, the aspect of the particular site and the impression of the extent of tree screening, generally gained from observation of the residence's setting from a nearby roadside vantage point or an elevated location at the wind farm site. The assessment of the visual catchment for each of the residences in Table 7.2 includes details of whether a partial view of a turbine is evident (tips) or if the wind turbine hub (as identified in Figure 3) is visible.

7.3 Impact Assessment

The following sections provide an assessment of the likely visual impact of the proposed wind farm for those residences within a three kilometre radius of the wind farm. The assessed visual impact for these residences has been rated from High to Low based on factors described in the following sections.

Residences which are at distances greater than three kilometres may also have views of the proposed wind farm, however the visual impact for those residences is considered to range from Moderate to Low with the visual impact decreasing the further the residence is from the proposed wind farm.

The visual impact assessment utilises the visibility assessment provided in Table 7.2, site visits to the neighbouring residences or their localities and analysis of the generated views in the computer model "Windfarmer" and viewfields using GIS software.

An important consideration in assessing the impact of the wind farm is the field of view from each homestead. With the exception of the "Hillside" residence, which is a dilapidated vacant residence on a windfarmer property, none of the neighbouring residences are surrounded by turbines. Additionally, while neighbouring residents will have views of portions of the proposed wind farm, the entire wind farm will often not be visible from individual residences (see Figures 7 to 10). The effect of tree screening has not been included in the computer model but is addressed in the following discussion.

The visual impact of the proposed wind farm on the surrounding residences has been classified as Low, Moderate or High using consideration of a range of factors including the degree of visibility of the wind farm, distance from the nearest turbine, view field angle, angle of elevation of the turbine hub above horizontal at the respective residence and the indicated viewer sensitivities (Table 7.3). Due to the subjective nature of the visual impacts of wind farms, the response of the various residents will vary. When assessing the potential visual impact of the wind farm it has been assumed that the residences will have high sensitivity, thus erring on the conservative side.

7.3.1 Residences to the east and south east of the proposed wind farm

The southern end of Furracabad Valley has nine separate residences within three kilometres of the wind farm. The closest turbines to the residences in this area are the six south eastern turbines (Turbines, 10, 18, 19, 20B, 21B and 22B). Some residences at this locality will also have views to the more distant western ridge turbines (10B to 17). In most cases the northern turbines (1 to 9) will not be visible from the residences in the southern end of the Furracabad Valley. A review of the likely visual impact on each of the residences follows.

"Hillside" residence

The "Hillside" residence is a vacant, dilapidated windfarmer residence (Plate 24), about 790 metres from the closest turbine (Turbine 22B). Due to the residence being surrounded by turbines (221 degree viewfield) and some of these being at close distance, the visual impact for this residence without screening is considered to be High. However, the residence is surrounded by thick vegetation and nestled into the side of a slope with an easterly aspect. As such some of the turbines will be screened from view. As the property is a windfarmer residence the visual impact on this residence is considered to be accepted by the landowner. The turbines having the greatest visual impact for the residence are indeed on the landowner's property. Photomontage 8 is the closest viewpoint relative to the Hillside residence. However, the viewpoint is 1.8 kilometres from the nearest turbine and does not have any

tree screening. Hillside was not used as a representative viewpoint due to the extent of screening of the wind farm site by vegetation.

"Highfields" residence

The "Highfields" residence (Plates 9 and 11) is the closest occupied non wind farmer residence to the proposed wind farm at 0.96 kilometres from the nearest turbine (Turbine 18). The homestead has an elevated north eastern aspect facing away from the wind farm site, with tree screening to the south and west (Plate 9), which will reduce the visibility of some turbines. However, the residence will have close views of Turbines 18, 22B, 21B and 20B with the wind farm occupying a view angle of about 140° from the residence. Plate 12 shows the view from the residence toward the wind farm site (Turbine 18). Some turbines on the western ridge of the wind farm are also likely to be visible from parts of the land surrounding the residence.

Without consideration of the tree screening the visual impact for this residence would be High. However, the existing screening by mature trees reduces the visual impact of the wind farm and additional trees could further reduce the visual impact of particular turbines. The option for additional tree screening was mentioned by the landowner during an early visit but the issue has not been discussed in detail and no arrangements have been made. Viewpoint 8 provides the nearest representative viewpoint for the residence. However, the viewpoint is 1.8 kilometres from the nearest turbine and does not have any tree screening. Highfields was not used as a representative viewpoint due to the extent of screening of the wind farm site by mature trees. As the closest turbine is at a distance of 0.96 kilometres and the turbine hub will be at an angle of about 12° above the residence, the visual impact is assessed as High.

Plate 11 – Highfields residence and view across Furracabad Valley

Plate 12 – View from Highfields toward site of Turbine 18

"Cherry Tree" (Eungai) residence

The "Cherry Tree" (formerly Eungai) residence (Plate 13) is about 1.6 kilometres from the nearest turbine (Turbine 18) and is situated at an elevation of about 1,100 metres on the floor of the Furracabad Valley. It will have direct views of the southern turbines 18, 19, 22B, 21B 20B and 10 and potentially some of the turbines to the west of these. The wind farm view angle for this residence has been assessed as 112 degrees and the turbine hubs will be at an angle of about 9° above the horizontal level of the residence location. The remainder of the outlook from the residence is of pastoral land within Furracabad Valley and more distant hills to the east and south.

Without any mitigation measures, the visual impact on this property is expected to be Moderate to High due to the close views to the wind farm and the sensitivities expressed by the landowners. The visual impact of the wind farm for the residence could be reduced by providing tree screening close to the western and north western sides of the residence. Trees of 10 to 15 metres height at between 30 and 50 metres from the residence could provide effective screening. Viewpoint 8 is about 500 metres from

the residence and is at 1.8 kilometres from the wind farm compared to the 1.6 kilometres distance from the wind farm for the residence. The residence has slightly more screening than is evident for Viewpoint 8.

"Mayvona" residence

The "Mayvona" residence (Plate 14) is a dilapidated vacant residence about 850 metres from Turbine 22B. It is situated at an elevation of 1100 metres within Furracabad Valley and with the land falling away slightly to the east. Although the residence is currently not fit for habitation, it could potentially be redeveloped in the future. The main visual impact will be from the south eastern group of turbines (18, 19, 10, 20B, 21B and 22B). The angle from horizontal to the closest turbine hubs will be about 14°. There are a number of trees close to the residence that could provide a degree of visual screening. The impact on the residence is considered to be High, however, should the residence be rebuilt, tree screening and orientation of views from the residence could be used to reduce the visual impact.

Plate 13 – View of Cherry Tree (Eungai) residence from eastern side –some tree screening

Plate 14 – Vacant Mayvona residence with view of ranges on eastern side Furracabad Valley

"Lombardy" residence

The "Lombardy" residence (Plates 15 and 16) is 1.9 kilometres east of turbine 22B. The residence is on relatively flat land within Furracabad Valley and has extensive screening by large trees which act as wind breaks and could provide some filtering of views to the wind farm. The angle from the residence to the turbine hubs will be about 7°. Viewpoint 8 is only about 300 metres from the residence location and is considered representative of the scale of the wind farm in the view from the residence. With such screening already in place the visual impact is considered to be Moderate to Low.

Plate 15 Entrance to Lombardy showing tree screening on western side

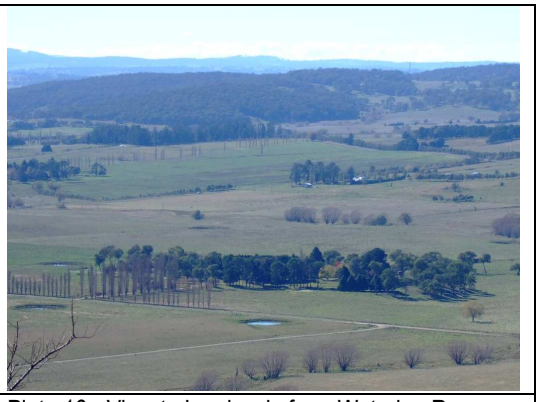

Plate 16 - View to Lombardy from Waterloo Range showing thick tree screening

Other viewpoints

The residences of "Wandsworth", "Klossie", "Nullagai" "Elm Vale" and "Moonarie" are between two and three kilometres east of the proposed wind farm, with some views of the central and southern portions of the wind farm.

"Wandsworth" residence in Furracabad Valley potentially has 360° views with the westerly aspect being toward the proposed wind farm. It currently has very little tree screening. The visual impact is considered to be Moderate based on its distance of 2.3 kilometres from the wind farm, a view angle of only 75 degrees and an angle from horizontal to the turbine hubs of about 6°. There is reasonable potential at this location for tree screening to reduce the visual impact for this residence location should the landowner consider it beneficial. Viewpoint 8 provides a representative viewpoint for this residence.

The "Nullgai" residence is on a slope with an easterly aspect away from the wind farm. There is also partial or full tree screening of the residence from the proposed wind farm. At a distance of 2.1 kilometres from the wind farm, with partial to full screening, a viewfield angle of 53 degrees and an angle from horizontal to turbine hub of about 7°, the impact is considered to be Low.

The "Klossie" residence has an easterly aspect directed away from the proposed wind farm. The residence has little tree or topography screening to the north, however there is a relatively small field of view of the wind farm (39°). Due to the aspect, field of view and a distance of 2.3 kilometres to the nearest turbine, the visual impact of the wind farm on "Klossie" is considered to be Moderate to Low. Tree screening could effectively further reduce the visibility of the wind farm.

A group of six residences is clustered on the eastern side of the Furracabad Valley near the intersection of Haymarket and East Furracabad Roads (Plates 17 and 18). These residences include Elm Vale, Moonarie, Nevada Park (2 residences), Wynona and Glen Rove. Viewpoint seven provides a representation of the visibility of the wind farm from the intersection which is relatively close to these residences. The "Elm Vale" residence at a distance of 2.9 kilometres from the wind farm may experience a Moderate visual impact but partial tree screening could reduce the impact. Additional tree screening may further reduce the visual impact for Elm Vale. The Moonarie and Nevada Park residences are at about three kilometres distance from the wind farm on the eastern side of Furracabad Valley and have a westerly aspect toward the wind farm. The three residences appear to have little screening and a view field angle of about 70 degrees. Viewpoint 7 is only about 300 metres from the residence location and accordingly is applicable for these residences.

Plate 17 - Moonarie, Nevada Park residence locality view towards the wind farm site

Plate 18 - Intersection of Haymarket and East Furracabad Roads looking west

7.3.2 Residences to the north east of the proposed wind farm

There are two residences to the north east of the proposed wind farm within three kilometres of the proposed wind farm, one of which is a windfarmer. The following section briefly describes the likely visual impacts on those residences.

"Glengarry" residence

The "Glengarry" homestead is about 2.1 kilometres from Turbine 10 on the eastern side of the ridge separating Reddestone and Furracabad Valleys. It will have limited views of the wind farm. Six turbines will be visible from the homestead which includes the south eastern turbines (turbines 10, 20B, 21B and 22B) and turbines 18 and 19 of the southern group. The western and northern turbines will not be visible due to topographic screening. The angle from horizontal to the turbine hubs is about 6°. The wind farm will represent a Moderate to Low visual impact at the "Glengarry" residence. Further mitigation is possible with tree screening to the south of the residence. Viewpoint six is at the nearby Mayfield residence. While viewpoint six is further distant from the wind farm the location of Glengarry at the foot of the hills will limit the visibility of turbines compared to their visibility from Mayfield.

"Rose Hill" residence

There are two residences on this windfarmer property. There will be moderate visibility of some turbines from Rose Hill A residence and a lesser impact for the Rose Hill B residence due to topographic screening. As the Rose Hill property is a windfarmer property the landowner has agreed to the installation of the proposed wind turbines. Additional tree screening could further reduce the visual impact of the wind farm for these residences if required.

"Mayfield" residence

The Mayfield residence is beyond 4 kilometres from the wind farm but will have views of parts of the southern section of the wind farm. Viewpoint 6 is close to this location and provides a representation of the installed wind farm visibility from the Mayfield residence.

7.3.3 Residences to the north of the proposed wind farm

There are three residences within three kilometres of the northern sections of the wind farm. The following sections provide a description of the likely visual impact for these residences.

"Wattle Vale" residence

The "Wattle Vale" residence is in an elevated location with a narrow field of view to the northern section of the wind farm. The M1 wind monitoring tower can be seen from this residence, which represents the hub height of the Turbines 1 and 2 that will be close to M1. The visibility of the wind farm will be restricted to the northern turbines with the southern part of the wind farm being progressively screened by topography. The angle from horizontal to the turbine hubs at this residence will be about 4°. There is some tree screening that adds to the topographic screening and further reduces the visibility of the wind farm. In addition, the Gwydir Highway and part of the transmission line are visible from the residence which runs between the house and the proposed wind farm. The visual impact on this residence is expected to be Moderate. The owners have indicated that they do not want any turbines on their property or closer to the Wattle Vale residence.

"Rivoli" residence

The "Rivoli" residence will have limited views of the proposed wind farm. The field of view of the wind farm is 17°, with the hubs of Turbines 1, 2 and 3 potentially visible and a portion of Turbine 4 visible. The residence is located in a sheltered valley with extensive topographic and tree screening. Should the turbines be visible the angle from the horizontal plane at the residence to the turbine hubs will be about 7°. The visual impact is regarded as Low for this residence.

"Girrahween" residence

The "Girrahween" residence (Plate 19) has an easterly aspect directed away from the proposed wind farm and there is also some tree screening on the western and southern sides of the residence. All northern and south eastern turbines will be visible from the residence and some of the southern turbines. The angle from horizontal to the turbine hubs at this residence will be about 6°. The visual impact on this residence is considered as Moderate to Low due to screening of the closest turbines by topography and trees and limited visibility of more distant turbines.

Plate 19 – Girrahween residence – View toward Ross Hill

Plate 20 – View of Sinclair Lookout and view to west over Wellingrove Valley

Sinclair Lookout

While not associated with a residence Sinclair Lookout is a public recreation area that provides an elevated lookout over the Wellingrove Valley. As can be seen in Plate 20, there are no amenities at Sinclair Lookout other than the turning circle for the unsealed access road and parking space. The lookout is located at the top of a short winding access road and appears to attract low levels of visitation for travellers on the Gwydir Highway that passes about 0.5 to 1 kilometres to the north.

Turbine no 1 is located to the south within 500 metres of the lookout and will be clearly visible beyond the transmission line that crosses Waterloo Range to the south of the lookout. The ridge rises very slightly to the south from the lookout and therefore views of the wind farm from the lookout will only encompass parts of it. Remnant woodland vegetation to the north and east limits views in those directions.

The presence of turbines to the south of the lookout will provide an additional point of interest for visitors to the lookout. The aspect of movement and the relatively gentle sound may also present a point of interest for visitors. The substation will be located to the south-east of the lookout beyond remnant woodland and there is likely to be limited visibility of the substation from the lookout. The transmission line that is visible immediately to the south of the lookout is expected to be upgraded by TransGrid from 66,000 volts to 132,000 volts. That upgrade could involve a marginal increase in the size of the pole structures and associated insulators and perhaps minor additional clearing where line clearances need to be increased due to the high voltage and design of the line.

7.3.4 Residences to the West and South West of the proposed wind farm

There are six properties with residences within three kilometres of the proposed wind farm within the Wellingrove Valley to the west of the proposed wind farm. The following sections discuss the visual impact on each of these residents.

"Illparran" property

There are two residences on this property, one of which is vacant (Plate 21).

As outlined in Table 7.2 there are 12 turbines visible from the occupied residence ("Illparran A") which include turbine 11B through to turbine 19. The northern and central eastern groups will not be visible due to screening by topography. The angle from horizontal to the turbine hubs at this residence will be about 12°. The potential visual impact is considered to be High without tree screening. Mitigation measures such as tree screening around the residence could reduce such impacts. Viewpoint 1 provides representative views to the south western part of the wind farm.

Plate 21 – Vacant Illparran B residence – View towards Waterloo Range

"Balaclava" property

There are two residences on this property, both of which will have views of most of the proposed wind farm. The residences are about 3 kilometres from the nearest turbine which will have a hub height more than 300 metres above the residence. The angle from horizontal to the turbine hubs at these residences will be about 6°. As can be seen in Plate 23 there are mature trees close to the residences. The visual impact on these residences is expected to be Moderate, however mitigation through further tree planting near the residences would potentially reduce this impact.

Plate 22 – Kalanga Residence locality from intersection on Illparran Road

Plate 23 – Balaclava residence viewed from Waterloo Range showing large trees at residences

"Kalanga" property

There are three residences on this property (Plate 22) which would have views to much of the proposed wind farm with the western turbines being more prominent. There is some tree screening around the houses, however the turbines will be a prominent feature in the landscape from this location. The angle from horizontal to the turbine hubs at all of these residences will be about 7°. The Waterloo Sugarloaf hill will provide some screening of the Turbines 14 to 13B. Additional tree screening could also be implemented to reduce the impact on the Kalanga residences. Viewpoint 2 provides a representative view from a distance of several hundred metres west of the residence locations.

"Minamurra" property

There are three residences on this property, which would have views to most of the proposed wind farm. There is some tree screening around the houses, however the turbines will be a prominent feature in the landscape from this location, with an angle from horizontal to turbine hub ranging between 7and 8° from these residences. The visual impact is expected to Moderate to High in this location. Further tree screening could be implemented to reduce the impact on these residences. Viewpoints 1 and 2 provide the best reference of wind farm visibility for the Minamurra residences.

"Glengyle" residence

This wind farmer residence (Plate 24) is 1.1 kilometres from the nearest turbine, however due to being close to the base of the western slope of the Waterloo Range that provides topographic screening and extensive tree planting around the house, very little of the wind farm will be visible. As it is a windfarmer residence the property owner has agreed to the wind farm development. The visual impact on this residence is considered to be Moderate to Low.

Plate 24 - Glengyle residence with large trees between residence and Waterloo Range

Plate 25 – Hillside residence – Vacant wind farmer residence in thick vegetation

"Oakes" residence

The "Oakes" residence will have views of the southern group of turbines and the tips of the northern turbine group. The angle from horizontal to the turbine hubs at this residence will be about 8°. The south eastern group of turbines will be screened by topography and trees. However, there is indicated to be some tree screening which will further reduce the wind farm visibility. The visual impact on this residence is expected to be Moderate to Low.

Table 7.2 – Review of Indicative visibility for viewpoints from neighbouring residences within 3 km of the wind farm site, other than the ten representative viewpoints

Location	W – Wind farmer N – Neighbour	Nearest turbine	Approx. no. of potentially visible turbines		Distance residence to nearest turbine (km)	Viewfield angle (degrees)	Estimated visibility class L, M, H	Screening by trees (Yes/No/ Partial)	Nearest photo-montage	Comment on potential visibility factors
			Tips	Hubs						
Balaclava A	N	11	26	22	2.9	110	H	P	2	There will be relatively clear views to the northern end of the wind farm but tree screening may limit some of the wind farm visibility
Balaclava B	N	11	27	22	3.0	96	H	P	2	
Caloola A	N	17	27	25	3.3	58	M	P	1	There will be relatively clear views to the central western part of the wind farm but tree screening may limit some of the wind farm visibility
Caloola B	N	17	27	26	3.1	59	M	P	1	
Matheson Church	N	3	27	26	2.9	65	M	P	3	The wind farm will be visible from some points outside the Church
Elm Vale	N	10	23	13	2.9	84	H	Y	7	Views to south east part of the wind farm may be screened by trees
Eungai	N	18	17	15	1.6	112	H	P	8	Clear views to central eastern part of the wind farm
Furracabad Station	N	19	12	7	3.1	32	M	Y	9	Limited views of wind farm, mainly southern turbines, some screening
Girrahween	N	1	14	12	2.0	95	H	Y	4	Limited views of wind farm due to screening by trees
Glengarry	N	10	6	6	2.1	20	M	P	6	Limited views of wind farm, mainly central eastern part of wind farm
Glengyle	W	11	9	8	1.1	73	H	Y	2	Limited views to wind farm due to topography and tree screening

Location	W – Wind farmer N – Neighbour	Nearest turbine	Approx. no. of potentially visible turbines		Distance residence to nearest turbine (km)	Viewfield angle (degrees)	Estimated visibility class L, M, H	Screening by trees (Yes/No/ Partial)	Nearest photo-montage	Comment on potential visibility factors
			Tips	Hubs						
Highfields	N	18	20	17	1.0	136	H	Y	8	North-east aspect away from wind farm. Some close views of turbines
Hillside	W	22B	24	15	0.8	221	H	Y	8	Vacant – Wind farmer residence.
Illparran B	N	13B	11	9	1.4	64	H	Y	1& 2	Vacant – Close to slope, limited views of wind farm
Ilparran A	N	17	12	12	1.5	85	H	P	1	Not inspected but close to slope, expected limited views of wind farm
Kalanga A	N	11	25	20	2.2	106	H	P	2	Views to western side of Range with turbines prominent on ridge. Some trees will provide a degree of screening but elevated location of residences above creek should provide clear views to wind farm where not subject to tree screening.
Kalanga B	N	11	26	22	2.3	104	H	P	2	
Kalanga C	N	11/13B	25	21	2.3	102	H	P	2	
Klossie	N	19	10	7	2.3	39	M	P	9	Turbines 18 and 19 will be prominent about 2.3 km to the north of residence. No screening
Lombardy	N	22B	17	13	1.9	90	H	Y	8	Extensive screening by large trees
Mayfield A	N	7	16	13	4.2	31	L	P	6	Aspect and tree screening will limit views
Mayfield B	N	7	19	13	3.2	59	M	P	6	Only central eastern part of wind farm visible
Mayvona	N	22B	10	10	0.9	128	H	P	7	Vacant – Close views to south east turbines, some tree screening

Location	W – Wind farmer N – Neighbour	Nearest turbine	Approx. no. of potentially visible turbines		Distance residence to nearest turbine (km)	Viewfield angle (degrees)	Estimated visibility class L, M, H	Screening by trees (Yes/No/ Partial)	Nearest photo-montage	Comment on potential visibility factors
			Tips	Hubs						
Minamurra A	N	13B	25	21	2.3	92	H	P	1	Views to western side of Range with turbines prominent on ridge. Some trees will provide a degree of screening but elevated location of residences above creek should provide clear views to wind farm where not subject to tree screening.
Minamurra B	N	13B	23	21	2.1	98	H	P	1	
Minamurra C	N	13B	25	24	2.5	88	H	P	1	
Moonarie	N	22B	21	14	3.0	67	M	N	7	Elevated position. Views to many of the turbines, particularly for southern and central parts of the wind farm, less visibility of northern end, some tree screening.
Nevada Park A	N	22B	23	16	3.2	68	M	N	7	
Nevada Park B	N	22B	22	16	3.2	66	M	Y	7	
Nullagai	N	19	5	2	2.1	53	H	Y	8	Limited visibility due to screening by topography and trees. Eastern aspect
Oakes	N	19	18	15	2.5	55	M	Y	1	Southern turbines most prominent, some screening by trees and topography
Rivoli	N	1	4	3	1.9	17	M	P	3 & 4	Limited views of wind farm. Mainly several of northern turbines.
Rosefield	N	1	26	20	3.6	61	M	P	4	Mid distance views to wind farm
Rose Hill A	W	6	25	21	2.4	113	H	P	4 & 6	Some screening due to topography and trees. Easterly aspect.
Rose Hill B	W	6	15	7	2.1	70	H	P	4& 6	Some views to wind farm, limited by topography and tree screening

Location	W – Wind farmer N – Neighbour	Nearest turbine	Approx. no. of potentially visible turbines		Distance residence to nearest turbine (km)	Viewfield angle (degrees)	Estimated visibility class L, M, H	Screening by trees (Yes/No/ Partial)	Nearest photo-montage	Comment on potential visibility factors
			Tips	Hubs						
Sinclair Lookout	N	1	6	4	0.3	48	H	P	Nil	Filtered views of northern turbines through trees
Talarook	N	17	27	27	3.6	69	M	P	1	Views to central western part of wind farm but may be filtered by trees.
Wandsworth	N	18	18	15	2.3	75	H	N	8	Views to central eastern part of wind farm and limited tree screening.
Waterloo	N	2	27	26	3.6	60	M	Y	3	Mid distance views to wind farm but may be some tree screening.
Wattle Vale	N	1	25	15	1.9	57	H	P	4	Elevated location but topography and tree screening may limit views to northern turbines.
Willow Glen	N	4	27	25	3.2	88	H	P	3	Clear views to Waterloo Range where not screened by trees around residence.

7.3.5 Summary of Visual Impact Assessment on local residences

Table 7.3 summarises the rating of the visual impact assessment for non wind farmer residences within three kilometres of the wind farm site.

Table 7.3 – Summary of Visual Impact Assessment for residences within 3 km of the Wind Farm

Residence	Distance km	View Angle	Elevation Angle	Visual Impact	Basis of Visual Impact Assessment Rating
0 to 1km distance from Wind Farm					
Highfields	0.96	136	12	High	High due to closest turbine at less than 1 km and elevation above the residence. Discussion with the landowner indicates concern as to the visual impact. Some screening by mature trees is present.
Mayvona	0.85	128	14	High	High due to turbines being at close distance and at elevation above the residence. The residence is vacant and in poor state.
1 to 2 km distance from Wind Farm					
Cherry Tree (Eungai)	1.6	112	9	High	High due to close distance, view angle and elevation of turbines above residence. Landowners have expressed concern regarding impact for their residence location. Tree screening at the residence could be used to reduce the visual impact.
Illparran A, B	1.4	85	12, 11	High	Potentially high due to distance and elevation of turbines above residences. Proximity to base of slope and trees may provide substantive screening.
Lombardy	1.9	90	7	Moderate	Moderate, reduced by thick tree screening
Rivoli	1.9	17	7	Low	Low due to topographic and tree screening
Wattle Vale	1.9	57	4	Moderate	Moderate due to proximity to turbine sites T1 & T2, and landowner's expressed concern.
Girrahween	2.0	95	6	Moderate	Moderate based on distance and view angle. Existing tree screening at residence is likely to significantly reduce visual impact.
2 to 3 km distance from Wind Farm					
Balaclava A, B	2.9	110	6	Moderate	Moderate based on tree screening. High without screening. Residence not visited.
Glengarry	2.1	20	6	Moderate	Moderate, limited views to wind farm and tree screening can reduce the impact
Kalanga A,B,C	2.2	106	7	Moderate	Moderate. Waterloo Sugarloaf will provide topographic screening for some turbines
Klossie	2.3	39	6	Low	Low due to limited view angle and potential for screening
Minamurra A,B,C	2.3	98	7	Moderate	Moderate but land owner may regard as Low based on consultation and indicated position in respect of renewable energy developments
Moonarie	3.0	67	4	Moderate	Moderate due to distance, indicated concern
Nullagai	2.1	53	7	Low	Low due to topographic and tree screening
Oakes	2.5	55	8	Moderate	Moderate due to topographic and tree screening, view angle for visible turbines may be less than indicated here
Wandsworth	2.3	75	6	Moderate	Moderate due to unscreened views. Potential for tree screening at residence

Note: -View angle is the lateral field of view and elevation angle is the angle from horizontal level at the residence to the hub height of nearest turbine

7.3.6 Visual Impact in a regional context

The Glen Innes Wind Farm is located within the southern part of the Border Rivers-Gwydir River Catchment to the north of the elevated Ben Lomond area that occurs between Glen Innes and Armidale. The Waterloo Range is a north south trending ridge that rises to the south and retains some of the remnant basalt sheet geology that cap much of the area. To the south are areas where granitic geology has resulted in landscape with large rounded tors. The variations in topography and geology have provided a reasonable diversity of landscapes. Typical landscape elements within the project area and its surrounds are described in section 2.4.3 together with representative photographs of these landscape elements.

The visual impact of the proposed Glen Innes Wind Farm on these landscape elements, in a regional context, is discussed in the following sections.

Pastoral setting

The predominant landscape element surrounding the proposed wind farm is cleared grazing land with hilly topography and intermittent areas of woodland. This pastoral setting is typical across the New England Tablelands region.

The ability of the pastoral landscape elements to absorb the proposed wind farm is considered to be high as the project is consistent with the surrounding land uses and visual changes that are seen in the highly modified landscape of farming and grazing areas.

The Waterloo Range

While the Waterloo Range is a distinctive feature within the local landscape, it is similar to many other low ranges within the New England Tableland region. The ranges to the south particularly toward the elevated Ben Lomond area present greater relief and steeper wooded slopes with upland plains further to the south toward Ben Lomond/Guyra. While there are more significant topographic features in the broader region, the Waterloo Range nevertheless remains a significant landscape feature for the community in the immediate vicinity of the project area.

The eastern side of the Waterloo Range has been extensively cleared, whereas the western side has tracts of remnant vegetation. In this respect the western side of the range may be viewed as more sensitive to the visual impact of a wind farm as areas of vegetation on the range are of low occurrence in this area. However, much of the range to the south and to the east of the project site is heavily vegetated, some of which are protected within National Parks.

The tracts of remnant woodland on the Waterloo Range will not be affected significantly by the development and they will still be present in views after the wind farm has been installed. Likewise, the few outcropping rock features in the mostly basalt terrain will be avoided or, if disturbed, relocated and can serve to maintain the appearance of the location.

As the Waterloo Range is a common landscape element within the Glen Innes – Severn region and the wider New England region the sensitivity to the visual impact from the wind farm is viewed as low.

7.4 Turbine Lighting

As the proposed wind turbine structures will have a height in the range of 124 to 130 metres consultation was initiated with Civil Aviation Safety Authority (CASA) as required under the Civil Aviation Safety Regulations.

CASA assesses the potential for the proposed structures to represent hazardous objects due to location, height or lack of lighting and has also issued guidelines for the lighting on wind turbines,

should it be required. It is generally believed that a wind farm without lighting will have reduced visual impact at night. Nevertheless, any lighting requirements required by CASA will be implemented by Glen Innes Wind Power. Consultation with CASA is continuing to confirm any lighting requirements for the wind farm.

If lighting is required, the obstacle lighting would likely be placed on selected nacelles as per section 9.2 of the CASA AC 139-18 (0): Obstacle Marking and Lighting of Wind Farms. CASA has the following requirements for obstacle lighting of wind farms:

- The interval between lighting of relevant structures should not be more than 900 metres
- The highest turbine must have lighting
- Two flashing red medium density lights are required for each turbine with lights
- All lights are required to flash simultaneously
- Light fixtures must be placed so they are not obscured by the hub
- Any design for obstacle lighting must be approved by CASA
- Lighting must be maintained in accordance with CASA requirements

7.4.1 Assessment of potential visual impact of turbine lighting

To date, wind farms which have been constructed within NSW have not required night lighting. However, in Victoria and South Australia some of the wind farms have night lighting, for instance the Lake Bonney Wind Farm. It has been found in such cases that the intensity of night lighting on turbines is less than that generated from the surrounding house, car or street lighting.

However, obstacle lighting is an obvious addition to the night skyline. Should lighting be installed on turbines, the potential visibility is demonstrated in Figure 12. It should be noted that the representation given in Figure 12 is conservative as it has been assumed that all turbines in the array will require lighting, although this is not necessarily the case.

Although the turbine lighting would be visible, the impact of night lighting on the surrounding residences is considered to be low. This is due to the lights being only visible at night or in conditions of poor visibility, when most people are indoors with little or no view to the turbines or the lights. In addition, when the lights are on inside a residence, there is little or no visibility to the outdoor environment through the windows due to the reflective nature of glass.

For locations within the township of Glen Innes the impact of turbine lighting will be negligible. The cumulative light sources within Glen Innes, including street lights, shop fronts, vehicles and residences will dominate, with turbine obstacle lighting contributing little to no light pollution in the township twelve kilometres from the site.

Should turbine lighting be required there are several mitigation measures acceptable to CASA which could be implemented to further reduce the impact of lighting. These include:

- Shielding of obstacle lights is permitted, provided it does not compromise their operational effectiveness. Shielding can restrict the downward component of light to 5% of nominal intensity being emitted at or below 5 degrees or no light is emitted at or below 10 degrees below horizontal (Section 10.4 of CASA AC 139-18 (0))
- With two lights mounted on the nacelle, light extinction of one of the lights can occur when the blade passes in front of the light, provided that at least one light can be seen from every angle in azimuth (Section 10.4 of CASA AC 139-18 (0))
- Lighting would not be used during daylight hours unless visibility is reduced

8. Visual aspects of ancillary works

The main considerations in relation to visual impact of ancillary works are discussed in the following sections. The location of these works is shown in Figure 2. Construction works including areas of earthworks and soil stockpiles of material excavated for turbine footings will be temporarily visible. These areas will be progressively restored following completion of the construction works at each turbine site.

8.1 Access tracks

In general, permanent tracks can be located and designed to minimise visual impact. Most of the access tracks to turbines will be near the top of the ridges and not visible from the surrounding countryside. In cases where new tracks are located on the sides of slopes and potentially more visible, their visibility will be minimised by the revegetation of batters following construction works.

The main access track to the wind farm site and ancillaries during construction will be via the former highway alignment. Once operational the main access could be via the same route or via Rose Hill Road and Ross Trig Station access track, which are existing roads and will only be marginally more visible to the public using the Gwydir Highway. Upgrading of some existing tracks and formation of new tracks may be readily visible from a range of viewpoints but overall the installation of the required access tracks will have a low visual impact.

Any temporary tracks will be removed and re-grassed after construction works are completed and will not have a long term visual impact.

8.2 Substation and associated buildings

The substation will be located to the north of the Waterloo Range adjacent to the existing 66,000 volt (or 132,000 volt) transmission line. Several small buildings will be constructed adjacent to or within the substation compound. Their location is such that they will only be partly visible from the Gwydir Highway as trees screen the view, reducing the visual impact.

8.3 Transmission lines

The final arrangements to connect to the existing 66,000 volt (or 132,000 volt) overhead line to the north of the site will be negotiated with Country Energy or TransGrid, as applicable. The construction arrangement could involve an additional pole structure within or adjacent to the existing line, or smaller overhead structures.

The route of the short section of overhead line for connection will be chosen to minimise clearing of remnant woodland and minimise its visibility from surrounding residences, local roads or public areas. The visibility of such lines at distances of 3 kilometres or more in rural landscapes is low.

There will be limited views of the new overhead line for grid connection from the public roads and it will be a minor visual element compared to the turbines themselves.

8.4 Temporary construction office and batch plant facilities

The proposed location of the contractor's temporary site office is at the northern end of the site adjacent to the Gwydir Highway on cleared land currently used by council to stockpile gravel for highway maintenance requirements. The site office may include several demountable buildings, an amenities block and portable pump-out toilet facilities which will be located on the site for the duration of construction work.

One or more additional smaller temporary office facilities may, if required, also be constructed at locations distant from the main facility (eg southern end of the site) to provide temporary shelter for workers and temporary storage areas at these locations.

Construction staff will be accommodated away from the construction site and camping on site will not be permitted.

At this stage, it is proposed that the concrete required during construction be supplied from Glen Innes rather than using a temporary batch plant on site. However, the contractor will determine the preferred option and if required seek separate approval for a batch plant.

8.5 Summary of impact for ancillary works

Having regard to the foregoing, the visual impacts of the ancillary works will be minor and insignificant compared to that of the wind turbines because:

- Most of the elements of the ancillary works are low level aspects compared to the turbines
- Many will not be visible to the public
- Significant distances exist between public vantage points and residences and most ancillary works

Screening for the ancillary features could also be applied if required. However, the factors above are likely to achieve satisfactory mitigation of the visual impact and additional screening of ancillary works is unlikely to be warranted.

9. Cumulative Visual Impacts

The land on which the wind farm will be developed has been substantially cleared. There will be minimal additional clearing and negligible change to the vegetation that forms the current landscape.

The development will add a new feature to the landscape that will affect views from points surrounding the wind farm to varying extents. The turbines will not significantly mask the existing landscape or reduce the natural elements of the landscape but may change the viewer's point of focus. As described in previous sections, the wind farm may occupy varying degrees of a particular view and the turbines may be partially or fully visible from various viewing points.

Much of the broader region, particularly the lower land, is considered unsuitable for wind farm development and the extent of future similar developments is limited. More elevated areas with potentially higher energy resource are located mainly to the south of the Glen Innes wind farm development. However for many of these, the rugged and vegetated terrain and limitation on grid access will lower the potential for development.

Project Approval is also being currently sought for a wind farm located two kilometres north of Ben Lomond. The proposed wind farm is spread over parts of the Guyra and Glen Innes Severn Council areas. The separation distance between the southern part of the Glen Innes Wind Farm and the northern parts of the Ben Lomond Wind Farm may be of the order of 15 to 20 kilometres. It is not expected that many residences in the vicinity of the Glen Innes Wind Farm would have views of the Ben Lomond Wind Farm due to the distance and the topography between the two developments.

10. Mitigating Options

The Glen Innes Wind Farm will introduce large wind turbines into some landscapes in the Glen Innes area with some neighbouring residences experiencing a high visual impact and more distant residences having a progressively lower visual impact.

Four occupied residences surrounding the wind farm site and between 0.96 and 1.6 kilometres have been rated as having potential for a High visual impact. Residences at other locations within three kilometres of the wind farm are rated as having a Moderate to Low visual impact. None of the neighbouring residences will be surrounded by turbines and the wind farm will only occupy part of the viewfield of the respective residences. The rating of visual impact provides a reference scale but the actual visual impact will be subjective and vary between individuals.

The layout for the wind farm incorporates setbacks from surrounding occupied residences with the closest occupied residence at 0.96 kilometres and others at much greater distances. While some additional turbine sites have been added during the planning process not all of the 27 sites may be developed. Neighbours in the Furracabad Valley have sought removal of some turbines from the south eastern part of the wind farm and this variation has been considered as part of planning. However, a range of factors limit the potential to remove turbines from this part of the layout while maintaining a viable wind farm.

Mitigation measures that will be incorporated to reduce the project's visual impact include:

- Clearing of vegetation will be minimised, few mature trees will be removed
- Earthworks will be restored as soon as practicable after completion of construction works
- Underground cables will be installed between turbines within each of the turbine groups
- Trenches that house the cables will be backfilled and revegetated so that once restored they will have no visual impact. The choice of underground cables for the ridge top turbine locations instead of above ground transmission lines has been made to minimise the visual impact of the development
- The colour of the turbines is that commonly chosen to create a more desirable visual outcome. Visual amenity was the only factor considered in the choice of the colour
- Tree planting could be undertaken on some of the closer neighbouring properties with agreement of the relevant landowners to screen parts of the development if considered beneficial by the landowner. The preferred types of plants for screening are local native varieties but it may be necessary to plant non-natives that are fast growing where expediency is essential or where property owners would prefer non-natives. Trees of 10 to 20 metres height within 30 to 50 metres of a residence can provide significant screening depending on the specific location of the residence relative to the wind farm. Individual assessments would be required to determine the arrangement of trees to provide effective screening where tree planting has been proposed
- The design and location of ancillary works will incorporate measures to reduce their visual impact. Screening of certain ancillary works, if required, can utilise vegetation planting at the location of the ancillary works
- Turbine 18 has been shifted to the south to increase the setback from Highfields residence

- Access roads have been minimised and located to limit their visibility from neighbouring public areas and to minimise clearing of woodland. The construction methods will also aim to reduce the visibility of disturbed ground

- Shielding of obstacle lights is permitted, provided it does not compromise their operational effectiveness. Shielding can restrict the downward component of light to 5% of nominal intensity is emitted at or below 5 degrees from horizontal and no light is emitted at or below 10 degrees below horizontal (section 10.4 of CASA AC 139-18 (0))

- With two obstacle lights mounted on the nacelle, light extinction of one of the lights can occur when the blade passes in front of the light, provided that at least one light can be seen from every angle in azimuth (section 10.4 of CASA AC 139-18 (0))

- Lighting would not be used during daylight hours unless visibility is reduced

The positioning of the turbines, blade diameter and the height of the turbines are determined by technical and commercial considerations. Reduction of the turbine hub height could reduce the visual impact. However, an assessment of capital costs, energy output, commercial return and net greenhouse gas emission savings indicated that a hub height of about 80 metres is required. On balance, it is considered that the benefits of an 80 metre hub height versus lesser hub heights are justified when compared to the marginal increase in visibility of the wind farm.

As noted in Section 1.1, some minor relocation of turbines within the site may occur during the implementation phase. However, such changes are unlikely to significantly alter the overall visual impact.

The substation site has been chosen so that the substation structures will be substantially screened by existing trees. Based on its location and maintenance of existing trees it will have a Low visual impact.

11. Conclusions

The Glen Innes Wind Farm will introduce up to 27 large wind turbine structures into some landscapes in the Glen Innes area with some neighbouring residences experiencing a high visual impact. The impact will result in a variation in the character of the landscape for neighbouring residences but as there will be minimal clearing of woodland vegetation, there will be little change to the existing elements of the landscape. More distant viewpoints will have progressively less visual impact.

While the wind farm is very different to the traditional pastoral uses of the land it represents a productive use of a natural resource at the locality. As such some people would regard the development as a practical measure to provide renewable energy without the emissions involved with fossil fuelled electricity generation. However, others, particularly some neighbours to development will regard the impact as an imposition being contrary to the character of the locality and unacceptable. Both responses have been obtained from consultation with neighbours to the wind farm site.

Ancillary items of the development will have a minor visual impact and a range of measures are available to limit that impact. However, in respect of the turbine structures, the proponent has limited options at the site for screening and other than removal of turbines, screening at the affected residence locations is the most effective means of mitigating the visual impact. Should neighbours to the wind farm request screening then Glen Innes Wind Power would consult with the neighbours and review the arrangement that would best achieve the required screening.

The option for removal of some of the closest turbines to neighbouring residences has been considered but due to the arrangement of properties involved and modifications that would be required this was indicated to result in a significant decrease in the viability of the project. The current array provides for a viable wind farm supported by the landowners on which the turbines will be located and which has setback from residences that are greater than has been used for many other international wind farm projects.

Overall the wind turbines will be prominent additions to the local landscape and will affect portion of the views from neighbouring residences. Most neighbouring residences will have other outlooks that are not impacted by the development and will be able to use tree screening to limit views of the development if that were considered desirable by the respective landowner. In the case of other wind farm developments it has been found that the visual impact raises less concern once the wind farm has been installed.

12. References

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APPENDIX A

Director-General's assessment requirements relating to Visual Amenity Impacts

The Environmental Assessment must fully describe all project components, locations and dimensions.

A photographic assessment clearly demonstrating the potential visual amenity impacts of the proposal must be provided along with clear description of visual amenity mitigation and management measures that the Proponent intends to apply to the project. An assessment of the feasibility, effectiveness and reliability of proposed measures and any residual impacts after these measures have been implemented must be included.

The Environmental Assessment must assess the visual impact of the proposal on this landscape (including existing and approved dwellings) for a distance of at least 10 kilometres from the turbines, taking into consideration the impact of shadow "flicker" and blade "glint", and having particular regard to the communities of Glenn Innes and Furracabad Valley.

The visual impact assessment should be prepared with regard to the Australian Wind Energy Association and Australian Council of National Trust's *Wind Farms and Landscape Values: Stage 1 Final Report - Identifying Issues, March 2005,* Appendix B: *Wind Farms and Landscape Values: Final Issues Paper*.

APPENDIX B

NSW Department of Planning's Wind Energy EIA Guidelines (Draft) June 2002

Visual Impact Assessment Matters

Issues which may need to be considered include:

(a) describe the existing landscape setting and the key features contributing to its character including its heritage values. Identify the likely risk that the landscape setting or surrounding land use will change in the short, mid or longer term.

(b) identify the visual catchment(s) of the wind farm or any associated infrastructure:

  (i) consider the visual quality and significance of the landscape including unique visual aspects and the extent of any existing visual degradation;

  (ii) identify areas (in particular public area) with the high visual impacts from the fore, middle and background;

  (iii) consider the visual absorption capacity of the area (particularly if towers protrude beyond the ridge line) including the compatibility of the proposal with the existing visual environment and scale of the proposal relative to existing land uses;

  (iv) outline the community's views on whether the project is likely to become a visual asset or liability to the landscape quality of the area. In this context, consider the impacts on the landscapes quality or particular features of local or regional significance or sensitivity from key vantage points;

(c) identify the potential for reflective light and shadow flicker from the blades of the wind turbine/s at residences, road or other public places outline any risks to road safety, and evaluate their significance

(d) outline measures to mitigate visual impacts including:
  (i) location, layout, surface treatment and colour of structures;
  (ii) any landscaping and the rehabilitation of constructions areas
  (iii) ongoing community consultation measures

(e) discuss the acceptability of impacts and the adequacy of the mitigation strategies to manage visual impacts;

(f) consider the risks associated with managing visual impacts if the surround land use changes; can contingencies be built into the project if the risks are high.