3 KEY ISSUES

3.1 Visual assessment

FINAL REPORT

Epuron Pty Ltd

Gullen Range Wind Farm
Landscape and Visual Assessment

July 2008

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FINAL REPORT

Epuron Pty Ltd

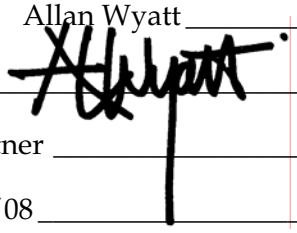
Gullen Range Wind Farm
Landscape and Visual Assessment

July 2008

Reference: 0069605 RP1 REVISON 2

For and on behalf of
Environmental Resources Management Australia

Approved by: Allan Wyatt

Signed: 

Position: Partner

Date 11/07/08

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1 INTRODUCTION

This report provides a landscape and visual assessment for a proposal by Epuron Pty Ltd Pty to install up to 84 wind turbines, near the township of Crookwell in Central New South Wales.

This landscape and visual assessment is one component of the overall information that forms part of the Development Application for this project.

This project is to be assessed as a Part 3A Major Project, under the New South Wales Environment Planning and Assessment Act 1979.

1.1 METHODOLOGY

The methodology used within this visual assessment is based on and responds to the the Australian Wind Energy Association and Australian Council of National Trust's *Wind Farm and Landscape Values – National Assessment Framework.* This methodology has been applied to projects undertaken by ERM in the visual assessment of wind farms in Victoria, South Australia and NSW.

The methodology used to assess the landscape and visual impact of the Gullen Range Wind Farm includes:

- Describing the visual components of the wind farm.
- Describing people's perception of wind farms in the landscape, based upon past research and research undertaken on the community surrounding the Gullen Range Wind Farm.
- Defining the viewshed of the wind farm based upon the parameters of human vision.
- Describing the existing landscape characteristics within the viewshed and define the landscape units and their sensitivity.
- Carry out a GIS based Zone of Visual Influence (ZVI) or seen area analyses that illustrate those areas from which wind turbines, in whole or part, are visible.
- Utilising the Seen Area Analysis, locate indicative viewpoints within the public domain (ie from roadsides or from recognised lookout or other vantage points) from which wind turbines will be visible, as a means of explaining the visual impact of the proposal on publicly accessible locations.
- Examine the potential impact on residential properties.
- Examine potential landscape mitigation measures that may apply to residences within the vicinity of the wind farm.
- Analyse the potential of cumulative visual impact of this proposal.
- Describe the potential impact of night lighting as well as any cumulative impact if multiple wind farms have hazard identification lighting.

This methodology responds to the relevant sections of the *Upper Lachlan Shire Council Development Control Plan (DCP) Wind Power Generation 2005* in particular the Key Assessment Requirements for Visual Amenity Impacts (*Section 75F of the Environmental Planning and Assessment Act 1979)*.

As well consideration has been given to *Auswind's Best Practice Guidelines for Implementation of Wind Energy Projects in Australia* (2006). In particular the Auswind Guidelines encourage community consultation and the social research / perception study undertaken by Epuron has far exceeded these Guidelines. The Director-General's Requirements also sought information on community and stakeholder values.

2 PROJECT DESCRIPTION

The Proposal will comprise:

- Up to 84 wind turbines in four clusters (indicative only),
- Electrical connections between wind turbines using a combinations of underground cable and overhead powerlines,
- A substation and transmission connection linking the wind turbines to the existing Transgrid 330kv transmission system located on site,
- Small car park, on site control room and equipment storage facilities,
- Internal access tracks required for the installation and maintenance of wind turbines and associated infrastructure.

Although the major visual components will be the wind turbines, the access tracks, a small car park, control room, storage and office building may also be visible from the surrounding road network.

2.1 WIND FARM LOCATION

The Gullen Range Wind Farm will comprise up to 84 turbines in a predominately rural area approximately 175km to the south west of Sydney, 80km north east of Canberra and approximately 23km north west of Goulburn (refer *Figure 2.1*.).

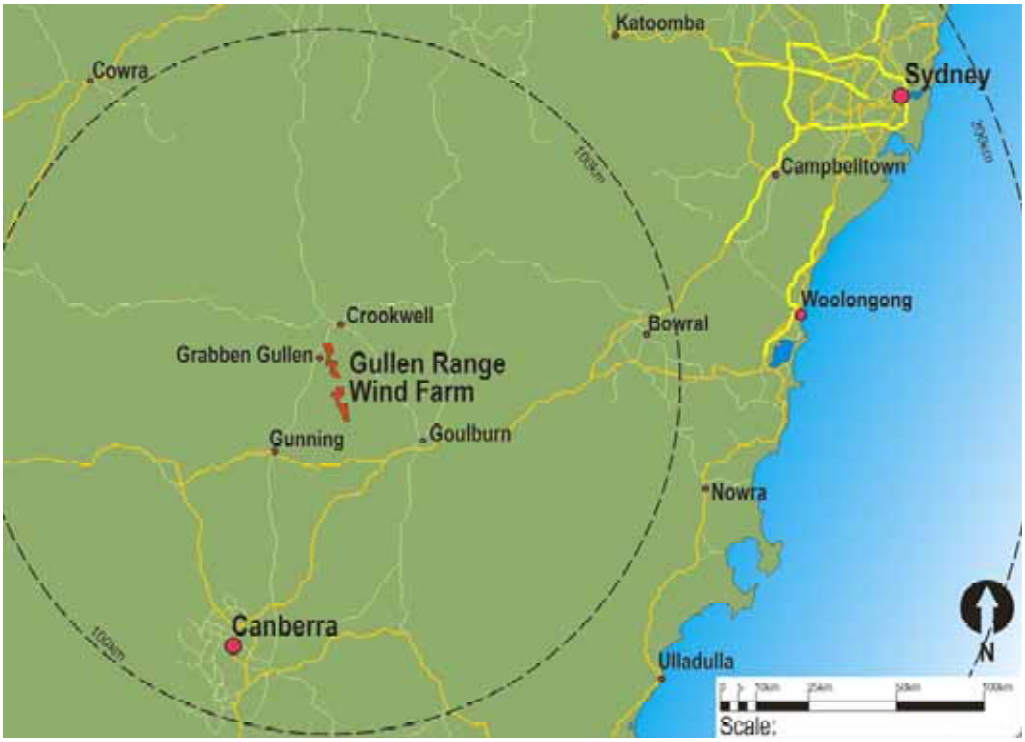


Figure 2.1 *Wind farm location*

The proposed wind turbines will comprise up to 84 wind turbines located in four clusters in two sections (refer *Figure 2.2*).

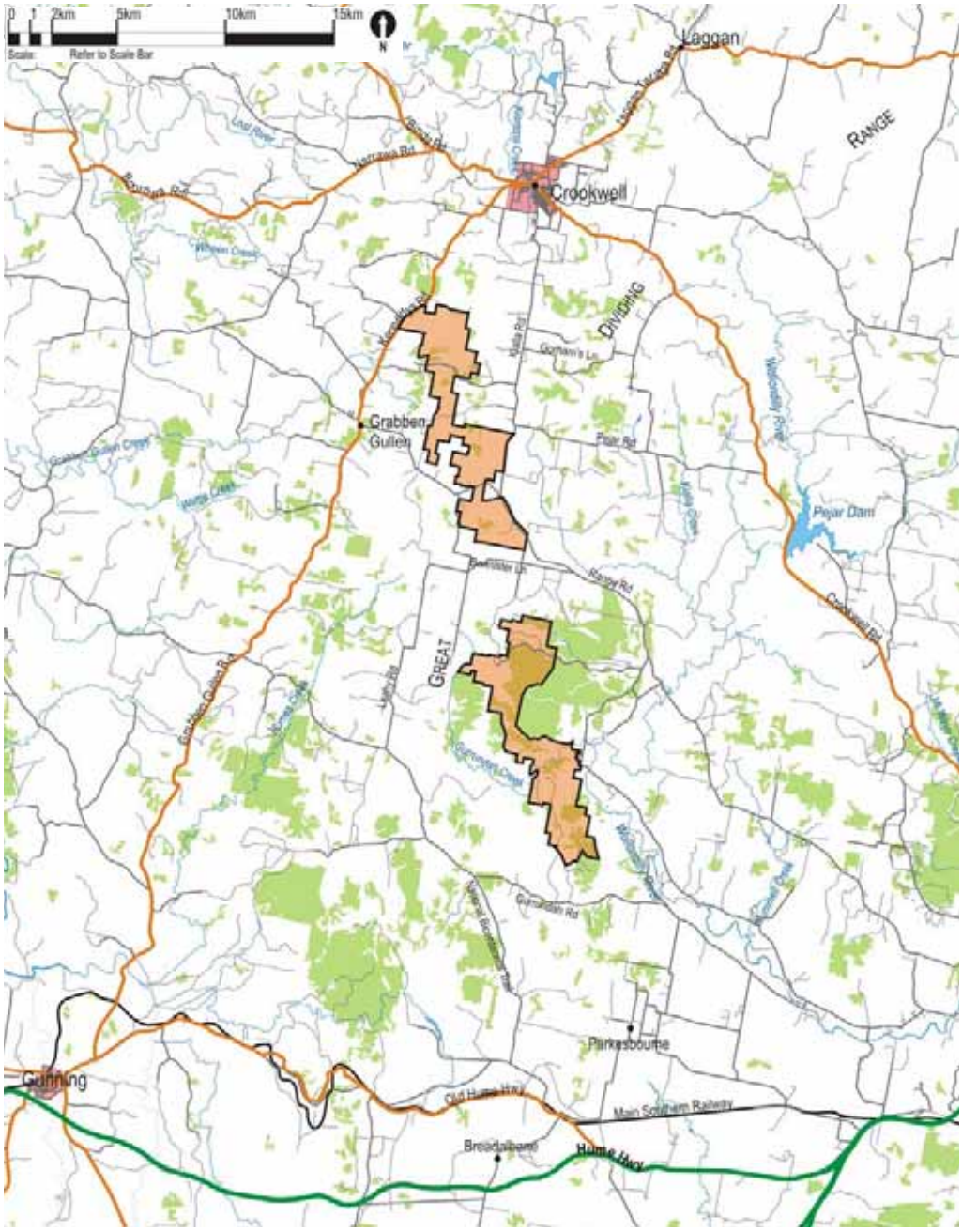


Figure 2.2 ***Gullen Range Wind Farm locality plan***

The wind turbines are located on a 22km long elevated ridgeline that runs in a north south direction. For the purposes of this report, where the four clusters of wind turbines are referred to individually they will be discussed as, Kialla Cluster, the Bannister Cluster, Pomeroy Cluster and the Gurrundah Cluster. However they are better described as in two sections, the northern Kialla / Bannister Section and the southern Pomeroy / Gurrundah Section.

Kialla / Bannister Section

The Kialla and Bannister sections of the wind farm are approximately 6km south of the Crookwell Township. The Bannister Section is located to the south of the Kialla section and finishes north of Range Road.

Pomeroy / Gurrundah Section

The Pomeroy and Gurandah sections are approximately 15km south of the Crookwell Township south of Range Road. This section commences approximately 3km south of

the Bannister section immediately south of the existing 330 kV power line. The Gurrundah section is south east of the Pomeroy Cluster and is the southern most cluster of turbines.

Figure 2.2 shows the location of the Gullen Range Wind Farm. Crookwell and Grabben Gullen are the nearest towns to the proposed wind farm.

Grabben Gullen is a small village approximately 3km to the west of the nearest wind turbine.

Crookwell is a larger town than Grabben Gullen and is approximately 6km north east of the nearest wind turbine. Crookwell is the largest urban/regional centre in the 17km Viewshed.

2.2 WIND TURBINE LAYOUT

Figure 2.2 shows the wind turbine layout for the Gullen Range Wind Farm. The wind turbines area located along an elevated range that runs in a north-south and is approximately 22 km long and runs in a north south direction

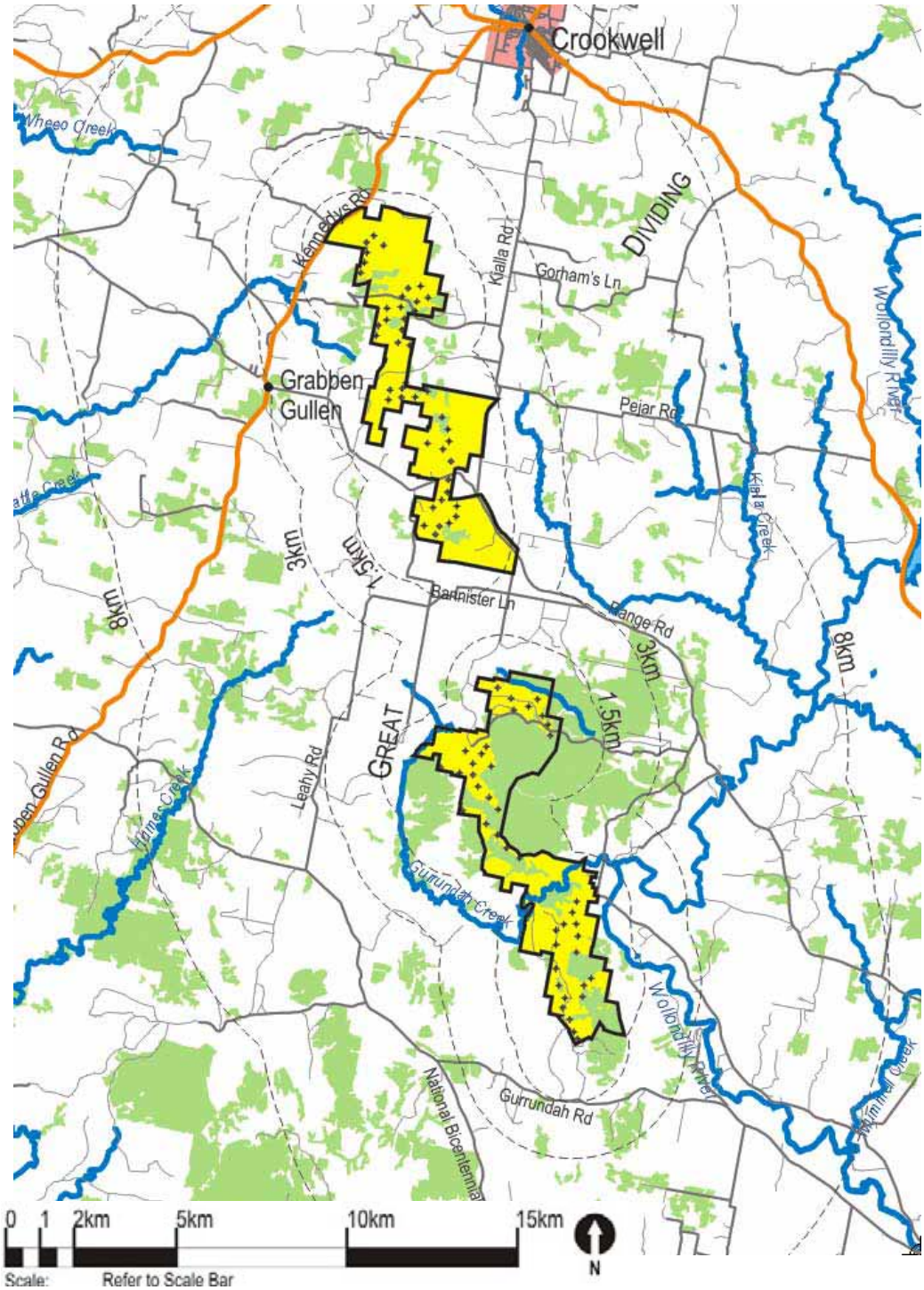


Figure 2.3 Wind turbine location

2.3 WIND TURBINES

The Proposal involves the installation of 84 wind turbines across the Site.

Epuron is currently considering a number of proposed wind turbine models. The tallest is the GE 2.5XL which has an overall height to the tip of the blade of up to 135m. Other turbine models being considered include the RE Power MM82 and the MM92. These are essentially the same wind turbine with a different rotor diameter. The MM82 has a hub height of 80m with an 82m rotor diameter. The overall height for this turbine is 121m. The MM92 has a hub height of 80 m with a rotor diameter of 92m. The overall height for this turbine is 126m.

This assessment has been based on the GE 2.5XL turbine will be installed as it provides the most conservative basis for assessment however, this may change depending on commercial negotiations.

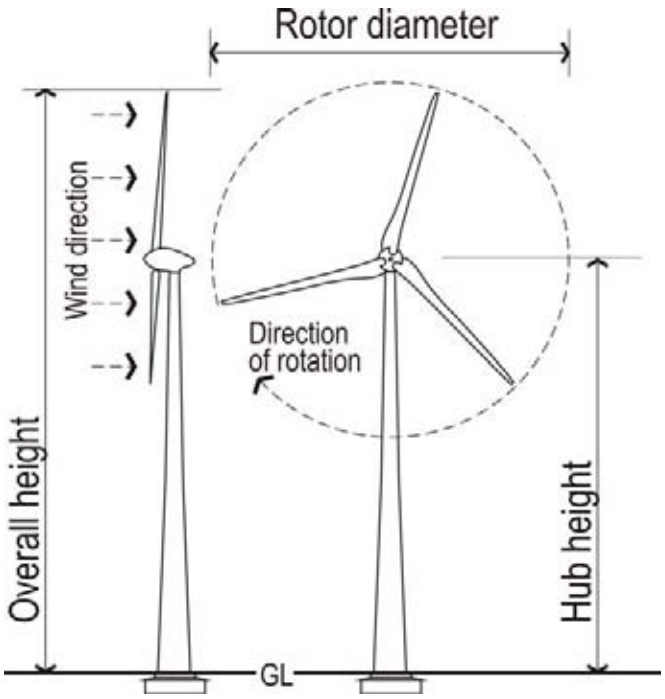


Figure 2.4 ***Indicative wind turbine***

Figure 2.4 shows an indicative wind turbine and its visible components. The specifications relating to these wind turbines are outlined in *Table 2.1*. As stated above the exact turbine model may be subject to change, however, it is confirmed that the maximum specifications provided in *Table 2.1* will not be exceeded.

Table 2.1 ***Maximum wind turbine specifications***

ITEM	Maximum values
Hub Height (approx)	85 metres
Rotor Diameter (approx)	105 metres
Overall Height (approx)	135 metres
Proposed number of wind turbines	84

2.4 AVIATION OBSTACLE LIGHTING

The Civil Aviation Safety Authority (CASA) has indicated that aviation obstacle lighting may be required as the height of the wind turbines exceed 110 m above ground level.

Options that may satisfy the CASA requirements are being explored and include:

- Lights mounted on the nacelle of wind turbines located at the corners of the site;
- Lights mounted on the nacelle of wind turbines located around the perimeter of the site at a distance of approximately 1 km; and
- Lights located on nacelles set at high points within the wind farm and at the corners of the site.

Further discussions with CASA will be required to determine the requirement for night lighting. However it is likely that due to the overall height of the proposed wind turbines, that night lighting will be required.

Typically, safety lights are configured with two red lights approximately 2 m apart mounted on the nacelle of wind turbines or on the wind monitoring masts. There are two types of lights that can be used, unblinking or blinking types.

The unblinking lights will consist of static light source mounted on top of the nacelle or the wind monitoring masts. The blinking lights consist of flashing lights that blink on and off at 3 second intervals. These lights will be baffled to decrease the visibility at the ground level.

2.5 SUBSTATION FACILITY

The proposed substation will include a control room, storage area, an O&M building and a small car park.

The substation is to be located within the Pomeroy section as it passes near to the existing 330kv transmission line that will connect to the Gullen Range Wind Farm.

2.6 POWER LINES

It is understood that this wind farm will involve the use of smaller scale network connection infrastructure. There will be one substation / switchyard. These components are considered to influence the visual impact of this Proposal.

A 330kv substation and transmission line will be located Pomeroy Section and will connect the wind farm and substation to the existing TransGrid, Yass-West Sydney 330kv overhead transmission line. The substation is located adjacent to the existing 330kv transmission line.

The overhead power lines will be 33kV and these will extend between Gurrundah and Pomeroy. There is the possibility of overhead power lines being installed along the Kialla Road connecting the Kialla and Bannister sections of the site.

It is considered that the network connection infrastructure proposed will not provide an un-acceptable visual impact. For example, 33kV power lines constructed using spun concrete poles appear similar in the landscape to domestic supply lines and small scale substations / switchyards can be mitigated using simple landscape measures.

2.7 ON SITE ACCESS TRACKS

Access tracks on the wind farm site will be required for the construction and on-going maintenance of the wind turbines.

During construction the access tracks will vary in width, depending upon crane requirements. After construction, wider access tracks, lay-down areas and crane hard stand areas will be rehabilitated to leave gravel access tracks up to 5 m in width, which will be similar in form to existing farm tracks.

The visual impacts associated with access tracks relates to the construction of tracks on uneven terrain requiring extensive cut and fills works (most evident on hill sides) and the use of foreign material (which contrasts the existing rock) for access track construction.

Epuron propose to use the overspill material from foundation excavation, or material sourced from local quarries (if required) to ensure that the road construction material is one which is common to the area.

3 PEOPLES PERCEPTION OF WIND FARMS

Viewer perception is an important issue to consider for wind farm proposals, especially in areas near tourist destinations or heritage areas. The visual impact of a wind farm ultimately depends on the opinion of the viewer. Community perception is discussed in the *Wind Farms and Landscape Values, National Assessment Framework* and has therefore been included in the assessment of the Gullen Range Wind Farm.

The degree of visual impact partly depends on how the viewer perceives renewable energy, the wind turbines and the landscape.

The presence of wind turbines will change the existing landscape character of this locality, however to postulate that these will create irreplaceable damage to the landscape values and negatively impact the amenity of the area is not substantiated on the basis of perception studies.

Perception studies show many people find wind turbines attractive and have shown that the majority of those surveyed enjoy the view to wind turbines. Therefore for many people the visual impact may be positive, not negative as suggested. And even if the wind turbines are visible at both sunset and sunrise, there is no evidence to suggest that this will be detrimental.

Perception studies continually show that in many Australian and overseas examples that between 60-70% of people find wind turbines an attractive element in the landscape, with up to 15% of respondents undecided and 20% disliked wind farms. Viewer perception is an important issue to consider, especially in areas near tourist destinations or other attractions.

Public opinion research on wind farms in New South Wales has been limited. Although community consultation is undertaken as part of the planning process for wind farms, this consultation is mostly qualitative in nature, in that it seeks the views on a number of aspects of the wind farm development from specific stakeholders, including the local community, and those further away, as well as the views of special interest groups, government and local government agencies involved or impacted by the development. This information is primarily anecdotal and is not rigorously documented.

However some social research has been undertaken by government agencies as well as wind farm proponents, to ascertain people's perception and response to wind farms in the Victorian landscape and this research is remarkably consistent.

3.1 GULLEN RANGE AREA – COMMUNITY PERCEPTION TOWARDS WIND FARMS

A study to ascertain the regions view towards wind farms was conducted from the 27th of July and concluded on the 2nd of August 2007. This study was undertaken in the Goulburn – Crookwell – Yass region's, which are located within the Southern Tablelands area. This area is known to high wind speeds and therefore has potential for wind energy projects. The respondents in this study were located in small urban and rural locations within the immediate vicinity of the proposed Gullen Range Wind Farm; further west towards Gunning and Yass, to the north west at Binalong, to the east towards Crookwell and to the south east towards Goulburn.

Within the study area, an existing wind farm, known as Crookwell I, is located to the immediate east of Crookwell township and an approved wind farm (Crookwell II), to the immediate south of Crookwell I. Further approved wind farms are located to the south east known as Walwa-Gunning and Cullerin Range. Located further to the west, to the west of Yass, is the approved wind farm at Conroys Gap.

At the beginning of the study, it wasn't known just how much respondents knew of these wind farm projects, what they knew of wind farms, what the wind turbine that populated and powered them looked like, or know what it actually did. This study examines community perceptions towards renewable wind energy, derived from wind farms, for the region of south east NSW and establishes baseline data on community perceptions in the study area.

This report is re-produced in full as Attachment 2.3 in the specialist studies. The conclusions are briefly restated here to back up the assertion that the greatest majority of residents living near the proposed wind farm are similar to those surveyed in other areas in Australia and overseas and all these studies support the view that the local residents are overwhelmingly in favour of a wind farm in their locality.

Results have shown an approval rating of almost 9 in 10 (89%) respondents in favour of wind farm projects being developed in the Southern Tablelands. With over 9 in 10 (96%) of respondents agreeing 'wind energy is a good alterative energy source', see *Figure 3.1*).

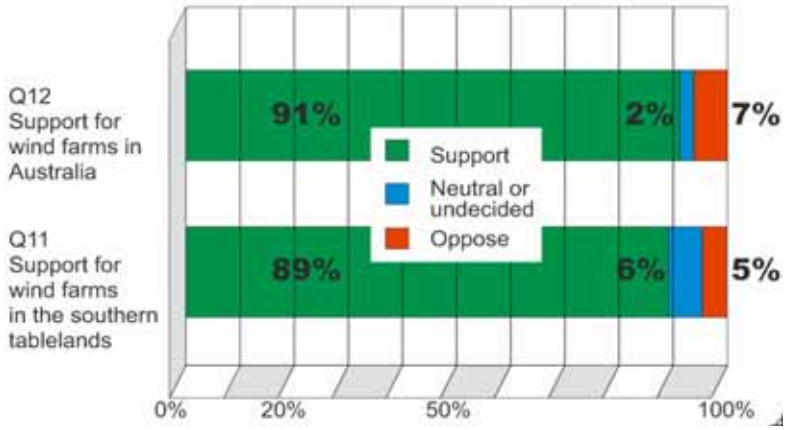


Figure 3.1 ***Support for wind farms***

Further to this, most respondents (83% favour, 8% opposed) were accepting of a wind farm set back 10 kilometres from their home, with a slight decrease to 7 in 10 respondents (71% Favour, 19% opposed) accepting a wind farm set one kilometre from their home, see *Figure 3.2*).

This is a very similar level of acceptance that has been identified in the recent Lal Lal Wind Farm study. Lal Lal wind farm was located in central Victoria in a landscape that was not dissimilar to that of the Gullen Range site.

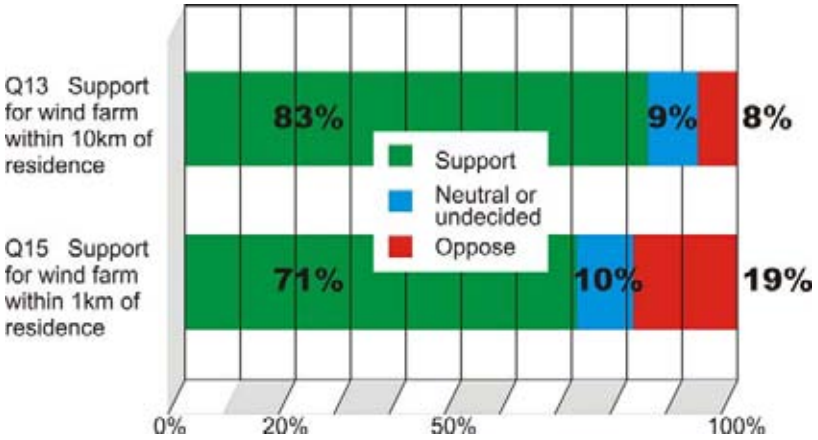


Figure 3.2 ***Support for wind farms near respondent's residence***

As well as the statistical similarity in the level of support between sites in Victoria and NSW, there is also a similarity ion the level of support when a wind farm is proposed within 1 kilometre of a respondent's residence and if it is located on some of the most scenic of Victoria's coastline (Kanos & Quint, 2000, cited in Section 2.2.1).

In response to introducing the concept of multiple 'typical' (15 to 80 turbines) wind farms in the local rural area, respondents accepted 76% (19% opposed) one typical wind farm, with three typical wind farms accepted by 64% (27% opposed) see *Figure 3.3*.

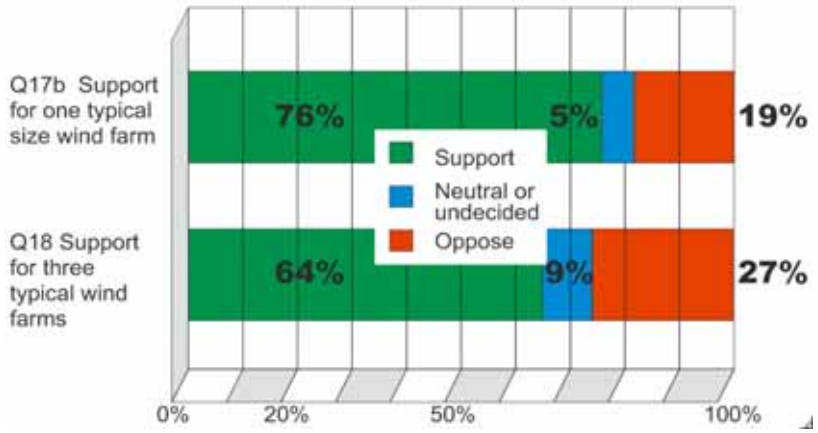


Figure 3.3 ***Support for multiple wind farms***

Figure 3.3 again highlights the remarkably consistent levels of approval for one or more wind farms in the area. The lowest level of acceptance at 64% for three wind farms is again very similar to the levels of support shown for the most sensitive of locations, weather with one kilometre of the respondent's house or on coastal headlands along Victoria's coast.

The study also found that the community has no clear preference between a few clusters, close together, or spread out at reasonable intervals along the highway. Therefore it would seem that this landscape can absorb future wind farm developments, as the community has not a strong preference.

This study shows the adult residents in the survey area are concerned about global warming and are aware of the alternatives available. The study also shows respondents know and understand what a wind turbine is, how wind farms appear in the landscape and are supportive of them.

Moreover when it comes to locating wind farms, respondents are not averse to having them in their immediate locality, and a majority still approving of a wind farm within one kilometre of their home.

It is suggested that respondents feel the creation of wind farms is positive and this study shows that many are prepared to embrace them in their local area.

These outcomes are remarkably consistent with results from other surveys conducted both within Australia and overseas and a clear pattern is emerging on the acceptance of wind farms in rural communities.

3.2 *LAL LAL WIND FARM – COMMUNITY PERCEPTION TOWARDS WIND FARMS*

A study was undertaken in an area surrounding a proposed wind farm at Lal Lal. Lal Lal is located to the south east of Ballarat, between the Midland Highway and the Western Freeway. This study (*Lal Lal Wind Farm, Report on Community Perceptions towards Wind Farms in Victoria for West Wind Pty Ltd*, prepared by ERM & Reark Pty Ltd, September 2007) has shown that there is a high degree of acceptance of wind energy by residents within the area surrounding the Lal Lal Wind Farm.

Results show an approval rating of more than 9 in 10 (93%) despite the visibility of wind turbines, most people felt that "*we need to use wind power as a source of energy even if it means changing the appearance of some landscapes*".

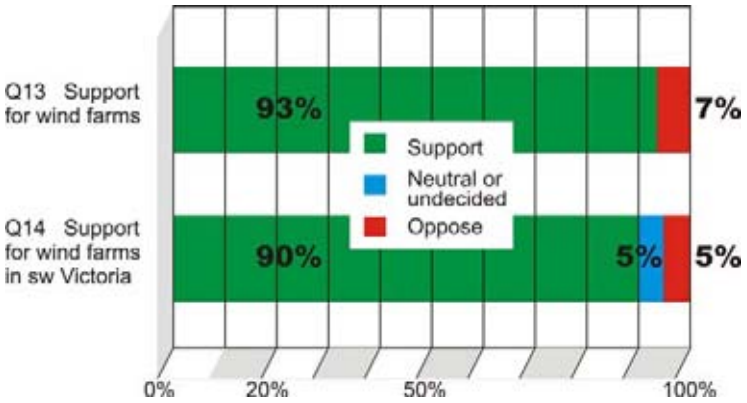


Figure 3.4 ***Lal Lal area: Support for Wind Farms***

In fact most respondents (82% favour, 8% opposed) were accepting of a wind farm that was set back 5 or 10 km from the coast on flat or undulating grazing land (82% favour; 8% opposed). These acceptance figures are greater than those found in past Victorian and overseas studies; however they are very similar to the figures for the Ararat Wind Farm.

Similarly, the level of acceptance of a wind farms was also high when the proposed wind farm was near to a respondent's place of residence. This is summarised in *Figure 3.5*.

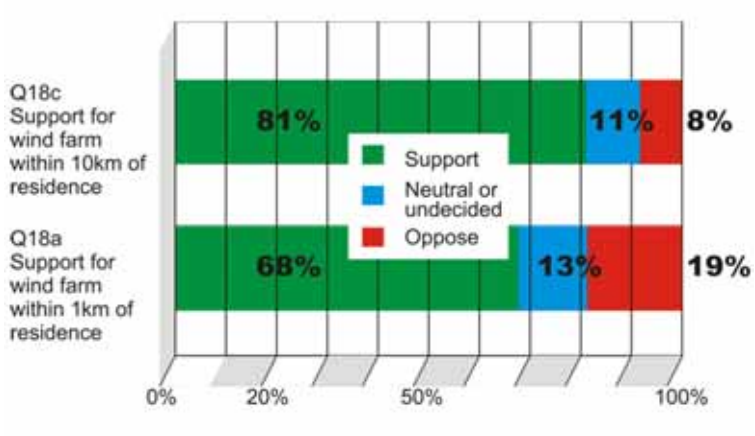


Figure 3.5 ***Lal Lal area: Support for Wind Farms near Residence***

This research has demonstrated an increase in acceptability of wind farms to previous studies although it may be hypothesised that the increasing political and community awareness of global warming and its impact on the environment has also increased the level of acceptance within this community.

3.3 ARARAT AREA – COMMUNITY PERCEPTION TOWARDS WIND FARMS

A similar study of community perceptions of wind farms in the Ararat area has been undertaken *(Report on Community Perceptions towards Wind Farms in the Ararat Region, Victoria* for RES Australia Pty Ltd, prepared by Environmental Resources Management Pty Ltd & Reark Pty Ltd, *November 2007*). This study has shown there is a high degree of acceptance of wind energy by respondents within Ararat and the surrounding area. While the entire perception study has been appended to the notification documentation, relevant sections are also included in this 'Preliminary Landscape and Visual Assessment' as appropriate.

Results have also shown an approval rating of over 9 in 10 (94%, 2% opposed) respondents in favour of wind farm projects being developed in south-western Victoria. With over 9 in 10 (96%) of respondents agreeing that '*wind energy is a good alterative energy source*', see *Figure 3.6.*

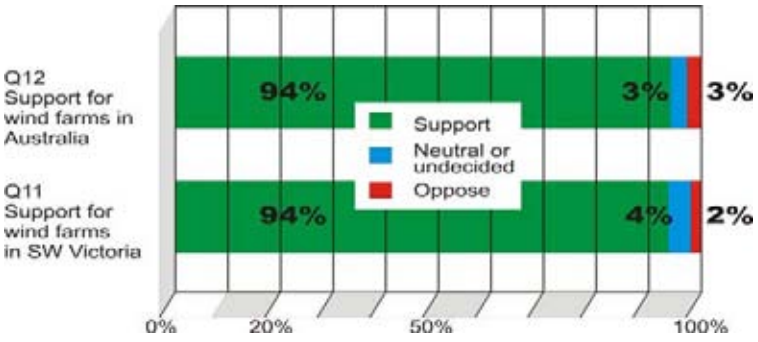


Figure 3.6 ***Ararat area: Support for wind farms***

Further to this, most respondents (82% favour, 2% opposed) were accepting of a wind farm set back 10 kilometres from their home, with a slight decrease to 7 in 10 respondents (71% Favour, 15% opposed) accepting a wind farm set 1 kilometre from their home, see *Figure 3.7.*

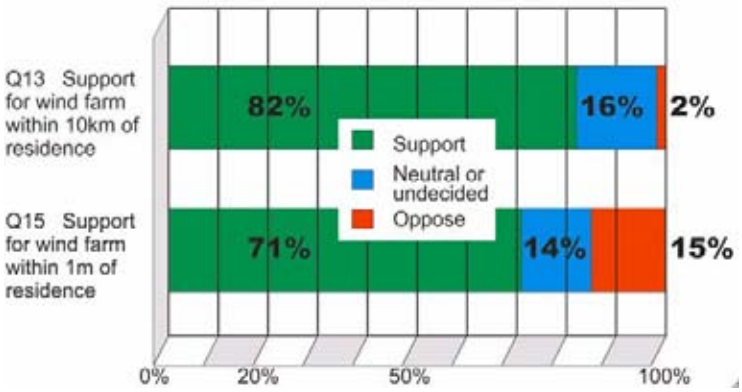


Figure 3.7 ***Ararat area: Support for wind farms near respondents' residence***

In response to introducing the concept of multiple 'typical' (30 to 40 turbines) wind farms in the local rural area, 87% respondents accepted (7% opposed) one typical wind farm, with three typical wind farms accepted by 71% (18% opposed), see *Figure 3.8*.

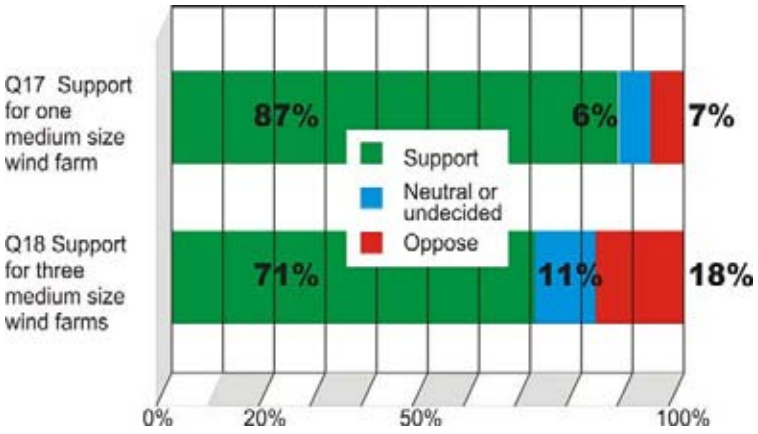


Figure 3.8 ***Ararat area: Support for multiple wind farms***

These results again highlight the remarkably consistent levels of approval for one or more wind farms in the area. The lowest level of acceptance at 71% for three wind farms is again very similar to the levels of support shown for the most sensitive of locations, whether within one kilometre of the respondent's house or on coastal headlands along Victoria's coast.

The study also found that the community has no clear preference between a few clusters, close together, or spread out at reasonable intervals along the highway. Therefore, it would seem that this landscape can absorb future wind farm developments, as the community has not a strong preference.

This is a very similar level of acceptance that has been identified in the recent Lal Lal Wind Farm study. Lal Lal Wind Farm was located in central Victoria in a landscape that was not dissimilar to that of the Ararat site.

3.4 OTHER AUSTRALIAN COMMUNITY PERCEPTION STUDIES

The following section builds upon ERM's discussion of perception issues in past visual assessments of other wind farms and is pertinent to the visual and landscape assessment of the proposed Ararat Wind Farm.

Coastal Headlands

In 2000, a study was undertaken for the Department of Natural Resources and Environment (Kantos & Quint, 2000) on the many issues concerning the Victorian Coastline including the construction of wind farms on coastal headlands.

Figure 3.9 summarises the results of this particular component. The study involved a series of nine workshops as well as telephone interviews (n = 700).

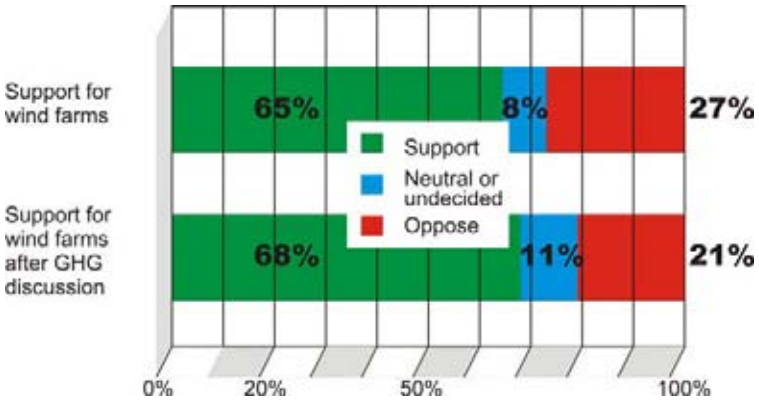


Figure 3.9 ***Wind farms on Coastal Headlands – Participant Responses***

Study participants initial support or opposition to the construction of wind farms on coastal headlands was measured. After being exposed to arguments on renewable energy, greenhouse gas emissions and climate change issues their responses were measured again. This study found that there was only a slight increase in participants' acceptance of wind farms on coastal headlands, from a 65% acceptance level before arguments on greenhouse gas emissions to 68% acceptance after these arguments were presented. However opposition reduced from 27% to 21%.

Nirranda Wind Farm

Similar figures have been found in a 2002 visitor survey undertaken for Stanwell Corporation Limited (Offer Sharp & Associates 2002) on the possible visual impacts of the proposed wind farm on the Bay of Islands viewing platform that is located adjacent to the Nirranda site, in the Shire of Moyne approximately 250km west of Melbourne.

Approximately 80% of people were generally in support of wind farms, however when presented with a proposal for a wind farm visible from a scenic coastal lookout (the Bay of Islands) the support for a wind farm at this location reduced to approximately 71%, whilst opposition to the presence of a wind farm at this location increased from 3% to 12%.

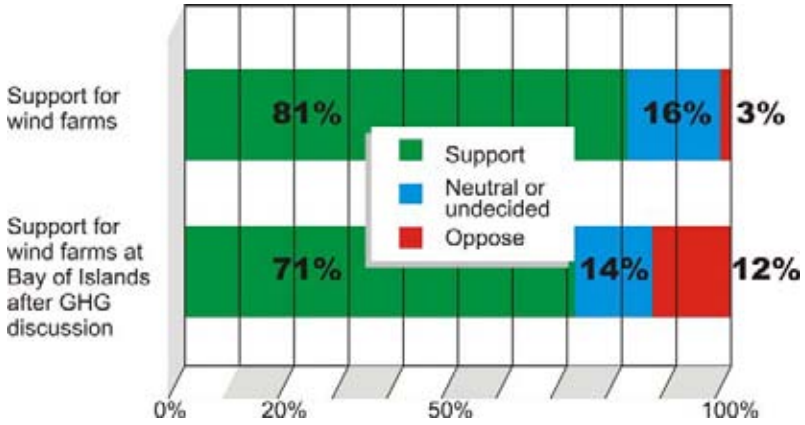


Figure 3.10 ***Nirranda Wind Farm Respondents Attitudes to Wind Farms***

*This figure of 71% support for wind farms is similar to the Kantos & Quint result of 68% reported previously for wind farms on exposed coastal headlands (**refer** Figure 3.9 Wind farms on Coastal Headlands – Participant Responses**).***

Yaloak Wind Farm

Research undertaken by Offer Sharp & Associates, 2004 presented at the Yaloak Wind Farm panel hearing in 2005 showed a similar level of community acceptance to wind farms on this inland site near Ballan, Victoria.

The study assessed community reaction to images of a wind farm in the Yaloak landscape as well as at another site at Crowlands in Western Victoria. Neither location was identified, however the Yaloak proposal had been publicised for some time before the survey and the landscape may have been recognised by some, and particularly local, respondents. Community reaction to the siting of wind turbines in these landscapes was based on interviews with 200 respondents from each of Melbourne, Bacchus Marsh and Ballarat.

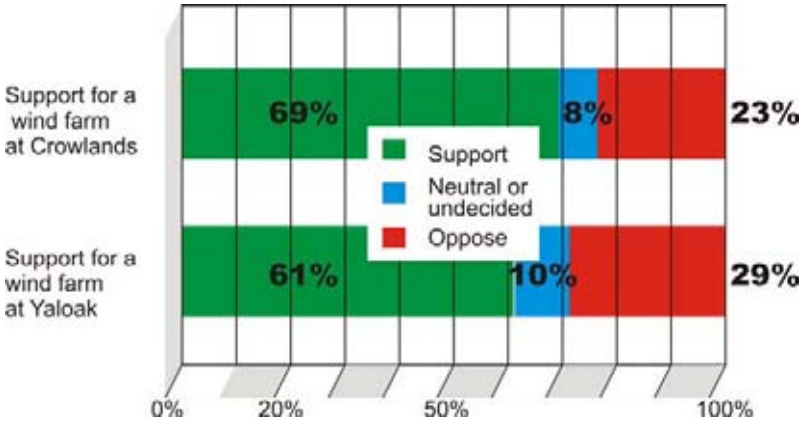


Figure 3.11 ***Level of Support for Potential Wind Farms at Yaloak and Crowland***

This data has been extracted from *Table 15 Crowlands* and *Table 19 Yaloak* in the Offer Sharp & Associates 2004 report and illustrates the acceptance levels for wind farms of each of these sites. The study also found slight differences in levels of support at Crowlands (67%, 66% and 73%) for respondents from Melbourne, Bacchus Marsh and Ballarat respectively, and slightly larger differences (61%, 55% and 68%) in support for the proposed wind farm at Yaloak.

However, the overall findings are similar of the earlier studies from the earlier Kantos & Quinn 2000 and Offer, Sharp 2002. All these Australian studies continually show a level of acceptance greater than 60%. Overseas studies show similar results.

3.5 OVERSEAS STUDIES

Community perception studies have also been undertaken overseas to gauge levels of community support and opposition to wind farms.

United Kingdom

A paper presented at the 20th British Wind Energy Association Conference (Anne Marie Simon Planning, 1996) gives an overview of thirteen studies undertaken between 1990 and 1996 by wind power proponents, opposition groups, the BBC, statutory authorities and a Liverpool University dissertation found that in all these studies:

- The overwhelming majority of respondents support the principal of development of wind power in the UK, and they also support their local wind farm;
- Those with direct experience of an operating wind farm are more supportive and positive than those without experience;
- Once wind farms are in operation, concerns about noise and visual impact decrease;
- The majority of people find the wind farms acceptable in the landscape and more find the wind turbines graceful than ugly; and
- A strong majority support and a small minority oppose wind farms, with more expressing no opinion than opposition (Freris 1998).

A summary of the results for eleven of these studies, which is taken from this paper (*Anne Marie Simon Planning, 1996*), are reproduced below.

Table 3.1 Summary of Eleven Studies Conducted in the United Kingdom into Attitudes to Wind Power from 1990-96

Location	Sponsor/Organiser	Date	In favour	Against	Don't know
Delabole, England	DTI	1992/3	84%	4%	11%
Cemmaes, Wales	DTI	1992/3	86%	1%	13%
Llandinam & Llangwyryfon, Wales	CCW	1992/3	83% 78%	3% 8%	14% 14%
Llandinam Rhyd-y-Groes Taff Ely, Wales	BBC	1994	76% 61% 74%	17% 32% 9%	8% 7% 17%
Kirkby Moor, England	National Wind Power	1994	82%	9%	9%

Bryn Titli, Wales	NWP (pre construction) NWP (open day)	1996	68% 94%	14% 3%	19% 3%
Trysglwyn, Wales	NWP (open day)	1996	96%	4%	-
Coal Clough, England	Liverpool University Dissertation	1996	96%	4%	-

Notes
NWP = National Wind Power (a wind farm developer).
CCW = Countryside Council for Wales (a statutory body)
BBC = BBC (Wales) and the University of Wales

In all these studies between 61% and 96% of survey respondents were supportive of wind power.

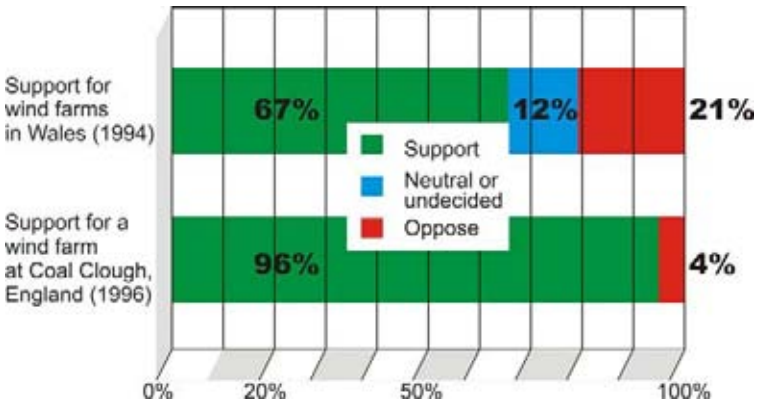


Figure 3.12 ***Comparison of Selected Wind Farm Community Perception Studies in the United Kingdom***

The lowest level of acceptance was one area within the BBC 1994 study which looked at attitudes towards wind farms in Wales (Interviews with 268 respondents, conducted in two stages; stage one being just after the wind farm was built and stage two one year later). The BBC study also looked at three locations, Llandinam, Rhyd-y-Groes and Taff Ely) with the lowest support for the wind farm at Rhyd-y-Groes with 61% support and 32% against, whilst overall the BBC study found that 67% of respondents were in favour of the development of wind power in Wales, and 21% were opposed.

The highest approval was that reported in the Coal Clough (Lancashire, England) study (Questionnaire completed by face to face interviews, sample of 50) with 96% approval and 4% opposition.

These figures are similar to those reported in the Australian studies.

Scotland & Ireland

A recent study (November 2005) on community perception of wind farms in Scotland and Ireland also has similar, but higher approval ratings. (found at http://www.your-energy.co.uk/pdf/windfarmpaper121205.pdf).

Table 3.2 ***Comparison of levels of acceptance between wind farms in Scotland and Ireland***

	Strongly support		**Support**		**Neutral**		**Oppose**		**Strongly oppose**	
	DL (%)	BH (%)	DL (%)	BH (%)	DL (%)	BH (%)	DL (%)	BH (%)	DL (%)	BH (%)
A. Wind power is Scotland	55	55	35	22	6	16	2	0	2	7
B. Local wind farm	63	47	25	16	3	20	3	4	5	13

DL = Dun Law (operational site). BH = Black Hill (proposed site).

(from *Public Perceptions of Wind Power in Scotland and Ireland*, Charles R. Warren, Carolyn Lumsden, Simone O'Dowd & Richard V. Birnie, Journal of Environmental Planning and Management, Vol. 48, No. 6, 853 – 875, November 2005, Table 4, p862).

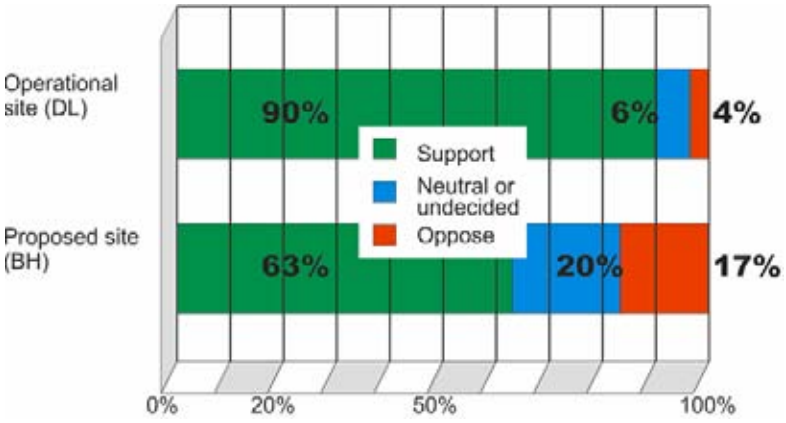


Figure 3.13 ***Acceptance levels - Scotland and Ireland***

Once again this reconfirms that the high level of acceptance, and this report also goes further and shows the increased level of acceptance within a community following construction. This is discussed in the next section of this report.

North Carolina, USA

Reported attitudes in a study from North Carolina (NC) in the USA are also similar. A paper prepared on public attitudes (Grady 2004) towards wind energy in eastern NC, which included coastal areas, and western NC, which includes mountainous areas, presented to the 'Efficient NC Conference' also found similar degrees of approval. Note: There was no information in this paper on the sample size.

Table 3.3 ***Public Attitude to Placement of Wind Farms in Eastern NC***

Placement	% Prohibited	% Not prohibited	% Don't know
Mainland	11.9	72.8	15.3
Mainland clustered	14.1	69.6	15.1
Sounds	16.6	63.6	19.8
Sounds clustered	28.0	50.2	20.5
Offshore	13.9	68.6	17.6
Offshore clustered	14.4	68.6	15.8

Table 3.3 shows the level of acceptance for clusters of wind turbines reduced to 50% for the Sounds which are the coastal areas along the eastern seaboard of North Carolina. The level of acceptance for clustered groups of wind turbines in the mainland area rose to 69.6%.

This paper (Grady, 2004) also presented levels of acceptance within the more mountainous areas of Western NC.

Table 3.4 ***Public Attitudes to Wind Farm Placement – Western NC***

Placement	% Prohibited	% Not prohibited	% Don't know
Ridgetops	20	64	17
Ridgetops clustered	28	57	15
Ridgetops with other towers	16	75	10

The western area of Northern Carolina is mountainous; many parts are uncleared and show few signs of human intervention. The level of acceptance for clustered groups of wind turbines on ridge tops in this area is less (57%) than the level of acceptance reported for the mainland areas of Eastern NC (69%), however if there are other towers on the ridge tops (ie there are obvious signs of human intervention) then the level of acceptance rises to 75%.

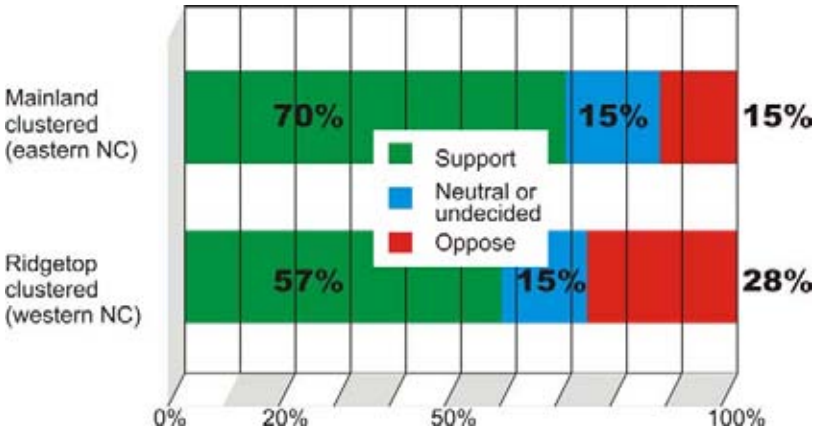


Figure 3.14 ***Acceptance Levels - Northern Carolina, USA***

In summary this paper reported that:

- "*within groups of middle aged, middle class, pragmatic, year round residents of the mountain and coastal regions of NC, there is support for developing renewable energy as a future source of fuel for electricity generation.*
- *More than 3 out of 4 would prefer to see more future electricity derived from solar and wind*
- *Less support for turbines in sounds or national forests*
- *2 out of 3 support turbines visible from home*
- *Over 80% support turbines for residential use."*(Grady, 2004)

The degree to which the respondents believe that wind farms on mainland sites should not be prohibited is very similar to the previously cited United Kingdom and Australian studies; with between 69-73% believing that wind farms should not be prohibited.

3.6 PERCEPTION ALTERATION AFTER CONSTRUCTION

There has been no research done on the visual impact of wind farms in Australia after construction, however overseas studies suggest greater acceptance levels by people who live in the vicinity of wind farms after their construction (Gipe n.d.)

Anne Marie Simon Planning and Research in the previously cited study also found that all studies that looked at perceptions before and after construction, reported an increase in acceptance after the Wind Farm was completed.

It is also interesting to note that the study on Scotland and Ireland (cited above) also shows a 27% increase in acceptance following construction, although the greatest proportion of people who changed their mind were in the "neutral or undecided" group, there was still a significant reduction from 17% to 4% in the group that opposed the wind farms.

This study supports the view that familiarity does not increase opposition to a wind farm, but rather increases acceptance and support for wind turbines in the landscape.

3.7 THE ROLE OF THESE PERCEPTION STUDIES ON THE VISUAL ASSESSMENT OF WIND FARMS

Part of the assessment must consider if the landscape around the proposed Gullen Range Wind Farm is of such a quality that the majority of viewers would be disturbed by the presence of a wind farm. Research supports the proposition that the vast majority of the community supports the creation of a further wind farm in the Gullen Range Wind Farm area.

It should also be acknowledged that while the older research may target viewers in the general community, including visitors, tourists and residents, viewing the wind farm from local roads, tourist locations and from other publicly accessible locations, the later research is focused on those who live in the area, those that are the most familiar with the local landscape.

These recent studies show a discernible rise in the level of public acceptance over the older studies on community perceptions to wind farms in Australia and overseas. The earlier research continually shows a level of community support at around 60-70% and a level of opposition between 5-30%, while the more recent research (Lal Lal and Ararat Wind Farms) shows a level of community support in excess of 90% and a level of opposition of between 3-5%.

The research for the area surrounding the Gullen Range Wind Farm shows similar levels of acceptance of wind farms to the recent Victorian examples where 5% of the people surveyed were in opposition of a wind farm development. However 81% of people surveyed in the local area were supportive of a wind farm development in the local area and 71% favoured a wind farm within 1km of their home. Further to this, 64% of the people surveyed in the local area were accepting of three typical wind farm in their local area.

It is important to realise that this acceptance level is unique to wind farms. Similar research to the visual impact of a transmission line, a major road or other large infrastructure projects would show a greater degree of dislike for the changes these projects make on the landscape. The much greater acceptance of wind turbines in the landscape may well be a result of their clean lines and aerodynamic shape, or perhaps with their perceptual link with green energy. Irrespective of the reason, it is clear that wind turbines are generally accepted by the majority of viewers in all but the most sensitive of locations.

Implications for the assessment of cumulative visual impact

Cumulative impact assessment for wind farms assesses the local communities position in relation to several wind farm being constructed in their local area. Recent community based perception studies in Victoria were asked for their acceptance of one additional wind farm in their local are (87% support, 7% oppose), and their reaction to three additional wind farms (71% support, 18% oppose).

The response to introducing the concept of multiple 'typical' wind farms (15 to 80) turbines in the local Gullen Range area,

- 76% one typical wind farm;
- 75% accepted two 'typical' wind farms; and
- 64% of those people surveyed were accepting of three typical wind farms and 17% were opposed.

This level of acceptance for multiple wind farms in the area would suggest that the level of cumulative impact would also be acceptable to the local community.

4 THE VIEWSHED

The area that may potentially be visually affected by the wind turbines is called the viewshed. This is not the same as the extent of visibility as it may well be possible to see the turbines from areas outside the viewshed, but rather it is a delineation of the area from which the wind turbines could create a recognisable impact within a man-modified landscape.

The viewshed for the Gullen Range Wind Farm is based on the characteristics of human vision. For readers not familiar with basing a viewshed on these calculations, the reasoning is explained in Annexure A.

Given that the overall height of the wind turbines at 135m, the viewshed can be considered to extend to a distance at which the 135m wind turbines will take up less than 5% of the full vertical field of view. Typically the field of view of a person is 10^{O}; therefore 0.5° is less than 5% of the vertical field of view. Therefore a wind turbine 135m high viewed from a distance of 15.5km will take up 5% of the vertical field of view.

However to be conservative this report will use 17km as the extent of the viewshed.

4.1 ZONES OF VISUAL IMPACT

Within the viewshed there are differing zones of visual impact. The visual impact of a wind turbine at 16.1km is obviously less than the visual impact of a wind turbine seen from 1km. Distance ranges are used as a guide only to determine zones of visual impact. However, it is recognised that visibility does not dramatically change when a viewer moves from 2.9km to 3.1km from the nearest wind turbine and therefore these zones are but a guide.

Table 4.1 Zones of visual impact

Distance from an observer to the nearest wind turbine	Visual impact
> 17 km.	*Visually insignificant* A very small element in the viewshed, which is difficult to discern and will be invisible in some lighting or weather circumstances.
8.5 km – 17 km	*Potentially noticeable, but will not dominate the landscape.* The degree of visual intrusion will depend on the landscape sensitivity and the sensitivity of the viewer, however the wind turbines do not dominate the landscape.
3.0 km -8.5 km.	*Potentially noticeable and can dominate the landscape.* The degree of visual intrusion will depend on the landscape sensitivity and the sensitivity of the viewer
1.5-3.0 km	*Highly visible and will usually dominate the landscape* The degree of visual intrusion will depend on the wind turbines' placement within the landscape and factors such as foreground screening.

< 1.5 km	*Will be visually dominant in the landscape from most viewing locations.* Dominates the landscape in which they are sited.

However as shown in *Table 4.1*, high visual impacts of a wind farm are greatest within 3km of the nearest turbine. With potentially noticeable visual impacts that may dominate the landscape up to 8.5km from the turbine depending on surrounding landscape characteristics.

Figure 4.1 shows the viewshed zones for the proposed Gullen Range Wind Farm.

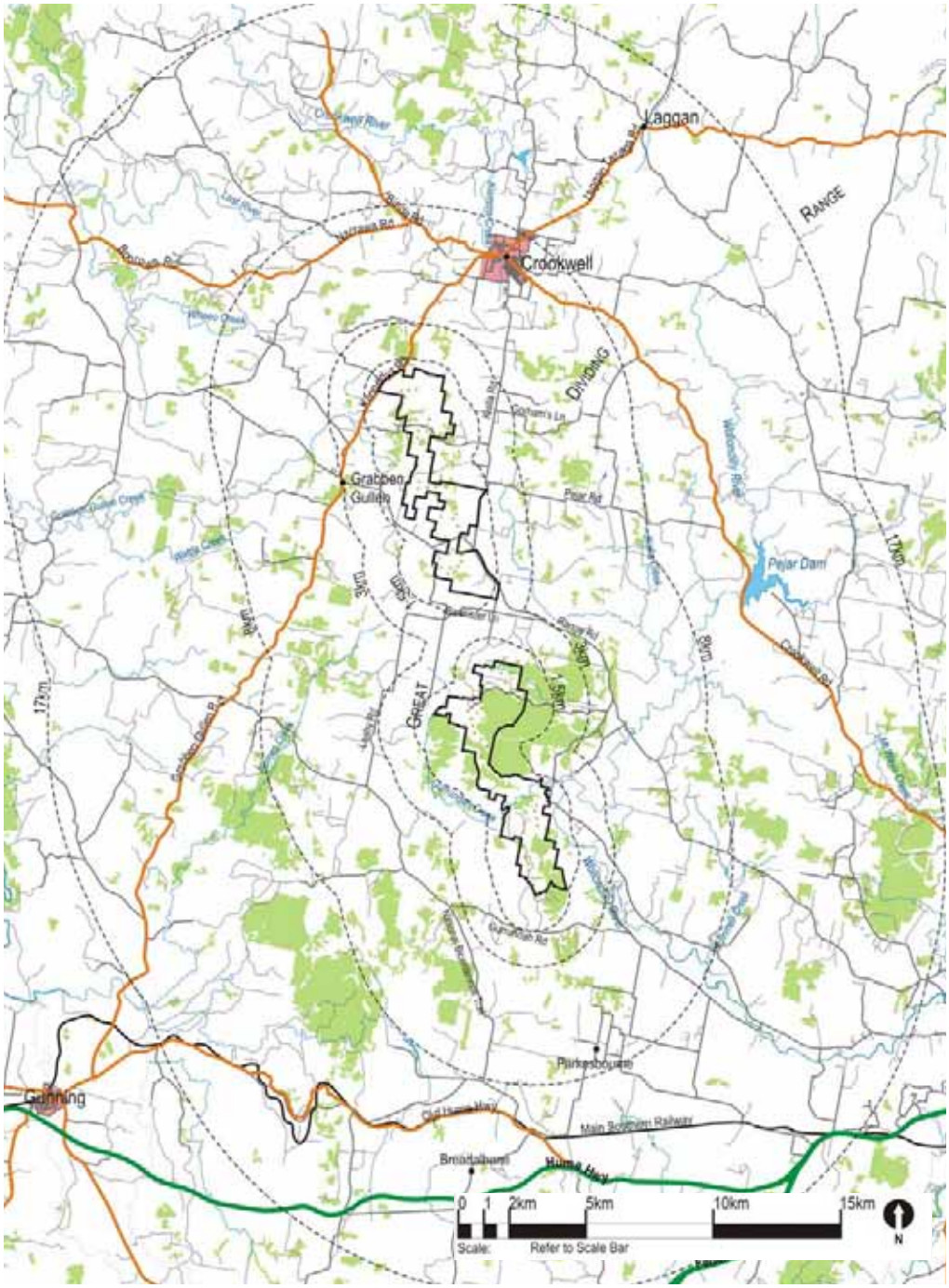


Figure 4.1 ***Viewshed of Gullen Range Wind Farm***

There are several small towns within the 17km viewshed including:

- Crookwell, approximately 5km to the north east;
- Laggan, approximately 15km to the north east;
- Grabben Gullen, approximately 3km to the west; and
- Breadalbane, approximately 10km to the south;

There are also several named 'localities' that consist of a few dwellings and/or buildings and with no shopping or convenience services.

Sections of the Hume Freeway, the old Sydney to Melbourne Highway and the Sydney to Melbourne Railway line is located in the southern extent of the of the 17km viewshed.

The town ship of Goulburn is located approximately 23km from the nearest wind farm boundary, outside the 17km viewshed.

5 LANDSCAPE UNITS WITHIN THE VIEWSHED

Landscape units are based on areas with similar visual characteristics in terms of topography, geological features, soil, vegetation, and land use. The following sections describe the underlying patterns of these elements to derive the landscape units within the viewshed.

5.1 TOPOGRAPHY AND GEOLOGY

The wind farm is located on a north south ridge that divides the catchment areas within the surrounding landscape. The northern sections are on relatively flat land, whilst the southern sections are on steeper igneous and sedimentary formations.

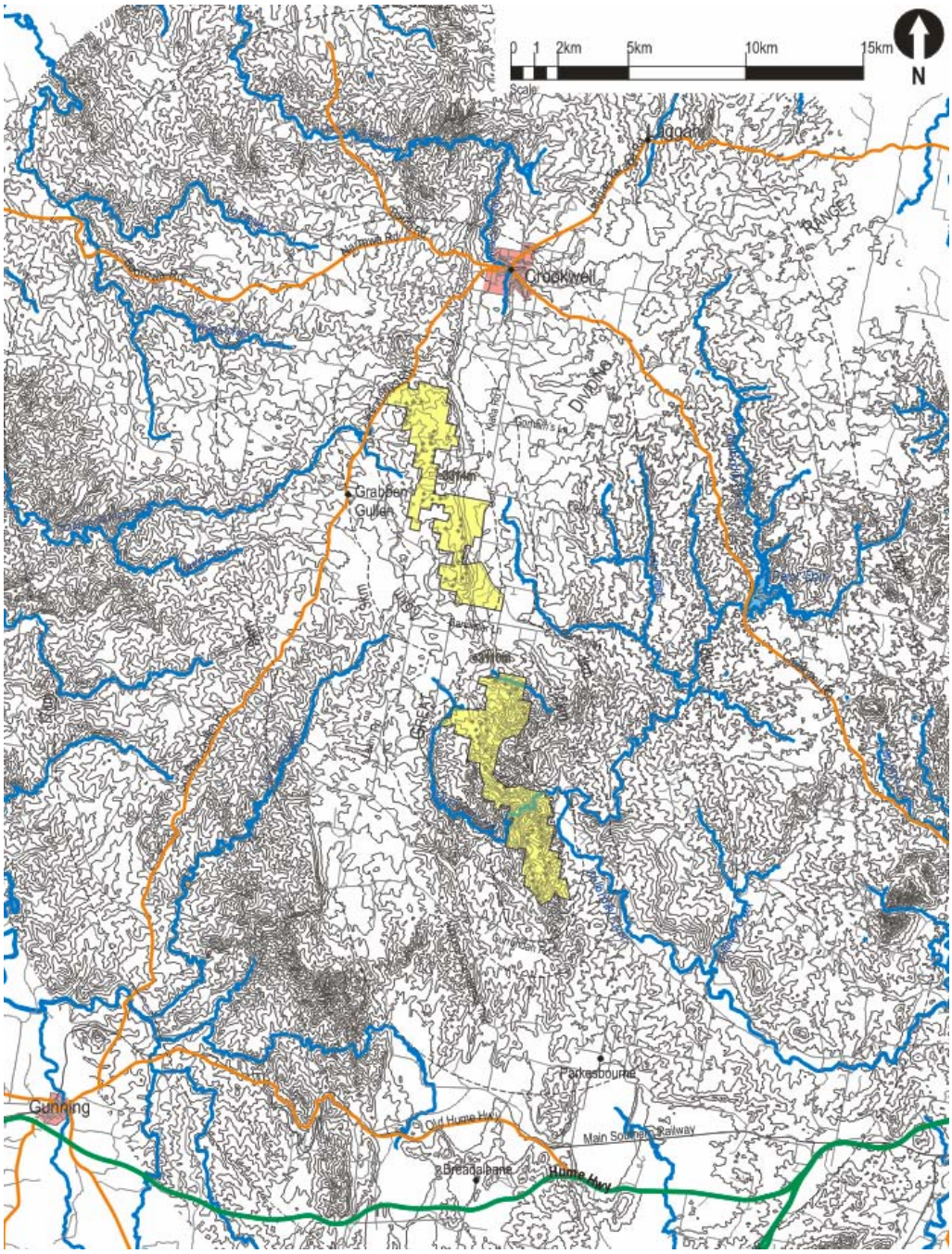


Figure 5.1 Topography & drainage

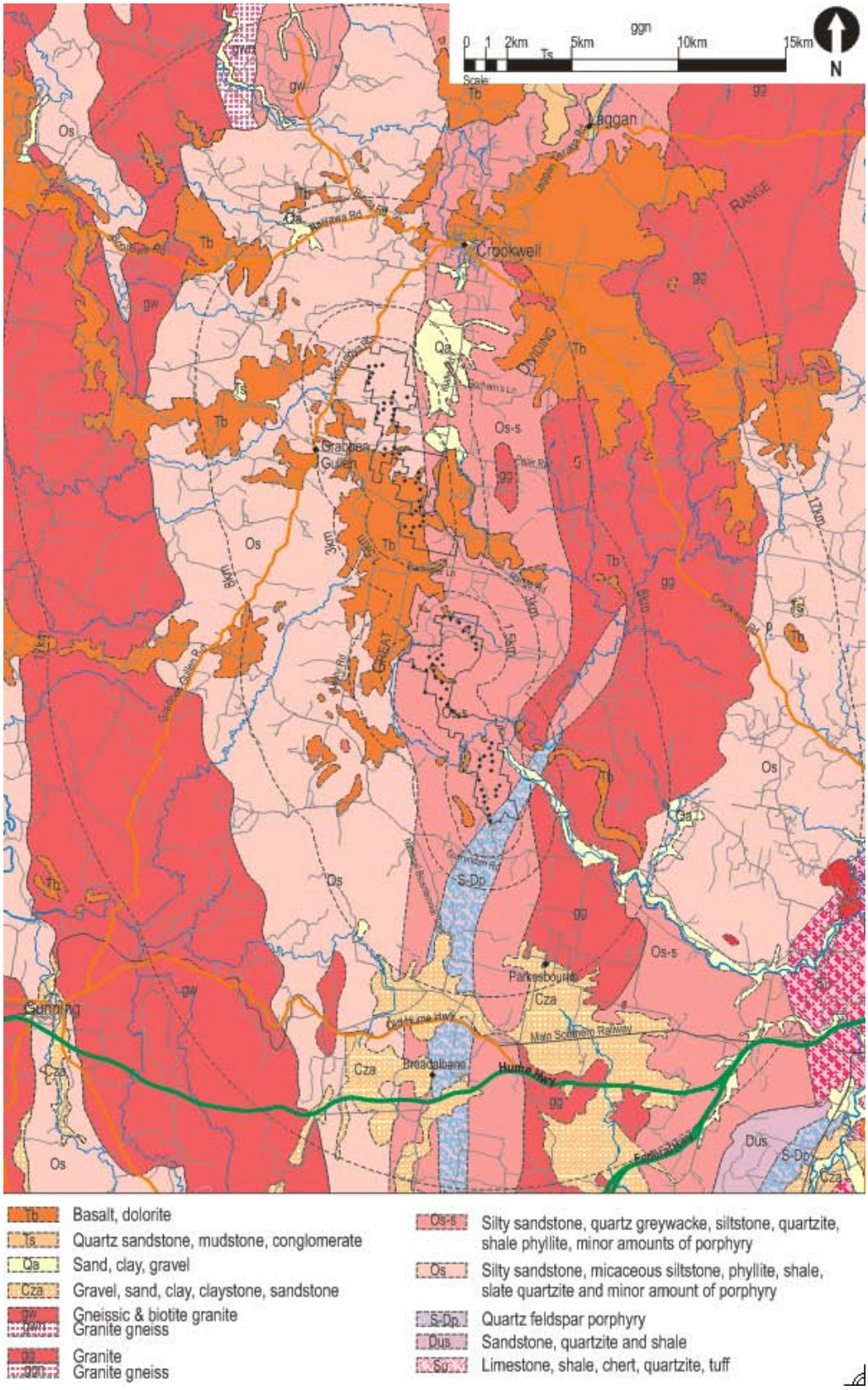


Figure 5.2 ***Geology within the viewshed***

The low lying hills are formed from tightly folded and faulted marine sandstones and shales. The lower slopes and drainage lines are susceptible to gully erosion.

The flatter areas surrounding the northern sections of the wind farm are of igneous as well as sedimentary /alluvium origin.

5.2 VEGETATION

The vegetation in part reflects the geomorphology of the area, and particularly soil quality and areas of steeper topography. The distribution of existing vegetation is shown in *Figure 5.3*.

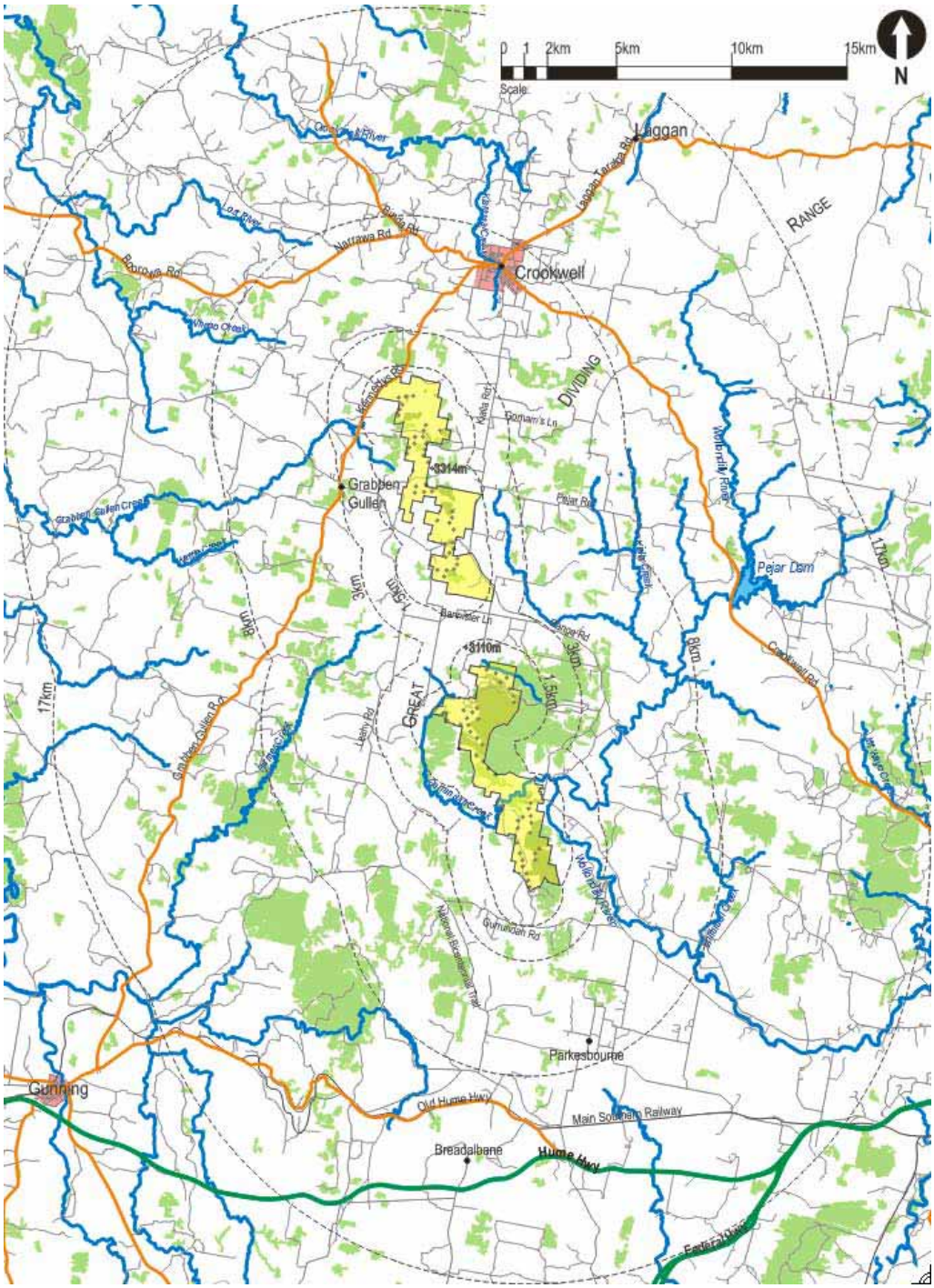


Figure 5.3 *Vegetation*

Areas of higher soil quality were cleared for agricultural use, while areas of poorer soils and on steeper slopes were left vegetated as they were insufficiently productive to warrant clearing. The cleared agricultural land is on richer soils associated with alluvium deposits and better quality igneous material. In agricultural areas, what appears to be natural vegetation is limited to linear bands along streams, drainage

lines and road sides. However there are also linear bands of planted shelterbelts along property boundaries, roads and fence lines.

5.3 LANDSCAPE UNITS

The characteristics of topography, geology, vegetation and the land use within the viewshed define the landscape units:

- *"Landscape Unit 1 – Gently Undulating Farmland"* is obviously man-modified, contains other infrastructure, is not topographically dramatic and contains the drainage lines. The *Gently Undulating Farmland Unit* is a common landscape type within the southern tablelands of New South Wales.
- "*Landscape Unit 2- Hilly Farmland*" is obviously man-modified, is not topographically dramatic although the slopes are steeper than those within the farmland Unit. It also has drainage lines with some dams constructed along these valleys. The Pejar Dam to the east of the wind farm is the largest water body within the viewshed. This *Hilly Farmland Landscape Unit* is also a common landscape type within the southern highlands.
- "*Landscape Unit 3 – Vegetated Areas*" are those larger areas that appear to have remnant indigenous vegetation. As discussed previously these are typically on areas with steeper slopes and where the soils are poorer.
- *"Landscape Unit 4 - Rural Townships"* accounts for those areas of village or townships within the viewshed.

Figure 5.4 Landscape units within the viewshed

Figure 5.4 shows the view looking east from Range Road and three of the landscape units within the viewshed.

The *Hilly Farmland Landscape Unit* is visible in the foreground, whilst the *Gently Unulating Farmland Unit* extends to the horizon although some of the *Vegetated Areas Landscape Unit* is also visible. Linear vegetated remnants along drainage lines and road reserves as well as planted vegetation within the farmland areas are also apparent.

Each of these landscape units is described further in the following sections.

5.4 LANDSCAPE UNIT 1- GENTLY UNDULATING FARMLAND

The *Gently Undulating Farmland Landscape Unit* is the most common landscape unit within the viewshed. It includes areas of flat alluvial land as well as low lying hills with gentle grades.

Figure 5.5 Gently Undulating Farmland Landscape Unit

Figure 5.5 is a view from the Kialla Road looking south west. Kialla Road is a north south road running from Crookwell near the northern and flatter areas of the wind farm and provides a view towards the low ridge on which the wind turbines are located.

The land within this landscape unit is predominately cleared with some shelter belts and linear vegetation bands along drainage lines, fencelines and roadsides.

Vegetation includes indigenous vegetation as well as introduced wind breaks of cypress and other non-indigenous species.

5.5 *LANDSCAPE UNIT 2 - HILLY FARMLAND*

The *Hilly Farmland Landscape* Unit describes those agricultural areas that have also been cleared, however the topography is more dramatic and there is more remnant vegetation on some of these hills.

Figure 5.6 Hilly Farmland Landscape Unit

Figure 5.6 is a photograph taken from Gurrundah Road looking north east. Gurrundah Road is an east west road which runs along the southern boundary of the wind farm. The view to the north east is towards the steeper hills common to the southern section of the wind farm.

The foreground of this Figure would be included within the *Gently Undulating Farmland Landscape Unit* discussed previously.

5.6 LANDSCAPE UNIT 3 – VEGETATED AREAS

The *Vegetated Areas Landscape* Unit describes those areas within the viewshed that have not been cleared, and appear as relatively large areas of indigenous vegetation. Although many of these areas have been cleared in the past or logged they appear as undisturbed areas of indigenous vegetation within the viewshed and therefore they have a higher landscape or visual value that is independent of their ecological value. So although many of these areas are greatly disturbed, they still have a higher degree of sensitivity to visual disturbance.

Figure 5.7 Vegetated Areas Landscape Unit

Figure 5.7 is a photograph taken from Gurrundah Road. As stated previously Gurrundah Road is an east west road which runs along the southern boundary of the wind farm.

Figure 5.7 is a view towards a vegetated section of these the steeper hills. *Landscape Unit 2 – Hilly Farmland* is visible in the foreground.

5.7 LANDSCAPE UNIT 4- RURAL TOWNSHIPS

The *Rural Townships Landscape Unit* delineates those areas of settlement within the viewshed. The small townships of Crookwell and Grabben Gullen lie within the visual catchment.

Figure 5.8 Crookwell, looking north west on Goulburn Street

Figure 5.8 is a view from the main street of Crookwell looking North West away from the Gullen Range Wind Farm.

Figure 5.9 Grabben Gullen looking west

Figure 5.9 is a view along the main road which runs through Grabben Gullen towards the Gullen Range Wind Farm. There are few residential dwellings in Grabben Gullen.

Crookwell is the largest town in the viewshed of the Gullen Range Wind Farm.

5.8 LANDSCAPE SENSITIVITY

The landscape sensitivity of the *Gently Undulating Farmland Landscape Unit* is considered low, as it is relatively common across a large area of central and southern New South Wales and regularly undergoes visually change through farming and grazing practices. Rural structures and associated activities like animal grazing, use of tractors, crop cycles and changes associated with farming and agriculture are constant reminders of human influence on the landscape.

The landscape sensitivity of the *Hilly Farmland Landscape Unit* is also considered low, although less common than the extensive cleared plains, these cleared hills are a common feature of the landscape of the region. Whilst these hills have been partly cleared, it must be recognised that some people value these hills.

The landscape sensitivity of the *Vegetated Areas Landscape Unit* is rated as medium as it appears to be intact indigenous vegetation and as these areas are relatively uncommon within the viewshed it should be recognised that the sensitivity of these areas would be higher than that for cleared agricultural land.

The *Rural Township Landscape Unit* has a medium sensitivity. This sensitivity recognises the number of residents viewing the surrounding landscape.

Table 5.1 summarises the sensitivity of the various landscape units within the visual catchment of the Gullen Range Wind Farm.

Table 5.1 Landscape Sensitivity

Landscape unit	Sensitivity
Unit 1 Gently Undulating Farmland Landscape Unit	Low This landscape unit is obviously man-modified, contains other infrastructure, is not topographically dramatic and does not contain areas of water. It is a common landscape type in the viewshed and across the Southern Tablelands.
Unit 2 Hilly Farmland Landscape Unit	Low This landscape unit is obviously man-modified, is not topographically dramatic and contains few areas of water. It is a common landscape type in the viewshed and across the Southern Tablelands.
Unit 3 Vegetated Areas Landscape Unit	Medium This landscape unit is relatively uncommon within the viewshed and vegetated areas appear as remnants of the pre-European settlement landscape and are therefore afforded a higher degree of sensitivity.
Unit 4 Rural townships	Medium The presence of a greater number of residences increases the sensitivity.

6 SEEN AREA ANALYSIS

A seen area analysis shows those areas within the viewshed from which wind turbines, or sections of wind turbines, may be visible.

The extent to which a wind farm is visible depends upon the nature of the intervening topography. The Gullen Range Wind Farm is located on hilly areas where the elevation change across the site may vary from 500- 1,000m AHD. Intervening ridges, depressions and rises between a viewer and the wind turbines can screen views to part or all of the proposed wind turbines.

The areas from which part or all of the proposed wind turbines can be mapped using Geographical Information Systems (GIS) software. The GIS mapping is based solely on topography and does not take into account screening by vegetation, minor topographic changes and building. These factors will obviously reduce the visibility from many locations and the GIS analysis is a conservative map of the extent of visibility.

Figure 6.1 and *Table 6.1* show the range of visibility options that have been mapped in the following GIS based analysis.

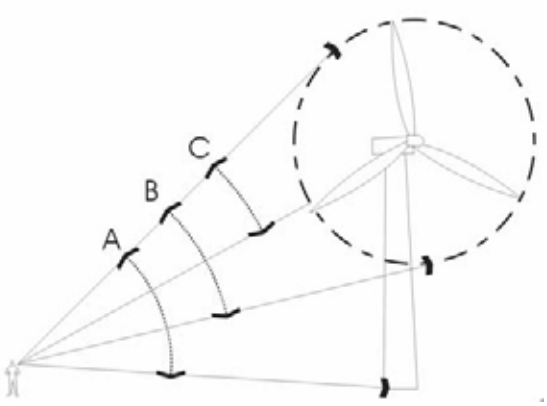


Figure 6.1 Visibility parameters (not to scale)

Table 6.1 Mapping visibility parameters

Zone	Extent that wind turbines are visible
Zone A	One or more wind turbines in their entirety
Zone B	The entire swept path of the blades of one or more wind turbines
Zone C	At least half of the swept path of one or more wind turbines
Zone D	Any part of the wind turbine blades of one or more wind turbines

These zones are not exclusive. For example a location that has the potential to view a wind turbine in its entirety falls into Zone A. A viewer at this location will also be able to see "any part of the wind turbine blades" and this location will also fall into Zone D.

6.1 AREAS FROM WHICH WIND TURBINES ARE POTENTIALLY VISIBLE

Each of these zones can be mapped using this GIS software. *Figure 6.2* shows the GIS based mapping of Zones A, B, C and D.

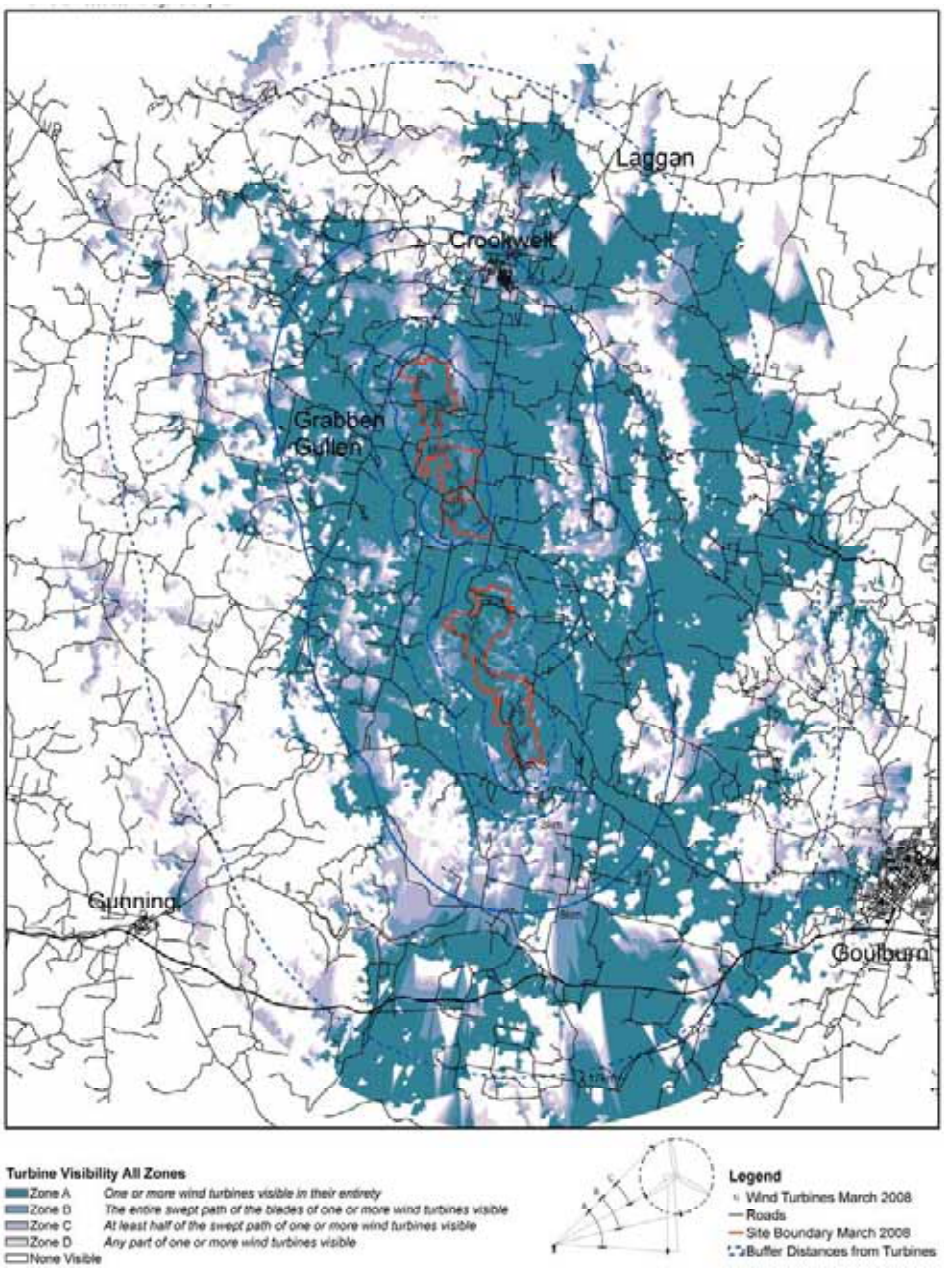


Figure 6.2 ***Areas of potential wind turbine visibility***

Wind turbines are either entirely visible (Zone A) or at least the entire swept path of the turbines' blades is visible (Zone B) from a large proportion of the viewshed. This is because the proposed wind turbines are located on a ridge.

However no wind turbines, in whole or part will be visible from the western, northern south eastern edges of the viewshed. These areas are shown in white in *Figure 6.2*.

6.2 *ZONE A – AREAS THAT CAN POTENTIALLY SEE ONE OR MORE WIND TURBINES IN THEIR ENTIRETY*

Zone A maps those areas from which viewers could potentially see entire wind turbines and the numbers of wind turbines that could be visible.

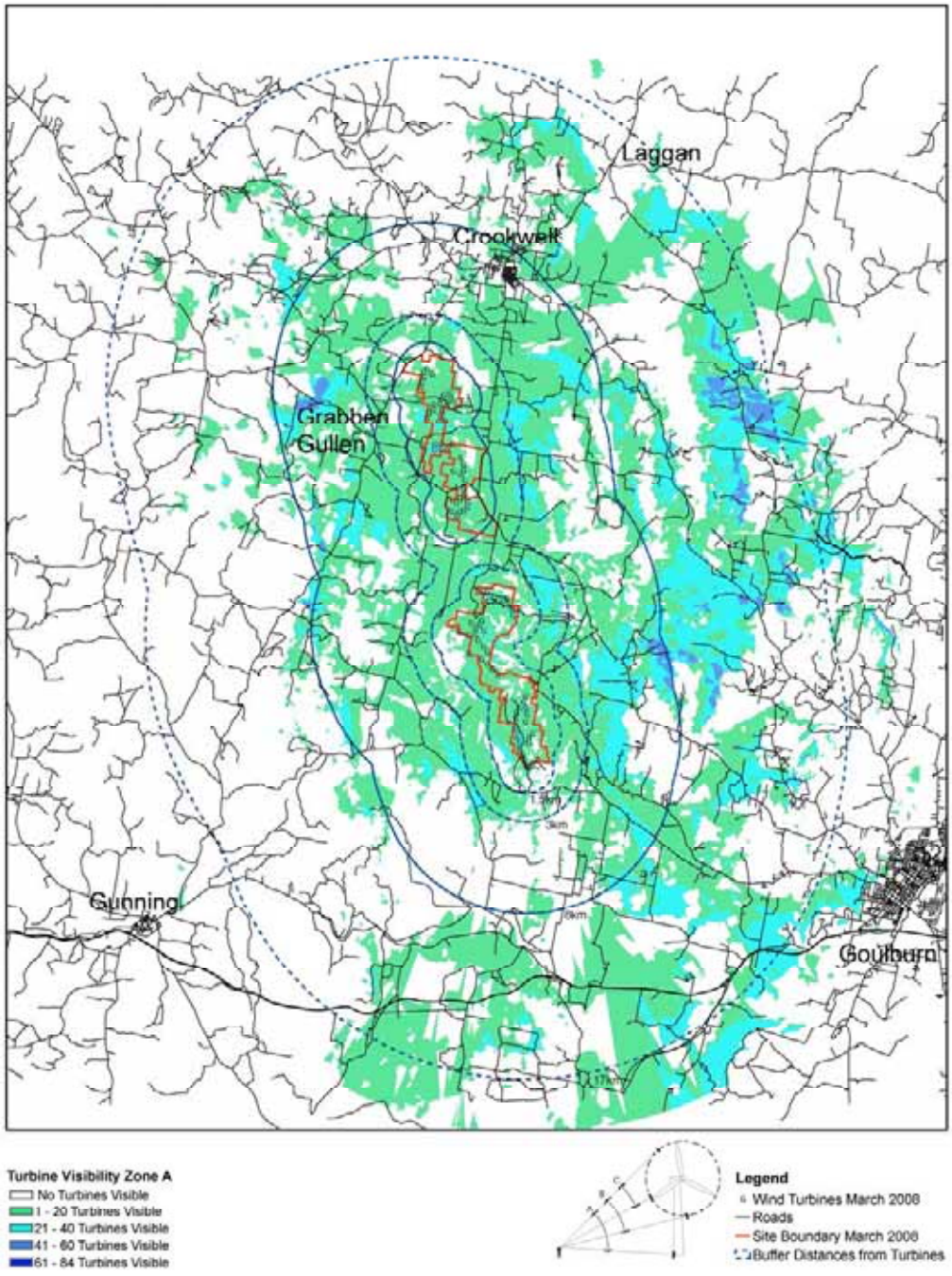


Figure 6.3 ***Zone A***

Figure 6.3 shows that viewers in areas near to the site may be able to see between 1-20 entire wind turbines, however there are no locations within the viewshed that can see all of the wind turbines in their entirety.

6.3 *ZONE B – AREAS THAT CAN POTENTIALLY SEE THE ENTIRE SWEPT PATH OR ONE OR MORE WIND TURBINES*

Zone B is the area where viewers could potentially see at least the entire swept path of the blades. This includes those areas from which entire turbines are also visible.

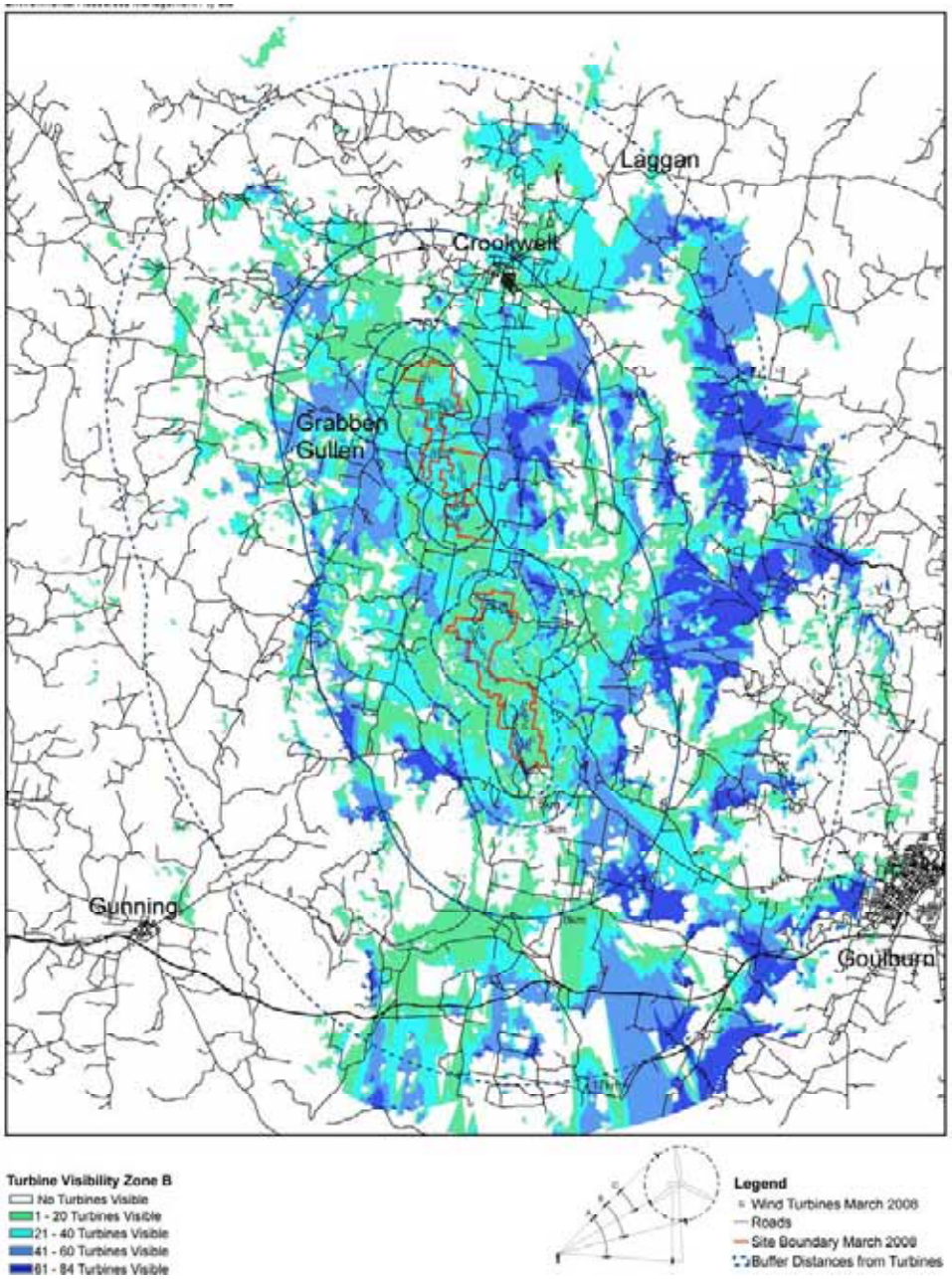


Figure 6.4 ***Zone B***

Figure 6.4 shows that there are some areas that viewers will potentially see the full swept path of the majority of the proposed wind turbines.

However, there are few areas within 3km of the proposed wind turbines that will potentially be able to see the full swept path of almost all of the proposed wind turbines.

In most of the areas that are not screened by topography, viewers may be able to see up to 20 turbines.

6.4 *ZONE C – AREAS THAT CAN POTENTIALLY BE SEEN FROM THE NACELLE AND ABOVE OF ONE OR MORE WIND TURBINES*

Zone C maps those areas from which a viewer can potentially see the nacelle and above, that is at least the upper half of the swept path of the wind turbine blades and the numbers of wind turbines that are visible.

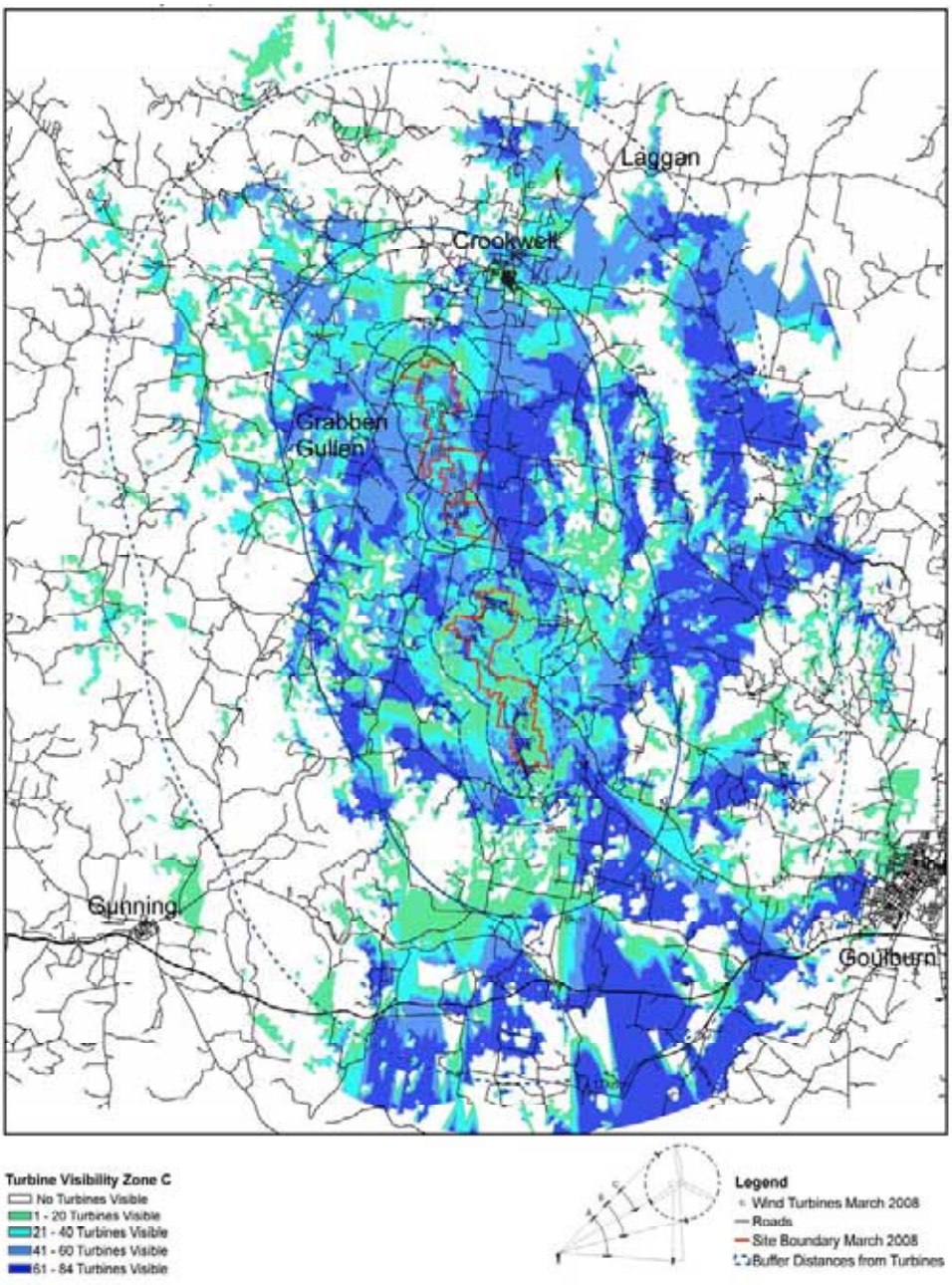


Figure 6.5 *Zone C*

Viewers to the east of the wind farm will be more likely to be able to see the upper half of the swept path of forty or more wind turbines. The area with the greatest possibility of visibility between 1.5 – 3km from the nearest wind turbine is immediately east of the Kialla Section along Kialla Road. Viewers in these areas may be able to see the nacelle upwards of between 40 - 79 wind turbines. However for the vast majority of viewers, there will be between 1-20 wind turbines visible.

6.5 *ZONE D – AREAS THAT CAN POTENTIALLY SEE ANY PART OF ONE OR MORE WIND TURBINES*

Zone B maps those areas in which a viewer may be able to see any part of a wind turbine, even those areas in which only the very tip of a turbine blade was visible. As such it is the most conservative seen area map.

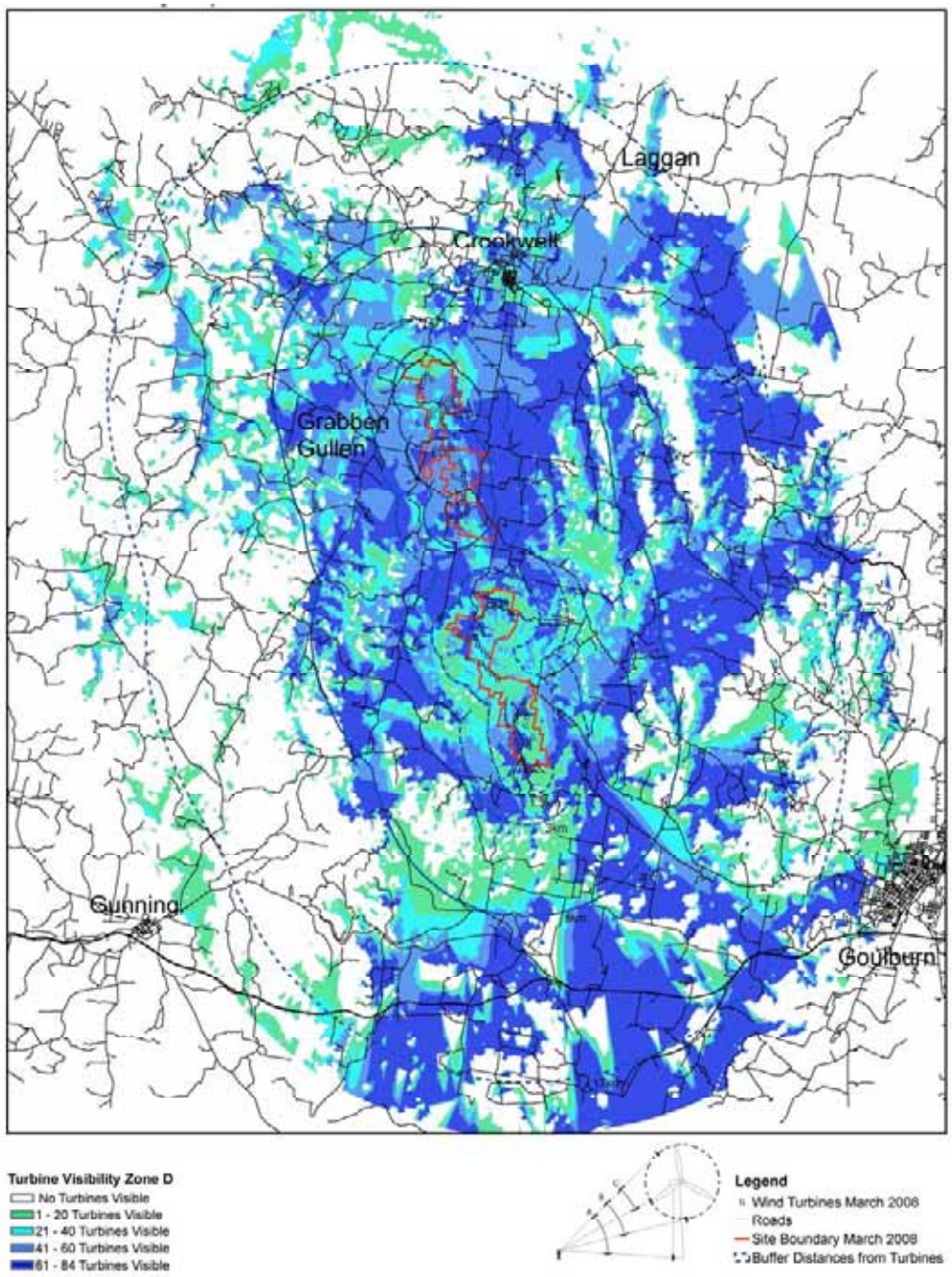


Figure 6.6 ***Zone D***

Even with the mapping criteria set at its most conservative, as in this case where even the visibility of a blade tip is included, there are still large areas to the west and north of the Site where the wind turbines will not be visible. Even without considering intervening vegetation, buildings or small topographical features there are still many areas from which no part of any wind turbine would be visible.

6.6 THE RELEVANCE OF THIS ANALYSIS TO VIEWPOINT LOCATION

The preceding seen area analysis shows clearly that the main areas that may be visually impacted by the Gullen Range Wind Farm lie to the east.

The nature of the surrounding landscape means that there are no locations within the 17km viewshed that can see all of the wind turbines in their entirety and there are very few locations within the viewshed that will view all of the proposed wind turbines from the nacelle and above.

The GIS studies show the potential for the wind turbines to be visible from Crookwell. However, while topography will not screen views from areas of Crookwell, views in a built up residential area are readily screened by existing buildings and vegetation. Wind turbines may also be visible from the township of Grabben Gullen.

The major visual impact from areas that are publicly accessible are those along sections of the Kialla Road to the east and Bannister Lane to the west of the proposed Gullen Range Wind Farm.

7 *ASSEEMENT OF INDICATIVE VIEWPOINTS FROM PUBLICLY ACCESSIBLE LOCATIONS*

The selection of publicly accessible viewpoints seeks to provide representative views from publicly accessible areas within the viewshed. In addition, results from the ongoing community consultation have been incorporated where applicable.

There were 13 viewpoints that have been selected as representative indicative publicly accessible viewpoints:

VP1	Corner Mullins Creek Road and Gurrundah Road	VP7	Range Road
VP2	Crookwell Gunning Road at Wattle Creek	VP8	Pejar Dam boat ramp
VP3	Pomeroy Road	VP9	Bannister Lane
VP4	Walkoms Lane	VP10	Crookwell
VP5	Bannister Lane	VP11	Grabben Gullen
VP6	Kialla Road	VP12	Laggan
		VP13	Breadalbane

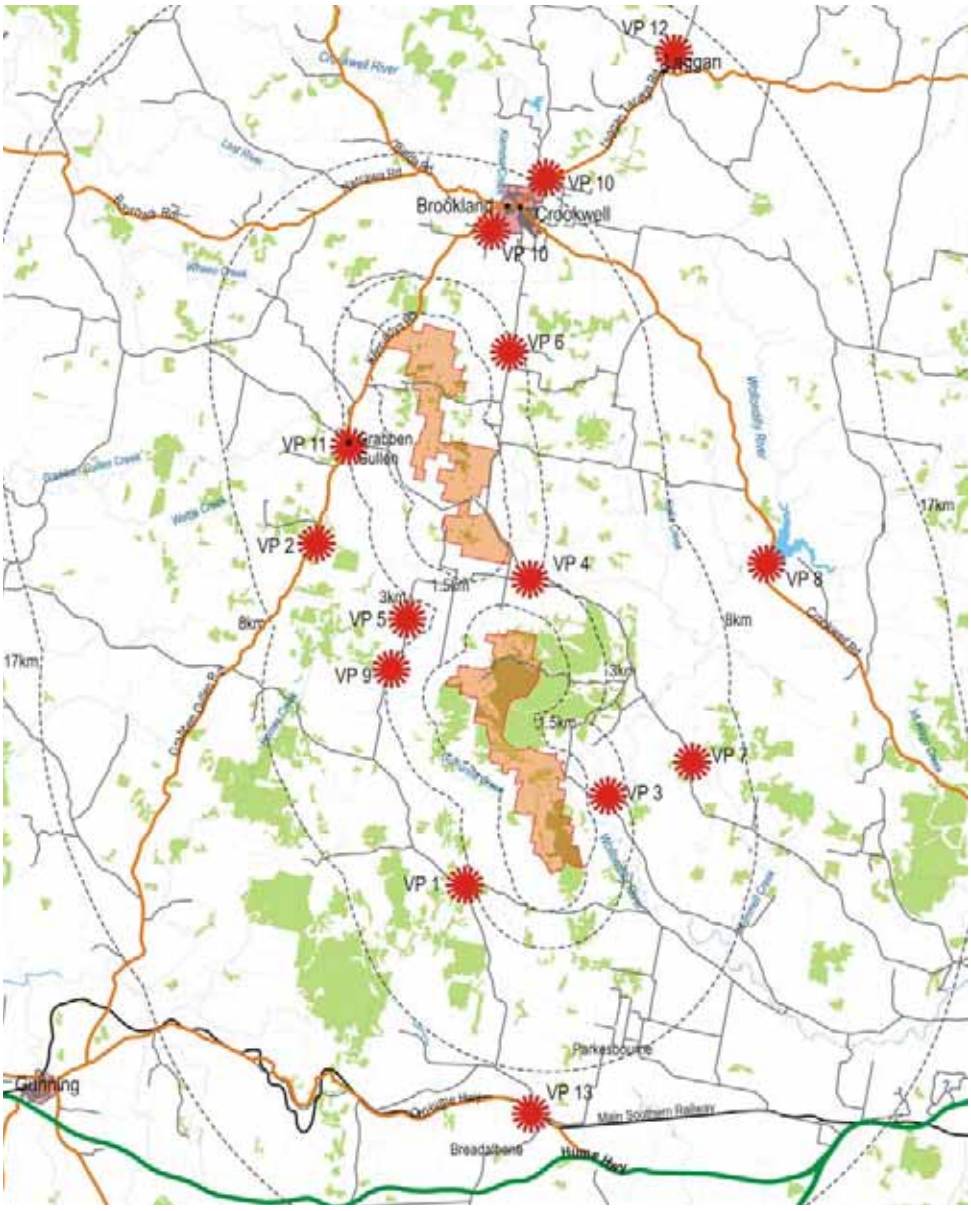


Figure 7.1 Selected Viewpoints from publicly accessible locations

These viewpoints represent a reasonable range of impacts from publicly accessible locations within the viewshed. As such they provide a reasonable range of views on which to evaluate the likely visual impact of the proposed wind farm on publicly accessible areas within the view shed.

Photographs and photomontages

It is stressed that the small images used within the report are only for referencing comments made within the text.

While technically correct, they do not accurately portray a perceptually accurate image to assess the visual impact. For this reason larger (A3) images are appended to this report (Annex D).

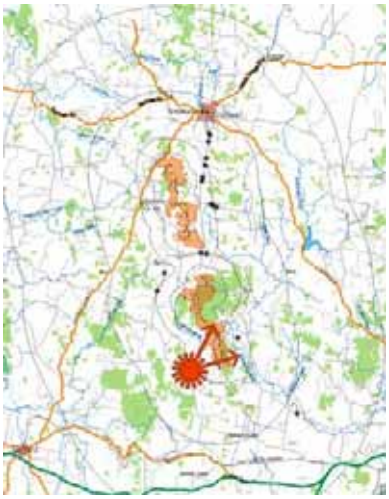
7.1 VIEWPOINT 1: CORNER MULLINS CREEK ROAD AND GURRUNDAH ROAD

Viewpoint 1 is located near the corner of Mullins Creek and Gurrundah Road at a break in the roadside vegetation that allows longer views out.

The Gurrundah Road is a two way, singe lane road that runs east west to the south of the proposed wind farm. This road is primarily used for local travel and would have low traffic numbers.

The nearest turbine is approximately 3.5km to the east of this location.

'Landscape Unit 2 – Hilly Farmland' is the most visible landscape unit when looking towards the Gullen Range Wind Farm form this location.



VP1 (Zone 55, E0718779, N6172337, Elevation: 886m)

Figure 7.2 shows the view looking north east towards the Gullen Range Wind Farm. The landscape has been cleared for agricultural purposes and this landscape regularly sees seasonal visual change through cropping and grazing activity. Vegetation is retained along property boundaries, drainage and fence lines. Residential dwellings and agricultural buildings are also often found in these landscapes.

Figure 7.2 View from Gurrundah Road looking east

The Bicentennial Trail runs along the western side of Gurrundah Road at this location (away from the wind farm) in this section.

Figure 7.3 Photomontage

Figure 7.4 Photomontage enlargement

Figure 7.3 shows the same view with the proposed wind turbines superimposed into the view. Whilst the wind turbines are located along an elevated ridge, the photomontages demonstrate the ability of the existing vegetation to filter or screen views to the wind turbines.

The nearest wind turbine to this location is approximately 3.5 km to the north. At this distance the wind turbines are noticeable and can dominate views. The existing roadside vegetation in this restricts most views over the landscape from most locations along the Gurrundah Road. Due to the overall distance to the nearest turbine, low visitor numbers, low landscape sensitivity and existing roadside vegetation, it is considered that the visual impact to this location would be low.

Summary of visual impact from Viewpoint 1

Item	Description	Evaluation
Landscape sensitivity	Landscape Unit 2 Hilly Farmland	Low
Viewer numbers	Low	Low
Distance to nearest turbine	Approx. 3.6 km	Low
Overall visual impact		**Low**

7.2 VIEWPOINT 2: CROOKWELL GUNNING ROAD AT WATTLE CREEK

Viewpoint 2 is located on the Garbben Gullen Road approximately 2.4km south of Grabben Gullen and west of the wind farm.

The Grabben Gullen Road is a two way, single lane road that runs between Gunning and Crookwell. This road is primarily used for local travel only therefore there are low traffic numbers.

The nearest turbine is approximately 4.7km to the east of this location.

'Landscape Unit 1 – Gently Undulating Farmland' is the most visible landscape unit when looking towards the Gullen Range Wind Farm from this location.

VP2 (Zone 55, E0718779, N6172335, Elevation: 886m)

Figure 7.5 shows the view looking east towards the wind farm from the Crookwell – Gunning Road near where it passes over Wattle Creek. This landscape has been cleared for agricultural purposes.

Figure 7.5 View from the Crookwell Gunning Road looking west.

Figure 7.6 Photomontage

Figure 7.6 shows the view from this location with the wind turbines. The nearest wind turbines to this location are approximately 4.7km to the east and are out of view. The turbines in this view are approximately 5.1km directly to the north east. At this distance the wind turbines will be potentially noticeable and can dominate the landscape.

Figure 7.7 Section of the photomontage showing the turbines and existing vegetation

Existing vegetation is too close to the proposed wind turbines to be effective in screening the entire wind turbines. This existing vegetation simply removes the visibility of the lower portion of the tower. This section of the photomontage also illustrates how lower vegetation, closer to the viewer, is the most effective in screening or filtering views.

Tis viewpoint is located on a local road with low visitor numbers, the landscape sensitivity is low and therefore it is considered that the visual impact for viewers from this location would be low.

Summary of visual impact from Viewpoint 2

Item	Description	Evaluation
Landscape sensitivity	Landscape Unit 1 Gently Undulating Farmland	Low
Viewer numbers	Local road	Low
Distance to nearest turbine	Approx. 5.1km	Low
Overall visual impact		**Low**

7.3 VIEWPOINT 3: POMEROY ROAD, MUMMEL

Viewpoint 3 is located on the Pomeroy Road outside of property number 1236 and 1235 Pomeroy Road.

Pomeroy Road is a gravel road that is primarily used for local travel and access to rural residential properties in this area.

The nearest turbine is approximately 1.9km to the west this location.

'Landscape Unit 2 –Hilly Farmland' is the most visible landscape unit when looking towards the Gullen Range Wind Farm form this location.

VP3 (Zone 55, E0729782, N6174776, Elevation: 691m)

Figure 7.8 and *Figure 7.9* show the view looking west towards the wind turbines from this location. *'Landscape Unit 2 –Hilly farmland'* is the most visible landscape unit in this area.

These landscapes have been cleared for agricultural purposes and regularly see seasonal visual change through cropping and grazing activity. In this particular view, there are fence lines, wind break and hedgerow plantings as well as residential dwellings and agricultural buildings.

Figure 7.8 View from Pomeroy Road (joins Figure 7.9)

Figure 7.9 View from Pomeroy Road (joins Figure 7.8)

Figures *Figure 7.10* and *Figure 7.11* show the wind turbines superimposed onto this view.

Figure 7.10 Photomontage (joins Figure 7.11)

Figure 7.11 Photomontage (joins Figure 7.10)

The nearest wind turbine to this location is approximately 1.9 km to the west. At this distance the wind turbines will be highly visible and will usually dominate the landscape. In this location as the wind turbines are located on an elevated ridge line.

Due to the low visitor numbers and low landscape sensitivity it is considered that the visual impact to this location would be low.

Summary of visual impact from Viewpoint 3

Item	Description	Evaluation
Landscape sensitivity	Hilly farmland	Low
Viewer numbers	Minor Road	Low
Distance to nearest turbine	Approx. 1.9 km	High
Overall visual impact		**Low**

7.4 VIEWPOINT 4: WALKOMS LANE

Viewpoint 4 is located on Walkoms Lane, which a gravel road used for local travel.

The nearest turbine is approximately 2.5km to the west and south west of this location.

'Landscape Unit 1 – Gently Undulating farmland' and *'Landscape Unit 2 – Hilly farmland'* are the most visible landscape units when looking towards the Gullen Range Wind Farm from this location.

Walkoms Lane becomes Bannister lane as is crosses over the ridge line.

VP4 (Zone 55, E0726459, N6169417, Elevation: 854m)

Figure 7.13 and *Figure 7.12* show the view looking north west and south west towards the wind turbines from Walkoms Road.

Figure 7.12 View from Walkoms Road looking west (joins Figure 7.13)

Figure 7.13 View from Walkoms Road looking west (joins Figure 7.12)

Figure 7.14 and *Figure 7.15* show the proposed wind turbines superimposed into the view.

Figure 7.14 Photomontage (joins Figure 7.15)

Figure 7.15 Photomontage (joins Figure 7.14)

Figure 7.16 View along Bannister Lane looking west

The nearest wind turbines to these locations are approximately 1.4km to the north and 2.0km to the south.

The nearest wind turbine to this location is approximately 1.5 km to the north. At this distance the wind turbines will be highly visible and will usually dominate the landscape. The wind breaks and intervening vegetation will assist to filter views to the wind turbines when they are near to a viewer.

Due to the low visitor numbers and low landscape sensitivity it is considered that the visual impact to this location would be low.

Summary of visual impact from Viewpoint 4

Item	Description	Evaluation
Landscape sensitivity	Landscape Unit 1 – Flat Farmland and Landscape Unit 2 – Hilly Farmland	Low
Viewer numbers	Minor Road	Low
Distance to nearest turbine	Approx. 1.4 – 2.4 km	High
Overall visual impact		**Low**

7.5 *VIEWPOINT 5: BANNISTER LANE*

Viewpoint 5 is located on Bannister Lane near the entrance to an existing chicken farm, west of the wind farm.

The singe lane gravel road is primarily used for local access.

The nearest turbine to this location is approximately 4.0km to the north east of this location.

'Landscape Unit 1 – Gently Undulating Farmland' is the most visible landscape unit when looking towards the Gullen Range Wind Farm from this location.

VP5 (Zone 55, E0722042, N6167465, Elevation: 896m)

Figure 7.17 shows the chicken farm that is located immediately to the east of this location.

Figure 7.17 View looking east towards the chicken farm

There have also been extensive boundary plantings recently undertaken to the east of this location as seen in *Figure 7.17*. These boundary plantings will assist to screen views.

Figure 7.18 shows the view looking north from Bannister Lane. The wind turbines are located in line with Bannister Lane when travelling north. In this particular view, there are wind break and hedgerow plantings, both of established vegetation and recent tree plantings.

Figure 7.18 View from Bannister Lane looking west

Figure 7.19 Photomontage

The nearest wind turbine to this location is approximately 4.0 km to the north east. At this distance the wind turbines will be noticeable however they will not dominate the landscape. The wind breaks and intervening vegetation will assist to filter views to the wind turbines when they are near to a viewer. Due to the low visitor numbers and low landscape sensitivity it is considered that the visual impact to this location would be low.

Summary of visual impact from Viewpoint 5

Item	Description	Evaluation
Landscape sensitivity	Landscape Unit 1 – Gently Undulating Farmland	Low
Viewer numbers	Local Road	Low
Distance to nearest turbine	Approx. 4.0 km	Low
Overall visual impact		**Low**

7.6 VIEWPOINT 6: KIALLA ROAD

Viewpoint 6 is located on the outside of the Kialla Airfield on Kialla Road approximately 3.0km of south of Crookwell.

Kialla Road is a two way, singe lane road that runs between Crookwell and Range Road. This road is primarily used for local travel.

The nearest turbine is approximately 2.8km to the west of this location.

There are several residential properties near to this location.

'Landscape Unit 1 – Gently Undulating farmland' and *'Landscape Unit 2 – Hilly farmland'* are the most visible landscape units when looking towards the Gullen Range Wind Farm from this location.

VP6 (Zone 55, E235541, N5839463, Elevation: 572m)

The view from this particular location takes in the Kialla Airfield which is extensively modified.

Figure 7.20 View from Kialla Airfield looking west

Figure 7.21 View from Kialla Airfield looking west

Figure 7.22 and *Figure 7.23* show the wind turbines superimposed into the view.

Figure 7.22 Photomontage

Figure 7.23 Photomontage

Figure 7.24 Photomontage enlargement

The nearest wind turbine to this location is approximately 2.8 km to the west. At this distance the wind turbines will usually dominate the landscape. The existing vegetation seen in the landscape along Kialla Road both in private lots and in the road reserves demonstrates that landscape mitigation measures could be employed to filter views to the wind farm if they were not considered desirable.

However the visual impact to the areas along Kialla Road is considered to be low.

Summary of visual impact from Viewpoint 6

Item	Description	Evaluation
Landscape sensitivity	Landscape Unit 1 Gently Undulating farmland and Landscape unit 2 Hilly farmland	Low
Viewer numbers	Local Road	Low
Distance to nearest turbine	Approx. 2.8 km	Moderate
Overall visual impact		**Low**

7.7 VIEWPOINT 7: RANGE ROAD

Viewpoint 7is located on Range Road. Range Road is a two way, singe lane road that runs from Grabben Gullen to the east. It runs between the two main sections of the wind farm. This road is primarily used for local travel with low traffic numbers.

The nearest turbine is approximately 5.8km to the west of this location.

'Landscape Unit 1 – Gently Undulating Farmland' is the most visible landscape unit when looking towards the Gullen Range Wind Farm from this location.

VP7 (Zone 55, E0733221, N6162899, Elevation: 779m)

Figure 7.25 shows the view looking west towards the wind farm. In this view, the landscape includes a farm dam and overhead transmission lines, boundary plantings and native vegetation (*Landscape Unit 3 – Vegetated Areas*).

Figure 7.25 View from Range Road looking west

Figure 7.26 shows the proposed wind turbines superimposed into the view.

Figure 7.26 Photomontage

Figure 7.27 Photomontage enlargement

The enlargement in *Figure 7.27* shows the wind turbines visible on the ridge behind the existing dam. These will be only be screened by foreground vegetation. This enlargement also shows the overhead powerlines in the foreground.

The nearest wind turbine to this location is approximately 5.5 km to the west. At this distance the wind turbines will be potentially noticeable however they will not dominate the landscape. The landscape between this location and the wind farm is highly modified regularly undergoes visual change and has a low sensitivity rating. For these reasons, the visual impact from this location is considered to be low.

Summary of visual impact from Viewpoint 7

Item	Description	Evaluation
Landscape sensitivity	Landscape Unit 1 Gently Undulating Farmland	Low
Viewer numbers	Local Road	Low
Distance to nearest turbine	Approx. 5.5 km	Low
Overall visual impact		**Low**

7.8 *VIEWPOINT 8: PEJAR DAM BOAT RAMP*

Viewpoint 8 is located at the Pejar Dam Reserve at Boat Ramp approximately 17.2km south east of Crookwell. The nearest turbine is to approximately 10.0km to the west of this location.

The reserve is used for recreational purposes such as swimming, fishing and boating. The boat Ramp is accessed of the Goulburn Crookwell Road approximately 100m west of this location.

'Landscape Unit 1 –Gently Undulating farmland is the most visible landscape unit when looking towards the Gullen Range Wind Farm from this location.

VP8 (Zone 55, E0727570, N6174469, Elevation: 907m)

Figure 7.28 shows the view looking west towards the wind farm from the Pejar Dam Boat ramp. This location was selected as it is near to the entrance from the Goulburn-Crookwell Road and is also a likely point of entry for recreational boat users of the Pejar Dam. It was therefore considered to a location that would be familiar to local and other users of the Pejar Dam.

Figure 7.28 View from Pejar Dam and Boat Ramp looking west

The nearest wind turbine to this location is approximately 10.0km to the west. The ZVI analyses discussed in section 6 shows that there are no views to the wind turbines from this location.

Summary of visual impact from Viewpoint 8

Item	Description	Evaluation
Landscape sensitivity	Moderate	Medium
Viewer numbers	Moderate	Moderate
Distance to nearest turbine	Approx. 10.0 km	Low
Overall visual impact		**Nil**

7.9 VIEWPOINT 9: BANNISTER LANE

Viewpoint 9 is located on Bannister Lane and to the west of the Gullen Range Wind Farm.

The nearest turbine to this location is approximately 3.0km to the east.

Bannister Lane is gravel road that is primarily used for local travel. There are low traffic numbers in this location.

'Landscape Unit 1 –Gently Undulating farmland is the most visible landscape unit when looking towards the Gullen Range Wind Farm from this location.

VP9 (Zone 55, E0721289, N6165563, Elevation: 851m)

Figure 7.29 and *Figure* 7.30 shows the view looking west towards the wind farm from this location. *'Landscape Unit 1 – Gently Undulating farmland'* is the dominant landscape character in this area. These landscapes have historically been cleared for agricultural purposes and regularly see seasonal visual change through cropping and grazing activity. In this particular view, there are fence lines, lattice high voltage transmission lines, and wind break and hedgerow plantings.

Figure 7.29 View from Bannister Lane looking east (joins Figure 7.30)

Figure 7.30 View from Bannister Lane looking east (joins Figure 7.29)

"Landscape Unit 3 Vegetated Areas", can be seen in the background. The wind turbines are located behind this vegetation on *"Landscape Unit 2 - Hilly Farmland".*

The existing transmission lines in *Figure 7.29* and *Figure* 7.30 demonstrate the ability of the hilly landscape unit to absorb visual change through topography and

undulation. As the transmission line and the lattice support towers move over the landscape only the tops of these structures are able to be seen before disappearing from view over the ridge. This will also be true for the wind turbines.

The following figures show the proposed wind turbines superimposed into the view.

Figure 7.31 Photomontage (joins Figure 7.32)

Figure 7.32 Photomontage (joins Figure 7.31)

Figure 7.33 Photomontage enlargement

The landscape in this already hosts many instances of visual change including road ways, fence and transmission lines. The wind turbines are located approximately 3.0km to the west. At this distance the turbines will be noticeable and have the capacity to dominate views. However *Figure 7.29* and *Figure* 7.30 as well as the photomontages show that the landscape in this area is readily able to absorb visual change.

For these reasons, the visual impact from this location is considered to be low.

Summary of visual impact from Viewpoint 9

Item	Description	Evaluation
Landscape sensitivity	Ladnscape Unit 1 Gently Undulating farmland	Low
Viewer numbers	Low	Low
Distance to nearest turbine	Approx. 3.0 km	Low
Overall visual impact		**Low**

7.10 VIEWPOINT 10: CROOKWELL TOWNSHIP

Crookwell is the largest rural township in the 17km viewshed.

There are two viewpoints selected from Crookwell to demonstrate the potential visual impact from the town.

Viewpoint 10A (Zone 55, E0726563, N6183068, Elevation: 918m) is located on southern edge of town on Barry Place. The nearest turbine to this location is approximately 6.0km to the south.

Viewpoint 10B (Zone 55, E07267701, N6184850, Elevation: 892m) is located on the northern edge of town and taken from the Crookwell – Laggan Road. The nearest turbine to this location is approximately 7.5km to the south.

VP10 (Zone 55, E0726563, N6183068, Elevation: 918m)

Crookwell is the largest township in the 17km viewshed of the Gullen Range Wind Farm. Goulburn Road runs through the centre of town and is lined by a commercial precinct that comprises one and two story buildings. The town comprises wide tree lined streets residential dwellings and a commercial shopping strip. The town and main street is generally low lying with the main street falling towards the Crookwell River as seen in *Figure 7.34.*

Figure 7.34 Crookwell, looking north west on Goulburn Street

Crookwell township comprises wide tree lined streets residential dwellings and a commercial shopping strip. The main street runs generally northwest – south east and is located approximately 6.5 km north of the Gullen Range Wind Farm. The main street is also lined with many two story buildings. There are no views to the Gullen Range Wind Farm form any areas along the main street of Crookwell due to its orientation away from the wind farm and the buildings which screen views from the main street to the wind farm.

Views from the centre of town are also screened by the intervening *Landscape Unit 2 – Hilly Farmland*. From the town's centre there are no views available to the proposed wind turbines.

Consequently the two chosen viewpoints (VP10A and VP10B) are located in areas towards the edge of the town, where views of the wind turbines are possible.

Viewpoint 10A is from Barry Place on the southern edge of Crookwell looking south. Views to the wind farm from this location are over '*Landscape Unit 1 – Gently Undulating Farmland*', refer *Figure 7.35*.

Figure 7.35 View from the southern edge of Crookwell looking south

Figure 7.36 shows a photomontage with the proposed wind turbines superimposed into the view.

Figure 7.36 Photomontage

Figure 7.37 Photomontage enlargement

At a distance of over 6.0km the wind turbines will potentially be noticeable however will not dominate the landscape. They can just be discerned within the valley on the photomontage enlargement.

Viewpoint 10B is from elevated locations on the northern side of Crookwell. Views from this location take in the rear of the retail precinct located along the main street and the residential areas to the south of Crookwell, refer *Figure 7.38.*

Figure 7.38 View from the eastern edge of Crookwell on the Laggan Crookwell Road looking west

Figure 7.39 shows a photomontage with the proposed wind turbines superimposed into the view.

Figure 7.39 Photomontage

Figure 7.40 Photomontage enlargement

The turbines will be located on the vegetated ridge in the background in the centre of the photomontage enlargement. The nearest wind turbine to this location is approximately 7.5 km to the south. At this distance the wind turbines may be noticeable however they will not dominate the landscape.

The residential areas within Crookwell are located to the north and south of the Goulburn Road and behind the retail precinct. This is also shown in *Figure 7.38*.

Although the town is located within *'Landscape Unit 3 - Rural Communities'* views from the edges of town and to the wind farm are over '*Landscape Unit 1 – Gently Undulating farmland'*

At a distance of over 6.0km the wind turbines will potentially noticeable however will not dominate the landscape. As well the locations for the Viewpoints 10A and 10B had to be carefully selected to obtain any view of some wind turbines. In many other areas of Crookwell the wind turbines would not be visible and therefore there would be no visual impact. For these reasons, it is considered that the visual impact to Crookwell is low.

Summary of visual impact from Viewpoint 10A and 10B

Item	Description	Evaluation
Landscape sensitivity	Rural Township	Moderate
Viewer numbers	High	High
Distance to nearest turbine	Approx. 6.5 km	Low
Overall visual impact		**Low**

7.11 VIEWPOINT 11: GRABBEN GULLEN

Viewpoint 11 is located on the Grabben Gullen Road, adjacent to the Albion Hotel at Grabben Gullen. Grabben Gullen is a small community with few residences, pub, hall and local Rural Fire Service branch.

This location was selected as it one of the few areas from within Grabben Gullen that has clear views to the wind turbines. The nearest turbine is approximately 3.0km to the east of this location.

'Landscape Unit 2 – Hilly Farmland' is the most visible landscape unit when looking towards the Gullen Range Wind Farm form this location.

VP11 (Zone 55, E0719665, N6175346, Elevation: 905m)

Figure 7.41 is taken from the main road looking west towards the main residential areas associated with Grabben Gullen.

Figure 7.41 View looking west away from wind farm

The majority of the residential dwellings in Grabben Gullen are located on the western side of Grabben Gullen Road. They are also generally visually oriented away from the wind farm and nestled amongst areas of extensive vegetation. There will be limited views to the wind farm from areas to the west of the Grabben Gullen Road.

Figure 7.42 shows the view looking east towards the hotel which is located on the eastern side of Grabben Gullen Road.

Figure 7.42 *View looking east towards wind farm from Grabben Gullen*

The hotel is situated on top of a local high point and will screen most views towards the wind farm form the western areas of the town.

There are however several residence in the town that are located on the eastern side of the Grabben Gullen Road and therefore nearer to the wind farm.

Figure 7.43 shows the view looking east towards the wind farm from the northern side of the pub, and from Grabben Gullen Road. 'Landscape Unit 1 – Gently Undulating farmland' is the dominant landscape character in this area. These landscapes have historically been cleared for agricultural purposes and regularly see seasonal visual change through cropping and grazing activity. In this particular view, the land has been partially cleared.

Figure 7.43 *View from Grabben Gullen looking east*

The existing vegetation also seen in left and right margins of *Figure 7.43* demonstrates the capacity of vegetation in this area to filter views to the wind turbines. In this location there are also fence lines, residential dwellings farm sheds and agricultural buildings.

Figure 7.44 shows the existing view from the northern side of the pub with the proposed wind turbines superimposed into the view.

Figure 7.44 Photomontage

Figure 7.45 Photomontage enlargement

The nearest wind turbine to this location is approximately 3.0 km to the east. At this distance the wind turbines will usually dominate the landscape. The majority of the residential areas associated with Grabben Gullen are located on the western side of Grabben Gullen Road, and are oriented away from the wind farm. These areas also have extensive areas of tree cover that will assist to filter views towards the wind turbines.

The visual impact to the areas west of Grabben Gullen Road is considered to be low.

Residences located on the eastern side of Grabben Gullen Road may be more visually exposed to the wind farm. Mitigation measure such as plating to the rear of house lots as discussed in mitigation measures further in this report could be employed to assist to filter views from locations where viewers do not like the appearance of wind turbines in the landscape.

Where there are views to the wind turbines from the visual impact to these areas would be moderate.

Summary of visual impact from Viewpoint 11

Item	Description	Evaluation
Landscape sensitivity	Landscape Unit 4 Rural Township	Moderate
Viewer numbers	Moderate	Moderate
Distance to nearest turbine	Approx. 3.0 km	Moderate
Overall visual impact	**Low from publicly accessible areas where there are no views or limited views to the wind turbines.** **Moderate from exposed publicly accessible locations.** **Moderate from exposed residential properties.**	

7.12 VIEWPOINT 12: LAGGAN

Viewpoint 12 is located on Peelwood Road that runs through the centre of Laggan Township. .

The Peelwood Road is a two way, singe lane road that runs between Laggan and Crookwell. This road is primarily used for local travel carries moderate traffic numbers.

The nearest turbine is approximately 15.0km the south west of this location of this location.

'Landscape Unit 3 - Rural Communities' is the most visible landscape unit when looking towards the Gullen Range Wind Farm form this location.

VP12 (Zone 55, E0732583, N6190237, Elevation: 886m)

Figure 7.46 shows the view looking south west towards the Gullen Range Wind farm.

Figure 7.46 View from Laggan looking south west towards wind farm

The viewshed studies discussed in section *6* show that there are no views to any wind turbines from this location.

Summary of visual impact from Viewpoint 12

Item	Description	Evaluation
Landscape sensitivity	Rural Township	Moderate
Viewer numbers	Main Road	Moderate
Distance to nearest turbine	Approx. 15.0 km	Low
Overall visual impact		**Low**

7.13 VIEWPOINT 13: BREADALBANE

Viewpoint 13 is located on the Old Hume Highway at Breadalbane, south of the Gullen Range Wind Farm.

The Old Hume Highway is a two way, singe lane road that runs between Breadalbane and Goulbourne. This road has been replaced by the Hume Freeway further to the south of location and is primarily used for local travel only.

The nearest turbine is approximately 9.9km to the north of this location.

This location will also provide and indicative view of the rail passenger service between Sydney and Melbourne.

Zone 55, E235541, N5839463
Elevation: 572 m

Breadalbane is a small town that has been bypassed by the Hume Freeway. The town is set low in the landscape and comprises many instance of visual change including the Sydney to Melbourne Rail line, over head power and transmission lines as well as houses and the surrounding road network. There are also many exotic and native trees located in residential lots.

Figure 7.47 shows Breadalbane from the Old Hume Highway looking east.

Figure 7.47 View from the Old Melbourne Highway looking east.

Figure 7.48 View to the Gullen Range Wind Farm from the Old Melbourne Highway.

Views to the Gullen Range wind Farm from Breadalbane will be over the Sydney to Melbourne rail line to '*Landscape Unit 1 – Gently Undulating Farmland*'. The nearest

wind turbine to this location is approximately 9.9 km to the north. At this distance the wind turbines may be noticeable however they will not dominate the landscape.

Due to the low visitor numbers, overall distance to the nearest turbine and low landscape sensitivity, it is considered that the visual impact to this location would be low.

Summary of visual impact from Viewpoint 13

Item	Description	Evaluation
Landscape sensitivity	Rural Township	Moderate
Viewer numbers	Main Road	Moderate
Distance to nearest turbine	Approx. 5.4 km	Low
Overall visual impact		**Low**

7.14 LANDSCAPE MITIGATION MEASURES FOR PUBLICLY ACCESSIBLE VIEWPOINTS

One potential mitigation measure for wind farms is the establishment of roadside vegetation. Recent site visits have shown that there are many breaks in the roadside vegetation. However, generally there is a low level of visual impact and therefore the establishment of vegetation, especially adjacent to the local road network, seems unnecessary. Furthermore, screening could convert the rural road network into a series of narrow corridors with dense screening vegetation along each side, which is undesirable.

The Panel decision for the Bald Hills Wind Farm in Victoria recommended that *"the proponent should fund and prepare a roadside landscape and windbreak management plan ……. in collaboration with the ....Council and abutting landowners, largely to address the likely, widespread loss of pine trees along these roads".* This project does not include the removal of significant roadside vegetation so the measures similar to Bald Hills would be unnecessary

Therefore there would be no need for management options to include planting along public roads as a visual mitigation measure.

7.15 SUMMARY OF VISUAL IMPACT FROM PUBLICLY ACCESSIBLE VIEWPOINTS

Table7.1 shows the summary assessment rating of all publicly accessible viewpoints discussed in the previous section. *Figure 7.49* has been repeated from *Figure 7.1* for clarity.

Table7.1 Summary assessment of publicly accessible viewpoints

VP	Distance to nearest wind turbine (approx.)	Direction to wind farm	Dominant landscape units	Visitor numbers	Landscape sensitivity	Overall visual impact
1	3.5km	E	Unit 2	Low	Low	Low
2	4.7km	E	Unit 1	Low	Low	Low
3	1.9km	W	Unit 2	Low	Low	Low
4	2.5km	N and S	Unit 2	Low	Low	Low
5	4.0km	E	Unit 1	Low	Low	Low
6	2.8km	W	Unit 1 and Unit 2	Low	Low	Low
7	5.8km	W	Unit 1	Low	Low	Low
8	10.0km	W	Unit 1	Moderate	Moderate	Low
9	3.0km	E	Unit 4	Low	Low	Low
10A&B	6.0km / 7.5km	SW	Unit 4	Moderate	Moderate	Low
11	3.0km	E	Unit 4	Moderate	Moderate	Moderate
12	15.0km	SW	Unit 4	Low	Moderate	Low
13	9.9km	N	Unit 1	Moderate	Moderate	Low

There are 13 publicly accessible locations that have been discussed in this report. Each location was selected to demonstrate the likely range of visual impacts that can be expected from the proposed Gullen Range Wind Farm. From the preceding analyses of these publicly accessible locations, there were no viewpoints that would be considered as having a high visual impact. Exposed areas within the Grabben Gullen township were assessed as having a moderate level of visual impact.

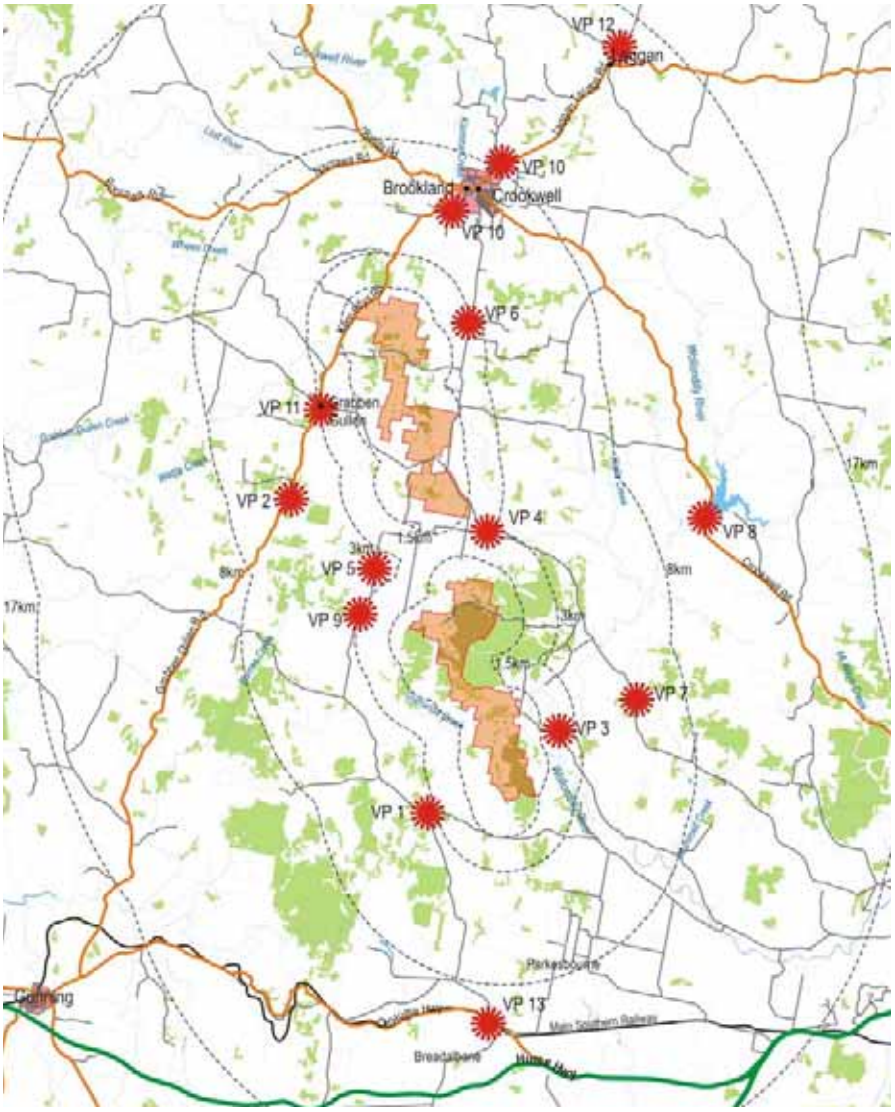


Figure 7.49 ***Selected Viewpoints from publicly accessible locations***

These viewpoints are indicative of the range of views for people travelling around or through the Gullen Range Wind Farm. However it must be recognised that these are static views chosen at selected locations where the wind turbines are the most visible. On one hand these static views can overstate the impact, in that they show the impact at the worst case locations, however people's perception of their neighbourhood is based on a memory of many views and there a static view analysis can understate the alteration to the landscape.

Static views can understate the impact as they cannot portray the possibility of a wind farm changing a viewer's cognitive map of the locality. It is simplistic to assume just because a wind turbine or a group of wind turbines disappear behind vegetation that they don't continue to be part of our understanding of an area.

This cognitive map cannot be shown through photomontages. Undoubtedly for some, the presence of wind turbines in the landscape will have a negative impact on their mental map of the area in which they live or are visiting, which will be greater than can be explained simply by visibility. For many people the result of a wind farm on the landscape may be positive.

8 IMPACT ON RESIDENTIAL PROPERTIES

The landscape and visual impact methodology that has been adopted within this report has been based on the *Wind Farm and Landscape Values – National Assessment Framework*.

Whilst this framework does not discuss limits or extents in which to undertake landscape and visual impact assessments, the methodology outlined in Section 4 of this report discusses the notion of the viewshed and the zones of visual impact.

These zones are based on the overall height of the proposed wind turbines and the parameters of the human vision. The Zones of Visual Impact are summarised in *Table* 8.1 which has been reproduced from section 4.

Table 8.1 Zones of visual impact (reproduced from section 4)

Distance from an observer to the nearest wind turbine	Visual impact
> 17 km.	*Visually insignificant* A very small element in the viewshed, which is difficult to discern and will be invisible in some lighting or weather circumstances.
8.5 km – 17 km	*Potentially noticeable, but will not dominate the landscape.* The degree of visual intrusion will depend on the landscape sensitivity and the sensitivity of the viewer, however the wind turbines do not dominate the landscape.
3.0 km -8.5 km.	*Potentially noticeable and can dominate the landscape.* The degree of visual intrusion will depend on the landscape sensitivity and the sensitivity of the viewer
1.5-3.0 km	*Highly visible and will usually dominate the landscape* The degree of visual intrusion will depend on the wind turbines' placement within the landscape and factors such as foreground screening.
< 1.5 km	*Will be visually dominant in the landscape from most viewing locations.* Dominates the landscape in which they are sited.

For the Gullen Range Wind Farm, the area that has the potential for the greatest level of visual impact is within a 1.5km radius of the proposed wind turbines.

Because wind turbines can be visually dominant out to 3km, a conservative approach considers the area within a 3km radius of the proposed wind turbines.

Table 8.1 also states that the wind turbines '*can dominate the landscape'* out to a distance of 8.5km. As stated in section 4, visibility does not dramatically change when a viewer moves from 2.9km to 3.1km away. Because of the transition effect areas nearer to 3.0km and that are within the 3.0 – 8.5km band will have a higher sensitivity rating that are 8.5km away from the wind turbines. The zones or bands are therefore used as a guide only.

This methodology is supported by past Victorian Planning Panel decisions and recent New South Wales Land and Environment Court decisions.

The directions in the judgement for the Traralga Wind Farm required the proponent (RES Southern Cross Pty Ltd) to undertake off-site landscape program works to a radius of 2km from the nearest wind turbine.

The Woolsthorpe Panel report in Victoria stated:

> *A simple way to give effect to this concept is to regard visual amenity impact as those visual consequences on people within about 3 km of the nearest turbine, and landscape impacts to be the visual effect beyond that distance. Out to about 3 km, a wind turbine, in the absence of screening, will be a dominant feature in the landscape. In a rural setting those most aware of the visual presence of a wind farm will be private individuals in and around their homes, those working properties and those travelling on local roads.*
>
> *If the viewer moves beyond that notional 3 km distance, a wind farm will become less visually dominant but, depending on topography and vegetation, may be more or less visible in the landscape. At this distance it is likely that the majority of those people visually aware of the wind farm will be the general public including tourists and visitors to the area who may have views from major roads, scenic attractions or towns.*

The Bald Hill Panel report stated:

> *Whilst the Panel has not found that there are any materially adverse amenity impacts at the 3 km range, its experience with this documentation would suggest that 3km represents an excellent precautionary threshold within which detailed mapping should be made available to a decision maker. (Bald Hills Planning Panel, 2004, P 219).*

The results outlined in the community perception studies show an approval rating of almost 9 in 10 (89%) respondents in favour of wind farm projects being developed in the Southern Tablelands.

Further to this, 83% of those surveyed (8% opposed) were accepting of a wind farm set back 10 kilometres from their home. 71% (19% opposed) were in accepting of a wind farm set within one kilometre from their home.

The visual impact assessment on residential properties has been assessed within 3km of the nearest wind turbine.

Given that 71% of the respondents to the Community Perception studies who were from the area surrounding the Gullen Range Wind Farm were in favour a wind farm within 1km of the home, 3km is a conservative basis upon which to asses the visual impact from residential locations.

3km is a conservative threshold to undertake visual impact on residential properties. This distance has been used for assessing the visual impact on residential properties associated with the Gullen Range Wind Farm.

8.1 NON-PARTICIPATORY RESIDENTIAL PROPERTIES

The greatest potential impact is on neighbouring and non-participatory residential properties. That is residential properties whose owners have not elected to be part of the wind farm. It can be assumed that those that have elected to for their land to form part of the wind farm consider the visual impact to be acceptable.

The locations of participatory landowners' residences and non-participatory residences have been provided by Epuron.

There are thirty-two non-participatory residences within 1.5km of the nearest wind turbine. The majority of these houses lie along the eastern edge of the wind farm. The Seen Area Analysis has shown that viewers in these eastern areas are less likely to be screened by topography. However, western boundary shelter belt / wind break planting is quite common and where present will screen views to the wind turbines from residences along the eastern edge of the wind farm.

There are eighty-six non-participatory residences more that 1.5km and less than 3km of the nearest wind turbine.

Table 8.3 ***Non-participatory houses within 3km of the nearest wind turbine***

Distance from house to its nearest wind turbine	Total number of houses	Total number of non-participatory houses
Within 1.5km	42	32
1.5km to 3.0km	89	86
TOTAL within 3km	131	**118**

Table 8.3 shows that there are 128 non-participatory residences and 13 participating residences within 3km viewshed of the wind farm.

Figure 8.1 shows the location of all houses that are within 3km of the nearest visible wind turbine.

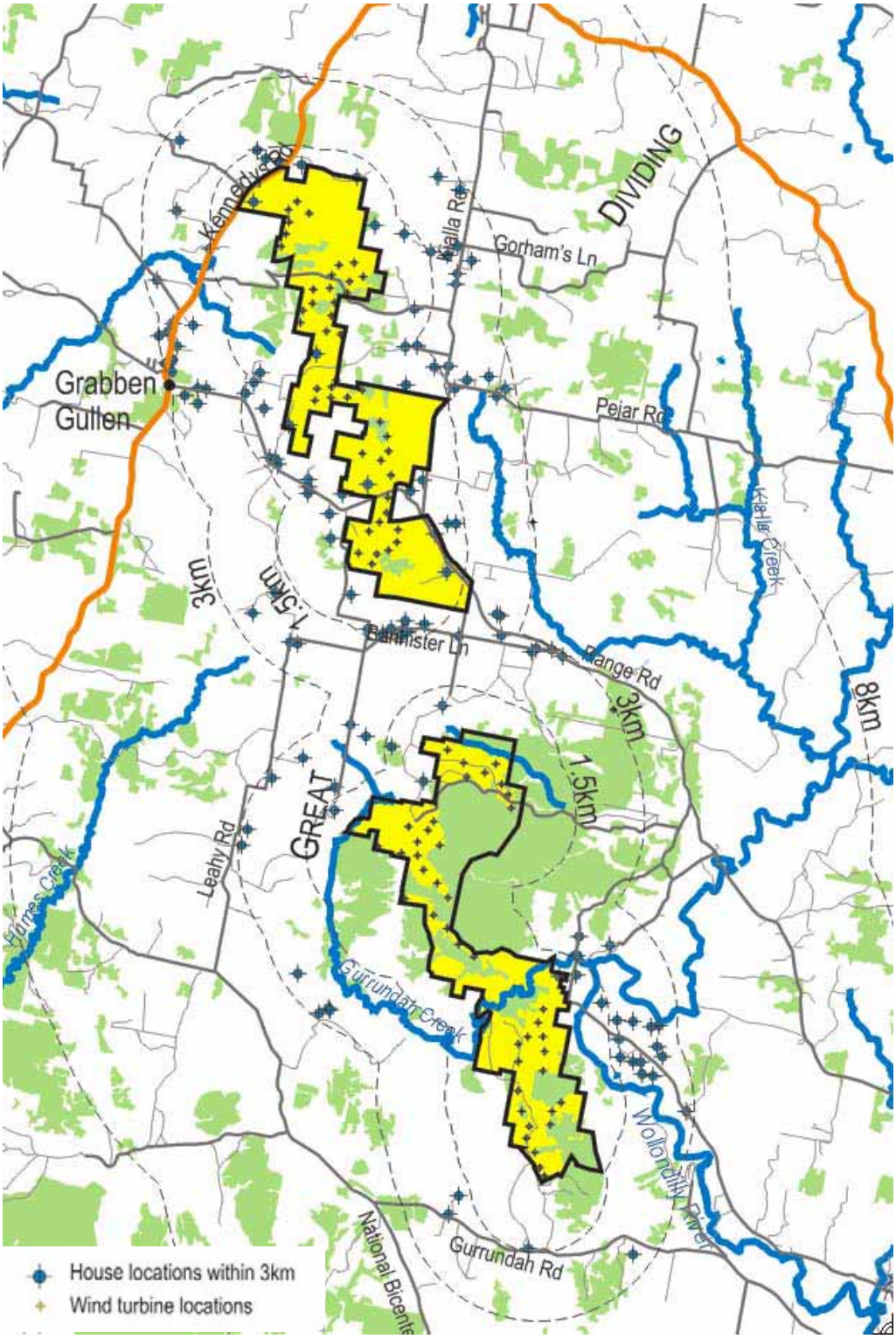


Figure 8.1 ***Houses within 3km viewshed***

Landscape mitigation is more effective for properties which lie to the north and to the east of a wind farm as additional planting to the south and to the west has both the added advantages of providing a wind break without impacting on solar access.

Landscape mitigation for properties to the south can sometimes impact on solar access to private courtyards which typically are orientated to the north.

8.2 COMMUNITY CONSULTATION AND STAKEHOLDER ENGAGEMENT

The *Wind Farm and Landscape Values – National Assessment Framework* discusses the importance of community consultation and stakeholder engagement in identifying culturally and locally sensitive areas with the surrounding community.

An open house session was held on 21 November 2007 at the Grabben Gullen Hall, Grabben Gullen. A representative from ERM was in attendance to discuss the landscape and visual impact assessment methodology as well the visual impacts associated with the Gullen Range Wind Farm. There were several photomontages also on display including the locations from where they were taken to assist in discussions.

There were 75 people who registered their attendance on the day and approximately 85 people who attended.

Feedback forms were handed out at the open house to encourage the community to list their concerns and provide feedback on the proposal and 22 feed back forms were returned. Visual, noise and community impacts were of most concern. There was also several requests for additional photomontages to be produced from locations including Mummel, Kialla, Bannister Lane and Walkoms Lane.

A follow up site visit was undertaken to photograph the additional locations from the surrounding road network.

8.3 VIEWPOINTS SELECTION FOR IMPACT ON RESIDENTIAL PROPERTIES.

The selection of viewpoints on which to asses the visual impact on residential properties seeks to provide representative views from a broad range of residential dwellings that surround the Gullen Range Wind Farm.

These locations were recorded from publicly accessible locations within 3km of the proposed wind turbines and from areas that were identified by the local community at the open house day.

Where there is a concentration of dwellings within any one area, a conservative viewing location was selected from the surrounding road network to demonstrate a worst case scenario.

There are 3 viewpoints that have been selected as representative views from clusters of residential dwellings and or individual residential dwellings within 3km of the proposed wind turbines.

The visual impact from these locations is discussed in the following tables

House Number	*Location (Zone 54/55H) Datum (WGS 84)*	**Photographs / photomontages**	**Comments**	**Overall Visual Impact**
Kialla Road 	**Zone 55, E235541, N5839463, Elevation: 572m**	  *Figure 8.2 Residential dwellings along Kialla Road with screening*   *Figure 8.3 Dwellings along Kialla Road without screening*	Houses located to the east of the wind farm often have dense plantings for windbreak and shade along their western boundaries. This existing planting will also screen views to the wind farm. The community perception studies for the area surrounding the Gullen Range Wind Indicated that 71% of respondents were in favour of wind farm projects being developed within 1km of their own house. Where viewers do not like the appearance of wind turbines in the landscape, the existing vegetation located in and around house lots along Kialla Road suggests that mitigation measures could be successful in screening views towards the wind farm from these locations. Figure 8.6 and *Figure 8.7* Show a photomontage from outside the Kialla airfield. This location is at the northern end of the proposed wind farm and has clear views to the wind turbines. These photomontages therefore represent a conservative view of the impact of the proposed wind turbines to residential properties located along Kialla Lane.	**Moderate** without screening **Low** with screening

House Number	*Location (Zone 54/55H) Datum (WGS 84)*	Photographs / photomontages	Comments	Overall Visual Impact
				

Figure 8.4 Existing View Kialla Lane looking south east

Figure 8.5 Existing view Kialla lane looking east

Figure 8.6 Photomontage Kialla Lane looking south east

Figure 8.7 Photomontage Kialla Lane looking east

House Number	*Location (Zone 54/55H) Datum (WGS 84)*	**Photographs / photomontages**	**Comments**	**Overall Visual Impact**
Pomeroy Road, Mummel 	**Zone 55, E0729782, N6174776 Elevation: 691m**	 *Figure 8.8 View from Pomeroy Road*  *Figure 8.9 View from Pomeroy Road*  *Figure 8.10 Photomontage (joins Figure 8.11)*  ***Figure 8.11 Photomontage (joins Figure 8.10)***	There are several residential properties along Pomeroy Road. *Figure 8.8* and *Figure 8.9* show the view looking west towards the wind turbines from this location. *'Landscape Unit 2 –Hilly Farmland'* is the most visible landscape unit in this area. The nearest wind turbine to this location is approximately 1.9 km to the west. At this distance the wind turbines will be highly visible and will usually dominate the landscape. This may be more pronounced in this location as the wind turbines are located on an elevated ridge line. Where there are open views to the wind farm from east and the viewers do not like the appearance of wind turbine in the landscape, the visual impact to these areas would be considered to be moderate. Where there are open views to the wind turbines and viewers like the appearance of wind turbines in the landscape, the visual impact is considered to be low.	**Moderate** without screening **Low** with screening

House Number	*Location (Zone 54/55H) Datum (WGS 84)*	**Photographs / photomontages**	**Comments**	**Overall Visual Impact**
Bannister Lane 	**Zone 55, E0726459, N6169417 Elevation: 854 m**	 *Figure 8.12 267 Bannister Lane (south side)*  *Figure 8.13 Bannister Lane (northern side)*  *Figure 8.14 Bannister lane (south side)*	Walkoms Lane becomes Bannister lane as is crosses over the ridge line. There are several residential dwellings along Bannister Lane. Several of these dwellings can be seen in *Figure 8.12* to *Figure 8.14*. The nearest wind turbines to these residential locations are approximately 1.4km to the north and 2.0km to the south. At a distance of 1.4km the wind turbines will usually dominate the landscape. *'Landscape Unit 1 – Gently Undulating Farmland'* and *'Landscape Unit 2 – Hilly Farmland'* are the most visible landscape units when looking towards the wind farm form this location. The majority of the dwellings on Bannister Lane are located amongst extensive areas of vegetation. There are also many established trees located in the Bannister Lane road reserve. The extensive canopy vegetation in this area confines most views to the wind turbines form this location. Where there are views to the turbines, the impact is considered to be moderate, where views are screened by existing vegetation, the impact will be low. The wind breaks and intervening vegetation will assist to filter views to the wind turbines when they are near to a viewer. The existing vegetation that is located within the road reserve and private lots in this location presents little viewing opportunities towards the proposed wind turbines from this location. Figure 8.17 and Figure 8.18 show a photomontage from an area	**Moderate** without screening **Low** with screening

House Number	*Location (Zone 54/55H) Datum (WGS 84)*	Photographs / photomontages	Comments	Overall Visual Impact
		 ***Figure 8.15 Existing view From Bannister Lane looking south west***  ***Figure 8.16 Existing view Bannister lane looking north west***  ***Figure 8.17 Photomontage Bannister Lane looking south west***  Figure 8.18 Photomontage looking north west	approximately 200m to the west of the residential cluster on Bannister Lane. This location has relatively near to the existing residential dwellings on Bannister Lane and has clear views to the proposed wind turbines.	

8.4 LANDSCAPE MITIGATION FOR RESIDENTIAL PROPERTIES

Landscaping is a mitigation option for residential properties. As the viewing location is relatively fixed, planting may be designed to either screen the wind turbines from view, or significantly reduce the visual dominance of wind turbines through filtering.

For the Gullen Range Wind Farm, landscape mitigation is possible and desirable for houses located to the north and east of the wind farm. For these properties screening vegetation positioned on southern and western boundaries will assist to filter views to the proposed wind farm. They will also assist to protect these properties from southern winds whilst not affecting solar access.

Many properties already have substantial wind break planting along their southern boundaries.

However, it is recognised that the landholder may not wish to establish boundary planting, due to the decrease in viable farmland, or for aesthetic reasons.

The desirability of landscape mitigation measures for houses to the south is lower than for properties to the north. Such measures could affect the solar access to living areas or courtyards. Landscape mitigation measures should be determined on a case by case basis in consultation with landholders to minimise adverse impacts.

Such a process has occurred in past projects, after approval of the wind farm with advice and funding being supplied by the proponent. For example, the Portland Wind Energy Project (Pacific Hydro) involved negotiation with affected landowners to mitigate the visual impacts of the proposed wind farm by landscaping on or adjacent to residences within 2km of the proposed wind farm. This involved a site visit to affected residences and creation of a landscape concept to be implemented by the proponent.

Similarly, the Panel decision for the Bald Hills Wind Farm in Victoria also required the proponent (Wind Power Pty Ltd) to undertake "*specific off-site landscape program works to address residential amenity impacts….subject to agreement with the landowners"*.

The directions within the judgement in the New South Wales, Land and Environment Court for the Traralga Wind Farm required the proponent (RES Southern Cross Pty Ltd) to undertake off-site landscape program works to a radius of 2km from the nearest wind turbine.

Here, three experts involved in the project (one for the proponent, one for the minister and one for the objectors) all agreed on a 2km radius as being a suitable distance to undertake off-site landscape mitigation works. This was also supported in the Ministers submission's to the hearing.

There was one exception to the 2km radius in the directions, where a residential property located *'marginally outside a 2km radius'* be included in the 2km buffer.

A similar process of landscape mitigation could occur on affected residences within 3km of the Gullen Range Wind Farm.

The proponent for the Gullen Range Wind Farm has agreed to off-site landscape mitigation out to a distance of 3km.

Figure 9.2 shows an example of landscape remediation for a dwelling. This example is based on the owner's desire that the views to the wind turbines should be screened or filtered.

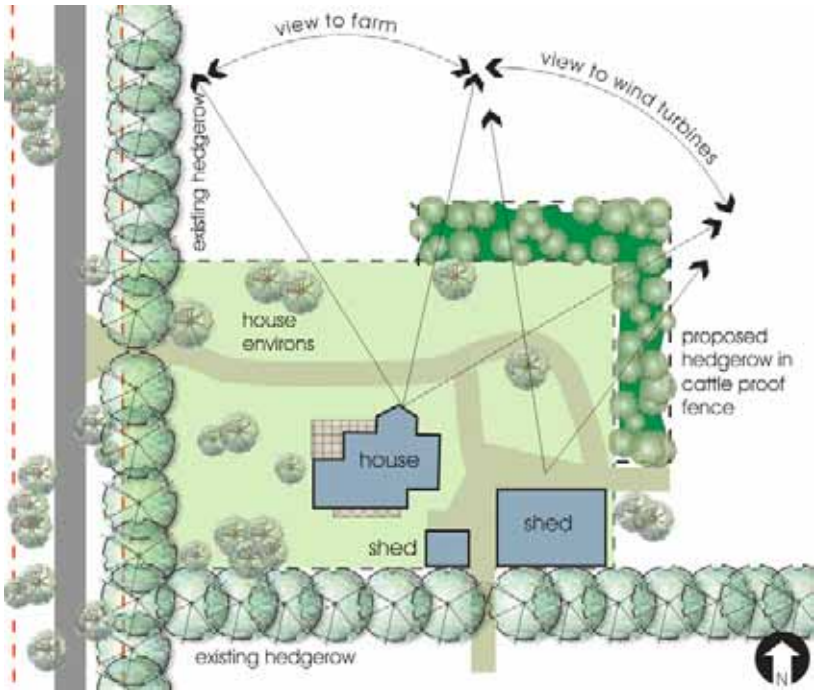


Figure 9.2 Potential Landscape mitigation measure

A site visit would determine the extent of planting between the proponent and the resident. Species selection would be determined in consultation with landholders using advice from the local Landcare group. This example used a mixture of Eucalyptus and Acacia species which was designed to filter the views to the north and to the wind farm.

Planting can be undertaken on residential properties within 3 km of the wind farm, after consultation and agreement with affected landowners. Any such offer should remain in place for a period of 1 year after construction, to allow people time to either adjust or to decide that landscape filtering or screening is warranted.

9 CUMULATIVE IMPACT

The presence of multiple wind farms in an area can create a cumulative visual impact. This can occur when either sequential and /or simultaneous views to wind turbines from publicly accessible viewpoints or from private viewing locations lead to a change in a community's, resident's or visitor's perception of a region.

Sequential views are those that occur when a viewer at one location observes a wind farm and then from a different location another wind farm. If for example multiple wind farms are located along a highway, then a series of sequential views can occur as a vehicle travels along the highway.

Simultaneous views are those where more than one wind farm is visible from the same location. This usually is defined as views within the same cone of view that is multiple wind farms visible within say a 60^{O} or 90^{O} cone of view. However, a simultaneous view can also occur where a viewer needs to turn their head to see more than one wind farm from a single location

9.1 WIND FARMS IN THE SOUTHERN TABLELANDS

Crookwell Wind Farm, which comprises eight wind turbines is the only constructed wind farm in the viewshed of the Gullen Range Wind Farm. There is an approval to extend this wind farm by a further forty-six wind turbines. The new wind farm boundary can be seen in *Figure 9.1.*

Other approved wind farm in the viewshed of the Gullen Range wind farm include the Gunning Wind Farm, which comprises 46 wind turbines and the Cullerin Range Wind Farm which comprises 15 wind turbines are located to the south west of the Gullen Range Wind Farm.

Table 9.1 Existing and proposed wind farms in the area

Project and Location	Proponent	Project Capacity	No. of Turbines	Status
Crookwell 1 WF, near Crookwell	Delta Electricity	4.8MW Built 1997	8	(Operational)
Cullerin WF, near Goulburn	Origin Energy	30MW	15	(Under construction)
Capital WF, Bungendore	Renewable Power Ventures	126MW	63	(Under Construction)
Woodlawn WF, near Tarago	Wind Energy JV	50MW	25	(DA approved)
Taralga WF, near Taralga	RES Southern Cross	186MW	62	(DA approved)
Gunning WF, near Gunning	Delta Electricity	64MW	32	(DA approved)
Crookwell 2 WF, near Crookwell	TME	92MW	46	(DA approved)
Gullen Range WF, near Gunning	Gullen Range Wind Farm Pty. Ltd.	Up to 278MW	84	(proposed)

Table 9.1 shows the existing and proposed wind farms in the vicinity of the Gullen Range wind farm.

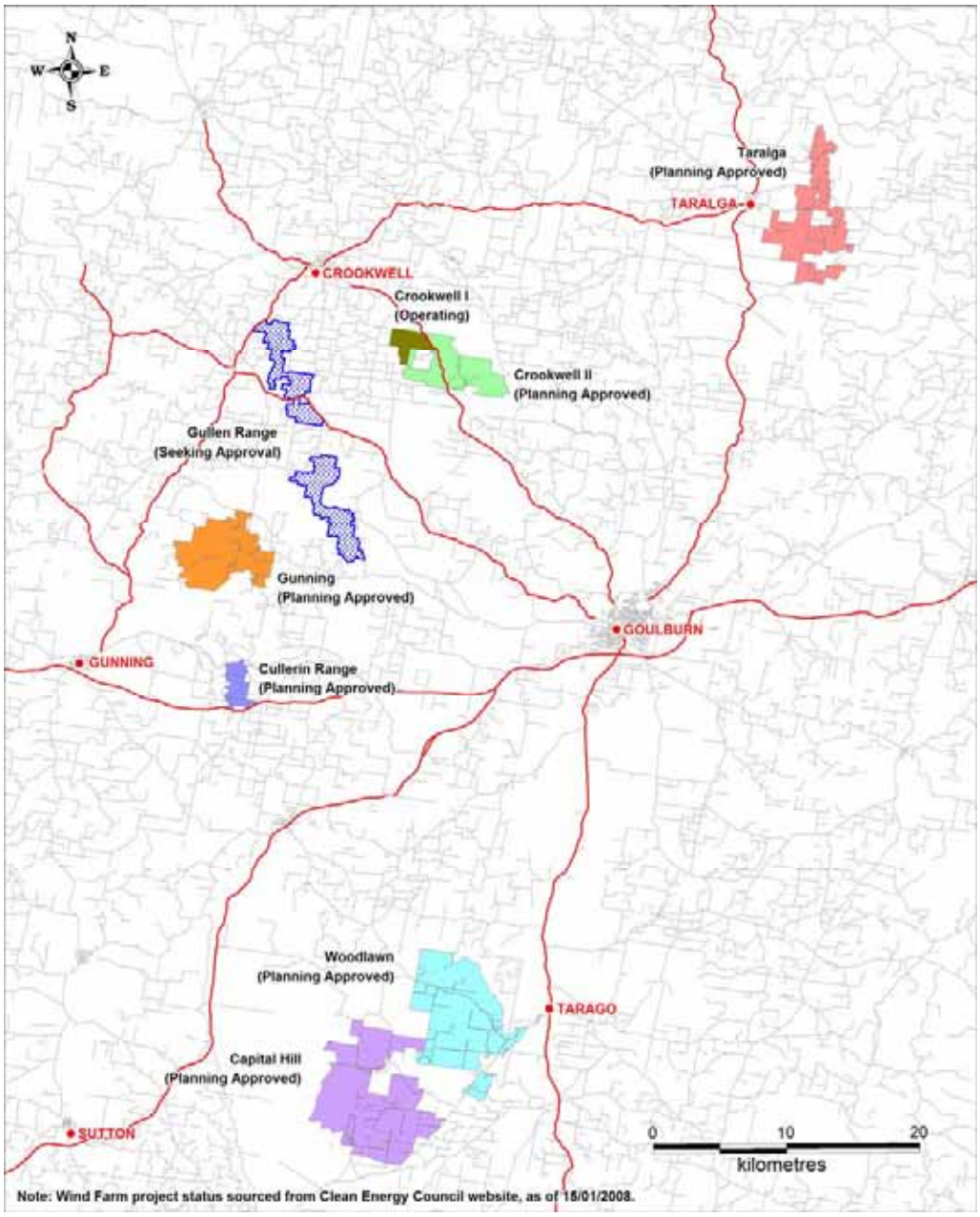


Figure 9.1 Existing and Proposed Wind Farms

Figure 9.1 shows the highways, local roads and townships in the vicinity of the Gullen Range Wind Farm and other approved and existing wind farms.

9.2 CHANGE IN PERCEPTION

The main cumulative visual impact is that which changes a visitor's or residents perception of an area through which they are travelling.

This is bought about by sequential and/or simultaneous views of multiple wind farms. The greatest chance of changing a viewer's perception of an area is when these views are available from the highways and roads that people use.

Views from towns and regional centres

There are limited locations within the township of Crookwell where one can perceive the Gullen Range Wind Farm. Similarly there are limited locations where Crookwell 1 and Crookwell 2 would also be visible. Therefore views to multiple wind farms would have a negligible impact on the township of Crookwell.

The Gullen Range Wind Farm would not be visible from the townships of Goulburn and Gunning as these are located beyond the viewshed of the Gullen Range Wind Farm. Therefore there would be no additional cumulative impact on these townships caused by the construction of the Gullen Range Wind Farm.

Views between Gullen Range and the Gunning Wind Farm.

The Gunning Wind Farm is located approximately 5km to the south west of the Gullen Range Wind Farm and is located within its 17km viewshed. It is the nearest wind farm to Gullen Range and has planning approval. These two wind farms are roughly parallel in this area and are therefore continually separated by approximately 5km. There are also few residences located in the area between the Gullen Range Wind Farm and the Gunning Wind Farm.

Residential properties in this area have the greatest potential to be affected by Cumulative impacts due to the presence of wind turbines both to the north east (Gullen Range Wind Farm) and south west (Gunning Wind Farm).

The landscape in this area is heavily folded and bisected. *Figure 6.5* shows that there are relatively small areas between the Gullen Range/Gunning Wind Farms that can potentially see the nacelle and above. It also shows a large area near to the location of the Gunning Wind Farm that cannot see any of the proposed Gullen Range wind turbines.

The gap between the Gullen Range Wind Farm and the Gunning wind farm is approximately 5km. There are also few residential properties in this location. Because of the separation of the two wind farms, and the folding nature of the landscape and existing vegetation in the area residences in this area are likely to be able to see only one wind farm at any one time.

The potential for cumulative impacts for individual residents located between the Gullen Range and the Gunning Wind Farm will be low.

View from main highways

Travellers along the Hume Highway will pass close by the Cullerin Range Wind Farm once it is constructed. Wind turbines at the Gunning Wind Farm and the Gullen Range Wind Farm may also be visible from the Hume Highway behind the Cullerin Range Wind Farm. However as has been demonstrated previously, views from the Hume Highway to the Gullen Range Wind Farm are very limited and where turbines are visible they would be a small additional element in the landscape.

For these reasons, whilst it may be possible for more than one wind farm to be viewed while travelling through this area in the Southern Highlands, the cumulative impact would be minimal. The main impact on Highway users would remain the nearby Cullerin Range Wind Farm.

Views from minor / local roads

There may be a cumulative visual impact for users of roads running north west from Goulburn past the Gullen Range Wind Farm to Crookwell where the Gullen Range Wind Farm and the Crookwell 1 and Crookwell 2 Wind Farms may also be visible either sequentially or simultaneously.

Crookwell Road is the main link between Goulburn and Crookwell. At some locations along the Crookwell Road these wind farms would be visible on both sides of the road.

Range Road also runs past both the Gullen Range Wind Farm and the Crookwell 1 and Crookwell 2 Wind Farms; however while closer to the Gullen Range Wind Farm it is further from Crookwell 1 and Crookwell 2 Wind Farms.

Similarly there may be a cumulative visual impact for users of the Grabben Gullen Road running from Gunning in a north easterly direction to Grabben Gullen and then to Crookwell. This road runs past the Gunning Wind Farm and then past the Gullen Range Wind Farm.

However these are local roads with lower visitor numbers with limited viewing opportunities due to topography and vegetation and the cumulative impact would be only slightly greater than the impact of the Gullen Range Wind Farm alone. The presence of multiple wind farms would not alter a traveller's perception of the landscape character of the area, beyond the alteration that will occur with the construction of the Gullen Range Wind Farm or the existing presence of Crookwell 1 Wind Farm..

Overall cumulative impact

This assessment of the cumulative visual impact of the Gullen Range Wind Farm has concluded that there would be minimal cumulative visual impact and that the

changes to peoples' perception of the surrounding area would not be significantly changed by the presence of multiple wind farms in the locality.

10 NIGHT LIGHTING ASSESSMENT

Wind farms are generally located away from major population centres and in areas where there are few roads. The assessment of the viewshed of the Gullen Range Wind Farm has identified the low density of occupants within the surrounding area as well as the relatively low usage of the local road network. In essence this has highlighted the fact that the wind farm is located in an area with little night time lighting – albeit with few night time viewers.

There have been no trials of night lighting undertaken in NSW. However some trials have been undertaken in Victoria and night lighting is installed at the Mount Millar Wind Farm in South Australia. These Victorian trials and the existing night lighting at Mt Millar are used to benchmark the impact of night lighting at the Gullen Range Wind Farm.

10.1 PREVIOUS TRIALS

The visual impact of hazard identification lights erected on wind turbines is little tested in NSW while some trials have been undertaken in Victoria to assess the possible impact of various forms of night lighting. Hazard identification lights have been temporarily erected at two Victorian wind farms to assess their visual implications.

Trial at Challicum Hills Wind Farm

Trial hazard identification lights were installed at the Challicum Hills Wind Farm by Pacific Hydro in 2005 to assess the potential loss of visual amenity caused by night lighting for the proposed Yaloak Wind Farm. The lights trialled were red flashing incandescent medium-intensity lights (2000cd). Challicum Hills Wind Farm is located on low lying cleared hills south of Ararat in central Victoria.

This trial demonstrated that the impact of this lighting configuration was high at ground level immediately adjacent to the tower on which the setup was installed particularly because of the light spill along the turbine blades which created a "strobing" effect which could be seen from some distance in the surrounding areas. There was little apparent diminution of visibility due to the horizontal baffles, which were fitted to the incandescent lights. The red glow was still visible against the darkened sky, even from immediately below the lights.

In a recent decision of Planning Panels Victoria, the Yaloak Panel came to the following conclusions after viewing a test site at Challicum Hills Wind Farm:

> *A night time inspection of the operating lights revealed that the obstacle lights are highly visible from distances of up to 25 kilometres with impact occurring from both the primary light source, and from reflection off the rear of the generator blades (thus increasing their impact). There was generally agreement at the site inspection that the amenity impacts of the lights is unacceptable and that the lights would have significant impacts on residents of the Parwan Creek valley.* (Yaloak Planning Panel 2005)

However, this assessment was primarily based on an inspection immediately adjacent to the installed lights and more emphasis should have been placed on assessing the

potential visual impact from greater distances where residents and travellers on the local road network were more likely to be located.

Since the trial at Challicum Hills Wind Farm other lighting options have been trialled to assess if they can reduce visual impact. One option was to replace the incandescent lights with light-emitting diodes (LED). LED's are a semiconductor device that emits incoherent narrow-spectrum light. These can be in any colour, including red. LED's are easier to baffle and as they are programmed to light to their peak intensity more slowly than incandescent lights, they seem to reduce the visual impact compared with that of incandescent lights, which immediately achieve full intensity when switched on.

Trial at Wonthaggi Wind Farm

Hazard identification lights of low-intensity (170cd) LED blinking type were erected at Wonthaggi Wind Farm in December 2005 and again in April 2006. Wonthaggi Wind farm is on the Victorian coast approximately 100km south east of Melbourne.

Trial #1 –Wednesday 14th December 2005

In December 2005, a blinking light was installed at the top of a single wind turbine on the Wonthaggi Wind Farm turbines on 14 December 2005 and photographs were taken to record the visual impact from various distances.

These lights blink in intervals in an irregular cycle. *(ON for 1sec, OFF for 0.5sec, ON for 1sec, OFF for 1.5sec).* The irregular cycles are considered best for safety and act as a deterrent to birds. These low-intensity lights currently meet air safety standards in some European countries.

Figure 10.1 Low-intensity hazard identification lights and car lights at Wonthaggi Wind Farm

Figure 10.1 illustrates the view from approximately 7.6km from the hazard identification lights. On the right of *Figure 10.1* one can just discern the hazard identification lights visible in the distance. Although indistinct in this photo they were still quite clear when viewed against the night sky. In fact their visibility at this distance was a little surprising. The diminution of clarity of the lighting did not reduce with distance to the same extent that objects do during daylight. To the left of *Figure 10.1* one can easily discern tail lights of moving traffic along the Bass Highway.

It is evident that these car lights are much more prominent against the night sky than the hazard identification lights at this distance.

This trial demonstrated that the visual impact on the surrounding areas of the low-intensity hazard identification lights was low. Unlike the visual impact of the incandescent medium-intensity hazard identification lights seen at the Challicum Hills Wind Farm, the W-Red lights of 170cd trialled at Wonthaggi Wind Farm had reduced the visual impact and completely removed the "strobing effect" that was apparent in close proximity to the wind turbines seen at the earlier demonstration at Challicum Hills.

While the red glow of the light was visible against the dark sky, its intensity was comparable (and in many cases far less than) with lights on rural properties and on streetlights or vehicles.

At Wonthaggi Wind Farm trial the use of the lower intensity (170cd) hazard identification lights reduced the visual impact and resulted in the reduction in "strobing effect" of the lights on the wind turbine blades. The visual impact of this light from ground level is comparable to the lights within rural properties.

Trial #2, Wednesday 19th April 2006

A further trial was undertaken in April 2006. In this trial two different hazard identification lights were erected. One was a MB80 medium intensity obstacle marker (2000cd), while the other was a Sealite AV 200 low intensity obstacle marker (170cd).

The low intensity light had less visual impact than the medium intensity light both were still less visible than local display lighting, street lighting and the lighting spill from domestic locations (*Wonthaggi Windfarm Obstacle Marker Light Evaluation for Sustainability Victoria, Robert J Showers and Associates, Lighting Consultants, May 17, 2006)*. This report also commented on the narrow beam distribution and the lack of illuminance at ground level, which also agrees with the observations later in this report of medium density lights.

10.2 *INSTALLED HAZARD IDENTIFICATION LIGHTS AT MT MILLAR WIND FARM IN SOUTH AUSTRALIA*

The Mt Millar Wind Farm is located on the Eyre Peninsula in South Australia, near the township of Cowell, which lies approximately 100km south of Whyalla. The hazard identification lights at the recently completed Mt Millar Wind Farm are medium intensity lights (2000cd).

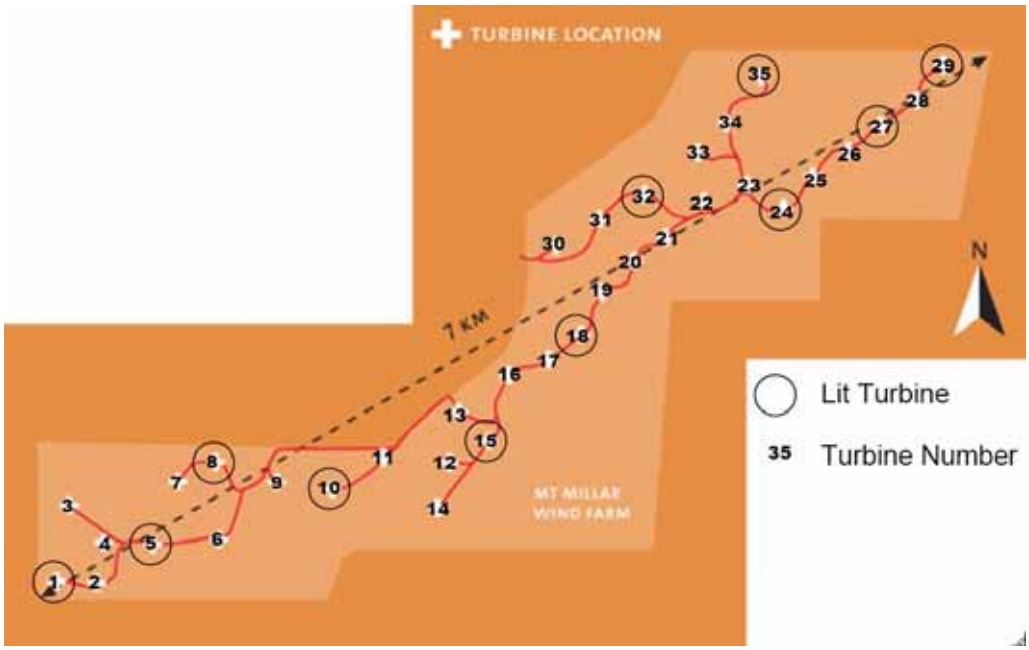


Figure 10.2 ***The layout of the 35 turbines and the lit turbines at the Mt Millar Wind Farm***

The 35 wind turbines are laid out along a ridge running from the north east to the south west. At the time of the site visit 9 wind turbines were lit with flashing red medium-intensity LED hazard identification lights. The lights were not synchronised. Subsequently two additional lights are operational, bringing the total number of wind turbines with night lighting to eleven.

The wind turbines were 2MW Enercon turbines, with a blade diameter of 71m and a turbine hub height of 85m giving an overall height of 120m.

However, unlike the medium intensity lights trialled at Challicum Hills Wind Farm in Victoria, these are LED lights which are baffled to ensure that the light spread is restricted to 3^{O} as shown in *Figure 10.3*. The light spread is approximately -0.5^{O} below the horizon line and approximately 2.5^{O} above.

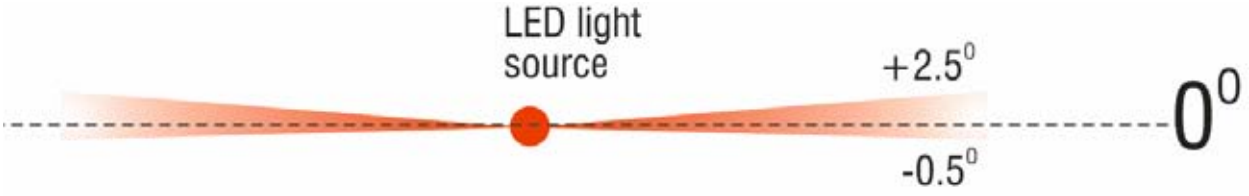


Figure 10.3 ***LED light spread***

The LED lights are able to be baffled far more affectively than the earlier medium-intensity lights trialled at the Challicum Hills Wind Farm and this has a major impact on the visual impact of the lights.

Site visit

The Mt Millar Wind Farm was visited in the evening of the 20th July 2006. It was a clear night, initially with some cloud cover on the horizon, and with very good visibility.

Figure 10.4 *Mt Millar Wind Farm at dusk*

When standing close to a lit wind turbine the difference between these lights and those used at the Challicum Hills trial was immediately obvious. At a distance of 350-400m there was a glow around the lights and only the faintest strobing effect along the moving blades.

Figure 10.5 *Lighting on a Turbine at a distance of 250m*

The strobing effect in this picture is very indistinct and much less than was observed at Challicum Hills.

A comparison with the security lighting at the substation also revealed that the lighting used at this facility was of a much greater intensity than that used on the wind turbines.

Figure 10.6 ***Lighting on the substation and a turbine in the background***

The substation is in the foreground of *Figure 10.6,* with the two hazard warning lights on a turbine immediately behind the substation. The hazard identification lights are less of a visual impact than this facility that has no more lights than many houses, dairies or farm working areas.

At a distance of 1km to 1.5km the similarities between these lights and the trial lights at the Wonthaggi Wind Farm became obvious.

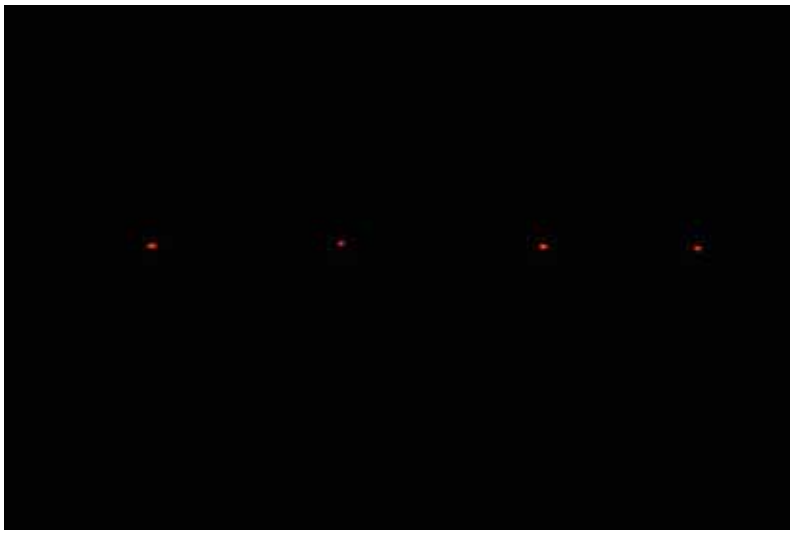


Figure 10.7 ***Lighting on the wind turbines from a distance of 2.0km***

Although the Mt Millar lights are 2000cd medium-intensity hazard identification lights, at these distances there was no sign of any strobing along the blades and the visual impact was identical to that observed at Wonthaggi with W-Red lights of 170cd intensity at a similar distance. That is, the lights were visible, but they had none of the eerie character of the Challicum Hill lights at a similar distance.

These trials and inspection of an operating facility have clearly identified that the type of lights do make a difference to the visual impact.

The night lighting trialled at Wonthaggi gave an acceptable level of visual impact. The planet Venus in the night sky and car lights at similar distances, were both of greater intensity than the proposed hazard identification lighting.

The hazard identification lights at Mt Millar have also supported the assessment that there are forms of hazard identification lighting that do not create such a degree of visual impact as that exhibited in the Challicum Hills trial.

That being said the hazard identification lights are still an obvious element in the landscape. There are few light sources in the proposed location of the Gullen Range Wind Farm. Wind turbines will therefore be an obvious addition to the night panorama. However, as stated earlier, few light sources are also an indication of few viewers.

Figure 10.8 ***Crookwell, looking north west on Goulburn Street***

Figure 10.8 shows the night lighting characteristics of Crookwell. There are many light sources in the both in the town.

Figure 10.9 shows the western edge of Crookwell form a new residential area that is exposed to the proposed wind turbines.

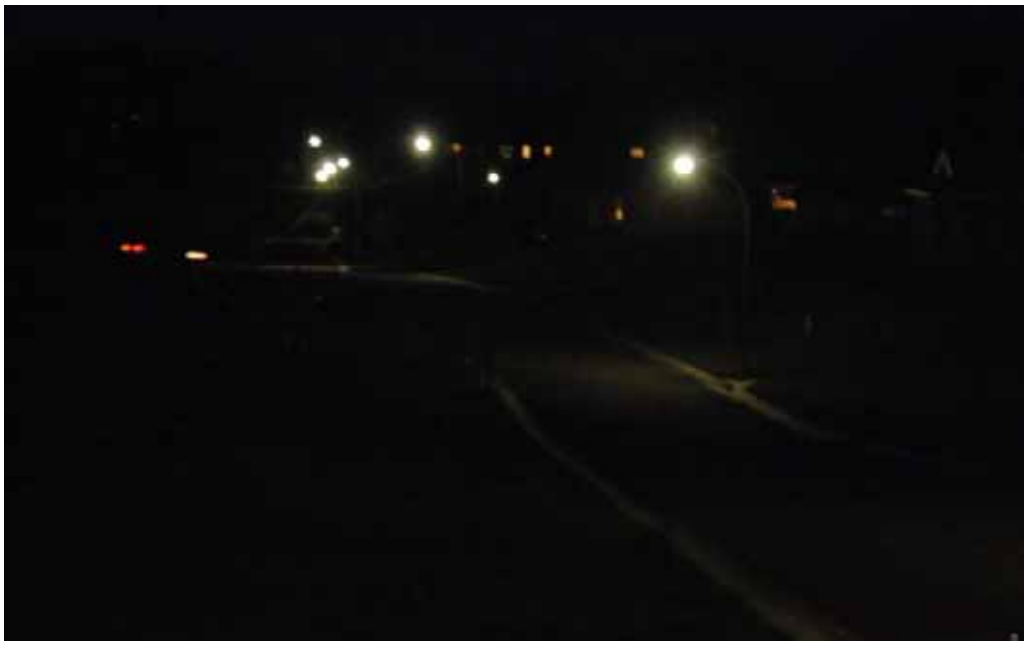


Figure 10.9 *View from the southern edge of Crookwell looking north*

For locations both in the centre and on the edges of Crookwell there are many light sources. These include street lights, shop fronts, residential dwellings and vehicles.

If lights are required by CASA, it is considered that the solution constructed at Mt Millar provides an acceptable level of visual impact while providing the required level of night time hazard identification.

10.4 CUMULATIVE IMPACT OF HAZARD IDENTIFICATION LIGHTING

A cumulative impact can potentially be envisaged for travellers on the Hume Highway, Crookwell Road, Range Road and Grabben Gullen Road passing multiple Wind Farms where hazard identification lighting may be visible. However, whilst the lighting may be visible, it will only be one further element in a traveller's experience which obviously includes the frequent presence of rear tail lights, headlights and lights from nearby houses and farms. As such the cumulative visual impact for these road users will be minimal.

There would also be some residents located in the area around the Gullen Range Wind Farm which may also be able to see the hazard identification lighting from other wind farms. However, although residents may be able to see hazard identification lighting of multiple wind farms such impact would:

a) effect few houses, and

b) be a relatively small visual impact because when people are at home at night and when inside lights are on, windows become mirrors, reflecting the interior of the house and not allowing views to the low level lights in the distance. Obviously when curtains or blinds are closed, there is also no visibility to the proposed lights in the surrounding area. Therefore at night in most situations,

a viewer needs to be outside to even see the proposed hazard identification lights.

For these reasons there would be negligible cumulative impact from the proposed hazard identification lighting if they were installed both at the Gullen Range Wind Farm and other wind farms in the vicinity.

11 CONCLUSION

In summary, this landscape and visual impact assessment of the site demonstrates that the site and its surrounds within the Southern Table Lands have a low visual sensitivity to a wind farm development and is a suitable landscape for the construction of a wind farm.

This conclusion is supported by:

- Perception studies which continually show that the majority of viewers do not object to the construction of wind turbines on any but the most sensitive and localised landscapes. In this instance the wind farm is located in a rural landscape on elevated ridges within an extensive alluvium plain.
- Targeted social research on perception was also undertaken by the proponent and has clearly demonstrated that there is a very high level of support for wind farms amongst local residents in the area with 89% supporting wind farms on the Southern Tablelands and 71% supporting wind farms within 1km of their residence.
- The Gullen Range Wind Farm site is in a man-modified landscape. The landscape units in the viewshed are well represented across this area of the Southern Tablelands. Agricultural activity, associated structures and other signs of human intervention have also created a landscape that can absorb other changes.
- There is minimal impact on townships. There are limited locations from which long distance views are available from the township of Crookwell and the visual impact would be negligible. There is minimal visibility of the wind turbines from other population centres such as Goulburn and Gunning.
- There is minimal visibility from major roads. The Hume Highway, which is one of the major roads within the region, runs more than 8km to the south of the nearest wind turbine and although there will be views from this highway, these will be limited and the visual impact will be low. Furthermore visibility of the wind turbines from the Hume Highway is restricted to a locations due to the presence of intervening ridges and roadside vegetation.
- Similarly there will be limited views to the wind farm for users of the Sydney to Melbourne rail line which closely parallels the Hume Highway.
- There will be a visual impact on viewers using the minor roads within the locality. These run along the eastern and western edges of the wind farm as well as cross between the northern and southern sections. Visibility from these minor roads, which have far fewer users than the highways and main roads, is also restricted by roadside vegetation. It is considered that the visual impact will be low from these locations partly as the viewer numbers are low, but also because this rural landscape can absorb further change.
- The Director-General's Requirements sought to understand the level of visual impact on significant public areas, such as the Pejar Dam. The aqnalysis has shown that there is no visual impact on the area around the boat launching ramp and gazebo, the most frequented areas at the dam.
- There are 128 non-participatory residences within 3km of the wind farm, the zone of greatest potential visual impact. However many of these existing residences have screening in the form of wind breaks. Landscape mitigation can be effective in lessening the visual impact on residential properties.

- The cumulative visual impact is not expected to be greater than the visual impact of the Gullen Range Wind Farm by itself. There are few roads where multiple wind farms become visible, either sequentially or simultaneously and as it is these viewing experiences that can change peoples' perception of an area. Therefore the cumulative visual impact is considered to be low.
- If obstacle identification lighting is required by CASA the visual impact would be low. In part this assessment is based on the type of lights now used and also on the night time environment of the area which already contains multiple existing light sources.

Annex A

Shadow Flicker

A.1 SHADOW FLICKER ASSESSMENT

A.1.1 Introduction

Due to their height wind turbines can cast shadows on the areas around them. Coupled with this, the moving blades create moving shadows. When viewed from a stationary position the moving shadows appear as a flicker giving rise to the phenomenon of 'shadow flicker'. When the sun is low in the sky the length of the shadows increases, increasing the shadow flicker affected area around the wind turbine. The extent of the shadow flicker is dependent on the time of day, geographical location, meteorological conditions of the site and local vegetation.

There are a number of factors influencing the effect and duration of shadow flicker, including:

- Position of the sun in relation to the turbine
- Time of year (season) and time of day
- Turbine height and rotor diameter
- Viewer's distance from turbine
- Topography of the area
- Vegetation cover
- Weather patterns, number of cloudy days per year, and
- Airborne particles, haze

In NSW there are no guidelines on which to assess shadow flicker generated by wind turbines. To carry out the shadow flicker assessment we have drawn on the Victorian Planning Guidelines [1] that limit the duration of shadow flicker to 30 hours a year. The South Australian Planning Bulletin [5] suggests that shadow flicker is insignificant once a separation of 500m between the turbine and house is exceeded. However, a conservative distance of 1 km has been used for this assessment.

A.1.2 Assessment

The modelling of the shadow flicker was conducted using specialist industry software based on Layout C (84 turbines) and using the largest turbine (maximum tip height) proposed for the site. This is a GE 2.5xl with 100m diameter blades on an 85m tower with a maximum tip height of 135m.

The number of annual hours of shadow flicker at a given location can be calculated using simple geometrical models incorporating data such as the sun path, the topographic variation and wind turbine details such as rotor diameter and hub height. In such models, the wind turbine rotor is modelled as a disc and assumed to be in the worst case (i.e. perpendicular) to sun-turbine vector. Furthermore, the sun is assumed to be a point light source.

Shadow flicker calculated in this manner overestimates the number of annual hours of shadow flicker experienced at a specified location [2, 3] due to several reasons.

1. The occurrence of cloud cover has the potential to significantly reduce the number of hours of shadow flicker.

2. The probability of wind turbines consistently yawing to the 'worst case' scenario where the wind turbine is facing into or away from the sun- wind turbine vector is less than 1 (i.e. less than 100% of the time).

3. The amount of aerosols in the atmosphere has the ability to influence shadows cast due to the following reasons.

   Firstly, the distance from a wind turbine that a shadow can be cast is dependent on the degree to which direct sunlight is diffused, which is in turn dependent on the amount of dispersants (humidity, smoke and other aerosols) in the path between the light source (sun) and the receiver [2].

   Secondly, the quantity of aerosols in the air is known to vary with time and it has the potential to vary the air density, thereby affecting the refraction of light. This in turn affects the intensity of direct light to cause shadows.

4. The modelling of the wind turbine blades as discs to determine shadow path overestimates the shadow flicker effect.

   The blades are of non-uniform width with the thickest viewable blade width (maximum chord) occurring closer to the hub and the thinnest being located at the tip of the blade. As outlined in point 3 above, the direct sunlight is diffused resulting in a maximum distance from the wind turbine that a shadow can be cast. This maximum distance is dependent on the human threshold which variation in light intensity can be perceived [2]. When the blade tip causes shadow, the diffusion of direct sunlight means that the light variation threshold occurs closer to the wind turbine than when a shadow is caused by the maximum chord. That is, the maximum shadow length cast by the blade tip is less than by the maximum chord.

5. Modelling the sun as a point light source rather than a disc has an effect similar to that of point 4 above.

   Firstly, situations arise where the light rays from different portions of the sun disc superimpose around a shadow resulting in light intensity variations less than human perception.

   Secondly, when the sun is positioned directly behind the wind turbine hub, there is no variation in light intensity at the receiver location and therefore no shadow flicker. However, when the sun is modelled as a point source, shadow flicker still arises.

6. The presence of vegetation shields incidences of shadow flicker.
7. Periods where the wind turbine is not in operation due to low winds, high winds or operational and maintenance reasons.

Taking the above issues into account, the modelling of shadow flicker has been conducted using simple geometric analyses. The wind turbine has been modelled assuming all wind turbines are disc objects positioned in the worst case with respect to shadow flicker. The sun has been assumed to be a point light source.

Due to points 3 and 4 above, an approximation for the maximum length of shadow flicker cast has been used. Guidance from the South Australian Government indicates

that this distance is 500 m [5]. We have adopted a more conservative approach and have limited the length that a shadow can be cast to 1 km [4].

Therefore, the modelling conducted here represents a very conservative scenario and is believed to overestimate the actual annual hours of shadow flicker experienced at a location.

A.1.3 Actual Conditional at Gullen Range

When the actual conditions of the Gullen Range site are taken into consideration, the number of hours of shadow flicker should be reduced. The major consideration in this respect is the weather patterns and particularly the number of cloudy days experienced that result in no shadow flicker.

Based on 32 years (1971 – 2007) of daily weather observations in Goulburn (Goulburn Tafe, Bureau of Meteorology [6]), the nearest source of data, the average number of cloudy days experienced is 134.3/year. The average number of clear days experienced is 86.9/year. These are based on observations at 9am and 3pm each day.

Cloudy Days Are Defined Bureau Of Meteorology As:

Average number of cloudy days in a calendar month or year, calculated over the period of record. This statistic is derived from cloud cover observations, which are measured in oktas (eighths). The sky is visually inspected to produce an estimate of the number of eighths of the dome of the sky covered by cloud. A completely clear sky is recorded as zero okta, while a totally overcast sky is 8 oktas. The presence of any trace of cloud in an otherwise blue sky is recorded as 1 okta, and similarly any trace of blue on an otherwise cloudy sky is recorded as 7 oktas. A cloudy day is recorded when the mean of the 9 am and 3 pm cloud observations is greater than or equal to 6 oktas. This definition has changed slightly over time. Prior to this, a cloudy day was defined as having greater than or equal to 5.5 oktas averaged over the 9 am and 3 pm observations.

Clear days are defined by the Bureau of Meteorology as:

Average number of clear days in a calendar month or year, calculated over the period of record. This statistic is derived from cloud cover observations, which are measured in oktas (eighths). The sky is visually inspected to produce an estimate of the number of eighths of the dome of the sky covered by cloud. A completely clear sky is recorded as zero okta, while a totally overcast sky is 8 oktas. The presence of any trace of cloud in an otherwise blue sky is recorded as 1 okta, and similarly any trace of blue on an otherwise cloudy sky is recorded as 7 oktas. A clear day is recorded when the mean of the 9 am and 3 pm cloud observations is less than or equal to 2 oktas. This definition has changed slightly over time. Prior to this, a clear day was defined as having less than or equal to 2.5 oktas averaged over the 9 am and 3 pm observations.

Accordingly based on 134.3days/year of cloud the number of shadow flicker hours should be reduced by 36.8%. Further reductions for vegetation screening should be considered and applied where appropriate on a case by case basis.

A.1.4 Results

The modelling has calculated the number of annual hours at each of the nearby houses and the results are presented below. A reduction of the theoretical maximum number of hours can be assumed based on the long term observation of cloudy days.

Residence No.	**Theoretical maximum shadow flicker (hrs/year)**	**Actual (reduced) shadow flicker (hrs/year)**	**Compliance with Victorian Planning Guidelines**
B1	35	22.12	Yes
B2	30	18.96	Yes
B6	18	11.37	Yes
B12a	0	0	Yes
B18a	0	0	Yes
B27	18	11.37	Yes
B33	119	75.2	No
B53	0	0	Yes
B121a	22	13.9	Yes
B122a	45	28.44	Yes
K2	25	15.8	Yes
PW7	23	14.54	Yes

The results show compliance with the Victorian Guidelines of 30hrs/year at all nearby residences except one (B33).

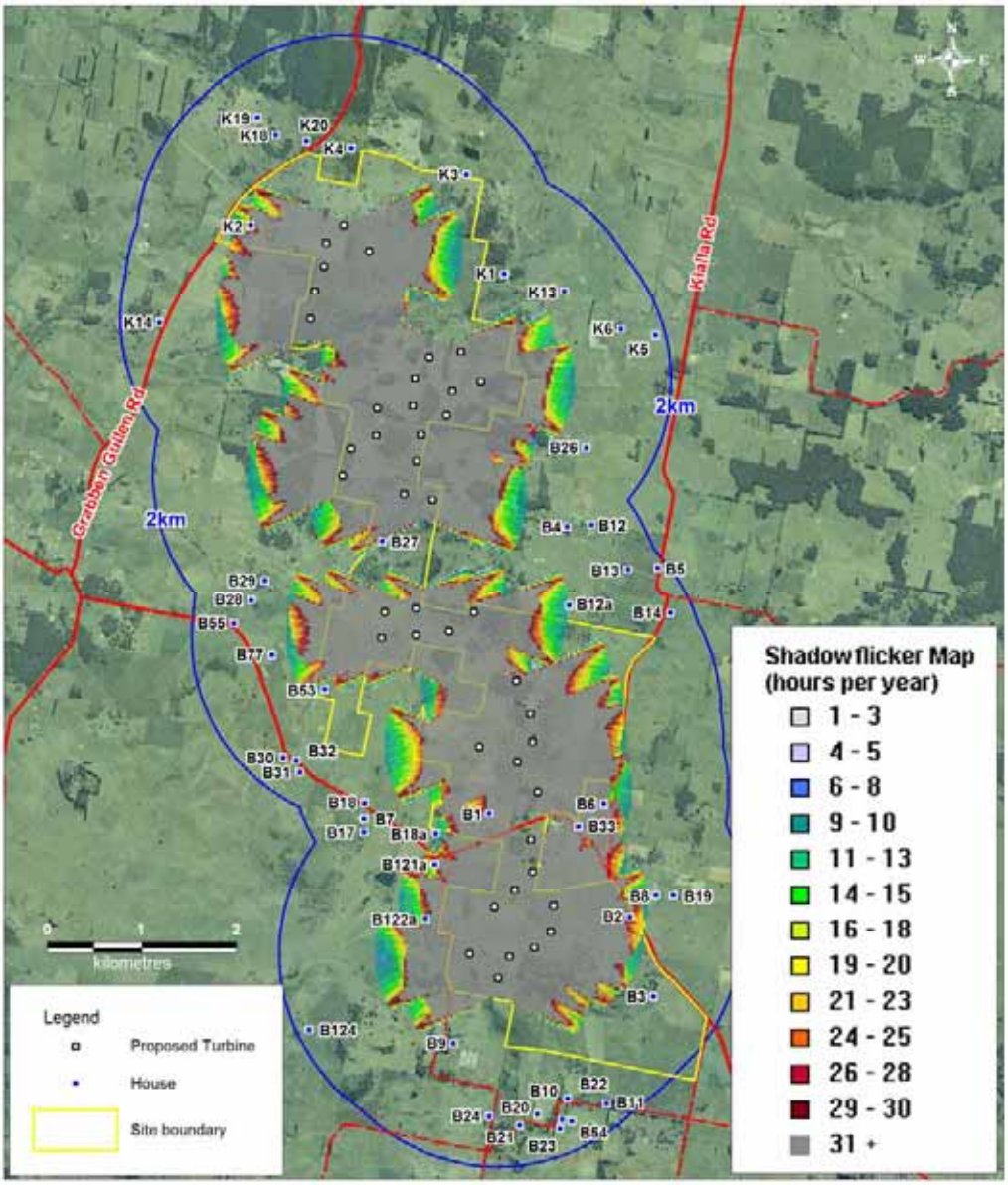


Figure 11.1 Shadow Flicker Results for the northern section of the Gullen Range Wind Farm

Dwelling B33 is surrounded by extensive vegetation on the western perimeter and the main living areas face predominantly east (as shown in the photo below), away from the proposed wind farm.

Figure 11.2 Dwelling B33

It is therefore anticipated that this dwelling will not receive the calculated level of shadow flicker (due to screening) and the shadow flicker that is received will impact on the non-living areas of the dwelling. In addition, this residence is considered a project stakeholder and understands the potential impacts of shadow flicker.

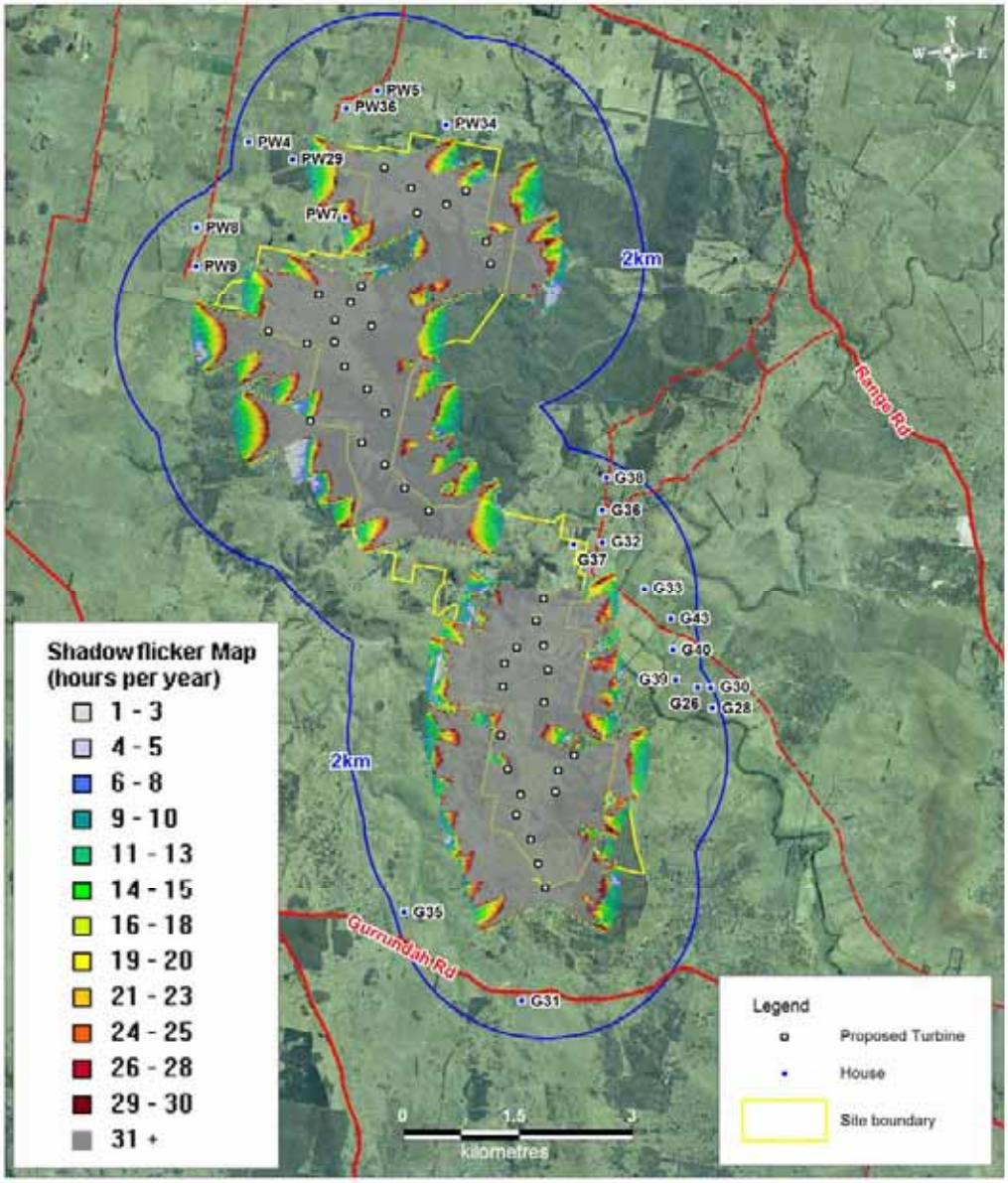


Figure 11.3 Shadow Flicker Results for the southern section of the Gullen Range Wind Farm

Other dwellings that receive a theoretical maximum greater than the prescribed Victorian standard are B1, B2 and B122a. It is anticipated that these three dwellings will receive less shadow flicker than this due to the limitations of the study outlined previously. In addition, B1 and B2 are project stakeholders and have entered into the agreement to host a wind farm understanding the potential for shadow flicker impacts. B2 is heavily screened by vegetation to the west which would further reduce the level of shadow flicker experienced. The dwelling described as B122a is a proposed dwelling and is not yet constructed. Discussions with the property owners have explored the opportunity for them to become involved in the project and landscaping has been offered to screen the proposed house from the wind farm.

The proponent intends to prevent shadow flicker from disrupting residences by offering landscaping as screening around sensitive areas of the residence. Alternatively the wind turbine control systems allow programming to automatically shut down individual wind turbines during specific times or conditions that could cause shadow flicker.

A.1.5 Health effects from shadow flicker

Flicker vertigo is an imbalance in brain cell activity caused by exposure to low frequency flickering or flashing of a light or sunlight seen through a rotating propeller (Rash 2004). It can result in nausea, dizziness, headache, panic, confusion and – in rare cases – loss of consciousness. Flicker vertigo is usually associated with a light flashing sequence, or flicker frequency, of between approximately 4 hertz (cycles per second) and 20 hertz (Rash 2004, NASA 2001).

Shadow flicker frequencies of between 8-30 hertz can trigger epileptic seizures for photosensitive epileptics. Less than 5% of cases involve photosensitive epilepsia, and only a portion of these photosensitive cases have experienced a seizure triggered by flickering light (Epilepsy Association of Australia).

Flicker frequency of rotating propellers, including wind farm rotors, is derived by multiplying the hub rotation frequency by the number of blades. Based on the rotation speed of the 3 bladed wind turbines proposed for the Gullen Range project, the maximum shadow flicker frequency would be 1 cycle per second (1 hertz), well outside the frequency range associated with flicker vertigo or photosensitive epilepsy.

The proposal is therefore unlikely to represent a health risk to local residents in relation to flicker vertigo or photosensitive epilepsy.

A.1.6 Blade Glint

Blade glint occurs when sunlight is reflected off turbines blades and is visible to a person. The concern is that this may, under rare circumstances, affect some motorists or cause annoyance at dwellings.

In reality, turbine manufactures around the world have acknowledged the possibility of blade glint and use a low reflectivity gel finish to reduce any reflectivity. The turbines proposed for this project will be finished in a matte, non-reflective finish to ensure blade glint impacts do not occur.

A.1.7 Conclusion

A detailed analysis of the potential for shadow flicker and blade glint to affect dwellings has been carried out.

All residences comply with the Victorian Planning Guidelines except one which may be affected by shadow flicker in excess of these limits. Further examinations reveal extensive vegetation and dwelling orientation will limit impacts to that this project stakeholder.

Blade glint will be avoided by the use of non-reflective coatings on the turbine blades.

A.1.8 Refs:

1. "Policy and planning guidelines for development of wind energy facilities in Victoria", Sustainable Energy Authority Victoria, 2003.
2. Freund H-D., Kiel F.H., "Influences of the opaqueness of the atmosphere, the extension of the sun and the rotor blade profile on the shadow impact of wind turbines", DEWI Magazin 20, Feb 2002.
3. Osten, T. & Pahlke T., "Shadow Impact on the surrounding of Wind Turbines", DEWI Magazin 13., Aug 1998.
4. http://www.windpower.org/en/tour/env/shadow/shadow2.htm
5. Planning SA, Planning Bulletin "Wind Farms, Draft for Consultation", South Australian Government, 2002.
6. http://www.bom.gov.au/climate/averages/tables/cw_070263.shtml
7. Rash, C.E. (2004) Awareness of causes and symptoms of flicker vertigo can limit ill effects Human Factors and Aviation Medicine March-April 2004, Flight Safety Foundation, Alexandria VA, USA
8. NASA (2001) ASRS Launches Aviation Security Study, Callback Issue No. 268 December 2001, Office of the NASA Aviation Reporting System, Moffet Field, CA, USA

Annex B

Parameters of the Human Vision

B.1 WIND TURBINE VIEWSHED BASED ON THE PARAMETERS OF HUMAN VISION

The viewshed for the Gullen Range Wind Farm can be determined by determining the extent to which an object is part of an observer's static field of view. The viewshed in a man-modified landscape has in past projects been delineated to that area in which an object takes up at least 5% of the field of view.

The measurement of the field of view is based upon the parameters of human vision outlined below. These provide a basis for assessing and interpreting the impact of a development by comparing the extent to which the development will intrude into the central field of vision (both horizontally and vertically).

B.1.1 Horizontal Field of View

The central field of vision for most people covers an angle of between 50^{O} to 60$^{O.}$ Within this angle, both eyes observe an object simultaneously. This creates a central field of greater magnitude than that possible by each eye separately.

This central field of vision is termed the 'binocular field' and within this field images are sharp, depth perception occurs and colour discrimination is possible.

These physical parameters are illustrated *in Figure AB*.

The visual impact of a development will vary according to the proportion in which a development impacts on the central field of vision.

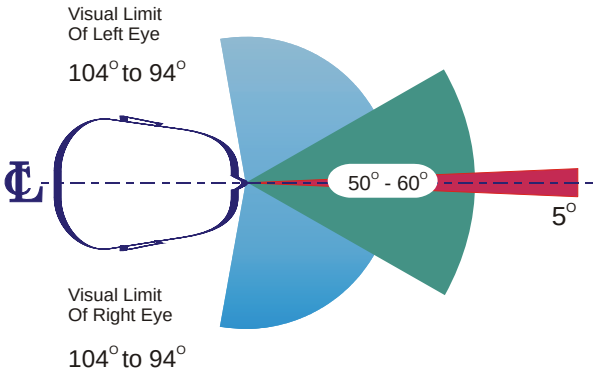


Figure B.1 Horizontal Field of View

Developments, which take up less that 5% of the central binocular field, are usually insignificant in most man-modified landscapes (5% of 50^{O} = 2.5^{O}).

B.1.2 Vertical Field of View

A similar analysis can be undertaken based upon the vertical line of sight for human vision.

These physical parameters are illustrated in *Figure B2*.

As can be seen in *Figure A2* the typical line of sight is considered to be horizontal or 0^{O}. A person's natural or normal line of sight is normally a 10^{O} cone of view below the horizontal and, if sitting, approximately 15^{O}.

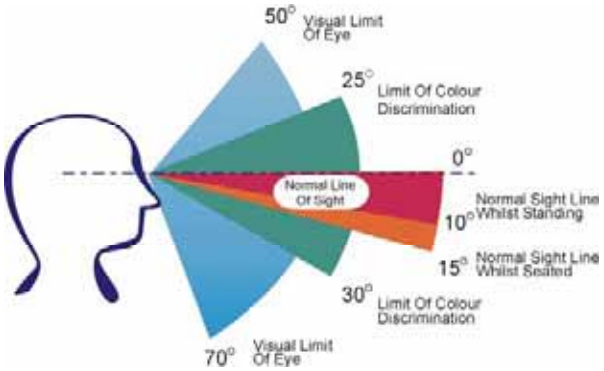


Figure B.2 Vertical Field of View

Objects, which take up 5% of this cone of view (5% of 10^{O} = 0.5^{O}) will only take up a small proportion of the vertical field of view, and are only visible when one focuses on them directly. However, they are not dominant, nor do they create a significant change to the existing environment when such short objects are placed within a disturbed or man-modified landscape.

B.1.3 Viewshed Based on the Horizontal Field of View

The viewshed of a single wind turbine is calculated on the extent to which a single wind turbine (in this example the widest section is the swept path of the rotor) would intrude into the 60^{O} central field of vision.

The table below analyses' the extent to which a swept path of a single rotor would interrupt the horizontal field of view.

Table B.1 *Viewshed based on the degree a swept path of a single rotor would take up in the horizontal field of view*

Horizontal Field of View	Visual Impact	Distance from an observer to a rotor with 92m diameter
<2.5^{O} of view (5% of 50^{O} = 2.5^{O})	Insignificant The swept path of the rotor would take up less than 5% of the central field of view. The rotor, unless particularly conspicuous against the background, will not intrude significantly into the view. The extent of the vertical angle will also affect the visual impact.	> 2290m
2.5^{O} – 30^{O} of view (60% of 50^{O} = 30^{O})	Potentially Noticeable The swept path of the rotor may be noticeable and its degree of visual intrusion will depend greatly on its ability to blend in with its surroundings and particularly the sky.	173m-2290m
>30^{O} of view	Potentially Visually Dominant At this distance the swept path of a single rotor will fill more than 50 percent of the central field of vision and will always be noticed and sympathetic treatments, such as paint colours to blend against a sky, will only be able to partially mitigate visual effects.	< 173 m

These calculations suggest that the impact of a 92m wide rotor would reduce to insignificance at approximately 2,290m, as the swept path of the rotor would, at this distance, form less than 5% or 2.5^{O} of the horizontal field of view. At distances less than 173m, a 92m wide rotor, would be visually dominant.

These calculations do not take into account the height of the wind turbines, nor do they allow for the placement of multiple wind turbines within the landscape. The distances suggested by the analysis based upon horizontal field of view of a single rotor are far less than experience would suggest to be reasonable.

B.1.4 Viewshed based on the vertical field of view

The previous calculation is based on the visual impact of a single rotor in the horizontal field of view. A single wind turbine has the same height as many wind turbines sited across several kilometres, and the intrusion into the vertical field of view may better determine the viewshed for a wind farm.

The point from which the wind farm becomes an indistinct line on the landscape, better determines the viewshed. That is the point at which the vertical size of a range of wind turbines diminishes to an imperceptible component within the vertical field of view.

The sketch below shows how the viewshed of a long horizontal object is determined by its height and not by its width.

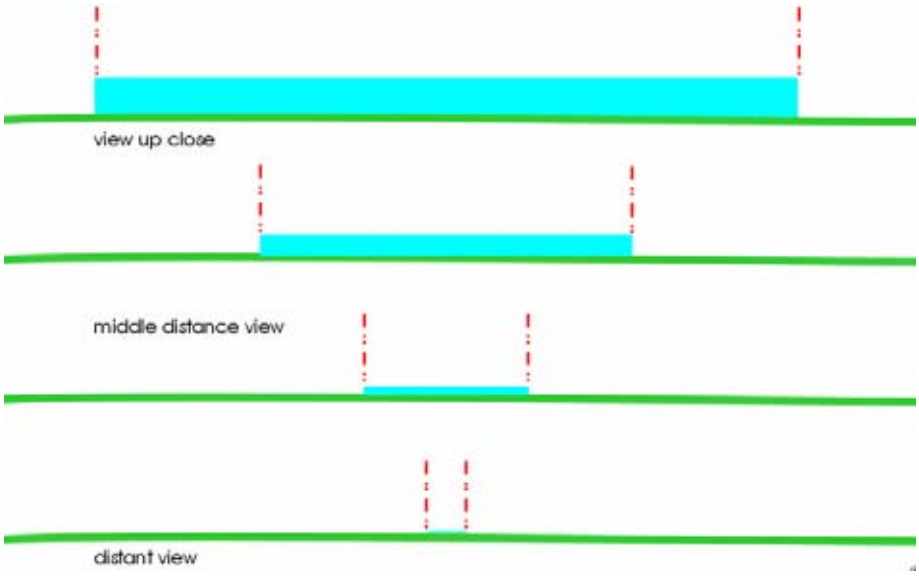


Figure B.3 The diminution in visibility with distance from a long horizontal object

As an observer moves further away from a horizontal object the width may still be apparent, however the vertical dimension reduces to insignificance

This effect can also be demonstrated by the example of a farm fence that may be several kilometres in width, yet as one moves further away, it becomes less apparent, until at some distance it is not possible to separate this element from the horizontal plane of the landscape. Similarly, the viewshed of a long horizontal object such as a wind farm can also be determined by its height.

As wind farms are comprised of many tall slim towers with rotating blades, wind farms are different to a solid structural mass such as buildings. At greater distances, the rotating blade becomes the most visible element and at closer distances, it is the overall height of the wind turbine that becomes most apparent.

The table below shows the relationship between impact based on the proportion that a wind farm, comprising of many wind turbines, will occupy within the vertical field of view, which in the table below is assumed to be 10^{O}.

Objects that take up 5% of this cone of view (5% of 10^{O} = 0.5^{O}) are considered visually insignificant. That is not to imply that the objects become invisible at this distance,

rather they become such a minor element in an already man modified landscape that their visual impact can be considered to be insignificant.

Once objects take up at least 10% of the vertical field of view, they can be more readily discernible (10% of 10^{O} = 1^{O}) and this visibility increases as the wind turbines increasingly take up a greater proportion of the vertical field of view.

When the wind turbines take up 25% of the vertical field of view, they become visually evident and when they take up 50% of the vertical field of view, they will dominate the view.

Table B.2 Visual impact based on the vertical field of view to a wind turbine

Vertical Line of Sight	**Visual Impact**	**Distance from an observer to a - 146.5m high wind turbine**
< 0.5^{O} of vertical angle (5% of 10^{O} = 0.5^{O})	Insignificant A thin line in the landscape.	16785m
0.5°-2.5°of vertical angle	Potentially noticeable The degree of visual intrusion will depend on the development's ability to blend in with the surroundings.	3355-16785m
2.5^{O} – 5^{O} of vertical angle	Visually evident Usually visible, however the degree of visual intrusion will depend of the width of the object and its placement within the landscape.	<3355m

The table above shows the distance at which a wind turbine approximately 146.5m high with a 92m diameter swept path of a rotor diminishes with distance within a vertical field of view.

In some lighting conditions, the rotor stands out in distant views and for this reason it is calculated separately for the outer edge of the viewpoint. As this calculation is intended as only a guide to setting the viewshed, all figures have been rounded to the nearest appropriate kilometre).

Insignificant visual impact & the limit of the viewshed occurs at approximately 17km, at which point a 146.5m high wind turbine is no longer a significant visible element in a man modified landscape except for the most sensitive of locations. The swept path of the rotor also becomes the only visible element in some lighting conditions as the supporting tower becomes imperceptible and possibly this could reduce the viewshed to 10km in these lighting conditions.

The 17km viewshed is based on a conservative assumption that the wind turbines are a solid mass 146.5m high, similar to a building. In reality the wind turbines are widely spaced and the wind farm is a far more visually transparent object than a solid building mass some 146.5m high and several kilometres in width. However, it is also to be noted that the turning of the rotor also attracts the eye, extending the viewshed.

It is stressed that these calculations attempt to locate the distance at which a wind farm becomes imperceptible within a man-modified landscape. This is not to say that wind turbines at 17km, or even at 27km, are invisible. Wind turbines of this height will be discernible in good lighting conditions to an observer who knows where the wind turbines are located and therefore focuses in that direction. However the visual impact within a man modified landscape is not considered significant beyond this distance, aside from exceptional circumstances.

Potentially noticeable visual impact occurs between 3km to 8.5kmkm where the entire wind turbine is visible and lighting does not alter the visibility of the tower versus that of the rotor. Foreground vegetation and intervening landform can reduce the degree to which the wind turbines are noticeable.

Visually evident occurs at distances between 1.5km and 3km where the wind turbines have increased in visibility and are evident and potentially dominant in the landscape. Landscape is less effective at screening wind turbines unless it is close to the viewer.

B.1.5 Viewshed based on panel deliberation

The Panel, considering the application for a wind farm at Bald Hills, which was based on wind turbines approximately 110m high, agreed that a wind turbine might be dominant when viewed from within 1km. However, the turbines proposed at Bald Hills are shorter than those proposed for Crowlands. The implication of the increased height of the wind turbines is discussed later in this report.

The Panel also considered that *if the extent of wind farm structures takes up more than a 90-degree arc within a horizon view from a dwelling, there may be "horizon dominance".* (Bald Hills Wind Farm – Assessment, August 2004).

This is broadly based on the notion that where a wind farm takes approximately 50% of the entire horizontal field of view (between 188^{O} and 220^{O}, refer Annex B) it can dominate the horizon. This is similar to the "dominant" rating outlined in the methodology used in this report.

Annex C

Photomontage Methodology

C.1 PHOTOMONTAGE METHODOLOGY

It is essential that photomontages are both technically accurate, in that they locate the wind turbines in their correct locations, and are also perceptually accurate, in that they give a good representation of what will be constructed on site.

C.1.1 Lens Size

A 50mm lens on a 35mm film camera is often used for visual assessments as it is called a "normal" lens because it produces roughly the same horizontal angle as the human eye (about 50°). However because of the 1:1.5 proportion of a photograph it also captures a vertical angle of approximately 35^{O}. This is much greater than a person's central vertical field of view and therefore vertical elements, especially in the middle and far distance, are reduced in scale. In some cases the images that have been produced using a 50mm "normal" lens have been criticised for their on site perceptual accuracy.

Photographs that formed the basis of the photomontages in this report were taken with a Nikon 60mm f2.8D lens on a Nikon D2X digital camera. The 60mm lens on the Nikon D2X, is the equivalent of a **90mm lens on a 35mm film camera**, and was chosen to take the photographs that are used in the photomontages because it more accurately captures the apparent vertical size of objects in the middle and far distance and hence provides a perceptually more correct image than the more typically used 50mm lens. A 60mm lens on this camera (Nikon D2X digital) has a picture angle of 26.5^{O} and a horizontal angle of view of approximately 21.3^{O}. http://nikonimaging.com/global/products/lens/af/micro/af_micro60mmf_28d/).

C.1.2 Photomontage – background photograph construction

When four photographs are overlapped approximately 1/3, the resultant image has a horizontal angle of approximately 60^{O}, which is very similar to the central cone of view of human vision. The vertical angle of the 60mm lens is 17^{O} and when the photomontages are slightly cropped the resultant vertical angle is about 15^{O}, which again closely matches the vertical field of view.

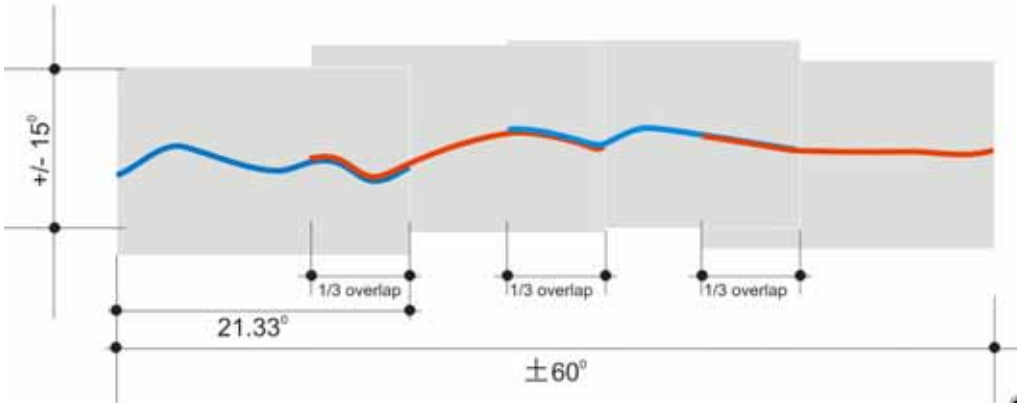


Figure C.1 *Four photographs overlapped 1/3 to create an image approximately the same as the central cone of view of human vision, ie 50-60^{O} horizontal and 15^{O} vertical.*

The GPS locations of each panorama are also recorded at the time the photographs are taken. The Nikon D2X camera also records the GPS coordinates as picture data.

C.1.3 Photomontage – background model construction

Cadastral data as well as proposed turbine locations and the physical characteristics of the turbines are modelled within a computer program (3D Max). A virtual camera is set up in the model at the GPS coordinates for each of the photographs that are being used within the panorama.

The digital model is overlaid on the photographic panorama. As the topography (or other predetermined points) must align, this verifies the location and apparent height of the proposed wind turbines.

After the background has been aligned, this is removed leaving only the wind turbines, which are rendered, either to match the lighting conditions at the time the photographs were taken, or, more typically, to maximise their visibility by increasing their contract against the background sky.

C.1.4 Photomontage verification

ERM has retaken photographs of wind turbines after construction to compare these with photomontages that were prepared prior to construction, to verify both the technical and perceptual accuracy of images.

All of the verification visits have proven that the resultant photomontages are technically accurate, and the results of one of these tests are attached to this report. However it was felt that earlier photomontages, especially those based on a 50 or 60mm lens on a 35mm camera tended to make the wind turbines less visible in the landscape. Over time the lens size has slowly increased to ensure the perceptual veracity of the photomontages.

As stated earlier the photomontages used within this report are based on a lens with the characteristics of a 90mm lens on a 35mm film camera.

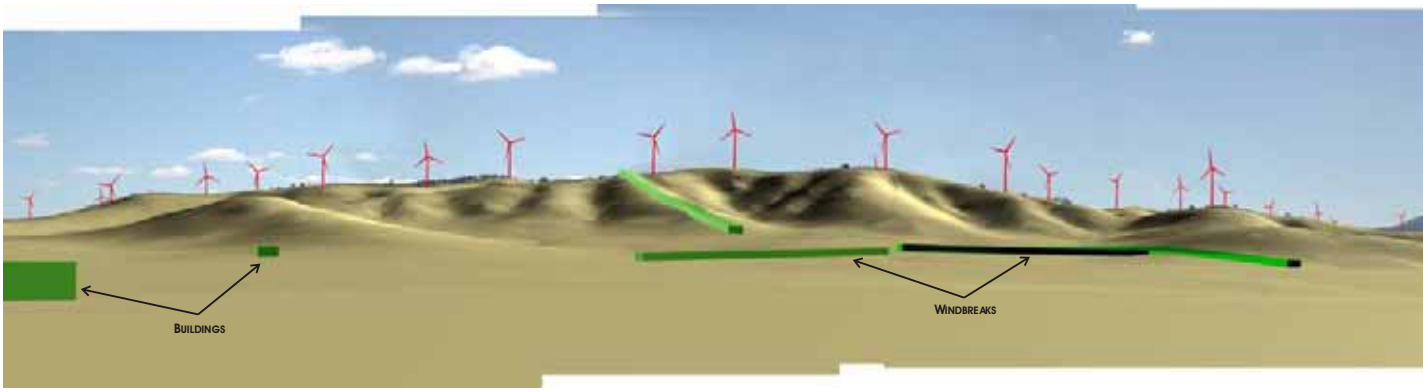
C.1.5 Image size

It is stressed that the small images used within the report are only for referencing comments made within the text. While technically correct, they do not accurately portray a perceptually accurate image to assess the visual impact. For this reason larger (A3) images are appended to this report (Annex C) and A1 size images, which accurately portray the perceptual visual impact, will also be provided.

All the photomontages have been prepared with a 60^{O} field of view, as this more accurately represents the size of objects within a photomontage (Refer Annex A). However to avoid criticism that the photomontages do not show the full extent of the potential visual impact, in many cases a 120^{O} field of view has also been used to fully model the extent to which wind turbines will be visible across the horizon.

Sixty Degree Field of View

View from Challicum Road with turbines removed from the photographs.



View with terrain model, turbines and marker(s) superimposed onto the photographs.

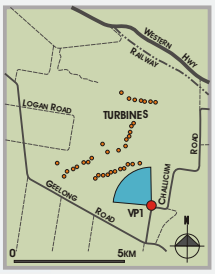
View showing the solid rendered Model of the wind turbines.

View showing the actual as-built wind turbines.

Photomontage Viewpoint 1

From Challicum Road

GPS: Easting:	688 537
Northing:	5 857 072
Grid Datum:	AMG Zone 55 on AGD 66
Camera Lens:	90mm
Distance to Nearest Turbine:	2,133m



Aerial photograph displaying viewpoint 1 location and turbine locations.

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Project No. 0010578
September 2006

ERM
Environmental Resources Management Australia Pty Ltd

Challicum Hills
Visual Assessment Verification

Ls1

Annex D

Photomontages

EXISTING VIEW from Mullins Creek & Gurrundah Road looking east

VIEW SHOWING THE PROPOSED WIND TURBINES SUPERIMPOSED ONTO THE ORIGINAL PHOTOGRAPHS

VIEWPOINT 1
FROM the
Gurrundah Road
looking east

LOCATION DATA REFERENCE:
GRID DATUM: MGA94 ZONE 55

EASTING: 724157
NORTHING: 6157103

ELEVATION: 845

DISTANCE TO NEAREST WIND TURBINE
3.5 KM

FOR:

EPURON
POWER FOR PORTFOLIOS

ERM

Project No:	0069605	Drawing No:	1
Date:	06/03/08	Drawing size:	A0
Drawn by:	LQ	Reviewed by:	AW

GULLEN RANGE WIND FARM

EXISTING VIEW from the Crookwell Gunning Road at Wattle Creek Looking East

VIEW SHOWING THE PROPOSED WIND TURBINES SUPERIMPOSED ONTO THE ORIGINAL PHOTOGRAPHS

VIEWPOINT 2
FROM the
Crookwell Gunning Road
at Wattle Creek
looking east

LOCATION DATA REFERENCE:
GRID DATUM: MGA94 ZONE 55

EASTING: 0718779
NORTHING: 6172335

ELEVATION: 886

DISTANCE TO NEAREST WIND TURBINE
4.7 KM

FOR:

EPURON
POWER FOR PORTFOLIOS

ERM

Project No:	0069605	Drawing No:	2
Date:	06/03/08	Drawing size:	A0
Drawn by:	LQ	Reviewed by:	AW

GULLEN RANGE WIND FARM

EXISTING VIEW FROM POMEROY ROAD, MUMMEL LOOKING WEST

VIEW SHOWING THE PROPOSED WIND TURBINES SUPERIMPOSED ONTO THE ORIGINAL PHOTOGRAPHS

VIEWPOINT 3
FROM Pomeroy Road,
Mummel
Looking West

LOCATION DATA REFERENCE:
GRID DATUM: MGA94 ZONE 55

EASTING: 729782
NORTHING: 6174776

ELEVATION: 691

DISTANCE TO NEAREST WIND TURBINE
1.9 KM

FOR:

EPURON
POWER FOR PORTFOLIOS

ERM

Project No:	0069605	Drawing No:	3
Date:	06/03/08	Drawing size:	A0
Drawn by:	LQ	Reviewed by:	AW

GULLEN RANGE WIND FARM

EXISTING VIEW From Walkoms Road Looking South West

VIEW SHOWING THE PROPOSED WIND TURBINES SUPERIMPOSED ONTO THE ORIGINAL PHOTOGRAPHS

VIEWPOINT 4A
FROM Walkoms Road
Looking South West

LOCATION DATA REFERENCE:
GRID DATUM: MGA94 ZONE 55H

EASTING: 726459
NORTHING: 6169417

ELEVATION: 854

DISTANCE TO NEAREST WIND TURBINE
2.5 KM

FOR:

EPURON
POWER FOR PORTFOLIOS

ERM

Project No:	0069605	Drawing No:	4a
Date:	06/03/08	Drawing size:	A0
Drawn by:	LQ	Reviewed by:	AW

GULLEN RANGE WIND FARM

EXISTING VIEW From Walkoms Road Looking West

VIEW SHOWING THE PROPOSED WIND TURBINES SUPERIMPOSED ONTO THE ORIGINAL PHOTOGRAPHS

VIEWPOINT 4B
FROM Walkoms Road
Looking North West

LOCATION DATA REFERENCE:
GRID DATUM: MGA94 ZONE 55H

EASTING: 726459
NORTHING: 6169417

ELEVATION: 854

DISTANCE TO NEAREST WIND TURBINE
2.5 KM

FOR:

EPURON
POWER FOR PORTFOLIOS

ERM

Project No:	0069605	Drawing No:	4b
Date:	06/03/08	Drawing size:	A0
Drawn by:	LQ	Reviewed by:	AW

GULLEN RANGE WIND FARM

EXISTING VIEW FROM Bannister Lane Looking North East

VIEW SHOWING THE PROPOSED WIND TURBINES SUPERIMPOSED ONTO THE ORIGINAL PHOTOGRAPHS

VIEWPOINT 5
FROM Bannister Lane
Looking North East

LOCATION DATA REFERENCE:
GRID DATUM: MGA94 ZONE 55H

EASTING: 722042
NORTHING: 6167465

ELEVATION: 896

DISTANCE TO NEAREST WIND TURBINE
4.0 KM

FOR:

EPURON
POWER FOR PORTFOLIOS

ERM

Project No:	0069605	Drawing No:	5
Date:	06/03/08	Drawing size:	A0
Drawn by:	LQ	Reviewed by:	AW

GULLEN RANGE WIND FARM

EXISTING VIEW FROM Kialla Airfield Looking West

VIEW SHOWING THE PROPOSED WIND TURBINES SUPERIMPOSED ONTO THE ORIGINAL PHOTOGRAPHS

VIEWPOINT 6A
FROM Kialla Airfield
Looking West

LOCATION DATA REFERENCE:
GRID DATUM: MGA94 ZONE 55H

EASTING: 235541
NORTHING: 5839463

ELEVATION: 572

DISTANCE TO NEAREST WIND TURBINE
2.8 KM

FOR:

EPURON
POWER FOR PORTFOLIOS

ERM

Project No:	0069605	Drawing No:	6a
Date:	06/03/08	Drawing size:	A0
Drawn by:	LQ	Reviewed by:	AW

GULLEN RANGE WIND FARM

EXISTING VIEW FROM Kialla Airfield Looking West

VIEW SHOWING THE PROPOSED WIND TURBINES SUPERIMPOSED ONTO THE ORIGINAL PHOTOGRAPHS

VIEWPOINT 6B
FROM Kialla Airfield
Looking West

LOCATION DATA REFERENCE:
GRID DATUM: MGA94 ZONE 55H

EASTING: 235541
NORTHING: 5839463

ELEVATION: 572

DISTANCE TO NEAREST WIND TURBINE
2.8 KM

FOR:

EPURON
POWER FOR PORTFOLIOS

ERM

Project No:	0069605	Drawing No:	6b
Date:	06/03/08	Drawing size:	A0
Drawn by:	LQ	Reviewed by:	AW

GULLEN RANGE WIND FARM

EXISTING VIEW from Range Road Looking West

VIEW SHOWING THE PROPOSED WIND TURBINES SUPERIMPOSED ONTO THE ORIGINAL PHOTOGRAPHS

VIEWPOINT 7
FROM Range Road
Looking West

LOCATION DATA REFERENCE:
GRID DATUM: MGA94 ZONE 55H

EASTING: 733221
NORTHING: 6162899

ELEVATION: 779

DISTANCE TO NEAREST WIND TURBINE
5.8 KM

FOR:

EPURON
POWER FOR PORTFOLIOS

ERM

Project No:	0069605	Drawing No:	7
Date:	06/03/08	Drawing size:	A0
Drawn by:	LQ	Reviewed by:	AW

GULLEN RANGE WIND FARM

EXISTING VIEW from Pejar Dam and Boat Ramp Looking West

VIEW SHOWING THE PROPOSED WIND TURBINES SUPERIMPOSED ONTO THE ORIGINAL PHOTOGRAPHS

VIEWPOINT 8
FROM Pejar Dam and Boat Ramp Looking West

LOCATION DATA REFERENCE:
GRID DATUM: MGA94 ZONE 55H

EASTING: 727570
NORTHING: 6174469

ELEVATION: 907

DISTANCE TO NEAREST WIND TURBINE
10.0 KM

FOR:

EPURON
POWER FOR PORTFOLIOS

ERM

Project No:	0069605	Drawing No:	8
Date:	06/03/08	Drawing size:	A0
Drawn by:	LQ	Reviewed by:	AW

GULLEN RANGE WIND FARM

EXISTING VIEW FROM Bannister Lane Looking East

VIEW SHOWING THE PROPOSED WIND TURBINES SUPERIMPOSED ONTO THE ORIGINAL PHOTOGRAPHS

VIEWPOINT 9A
FROM Bannister Lane
Looking East

LOCATION DATA REFERENCE:
GRID DATUM: MGA94 ZONE 55H

EASTING: 721289
NORTHING: 6165563

ELEVATION: 851

DISTANCE TO NEAREST WIND TURBINE
3.0 KM

FOR:

EPURON
POWER FOR PORTFOLIOS

ERM

Project No:	0069605	Drawing No:	9a
Date:	06/03/08	Drawing size:	A0
Drawn by:	LQ	Reviewed by:	AW

GULLEN RANGE WIND FARM

EXISTING VIEW FROM Bannister Lane Looking East

VIEW SHOWING THE PROPOSED WIND TURBINES SUPERIMPOSED ONTO THE ORIGINAL PHOTOGRAPHS

VIEWPOINT 9B
FROM Bannister Lane
Looking East

LOCATION DATA REFERENCE:
GRID DATUM: MGA94 ZONE 55H

EASTING: 721289
NORTHING: 6165563

ELEVATION: 851

DISTANCE TO NEAREST WIND TURBINE
3.0 KM

FOR:

EPURON
POWER FOR PORTFOLIOS

ERM

Project No:	0069605	Drawing No:	9b
Date:	06/03/08	Drawing size:	A0
Drawn by:	LQ	Reviewed by:	AW

GULLEN RANGE WIND FARM

EXISTING VIEW from the Southern Edge of Crookwell Looking south

VIEW SHOWING THE PROPOSED WIND TURBINES SUPERIMPOSED ONTO THE ORIGINAL PHOTOGRAPHS

VIEWPOINT 10A
FROM the
Southern Edge of Crookwell
Looking south

LOCATION DATA REFERENCE:
GRID DATUM: MGA94 ZONE 55H

EASTING: 726563
NORTHING: 6183068

ELEVATION: 918

DISTANCE TO NEAREST WIND TURBINE
6.0 KM

FOR:

EPURON
POWER FOR PORTFOLIOS

ERM

Project No:	0069605	Drawing No:	10a
Date:	06/03/08	Drawing size:	A0
Drawn by:	LQ	Reviewed by:	AW

GULLEN RANGE WIND FARM

EXISTING VIEW from the Eastern Edge of Crookwell on the Laggan Crookwell Road Looking South

VIEW SHOWING THE PROPOSED WIND TURBINES SUPERIMPOSED ONTO THE ORIGINAL PHOTOGRAPHS

VIEWPOINT 10B
FROM the
Eastern Edge of
Crookwell on the
Laggan Crookwell Road
Looking South

LOCATION DATA REFERENCE:
GRID DATUM: MGA94 ZONE 55H

EASTING: 07267701
NORTHING: 6184850

ELEVATION: 892

DISTANCE TO NEAREST WIND TURBINE
7.5 KM

FOR:

EPURON
POWER FOR PORTFOLIOS

ERM

Project No:	0069605	Drawing No:	10b
Date:	06/03/08	Drawing size:	A0
Drawn by:	LQ	Reviewed by:	AW

GULLEN RANGE WIND FARM

EXISTING VIEW from Grabben Gullen Looking East

VIEW SHOWING THE PROPOSED WIND TURBINES SUPERIMPOSED ONTO THE ORIGINAL PHOTOGRAPHS

VIEWPOINT 11
FROM
Grabben Gullen
Looking East

LOCATION DATA REFERENCE:
GRID DATUM: MGA94 ZONE 55

EASTING: 0719665
NORTHING: 6175346

ELEVATION: 905

DISTANCE TO NEAREST WIND TURBINE
3.0 KM

FOR:

EPURON
POWER FOR PORTFOLIOS

ERM

Project No:	0069605	Drawing No:	11
Date:	06/03/08	Drawing size:	A0
Drawn by:	LQ	Reviewed by:	AW

GULLEN RANGE WIND FARM