7 ASSESSMENT OF KEY ISSUES

7.1 Scoping and prioritisation of issues

Recent reforms to the *Environmental Planning and Assessment Act 1979* and associated planning instruments (Part 3A) provide for improvements to efficiency in the assessment and approval process, by allowing assessments to focus on key issues.

Key issues are those with the potential to produce significant environmental or human impacts. They have been identified with respect to this proposal in the Director General's Requirements (refer to Section 5.1.3). The impact assessment process that this EA report documents is focussed on these key issues. Table 7.1 summarises the key issues and the investigation strategies employed to investigate them. Section 7 summarises the methodologies, results and mitigation measures recommended by these investigations, for each key issue individually.

Additional issues were identified using the risk analysis methodology, Section 8, Table 8-1. These additional issues are discussed separately in Section 8.

Table 7-1 Categorisation of key impact areas related to the proposal

Issue	Investigation strategy
Visual	Specialist report including photomontages of turbine layouts
Noise	Specialist report including modelling and mapping
Biodiversity	Specialist report including flora, fauna Separate desktop investigation of Mitchell landscapes
Aboriginal archaeology	Specialist report, including consultation
Aviation	Specialist report including consultation
Communications	Desktop review and consultation
Electromagnetic fields (EMFs)	Desktop review and consultation
Land values	Desktop investigation with recourse to an existing specialist report
Traffic and transport	Specialist report
Fire and bushfire	Desktop review and consultation
Water quality	Desktop review and consultation
Mineral resource	Desktop review and consultation

7.2 Visual impact

A landscape and visual assessment was completed by Environmental Resources Management (ERM) Australia for the proposed Gullen Range Wind Farm. It assessed the visual impact of the constructed wind farm, taking into account access roads, powerlines, substation and control building as well as the turbines themselves. A summary of the methodology, key results and proposed mitigation measures is described below. The landscape and visual assessment is appended in full, Attachment 3.1.

Approach

The methodology used within the visual assessment is based on the *Policy and Planning Guidelines for Development of Wind Energy Facilities in Victoria (May 2003)* as well as past projects undertaken by ERM in the visual assessment of wind farms in Victoria, South Australia and NSW. This methodology is supported by the *Wind Farms and Landscape Values, National Assessment Framework.* It responds to the relevant sections of the Upper Lachlan Shire Council *Development Control Plan (DCP) Wind Power Generation 2005,* the Key Assessment Requirements for Visual Amenity Impacts (Section 75F of the *Environmental Planning and Assessment Act 1979)* and *Auswind's Best Practice Guidelines for Implementation of Wind Energy Projects in Australia* (2006).

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
- Defining the viewshed of the wind farm based upon the parameters of human vision
- Describing the planning policies that apply within the viewshed, particularly those such as Significant Landscape Overlays that recognise landscape values within the viewshed
- Describing the existing landscape characteristics within the viewshed and defining the landscape units and their sensitivity
- Carrying out a GIS based Zone of Visual Influence (ZVI) or 'seen area' analyses that illustrates those areas from which wind turbines, in whole or part, are visible
- Utilising the ZVI analysis to locate indicative viewpoints within the public domain (i.e. from roadsides or from recognised lookout or other vantage points) from which wind turbines would be visible, as a means of explaining the visual impact of the proposal on publicly accessible locations
- Examine the potential visual impact and 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 visual impact of night lighting

Results

<u>People's perception of wind farms</u>

Studies undertaken in the local area, within Australia and overseas indicate an increasing level of public support for wind farm development. Research supports the proposition that the vast majority of the community supports the creation of additional wind farms.

It should also be acknowledged that while the older research utilized in this study 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 more recent research is focused on those who live in the area and are the most familiar with the local landscape. The recent studies show a discernible rise in the level of public acceptance over the older studies 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%. The more recent research shows a level of community support in excess of 90% and a level of opposition of between 3-5% (refer to full report, Attachment 3.1).

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 design or 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.

Viewshed and zones of visual influence

The area that may potentially be visually affected by the wind turbines is called the viewshed. This viewshed may be broadly based on the characteristics of human vision (discussed in more detail in the full report, Attachment 3.1).

Within the viewshed of the wind farm there are differing zones of visual impact. The visual impact of a wind turbine at 16km 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.

The zones of visual influence for the proposed Gullen Range wind farm are summarised in Figures 7-1 – 7-4.

Table 7-2 Zones of visual influence

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.

Of note, 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
- 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 outside of the 17km viewshed and has not been assessed.

Existing landscape characteristics within the viewshed and landscape unit sensitivity

Landscape units are based on areas with similar visual characteristics in terms of topography, geological features, soil, vegetation, and land use. The landscape units relevant to the proposed Gullen Range wind farm include:

- *Landscape Unit 1 – Gently undulating farmland* is obviously man-modified, contains other infrastructure and is not topographically dramatic. It is a common landscape type in this area of NSW
- *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 contains drainage lines and some dams and is a common landscape element in this area of NSW
- *Landscape Unit 3 Vegetated areas* have remnant indigenous vegetation, typically on steep slopes and where soils are poorer
- *Landscape Unit 4 Rural townships* has a greater concentration of residences

The table overleaf summarises the sensitivity of the various landscape units within the visual catchment of the Gullen Range Wind Farm.

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 wind turbines are located on hilly areas in the landscape; the elevation change across the site may vary in height between approximately 500 to 980m AHD. Intervening ridges, depressions and rises can assist to screen views to the wind turbines from locations surrounding the wind farm.

Based on a categorization of visibility (see table overleaf), GIS analysis and mapping produced a series of maps to illustrate the degree of visibility of the proposal in the locality. The GIS analysis graphically illustrates those areas from which wind turbines, in whole or in part, will be visible within the viewshed. This is based solely on topography and does not take into account screening by vegetation, minor topographic changes and building. This screening will obviously reduce the visibility from many locations.

Zone A, B, C and D mapping is provided in this summary on the following pages. This analysis shows that the main areas that may be visually impacted by the proposal lie to the east. The ZVI studies show the very low potential for the wind farm to have an impact on built up areas associated with Crookwell. Even the most conservative of these studies (Zone D), shows that little of the urban areas associated with Crookwell will have views to the site. Wind turbines, either in whole or in part, will be visible from the townships of Crookwell and Grabben Gullen, however 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.

Table 7-3 Sensitivity of local landscape units

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.

Table 7-4 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

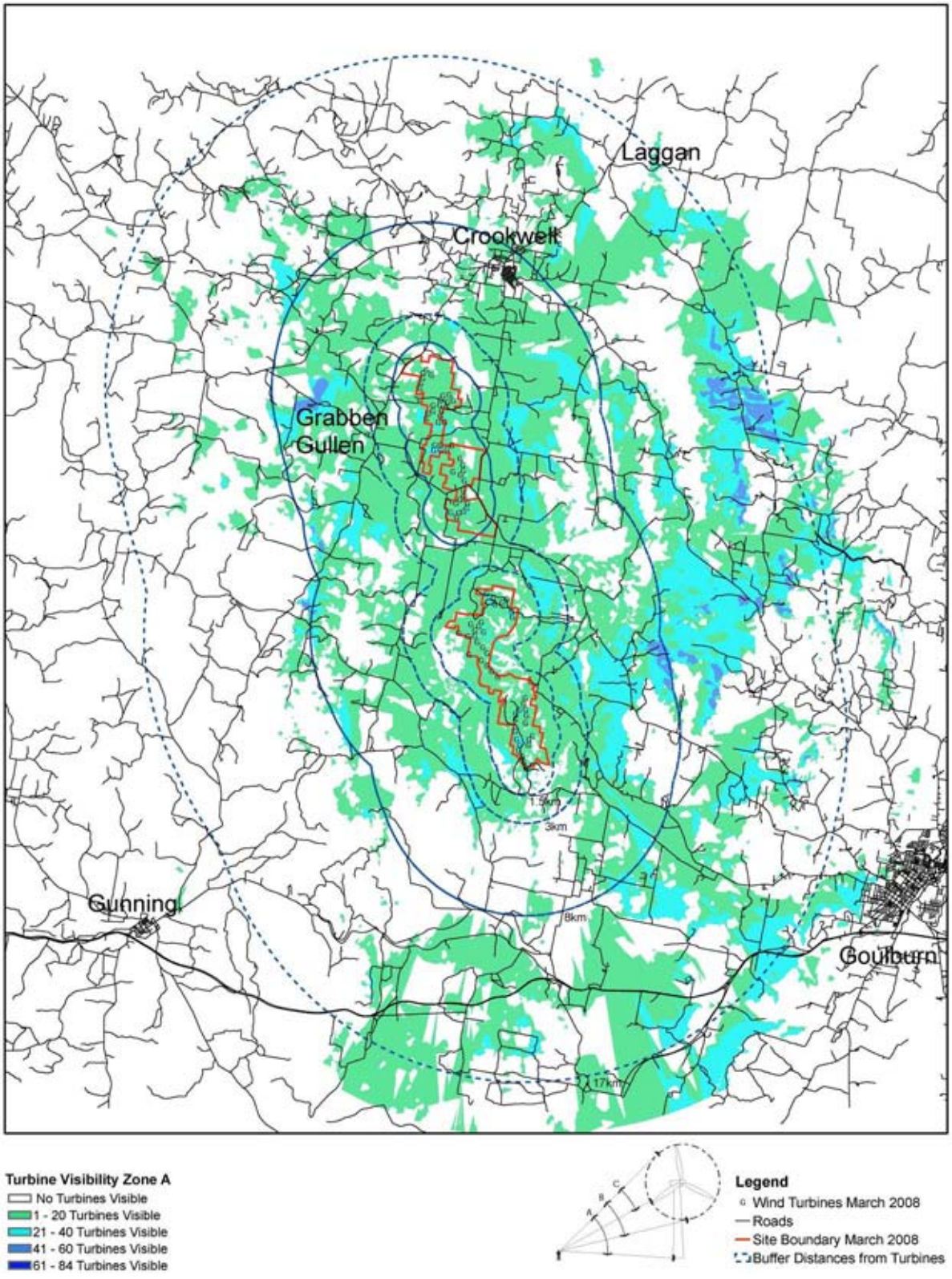

Figure 7-1 Turbine visibility Zone A

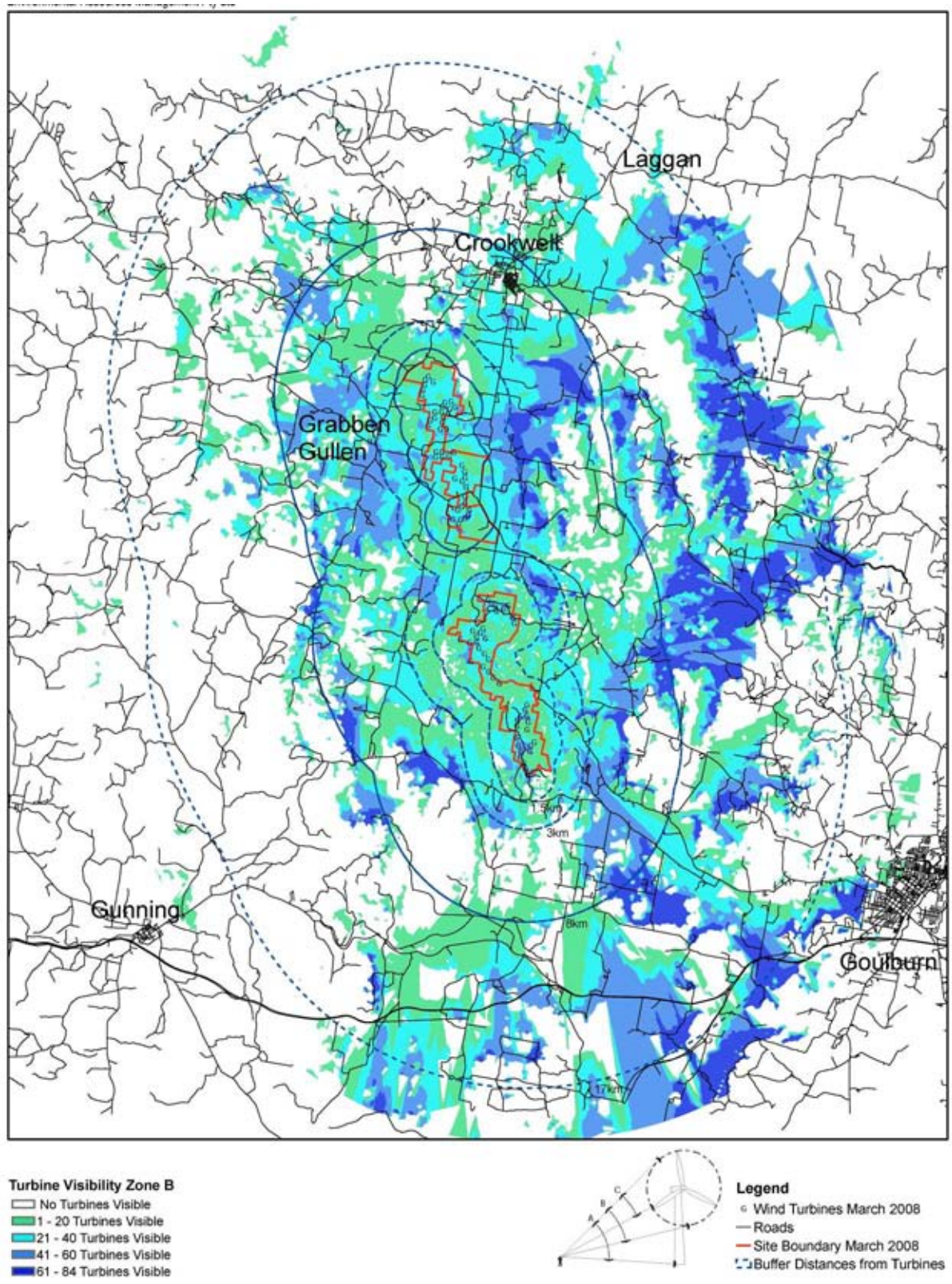

Figure 7-2 Turbine visibility Zone B

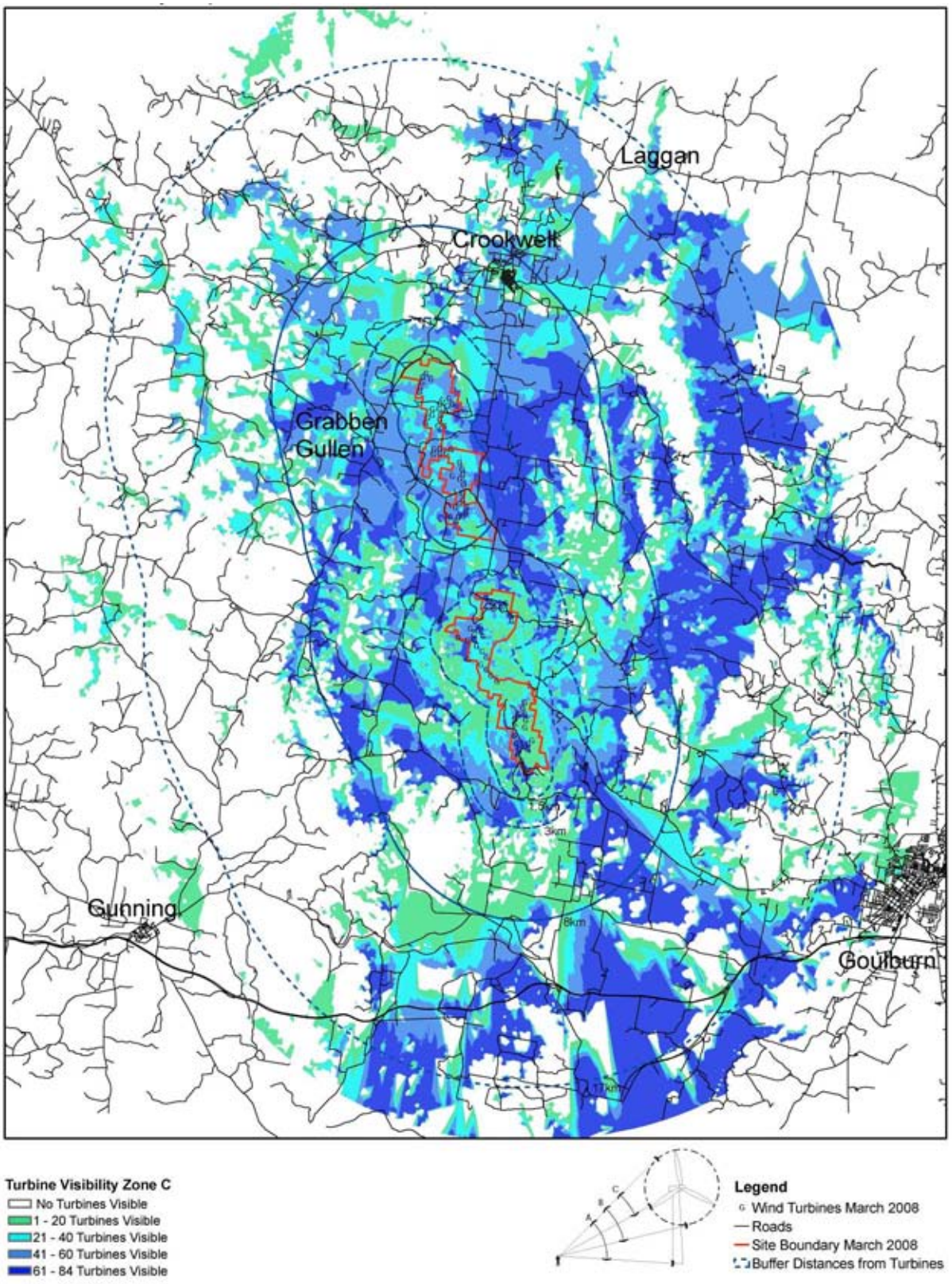

Figure 7-3 Turbine visibility Zone C

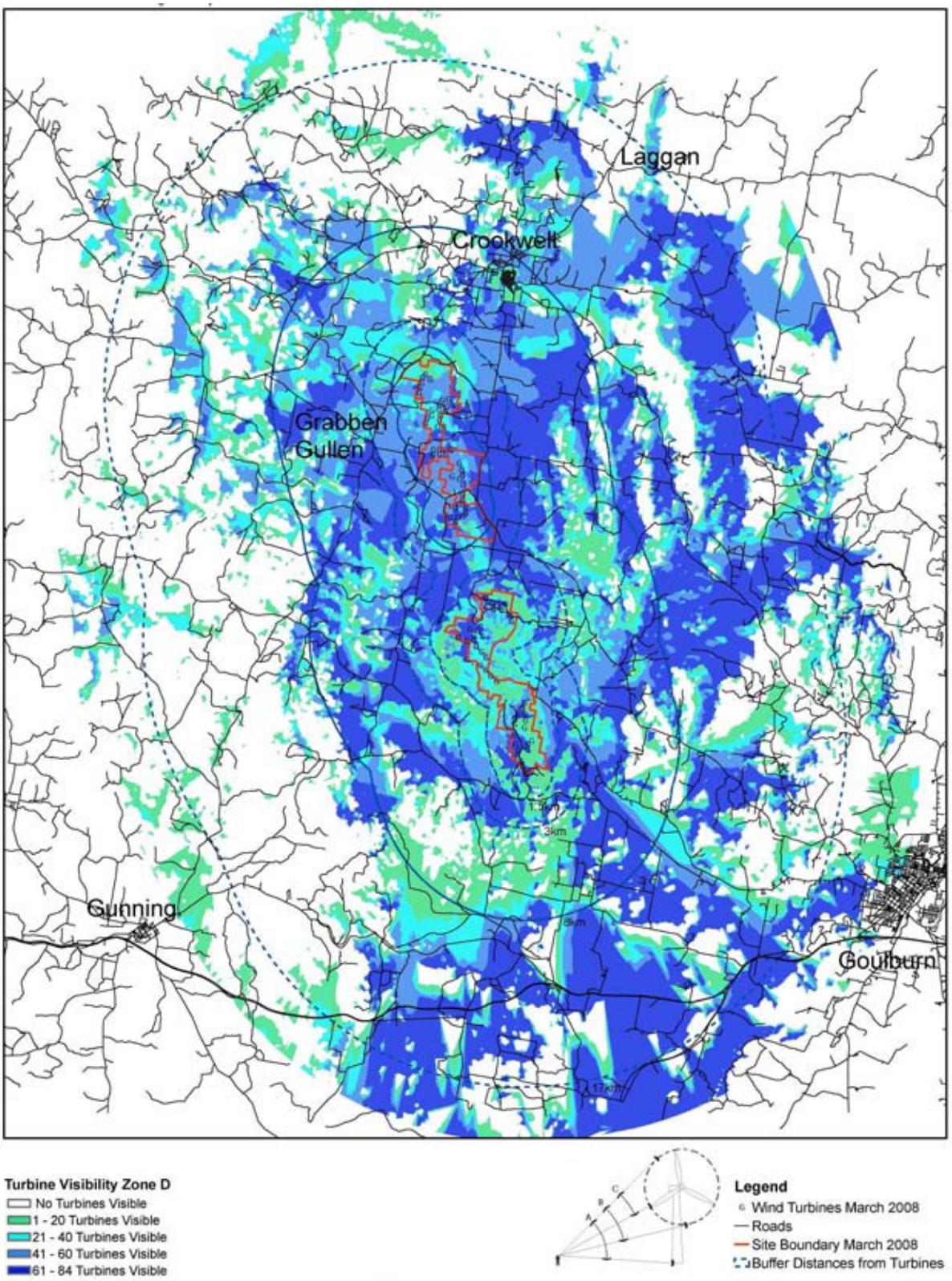

Figure 7-4 Turbine visibility Zone D

Indicative viewpoints within the public domain

The selection of publicly accessible viewpoints seeks to provide representative views from each of the character types within the viewshed and from locations identified via the 'seen area' analyses. 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:

1. Corner Mullins Creek Road and Gurrundah Road
2. Crookwell Gunning Road at Wattle Creek
3. Pomeroy Road
4. Walkoms Lane
5. Bannister Lane
6. Kialla Road
7. Range Road
8. Pejar Dam boat ramp
9. Bannister Lane (West)
10. Crookwell
11. Grabben Gullen
12. Laggan
13. Breadalbane

Photomontages have been prepared for each of these locations. Due to the resolution required to portray these montages, they are provided separately in Attachment 3.1. These viewpoints represent a reasonable range of impacts from publicly accessible locations within the viewshed, and that have the highest potential impact.

Based on an evaluation of landscape sensitivity, viewer numbers and distance to the nearest turbine, 12 out of the 13 viewpoints were assessed to have nil to low visual impact. No viewpoint was assessed to have high visual impact. Viewpoint 11: Grabben Gullen is located within Landscape unit 4 (rural township), has moderate visitor numbers, moderate landscape sensitivity and was assessed to have moderate overall visual impact. The impact relates to exposed publicly accessible locations and exposed residential properties.

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. Further, screening could convert the rural road network into a series of narrow corridors with dense screening vegetation along each side, which is undesirable from a visual perspective. This assessment concludes that there would be no need for management options to include planting along public roads as a visual mitigation measure.

Impact on residential properties

The landscape and visual impact methodology used in this report is based on the *Wind Farm and Landscape Values – National Assessment Framework* and is supported by past Victorian Planning Panel decisions and recent New South Wales Land and Environment

Court (LEC) decisions. The methodology (as described in detail in Section 3.1) discusses the notion of the viewshed and zones of visual impact. These zones, summarised in table 7.2, are based on the overall height of the proposed wind turbines and the parameters of human vision.

The major impact of wind turbines on residential properties occurs where wind turbines are within 1.5km. However wind turbines can be dominant out to 3km. The greatest potential impact is on neighbouring non-participatory residential properties. That is residential properties whose owners have not elected to be part of the wind farm, as it can be assumed that those that have elected to for their land to form part of the wind farm, the visual impact is acceptable.

There are 32 non-participatory residences within 1.5km of the nearest wind turbine. These houses lie along the eastern edge of the wind farm and are therefore potentially in areas where the previous 'seen area' analysis has shown that viewers are less likely to have views screened by topography offers. However western boundary shelter belt / wind break planting is quite common and where present will screen views to the turbines from residences along the eastern edge of the wind farm. There are 86 non-participatory residences more that 1.5km and less than 3km of the nearest wind turbine (refer to Attachment 3.1 for the location of these residences).

The *Wind Farm and Landscape Values – National Assessment Framework* discusses the importance of community consultation in identifying locally sensitive areas in the surrounding community. An Open House (Information Day) was held on 21 November 2007 and a specialist was in attendance to discuss the methodology and landscape and visual impacts associated with the project. Following the Open House, a site visit was undertaken to photograph additional locations to assess the visual impact on residential properties. This was done by identifying viewing locations that conservatively represent a concentration of dwellings and therefore demonstrate a worst case scenario. Three additional viewpoints were added to represent Kialla, Mummel and Bannister Lane. While the existing residences have varying levels of existing vegetation surrounding them, the overall visual impact on residences in each of these areas was assessed as being moderate, without screening, or low with screening and this is presented in Table 7-5.

Table 7-5 Visual locality assessment summary

The information below is extracted from the Visual Assessment report. The Figure numbering system in this table is as used in the Visual Assessment.

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.	

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.

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. Examples of screening options are provided in Attachment 3.1.

Cumulative visual impact

Cumulative visual impact can occur either by sequential and simultaneous views to wind turbines from publicly accessible viewpoints or from private viewing locations, or from changes to a communities or visitor's perception of a region due to the presence of multiple wind farms in an area. Figure 7-5 illustrates the viewsheds of existing and proposed wind farms (based on the height of wind turbines proposed) in the region. The potential for cumulative impact was assessed from townships, local roads and major transport corridors.

There are limited locations within the township of Crookwell where one can perceive the Gullen Range wind farm or where Crookwell 1 and Crookwell 2 would also be visible. The Gullen Range wind farm would not be visible from the townships of Goulburn and Gunning.

Travelers along the Hume Highway will pass close by the Cullerin wind farm, once constructed. Wind turbines at the Gunning and Gullen Range wind farms may also be visible from the Hume Highway behind the Cullerin wind farm. However, due to limited views, they would be a small additional element in the landscape. Whilst it may be possible for more than one wind farm to be viewed while traveling through this area in the Southern Highlands, the cumulative impact would therefore be minimal.

There may be a cumulative visual impact for users of roads running north-west from Goulburn past the Gullen Range wind farm to 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 wind farms. Similarly there may be a cumulative visual impact for users of the Grabben Gullen Road from Gunning in a north-easterly direction to Grabben Gullen and then to Crookwell. However, these are local roads with lower visitor numbers with limited viewing opportunities due to topography and vegetation. The cumulative impact would be only slightly greater than the impact of the Gullen Range wind farm alone.

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.

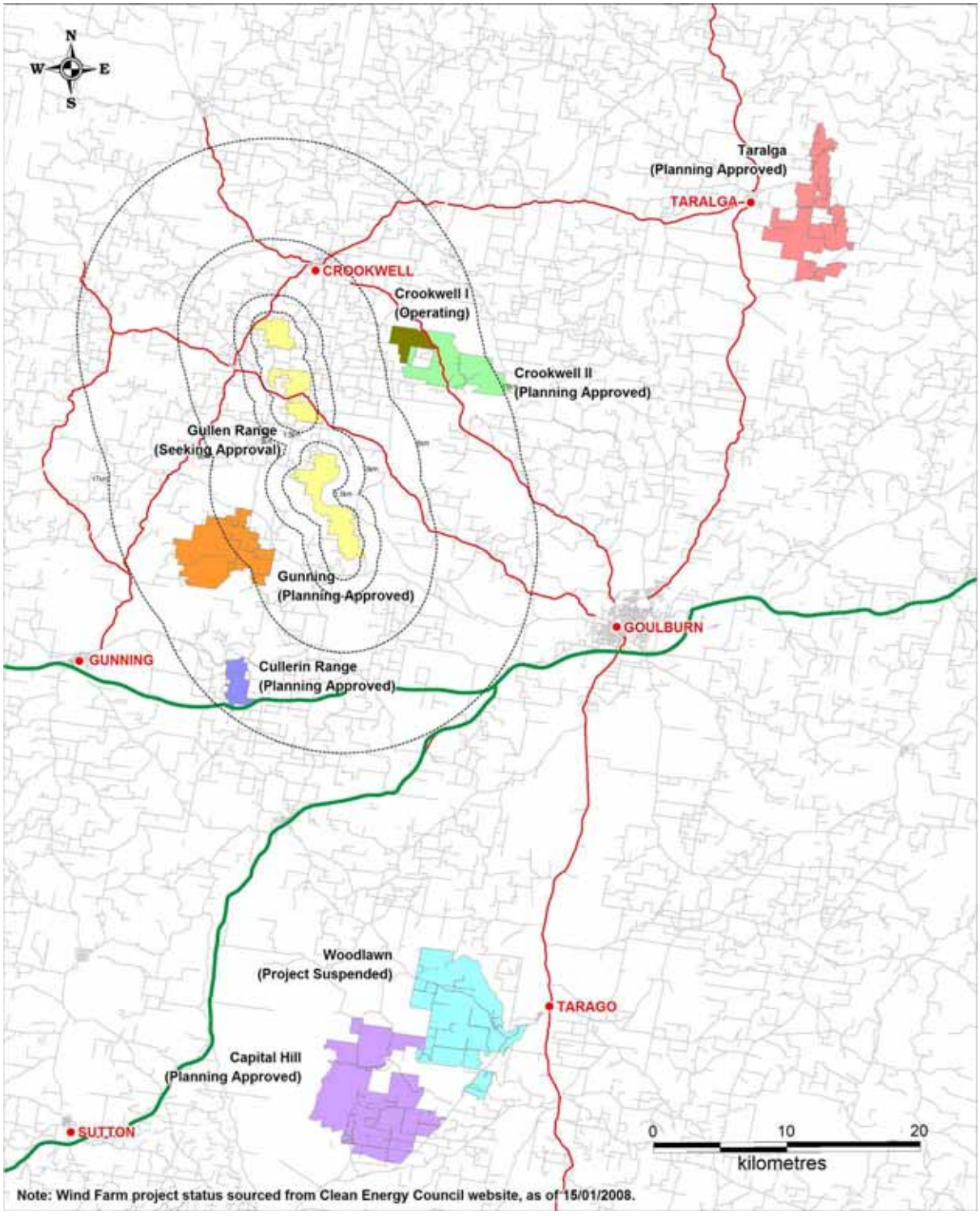

Figure 7-5 Viewshed of existing and proposed wind farms

Visual impact of night lighting

The assessment of the viewshed of the Gullen Range wind farm has identified the low density of occupants within the surrounding area and relatively low usage of the local road network. This has highlighted the fact that the wind farm is located in an area with little night time lighting and with few night time viewers.

The assessment of lighting impact has been made with recourse to a limited number of Victorian trials. These trials identify that the type of lights do make a difference to the visual impact; there are forms of lighting that can be used to reduce visual impact. Hazard identification lights are still an obvious element in the landscape, particularly where there are few light sources and these will be an obvious addition to the night panorama. However, few light sources are also an indication of few viewers. If lights are required by CASA, it is considered that the solution constructed at Mt Millar (detailed in Attachment 3.2) provides an acceptable level of visual impact while providing the required level of night time hazard identification.

The cumulative impact of night lighting on town and property residents as well as road users was considered. Residents may be able to see the hazard identification lighting of multiple wind farms. This impact would affect few houses, and be a relatively small visual impact; when people are at home at night with inside lights are on, windows become mirrors, reflecting the interior of the house, reducing the visibility of external lights at distance. Therefore at night in most situations, a viewer needs to be outside to even see the proposed hazard identification lights. Whilst night lighting may be visible to road users, it will only be one further element in a traveler's experience which includes the frequent presence of other necessary lighting (rear tail lights, headlights and lights from nearby houses and farms). For these reasons, the cumulative impact of night lighting has been assessed to be negligible.

Impact assessment

Construction and decommissioning impacts

The landscape and visual assessment by ERM concentrated on the visual impact of the proposal post construction. Additional visual impacts would be present during construction and decommissioning however. Large and heavy vehicles enroute to the site, road works on specified access roads, as well as turbine assembly onsite, would be visible to passing traffic and local residents in some locations.

This is considered to be a temporary impact. The areas that would be affected are covered in the visual assessment for the constructed turbines, summarised below. No mitigation measures additional to those discussed for operational impacts below are considered necessary.

Operational impacts

The landscape and visual impact assessment demonstrates that the site and its surrounds within the Southern Tablelands 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 continually show that the majority of viewers do not object to the construction of wind turbines on any but the most sensitive and localized landscapes.
- The Gullen Range Wind Farm site is in a modified landscape. The elements in the landscape are well represented across this area. Agricultural activity, associated structures and other signs of human intervention have created a landscape that can absorb other changes
- There are limited long distance views from the township of Crookwell and the visual impact would be negligible even from an elevated tourist lookout at this location

- The Hume Highway, which is one of the major roads within the region, is located to the south of the wind farm and although there will be views from this highway, they will be limited and the visual impact will be low. Visibility of the wind turbines from the Hume Highway is restricted to a few kilometres due to the presence of intervening ridges and roadside vegetation
- 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. Visibility from these minor roads, which have far fewer users than the highways and main roads, is also restricted by roadside vegetation
- There are 118 non-participating residences within 3km, the zone of greatest potential visual impact, and many of these existing residences already have screening in the form of wind breaks. Landscape mitigation can be effective in lessening the visual impact on residential properties
- If CASA requires obstacle lighting, the visual impact of night lighting would be low based on the type of lights now used and considering the night environment contains multiple light sources

Mitigation measures:

The following mitigation measures would be implemented to address the impacts discussed in this section:

- A site visit would determine the extent of planting between the Proponent and the resident for properties within 3km of a wind turbine. Species selection would be determined in consultation with landholders using advice from the local Landcare group. Any such offer would remain in place for a period of 1 year after project construction, to allow people time to either adjust or to decide that landscape filtering or screening is warranted
- This assessment concludes that there would be no need for management options to include planting along public roads as a visual mitigation measure

7.3 Operational and construction noise impacts

A noise impact assessment was completed by Marshall Day Acoustics Pty. Ltd. for the proposed Gullen Range wind farm. The construction noise assessment considered the type of equipment that would be utilised to construct the wind farm. The noise assessment for operational impacts was undertaken for six scenarios (a combination of three alternative turbine layouts and two alternative turbine models). Scenarios contained a range of total turbine numbers, from 77 to 84. A summary of the methodology and key results is described below. The noise assessment is appended in full, Attachment 3.2.

A specific turbine has not been selected for the project and accordingly the REpower MM82 and MM92 turbines have been used for the noise assessment as being representative of the range of turbines that are being considered. Results may vary slightly with different turbines and therefore, further noise modelling would be required to ensure compliance with the guidelines should the turbines or layouts change.

Approach

There are approximately 250 residential dwellings within a 5 kilometre radius of the wind farm, with the majority located to the east of Grabben Gullen Road. These dwellings are predominately concentrated in the Grabben Gullen, Kialla and Bannister areas. The approach of this assessment was as follows:

- The operational noise assessment was completed in accordance with the South Australia EPA *Environmental Noise Guidelines: Wind Farms (2003)*
- The construction noise assessment was completed in accordance with the NSW EPA *Environmental Noise Control Manual*
- A preliminary noise assessment was undertaken using SoundPLAN, a proprietary environmental noise prediction software package. This model was completed for all dwellings within a 5 kilometre radius of a proposed wind turbine. The model first utilised the input wind speed value of $9ms^{-1}$ with subsequent assessment calculated for the wind speed range of 3-12 ms^{-1} (wind speed range dependant upon turbine type)
- All models generated as part of the noise assessment used the algorithm described in *ISO9613-2: 1996 – Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation.* This standard facilitates the prediction of noise levels through spherical spreading effects and directivity and allows for variables including screening, atmospheric absorption and ground attenuation
- At locations where the preliminary noise assessment indicated sensitivity of a receiver location to the acceptable noise criteria, a detailed assessment was undertaken. All dwellings that had an initial predicted noise level of $32dBL_{Aeq}$ or greater were the subject of further assessment, with dwellings having less than $32dBL_{Aeq}$ assumed to comply with the relevant noise criteria. The results of this additional assessment identified that 17 relevant receivers required short term noise monitoring
- A background noise monitoring assessment $L_{A90,\ 10\ minute}$ was then undertaken at each of the 17 identified relevant receivers over a two week period. The background monitoring was undertaken primarily during winter 2007 over a 10 week period which is considered most likely to coincide with possible van den Berg effects and is therefore seen as conservative. In areas where a cluster of receiver locations occurred, a determination of the worst case single location was made to represent that cluster of receivers. The background noise data was collected using Acoustic Research laboratories (ARL) noise loggers, which are Type 1 and 2 measurement devices certified in accordance with AS1259-1990 or IEC-61672 (*International Electrotechnical Commission 2002).* These loggers were generally placed within 20 metres of a house, no closer than 5 metres from any reflective surface and at a consistent height of 1.2 metres above ground level
- Local weather conditions were monitored in conjunction with the background noise assessment to accurately identify periods of rain fall that occurred during the monitoring campaign. Data was excluded from the data set during periods of rain. A regression analysis was then completed to identify the site specific background noise levels
- The noise assessment also included a comparison between predicted equivalent L_{Aeq} levels and the L_{A90} noise limits set in accordance with the guideline values at each relevant receiver for each of the three proposed layouts

Impact assessment

Construction and decommissioning impacts

An impact assessment of the potential construction noise levels likely to occur during the construction phase of the project was undertaken. The impact assessment was completed using the known operational noise levels of a variety of heavy machinery and noise generating activities likely to be used during construction as detailed below.

- Excavator
- Grader
- Dump truck
- Concrete truck
- Front end loader
- Crane
- Bulldozer
- Delivery and 4WD vehicles
- Rock breaking
- Concrete batching

For the purpose of the noise assessment, it was considered appropriate to allow the construction noise level to exceed the background noise level by up 20 dBA, when measured over a 15 minute period. Therefore, the noise levels were predicted for each relevant receiver over a 15 minute assessment period as described in the *NSW Industrial Noise Policy.*

The results of the construction noise assessment indicated that predicted noise levels associated with the use of a variety of different machinery during the construction of the wind farm would comply with the limits described in the DECC *Environmental Noise Control Manual.*

Construction hours proposed for Saturday are from 7am to 4pm which represents a longer duration than set out in the Environmental Noise Control Manual (Saturday 7am to 1pm). However, the L_{10} levels predicted at each receiver location are significantly below the noise limit criteria (based on L_{90} + 20dBA) therefore the extension of construction hours will have a negligible impact. Longer hours will facilitate a shortened construction schedule, lessening prolonged impacts on neighbours.

Should bedrock be encountered during foundation excavations, blasting may be required. A blasting assessment was not completed as part of the noise impact assessment completed by Marshall Day Acoustics. It was noted in the noise impact assessment that the understood minimum distance between likely blasting points and the nearest residents would be approximately 550 metres. Marshall Day Acoustics considered that a blast with a maximum instantaneous charge of 15-18 kg would unlikely lead to a non compliance of the site specific noise criteria.

Mitigation measures:

Marshall Day Acoustics recommends the following mitigation measures be adopted during the construction phase of the project to minimise the construction noise impacts of the proposal:

- Limit hours of high noise generating activities
- Establish communication with relevant authorities and local residents
- Adoption of a site representative responsible for noise and vibration issues
- Undertake noise monitoring during construction. Develop an appropriate protocol to be followed in the event of a noise exceedance
- The contractor would select appropriate machinery for the proposed works. This machinery would have low inherent potential for noise generation where practicable

- Barriers would be erected around potentially high noise generating areas including generator and high duty compressors
- Appropriate siting of noisy machinery. This siting would be as far away from the nearest receiver as possible

Operational impacts

Noise impacts predicted to occur as a result of the operation of the wind farm were modelled using a three dimensional computer noise model in accordance with the ISO9613-2: 1996 propagation standard. A number of factors were considered when assessing the potential impacts, as presented below (refer to the detailed description of attenuation factors in Attachment 3.2). These include:

- L_w – Point source sound power level
- D – Directivity factor
- A_{div} – Unidirectional spherical divergence
- A_{atm} – Atmospheric absorption
- A_{ground} – Ground effect
- A_{screen} – Acoustic screening
- A_{misc} – Miscellaneous effects

As previously indicated, six alternate scenarios were assessed as part of the operational noise impact assessment. Of these scenarios, three were predicted to be in compliance at all receiver locations and three were noted to have marginal exceedances at one or more receiver location. The results indicated that the layout design of the wind turbines was not the influencing factor with regard to the noted exceedances, rather it was the model of wind turbine selected in the scenario. For all three turbine layouts, wind turbine MM82 was calculated to be compliant at all receiver locations. Conversely, for all three turbine layouts, wind turbine MM92 was calculated as having marginal exceedances at one or more receiver location. Noise plots are included for these two turbine types, Figure 7-6 and Figure 7-7.

Accordingly this demonstrates that appropriate turbine selection will allow the proponent to construct a wind farm which is compliant with the relevant noise criteria.

Additional analysis of the sensitivity of the physical dimensions (hub height and maximum tip height) and rated power of the turbines under consideration was undertaken to demonstrate that these parameters did not significantly increase noise propagation to receiver. To test the impact of height adjustments (hub and maximum tip heights), the Repower MM92 turbine was modelled on a 90m hub (with 136m maximum tip height) and the results were not significantly different from the MM92 modelling in the noise assessment (80m hub and 126m tip height). This analysis also presented the worst case noise impacts based on the turbine with the highest sound power curve (V90) on the current layout (layout C) and identifies that mitigation would be required to achieve compliance if this turbine was ultimately used.

Transformer noise was assessed with the transformers located to the south of the existing 330kV transmission line. The estimated sound power level for the dual Transgrid 33-330kV transformers was 98dBA each. In addition, it was noted that transformers of this nature exhibited strong tonality at 100Hz. Noise levels for the dual transformer were predicted for the nearest dwelling, located 875 metres to the south-west and were adjusted for the expected tonality in accordance with the NSW Industrial Noise Policy. The predicted noise level at the nearest dwelling is 24dBA, which was noted to be below the existing ambient level in addition to the predicted cumulative noise level from the wind farm. Visual screening proposed at this location would act to reduce this level further.

A tonality assessment was completed by WindTest as part of the operational noise assessment. The guideline states that a 5dBA penalty can be applied to the cumulative predicted results at each receiver location. This tonality assessment was completed in accordance with the IEC-61400-11. The assessment determined that for the wind speed range considered it was evident that tonality is not an audible component of either the MM82 or MM92's sound power spectra and as such no penalty is required.

The SA Noise Guidelines was developed with inherent noise characteristics of wind turbines specifically taken into account. This includes the aerodynamic noise from the blades passing through the air usually referred to as 'swish'. In addition, it is now commonly accepted that modern wind turbine designs do not exhibit significant levels of infrasound (low level sound) in their frequency spectra.

The issue of the van den Berg Effect was explored during the Taralga wind farm appeal heard by the NSW Land and Environment Court in 2006. The judgment handed down by the Land and Environment Court of NSW noted that the SA guidelines adopted a very cautious approach to accommodate the impacts of any and all noise effects caused by wind farms by using a lower 35dBA limit instead of 40dBA as adopted by New Zealand (NZ 6808). It further observed that the if the van der Berg Effect did occur, it would be on a cold winters night when people were unlikely to be outside their dwellings and the façade effect (estimated at 10dBA) would reduce the transmission loss for exterior noise to the interior of the house.

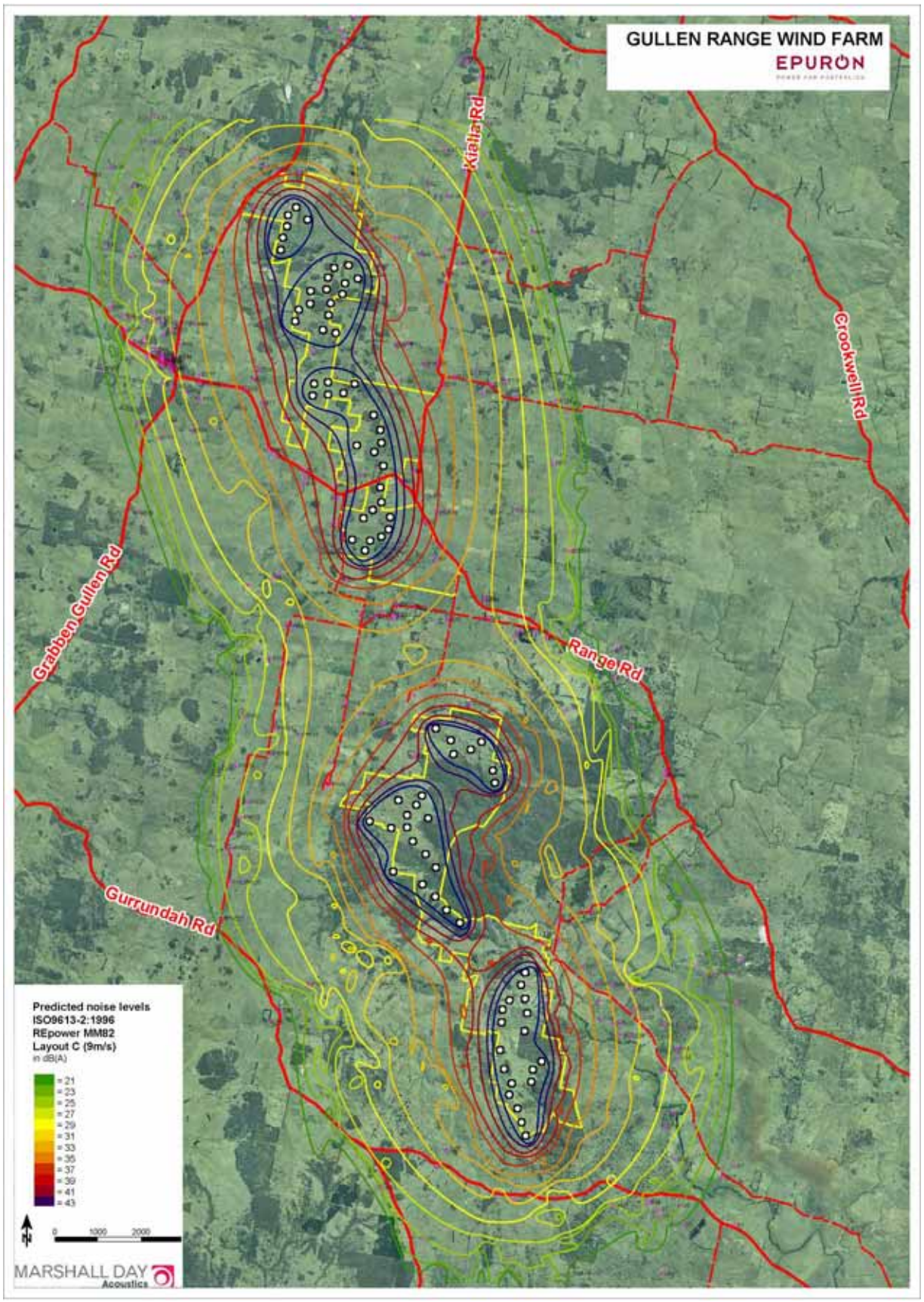

Figure 7-6 Predicted noise plot for turbine type MM82

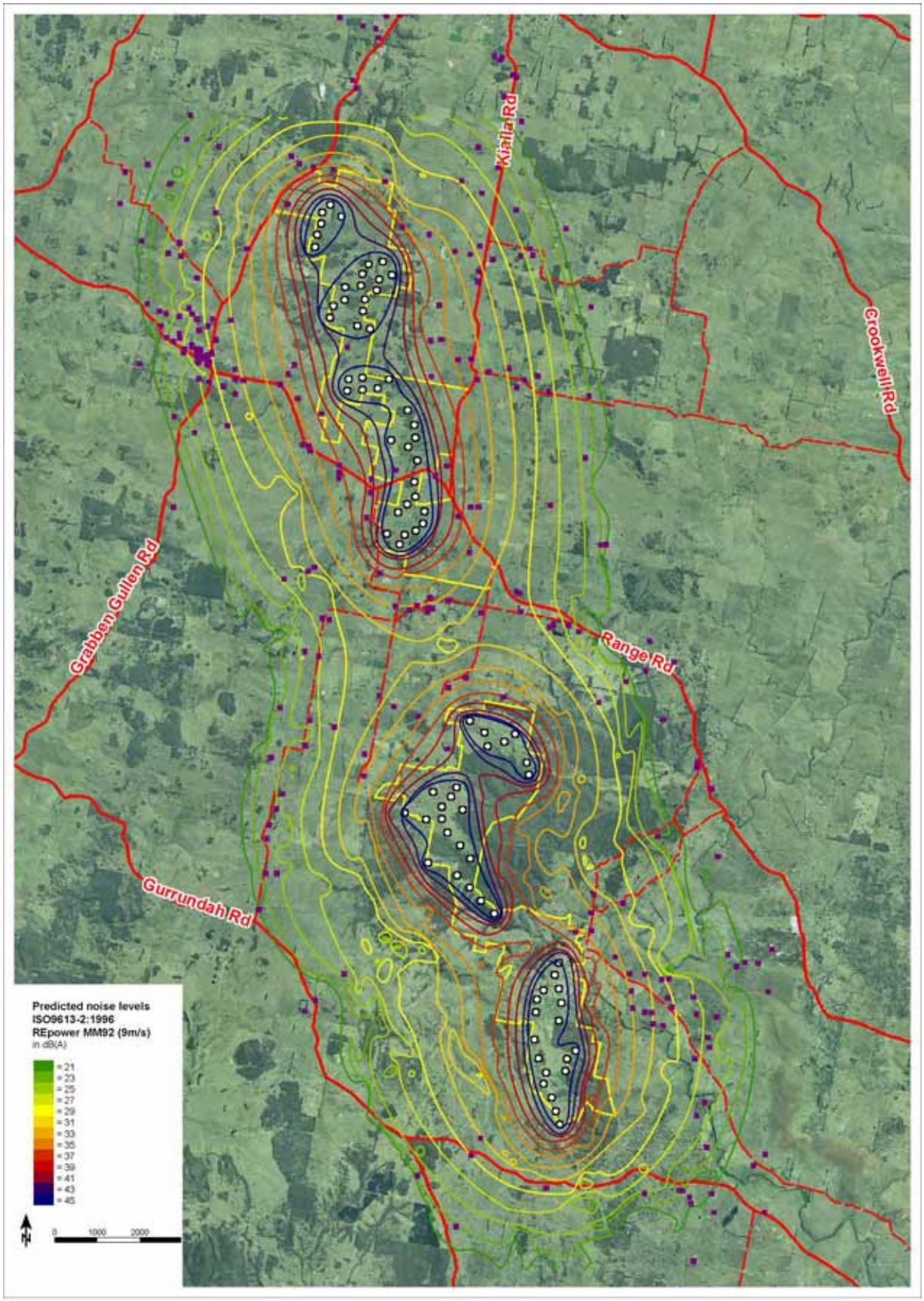

Figure 7-7 Predicted noise plot for turbine type MM92

Mitigation measures:

- The proponent will adjust turbine selection and turbine layouts to ensure noise predictions meet the SA Noise Guidelines of 35 dB(A) or background plus 5 dB(A) (whichever is higher) for all non-involved residential receivers

- The proponent will adjust turbine selection and turbine layouts to ensure noise predictions meet the World Health Organisation Guidelines for Community Noise requiring 45 dB(A) or background plus 5 dB(A) (whichever is higher) for all involved residential receivers

- Prior to construction, the proponent will prepare and submit to the Department of Planning a noise report providing final noise predictions based on the final turbine model and turbine layout selected and demonstrating compliance with these relevant guidelines for all residences

- If, following these assessments, minor exceedances are predicted to occur for facades that include noise sensitive uses, such as bedrooms, consideration will be given to providing mechanical ventilation (to remove the requirement for open windows) or structural acoustic treatments (such as improved glazing) to the satisfaction of the relevant residents

Note:

i. It should be noted that an excess between 0.6 to 1.6dBA is not perceptible to human hearing. An excess of 3dB is just perceptible

ii. No penalty has been applied to predicted results due to wind turbine generator annoying characteristics, namely infrasound and tonality

iii. Predictions using the ISO9613-2:1996 noise propagation standard allow for down wind propagation in all directions, which is analogous to moderate temperature inversion conditions

iv. Construction noise has been predicted to each receiver location with the results indicating that noise levels would be within predetermined limits

v. Transformer noise has been predicted to the closest noise sensitive receiver location (PW07) and has been found to be of an acceptable level

vi. It is appreciated that the final turbine selection has not been made and accordingly further assessment is required to ensure compliance. However this assessment concludes and demonstrates that the layout has the flexibility to be compliant with the SA Noise Guidelines across a range of turbines by slightly relocating turbines (within 250m), removing turbines or using active noise control functions of the turbines

7.4 Biodiversity

7.4.1 Flora and fauna

nghenvironmental were commissioned to undertake a flora and fauna assessment, covering all areas that would be affected by the development. This section summarises the approach, results and mitigation measures required to avoid and, where avoidance is not possible, minimise potential adverse biodiversity impacts. Detailed results, including vegetation and constraints mapping, are provided in the Biodiversity Assessment, Attachment 3.3. (Constraints are summarised at the end of this section in Figure 7-8, Figure 7-9, Figure 7-10, Figure 7-11, overlaid on the infrastructure layout).

Approach

The flora and fauna assessment considers all impacts that the proposal may generate. These include impacts due to the installation, operation and decommissioning of the wind farm, such as loss and modification of habitat, potential to fragment habitat, potential for animals to collide with turbines and indirect impacts such as noise and dust generation.

The work began with a desktop assessment and regional review to identify species and communities of conservation significance which may be present in the study area. Threatened flora recorded from the Gunning, Goulburn, Canberra, Braidwood, Crookwell and Taralga 1:100,000 map sheets or elsewhere on the Southern Tablelands in grassy woodland habitat were considered. Threatened fauna from the Gunning, Crookwell and Goulburn 1:100,000 map sheets were considered. Matters of national significance, listed under the *Environment Protection and Biodiversity Conservation Act 1999,* within a 50km buffer around the development envelope, were investigated using the EPBC reporting tool.

Survey work on site included vegetation mapping, habitat evaluations, fauna censuses (frog, bird, reptile), mammal trapping, spotlighting and call playback and recording the calls of microbats. Work was focussed in the better quality habitats within and adjacent to the development envelope to maximise activity recorded. Likely locations for access tracks and the substation were also assessed. The surveying was undertaken in autumn 2007 with a follow-up assessment in spring 2007.

The flora survey methodology was the random meander method of Cropper (1993). No quadrat-based survey was undertaken, but greater survey effort, equivalent to that required for quadrats, was applied to areas which were in better condition, or appeared likely to fall within the definition of the various Endangered Ecological Communities (EECs) which could occur in the vicinity. The total survey effort on the first field survey was 5 full days by two botanists, with some additional time on the subsequent two days by a single botanist (total c. 11 person days). The second field survey (covering three additional areas, and briefly revisiting one of the earlier sites, Kialla) consisted of 1.5 person days.

Exact locations of flora surveys within the development footprint were not documented, but surveys were undertaken in all areas of woody vegetation located within or adjacent to the development envelope. On the flatter sites (Kialla and Bannister) this amounted to all areas of native vegetation, while on the steeper Pomeroy and Gurrundah sites mainly the upper edges of vegetation on steeper parts of the site was assessed, as the proposed infrastructure is predisposed to be located on ridgelines. However, some gullies and creek banks were also checked on Pomeroy. Checking within the extensive areas of pasture was more limited, but representative areas of native and exotic pasture were assessed. Despite the survey limitations with regard to timing and intensity, it was considered unlikely that significant or threatened species would occur at sites likely to carry the wind turbines, largely because of the degree of disturbance of these areas. The survey effort is considered by the authors of this report to have been appropriate to the identification of biodiversity constraints.

The biodiversity assessment focuses on species and communities listed as threatened at the state or national level however, non-threatened species assessed to be at risk were also considered. In no case was the lack of detection of a threatened species during onsite surveys grounds for ruling it out of impact assessment and design of mitigation measures. The primary role of the survey effort is to better understand the availability of onsite resources, the context of the resources (by consideration of surrounding resources) and secondarily to obtain information on the plants and animals onsite. Survey results are considered a 'snap shot' and never the basis for ruling out the potential for threatened species to occur, particularly given the rarity and cryptic nature of most threatened species.

The methodology was guided by publications including the Department of Environment and Climate Change and Department of Primary Industry, Draft Guidelines for Threatened Species Assessment (2005), EPBC Act Supplementary Significant Impact Guidelines 2.1.1 (2005) and the Auswind Wind Farms and Birds: Interim Standards for Risk Assessment (2005).

Regional review

The four locations proposed for this development fall within the administrative jurisdiction of the Hawkesbury Nepean Catchment Management Authority, Upper Wollondilly River Subcatchment. The Upper Wollondilly River Subcatchment is the highest point in the catchment and is located adjacent to the westward flowing Lachlan River Subcatchment. There are two reservoirs and several weirs within the subcatchment.

Diverse vegetation communities occur across the Bioregion, varying according to topography, soils and micro-climate. Communities of yellow box (*Eucalyptus melliodora*), red box (*Eucalyptus polyanthemos*) and Blakely's red gum (*Eucalyptus blakelyi*), and white box (*Eucalyptus albens*) occupy lower areas. Red stringybark (*Eucalyptus macrorhyncha*), Broad-leaved Peppermint (*Eucalyptus dives*) and White Gum (*Eucalyptus rossii*) associations dominate hills in the west of the bioregion (NSW NPWS 2005). The yellow box, Blakely's red gum woodlands and natural temperate grasslands have been heavily cleared and fragmented by agricultural activities, and are listed as Endangered Ecological Communities. A range of riparian and wetland habitats occur in the bioregion, including river oak forest, heathy swamps and sedgelands. These wetlands can be ephemeral, attracting large numbers of birds in wet seasons. Lower elevation wetlands can be extensively depleted and degraded by draining, salinity, nutrient pollution, grazing, sedimentation and weeds.

Many declines in species number and abundance have followed the European settlement of the region (Falconer 2004). Examples include the brolgas, bettongs, bustards, rock wallabies, koalas, bush stone-curlews, bandicoots, quolls and rat kangaroos.). Large areas of well connected habitat are necessary for many locally occurring threatened species. While many species can persist in smaller patches, these are often subject to disturbances which can impact on population viability (NSW NPWS 2003).

Vegetation types

In general, the development envelope carries a combination of pasture and woodland. The ridges likely to carry the turbines on the four locations carry some remnant native vegetation in the form of scattered trees and small to medium sized (1-3 hectares) patches of remnant or regrowth woodland or forest, and some of the relevant paddocks consist of predominantly native pasture. Other areas consist of largely or entirely exotic ("improved") pasture or weeds. The surrounding slopes and gullies are unlikely to become turbine sites but could be affected if access routes for vehicles or powerlines were routed through them. In most cases the slopes and gullies carry substantially more native vegetation than the ridge tops. Apart from past agricultural usage, two main factors govern vegetation types on the locations: geology and altitude. The pasture and six woodland vegetation types present in the study area are described below (vegetation maps are provided in the Biodiversity Assessment, Attachment 3.4).

Table 7-6 Vegetation types and their determinants onsite and on potential access routes.

Grey shading indicates the vegetation communities that fall within the definition of EECs, including the EEC Basalt White Box, Yellow Box, Blakely's Red Gum Woodland.

Locations	Kialla	Bannister	Pomeroy	Gurrundah	On access routes
Elevation	~980m ASL	~980m ASL	~860m ASL	~780m ASL	
Geology					
Basalt	No	Yes - Produces a heavy soil, located predominantly on flats. Converted to exotic pasture more frequently than other soils with a greater tendency to weed infestation.	Yes - Produces a heavy soil, located predominantly on flats. Converted to exotic pasture more frequently than other soils with a greater tendency to weed infestation.	No	
Ordovician metasiltstone	Yes – Produces relatively infertile soils.	Yes – Produces relatively infertile soils.	Yes – Produces skeletal and relatively infertile soils. Predominantly located on steeper ridges with rock outcrops.	Yes – Produces skeletal and relatively infertile soils. Predominantly located on steeper ridges with rock outcrops.	
Vegetation type					
1. Scribbly gum-brittle gum-broad-leaf peppermint dry forest SCRA classification: Forest Ecosystem 113, North-East Tablelands Dry Shrub/ Grass. SCIVI classification: DSF p9, Tableland Low Woodland or DSF p14 Western Tablelands Dry Forest.	No	No	No	Dominant on upper slopes with a large retained patch on east-facing side.	
2. Broad-leaf peppermint-brittle gum dry forest SCRA classification: Forest Ecosystem 109 Widespread Tablelands Dry Shrub/ Tussock Grass Forest. SCIVI classification: GW p23 Tableland Hills Grassy Woodland.	No	No	Dominant on upper slopes on east-facing side, mostly young (<30 yrs) regrowth.	No	Common on verges of approach roads.

Locations	Kialla	Bannister	Pomeroy	Gurrundah	On access routes
3. Apple box- yellow box grassy woodland SCRA classification: Forest Ecosystem 90 Northern Tablelands Acacia Herb/ Dry Grass Forest. SCIVI classification: GW p24, Tableland Grassy Box-Gum Woodland. Potential EEC: White Box, Yellow Box, Blakely's Red Gum Woodland	No The patch at the front gate of Kialla does not contain yellow box and is heavily sheep trampled. It does not qualify as EEC. This EEC does not occur within the Kialla boundary.	No	Some retained patches in fair condition east from the stockyards in southern half of site, around upper edges of some gullies and remnant trees with exotic groundcover in eastern part of northern half of site.	Scattered yellow box indicate the presence of a mid-slope band of this woodland type, now largely cleared. The remnants are likely to be below the development envelope.	
4. Blakely's red gum- yellow box grassy woodland SCRA classification: Forest Ecosystem 160 Northern Slopes Dry Grass Woodland. SCIVI classification: GW p24, Tablelands Grassy Box-Gum Woodland. Potential EEC: White Box, Yellow Box, Blakely's Red Gum Woodland	No	No	No	No	Present in one or two patches of roadside remnant on Range Rd and Pomeroy Rd.
5. Mountain gum – broad-leaf peppermint moist forest SCRA classification: Forest Ecosystem 111, Central Northern Tablelands Dry Shrub/Grass Forest. SCIVI classification: Part of a broader group, GW p20, Tableland Basalt Forest. Potential EEC: Tableland Basalt Forest (partial only).	The only woodland community present on this location, with numerous remnant patches. Only patches in drainage lines where mountain gum is dominant could be considered as part of the EEC.	One large patch north on Banfield property, small patches on Leonard property. Where broad-leaf peppermint is dominant, the EEC is not present.	Yes	No	

Locations	Kialla	Bannister	Pomeroy	Gurrundah	On access routes
6. Snow gum or ribbon gum moist forest SCRA classification: Part of a broader group, Forest Ecosystem 89, Eastern Tablelands Acacia/Herb/Grass Forest. SCIVI classification: Part of the broader group WSF p73, Cool Montane Wet Forest. Potential EEC: Tableland Basalt Forest	No	Eastern boundary of this location in mid-northern section (near old buildings) and mid-southern section on steep slope above and around dam.	Yes	No	
7. Narrow-leaf peppermint moist forest SCRA classification: FE56, Tableland and Escarpment Moist Herb/Fern Forest - E radiata/E. viminalis/Viola spp. SCIVI classification: WSF p73 Cool Montane Wet Forest. Potential EEC: Tableland Basalt Forest	No	North-west corner of Banfield property, in good condition. Narrow east-west belt on eastern side of Leonard property in poor condition. Potential for some associated native pasture, if present, to be EEC.	No	No	No
8. Natural Temperate (wet) Grassland SCRA classification: FE147, Tablelands Moist Sedge/Herb/Grassland. SCIVI classification: FOW p54, Tableland Swamp Woodland. Potential EEC: Natural temperate grasslands of the southern tablelands	One area in an upper drainage line in the north-east corner of Elliott property, dominated by Poa labillardierei.	No	No	No	No

Vegetation of conservation significance

No plant species listed as threatened in Schedules 1 and 2 of the *Threatened Species Conservation Act 1995* were found on or near the locations. One species listed nationally under the *Environment Protection and Biodiversity Conservation Act 1999* was identified from a single non-flowering plant in pasture on Gurrundah, the Hoary sunray. Twenty-seven threatened species were evaluated for their potential to occur within the areas that would be impacted by the proposal. Twenty-six species rated nil or low likelihood for impact and were not evaluated further. Only the Hoary sunray, was identified as having greater than low potential for impact as a consequence of the proposal.

An assessment of significance was carried out, pursuant to the EPBC Act, for the Hoary sunray. The poor quality of habitat in which this species was observed and low likelihood of a viable local population being present, were the key determinants in this assessment. A significant impact is not anticipated as a consequence of the proposal.

Two vegetation types were identified during the site assessment which fall within the definition of the Endangered Ecological Community (EEC) White Box, Yellow Box, Blakely's Red Gum Woodland. These were vegetation type 3-Apple box- yellow box grassy woodland and vegetation type 4-Blakely's red gum- yellow box grassy woodland. This EEC is listed in NSW under the *NSW Threatened Species Conservation Act 1995* and is covered by the national listing of Grassy White Box Woodland under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

Assessments of Significance, as specified under the *TSC Act* and the *EPBC Act* were completed to properly characterise the threat to the White box- Yellow Box – Blakely's Red Gum Grassy Woodland EEC. These assessments concluded that, as infrastructure placement would largely avoid the mid slope position where this community occurs, the potential for direct impact would be low. Most remnants of this community onsite are already substantially degraded and are unlikely to suffer a negative impact from the proposal. Nonetheless, where possible, this community should be avoided.

Two vegetation types may fall within the definition of the EEC Tableland Basalt Forest. These are vegetation type 6-Snow gum – ribbon gum moist forest and vegetation type 7-Narrow-leaf peppermint moist forest. Assessment of Significance, as specified under the *TSC Act* was undertaken to characterise impact to this community. It was concluded that it is unlikely to suffer a negative impact from the proposal. The occurrences of this community on the 'old' Kialla site is restricted to drainage line positions which are unlikely to be developed. Occurrences on 'new' Kialla sites are close to a dwelling, and are therefore unlikely to be developed. It is assumed that turbines will be sited in areas which do not require the removal of large numbers of trees, so the relatively undisturbed occurrences of this EEC on the Bannister site are unlikely to be directly affected. Some low quality small remnants with an almost entirely exotic understorey in the southern part of Bannister may be cleared, but these represent only a small proportion of the occurrence of this EEC in the vicinity, and are already severely degraded by grazing and weed invasion. Areas of pasture in the vicinity of the EEC stands are unlikely to qualify as EEC themselves, due to the pasture on basalt on Bannister being almost entirely exotic.

No probable access routes pass through any of the better quality remnants of EEC. So long as forest remnants are not cleared and an adequate buffer zone is left undisturbed around remnants, the impact on this community should not to be significant. Smaller degraded remnants would be of lesser significance, such as the one through which the track south from Range Road passes on the Banfield property, and various small isolated remnants south from Range Road. A 250m long easement would be required through Snow gum – ribbon gum moist forest at the south of the Pomeroy site. In this location, mature trees are located predominantly in the gully, which would be avoided. It is considered that the easement could be routed through and area previously thinned and thereby minimise fragmentation and the risk of impact on community integrity.

Fauna habitat provision

Three broad habitat types were identified, providing different habitat resources for fauna onsite:

- Pasture, often containing isolated paddock trees,
- Woodland, predominantly occurring as patches of native tree regeneration, and
- Wetlands, predominantly small dams but also including nearby creeks and rivers.

Important fauna habitat features within the development envelope include hollow-bearing trees, linking woodland remnants, wetlands, rocky outcrops and native pasture. While these features are largely located outside areas that would be directly impacted by the development of the wind farm (which would be predominantly located in cleared ridges and flats), they play an important role in sustaining native fauna populations at the sites and potentially, in the locality. The potential for indirect as well as direct impacts of the proposal on these features was considered.

Fauna of conservation significance

Five threatened fauna species were recorded during the field work: Common Bent-wing Bat (possible and probable[1]), Large-footed Myotis (probable), Eastern False Pipistrelle (possible), Powerful Owl and Squirrel Glider. These species are listed as Vulnerable under the NSW *Threatened Species Conservation Act 1995*. The Common Bent-wing Bat is also listed as Conservation Dependant under the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999*.

An evaluation of 46 other threatened species with potential to occur onsite was undertaken. Thirty-two species were found to have potential for a moderate to high level of impact. Some of these impacts are readily avoided or mitigated while other impacts may pose a significant threat to the species considered. To properly characterise the impact of the proposal on threatened fauna, pursuant to the *NSW Environmental Planning and Assessment Act* and the Commonwealth *Environmental Protection and Biodiversity Conservation Act*, an 'Assessment of Significance' was conducted (refer to Appendix E, Attachment 3.3) for species for whom effective mitigation strategies would be more difficult:

Birds: Glossy Black Cockatoo, Blue-billed Duck, Square-tailed Kite, Brown Treecreeper, Regent Honeyeater, Powerful Owl, Speckled Warbler, Fork-tailed Swift, White-throated Needletail, Rainbow Bee-eater, Satin Flycatcher, Rufous Fantail, Great Egret, Cattle Egret, Latham's Snipe, Gang-gang Cockatoo, Diamond Firetail, Swift Parrot and Superb Parrot.

Bats: Eastern False Pipistrelle, Large-eared Pied Bat, Eastern Freetail Bat, Grey-headed Flying Fox and Common bent-wing bat.

Reptiles: Grassland Earless Dragon.

Based on these assessments, mitigation measures were identified that would ensure the level of potential impact on these species is minimised or, where possible, avoided (detailed below). On the basis of effective implementation of these mitigation measures, significant impact is not anticipated for these species.

Key constraints

Key constraints were identified and mapped for each site (Figure 7-8, Figure 7-9, Figure 7-10, Figure 7-11). These related to the distribution of:

[1] Confidence levels of possible and probable were obtained from microbat call analysis.

Kialla

- Vegetation of conservation significance
- Mature vegetation with high potential for threatened mammals
- Woodland fragments with a moderate level of connectivity
- High potential for threatened reptiles
- A large offsite dam

Bannister

- Vegetation of conservation significance
- Mature vegetation with potential for threatened mammals
- Woodland fragments with a moderate level of connectivity
- Areas of high potential for threatened reptiles

Pomeroy

- Vegetation of conservation significance
- Mature vegetation with high potential for threatened mammals
- Woodland fragments with a moderate level of connectivity
- High potential for threatened reptiles
- Large offsite water bodies

Gurrundah

- Vegetation of conservation significance
- Mature vegetation with high potential for threatened mammals
- Woodland fragments with a moderate level of connectivity
- Areas of high potential for threatened reptiles
- Water bodies, keep turbines as far back from here as possible

Impact assessment

A number of environmental gains are associated with wind farm development. Wind farms have potential to address Anthropogenic Climate Change (listed in New South Wales as a Key Threatening Process) by reducing reliance on the burning of fossil fuels for energy. Climate change would add to existing stresses on biodiversity, contributing to degradation and fragmentation of natural ecosystems, increased fire frequency, soil erosion and dryland salinity, causing some systems to exceed critical thresholds (Pittock 2003). Less intensive grazing beneath turbines in drought years may be achievable within the development envelope as a result of the additional income from lease agreements. This would have benefits for soil health and biodiversity. However, through clearing, soil disturbance and the installation of infrastructure, direct and indirect biodiversity impacts have been identified and would require mitigation to ensure that impacts are avoided where possible or minimised where avoidance is not possible.

Construction and decommissioning impacts

Loss of habitat and habitat degradation are the key potential impacts of the construction phase. The discrete development footprint of the proposed wind farm does not contain unique or quality breeding or foraging habitat for flora or fauna and as the turbine locations

are proposed for sites that are largely cleared of native vegetation, the impact to the amount and quality of habitat onsite would be minimal. The exception to this statement is where the development overlaps dams, roadside remnants, isolated paddock trees, woodland remnants and the areas of potential threatened reptile habitat identified in the constraints maps.

The Biodiversity Assessment (Attachment 3.3) was based on a 'turbine envelope' which showed that placement of turbines and associated infrastructure could be undertaken entirely within cleared areas, with the exception of 250m segment of electricity easement at the southern end of the Pomeroy site. The current infrastructure layout shows that all turbines would be placed in areas cleared of trees. Some turbines abut woodland and at the scale of the constraints maps provided may appear to be within woodland but are not. The area of woodland at the southern end of the Pomeroy site which would require some clearing of trees to establish an electricity easement from Pomeroy to Gurrundah has been quantified and the impact of clearing assessed in the Biodiversity Assessment.

The proposal requests some flexibility in turbine layout and the Proponent has committed to locating infrastructure in cleared areas (as shown) where practical. It is possible that some lopping or even tree removal may later be required based on the final infrastructure layout. In the case that tree removal is required, the decision to place infrastructure in treed areas would be justified by the Proponent on the basis of wind speed optimisation and topographical constraints, thereby improving the viability of the proposal.

The Biodiversity Assessment considers that there is ample ability to offset onsite for the minor amount of proposed clearing within the site boundaries. Woodland at Pomeroy, adjacent to the proposed power line, could be managed in perpetuity to preserve this habitat. Additionally weed control at Pomeroy to address existing serrated tussock infestations is proposed. These measures would ensure that the net biodiversity outcome is positive.

The final infrastructure layout will determine the precise amount of clearing required. At that time, formal agreements would be sought with the affected involved land owners. It appears that, by locating infrastructure in cleared paddocks, most of which are dominated by exotic species, addressing noxious weed infestations and by agreeing to manage those areas which have been identified as exclusion zones in the constraints mapping, that the project is well able to achieve a net benefit in terms of environmental outcomes onsite. This should also be viewed in terms of the wider environmental benefits of establishing renewable energy generation in rural areas, which has significant broad level environmental benefits.

The sites contain livestock and their current management involves the operation of machinery and vehicles in largely cleared areas. The increased noise, vehicle emissions and dust expected during the construction phase are not anticipated to be cause for concern for fauna onsite. Temporarily de-stocking areas where construction works are underway would reduce potential for injury to stock during the construction phase. Adhering to predetermined access routes and low speeds (max. 40km/hr) would reduce the risk of vehicles colliding with stock or native fauna onsite.

Habitat degradation resulting from the construction of the project is readily avoided and controlled using standard best-practice mitigation methods (sediment and erosion controls, noise controls, weed controls). These measures would also minimise the impact to fauna onsite during construction.

Mitigation measures:

- Wherever practical, infrastructure would be confined to cleared areas, avoiding woodland patches. A buffer around mature woodland patches would be established to ensure indirect impacts (such as noise and dust) are minimised where practical. Access tracks through these areas would not be appropriate

- An electricity easement would be required through woodland at the south of the Pomeroy site. The Proponent would locate the easement where vegetation has been previously thinned. Suitable power line clearance would be achieved so as to avoid the more mature gully vegetation. The width of the easement would be minimised
- Wherever practical, isolated mature trees (>60cm diameter at breast height) in cleared areas would be retained
- The final infrastructure layout (including access tracks and electricity easements) would avoid potential habitat for the threatened shrubs *Bossiaea oligosperma, Dillwynia glaucula, Pultenaea pedunculate,* spring-flowering orchids *Caladenia tessellata, Diuris aequalis* and the threatened reptiles Striped Legless Lizard *Delma impar*, Pink-Tailed Worm-Lizard *Aprasia parapulchella*, and the Grassland Earless Dragon *Tympanocryptis pinguicolla* (refer to constraints maps in this EA: Figure 7-8, Figure 7-9, Figure 7-10, Figure 7-11)

  Particularly, if the Grassland Earless Dragon is present in the location identified at Gurrundah north, a viable population of this species could be placed at risk of extinction by the development of a track and turbine through this area. Revised site planning now shows the core area of potential habitat would be avoided by works. Development on the periphery, which is more marginal habitat, is acceptable. Continued grazing at current intensity is recommended in this area to preserve the existing habitat qualities
- The Proponent would commit to offsets determined by a qualified expert on the basis of the quantum of vegetation to be removed, pending development of the final infrastructure layout
- Weed and sediment erosion controls would be implemented to prevent onsite habitat degradation during and following the proposed works. A Construction Environmental Plan would be the appropriate vehicle for these controls. Weeds such as serrated tussock would be treated before the commencement of works to avoid spreading the infestation
- All areas of disturbed soil would be rehabilitated progressively as soon as practicable after disturbance, in order to resist erosion and colonisation by weeds. This may require restricting stock access and implementing revegetation activities
- Wherever practical, and where the initial monitoring program demonstrates a need, the Proponent will liaise with landowners to fill in dams within 100m of a turbine on involved properties to reduce the potential to attract birds and bats which might collide with turbines. Dams removed due to site development would be reinstated in more appropriate locations to retain this habitat resource onsite.
- The proposed substation location at Pomeroy is endorsed by the findings of this assessment. It has no biodiversity constraints to development
- A final site inspection would be required for the electricity easement between Pomeroy and Gurrundah to allow micro-siting of the easement in areas of least vegetation
- A final site inspection would be required if the alternative access off Prices Lane to Pomeroy becomes the preferred option
- A final site inspection would be required if the western access option (a paper road) to Gurrundah becomes the preferred option
- A flora assessment should be conducted as part of the construction environmental management plan, to microsite infrastructure such as tracks away from better quality patches of understorey.

Operational impacts

No operational flora impacts are anticipated. Conversely, the key fauna impacts are expected to be related to the operational phase of the wind farm. Bird and bat strike are the foremost concerns, as inappropriately sited turbines have potential for frequent and / or large numbers of mortalities for certain species. Risks to birds and bats from operational wind farms can be categorised as either direct collision impacts (most notably with turbine blades), or indirect impacts on habitat utilisation (for example, avoiding resources near turbines). For flocking / colonial species and species which occur at low density in the landscape, collisions may constitute a threat to a local population.

A risk assessment and evaluation of collision and avoidance impacts is undertaken within the appended Biodiversity Assessment, Attachment 3.3. For raptors, the risk is related primarily to foraging. There is potential to reduce this risk by managing the availability of prey onsite. Where a level of risk remains that mortalities would occur, monitoring is required to ensure that mortality levels do not reach unacceptable levels without action being taken.

For species such as the Fork-tailed Swift and White-throated Needle-tail, the risk was related to migration or long-distance movements. For resident birds and bats, the literature suggests that a degree of acclimation to turbines occurs. In conjunction with the management of onsite resources for these species (such as prey populations beneath turbines and water sources within close proximity of turbines) and monitoring collisions as part of an adaptive management monitoring program, the risk of collision is considered manageable. However, for long distance migrations of birds or bats, where an individual bird or bat may only fly over the site once, there is not acclimation potential, no ability to manage onsite resources (as none occur) and no ability to respond adaptively to recorded collisions via an adaptive management monitoring program. The risk assessment in the Biodiversity Assessment evaluated the likelihood and consequence of this potential impact. Species ecology, the non-linear arrangement of woodland fragments, lack of known migration pathways and lack of clearly defined ridges were factors considered in determining that the risk to these species was not unacceptable.

In terms of behaviour modification, the proposal is unlikely to influence the movement of waterbirds along riparian corridors but may be more likely to influence the movement of woodland birds and bats moving between woodland patches onsite and in the locality. The southernmost sites, Pomeroy and Gurrundah, contain extensive woodland habitat to the east of where turbines are proposed. There is potential for the birds and bats in these areas to avoid moving west to use smaller woodland remnants. While little information is available pertaining to the seasonal and diurnal migration routes for bird species at the site, it is not known to be a migration corridor for waterbirds or woodland species. Furthermore, the fragmented habitat and abundance of aggressively territorial species (magpies, white winged choughs, ravens) suggests that these smaller woodland patches would not be preferred habitat to many other woodland birds.

A range of mitigation measures is available for incorporation into the development design, to address where possible the risk of the operational phase of the development.

Mitigation measures:

- Aviation lighting, if required, would be minimised in number and fitted to reduce their ability to attract migrating birds and insects. Red lights are preferred, with the least number of flashes per minute. Cowls may also shield the light when viewed from the ground and reduce potential to attract wetland birds taking off at dusk
- Guy lines would not be fitted to towers or associated structures, where practical
- The turbine towers would be designed to minimise provide perching opportunities

- Electrical connection lines should be installed underground where practical
- Power poles and overhead powerlines would be bird-safe using flags or marker balls, large wire size, wire insulation, wire and conductor spacing
- To reduce the attractiveness of the site to foraging raptors, rabbits should be controlled on the turbine ridges, carrion would be removed from the site as quickly as possible
- A monitoring program would be designed to document mortalities, remove carcasses and assess the effectiveness of controls (outlined in Section 9.3.1)
- If mortalities exceed a pre-determined threshold (set out in the monitoring program), additional mitigation measures would be considered, such as diversion structures, blade, turning off turbines at critical times, further habitat modification and enhancement of off-site habitats

Decommissioning impacts

Decommissioning of the wind turbines would involve similar impact types to the construction phase. A reduced level of impact is anticipated however, as all below-ground structures (footings, concrete slabs, underground cabling) would remain *insitu* reducing the amount of excavation required and associated environmental impacts to soil, water and native vegetation. The required stabilisation of disturbed soil would relate primarily to the redevelopment of vehicle tracks and hard stand areas.

Mitigation measures:

- A flora and fauna assessment would be undertaken prior to decommissioning to identify biodiversity constraints
- Weed and sediment erosion control principles would be developed and implemented
- Disturbed ground would be stabilised and rehabilitated as soon as practicable after works

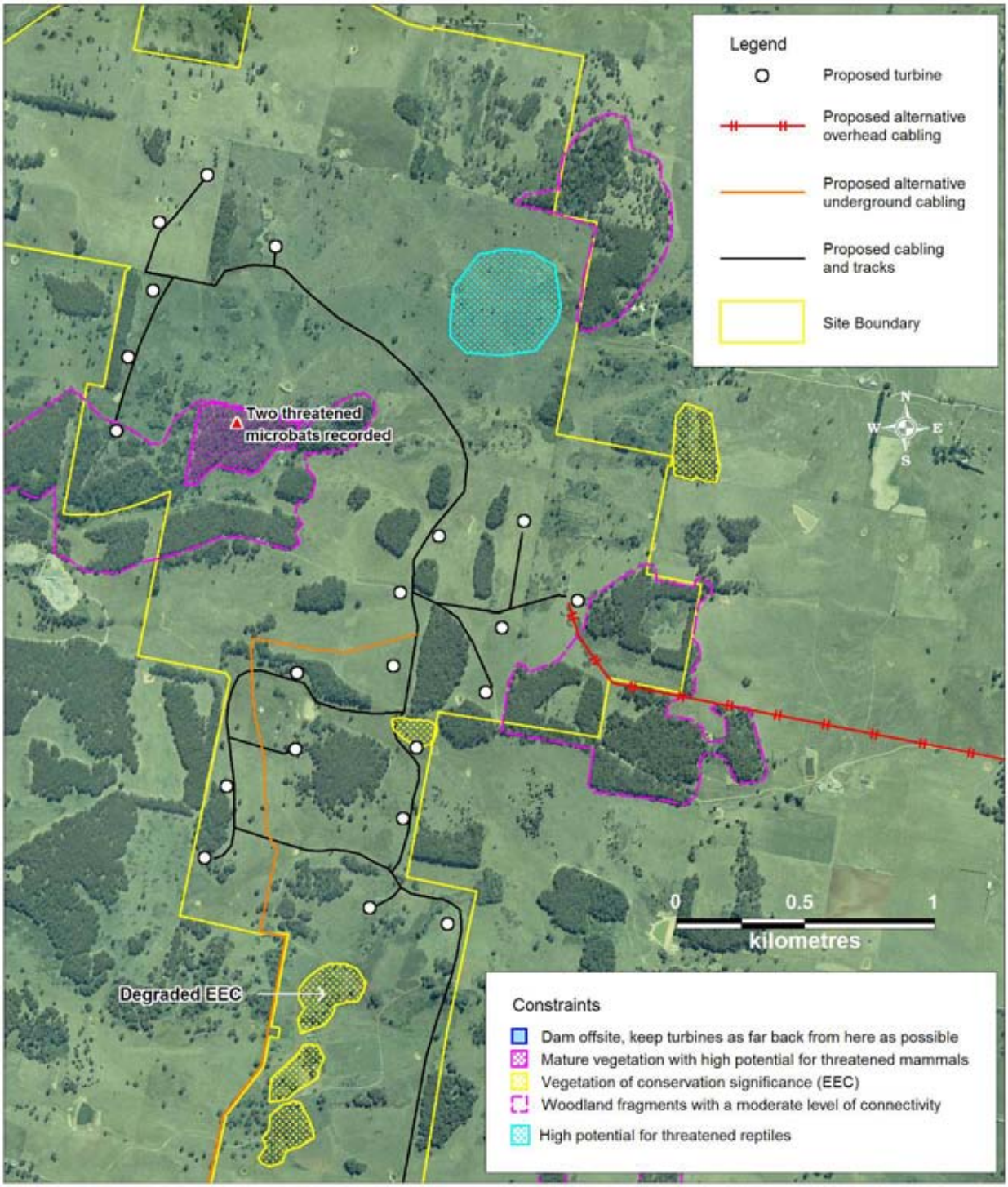

Figure 7-8 Biodiversity constraints: Kialla

Proposed infrastructure, overlaid on areas identified as biodiversity constraints

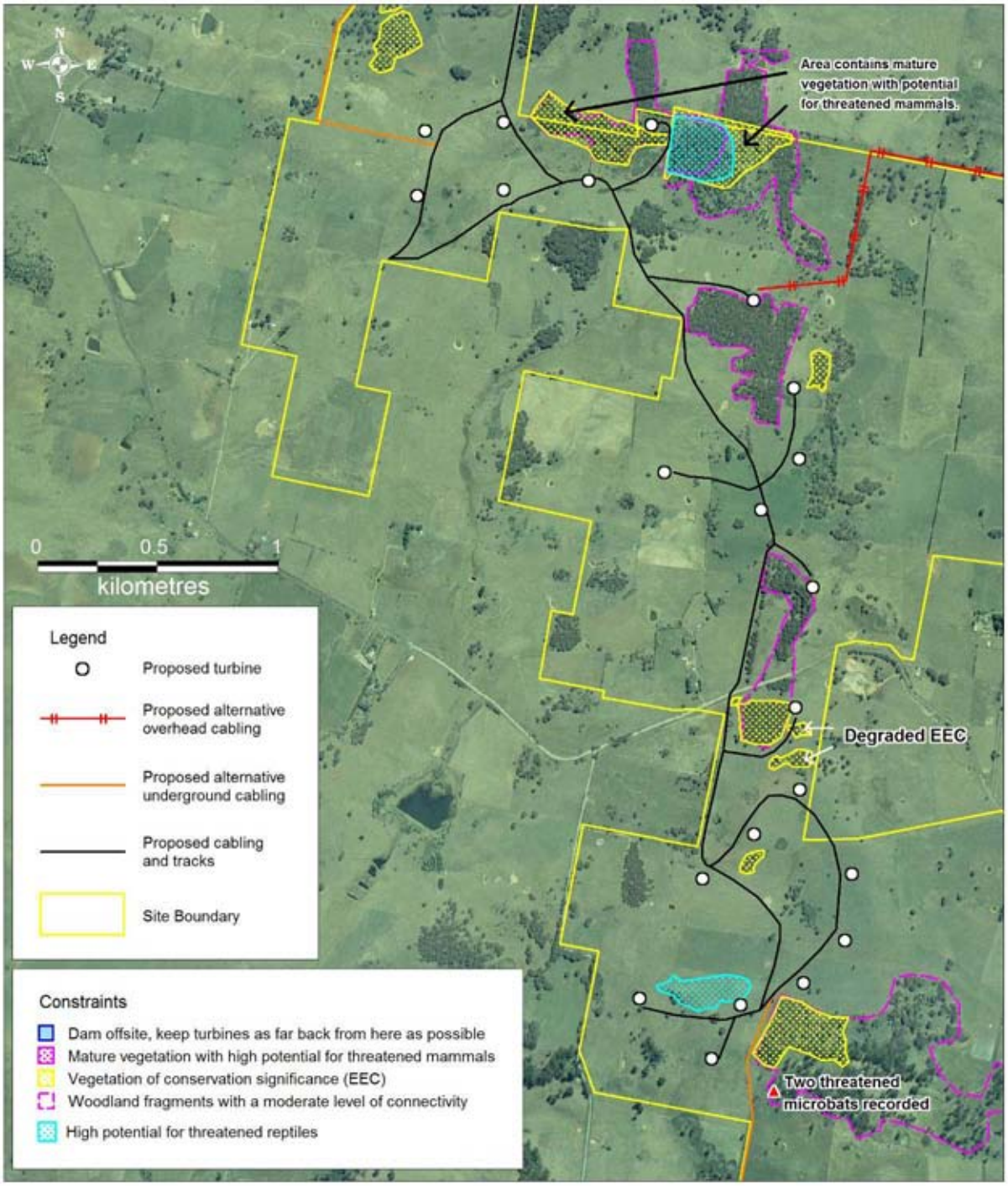

Figure 7-9 Biodiversity constraints: Bannister

Proposed infrastructure, overlaid on areas identified as biodiversity constraints

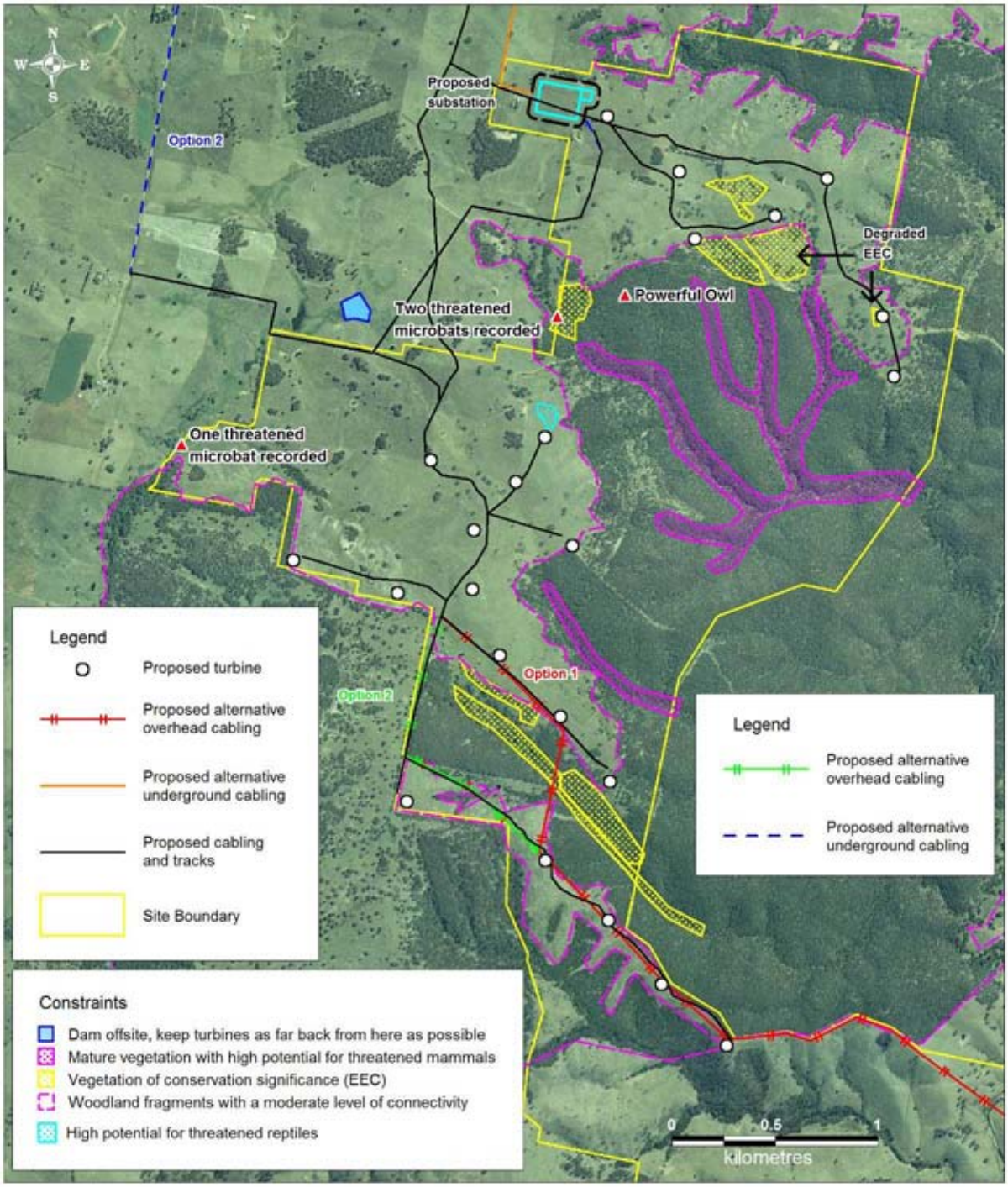

Figure 7-10 Biodiversity constraints: Pomeroy

Proposed infrastructure, overlaid on areas identified as biodiversity constraints

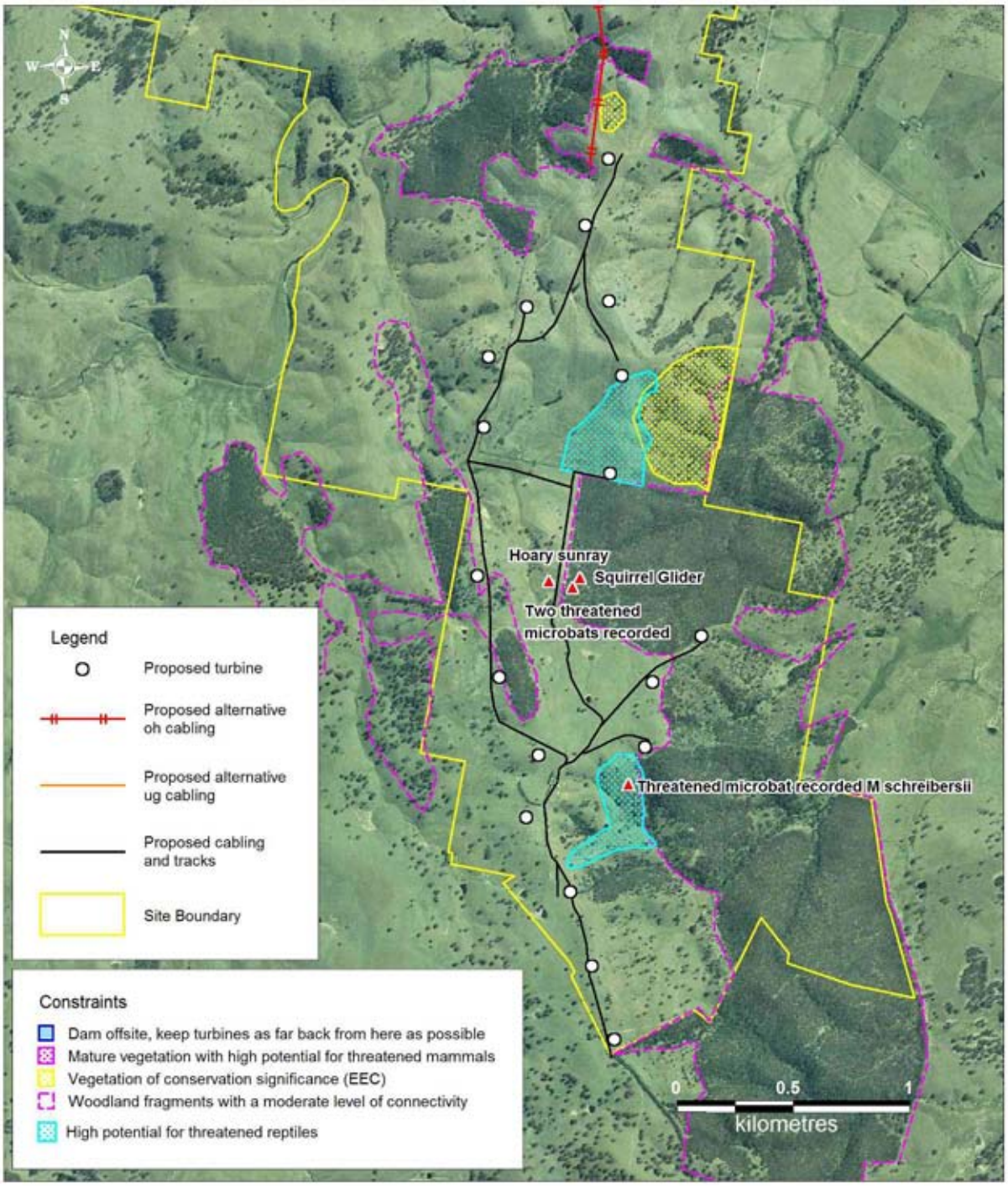

Figure 7-11 Biodiversity constraints: Gurrundah

Proposed infrastructure, overlaid on areas identified as biodiversity constraints

7.4.2 Mitchell landscapes

Existing environment

Mitchell Landscape mapping provides an overview of geology, geomorphology, topography, soils and geodiversity for bioregions within NSW. The mapping scheme categorises bioregions using these attributes. Data exists on the level of modification (such as clearing) that has occurred within the Mitchell Landscape mapping units and in this way the significance of further impact can be evaluated. For example, a Mitchell Landscape which has been over 70% cleared since European settlement would be considered significant; further clearing within this landscape may have ecological implications for the bioregion. This data is used by Catchment Management Authorities within NSW.

Four Mitchell landscapes occur within the development envelope. These include:

1. Rockley Plains (62% cleared)
2. Gundary Plains (78% cleared)
3. Crookwell Basalts and Sands (94% cleared)
4. Breadalbane Swamps and Lagoons (96% cleared)

The latter three landscapes are considered to be overcleared, having undergone more than 70% vegetation clearance since European settlement. Under the *Native Vegetation Act 2003*, vegetation in moderate to good condition (as determined by the Environmental Outcomes Assessment Methodology - EOAM) within overcleared Mitchell landscapes would not be permitted to be cleared. Although this Act does not apply to Part 3A developments, this goal has been adopted by the Proponent as a strategy for minimising the biodiversity impact of the Gullen Range wind farm.

Figure 7-12 overlays the Mitchell Landscapes on the broad development envelope. While most of the southern envelope corresponds to Rockley Plains, the northern envelope mostly corresponds to the overcleared Gundary Plains and Crookwell Basalts and Sands. The greatest potential for impact is therefore in the northern half of the site.

Kialla

The vegetation at the Kialla site has been assessed in terms of vegetation type and condition. One area of naturally treeless native grassland was found in the Kialla area, in the north-east corner of the Elliot property. This area could fall within the definition of the Endangered Ecological Community, Natural Temperate Grassland of the Southern Tablelands of NSW and the Australian Capital Territory, listed as nationally endangered under the EPBC Act. This area has been mapped as a constraint (refer to biodiversity constraints mapping, Section 7.4 of this report). No works would be undertaken in this area. Woodland fragments have also been excluded from development. Groundcover over the remaining ridge crests is substantially altered by a long history of grazing and in many areas by ploughing and sowing of exotic pasture species, and it therefore could no longer be considered to be native vegetation in moderate to good condition.

Bannister and Pomeroy

On basalt soils, the conversion to exotic pasture has been more successful, with predominantly exotic pasture grasses such as phalaris and perennial ryegrass dominating in some areas on Bannister and the noxious weed serrated tussock dominant on the basalt areas of Pomeroy. Woodland fragments have been excluded from development.

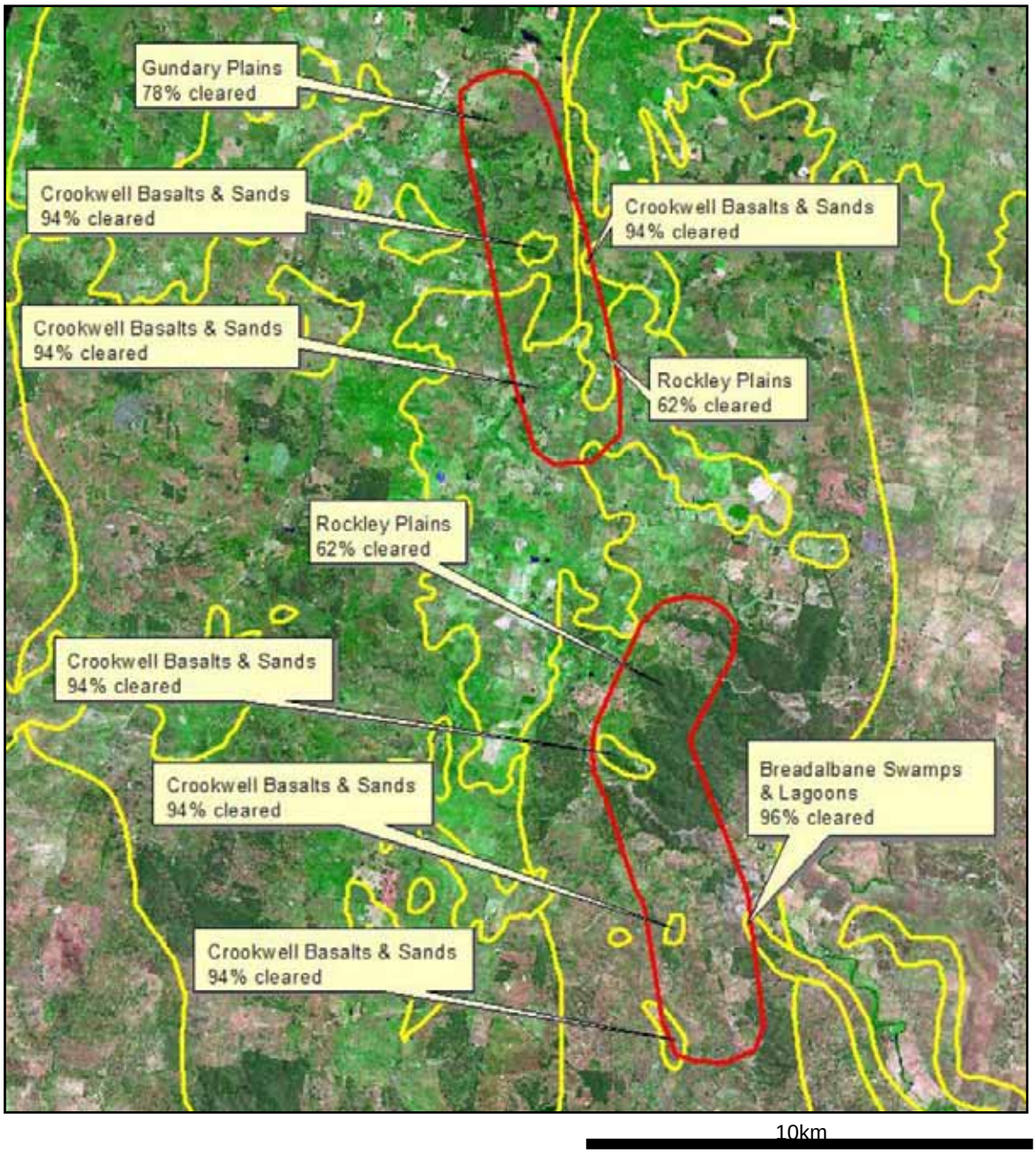

Figure 7-12 Mitchell landscapes occurring within the broad development envelope

Mitchell landscape mapping provided by the HN-CMA.

Gurrundah

Gurrundah has soils derived from metasiltstone ploughing where pasture "improvement" has generally resulted in a predominantly native pasture dominated by wallaby grasses (*Austrodanthonia* species) and weeping grass (*Microlaena stipoides*), with a variable proportion of exotic legumes (clovers, *Trifolium* spp and medics, Medicago spp) and weeds such as sheep sorrel (**Acetosella vulgaris*) and flatweed (**Hypochaeris radicata*). In areas which have had tree removal but no ploughing, the native understorey grasses *Joycea pallida* and *Poa* spp still dominate, and some of these areas also include some native forbs, although in general these are uncommon in treeless areas, probably due to a long history of grazing. However, at Gurrundah, the more common Mitchell landscape Rockley Plains dominates. Woodland fragments have been excluded from development (refer to figures in Section 3 of this report).

Impact assessment

Construction impacts

Impact types, extent and vegetation condition have been discussed in *Section 7.4.1 Flora and fauna*. In summary, loss of habitat and habitat degradation are the key potential impacts of the construction phase. The discrete development footprint is proposed for sites that are largely cleared of native vegetation and therefore the impact to the extent and integrity of overcleared Mitchell landscapes is considered to be low.

The potential for habitat degradation as a consequence of the construction of the project is readily avoided and controlled using the constraints mapping set out in *Section 7.4.1 Flora and fauna* and best-practice erosion, sediment and weed controls). Mitigation measures relevant to Mitchell landscapes are stated below.

Mitigation measures:

- Infrastructure would be confined to cleared areas, avoiding woodland patches. A buffer around mature woodland patches would be established to ensure indirect impacts (such as dust and soil compaction) are minimised
- Weed and sediment erosion controls would be implemented to prevent onsite habitat degradation during and following the proposed works. A Construction Environmental Plan would be the appropriate vehicle for these controls. Weeds such as serrated tussock would be treated before the commencement of works to avoid spreading the infestation
- All areas of disturbed soil would be rehabilitated progressively as soon as practicable after disturbance, in order to resist erosion and colonisation by weeds. This may require restricting stock access and implementing revegetation activities

Operational impacts

No operational flora impacts are anticipated.

Decommissioning impacts

As for *Section 7.4.1 Flora and fauna*, decommissioning of the wind turbines would involve similar impact types to the construction phase. A reduced level of impact is anticipated however, as all below-ground structures (footings, concrete slabs, underground cabling) would remain *insitu* reducing the amount of excavation required and associated environmental impacts to soil, water and native vegetation. The required stabilisation of disturbed soil would relate primarily to the redevelopment of vehicle tracks and hard stand areas. Mitigation measures relevant to Mitchell landscapes are restated below:

Mitigation measures:

- Weed and sediment erosion control principles would be developed and implemented
- Disturbed ground would be stabilised and rehabilitated as soon as practicable after works

7.5 Aboriginal archaeology

New South Wales Archaeology Pty. Ltd. was commissioned in July 2007 to undertake the archaeological assessment of the proposed Gullen Range wind farm project area, covering all areas that would be affected by the development (full report appended, Attachment 3.4). This section summarises the approach and results of the archaeological investigation.

Approach

The field survey and assessment was undertaken in partnership with Pejar Local Aboriginal Land Council (PLALC) and Onerwal Local Aboriginal Land Council (Onerwal). The assessment was conducted in accordance with the consultation process outlined the Interim *Guidelines for Aboriginal Community Consultation - Requirements for Applicants* (NSW DEC 2004). Additionally, the study has been conducted in accordance with the *Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation* (NSW DEC July 2005). The latter guidelines have been prepared specifically for development applications assessed under Part 3A of the *Environmental Planning and Assessment Act 1979.*

The assessment sought to identify and record any Aboriginal objects which may be present in the development envelope, to assess the archaeological potential of the landform elements present and to formulate management recommendations based on the results of background research, a field survey and site significance assessment. The investigation included both a literature review and field survey. Field work was undertaken in August and September 2007. The field survey was focused on investigating broad development envelopes and these were subject to a comprehensive assessment.

The approach to archaeological recording in the study has been a ‘nonsite’ methodology: the elementary unit recorded is an artefact (described as artefact locales). It is assumed that stone artefacts would be distributed across the landscape in a continuum with significant variations in artefact density and nature in different landform elements. The proposal area has been divided into a number of Survey Units each of which has been defined on the basis of a combination of environmental variables. These areas have been defined according to landform element, gradient and aspect. Survey Units are utilised as a framework of recording and analysis.

Results

A review of previous archaeological investigations in the area was undertaken in order to provide an analytical context to the assessment.

Human occupation of south east NSW dates from at least 20,000 years ago. The Bulee Brook 2 site in the south coast hinterland ranges, excavated by Boot (1994), provides

evidence that occupation of this zone had occurred by at least 18,000 years ago. Pleistocene occupation sites are however few with the majority of recorded sites dating from the mid to late Holocene. It is nevertheless reasonable to assume that the Goulburn/Crookwell area was occupied and utilised by Aboriginal people from the late Pleistocene onwards.

The earliest European reports regarding the Aborigines of the region are provided through the written observations of the first explorers, adventurers and settlers to the district. These sources present only fragmentary and incomplete accounts of the traditional culture of those Aboriginal groups who inhabited the area. Very soon after European contact, with increasing numbers of white settlers after the 1820s, much of the Aboriginal language and lifestyle had changed before it could accurately be recorded. Because of this, reliable information is limited regarding traditional Aboriginal culture and the extent of group territories at the time of European arrival.

Tindale (1974) determined that the area of present-day Goulburn was situated at the boundary of two tribes – the Gandangara to the north and the Ngun(n)awal to the south. Tribal boundaries are derived principally from linguistic evidence and a virtually identical correspondence in word lists recorded from both the Ngun(n)awal and Gandangara languages has been observed (Eades 1976:6). Because of this there remains conjecture as to which of these two groups actually occupied the region in which the study area is situated at the time of European settlement. The paucity of reliable ethno-historic sources for this early period of European settlement also means that an estimate of the pre-European Aboriginal population of the district cannot confidently be established.

A search of the New South Wales Department of Environment and Climate Change (the NSW DECC) Aboriginal Heritage Information Management System (AHIMS) indicated that there are no previously recorded sites located within the proposed impact area (AHIMS #19576: 24th July 2007).

Survey units and sites recorded during field work are illustrated within the full Archaeology report, appended Attachment 3.3, and are discussed below.

Kialla

The Kialla development envelope has been divided into 26 Survey Units. Based on a consideration of the environmental context, the Kialla survey area is predicted to contain stone artefacts in low or very low densities only.

The Kialla development envelope surveyed during this assessment measured approximately 458.8250 hectares in area. Ground exposures inspected are estimated to have been 14.3415 hectares in area. Of that ground exposure area archaeological visibility (the potential artefact bearing soil profile) is estimated to have been 2.9575 hectares. Effective Survey Coverage (ESC) is therefore calculated to have been 0.6% of the Kialla development envelope; this is a very low ESC although it is typical of what is encountered in grassed paddocks.

A total of ten stone artefacts were recorded across six different artefact locales in the Kialla development envelope. The low number of artefacts recorded during the survey is assessed to be a reasonably true and reliable reflection of the artefactual nature of the proposal area. The predicted model of Aboriginal occupation indicates that the area would have been used for low levels of occupation that probably included intermittent hunting and gathering activities conducted away from base camp locations, movement through country and so on. Such landuse is predicted to have resulted in a corresponding low level of artefact discard. Furthermore, while the overall ESC is very low it is worth noting that only ten stone artefacts were recorded across almost three hectares of archaeological visibility, which would indicate a predicted artefact density in the order of less than five artefacts per hectare. Accordingly, the Kialla development envelope is assessed to be of low Indigenous archaeological potential and sensitivity.

Bannister

The Bannister development envelope has been divided into 18 Survey Units. Based on a consideration of the environmental context, the Bannister survey area is predicted to contain stone artefacts in low or very low densities only.

The Bannister development envelope surveyed during this assessment measured approximately 533.8 hectares in area. Ground exposures inspected are estimated to have been 30.452 hectares in area. Of that ground exposure area archaeological visibility (the potential artefact bearing soil profile) is estimated to have been 9.61075 hectares. Effective Survey Coverage is therefore calculated to have been 4.25% of the Bannister development envelope.

A total of 34 stone artefacts were recorded in the Bannister development envelope. These artefacts were recorded in ten different artefact locales. As discussed above with regard to the Kialla study area, the predicted model of Aboriginal occupation for the Bannister development envelope indicates that the area would have been used for low levels of occupation that probably included intermittent hunting and gathering activities conducted away from base camp locations, movement through country and so on. Such landuse is predicted to have resulted in a corresponding low level of artefact discard. Furthermore, given that only 34 stone artefacts were recorded over an estimated 9.6 hectares of archaeological visibility it is calculated that the overall artefact density would be in the order of less than five artefacts per hectare. Accordingly, the Bannister development envelope is assessed to be of low Indigenous archaeological potential and sensitivity.

Pomeroy

The Pomeroy development envelope has been divided into 19 Survey Units. Based on a consideration of the environmental context, the Pomeroy survey area is predicted to contain stone artefacts in low or very low densities only.

The Pomeroy development envelope surveyed during this assessment measured approximately 189.05 hectares in area. Ground exposures inspected are estimated to have been 23.25 hectares in area. Of that ground exposure area archaeological visibility (the potential artefact bearing soil profile) is estimated to have been 17.7 hectares. Effective Survey Coverage is therefore calculated to have been 9.4% of the Pomeroy development envelope; this is a relatively good level of coverage for a survey in a pastoral context. The elevated levels of ESC within this study area can be attributed to the fact that the soils were often relatively shallow and the areas of bare earth inspected thus displayed a higher archaeological visibility with relatively good exposure of potential artefact bearing deposits.

A total of 118 stone artefacts were recorded across 27 different artefact locales in the Pomeroy development envelope. While this appears to equate to a significantly higher incidence of stone artefacts than that which was encountered in the other development envelopes, the differing levels of archaeological visibility largely explain it. That is, given that the ESC at Pomeroy was substantially higher than that encountered at Kialla and Bannister, it is to be expected that a greater number of artefact recordings would result. To that end, it is worth noting that the calculated artefact density, based on estimated archaeological visibility, is of a similar order to the other survey areas and equates to around six or seven stone artefacts per hectare. This corresponds to a very low artefact density; it is in keeping with the predicted model of Aboriginal landuse, which indicates that the area would have been used for low levels of occupation that probably included intermittent hunting and gathering activities conducted away from base camp locations, movement through country and so on. Such landuse is predicted to have resulted in a corresponding low level of artefact discard. Accordingly, the low number of artefacts recorded during the survey is assessed to be a reasonably true and reliable reflection of the artefactual nature of the proposal area and the Pomeroy development envelope is assessed to be of low Indigenous archaeological potential and sensitivity.

Gurrundah

The Gurrundah development envelope has been divided into 18 Survey Units. Based on a consideration of the environmental context, the Gurrundah survey area is predicted to contain stone artefacts in low or very low densities only.

The Gurrundah development envelope surveyed during this assessment measured approximately 260.75 hectares in area. Ground exposures inspected are estimated to have been 68.15 hectares in area. Of that ground exposure area archaeological visibility (the potential artefact bearing soil profile) is estimated to have been 36.61 hectares. Effective Survey Coverage is therefore calculated to have been 14% of the Gurrundah development envelope. This is a relatively high ESC that is the result of skeletal soils and erosion scours that have afforded very good levels of visibility into potential artefact bearing deposits.

A total of 33 stone artefacts were recorded across five different artefact locales in the Gurrundah development envelope. The low number of artefacts recorded during the survey is assessed to be a reasonably true and reliable reflection of the artefactual nature of the proposal area. The predicted model of Aboriginal occupation indicates that the area would have been used for low levels of occupation that probably included intermittent hunting and gathering activities conducted away from base camp locations, movement through country and so on. Such landuse is predicted to have resulted in a corresponding low level of artefact discard. Furthermore, given that only 33 stone artefacts were recorded across almost 37 hectares of archaeological visibility, it is calculated that the overall artefacts density is in the order of less than one artefact per hectare. This is an extremely low artefact density that corresponds to an almost negligible artefactual presence. Accordingly, the Gurrundah development envelope is assessed to be of low Indigenous archaeological potential and sensitivity.

Impact assessment

Construction impacts

Aboriginal objects in the form of stone artefacts have been recorded in a number of locales across each of the four development envelopes. It is predicted that additional stone artefacts are likely to be present in either low or very low density in a subsurface context across the majority of the proposal area. The development of the Gullen Range wind farm project would therefore result in impacts on both recorded stone artefact locales and subsurface artefact distributions within many of the defined Survey Units.

However the proposed impacts would occur in small and discrete areas within the development envelopes. Therefore impacts to stone artefact distributions would be partial rather than comprehensive. Given that approximately 93% of the four development envelopes would not be subject to ground disturbing impacts the majority of the archaeological resource in the proposal area would be excluded from impact. It is concluded that the proposed Gullen Range wind farm would result in insignificant impacts to the Aboriginal archaeological resource.

Mitigation measures:

- The Pejar LALC propose to collect artefacts located within proposed impact areas as a form of mitigation prior to the commencement of construction
- An Aboriginal Heritage Management Plan would be prepared, pending Project Approval and prior to any impact, which outlines the strategy of artefact collection, s85A NPW Act (transfer of Aboriginal objects) procedures, and contingencies for unexpected finds such as skeletal remains.

Operational and decommissioning impacts

Potential impacts on aboriginal heritage sites would be confined to the construction phase, as operational and decommissioning phases are not anticipated to disturb additional areas of land.

7.6 Aircraft hazard impacts

Aviation Projects Pty. Ltd. was commissioned in November 2007 to undertake an assessment of the compliance requirements and operational impacts of the proposed Gullen Range wind farm on local airstrips (full report appended, Attachment 3.5). This section summarises the approach and results of that investigation.

Approach

Following the Planning Focus Meeting, held on 15 Aug 2007, several stakeholders including the Department of Defence and Civil Aviation Safety Authority raised concerns and/or advised of regulatory requirements related to safe flying operations. Concern was also expressed by several aircraft operators about the impact of some wind turbines in the proposed development on safe operations to and from the airstrips at Crookwell and Ashwell and on aircraft transiting the area in low visibility conditions such as low cloud, rain and/or haze.

The objectives of the aviation hazard report included to:

i. Assess the compliance of the wind farm proposal with the aviation regulations

ii. Review the wind farm proposal in terms of operational safety of the aircraft using the Crookwell airstrip and provide any recommendations

iii. Review the wind farm proposal in terms of low visibility, poor weather operations and provide recommendations and comment on the need for lighting

iv. Review the operability of fire fighting aircraft from the Crookwell airstrip in relation to the proposal

v. Review and comment on the impact of the proposal on the Ashwell airstrip

The assessment methodology included:

- Review of documentation provided by Epuron
- Site visit to the proposed wind farm development, including a physical inspection of Crookwell airstrip and a drive-by of Ashwell airstrip
- Consultation with key stakeholders
- Analysis of derived information and review of relevant statutory requirements

The following limitations impacted on the conduct of the study:

- There was no evidence regarding the frequency and type of operation at Crookwell airstrip made available to the author
- The author did not physically inspect the Ashwell airstrip during the site visit.

Results

The results of this investigation are structured under the headings: Stakeholder analysis, Technical and operational analysis, Compliance requirements and Recommendations. Summaries of these sections are provided below.

Stakeholder analysis

The following stakeholders were identified by the assessment: Epuron, Upper Lachlan Shire Council and local communities surrounding the proposed development, Mr. Jim Hutson (aircraft operator and neighbour of Crookwell Airstrip), Mr. Stephen Friend (owner and operator of Ashwell Airstrip), as well as operators and users of the airstrips and itinerant aviation operations in the vicinity of the proposed wind farm.

Council identified that there are no long term plans for the airstrip at Crookwell but that funds are allocated for maintenance. Council provides public liability insurance cover for activities on the airstrip.

Mr Jim Hutson feels that the wind turbines would impinge on safe operations at the airstrip and would pose a safety hazard to aircraft attempting to cross the ranges in low visibility conditions such as heavy rain and low cloud. Mr Stephen Friend, of Ashwell airstrip, considered that in the future, the wind turbines might inhibit the design of a GPS-based instrument approach to Ashwell. He also expressed concern about the vertical extent and visibility of the wind turbines in conditions of low cloud and rain.

There are two aircraft parked in hangars adjoining Crookwell airstrip which are used relatively infrequently. There is one aircraft, which is used relatively infrequently, parked at Ashwell airstrip. Other aircraft that use the airstrip/s or operate in the vicinity of the proposed wind farm include:

- Flying training schools from Bankstown use the airstrip/s to practise outfield or forced landings
- Fire fighting aircraft
- Aerial agricultural aircraft
- Government and private charter
- Itinerant aircraft transiting the area

Technical and operational analysis

Crookwell airstrip is located in a low lying area to the south of Crookwell township. It is bounded to the east by a road, and by a ridge line approximately 2000m to the west that limits take off climb performance for departures to the west. The Ashwell airstrip is located in a low lying area between ridgelines approximately 3000m to the east and west. The physical characteristics of the Crookwell and Ashwell airstrips were documented, including their elevation, runway characteristics, obstacles and prevailing winds (refer to full report, Attachment 3.5).

Chapter 13 of the Civil Aviation Safety Authority (CASA) Manual of Standards 139 (MOS) sets out standards for aerodromes intended for small aeroplanes conducting air transport operations under CASR 121B. These are the highest standards likely to be applicable to operations at the airstrips under consideration and were therefore used as the standard for this assessment. It is important to note that, unless an aerodrome is Registered or Certified, which neither of these airstrips is, CASA does not regulate the aerodrome operator. There is therefore no current requirement for the airport to conform to the Manual of Standards 139.

Crookwell airstrip has several obstacles that infringe the transitional surface, including very large trees to the north of the western end of the airstrip, while the ridgeline to the west of the runway infringes the inner horizontal surface which extends 2000m at a height of 45m above airfield elevation. The proximity of the ridgeline to the west of the runway may impose limitations on takeoff climb performance. Crookwell airstrip therefore does not currently comply with the MOS 139 obstacle limitation surface requirements.

Ashwell airstrip was not surveyed for compliance with obstacle limitation surface requirements as there was no objection to the location of the wind farm from the owner /

operator of Ashwell airstrip in relation to it creating obstacles within the immediate vicinity of the airstrip. If instrument approach procedures are developed, the impact of turbine locations on instrument approaches can be assessed. At the time of writing this report, no procedures had been developed and therefore the report does not assess the impact of turbines on the future development of instrument approaches. However it is noted that the location of turbines will need to be considered in the development of any such procedures and may even preclude the establishment of instrument approach procedures.

To conduct an analysis of the impact of the proposed location of the wind turbines on aircraft performance during operations to and from the subject airstrips, the flight path derived from a representative aircraft was plotted on an aerial plan of the area (refer to full report for assumptions of this model, Attachment 3.5). The generic flight path for a circuit at Crookwell is presented in Appendix D, Attachment 3.5. The flight path is approximately 475m horizontally from the nearest proposed wind turbine. The generic flight path for a circuit at Ashwell airstrip is shown at Appendix E, Attachment 3.5. A standard circuit will be technically possible from either runway (notwithstanding aircraft performance limitations) at each airstrip under consideration with no additional limitations caused by the construction of wind turbines in the proposed locations. Accordingly it is concluded that there is no reason why an aircraft, including fire fighting aircraft, would not be able to safely take off and/or land at Crookwell airstrip if the wind farm is constructed as proposed.

Due to the close proximity of a ridgeline to the west of the Crookwell airstrip, local procedures are in place to provide a margin of safety during takeoff (included in full report, Attachment 3.5). This local knowledge should ideally be formalised and provided to airstrip users on the briefing sheet provided by Council, or in other operational information references such as those provided by Aircraft Operators and Owners Association or FlightAce. There were no significant issues relating to aircraft operations under current conditions.

Obstacle visibility and clearance was considered. The wind farm would be situated in an aircraft corridor. Any aircraft operating at 500ft above ground level should be able to see the entire wind turbine. Under low visibility conditions such as low cloud, rain or haze, aircraft sometimes need to descend to lower than normal through stress of weather to maintain the required forward visibility and avoid obstacles. CASA directs that lights be installed on the top of the nacelle, which will be approximately 85m above the ground, equating to approximately 280ft. This is significantly lower than the height required for safe flying operations (500ft agl) and under most circumstances should provide sufficient margin of safety over normal conditions. There are several other wind farms in the area both constructed and proposed which impose similar restrictions on aircraft transiting the area. There is no reason why the installation of the wind turbines as proposed will prevent diligent and competent aircraft operators from complying with obstacle clearance requirements.

Compliance requirements

The Civil Aviation Safety Authority outlines the requirements for obstacle marking and lighting of wind farms in Advisory Circular 1390-18(0). In accordance with the Advisory Circular, the Proponent has notified CASA of the proposed development and received advice from Mr Frank Leonardi and Mr Byron Sullivan in response. Lighting as required by CASA in the Manual of Standards 139 – Aerodromes and Advisory Circular 139-18(0) and subsequent revisions will need to be installed.

The proponent has written to the Department of Defence and in response was requested to provide to RAAF Aeronautical Information Service (AIS) the location and height details once the final position of the wind turbines have been determined and before construction commences. After construction is complete, “as constructed” details should also be provided to AIS.

Impact assessment

Construction impacts

It is the physical placement of turbines on the site that generates the potential for air hazard impacts. As turbines are installed in the construction phase, mitigation of impact must be undertaken prior to the construction of the wind turbines. The following mitigation measures have been recommended by the Air hazard report. Some of these measures would be undertaken directly by the Proponent. The Proponent would prompt the relevant stakeholders to undertake the latter measures.

Mitigation measures:

- The Proponent would install lighting as required by CASA.
- The Proponent would provide to the RAAF Aeronautical Information Service (AIS), CASA and Air Services Australia the location and height details once the final position of the wind turbines have been determined and before construction commences. After construction is complete, "as constructed" details would also be provided to AIS
- The Proponent would notify known users of the Crookwell and Ashwell Airstrips of the location of the wind turbines and any changes to operational procedures
- The Proponent would notify other operational information providers such as the Aircraft Owners and Operators Association and Flight Ace of the location of wind turbines in close proximity to Crookwell and Ashwell Airstrips
- There are limited means of providing timely operational information to the aviation community regarding non-regulated airstrip operators such as Crookwell and Ashwell. Once the starting date for construction is known, a briefing sheet including a description and an aerial view of the proposed development, expected construction times, extent of the development, lighting, likely operational impacts and contact details of the developer would be distributed widely

Additional measures:

The Proponent would provide the following advice to the relevant stakeholders, prompting them to undertake the specified actions:

- That Crookwell Airstrip consider formalising guidance to airstrip users regarding takeoff and landing procedures giving due consideration to the location of wind turbines and other obstacles, surrounding terrain, aircraft performance, prevailing conditions, runway physical characteristics, regulatory requirements and any other operational limitations
- That Upper Lachlan Shire Council's Information Sheet for Crookwell Airstrip be updated to include reference to the location of the wind turbines in close proximity to the airstrip

Operational and decommissioning impacts

No impacts additional to those discussed and addressed above relate specifically to the operation or decommissioning of the wind farm. No additional measures are considered to be warranted for these stages of the development.

7.7 Communication impacts

Potential telecommunications impacts were researched by Anthony Micallef BE (Electrical), Epuron Pty. Ltd. The objective of the investigation was to determine potential impacts of the Gullen Range wind farm on existing telecommunications services in the vicinity of the proposal and to propose appropriate mitigation strategies for any impacts identified.

The following is a summary of the approach, results and proposed mitigation measures related to potential telecommunications impacts. The full investigation is appended, Attachment 3.6, including a glossary of acronyms used in the investigation, maps, footnotes and references.

Approach

The following approach was adopted to identify the impact of the proposal on telecommunications:

- Identify license holders within a 25km radius of the proposed wind farm site, and point-to-point links in the vicinity of the site, using information provided on the ACMA RADCOM database
- Provide written notification of the proposal and seek comments from each license holder identified via the ACMA RADCOM database within a 25km radius of the site
- Record and review all responses received to identify any issues raised by license holders
- Discuss issues raised with relevant license holders with the aim to resolve or identify mitigation options
- Carry out an assessment of the Fresnel zone associated with each fixed point-to-point communications link in the vicinity of the site. (A Fresnel zone is one of number of concentric ellipsoids of revolution which define volumes in the radiation pattern of an aperture).
- Determine appropriate 'exclusion zones' for proposed turbine layout based on Fresnel zone calculations and advice from license holders
- Confirm that all turbines (including blades) are located outside the 'exclusion zone'
- Determine appropriate additional mitigation measures which may be required

Results

The possible impacts of the proposed wind farm on the four most common communications services has been investigated separately and are summarised below. These services include television and radio broadcast services, mobile phone services, radio communication services and aircraft navigation services. Mitigation measures are stated at the end of the section, under these service headings.

<u>Television and radio broadcast services:</u>

The ACMA RADCOM database lists the following broadcasters for television and radio, under postcodes 2580, 2581 and 2583.

- Television broadcasting: ABC, CBN, CTC, SBS and WIN
- Radio broadcasting: 2ABCFM, 2ABCRN, 2ABCRR, 2GN, 2JJJ, 2RN, 2SNO

Canberra (Black Mountain) is the nearest TV transmission source for the locality of the proposed Gullen Range wind farm and is located approximately 85km S/SW of the site. There are local repeater stations at Mount Gray (Goulburn) and Braidwood, but these serve small localised areas in the proximity of the repeater station.

Television: Television Interference (TVI) is dependent on a range of factors including environmental factors (topography, direct signal strength, transmitter type, and receiver type) and wind farm design factors (turbine elevation, rotor size and orientation, speed of rotation, blade material and pitch). Due to the variability of local conditions and the characteristics of antennae used in particular installations, there is a degree of uncertainty regarding predicted levels of interference.

The zone of potential interference for a wind farm is the resultant total of the effects from the individual turbines. There are approximately 248 houses within a 5km radius of the proposed wind farm (refer to figure in Attachment 3.6).

VHF TV reception at dwellings within approximately 1 km of the wind farm turbines and with antennas having turbines located with +/- 25 degrees angle of their reception direction would have some probability of noticeable "ghosting" at times.

For UHF TV, time variant ghosting may be evident out to about 2 km for turbines located +/- 20 degrees from the reception direction. Digital TV is not susceptible to visible "ghosting" degradation. For any confirmed wind farm interference problems where TV antenna system improvements are unsuccessful, the use of the digital TV services in the area may be the best solution, requiring the provision of a digital set top converter.

It is difficult to assess the likely impact on specific house locations and once the wind farm is operational it is possible that television reception could be affected at some of these locations unless some form of mitigation is introduced. The International Telecommunications Union Recommendation ITU-R BT.805 states that impacts beyond 5 kilometres are unlikely.

Radio: The level of radio broadcast interference experienced can be influenced by a variety of variables including abnormal weather conditions, multi-path distortion (reception of a signal directly from a transmitter and also a reflected signal from hills, structures etc.), overloading (when an FM receiver receives too strong a signal) and electrical interference.

Low power national FM stations on 107.7 & 106.9MHz are listed on the Wades Hill TV site at Crookwell. National, community and commercial services on 101.5, 102.3, 105.5, 104.7, 98.3, 99.1, 92.7, 91.9, 91.1, 106.3 and 103.9MHz are located on Black Mountain. Wind farm effects on MF radio are highly unlikely and therefore the stations serving the area have not been listed.

Mobile phone (and wireless broadband) services

This section covers CDMA, GSM and Telstra 3G services (high frequency communications links used for mobile transmission networks are discussed in the next section: Radio communication services). Figures showing the existing local mobile phone coverage from the three main providers are presented in Attachment 3.6.

A mobile phone network consists of a system of adjoining zones called 'cells', which vary in size with a radius of 2-10 km. Each cell has its own base station that sends and receives radio signals throughout its specified zone. Mobile phone antennas need to be mounted clear of surrounding obstructions such as buildings to reduce 'dead spots' and allow the base station to effectively cover its intended cells. No GSM/CDMA mobile services are registered at sites in the close vicinity of the wind farm. The Telstra mobile service from Wades Hill, Crookwell is too distant to be affected by the wind turbines. Telstra plans to shut down its CDMA network in April 2008.

A small number of mobile base stations exist in the area surrounding the wind farm site, including at Crookwell. These bases potentially provide cover to mobiles in a 360 degree arc from their bases. No significant impact from the wind farm on base coverage beyond normal mobile operational performance is predicted in view of the geographic separation between the base antennas and the turbine structures.

Wirefree provides a wireless broadband service to the local Crookwell area that operates at a frequency similar to mobile phone networks (900MHz). One Wirefree transmitter is located on the wind farm site at Bannister. From studies in other areas (Mahinerangi, NZ) it is concluded that the minimum separation between wind turbines and mobile broadband transmitters is approximately 240m. The Proponent appreciates the importance of this service to the local community and has consulted with Wirefree regarding their network. The

Proponent commits to work with Wirefree to avoid any impact on the service to nearby residents.

Radio communication services

The organisations identified as operating radio communication licences (including fixed link communications) within 25km of the wind farm were consulted. Each was asked to provide independent comments / advice on the possibility of the wind farm development interfering with their communications links (license holders within 25km listed in full, Attachment 3.6).

A fixed link radio transmission is a point-to-point transmission path typically between two elevated topographical features. The transmission path may become compromised if a wind farm is located within the direct line of sight or what is known as the Fresnel zone around the line-of-sight between the sending and receiving antennae. Communications are only likely to be affected if a wind farm is in the line-of-sight between two sending and receiving antennae or within a zone of the line-of-sight of these antennae.

The point-to-point communication links were identified and mapped in the vicinity of the proposed wind farm site to establish the line-of-sight path. In order to ensure that no obstruction to transmission paths occurs, calculations of the 2nd Fresnel zone of the point-to-point communications links in proximity to the site were undertaken. It is suggested that beyond the 2nd Fresnel zone, the power of a scattered signal from a structure such as a wind turbine would be small enough such that it would not result in significant interference at the receiver.

Seven point-to-point communications links were identified as crossing the site. In order to determine whether a radio link could be affected by the wind turbines, an 'exclusion zone' was defined, beyond which the level of interference would not disrupt the radio link, based on the concept of the Fresnel zone, as previously described.

The Proponent previously contacted all organisations identified as operating radio communication licences (including fixed link communications) within 25km of the nearby Cullerin wind farm proposal. Each license holder was asked to provide independent comments / advice on the possibility of the wind farm development interfering with their communications links and their suggestions have similarly been applied to the Gullen Range proposal. At that time, no organisation within the 25km radius raised concerns. Optus, Vodafone and Telstra provided general recommendations applicable to the planning of all wind farms. Their suggestions have also been incorporated into the planning of the Gullen Range proposal.

CB radios are not individually licensed, the equipment being subject to class licensing only. Therefore, no records of location or operators of CB radios exist, and the channels are shared without any right of protection from interference. No impact from the wind farm is predicted except perhaps for very local effects to portable or mobile units in the immediate vicinity of the turbines which could be avoided by a small location change of the unit.

As a result of the exclusion zones established in planning the wind farm, no significant impacts would occur in relation to existing point-to-point links and therefore no mitigation would be required.

Aircraft navigation systems

The closest airports to the proposed wind farm site are Canberra and Goulburn. There is one radar installation in the vicinity of Canberra airport, namely Mt Majura. A secondary radar installation is located at Mt Bobbara.

The Proponent has consulted with the Civil Aviation Safety Authority (CASA), Airservices Australia and the Department of Defence in relation to the proposal. Due to the height of the turbines (>110m), the Civil Aviation Safety Authority recommends that obstacle lighting be provided as per section 5.5 of Advisory Circular 139-18(0) - *Obstacle Marking and Lighting of Wind Farms.*

A review of the proposal was undertaken by Airservices Australia and it was determined that the wind farm site was sufficiently away from the Airservices Australia transmission link path so as not to be an issue. The nearest Airservices Australia Radio Site is 30 km away at Mt McAlister to the northeast. No wind turbine impact on this site is predicted. Airservices Australia confirmed that they do not have any objection to the proposal.

A review of the proposal was undertaken by the Department of Defence. No objection to the proposal was made. Mr. Gary Lee of the Department of Defence mentioned that the closest military radar to the site was the HMAS Albatross, near Nowra which is approximately 90 - 100 km away from the site and so should not be an issue.

Impact assessment

Following a review of the communication services near the wind farm site, the nature of potential interference and consultation with the service providers, it is considered that the wind farm would have minimal effect on telecommunications services. Mitigation strategies are proposed to ensure any impacts can be managed and mitigated. These are stated below.

Construction and decommissioning impacts

No telecommunications impacts are anticipated during the construction and decommissioning phases of the wind farm development. However, some measures are best instituted during this stage. These include:

Mitigation measures:

Television and radio broadcast services

- Use of primarily non-metallic turbine blades
- Use, wherever practical, of equipment complying with the Electromagnetic Emission Standard, AS/NZS 4251.2:1999

Operational impacts

All impacts would be confined to the *operational phase* of the wind farm, as discussed previously in this section.

Mitigation measures:

Television and radio broadcast services

Once the wind farm is operational, the Proponent would offer to undertake a monitoring program of houses within 5km of the wind farm to determine any loss in television signal strength if requested by the owners. In the event that television interference (TVI) is experienced by existing receivers in the vicinity of the wind farm, the source and nature of the interference would be investigated by the Proponent.

Should investigations determine that the cause of the interference can be reasonably attributable to the wind farm; the Proponent would put in place mitigation measures at each of the affected receivers in consultation and agreement with the landowners.

Specific mitigation measures may include:

- Modification to, or replacement of receiving antenna
- Provision of a land line between the effected receiver and an antenna located in an area of favourable reception

- Improvement of the existing antenna system
- Installation of a digital set top box or
- In the event that interference cannot be overcome by other means, negotiating an arrangement for the installation and maintenance of a satellite receiving antenna at the Proponents cost

Mobile phone (and wireless broadband) services

Recommendations from telecommunications companies have been incorporated into the planning of the project.

- Mobile phone services in the area are not expected to be impacted by the wind farm or its operation
- The Proponent appreciates the importance of Wirefree broadband to the local community and commits to work with Wirefree to avoid any impact on the service

Radio communications services

A single microwave link (1xE1 HSB or equivalent) between Mt Mary and Mt Gray (Goulburn) would replace the three existing UHF links from Mt Mary to Goulburn and thus resolve any current and future conflicts between the wind farm and RFS communications links. The RFS would undertake the preliminary design work necessary for the new communications link and provide the Proponent with the required frequency and exclusion zone around the new link along, with an estimated cost for the link hardware required and installation. The Proponent has made provisions for a 100m corridor for the RFS links from Mt Martin to Mt Gray. Thus, conflicts between the point to point radio systems and the wind turbines are expected to be avoided with appropriate clearances being established.

In the event that any issues with license links are identified as a result of the wind farm, whether prior to or post construction, the proponent would consult with the operator and undertake appropriate remedial measures, which may include:

- Modifications to or relocation of the existing antennae
- Installation of a directional antennae and/or
- Installation of an amplifier to boost the signal

7.8 Electromagnetic fields (EMFs)

Existing environment

Electromagnetic fields (having both electric and magnetic components) are generated by operational electrical equipment, including transmission lines, substations, and the wind turbines. Transmission lines and electrical devices, including substations and wind turbines, generate 50 Hz electric and magnetic fields within their vicinity.

Electromagnetic fields can have acute and chronic health impacts. The Australian Radiation Protection and Nuclear Safety Agency (APANSA) have produced fact sheets which state that studies to date have consistently shown that there is no evidence that prolonged exposure to weak *electric* fields (such as those found in the home or in most workplaces), results in adverse human health effects. Whether chronic exposure to weak *magnetic* fields is equally harmless remains an open question. While there is no evidence that these fields cause immediate, permanent harm, laboratory studies on animals and cell cultures have shown that weak magnetic fields can have effects on several biological processes (hormone and enzyme levels, the rate of movement of some chemicals through living tissue). The fact sheets state that while most studies have produced inconclusive results or no increased cancer incidence in laboratory animals following exposure to EMFs, a few studies have indicated an increased incidence (APANSA web page updated 2007).

The Australian Radiation Protection and Nuclear Safety Agency (APANSA) was formed in 1998 as a Federal Government agency charged with responsibility of protecting the health and safety of people and the environment, from the harmful effects of ionising and non-ionising radiation. ARPANSA is currently developing guidelines on exposure limits to EMFs but in the meantime they refer to the National Health and Medical Research Council Interim Guidelines. The National Health and Medical Research Council Interim Guidelines on Limits of Exposure to 50/60 Hz Electric and Magnetic Fields recommended limit for 24 hour exposure is 1000mG for magnetic fields and 5kV/m for continuous public exposure to electrical fields. They note that research suggests that health effects are associated with prolonged exposure; measurements at one point in time do not accurately reflect prolonged exposure levels.

Electric fields can be reduced both by shielding and with distance from operating electrical equipment. Magnetic fields are reduced more effectively with distance.

Impact assessment

Operational impacts

Potential for EMF impacts occurs only during the operational phase of the wind farm when electrical infrastructure is capable of generating EMFs. Due to the type and configuration of the wind farm infrastructure proposed, the electromagnetic fields would vary in different locations onsite, as discussed below.

Transmission lines

Underground transmission lines connecting turbines on each site would be 33kV. Overhead transmission lines connecting each site would be 33kV. From the substation, the voltage would be stepped up and electricity produced by the wind farm would be fed into the existing 330kV high voltage lines at Pomeroy.

The magnetic field level associated with a transmission line at any moment in time depends on a range of factors, including the amount of power flowing in the line and the distance of the measurement point from the conductors. Typical levels of magnetic field under a 330 kV high voltage transmission line range from 5 - 50 mG at a distance of 30 metres from the centre of the easement. The strength of the field falls away rapidly with increased distance. High voltage lines can produce magnetic fields of up to 80 mG. These figures are far less than the 1000mG limit recommended for 24 hour exposure (National Health and Medical Research Council Interim Guidelines on Limits of Exposure to 50/60 Hz electric and magnetic fields).

Electric fields from power lines diminish rapidly with distance from the source. Their levels are extremely low, with levels of 0.07V/m and 0.01V/m recorded at 30m and 60m from a 115kV power line (Hafemeister 1996), and are significantly less than the 5kV/m (5000V/m) NHMRC interim guideline for continuous exposure. At the voltage (33kV) proposed in this project, the effects are considered negligible.

In a 33kV transmission line, the load may be ‘unbalanced’ (greater at one end than the other) and located closer to the ground than in a 132kV line and as such has the potential to generate larger EMFs than higher voltage lines (pers. comm. Mr Colin Hackney, Country Energy 2006).

Where practical, 33kV lines would be underground, maximising the shielding effect to minimise EMF exposure. Cables used in the 33kV onsite reticulation cabling will contain three core conductors in trefoil (three lobed) arrangements to cancel out the effects of magnetic fields from adjacent conductors. There is the potential for an overhead 33kV cable along Kialla Road however the magnetic field under a typical distribution overhead power line has been measured by Energex to be low and less than that generated by an electric blanket. Typical measurements of 10 milligauss were recorded directly under a distribution power line vs 20 milligauss for an electric blanket (Energex 2008).

Any off-site electricity lines will be located and designed in accordance with the Principals of Prudent Avoidance, that is, taking appropriate precautions at modest cost without undue inconvenience to avert possible risk. Electricity cables will be located away from residences, where practical, to minimise magnetic fields from any off-site transmission lines.

Substation

The United Kingdom National Grid Company has conducted a survey of suburban substations to determine the level of EMFs produced. Measurements were taken at 0.5m above ground level within 1 m of enclosures. The results revealed mean magnetic flux densities of about 19mG, halving at an average distance of 1.3m and becoming indistinguishable from the background due to other domestic sources within 5m (HPA 2004).

Fencing around the substation and the location of the substation and control building would ensure that the EMF exposure to receptors including the public and property owners and workers are well below the 1000mG levels determined for public health.

Wind turbines

A report investigated the expected magnetic field for 1,650 kW proposed wind turbines (a similar capacity to that proposed for the Gullen Range site) for Windrush Energy in 2004 (Iravani *et al.* 2004). The study was based on research and measurements of an existing wind turbine. The measured magnetic field at the door of the existing turbine was 0.4mG and the typical value around the wind turbine was 0.04mG. The acceptable magnetic field is 833mG. The results determined that no measurable magnetic field would be expected at distance of 8 metres from the 1,650 kW wind turbine.

The report concluded:

> *"It is our strong belief that the magnetic fields produced by the generation and export of electricity from the Windrush wind turbine does not pose a threat to public health."*

Receptors

The areas proposed for installation of the Gullen Range wind farm infrastructure would have limited public access. Access to these areas by the general public would be restricted, with periodic access by appropriately trained and qualified maintenance staff. Property owners accessing the sites for ongoing agricultural use would have no reason to spend extended periods near the infrastructure, which has been located at a distance from frequent use areas such as sheds, yards and residences. Should property owners require access to control building or other wind farm infrastructure, they would be accompanied by an appropriately trained and qualified maintenance staff member.

Wind farms present an opportunity for tourist and educational use. Although it does not form part of this proposal, there is a potential for one or more of the Gullen Range wind farm locations to be used in the future as an educational facility. Again, extended exposure is not anticipated from tours however, appropriate safeguards would be put into place prior to the operation of the education facility to ensure the opportunity for human exposure to EMFs is minimised and within recommended guidelines.

Summary

Acute impacts are not anticipated as a consequence of the low exposure rates in combination with the low likelihood that people or stock would be within range of high exposure levels for extended periods.

Onsite, underground cabling with conductors in a trefoil (three lobed) arrangement would be used where practicable which would assist in shielding EMFs. Fencing around the substation and the location of control building and wind turbines would ensure that the EMF exposure to receptors including the public and property owners and workers are well below the 1000mG levels determined for public health.

Mitigation measures:

- The substation would be designed in accordance with all applicable codes and industry best practice standards in Australia
- Onsite, underground cabling would be used in preference to overhead cabling where practicable to reduce the electric component of EMFs
- The turbines, control building, substation and transmission lines would be located as far as practicable from residences, farm shed and yards in order to reduce the potential for both chronic and acute exposure

7.9 Land value impacts

Existing environment

Local determinants of land value

It has been speculated that the Gullen Range wind farm has potential to affect land values in the immediate area of the wind farm as well as the general locality. While public perception of wind farms is highly variable and subjective (SRSC 2005), there is the potential for a section of the market to be negatively affected by perceived visual or noise impacts, or by changes to compatible land uses (community impacts have been addressed in Section 8.2 *Community well-being*).

Gullen Range is located in an area where agricultural capacity has traditionally been the largest determinant of land prices. Increasingly however, rural subdivision lots are being created in the general area and the area being increasingly valued for is rural character and lifestyle values. Three such subdivisions have been proposed near the Gullen Range. Commutable proximity to the larger population centres of Canberra and Queanbeyan is likely to be an important factor in this trend.

The land surrounding the proposal site is zoned 1(a) Rural Zone, used for extensive sheep and cattle grazing. Lots within this zone, for the purpose of erecting a dwelling, can be no less than 40ha (Mulwaree LEP) or 80ha (Gunning and Crookwell LEPs).

Future rural subdivisions

There are major shifts occurring in agriculture in the region driven by declining international agricultural markets, extended droughts and the introduction of new farming methods. Rural subdivision applications are being made in the Upper Lachlan Shire because of farmers wanting to capitalise on property values and ahead of expected changes to the minimum lot sizes allowed under the new ULSC LEP and the proposed abolishment of concessional lots.

Potential impacts of the proposed wind farm on residents of nearby rural subdivisions could include noise and visual impacts. Visual impacts and noise assessments (Sections 7.2 and 7.3 refer) has been undertaken for existing residences and proposed new residences near the site. These assessments give an indication of impact level in different regions surrounding the wind farm and therefore of the likelihood to affect subdivision potential. However it is not possible to detail the impact of the proposal on potential future rural subdivisions in the area because there is no certainty that the proposed subdivision will occur and the location of residences is not known and subject to development approval.

While the wind farm may reduce the subdivision viability of some locations close to the site, based on visual and noise impacts, these impacts are not incongruous with other large developments, such as the location of nearby chicken farms, which may also reduce the attractiveness of subdivisions in the immediate vicinity.

Land value studies

The impact of wind farms on land values has been raised as a key concern by individuals in the local area (**ngh**environmental 2006; Twyford Consulting 2007). It is likely that land value fluctuations are a result of many factors. There are examples of successful residential estates being developed near existing wind farms, in Australia (an informal study of the Salmon Beach estate near the Esperance wind farm in Western Australia showed a strong trend of increasing house prices; AusWEA 2004). However, the interplay of multiple determining factors complicates comparability of existing studies and the assessment of impact.

Land values are influenced by prevailing and permitted land uses, economic conditions, access and proximity to markets and workplaces, demand for lifestyle as well as a range of other factors. While the development of wind turbines does not preclude agricultural use, it remains unclear what impact such developments have on land values. Prediction and quantification of land value impacts is problematic as there are few studies examining the effects of wind farms on land values in Australia and these are difficult to compare across geographic and land use boundaries.

Henderson and Horning Property Consultants undertook a study into local property values around the Crookwell 1 wind farm, the only operating wind farm in the study area, in relation to the potential impact of the Cullerin wind farm (proposed to be located approximately 10km south-west of the Gullen Range proposal). Their study explored the trends of a wind farm on local land values, by recourse to the impacts resulting from other wind farm developments, in Australia and overseas. The full Land Value Assessment is attached to this EA, Attachment 3.7, and is summarised below. The report sourced a statistical analysis in the United States and two perceptual studies (United Kingdom and Australia) and also looked at land transactions around the existing Crookwell wind farm.

The United States report (Sterzinger *et al.* 2003) was an empirical review where data from 10 wind farm sites was collected and subjected to a statistical regression analysis to determine price changes in three ways:

- How property values changed over the entire period of the study for the view shed and comparable region;
- How prices changed in the view shed before and after the projects came on-line; and
- How property values changed for both the view shed and comparable community but only for the period after the project came on-line.

This study concluded that:

> *"there is no support for the claim that wind development will harm property values"*

and was qualified with a statement that more data would need to be analysed as it becomes available.

The United Kingdom perceptual study gauged professional property opinions about the impact wind farm development had on both residential and agricultural land values. It received 405 responses of which 81 indicated they had dealt with residential transactions affected by wind farm development. The report concluded the main negative impact on property values are visual impact, fear of blight and the proximity of a property to a wind farm. Seventy-two percent of the sample believed wind farm development had no impact or a positive impact on agricultural land values. Sixty percent believed wind farms decreased the value of residential properties where the wind farm was in view. The perceived negative impact was recorded to continue but becomes less severe two years post completion.

A recent study (Dent and Sims 2007) looked at 919 residential property transactions at three locations in Cornwall, within 5 miles of wind farms. The results were analysed and local estate agents were interviewed to understand the underlying reasons for any variation in property prices.

The results were generally inclusive with terrace and semi-detached houses within a mile of a turbine were significant lower in price than a similar house located further away. Detached houses and all property greater than a mile from a turbine showed no clear linear relationship between physical distance and transaction price. Upon investigation with local real estate agents it became clear that the lower prices of terraced and semi-detached houses within 1 mile of a turbine were not related to the presence of a wind farm by were ex-defence housing properties and were less desirable.

The study concluded that the relationship between property price and distance from turbines was inconclusive however it suggested that factors other than wind farms had a more significant effect on property prices. It also concluded that the 'threat' of a wind farm may have a more significant impact than the actual presence of one.

In Victoria Australia, the Bald Hills Wind Farm Panel Inquiry examined the issues of property devaluation for neighbouring properties in a similar manner; property valuers and real estate agents provided submissions and appeared before the Panel Inquiry as expert witnesses. The Panel Inquiry report concluded that:

> *"All that appears to emerge from the range of submissions and evidence on valuation issues is the view that the effect of wind energy facilities on surrounding property values is inconclusive, beyond the position that the agricultural land component of value would remain unchanged. On this there appeared to be general agreement."*

The Crookwell wind farm was developed in NSW in 1998. It is the nearest wind farm to the Gullen Range site, has similar surrounding land uses (agricultural and rural residential) and several sales have taken place since the development of the wind farm. Sales transactions over a 15 year period were searched (1990 to 2006). Properties that surround the development and have some direct impact from a valuation perspective were investigated (principally aesthetic influences including, visual, noise and shadow effects).

The context of the study was a general trend of larger properties being sold and broken up into smaller lots commencing in the late 1990's, with very few sales occurring in the period prior to the development of the wind farm. This trend is an example of the changing nature of land use in the area, from commercially operating grazing land to a more passive rural residential use. Market forces appear to value the rural residential amenity above that of the agricultural productive capacity of the land.

Discussions with local agents generally indicated that although topical, the existing wind farm had little or no effect on land values in Crookwell. However, the perception of the proposed wind farm (Crookwell II) planned close to the existing farm could have an effect. The analysis of sales evidence indicated that no detectable discount exists for properties deemed directly affected by the existing wind farm. That is, the market evidences suggests that having a view of the wind turbines did not have an effect on land value.

It is clear that the underlying agricultural productive capacity of the land and the surrounding property subject to the wind farm is not in any measured way affected by the development of the Crookwell wind farm, meaning there has been no reduction in values. Indeed the property subject to the development enjoys additional revenue (leasing agreements) and additional benefits including improved access, erosion control and passive wind protection for stock from the sub stations and turbine tower structures. The revenue stream from the wind farm plus the underlying agricultural production from the land may well outbid the subdivision potential for the site. This is premised on the rental income from the turbines being at market value.

The Land Value Assessment report concluded that further research would be required to determine what value the market would place on the wind farm revenue streams however, it is suggested that the capitalisation rates would be similar to other infrastructure improvements like mobile communication towers and signage investments. Therefore the wind farm development has the potential to slow down the process of productive agricultural land changing to rural residential uses in the short to medium term with the shift caused by the additional income generated from the wind farm revenue making the agricultural use of (involved properties) more viable.

Impact assessment

Construction and decommissioning impacts

During the construction and decommissioning phases of the wind farm, a temporary increase in traffic loads, as well as increased noise and visual impacts would occur. These impacts would be temporary and would not be anticipated to be reflected in the land value of the site or land values in the area.

When the site is decommissioned, it could continue to be used for extensive agricultural activities. All disturbed soil, excluding access trails which the landowners may wish to retain, would be stabilised and rehabilitated. Concrete footings used to anchor turbines and buildings during the development would remain onsite (estimated area 4.93 ha including 84 turbines, an onsite control room and substation). These may have a minor impact on land use however, the lease agreements during the life of the project are intended to compensate the landowner for this. This impact would not be anticipated to be reflected in the land value of the site or land values in the area.

Post decommissioning, the minor amount of land affected by in-ground footings is not anticipated to affect other land uses such as rural residential subdivisions or other commercial activities.

Operational impacts

The operational impacts of the development have the greatest bearing on land value. While the lease agreements are intended to compensate the involved landowners during the life of the project, the development may potentially affect the land values of the surrounding properties that are in some way affected by the development; those with a view of the site or near enough to experience operational noise. Operational traffic impacts would be negligible during the operational phase and, if anything, access improvements may positively affect local land values.

The conclusions of the studies considered in this section, applied to the Gullen Range site, suggest that:

- The agricultural productive capacity of land affected by the wind farm (including the site itself as well as surrounding properties) is not anticipated to be affected by the development of the wind farm.
- The revenue stream from the wind farm and associated benefits (such as improved access) plus the underlying agricultural production capacity of the sites directly affected may well outbid the subdivision potential of the sites, slowing down the process of productive agricultural land changing to rural residential uses in the short to medium term.
- The evidence suggests that having a view of the wind turbines would not adversely affect the land values of surrounding properties. Any negative perceptions that this is the case are likely to decrease two years post construction.
- The wind farm may dampen a sensitive section of the property buying market however, this effect is balanced by other influences such as demand for land and housing within a

commutable distance from a larger centre and the creation of a development-oriented or green energy aesthetic.

- As the site would be returned to its current appearance at the end of the project's life, the potential impacts to land values are reversible in the long-term.

While the wind farm cannot be developed without the risk of some land value impact on surrounding properties during the construction and operational phases, it is considered by this assessment that on balance the benefits of the proposal are sufficient to outweigh this risk. The risk is not dissimilar to that posed by other large scale infrastructure developments undertaken to meet increasing energy demands.

No mitigation is considered to be required for the potential impacts to land values. As a large component of this issue is related to community perceptions, measures outlined in Section 8.2 for mitigation of impacts to the community are considered sufficient to address this issue.

7.10 Traffic and transport

Bega Duo Designs was commissioned to complete the Traffic Impact Study for the proposed Gullen Range wind farm (full report appended, Attachment 3.7). The report provides a technical appraisal of the traffic and safety implications arising from the proposal. The report also develops measures and makes recommendations for the minimisation of traffic impacts during the construction and operation of the wind farm. The approach, key results and mitigation measures are presented in this section.

Approach

The Traffic Impact Study conforms to the *Guide to Traffic Generating Developments* as recommended by the NSW Roads and Traffic Authority This report does not include a detailed route assessment for the transportation of the over-mass and over-dimension turbine and transformer components, which would be required to be produced by the haulage contractor before the commencement of the construction phase.

Detailed assessments of the possible routes from the ports and manufacturing centres to Goulburn are contained in the report prepared for the Crookwell 2 project by URS (URS 2004) which also reports on the route through Goulburn and along Crookwell Road to the proposed Crookwell 2 wind farm (approx 30km west of Goulburn). An assessment for transportation of heavy and oversize loads from the south via Breadalbane is contained in the report prepared for the proposed Gunning wind farm by Connell Wagner PPI (Connell Wagner). These assessments have been sourced in the preparation of the Gullen Range wind farm Traffic Impact Study and adequately cover the assessment of transporting oversize components from the point of origin (Port Kembla or Victoria) to the immediate area of the site.

Results

An annotated map of local access roads was produced to facilitate this investigation, Figure 7-13.

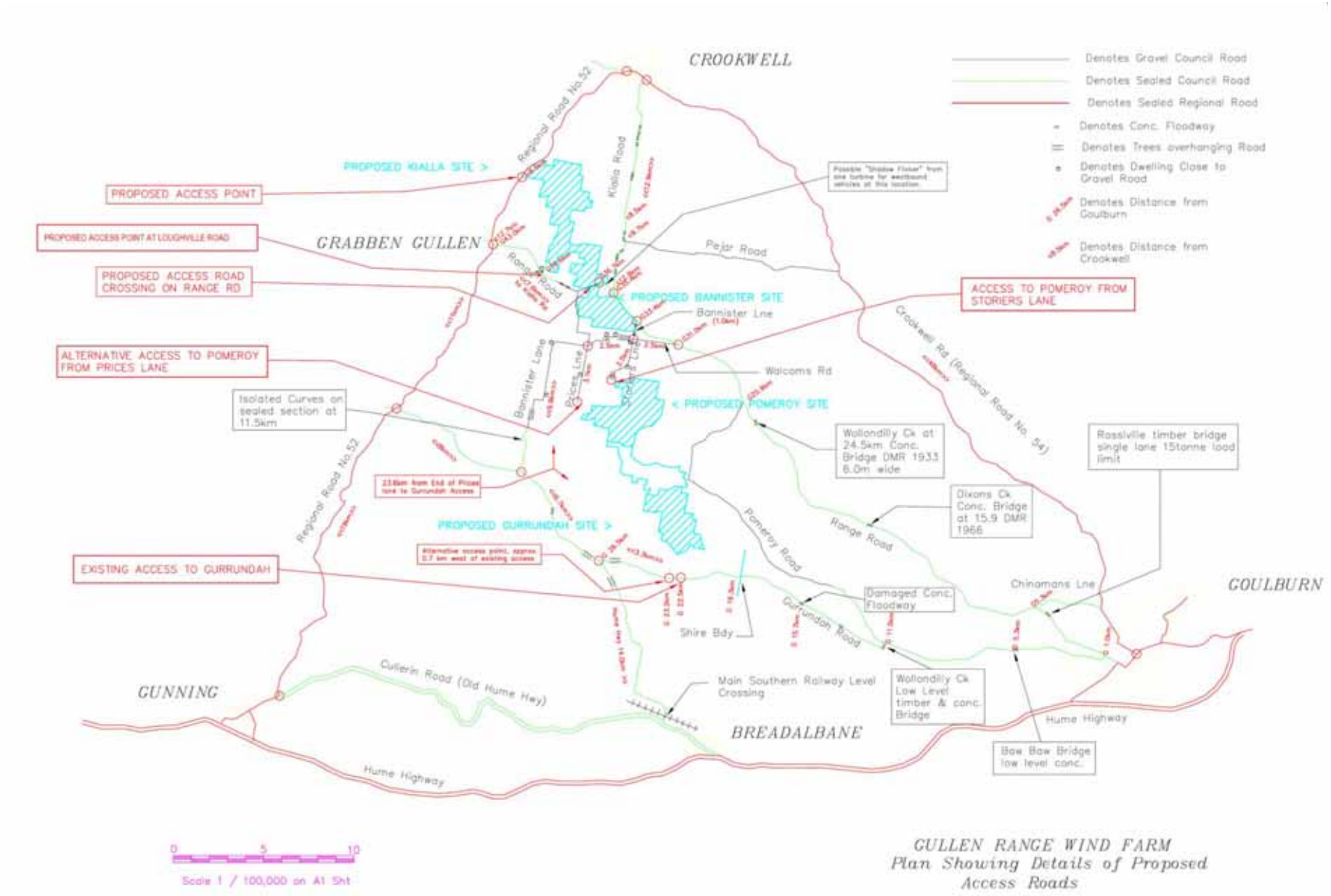

Figure 7-13 Proposed access roads: traffic assessment

The study is guided by Table 2.1 of the Roads and Traffic Authority's *Guide to Traffic Generating Developments*. Additional issues have been included because of the unique nature of the development. These include driver distraction effects and the structural condition of the existing road surfaces.

Key issues that were investigated include existing road hierarchy and proposals for improvement, impact on road safety, impact on traffic noise, traffic counts, traffic volumes and trends, existing parking and demand, traffic generation, safety and efficiency of internal roads, impact on intersections and surrounding developments, safety and efficiency of access routes (including capacity) between the site and adjacent road networks.

Base project information was obtained from **ngh**environmental and the Proponent, further information and feedback was received from government stakeholders at the "Planning Focus Meeting". Existing mapping was used to identify features during the site inspection, planning documentation for other wind farm proposals in the region was reviewed, all affected roads were inspected, inventories prepared and photographs taken, approximate traffic count information was obtained from observations on the sites and RTA published data, intersections were inspected and photographed, discussions were held with representatives from nghenvironmental, the Proponent, Upper Lachlan Shire Council and Goulburn/Mulwaree Shire Council.

Impact assessment

Construction phase

Heavy and over-sized haulage routes would include Hume Highway, Crookwell Road, Grabben Gullen Road, Bannister Lane, Kialla Road, Storriers Lane, potentially Prices Lane, part of Gurrundah Road and the Breadalbane route. There are a number of constraints common to all of these routes and some that need special consideration including schools and residential areas along the route, school bus routes, overhead cables and trees at low-level, intersections inadequate for the manoeuvring of the haulage vehicles, railway crossings, narrow and structurally deficient structures.

The potential impacts associated with these constraints include risks/delays to local traffic and pedestrians, noise, and additional works to modify the route so that it is suitable for haulage vehicles. These impacts would be temporary, as the equipment haulage is not a continuous program. It is scheduled to take place over a number of months and would be managed through a number of specific mitigation measures developed and implemented in conjunction with both RTA and local Councils (refer to Mitigation measures, below).

Council Roads which would experience a significant increase in traffic include Kialla Road, Range Road, Bannister Lane, Storriers Lane, Prices Lane, Gurrundah Road and the Breadalbane route. The potential impacts along these routes include delays to local traffic, noise, dust and works required to modify the route so that it is suitable for the haulage vehicles.

Because of the potentially large increase in the number of vehicles using these routes there are many impacts to be considered. The volumes are likely to increase from several vehicles to over 200 per day during concrete pouring operations. Projected traffic volumes however, remain well within the road capacity which is normally described as "Level of Service" for all roads considered.

In many sections, the roads are narrow, of a low standard of horizontal and vertical alignment, are unsealed or have failing pavement sections, lanes are not well delineated, and trees and other roadside objects have the potential of obstructing the passage of long wide loads and high loads. Furthermore, school buses use many of the routes (refer to Mitigation measures, below).

Traffic impacts and safeguards have also been identified at key locations (refer to mitigation measures, below).

The area proposed for the Gullen Range wind farm is sparsely populated and well served with access roads from all directions. The volume of traffic projected is within the road capacity (level of service) for each road considered.

The local roads were not constructed for high volumes of heavy traffic, however adoption of all the safeguards for minimising traffic impacts outlined should reduce the risk of traffic accidents and minimise structural and environmental damage.

The key to minimising the impacts to the residents of the area is to seek their cooperation in implementing safety and protection measures as early as possible during the planning process. These safeguards would be implemented in consultation with the Upper Lachlan Shire Council, Goulburn Mulwaree Shire Council and the Roads and Traffic Authority.

Mitigation measures:

- Use of a licensed haulage contractor with experience in transporting similar loads, responsible for obtaining all required approvals and permits from the RTA and Councils and for complying with conditions specified in the approvals
- Development of a **Traffic Management Plan** to include scheduling of deliveries, managing timing of transport through Goulburn and Crookwell to avoid peak hours (beginning/end of the school day), limiting the number of trips per day, undertaking community consultation before and during all haulage activities, designing and implementing temporary modifications to intersections and street furniture (particularly the Hume Highway junction at Breadalbane), restoring all changes to their original condition and managing the haulage process
- Implementation of all aspects of the **Traffic Management Plan** in coordination with the local Councils and RTA
- Providing a dedicated telephone contacts list to enable any issues or concerns to be rapidly identified and addressed
- Installing required signage to direct traffic flows appropriately during haulage through Goulburn and Crookwell
- Reinstating pre-existing conditions after temporary modifications to the roads and pavement along the route
- Undertaking forward planning to ensure equipment transportation complies with requirements of the management plan, RTA and Council
- The realignment of some of the low speed sections of Bannister Lane would be considered
- The erection of warning signs and/or advisory speed posting would be considered
- The pavement and drainage structures require inspection and possible upgrading after consultation with Council
- The Proponent would prepare road dilapidation reports covering pavement and drainage structures in consultation with Council. Any damage resulting from the construction (or decommissioning) traffic, except that resulting from normal wear and tear, would be repaired at the Proponent's cost. Alternatively, the Proponent may negotiate an alternative for road damage with the relevant roads authority
- A speed limit would be placed on some of the roads near dwellings or sub standard junctions. The speed restriction would be included in the **Traffic Management Plan** to be submitted to Council

- A procedure would be established to monitor the traffic impacts during construction, such as noise, dust nuisance and travel times and work methods modified to reduce the impacts
- A procedure could also be established to inform vehicle operators on the precise timing of school buses
- Regular monitoring and scheduled maintenance of gravel pavements such as grading, dust suppression and drainage control would take place during the construction period
- Signposting to warn horse riders of construction traffic and clearing (slashing) of vegetation from verges on the Bicentennial National Trail to allow horses to move off the road when vehicles approach

Specific measures:

- Hume Highway Junction at Breadalbane -
    - Speed controls. The Roads and Traffic Authority are generally not in favour of speed restrictions on the Hume Highway because of the loss in efficiency of the route. However, the use of speed controls for specific short-term activities would be included in a traffic control plan
- Crookwell Road -
    - The business owners, retailers etc in the main street of Crookwell would be made aware of the timing for heavy, over-mass and over-dimensional vehicles
- Grabben Gullen Road -
    - The junction is to be designed and constructed in consultation with Upper Lachlan Shire Council and the Roads and Traffic Authority
- Range Road -
    - The new junction required to be constructed on Range Road would be designed and constructed in consultation with Upper Lachlan Shire Council
    - Consideration would be given to the reconstruction and sealing of the 1.8km length of unsealed pavement which would include the proposed junctions
    - The shadow flicker effects would be monitored following commission and any remedial measures to address concerns would be developed in consultation with the Council and the Department of Planning
- Bannister Lane, Storriers Lane, Prices Lane -
    - A program would need to be established to consult with all of the road users and residents in the area particularly those living in the residences close to the roads. The construction noise assessment indicates several measures to address potential noise impacts of construction (refer to Section 7.3)
- Breadalbane to Gurrundah Road -
    - The Gurrundah Road junction is to be designed and constructed in consultation with Upper Lachlan Shire Council
    - A procedure would be established for all vehicles associated with the Gullen Range wind farm project to make contact with a railway service to establish approximate timing of trains so that crossings could be made during the safer periods. The need to always visually check for the approach of trains would be stressed to vehicle operators

Operational and decommissioning impacts

The peak road usage, and therefore the greatest potential for impact, would occur during the construction phase. Mitigation measures have therefore targeted this phase. These measures would amply mitigate impacts during the operational and decommissioning phases of the wind farm.

7.11 Fire and bushfire impacts

Existing environment

The wind farm would be located predominantly in cleared exotic pasture however, scattered trees, woodland fragments as well as more extensive woodland areas are located within close proximity of the proposed infrastructure (refer to aerial photography, Section 3). Factors mitigating fire risks at the site include the sparse and fragmented nature of woodland and forest remnants at Kialla and Bannister, the distance proposed between infrastructure at Pomeroy and Gurrundah and their more extensive woodland areas as well as the low density of human settlement and assets in the area. Additionally, there is the local presence of the Rural Fire Service and the continued grazing regimes at all sites act to reduce fuels.

The bushfire danger period for the Upper Lachlan Shire Local Government Area is generally between 1st October and 30th April, but can vary subject to local conditions. Summer conditions in the Goulburn district can be dry and hot with high wind speeds, producing local grass fire hazards. Potential ignition sources include farm machinery, hay storage, vehicles stopping in long grass on road verges, cigarette butts thrown from car windows and lightening strikes. The elevated position of the sites may increase the frequency of lightning strike. The steep topography and absence of built areas or natural fire breaks such as large water bodies may assist the rate of spread of wildfires.

The NSW Fire Brigade defines hazardous materials as 'anything that, when produced, stored, moved, used or otherwise dealt with without adequate safeguards to prevent it from escaping, may cause injury or death or damage to life, property or the environment'. The fuels and lubricants required to construct and operate the wind farm constitute hazardous materials under this definition.

The NSW Fire Brigade has the authority to attend, combat and render safe any land-based or inland waterway spillage of hazardous materials within the State. All fire stations are equipped with trained personnel and resources for dealing with hazmat incidents. The Hazardous Materials Response Unit has a 24 hour phone contact (Tel: 02 9742 7155). Intermediate hazardous materials response is delivered by 20 strategically located units; each unit is equipped with detection equipment and has the capability to access chemical databases with information on chemical, biological, radiological and toxic industrial chemical substances. The closest NSW Intermediate Hazardous Materials Response Unit is located at Goulburn Fire Station 157 – 161 Burke St. Goulburn (Tel: 4822 1608). The travel time to the site would be 30 minutes (33km).

Rural Fire Service trucks are located at Gurrundah (1), Bannister (1), Grabben Gullen (2), Cottawalla (2), Crookwell (1) and Bialla (1). The longest response time anticipated to any part of the site is 20 minutes (pers. comm. Ian Kennerley, RFS Crookwell, October 2007). The Crookwell air strip is located near to the site. This area is used by the local RFS for training purposes.

Issues relevant to the proposal and bushfire impacts include:

1. Activities such as hot welding in fire danger periods;
2. Potential for infrastructure to start or influence a fire; and

3. Access to the site and fire fighting strategies onsite.

These issues are discussed below.

Impact assessment

Construction and decommissioning phases

Flammable materials and ignition sources brought onto the site, such as fuels, would increase the risk of fire during the construction period. Correct handling and storage procedures would mitigate against the risk of ignition. Appropriate fire fighting equipment would be held on site when the fire danger is very high to extreme, and a minimum of one person on site would be trained in its use.

The Rural Fire Service would be consulted in regard to the adequacy of bushfire prevention procedures to be implemented on site during construction, operation and decommissioning. These procedures would in particular cover hot-work procedures and response measures to control any incident.

Operational phase

Ignition sources

Being electrical equipment and containing petrochemicals, there is potential for the wind turbines, substation, control building and transmission lines to start or influence the spread of fire onsite. For the wind turbines themselves, the risk of fire can be associated with malfunctioning turbine bearings, inadequate crankcase lubrication, cable damage during rotation, electrical shorting or arcing occurring in transmission and distribution facilities (AusWEA 2001).

Zilkha Renewable Energy (2002) reports that records from a leading insurer show that fires due to equipment failure are very rare in modern wind turbine designs. In 15 years and with over 12,000 insured turbines, the insurer has had only one case of third party damage from fire caused by a turbine. Turbines automatically shut down if ambient temperatures exceed the safe operating range, or if components overheat.

There remains however, a possibility that electrical failure could produce a fire within a turbine tower. In the event of a turbine igniting onsite, the generally low fuel levels in surrounding pasture and fragmented woodland would reduce the chance and intensity of wildfire. The ready visibility of the turbines and local presence of RFS equipment and personnel would and assist detection, response time and control. In addition, shut down mechanisms would be installed in the wind turbines, and remote alarming and maintenance procedures would also be used to minimise risks.

Lightning conductors are installed in turbines to ground lightning strikes in order to minimise risk of damage to the turbines and risk of ignition of a wildfire. Relatively minor damage to turbines may occur from lightning strike. At the existing Crookwell I site, north-east of the Gullen Range proposal, a direct strike resulted in damage to one of the turbine blades, which was repaired onsite. No wildfire resulted. The risk of turbine ignition is considered to be low, based on the low likelihood of electrical failure or over-heating and a range of factors mitigating the fire hazard.

Electrical transmission lines would be installed to connect the wind farm to the electricity grid system. The lines are underground across most of the site and overhead to connect the sites to the substation. The overhead lines have been routed to avoid trees and forest fragments where possible, reducing the need for clearing and eliminating ongoing fire risks from tree growth and in the event of a line breakage. Cable routes would be periodically inspected to monitor any regrowth.

The transformers located in the substation facility at the Pomeroy site would contain transformer oil for the purpose of cooling and insulation. The facility would be bunded with a

capacity exceeding the volume of the transformer oil to contain the oil in the event of a major leak or fire. The facility would be regularly inspected and maintained to ensure leaks do not present a fire hazard, and to ensure the bunded area is clear (including removing any rainwater). Transformer oil would be changed regularly at appropriate intervals by qualified staff to minimise the potential for fire caused by contaminated oil. The oil would be removed from the site and disposed of appropriately.

The substation, which has been located in an area of exotic grass and few trees, would be surrounded by a gravel and concrete area free of vegetation to prevent the spread of fire from the substation and reduce the impact of bushfire on the structure. The substation area would also be surrounded by a security fence as a safety precaution to prevent trespassers and stock ingress. An asset protection zone would be maintained around the control room and substation buildings, compliant with the RFS *Planning for Bushfire Protection* guidelines. Workplace health and safety protocols would be developed to minimise the risk of fire for workers during construction and during maintenance in the control room and amenities.

Impacts on fire-fighting operations

Wind farms have been found to influence temperature and wind speed around turbines and have the potential to influence bushfire behaviour. A distance of up to 1.25km (SEDA 2002) around each wind turbine is likely to experience warmer night temperatures and faster wind speeds on average, although this attenuates rapidly with distance from the turbine. While the amount of increase is small (approximately 0.7^{o}C increase and approximately 0.6 metres/second increase at ground level; Baidya, *et al.* 2004) these factors may enhance bushfire conditions, slightly increasing the intensity or rate of spread of a bushfire at the site. Given the already low fire hazard at the site, this minor increase in fire intensity is not considered likely to noticeably affect the rate of spread or controllability of wildfires.

The turbines have the potential to present a hazard to fire fighting helicopters and planes. Given the absence of large water bodies, these aircraft are unlikely to fly close to the turbines to obtain water for fire fighting. The Crookwell airstrip can be used for fire fighting operations and the proximity of turbines to the airstrip would not prevent the safe operation of fire fighting aircraft (refer to Section 7.6).

The access tracks installed to build and maintain the wind farm would increase the accessibility onsite and would therefore have a positive impact on the response time and ability to fight fires onsite or on neighbouring properties.

A concern raised during wind farm community consultation was the reliance of the proposal on local RFS volunteers, who have no experience in fighting fires in the vicinity of wind farms. The RFS responded to this issue during consultation, stating that due to the hazardous materials stored onsite (hydrocarbons within turbines and the substation), the local RFS would only ever act in a support capacity to the NSW Fire Brigade, in the event of an infrastructure related fire onsite. The RFS and NSW Fire Brigade would be consulted regarding safety, communication, site access and response protocols in the event of a fire originating in the wind farm infrastructure, and also in the event of an external wildfire threatening the wind farm.

Mitigation measures:

- The Rural Fire Service and NSW Fire Brigade would be consulted in regard to the adequacy of bushfire prevention measures to be implemented on site during construction, operation and decommissioning. These measures would in particular cover hot-work procedures, asset protection zones, safety, communication, site access and response protocols in the event of a fire originating in the wind farm infrastructure, or in the event of an external wildfire threatening the wind farm or nearby properties

- Flammable materials and ignition sources brought onto the site, such as hydrocarbons, would be handled and stored as per manufacturer's instructions.
- During the construction phase, appropriate fire fighting equipment would be held onsite when the fire danger is very high to extreme, and a minimum of one person on site would be trained in its use. The equipment and level of training would be determined in consultation with the local RFS
- The substation facility would be bunded with a capacity exceeding the volume of the transformer oil to contain the oil in the event of a major leak or fire. The facility would be regularly inspected and maintained to ensure leaks do not present a fire hazard, and to ensure the bunded area is clear (including removing any rainwater)
- The substation would be surrounded by a gravel and concrete area free of vegetation to prevent the spread of fire from the substation and reduce the impact of bushfire on the structure. The substation area would also be surrounded by a security fence as a safety precaution to prevent trespassers and stock ingress
- Asset protection zones (APZs), based on the RFS *Planning for Bushfire Protection*, would be maintained around the control room, sub-station and in electricity transmission easements. Workplace health and safety protocols would be developed to minimise the risk of fire for workers during construction and during maintenance in the control room and amenities
- Fire extinguishers would be stored onsite in the control building and within the substation building
- Shut down of turbines would commence if components reach critical temperatures or if directed by the RFS in the case of a nearby wildfire being declared (an all hours contact point would be available to the RFS during the bushfire period). Remote alarming and maintenance procedures would also be used to minimise risks
- Overhead transmission easements would be periodically inspected to monitor regrowth of encroaching vegetation

7.12 Hydrology (water, water quality and water-table impacts)

Existing environment

The site is situated in the Lachlan catchment and sits partially within the hydrological catchment defined by the NSW Regional Environmental Plan No. 1 Drinking Water Catchments. Although this REP does not apply to Part 3A developments, the aim of neutral or beneficial impact to water quality is still considered the appropriate water quality goal for this proposal.

The Lachlan River is the largest river in the area. It is located approximately 20 kilometres west of the development site. There are a number of creeks in the vicinity of the sites where infrastructure would be installed and operated. Banks appear extensively denuded in the area with active erosion gullies common. Larger creeks, including Heffernans Creek and Gurrundah Creek, have a greater degree of upper strata riparian vegetation than smaller water bodies, usually vegetated with a mix of native and exotic grasses and graminoids.

The Lachlan Catchment frequently has nutrient concentrations higher than those recommended for the protection of modified aquatic ecosystems, primarily related to turbidity (Thurtell 2003). Higher nutrient concentrations can increase the extent and duration of toxic algal blooms in catchments. Measures recommended to reduce these levels, include addressing catchment and in-stream erosion, the degradation of stream banks and riparian areas throughout the catchment (Thurtell 2003).

Impact assessment

Construction and decommissioning impacts

A bore is located at the Pomeroy site that can produce approximately 22kL/hr. It is estimated that approximately 5.6 ML of water would be required for the production of concrete for the project. A significant amount of this water would be sourced from this bore with the balance from other on-site dams and local sources for a second batching plant at Gurrundah. Water would be reused where possible to reduce the amount required. No water would be sourced from local creeks or rivers without relevant permits being obtained. No water would be discharged into drainage lines or other water bodies during any phase of the project.

The water bodies in the area are sensitive to input from erosion and nutrients. The works would be concentrated away from water bodies and drainage lines however, there is potential for impact indirectly by sediment or pollutant-laden run-off during larger rainfall events. This is particularly relevant to haulage routes, where they are within close proximity of drainage lines (such as culverts and crossings on Gurrundah Road, Bannister Road and Range Road). Dust, soil sediments and potentially pollutants (in the case of a spill) may be transported in run-off to water bodies. Materials being transported to and from the sites along the haulage routes that could pose a risk to waterways would include dust, soil, hydrocarbons (fuel), cement, aggregates, fertiliser, herbicides and plant seed.

Onsite, the installation of infrastructure would be primarily focussed on high elevation land and away from drainage lines hence direct impacts to the surrounding water bodies are not expected. There is potential for construction materials such as alkaline concrete wash to be discharged from the construction sites. Chemicals are found in concrete products, soil additives used for stabilisation and other purposes, concrete-curing compounds, fuels as well as other sources. When used or stored improperly, these chemicals can become mixed with stormwater and carried by sediment and runoff from construction sites. Eutrophication of surrounding waters could also occur from the use of fertiliser (during revegetation), and nutrient release from sediments as a result of erosion and release of turbid waters during construction. These impacts are considered to be manageable.

No water crossings are required to be constructed. Footing designs of infrastructure including turbines are not anticipated to impact on the water table but would be designed in consultation with geotechnical engineers to ensure they are appropriate. No sewerage or septic would be installed for the construction phase; portaloos would be available to construction staff during this phase.

It is envisaged that minor upgrades to current roads and access tracks would need to be undertaken as part of this proposal. In addition, it is expected that minor access tracks would be created between the turbines.

The impacts of the proposal are considered manageable with regard to water quality. Specific activities that would be undertaken and their associated mitigation strategies are outlined in the table below.

Mitigation measures:

- Water would be sourced from an onsite bore (Pomeroy) as well as other local sources including onsite dams. It would be reused where possible to reduce the total amount required. No water would be sourced from creeks or rivers without relevant permits being sought. No water would be or discharged into creeks, rivers or drainage lines
- All bridges used would be assessed prior to works to check they are able to bear the projected loads of the laden vehicles
- All vehicles onsite would follow established trails and minimise onsite movements
- Machinery would be operated and maintained in a manner that minimises risk of hydrocarbon spills

- Maintenance or re-fuelling of machinery would be carried out on hard-stand areas (i.e. existing or proposed road surface or hard-stand areas beneath turbines). Where possible, maintenance and re-fuelling would not occur on areas that either contain native vegetation, or would be revegetated
- The concrete batching plants would contain settling ponds sufficient to capture all concrete wash. Wash water would be recycled onsite (in cement mix, road base and dust control) and would not be released
- Waste sludge would be recovered from the settling pond and used in the production of road base manufactured onsite. The waste material would be taken from the batching plant to be blended in the road base elsewhere onsite
- The concrete batching plant areas would be fully remediated at the completion of the construction phase
- Dust suppression would be carried out where required. Central to controlling dust are means to determine when dust suppression is required and having adequate access to water or chemical dust suppression alternatives to control dust. These specifications would be included in the **Construction Environmental Management Plan** prepared for the project prior to construction
- Sediment and erosion would be controlled as part of a formal **Sediment / Erosion Control Plan**, as a sub plan of the **Construction Environmental Management Plan**. This plan would include the following provisions:
    - Sediment traps would be installed wherever there is potential for sediment to collect and enter waterways
    - Stockpiles generated as a result of construction activities would be bunded with silt fencing, (hay bales or similar) to reduce the potential for runoff from these areas
    - Soil and water management practices would be guided by the Best Practice guidelines contained within *Soils and Construction Vol. 1* (Landcom 2004)
- A **Water Management Strategy** would be developed for the site as part of the Construction and Operational Environmental Management Plans. This would aim to integrate the total water cycle of the site in terms of water supply, stormwater and wastewater, and maximise the use of best management practice techniques for stormwater and wastewater management. Devices such as swales to disperse rather than concentrate runoff would be implemented. Water use would be minimised by maximising reuse. Detailed measures would be devised in conjunction with the development of the construction drawings.
- A **Site Restoration Plan** would be prepared as part of the **Construction Environmental Management Plan**. This would set out protocols for restoration works including:
    - Site preparation
    - Stabilisation
    - Revegetation
    - Monitoring
- The contractor would prepare and implement a **Spill Control Plan,** as a sub-plan of the **Construction Environmental Management Plan.** It would:
    - Identify persons responsible for implementing the plan if a spill of a dangerous or hazardous chemical/waste would occur
    - Material Safety Data Sheets (MSDS) for all chemical inventories would be located on site and readily available

  - Where chemicals are used, their application and disposal would comply with manufacturers recommendations
  - Any spill that occurs, regardless of size or type of spill, would be reported to the Construction Manager
  - The event and clean up processes would be recorded. Information that would be recorded in the event of spill would include time and date of spill, type of chemical or waste spilt, approximate volume spilt, general area in which the spill occurred, corrective actions applied, and disposal of spilt material
  - Spill protocols in this plan would dictate when the EPA would be notified
  - Chemical / fuel storage areas would be identified, and be bunded to prevent loss of any pollutants
  - Hydrocarbon spill kits would be stored at the site. A number of site staff are to be trained in the use of the spill kits

- The guiding principle of the development with regard to water quality would be to have neutral or beneficial impact. In addition to the mitigation measures proposed above, several measures have been proposed under *Section 7.4 Biodiversity* and *Section 8.8.3 Soils and Landforms* to manage water quality impacts

Operational impacts

Water tanks may be installed to collect rain water from the control building, in order to supply water for maintenance staff facilities. No additional water connections are anticipated. A septic system may be installed in the control building. These would meet Upper Lachlan Council standards.

The operation of the wind farm would require minimal traffic on roads/tracks, which would have been upgraded to accommodate heavy loads during the construction phase. The increase in compacted areas as a result of the track upgrades may potentially increase the amount and turbidity of runoff around these tracks, although this is expected to be minimal.

Infrastructure including the substation and turbines would be bunded to ensure that oil could not escape.

Mitigation measures:

- Infrastructure would be bunded to ensure that the amounts of oil could be fully contained in the event of a leak. Bunding provisions would be regularly inspected
- Septic systems, if installed, would meet Upper Lachlan Council standards

7.13 Mineral exploration impacts

Existing environment

Geologically, the area proposed for the Gullen Range wind farm lies in the eastern Lachlan Fold Belt, an area consisting of Palaeozoic age sequences (Ordovician to Permian) overlain in part by Cainozoic age basalts and sediments. Over 580 metallic mineral occurrences are known in the Goulburn 1:250 000 map sheet area. Significant amounts of gold and base metals have been mined from the area. Important industrial minerals including coarse aggregate, sand and iron oxide are also found in the local area (Department of Primary Industries 2005).

The Department of Primary Industries has indicated during the consultation process that the impact of the proposal on mineral exploration and mining is a key concern. They have provided a map indicating mineral occurrences relevant to the proposal (Figure 7-14). They suggest that while the construction of the wind farm may not physically prevent exploration from being undertaken within the area, it could be a disincentive to explorations if it restricts or precludes the mining of any resources that may be discovered.

Two companies hold current exploration licences over part of the study area; Golden Cross Resources Ltd and Tri Origin Mining Pty. Ltd. These companies have formed a joint venture arrangement to explore the area. Exploration leases entitle the holders to carry out exploration and prospecting for minerals within the specified areas. Lease boundaries are indicated on Figure 7-15 and overlap a considerable portion of the proposed wind farm project area; Gurrundah and Pomeroy sites; Areas 1 and 6. These areas are not currently being investigated however, they have been highlighted by Golden Cross as warranting further investigation.

Extract from Golden Cross Operations Pty. Ltd. Breadalbane Information Memorandum 2003:

> *Area 1*
>
> *If the structural interpretation presented here is correct, the northern part of the licence is a dilatant zone and clearly warrants further investigation. It hosts a broad magnetic low anomaly similar to the Wet Lagoon area, open-ended geochemical anomalies, NW-trending structures and areas of poorly mapped rocks.*
>
> *Area 6*
>
> *This is the Lucky Hit-Gurrundah sone which hosts both VHMS and shear-hosted sulphide mineralisation. A systematic re-evaluation of this zone with respect to gold mineralisation is required, as little historic gold assay work has been completed.*

Impact assessment

Construction and decommissioning impacts

Sterilisation of the mineral resource and inhibition of an active exploration program would be the key mineral resource concern posed by the proposal. This may occur during the construction phase, when infrastructure is developed and would depend on the size and location of the infrastructure, including the substation, turbines footings, control building and access roads, as well as the unknown quality, quantity and location of the mineral resource.

The development envelope calculations and layout maps (Section 3) quantify the areas that would be 'sterilised' to purposes such as agricultural grazing or mineral exploration. This totals 91.5 hectares. This information has been forwarded to the current mineral lease holders and the Department of Primary Industries, Minerals by email on 14 January 2008. When the final turbine layouts are determined, these would be forwarded to the mineral lease holders and the Department of Primary Industries, Minerals.

While only Exploration Leases occur over the area at this time, if a mineral deposit is discovered then an application for a Mining Lease can be made. There is no certainty that a discovery would be made or a Mining Lease would be granted and accordingly the amount of potential lost mining revenue cannot be known in advance. In comparison to the lease area, the relatively small land area that would be sterilised and the level of reversibility of the proposal suggest that this impact is justifiable; the temporary loss of these areas for mining would be offset by the utilisation of a renewable resource during the project's life. The benefits of the wind farm proposal would extend to involved property owners (via lease agreements), the community (via the Community Fund), Gullen Range wind farm and its shareholders as well as the end users of the renewably generated electricity.

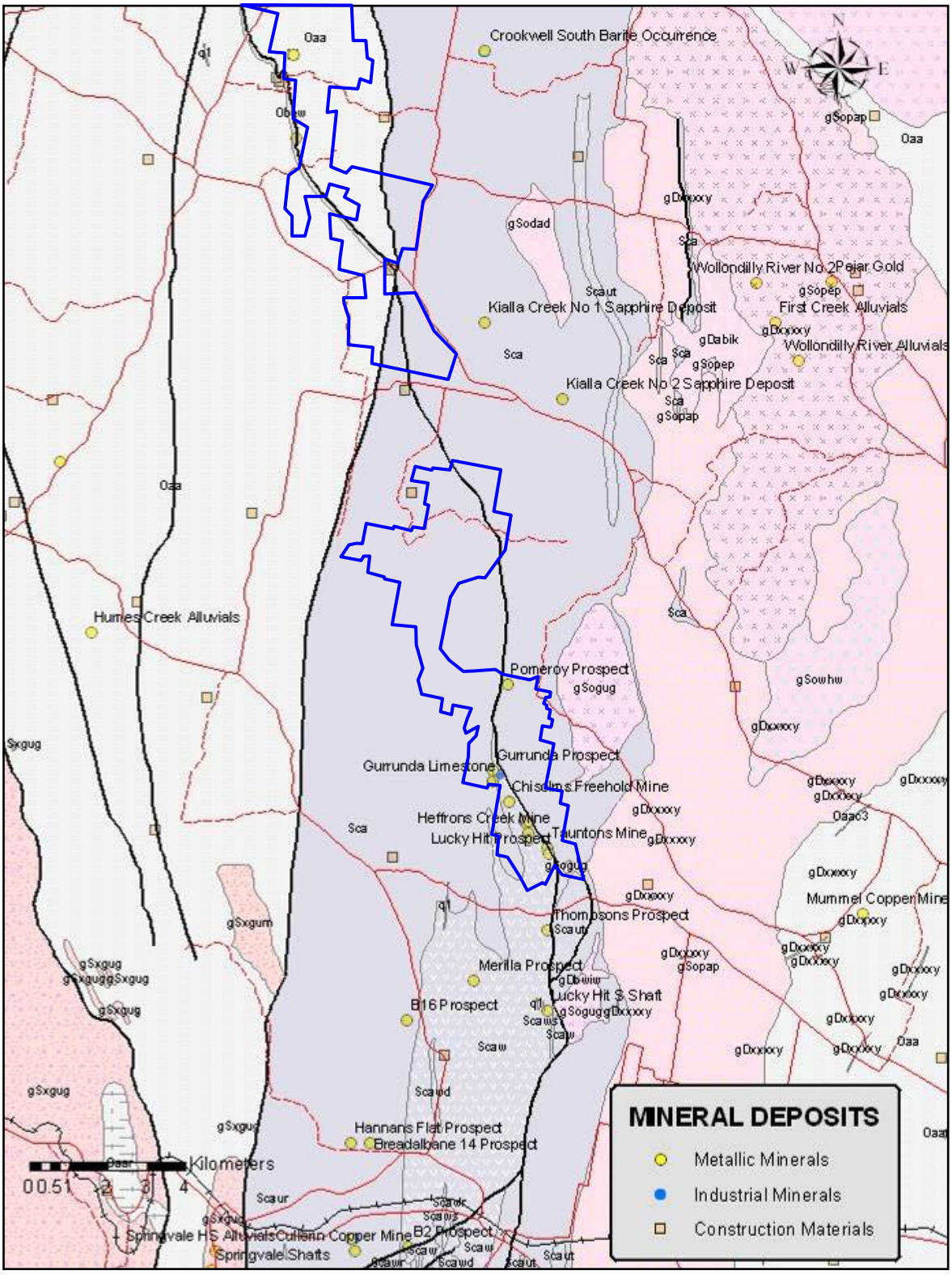

Figure 7-14 Mineral deposits mapped near the proposal area

Map provided by Department of Primary Industries, Minerals. The Gurrundah prospect (blue) is barite with associated base metal mineralisation. The development envelope is overlaid in blue.

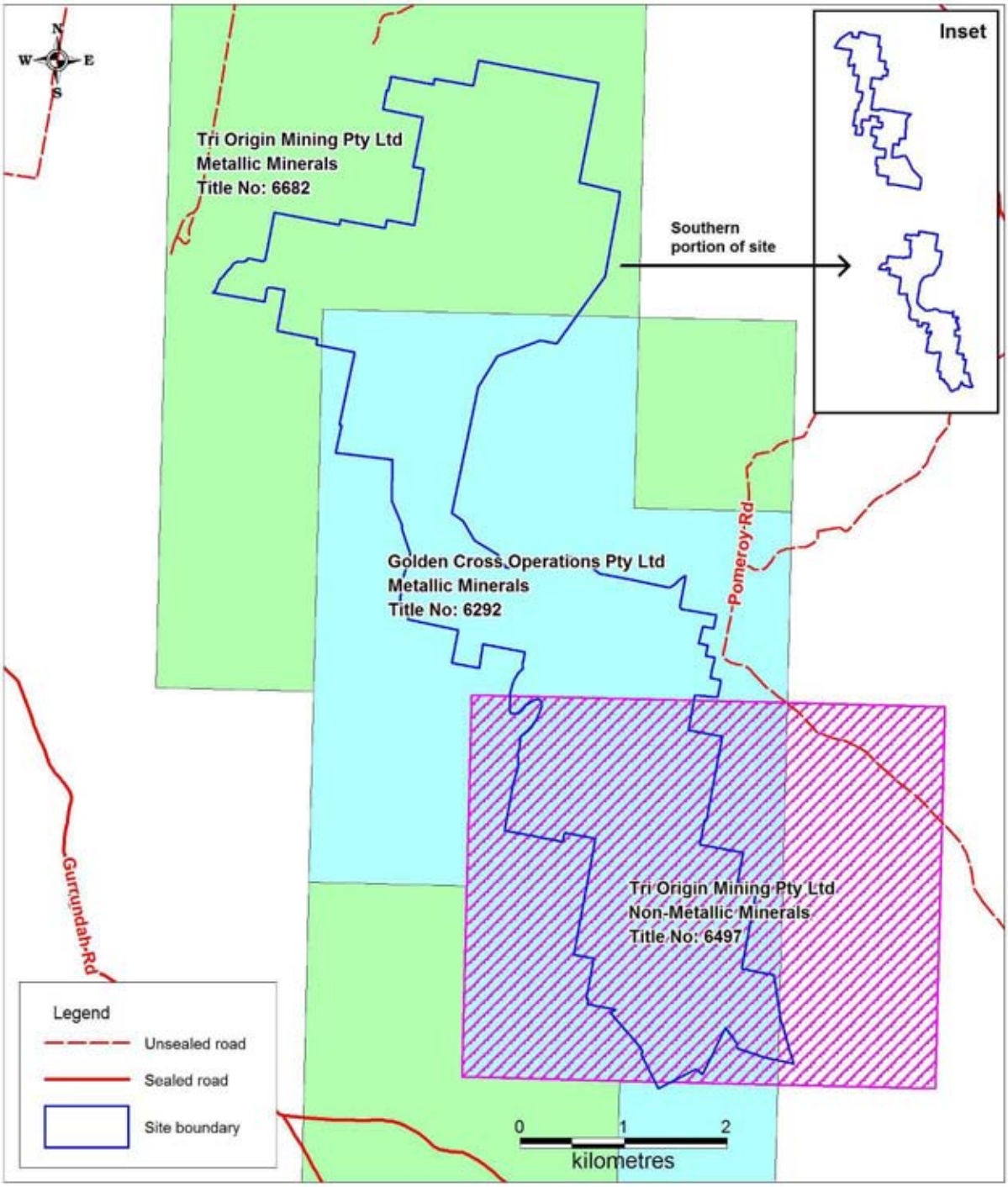

Figure 7-15 Breadalbane Project location map

Source: Golden Cross Operations Pty. Ltd. Breadalbane Information Memorandum 2003. The southern development envelope is overlaid in blue.

Mitigation measures:

- The Proponent would liaise with the current mineral lease holders, providing a final turbine and infrastructure layout, prior to the construction phase
- The Proponent would liaise with the current mineral lease holders during the construction phase, to ensure that where possible, the works program does not unnecessarily interfere with planned exploration activities
- The Proponent would liaise with the involved land owners and current mineral lease holders prior to rehabilitation, to ensure that any project access roads that they may wish to retain are retained. Several of these access roads are likely to be of benefit both to routine agricultural activities as well as to exploration activities onsite

Operational impacts

In principle, there is no reason why the exploration of minerals could not occur around the operational wind farm. Access roads may even benefit this purpose. However, it is possible that the operational wind farm may impede the exploration of minerals within the lease areas, within close proximity to infrastructure such as turbines and access roads. This may be due to restrictions on the manoeuvrability of exploration machinery and safety considerations. These impacts would be reversed at the end of the project's life, allowing exploration of all areas except for those discussed above; substation, turbines, and control building footings. This combined area is small in relation to the lease area and as stated in relation to construction and decommissioning impacts, the impact is considered to be well justified.

8 ASSESSMENT OF ADDITIONAL ISSUES

Beyond the key issues identified by the Department of Planning in the Director General's Requirements, additional areas of impact were identified using a risk analysis model. This model considers the nature of the potential impact (i.e., is it temporary, reversible, likely to have associated indirect impacts?), the receiving environment (i.e., sensitivity to impact, recovery response time) and likelihood of the impact occurring (considering the ability to manage the impact).

Table 8-1 Risk analysis of remaining issues

The risk rating has been calculated as a factor of the anticipated nature of the impact and sensitivity of the receiving environment:

1 = low anticipated impact / sensitivity / likelihood of occurrence

5 = high anticipated impact / sensitivity / likelihood of occurrence

Risk ratings are then portrayed from least to greatest: green, yellow, orange, red.

Discussed in this Section:	Impact area	Nature of impact	Sensitivity of receiving environment	Likelihood of occurrence	RISK RATING
Section 8.1	Economic impacts *	3	3	5	45
Section 8.2	Community wellbeing	3	4	3	36
Section 8.3	Lifestyle values	3	3	4	36
Section 8.4	Tourism	3	3	4	36
Section 8.9	Resource use	2	3	5	30
Section 8.10	Cumulative impacts	3	2	5	30
Section 8.6	Health and safety	5	2	2	20
Section 8.7	Heritage values	3	3	2	18
Section 8.8.3	Soils	3	3	3	18
Section 8.5	Agricultural impacts	2	2	2	8
Section 8.8.1	Local climate	1	1	5	5
Section 8.8.2	Air quality	1	1	5	5

** Note: direct economic impacts are generally considered to be positive.*

Excluding Economic impacts, the greatest risk ratings have been assigned to the areas of: Community wellbeing, Lifestyle values and Tourism. Generally, this reflects greater sensitivity to impact and greater likelihood of occurrence, considering the manageability of the impact.

These impact areas are evaluated further in this section of the EA.

8.1 Economic impacts

Existing environment

The Upper Lachlan Shire Council was formed in February 2004 from the Crookwell shire, the majority of the Gunning Shire and part of the Mulwaree Shire. The local government area is a sparsely populated, predominantly rural area. The LGA covers 7,200km2 with a population of approximately 7,600 people (data sourced from the Upper Lachlan Shire Council Annual Report 2005-2006. The demographic trends indicate an aging population (data sourced from the Upper Lachlan Shire Council Annual Report 2005-2006). Key statistics pertaining to the LGA, prior to amalgamation are provided in Table 8-2.

Table 8-2 Key statistics for the LGA

	Mulwaree (1999)	**Crookwell (1996)**	**Gunning (1996)**
Size of shire: Area of sq km.	5204	3615	2209
Population			
Number	6192 (1999)	4325 (1996)	2,300 (1996)
% Growth since 1991	1.9%	-0.05%	5.2
Medium age 1996 (yrs)	37	37	35
Value of Industry $ Million			
Tourism	6.0	8.0	4.0
Retail	6.0	11.1	3.2
Manufacturing	n/a	1.9	n/a
Agriculture	33.5	42	20.4
Value of Building Approved	5.4	3.1	2.7
Education			
Number of people with			
- post-school qualifications	1397	760	586
- trade qualifications	799	468	325
- tertiary qualifications	598	292	261
Top Industries (number of people employed)			
Agriculture, Forestry & Fishing	539	687	326
Retail Trade	266	158	69
Health & Community Services	236	137	68
Education	158	117	
Manufacturing	194		
Governments Admin & Defence		89	109
Property & Business Services			81
Number of Business 1996	741	784	410

Source: ABS, Tourism NSW

The shire is largely agricultural. Extensive grazing of sheep and cattle are the predominant land uses. Two chicken farms and potato farming also occur within close proximity of the proposal site. Crookwell is the nearest town to the wind farm site (~7km) and the administrative centre of the Upper Lachlan Shire. Grabben Gullen is the nearest village (~2.5km). Gunning is located approximately 20 kilometres south-west, traditionally built around wool and seed potato production, the area is now diversifying into olive production, alpaca and horse enterprises. Goulburn, approximately 25km to the east, is the largest regional centre with a population in 2001 of 21,400 (over 75% of the regional population is located in Goulburn). Tourism is the third largest industry behind agriculture and retail. The locality offers visitors an historic rural experience and provides employment in agriculture, several service sectors but few manufacturing opportunities by comparison.

The proposed wind farm would provide temporary (during construction and decommissioning) and permanent (during operation) employment. It is also likely to generate increased demand for services in the local area, most likely during the construction phase. There is an opportunity for local contracting and manufacturing services to be contracted during site development, as discussed below.

Impact assessment

Construction and decommissioning impacts

The construction and decommissioning phases of the wind farm would generate the largest economic gain for the largest number of people. The local area appears suited to benefit from the temporary provision of up to 180 additional jobs. These would include concreting, earthworks, steel works and electrical cabling. As well, as other service related employment would follow, with the provision of food, fuel, accommodation and other services to contractors.

The provision of a Community Fund, to which Gullen Range Wind Farm Pty. Ltd. would contribute throughout the life of the project, would assist in improving the equity of financial benefits to the community. Under the direction of a community board and the Upper Lachlan Shire Council, this fund may be used to provide environmental and social services in the area, as the board sees fit.

Precise economic benefits would vary depending on final site design, turbine suppliers, timing of works, and other details. It is estimated that between $60 and $90 million could be spent within the region as a result of the wind farm over its life.

Gullen Range Wind Farm Pty. Ltd.'s preference is to use local companies for the construction and decommissioning. The local area has concrete, steel and earthworks capabilities. In addition, the Goulburn region has the potential to construct the large steel turbine towers required for this project. A consortium involving Ainsworth Engineering, Vale Engineering, Rigby Jones, Edwards Construction and Southern Steel Group, supported by Bluescope Steel, is currently finalising plans to commence tower manufacture in Goulburn. This could provide a large number of jobs and additional economic benefits to NSW.

As the construction and decommissioning phases of the projects would take place over a considerable time period (estimated to be 12 - 24 months for construction and 12 months for decommissioning), there is potential to adversely impact current grazing activities on the sites that would be developed and for the additional heavy vehicle traffic on public roads to interfere with other economic activities, for example, scenic drives, field days and other tourist related activities. These impacts are discussed specifically in Sections 8.5 and 8.3.

To maximise the economic benefit of the proposal the following measures are recommended:

Mitigation measures:

- Maximise use of local contractors. The Proponent would liaise with local industry representatives to maximise the use of local contractors and manufacturing facilities in the construction and decommissioning phases of the project
- Co-ordinate construction activities with local events. The Proponent would liaise with the local visitor information centres to ensure that construction and decommissioning timing and haulage routes are known well in advance of works

Operational impacts

Wind farms are an economically viable means to generate electricity. The project would be privately funded by the Proponent. There would be no ongoing financial expenses to the community or to the Upper Lachlan Shire Council.

The operational wind farm is compatible with the current agricultural use of the Gullen Range sites and would be similarly unlikely to impact on the profitability of agricultural activities of adjacent land parcels (discussed in more detail in Section 8.5).

8.2 Community wellbeing

Existing environment

Wind farms have been seen as divisive developments in terms of local communities. To investigate the potential for adverse impact to the community, this section considers the current makeup of the local community, indicators of community well being, documented responses by communities to wind farm developments, and specific responses of the local community to the Gullen Range wind farm proposal.

Local community make-up

The make-up of the local community can be seen as being comprised of families that have been in the area for several generations and newer residents attracted by work opportunities or by the rural lifestyle. While the 'tree change' phenomenon can bring skills and diversity to a community, it can also be a source of division by increasing the pace of change and affecting established structures or attitudes in a community. By virtue of the increased transient population alone, the tree-change (or sea change) demographic shift can result in a loss of sense of community (Gurran *et al.* 2005). Additionally, the amalgamation of the local government areas in 2004 has been recognised as having had an adverse impact on some aspects of the community; weakened connections between community groups and fuelling rivalries (pers. comm. M. Breen 2004).

The Proponent engaged Twyfords consulting to undertake some research in the Upper Lachlan LGA (Twyford Consulting 2007), to inform community engagement planning of the Proponent's projects. Six community stakeholders were interviewed, representing local consultants, landowners, media and government. While six interviews do not amount to a comprehensive survey of the community, some important themes were revealed:

- The issue of wind farms is contentious and have potential to remain so
- An organised wind farm opposition exists and the manner in which these people are engaged would be important to the success of any large development in the area
- Strong networks exist around community activities such as sport, pubs and clubs, service clubs, the Country Women's Association, Landcare and others
- Beyond the expected issues of noise and visual impact, the issue of secrecy stood out as an important generator of angst. Typically in these communities there is not a strong culture of secrecy
- The community is generally open to 'outsiders' but community members are sensitive to being told what to do or think. A good relationship will take time to build.

The Goulburn region has, over the last several years, had several wind farms proposed and one wind farm developed. Excluding proposals by the Proponent, recent proposals have all been for large scale wind farms. The local Council and state government have been the consent authority variously. Criticisms have been levelled at the community consultation processes employed (Upper Lachlan Shire Council pers. comm. 2005) and frustration has

been observed in the community related to the developers, type of development and the assessment and consent process for both state and council approved developments (Twyford Consulting 2007).

Indicators of wellbeing

Community wellbeing is related to the quality of the natural and urban surroundings, socio-economic position, the availability of services and perceptions of safety (Upper Lachlan Shire Council State of the Environment 2005-06). One measure of 'community' is the willingness of individuals to be involved in volunteer organisations such as the Bush Fire Brigade, Meals on Wheels, the Country Women's Association and farmers' associations. Local sports and recreation clubs are also well represented in the region. These organisations are based on shared goals and maintained by volunteer efforts. The additional element of people who have long associations with the area can strengthen the fabric of the local community. These features are present in the local community.

A Social and Community Plan was adopted by the ULSC in November 2006. The plan incorporates issues that have an impact on community wellbeing, provides an overview of the community and identifies key issues and strategies to address these issues. Key strengths of the community included:

- Social connectedness, evidenced by the extensive and diverse range of community organisations, covering all age groups.
- The high level of volunteer activity in community groups.
- Positive community feelings. Residents described their neighbours and community as assets using positive terms including, 'pulling together', 'rallying around', 'choosing to live here'.

Economic inequalities noted in the plan include:

- Lower levels of education and professional employment when compared to other areas in NSW.
- Lower numbers of Aboriginal people with educational attainment beyond Grade 10 and in professional employment, when compared to non-Aboriginal people. Unemployment is also higher for Aboriginal people.
- Youth unemployment is higher in the LGA, compared to the NSW average.

Issues for community wellbeing identified during the State of the Environment 2005-06 reporting period were:

- Drinking water quality.
- No options for post secondary education within the LGA.
- Limited public transport to many residents in the LGA.

The Social and Community Plan concludes with a set of priority actions for targets groups including, children, women, older people, people with disabilities, from culturally or linguistically diverse backgrounds, Aboriginal and Torres Straight Islanders, men and 'our farming community'. The latter is most relevant to the Gullen Range proposal. The impacts of ongoing drought heighten the existing levels of stress on this sector and have clear links to stress and adverse health impacts within the community. The priority actions formulated by the Social and community plan are reproduced below:

1. Address impact of drought on heath and well being.
2. Enhance links to financial, agricultural and business support/advice agencies.
3. Build on the contact and relationships formed from the 'Community Cares' nights at Crookwell, Laggan, Taralga and Binda in 2006.

4. Build a relationship with the southern highlands Chamber of Commerce to support local villages and rural communities through the 'Back a Bushie' program.

The Social and Community Plan concludes;

> *"Healthy communities have high levels of community participation, harmony and safety as well as adequate access to services and facilities and sufficient economic resources to meet the needs of everyone in the community. There are many aspects of the Upper Lachlan community that promote health and wellbeing…diverse community organisations, the physical and environmental assets and roads and infrastructure."*

It is recommended that, to address the potential for the Gullen Range wind farm proposal to be divisive and generate stress within the community, adversely affecting community wellbeing, that the Social and Community Plan priority actions be used as a guide when considering mitigation measures.

Community response to wind farms

Warren *et al.* (2005) observed that the move from centralised power generation to decentralised use of renewable sources raises novel and challenging issues for planning, land use and social engagement. Their study of wind farms in Scotland and Ireland investigated the nature of community views about wind farms.

The study found that aesthetic perceptions (whether positive or negative) are the strongest single influence on individuals' attitudes towards wind farms and that proximity to wind farms is not a reliable indicator of perception in the long-term. Surveys showed that people with anti-wind farm views perceived turbines as noisier and more intrusive than those in favour of wind turbines, regardless of the actual recorded levels (Krohn and Damborg 1999, cited in Warren *et al.* 2005). The study observed that opposition arises in part from exaggerated perceptions of wind farms that living near a wind farm dispels (Elliott 1994; Redlinger *et al.* 2002; SEDD 2002; Braunholtz 2003; SEI 2003a, cited in Warren *et al.* 2005). More positive feelings about wind farms were recorded closer to the wind farm site than further away (Warren *et al.* 2005).

Warren *et al.* (2005) state that a consistent picture of public attitudes to wind power is emerging from surveys and case studies in Europe. Large majorities are strongly in favour of wind farms, their opinions formed by personal experience, in contrast to a minority in opposition whose opinions are formed not by experience but by misinformation and prejudice. This does not discount the real issues associated with community impacts, those being landscape aesthetics and the speed, scale and uncoordinated nature of the wind farm developments (Warren *et al.* 2005).

Public attitudes are critically influenced by the nature of the planning and development process; the more open and participatory, the greater the level of public support (Birnie *et al.* 1999; Khan 2003, cited in Warren *et al.* 2005). Past experience with wind farm developments and the assessment and approvals process in the Goulburn region have created a history that influences the community's perception of this proposal.

<u>Community perceptions towards wind farms in the Southern Tablelands</u>

A specialist report, *Report on Community Perceptions of Wind Farms in the Southern Tablelands, New South Wales* was prepared for the Proponent in October 2007. The study was commissioned by the Proponent to facilitate the collection of a bench mark measure of attitudes of local residents towards the construction of a wind farm in their local community. The study area was a collection of rural localities situated in the Goulburn – Crookwell – Yass region within the southern highlands of NSW. The survey was undertaken by ERM in conjunction with REARK Pty. Ltd., a consulting firm that specialises in public opinion and market research surveys. The methodology for the public opinion survey is detailed below.

- The study was conducted by telephone in a prescribed geographic area defined by post codes and locality names
- Sample source was derived from the electronic white pages listing of residential numbers within the defined area
- The sample size for the survey was defined at 300. The report indicated that 50% of the sample of 300 would have a sampling precision of 50±5.7%. Further details of the sample statistics are detailed in ERM (2007), presented in Attachment 2.3.
- The respondent for this survey was defined as a randomly selected adult resident within the residence called using the closest birthday technique
- The telephone study was undertaken with the assistance of a Computer Assisted Telephone Interviewing (CATI) system. Field work was undertaken by appropriately qualified personnel
- A questionnaire was developed for the purposes of this study. The questionnaire is presented in ERM (2007), Attachment 2.3. The field work was conducted during the evening and concluded in early August, 2007
- The data collected was analysed and presented in the form of tabulated results within ERM (2007)

Prior to the commencement of the survey, the level of knowledge held by the community with regards to wind farms and associated infrastructure was a relative unknown. The outcomes of the study undertaken as adapted from ERM (2007) are presented below.

- Eighty percent of respondents are concerned with the threat of global warming and its impact on the environment. Conversely, 16% of respondents indicated that were not concerned
- General awareness of wind turbines was very high. Almost all of respondents had claimed that they had seen a wind turbine and 9 in 10 claimed to have actually seen a turbine. Further, in excess of 8 in 10 respondents had seen the current wind farm located at Crookwell
- Approximately 90% of respondents were aware of announcements relating to wind farms
- Eighty-nine percent of respondents were in favour of wind farm projects to be developed in the southern tablelands with 5% opposed. Of the 89%, 83% stated *"I would be happy to see a wind far, built on farm land near where I live"*
- Eighty-seven percent of respondents supported the development of a wind farm within 25 kilometres of their house, with 71% supporting a wind farm within 1 kilometre of their house
- With respect to the construction of multiple wind farms, 75% accepted two 'typical' wind farms (15 to 80 turbines) in their local rural area, with 17% opposed

The study concluded that generally adult residents in the survey area are concerned about global warming and are aware of alternatives available. Additionally, the respondents were generally aware of wind turbines and how wind turbines appear within the landscape and are generally supportive. Survey results further indicated that respondents were generally not adverse to the development of wind farms in the immediately locality. The survey also indicated that 89% of the respondents indicated that they were in favour of the development of a wind farm within the southern highlands. In addition, over 9 in 10 respondents agreed that '*wind energy is a good alternative energy source*'. The survey also found that the community had no clear preference between a few clusters, close together, or spread out at reasonable intervals along the highway (ERM 2007).

Based on the results of the survey undertaken by ERM in 2007, it would appear that the community within the southern tablelands and more specifically within the study area are generally supportive of wind farms. It is considered that the community would be generally accepting of the development of a wind farm in the general vicinity of the usual place of residence. The survey also indicated that the community was aware of announcements relating to wind farm development in the region.

A Community Consultation Process was implemented as part of the Gullen Range wind farm proposal (refer to Section 6.2). The main vehicle for feedback was an open house forum, held on 21 November 2007 at the Grabben Gullen Hall, Grabben Gullen. It is estimated that in total, around 85 people attended the day (75 people registered on a sign-in sheet). Key issues raised by the local community included visual, noise and community impacts. (Documented in Section 6.2)

Impact assessment

Construction issues

The proposed road upgrades would contribute positively to community wellbeing, building on local infrastructure. In the provision of local jobs it would contribute to the socio-economic aspect of wellbeing directly. There is also scope to provide a boost to local volunteer organisations, discussed in the Community Enhancement Program further below.

The construction of the wind farm would generate a level of community disruption, not necessarily related to actual construction impacts but rather to this phase marking the beginning of a proposal that people have strong views about. As discusses above, adverse impacts arise for a number of reasons:

- The development represents a large outside force over which the individual feels little control
- The development process takes the power of consent out of the hands of local representatives, being decided at the state (and sometimes federal) level
- The development is of a nature that would be highly visible, relatively novel and may not be avoidable (in a visual context) during day to day activities
- The development is of a nature which focuses monetary benefits on a relatively small number of directly involved property owners, often creating resentment and inequity

The construction phase may be the trigger for feelings of resentment about the development. The long-term effects of stress can compound over time. The pertinent points, if wind power is to develop and form part of the energy solution in rural areas, are stated below, as mitigation measures to which the Proponent would commit, pending Project Approval of the Gullen Range wind farm.

Mitigation measures:

- Dissemination of accessible and independent information on impacts

  Monitoring information collected during the operation of the wind farm would be made publicly available

- Equitable distribution of benefits

  Gullen Range wind farm would address the potential for wider adverse community impacts by way of a Community Enhancement Program as presented in Section 4.4.2.

Operational issues

The proposal is not anticipated to impact community wellbeing in ways additional to those issues discussed above, during the operational phase. No mitigation measures are considered to be required.

Decommissioning issues

The proposal is not anticipated to impact community wellbeing in ways additional to those issues discussed above, during the decommissioning phase. No mitigation measures are considered to be required.

8.3 Lifestyle impacts

Existing environment

For local residents and visitors alike, the rural land use and large land holdings in the area create a landscape amenable to recreation (horse-riding, walking, fishing) and one in which many people seek to retire or 'escape' from a more urban environment. The number of people in the Gunning area that commute to Canberra is not currently known (anticipated to be known after the 2006 census - Upper Lachlan Shire Council Annual Report 2004-2005) but the number is likely to be increasing, indicating that the area holds land uses other than the purely functional agricultural use or transient tourist use. The rural landscape of the area was also nominated as an important value of the area by the local community at the Gullen Range open house session in November 2007.

The zoning of the land on and surrounding the site proposed for the Gullen Range wind farm 1(a) Rural Zone. Lots within this zone, for the purpose of erecting a dwelling, can be no less than 40ha (Mulwaree LEP) or 80ha (Gunning and Crookwell LEPs). However, the Upper Lachlan shire Council have indicated that three subdivisions occur or are proposed near the proposed wind farm site, Pomeroy locality. One of the aims of the 1(a) zone include to maintain the rural character of the area, encourage the use of rural land for agriculture and other forms of development which are associated with rural activity or which require an isolated or rural location, and to protect natural resources including prime crop and pasture land.

Impact assessment

Construction and decommissioning impacts

Construction noise, the generation of dust from vehicles and the increased traffic flow during construction and decommissioning may impact on the lifestyle values of the locality in the short term. Impacts would be experienced by nearby properties as well as properties on the haulage route.

Impacts would attenuate rapidly with distance from the work sites. These impacts would be temporary, occurring over a 12 - 24 month period (not continuous in any one location), and would be regulated by occupational health and safety and noise and pollution restrictions. Due to the temporary duration of the impact and the low population density, this is not expected to generate an unacceptable level of impact. Traffic, tourism and air quality impacts are evaluated in more detail and mitigation measures stipulated in Sections 7.10, 8.4 and 8.8.2. No additional mitigation measures are considered to be required.

Operational impacts

It is considered that the greatest impact of the proposal on lifestyle values would occur during the operational phase of the wind farm. While the operational wind farm would not preclude nearby residential or recreational land uses, the perceived visual, noise, health and land value impacts may adversely affect the experience of those seeking the quiet, rural character of the area. These impacts are expected to attenuate with distance from the site. Time can

also lessen the perceived adverse impacts of a wind farm, as actual experience replaces initial exaggerated perceptions (cited in Warren *et al.* 2005).

Specialist reports have quantified and evaluated the visual, noise and land value impacts of the proposal (refer to attachments for full reports, Attachments 3.1, 3.2, 3.7, respectively). Health impacts have been evaluated in Section 8.6. On the basis of these assessments, the impact on the life style values of the site is expected to be manageable by specifically managing visual impact, operational noise impact, community wellbeing impacts and health and safety impacts, as detailed in Sections 7.2, 8.2 and 8.6 of this report.

8.4 Tourism impacts

Existing environment

The location proposed for the development of the wind farm occurs between the local service centres of Crookwell, Goulburn and Gunning. These towns and their surrounds have historic appeal, retaining buildings and other historic features of interest to locals and tourists alike. Historic buildings (some of which are registered on local, state or federal registers) are scattered across the landscape.

The Upper Lachlan Shire Council is in the process of developing a five year shire-wide strategic tourism plan. Specific tourism activities encouraged by Council in the area include tourist drives, farm stays, bed and breakfasts, festivals and shows (Upper Lachlan Shire Council Annual Report 2004-2005). The most significant tourist draws have been the special events conducted throughout the year. These events have been increasing and provide an important economic contribution to the region. The tourist association proposes to add to these events to ensure that regardless of the time of year, the area is ‘always a nice place to visit’ for tourists and residents (Upper Lachlan Shire Council Annual Report 2005-2006).

Other tourism activity types in the area include tours of historic buildings (Post Office, Town Hall, St Peter and St Paul's Catholic Cathedral, the Old Goulburn Brewery, Goulburn Rail Heritage Centre), museums, memorials and galleries (the Goulburn Steam Museum, Rocky Hill War Memorial, Goulburn Regional Art Gallery, Fibre Design Textile Gallery) and nature-based recreation (Wollondilly Walking Trail, Heritage Walking Tour, Bungonia State Recreation Area, Pejar Dam, Bicentennial National Trail). Refer to Section 8.7 for a full treatment of historic significance.

Mineral fossicking has occurred around Grabben Gullen along the feeder streams of the Lachlan River; sapphires, garnets, zircons and gold can still be found today.

Bicentennial National Trail

The Bicentennial National Trail occurs in the area, located south of Crookwell and travelling south west, east of Gunning. Horse riders and other users of the trail are likely to travel within close proximity of turbines through the central part of the site. The trail passes along Bannister Lane and Kialla Road to Crookwell and is further than 500m from the nearest turbines.

The Bicentennial National Trail is 5330 km in total, traversing bush, wilderness and mountain areas from Victoria to North Queensland, following historic coach and stock routes, old pack horse trails, and country roads and providing where possible a "living history" of the county. It is utilised by horse riders, walkers and mountain bike riders.

Activities that may affect the Bicentennial National Trail and the experience of users of the trail include track upgrades to allow access during the construction phase, loss of heritage appeal through visual impact, and safety impacts (including noise, shadow flicker and the unexpected start up of turbines).

The visual impact of the proposal was assessed as a key issue in Section 7.2 of the EA. A specialist report categorised the landscape into character types and uses. Based on the

nature of the modified rural landscape in the area, and the many significant built elements visible in the landscape, it was determined that there were no landscape character types in the area where the contrast between the wind farm and the landscape would be unacceptable. This assessment took into account the recreational use of the area by horse riders.

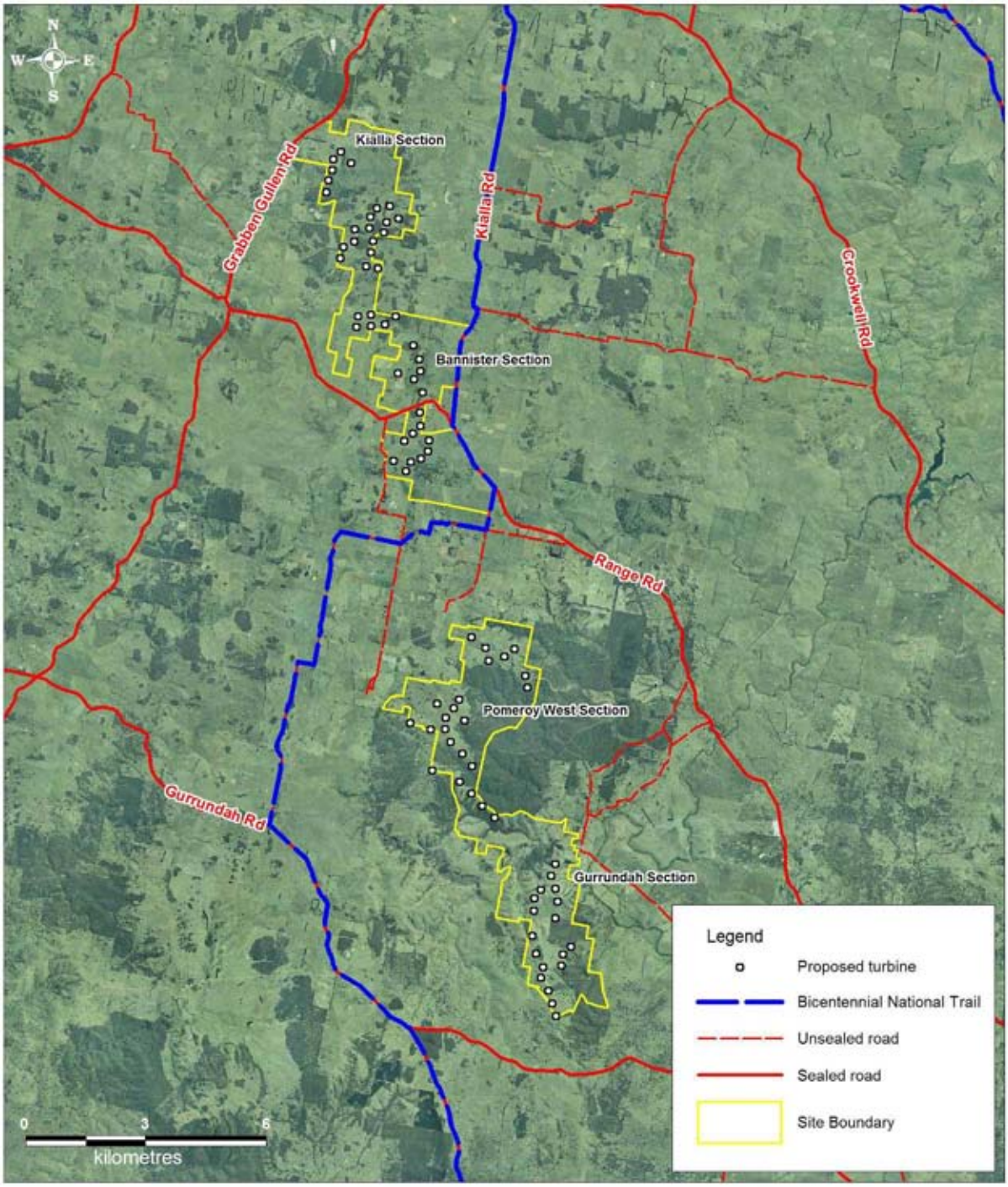

Figure 8-1 Location of the Bicentennial National Trail

Impact assessment

Construction and decommissioning impacts

The site is not located on a tourist drive, however the roads surrounding the site serve as important local throughways, connecting the smaller localities of Kialla, Bannister, Grabben Gullen, Pomeroy and Gurrundah to the service centres of Crookwell, Goulburn and Gunning. The low traffic volumes on these roads (which include Range Road, Grabben Gullen Road, Gurrundah Road and Kialla Road) have been verified by the Traffic Assessment (summarised in Section 7.10) and indicate that inconvenience throughout the construction and decommissioning phases would be low and manageable. Traffic impact mitigation measures are outlined in Section 7.10. Additionally, liaison with the visitor information centres during the construction and decommissioning phases is recommended in order to ensure that organisers of any local events occurring during this period are aware of the increased construction traffic around the proposed site.

Mitigation measures:

- Co-ordinate construction activities with local events. The Proponent would liaise with the local visitor information centres to ensure that construction and decommissioning timing and haulage routes are known well in advance of works

Operational impacts

The number and type of visitors to the area is not anticipated to be impacted by the operational wind farm on the Gullen Range. The development is not incongruous with the production-based economy of the area.

The development may generate increased tourism if it is promoted as a tourist destination (pull over area with information or potentially tours of the site). The level of promotion that the development receives would be determined as a separate matter to this development application. It would not be instigated by the Proponent but would be supported by the Proponent if it appeared to be something that the involved landowners, local community and Upper Lachlan Shire Council desired. Promotion of the development is not part of this proposal.

The site is not situated near formalised nature-based recreation activities. However, the proposed wind farm would be situated within a sparsely developed historic landscape; rural buildings, ruins and the Bicentennial National Trail are located in the area. The visual impact of the development may affect the visitor's experience of the area although it would not preclude existing tourist activities. Visual impact is evaluated in detail in Section 7.2.

Mitigation measures:

- The Proponent would work with the involved landowners, the community and Upper Lachlan Shire Council to allow for the development of the wind farm as a tourist attraction, if this option becomes desirable to these three parties.

8.5 Agricultural impacts

Existing environment

Agriculture is the main land use in the Upper Lachlan LGA, occupying over three quarters of the total area or about 510,400 hectares. A shift from grazing to cropping and mixed farming is a recent trend and may be related to the recent drought conditions; this trend has been recognised as having implications for land degradation as the land capability is not suited to long-term cultivation (Upper Lachlan Shire Council 2006b).

The proposed development occurs across 90 land titles. The zoning of the land is 1 (a) Rural Zone (the development is permissible under the Gunning, Mulwaree and Crookwell Local Environmental Plans). In general, it is comprised of cleared flats containing scattered trees and slopes with scattered trees to open woodland. All properties are currently used for extensive grazing (sheep and / or cattle). In some cases the stock are excluded from the adjoining woodland, either by fence or the steepness of the topography. The pasture is a mixture of native and exotic species. Surrounding land use is also agricultural; extensive sheep and cattle grazing. Potato growing and intensive chicken production are also undertaken near the Bannister site.

General warming will increase potential evaporation and water demand, potentially reducing the capacity of the land. Pittock (2003) observed that a significant proportion of Australian exports are agricultural products sensitive to changes in climate, water availability, carbon dioxide, fertilisation, and pests and diseases. As well as direct impacts, agricultural profits could be affected by a projected increase in agricultural production in mid to high latitude northern hemisphere countries (Pittock 2003). The development of land uses compatible with agricultural activities, such as wind power, have potential to provide increased economic security to rural industries. As well, they provide a substitute for carbon emission producing electricity production that is stable (not dependent on other countries) and renewable.

There is potential for wind power to become a new rural industry, providing a significant new income stream for rural communities at a time when traditional land uses are under pressure (Warren *et al*. 2005). Agriculture has been identified as having a significant role to play in carbon offsetting by a CSIRO report commissioned by the Agricultural Alliance on Climate Change, which includes farming and green organisations (posted 16/10/07 on http://www.abc.net.au/news/stories/2007/10/16/2060466.htm). The report states that farmers could make an extra $3 billion a year by helping to produce clean energy and by offering carbon offsets to polluters. The Climate Institute states this is a key step needed to cut greenhouse gases. These points are particularly relevant to the Goulburn area where agricultural profits have been greatly impacted by recent drought and where anticipated climate change projections indicate a continuation of this trend. The proposal would provide a drought resistant supplementary income stream for involved land holders, compatible with current grazing practices. By way of the lease agreements negotiated with Gullen Range Wind Farm Pty. Ltd., land managers could afford to manage the land more sustainably (lesser stocking rate, improved pasture management, increased funds to address erosion gullies, benefiting erosion and water quality on and offsite).

Impact assessment

Construction and decommissioning impacts

Adverse impacts affecting the agricultural use of the site and surrounding properties would be greatest during the construction and decommissioning phases of the development. They would centre on restrictions to stock movement and loss of grazing land.

During construction and decommissioning, stock would need to be excluded from the works area and, in some cases, restricted from access roads, to minimise the risk of vehicles colliding with stock. This would be temporary and in some cases adherence to low speeds may adequately mitigate the risk.

During the construction phase, soil disturbance to upgrade tracks, lay electrical cables, excavate footings and create hardstand areas would remove pasture currently available for grazing. Based on the development area calculations (refer to Table 3-2), the total impact area amounts to approximately 91.5 hectares. In many cases, this impact would be temporary, as disturbed areas would be rehabilitated before the completion of the construction phase (crane hard stand areas, access tracks not required during the operational phase and underground cable trenches; approximately 19 hectares). During decommissioning, further areas would be restored to their pre-existing capacity (access and spur tracks not required by the landowner, electricity easements; approximately 55 hectares). During the restoration activities, stock access would be periodically restricted while vegetation is re-established. The total amount of land not able to be returned to pre-project agricultural capacity is a minor proportion of the total impact area (access tracks, the footings of turbines, control building and substation; approximately 12.32 hectares). The impacts are therefore considered to be largely temporary and minor in nature. Affected land owners would be compensated for this loss by way of the lease arrangements they enter into with the Proponent.

Surrounding agricultural activities may be affected by the increased traffic volumes during construction and decommissioning. The increased traffic may increase the risk of vehicles colliding with stock grazing within the road verge or large or heavy agricultural vehicles. The construction period is a temporary phase which would generally progress sequentially; completing construction at one site before commencing at the next site. This would minimise the duration of the disruption on many roads although the larger roads (particularly Range Road) are likely to experience increased traffic volumes for the majority of the construction phase. The work program can be made available to affected landowners and a point of contact between land owners and the construction manager established to minimise the disturbance.

Noise and dust generated during the construction and decommissioning are manageable and considered to represent negligible impacts for agricultural activities, given the mitigation proposed (detailed in Sections 7.3, 8.6, 8.8.2).

Pasture improvement has occurred at all four sites considered for the Gullen Range wind farm; Kialla, Bannister, Pomeroy and Gurrundah. Pasture improvement is the practice of replacing the native understorey species with exotic grasses to improve the production capacity of the land. Where adequate moisture occurs, this can be sustainable; in more marginal areas, the senescence of individuals over summer can leave paddocks bare, susceptible to erosion and weed infestation (pers. obs. J. Miles). In the last 50 years, the southern tablelands of NSW have seen a decline in the productivity of some types of sown pastures (Vere and Dowling 2003). Evidence of sown pasture decline suggests at least an equal role for native pastures; species of Danthonia (which is present onsite) looks to be a particularly valuable component in native systems (Garden *et al.* 1996).

There is an opportunity to improve the native composition of the site and production capacity in some areas onsite. The ongoing expense of resowing exotic species as well as the resultant loss of soil condition and ingress of weeds are good reasons to investigate the sustainability of using native species rather than replacing them with exotics during site restoration. The sites proposed for the development of the Gullen Range wind farm retain varying degrees of native understorey, a result of soil type, stocking rate and improvement practices. The rehabilitation and encouragement of native grasses onsite could have production and conservation benefits and should be explored as a potential offset to clearing during the construction phase of project development. Revegetation of disturbed and weedy areas with productive native species, excluding stock from unstable areas as well as management of the timing and intensity of grazing, could be implemented during and following site development to benefit landform stability, native vegetation diversity and may create more drought tolerant pastures.

Mitigation measures:

- A **Traffic Management Plan** would be developed and would include provisions for construction traffic on access roads where stock may be grazing. These may include specifications for safe speed limits and provision of a construction timetable to affected landowners
- Stock would be restricted from works areas where there is a risk stock injury. For example, near excavated trenches and within high traffic areas
- A **Site Restoration Plan** would be prepared as part of the **Construction Environmental Management Plan**. This would set out protocols for restoration works including:
    - Site preparation
    - Stabilisation
    - Revegetation
    - Monitoring
- Liaison would be undertaken with involved landowners to explore the possibility of enhancing the native component of the understorey in pasture production. This could be incorporated into the site restoration plan which would dictate protocols for the rehabilitation of areas disturbed during construction
- Stock would be restricted from areas being rehabilitated, until surfaces are able to withstand resumed grazing
- Liaison would be undertaken with involved landowners to restrict stock access within construction zones during the construction and decommissioning phases. This is aimed at reducing potential for collision and ensuring stock are not able to escape during construction
- Liaison would be undertaken with neighbouring landowners and landowners adjoining access roads, to provide information about the timing and routes to be used during construction and decommissioning. This could be in the form of advertising and provision of a contact point for further inquiries. The aim would be to reduce the risk of interference with agricultural activities on affected roads and road verges.

Operational impacts

The operational wind farm is not anticipated to affect the way that involved landowners or neighbouring landowners currently manage their agricultural activities. Nor is it anticipated to affect the production capacity of the land, apart from a minor loss of the available grazing area taken up directly by the foot print of the proposal (refer to Table 3.2). The operational wind farm provides a benefit to involved landowners, a supplementary drought resistant income stream throughout the life of the project.

Concerns have been raised previously by the local community as to the health effects of wind farm infrastructure on stock that graze within close proximity. This issue is considered separately below, for horses and then general livestock.

Horses

While there are no equestrian facilities in the vicinity of the project, potential impact on horses and horse riders should be considered because of the proximity of the proposal to the Bicentennial National Trail. The British Horse Society has prepared a wind farm advisory statement (British Horse Society 2005). This statement suggests that wind farms have safety implications for horses and their riders and drivers of horse drawn vehicles during the construction and operational stages. The safety issues arise due to the natural instinct of the

horse, when faced with a perceived threat, to flee. Equally important, the statement notes, is the riders/drivers ability to handle the horse.

Two characteristics listed by the British Horse Society as potentially eliciting a dangerous response include:

i. The sudden appearance of the turbines in the horse's line of sight

ii. Unexpected start up of turbines

Generally, the development can be seen to be situated such that riders traversing local roads would not suddenly come upon a dominating view of the turbines. Local through roads would allow a view of the turbines at distances as close as 140m but local residents advise that it is uncommon for horses to be ridden along these roads. On properties surrounding the proposal, it is considered that riders and horses within such close proximity of the site would be aware of the turbines and therefore not susceptible to this risk.

The impact of the unexpected start up of turbines would vary dependant on the horse, the rider and also the location at the time of turbine start up (turbines start up and shut down independently of each other). Signage should be placed on local roads to warn riders of this risk.

The British Horse Society advisory statement goes on to suggest that all of these features are diminished with distance from the turbines and a 200m buffer is suggested. This distance was also accepted during the Environment Court hearing of the Awhitu wind farm in New Zealand (decision 148/2005) where a wind farm was granted consent close to equestrian facilities.

The Bicentennial National Trail passes close to the site but is further than 500m from the nearest turbines. Therefore it is not expected that the proximity of operating turbines would have a significant impact on horses and their riders.

Impact to grazing stock

Sheep and cattle are grazed on and nearby the Gullen Range site. Thus, it is important to agriculturalists that the turbines do not constitute a threat to the health of livestock or otherwise adversely affect the production capacity. It is assumed that the operational impacts of the wind farm would be of most concern, as stock would be excluded from the works area during the installation of the proposal.

Livestock are assumed to be less sensitive to sudden movements and the sight of the turbines, given they would be confined to areas within close proximity of the turbines for a longer duration and, in comparison to horses being ridden past the site, this may provide the opportunity for livestock to acclimatise to the characteristics of the operational turbines.

Wind energy organisations promote the capability to graze stock right to the base of wind turbines without ill effect (Union of Concerned Scientists 2005; AusWEA undated (a)). Given the number of wind farms and duration of their operation on grazing land and the lack of data available to indicate adverse impact, it is assumed that the turbines would have minimal impact on livestock grazing onsite and nearby. A 'settling in period' is likely to occur during which livestock become accustomed to the turbines (I. Newton, Wind Farm Manager, Eraring pers. comm. Jan 2005; *AusWEA* undated (b); British Wind Energy Association undated). There is no evidence to suggest that this would be drawn out or adversely impact animal welfare or agricultural productivity.

Agricultural flying

The use of aeroplanes and helicopters for agricultural purposes such as crop dusting, spraying and fertilising occurs throughout the Southern Tablelands and in the region of the Gullen Range site. This is significant to the safety of aircraft operating in the vicinity of wind turbines and the potential limitation of aerial operations due to the presence of turbines.

Agricultural operations involve low level flying can only occur in good conditions (high visibility) in accordance with the aviation regulations, where wind turbines would be highly visible. Pilots who are engaged in low level flying and agricultural operations are required to undertake a risk assessment for each flight. This would identify specific hazards such as trees and powerlines. Wind turbines would be treated no differently. Therefore the operation of agricultural aircraft in the vicinity of wind turbines does not represent an unacceptable risk and is considered safe provided that normal operational procedures are followed.

The location of wind turbines may provide a potential limitation on the aerial application of fertiliser or spraying in the immediate location of a turbine. CASA has no regulations for the minimum distance that agricultural pilots can fly from objects such as wind turbines. The pilot is responsible for assessing the risks with each job. As the turbines are located on ridges predominately used for grazing, spraying activities associated with crops is unlikely. Additionally the turbines are located on involved landowners properties who have consented to the project. Any turbines located adjacent to property boundaries will have a restricted impact on the ability to conduct aerial operations on neighbouring lands. Therefore it is considered unlikely that the presence of turbines will significantly effect aerial spraying in the vicinity of the Gullen Range project.

Mitigation measures:

- The **Traffic Management Plan** would contain procedures to manage horse riders using the Bicentennial National Trail during the construction period including keeping the verge of the road clear for riders to allow riders to move off the road. This would include ongoing consultation and liaison with the BNT co-ordinator
- The substation area would be surrounded by a security fence as a safety precaution to prevent trespassers and stock ingress

8.6 Health and safety

There are a number of hazards associated with the construction, operation and decommissioning of wind farms, including construction activities, construction noise, shadow flicker and the stability of turbines. These issues are discussed below. Note that operational noise impacts and electromagnetic fields are discussed separately in Sections 7.3 and 7.8, respectively.

8.6.1 Construction activities

Existing environment

Hazards inherent with wind farm construction activities relate to the size and movement of infrastructure (large rotating blades at a great height), high voltage electricity and high wind speeds. The risks are similar to working on other large infrastructure, such as tall buildings and transmission lines. No member of the public has been killed by a wind farm. Fourteen construction or operation staff have been killed world wide, most during construction-related activities, since the early 1970s (SEDA 2004). Industry practice has improved over this time and many dangerous activities have been eliminated or reduced (SEDA 2004). Employee safety is managed through the application of standard work place practices, such as restraints, fall arrest systems, protective clothing and procedures that enable infrastructure to remain stationary during specific activities. Emergency response protocols and equipment and reminders of the requirement for workers to take responsibility for their safety are able to address a large component of potential risks.

Construction works would take place over a 12-24 month period, utilising main and local roads. Considering traffic flow to and from the site, the maximum daily rate of traffic at any point in the project's road network is approximately 300 vehicles per day (refer to Attachment

3.8). As the sites are spread over several locations, there would be a number of individual turbines sites and sections of road works. As such, construction impacts at any one location are unlikely to be continuous.

The safety issues associated with construction traffic have been discussed in Section 7.10. Access routes have been selected which, with the implementation of recommended environmental safeguards, would minimise risks to workers, the public and stock during the construction phase.

Impact assessment

Construction and decommissioning impacts

Hazards and associated risks that construction staff would be exposed to as a result of the proposal are considered manageable through the implementation of a site occupational health and safety plan.

Mitigation measures:

- A detailed **Health and Safety Plan** would be prepared, as a sub plan of the **Construction Environmental Management Plan**, identifying hazards associated with construction works, the risks of the identified hazards occurring and appropriate safeguards would be prepared prior to the commencement of construction works. Additionally:
    - The plan would incorporate standard work place practices, such as restraints, fall arrest systems, protective clothing and procedures that enable infrastructure to remain stationary during specific activities
    - Emergency response protocols and equipment and reminders of the requirement for workers to take responsibility for their safety would be implemented
    - All site workers are to be inducted to the site on their first day of employment. The induction would include a detailed briefing of the health and safety plan
    - Workplace health and safety protocols would be developed to minimise the risk as a result of the ignition of fire from and to workers during construction and during maintenance in the control room and amenities
- A **Traffic Management Plan** would be prepared and implemented, incorporating the measures outlined in the Traffic assessment, Attachment 3.9.
- Liaison would occur between property owners and construction staff in relation to land and stock management during construction (during construction and decommissioning, stock would be excluded from the works area - this would exclude road works)
- Site fencing would be installed where there is a risk to the safety of the general public (i.e. when the trench is left open for extended periods)

Operational impacts

The health hazards associated with the operational phase of the wind farm would be low. Standard vehicles would be used to during maintenance visits. The control building would be council approved. Procedures would be put in place to ensure a safe working environment is maintained.

Mitigation measures:

- Employee safety would be managed through the application a **Health and Safety Plan**
- A **Traffic Management Plan** would be prepared and implemented, incorporating the measures outlined in the Traffic assessment, Attachment 3.9
- Liaison would occur between property owners and maintenance staff to ensure that access visits do not interfere with agricultural management

8.6.2 Shadow flicker

Existing environment

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.

In NSW there are no guidelines on which to assess shadow flicker generated by wind turbines. To carry out the shadow flicker assessment, the Victorian Planning Guidelines [1] that limit the duration of shadow flicker to 30 hours a year have been sourced.

The effect of 'chopping the light' attenuates with distance and is not considered, by modellers of shadow flicker (Danish Wind Industry Association 2003) to be noticed beyond 500-1000m from a turbine. The operational wind turbines are not anticipated to produce a flicker frequency high enough to pose a health risk. Comparable turbines have been rated 0.45 to 0.95 Hz, significantly below critical levels of 8-30 Hz for public health.

Impact assessment

Construction and decommissioning impacts

There are no shadow flicker impacts associated with the construction and decommissioning phases.

Operational impacts

A detailed analysis of the potential for shadow flicker and blade glint to affect dwellings has been carried out and the full report is presented in Annex A to the Visual Assessment, Attachment 3.1.

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 to represent the worst case impact scenario.

The calculated number of annual hours at each of the nearby houses where shadow flicker may be experienced is presented below in Table 8-3. A reduction of the theoretical maximum number of hours was assumed based on the long term observation of cloudy days.

In NSW there are no guidelines on which to assess shadow flicker generated by wind turbines. To carry out the shadow flicker assessment the Victorian Planning Guidelines that limit the duration of shadow flicker to 30 hours a year has been referenced. The South Australian Planning Bulletin 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.

Table 8-3 Calculated hours of shadow flicker predicted for nearby residences.

Residence No.[2]	**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). All residences comply with the Victorian Planning Guidelines for acceptable shadow flicker impacts except one (B33) 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.

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.

[2] Residence number codes supplied as Attachment 5.

Mitigation measures:

- If shadow flicker is found to be a nuisance to residents, conditions would be pre-programmed into the control system and individual wind turbines automatically shut down whenever these conditions are present
- Shadow flicker effects on motorists using Range Road would be monitored following commissioning and any remedial measures to address concerns would be developed in consultation with the RTA and the Department of Planning

8.6.3 Stability of turbines

Existing environment

The stability of turbines has been an issue raised by the local community. Fear that component parts may detach and fall from the turbines can create distress to nearby landowners. The wind turbines, at up to 135m in height, would represent a hazard if inadequate anchorage resulted in a turbine falling over or if a blade were to detach during operation and fall to the ground. Ice may also be propelled from the blades in extremely cold conditions. However, the likelihood of these events occurring further than 210m from a turbine has been calculated as 1:10,000,000 (Taylor and Rand 1991, cited in SEDA 2004).

Impact assessment

Due to the size of component parts, objects are not likely to fall far from the turbine. Three hundred metres has been suggested as the upper buffer distance required to ensure no buildings or populated areas are within range (SEDA 2004). SEDA (2004) also notes that this would always be less than the buffer required to meet visual and noise criteria.

Modern wind turbines are extremely safe and reliable, with a history of independent certification and compliance of over 25 years. Wind turbines supplied by the leading global manufacturers (including those identified in Table 3-1) are designed and built to high industry standards, such as the International Electrotechnical Commission (IEC). Type Certification of particular wind turbine models is provided by independent certification authorities that specialise in wind turbines such as Det Norske Veritas (DMV), Germanischer (GL) and TUV Rheinland (TUV). The Type Certification process establishes the safety and reliability of the design and the validity of its supporting calculations, including the assumptions and inputs on which the certificates are based.

The wind turbine foundations are designed to meet the requirements and loads for the particular wind turbine model, as well as the site specific geotechnical, seismic and climatic conditions. The design and construction of the wind turbine foundations would be in accordance with the Australian Standard for concrete structures (AS3600).

> "Wind energy is one of the safest energy technologies. It is a matter of record that no member of the public has ever been injured during the normal operation of a wind turbine, with over 25 years operating experience and with more than 70,000 machines installed around the world"
>
> (British Wind Energy Association 2007)

Mitigation measures:

- Mitigation of these risks involves receiving and implementing sound geotechnical advice during construction, choice of a reliable turbine and proper installation and maintenance of the turbines

8.6.4 Complex noise effects on health

Wind turbines and the noise produced from these generators is a relatively new and complex concept. Large changes have been made to turbine design affecting noise propagation over recent years. The complex nature of the noise from wind turbines has motivated recent research on the possibility of adverse health effects from wind turbine noise. There are numerous conflicting papers dealing with this issue yet to date there is no clear evidence to suggest that wind turbine noise causes any physical health problems. Adopting a precautionary approach to this potential impact, a review of these studies is presented below.

A British General Practitioner conducted a study of 42 people suffering adverse affects and *living within 2km of wind turbines*. Despite the small sample size, anecdotal survey style (this paper has not been published or formally peer reviewed), Dr. Harry made several points of interest for wind farm development:

- The noise produced by wind turbines is complex (intermittent, involving low frequency sound, complicated by other factors) and therefore, the responses produced can also be complex
- The kind of symptoms experienced can act to reinforce each other; sleep disturbance, tiredness, anxiety, head aches and migraines, depression. Having one family member who experiences any or all of these symptoms is likely to affect the well being of other family members, who may not experience adverse noise effects directly
- People most susceptible are those with noise sensitivity; children, the elderly, those with existing stress or depression
- Attitudes to wind turbines and to the amenity value of the landscape and 'peace and quiet' values also appeared to affect the level of adverse impact
- The vibrational component and the visual reinforcement of the moving turbines can compound the effects
- There can be a disincentive for affected people to report symptoms due to the effect it may have on their ability to sell a house near a turbine, generating a 'catch 22' for sufferers

The Swedish Environmental Protection Agency commissioned a report on noise from wind turbines conducted by E. Pedersen from Halmstad University. The aim of the report was to review all present knowledge on perception and annoyance of noise from wind turbines in residential areas as well as recreational areas. The report was to form a base for further discussions on regulation and guidelines for noise from wind turbines in Sweden. The results of the review came to the following conclusions:

- Annoyance from wind turbines is to a degree correlated to noise exposure, but is also influenced by the turbines' visual impact on the landscape
- Wind turbine noise does not directly cause any physical health problems
- Regulations regarding noise from wind turbines for different countries in Europe were inconsistent. The recommended levels, where stated absolutely, varied from 40 – 55 dBA during the day and 35 – 45 dBA during the night when recorded from outside a dwelling. Countries such as France and Scotland recommend that wind farm noise be limited to between 3 – 5 dBA above background noise

The World Health Organisation (WHO Guidelines for Community Noise, 1999) has developed guideline values for community noise that present noise levels where the lowest adverse effects may occur as a result of noise including temporary or long term deterioration in physical, psychological or social functioning.

The available knowledge of the adverse effects of noise on health is sufficient for the WHO to develop guidelines on the following:

1. Annoyance
2. Speech intelligibility and communication interference
3. Disturbance of information extraction
4. Sleep disturbance, and
5. Hearing impediments

The most significant and relevant of these in relation to wind farms is the noise levels that could impact the ability of nearby residents to sleep. The WHO guidelines on noise levels that do not result in sleep disturbance is 45dBA measured outside the residence. This is above the criteria levels of the SA noise guidelines of 35dBA that the wind farm must comply with for non-involved landowners.

Early identification of the noise problems and mitigation of its effects may be the best approach to avoiding potential health problems. The Proponent commits to monitoring and mitigating noise exceedances in accordance with the SA EPA Guidelines (refer to Section 7.3). Visual impact mitigation is discussed in Section 7.2. Community level impacts are discussed in Sections 8.2 and 8.3.

As personal perceptions differ, it would never be possible to ensure all members of the local community are in favour of the proposal. It is hoped that commitments such as the Community Enhancement Program would demonstrate the Proponent's responsibility to the local community as well as the broader benefits of the proposal.

8.7 Historic heritage

'Heritage (or cultural) significance' is a term used to describe the inherent cultural and historical value of an item. An assessment of heritage significance was undertaken by Glenn Shaw, Heritage Project Officer for **ngh**environmental (attached in full, Attachment 3.9).

Approach

The heritage assessment considered existing reviews (draft heritage review of the Goulburn region was prepared in 2003 by the Goulburn City Council and for the Mulwaree Shire in 2002-2004), heritage listings on various registers, cultural landscapes and unlisted heritage items known from the local area. The evaluation of potential impacts had recourse to the NSW Heritage Office guidelines on the potential impacts of wind farms on heritage items. I

Results

In Australia, there are heritage registers protecting places of heritage significance at the Commonwealth, State and local levels. Results of searches of these registers within the Upper Lachlan Shire are summarised in the table below.

Table 8-4 Summary of heritage listings in the Upper Lachlan Shire Council area

Name of register	Number of places
World heritage	1
National heritage list	2
Commonwealth heritage list	0
Register of the National Estate	29
NSW State Heritage Register	4
Section 170 NSW state agency heritage registers	4
Local Environment Plan (LEP)	42

World heritage

The southern tip of the Greater Blue Mountains Area falls within the Council area and was inscribed on the World Heritage List in December 2003.

National heritage listings

A search of the Australian Heritage Database (AHD) resulted in 32 heritage places listed within the Upper Lachlan Shire.

State heritage listings

A search of the NSW SHR within the Upper Lachlan LGA indicated four listings within the register. These included:

1. Catholic Church of Christ the King located on Macarthur Street, Taralga
2. Crookwell Railway Station and yard group, Goulburn-Crookwell Railway, Crookwell
3. Gunning railway signal box movable relics, Main southern Railway, Gunning, and
4. Gunning Railway Station and yard group, Main southern Railway, Gunning.

Section 170 NSW State agency heritage registers

A search of places listed by State Agencies under s.170 of the NSW *Heritage Act 1977* also listed 4 heritage places. These are:

1. Crookwell District Hospital, Crookwell
2. Crookwell Railway Station and Yard Group, Goulburn-Crookwell Railway, Crookwell
3. Fish River Water Supply, Fish River, and
4. Gunning Railway Station and yard group, Main southern Railway, Gunning.

Local heritage listings

The site proposed for the Gullen Range wind farm is covered by three LEPs, Gunning 1997, Mulwaree 1995 and Crookwell 1994. Schedule 2 of the Gunning LEP, schedule 1 of the Mulawaree LEP and schedule 1 of the Crookwell LEP list heritage items in the areas governed by the applicable LEP. Similar to the National and State listings, heritage significance may be attributed to an item on social, architectural, natural, scientific, archaeological, aesthetic, historic or cultural grounds (Gunning LEP 1997). It is should be noted that similar definitions are provided for in Mulawaree and Crookwell LEPs. Forty-two heritage items are listed within each of the LEPs (refer to Attachment 3.9 for full list).

Cultural landscapes

No listed cultural landscapes were identified from searches of the above heritage databases.

Unlisted heritage items

During a vehicle based assessment in the locality, several historic features were observed. These included Railway bridges present where the Southern Railway crosses the Old Hume Highway and drainage lines; on Wollogorang Road, large residential and agricultural buildings were observed; and on Gurrundah Road several old characteristic cottages are present. Storriers Lane and Bannister Lane may have been old coach routes (pers. comm. R. Ubrihien, 17 December 2007). There is also what appears to be an historic monument located near Bannister Lane on the other side of some very large mature trees.

Several additional European heritage items were recorded within the study area during the archaeological survey of the site. This included two European heritage site complexes in the Kialla development envelope; one site complex consists of the remains of a house and associated sheep yards and dip, the other consists of two structures one being a stone house and the other its associated barn. Two European heritage site complexes were recorded in the Bannister development envelope; one site complex consists of the remains of house and shed, the other consists of the remnants of a stone house. One other heritage item has been recorded in the Gurrundah development envelope; an old crank start tractor.

Impact assessment

As no generic assessment principles can be applied to impacts from wind farms, assessment must be on a case by case basis. The wind farm would not occur within the curtilage of any heritage items. However, as several listed heritage sites are located near the proposal area, the guidelines of the NSW Heritage Office (cited in Attachment 3.9) have been considered in the following impact assessment.

Construction and decommissioning impacts

The construction and decommissioning phases have the potential to materially affect listed heritage items occurring in the area. A maximum rate of approximately 300 vehicles per day has been calculated for construction traffic of the construction period (refer to Attachment 3.8). Although the works would not take place within close proximity of any listed or unlisted heritage items, the transport of heavy and large vehicles on roads passing near these items may subject the sites to increased levels of dust and vibration and affect the character of the area during this time.

The proposed route for heavy vehicles may include Gurrundah Road, Bannister Lane, Storriers, Lane, Kialla Road, Range Road, Grabben Gullen Road and Crookwell Road (refer to *Section 7.10 Traffic and transport*). Large and heavy vehicles are likely to travel through the main streets of Grabben Gullen, Crookwell and Goulburn. Large and heavy vehicles would not be required to travel through the main streets of Gunning, Collector or Dalton. A traffic study has been completed investigating these routes, with mitigation measures recommended to improve safety and trafficability.

Traffic impacts such as the generation of dust and vibration, are not anticipated to impact upon any historic items, listed or unlisted, due to the distance between these routes and identified items and the capacity of the routes to handle these large loads. A statement of heritage impact is therefore not considered to be required for this proposal. The effect of large and heavy traffic on the historic character of the area may inconvenience tourists and residents alike, particularly if works are carried out near festivals or other events. This latter impact is dealt with more fully in *Section 8.4 Tourism impacts*.

To reduce the potential for impact to heritage values during the construction and decommissioning phases of the wind farm, it is recommended that the following measures be employed:

Mitigation measures:

- Co-ordinate construction activities with local events. The Proponent would liaise with the local visitor information centres to ensure that construction and decommissioning timing and haulage routes are advertised with these agencies well in advance of works
- The Proponent would liaise with the Upper Lachlan Shire Council and Goulburn-Mulwaree Council to ensure that construction and decommissioning timing and haulage routes are advertised with these Councils well in advance of works
- Inform the Upper Lachlan Shire Council, Goulburn-Mulwaree Council and the NSW Heritage Office of the proximity of final access routes
- Avoid where practical, transport of heavy vehicles through Breadalbane, Crookwell and Goulburn, where historic buildings are located

Operational impacts

While the operational wind farm would not have direct impacts on heritage features, the appearance of infrastructure onsite (turbines, control building, substation) that would be present for the life of the project may detract from aesthetic heritage values desired by the community, also important in projecting an attractive image to motorists in transit and visitors to the area.

To reduce the potential for impact to heritage values during the operational phase of the wind farm, it is recommended that the following measures be employed:

Mitigation measures:

- Building design, materials and colour should be appropriate to the heritage values of the area. Overly modern or industrial design and materials would detract from the area's heritage values
- Underground rather than overhead transmission should be used where practical and where it would not result in inappropriate risks to soils and land forms. Although extensive existing electricity transmission infrastructure is present on the site and to the south, the cumulative impact of the development should be reduced where possible

In summary, there would not be any direct impacts to any listed heritage items to warrant further assessment of heritage impacts relating to the proposed works.

8.8 Physical impacts

8.8.1 Climate

Existing environment

The proposed Gullen Range development envelope would occupy a total development envelope area of approximately 1,400 hectares, with infrastructure located predominantly on elevated ridges and plateaus, stretching over approximately 22km of ridge system, from south of Crookwell to north of Gunning.

Data obtained from the Bureau of Meteorology weather station at Crookwell indicate that the highest mean maximum temperature occurs in January (26.5°C) and the lowest mean minimum occurs in July (9.5°C). The mean annual precipitation in the Crookwell area is recorded as 855.8mm, between 1883 and 2007. However, precipitation in the Crookwell area

has been lower than average for the last six years. The annual precipitation totals for the last six years are as follows: 656.3mm (2001), 554.4mm (2002), 726.7mm (2003), 682.9mm (2004), 779.5 (2005) and 415.2 (2006). Highest monthly rainfall historically occurs from June to August with the lowest monthly rainfall historically occurring from February to April. Climatic data for the Goulburn area indicates that diurnal conditions in summer can be dry and hot with high wind speeds. This could be expected to produce dusty conditions, particularly in drought where heavily grazed paddocks are prone to wind erosion. Although the local topography of ranges and plateaus can result in localised climatic conditions, climatic conditions onsite are expected to be similar to that described.

The Crookwell / Goulburn area is one of a small number of inland areas of New South Wales that has been targeted for the development of wind farms, due to the reliably high wind speeds recorded on ridges in the area. Davy and Coppin (2003) analysed wind speeds at several sites in South East Australia, including Goulburn. Summer showed the largest potential for wind generation capacity, with lowest seasonal capacity in autumn.

Impact assessment

Construction and decommissioning impacts

No climatic impacts are anticipated to be generated during the construction or decommissioning phases. Dust and erosion mitigation are discussed in Sections 8.8.2 and 8.8.3, respectively.

Operational impacts

Local climate impact

The local climate may be affected to a minor degree by the increase in turbulence caused by the operational wind turbines. Modelling and experimentation on real wind turbines has shown that the mixing effect of thermal layers has very little effect on temperature during the day (Baidya, *et al.* 2004). Recordings taken below wind turbines and averaged over a 24 hour period were observed to be greater than existing ground level wind speeds by approximately 0.6 metres/second and raise temperatures by approximately 0.7^{o}C (Baidya, *et al.* 2004).

Wind speed impacts have been suggested as being confined to a distance from each turbine equivalent to 10 times the vertical height of the turbine (SEDA 2002). For the turbines considered, (maximum of 135m from the ground to blade-tip), an effect up to 1.32km from each turbine may be noted (attenuating with distance from the turbines). As the local topography is undulating, the horizontal distance from each turbine may be less than this amount in actuality.

The turbines would turn slowly in low wind conditions and faster with increasing wind speeds; hence they would amplify rather than counter natural wind conditions. The anticipated change in wind speed and temperature at ground level is not considered large enough to impact vegetation or be in conflict with the continued agricultural use of the land. This impact would be ongoing but negligible.

Broad climate impact

The proposal would make a positive contribution to the reduction in greenhouse gas emissions by providing an alternative to electricity sourced from fossil fuels. This constitutes the chief environmental benefit of the proposal, as discussed in detail in Section 4 of this document.

For each megawatt-hour of electricity consumed in the NSW electricity pool, approximately 1,000 kilograms of greenhouse gases are emitted, primarily from coal fired power stations.

The Gullen Range wind farm would represent a renewable method of electricity generation to meet increasing demand of non-greenhouse gas producing electricity generation. Given stable demand, every megawatt-hour of electricity generated by the wind farm could prevent one megawatt-hour of electricity being generated at a coal fired power station, as well as potentially preventing losses within the electricity transmission system. This represents a potential reduction of at least 1,000 kilograms of greenhouse gases for each megawatt-hour of electricity generated by the wind farm.

Reduction in greenhouse gas emission directly contributes to combating the adverse impacts associated with climate change including:

- The increase in extreme weather events
- Increased demand for water and associated impacts on natural systems, and
- Economic impacts associated with changing land capability.

Adverse impacts noted specifically for Australian agricultural communities include an increase in floods, droughts and forest fires. As a consequence of reduced local production capacity in conjunction with increased production in positively affected northern hemisphere countries, the economic impact of climate change is particularly relevant to agricultural economies (AGO 2003) such as the Goulburn region.

No adverse climate change impacts related to the operational phase of the wind farm would result. An energy analysis comparing wind farms to alternative energy production plants is discussed in Section 8.9.

8.8.2 Air quality impacts

Existing environment

The zoning of the site and all surrounding lands is 1 (a) Rural Zone. The site and surrounding lands are used for extensive agricultural operations. Additionally, two chicken farms are present south of the Bannister site and some wooded areas at Gurrundah and Pomeroy are fenced from stock.

Agricultural activities can produce periodic adverse affects on air quality during activities such as sowing pasture, harvesting or slashing pasture. During drought conditions particularly, large areas of bare ground may occur after intensive grazing, fire or periods of low rainfall. This may increase wind erosion with resultant increases in dust levels.

The State of the Environment (SoE) report for the Upper Lachlan Council for 2005 notes localised reduced air quality due to bush fires and solid fuel fires during the previous 12 months. The latter is more likely to be experienced in urban areas. The Upper Lachlan Shire SoE report discussed that due to the low population density, no significant adverse health impact is expected to result from motor vehicle use. Additionally, there are no heavy polluting industries and therefore no monitoring of air quality is currently being undertaken. The SoE suggested actions to improve air quality including reducing the use of hydrocarbon based fuels and fossil fuel based energy sources and increasing efforts to establish renewable energy sources.

Receptors which may be considered sensitive to air quality impacts during and following the development of the Gullen Range wind farm include residences, places of work, schools, and social gathering places such as churches.

Impact assessment

Construction and decommissioning impacts

Dust and emissions are likely to be generated during clearing, excavation, blasting (if required), concrete batching, rock crushing (if required), road works and during the transport of infrastructure and materials to the site. It is considered that any impacts likely to occur would be greatest during the construction and decommissioning phases, both temporary phases, likely to last between 12 - 24 months. In addition, the works area would not be static for this period, it would move as infrastructure is progressively installed and therefore the impact would not be experienced continuously at any one place during these phases.

The works area and location of houses are identified in Section 3. The distance between the proposed activities and the receptors as well as the potential for mitigation suggest that air quality impacts during construction and decommissioning would not be high. The impacts of the proposal during the construction and decommissioning phases are considered manageable with regard to air quality. Mitigation strategies that would be employed during these phases to manage the potential for adverse air quality impacts are presented, below.

Mitigation measures:

- Landforms would be stabilised during construction works. Additionally, landforms would be rehabilitated progressively as soon as practicable after the completion of construction activities in accordance with a **Site Restoration Plan**.
- A **Site Restoration Plan** would be prepared as part of the **Construction Environmental Management Plan**. This would set out protocols for restoration works including:
    - Site preparation
    - Stabilisation
    - Revegetation
    - Monitoring
- Subsoil would be separated from topsoil for rehabilitation purposes. All topsoil from the excavation sites would be stockpiled and replaced to its original depth for seeding and fertilising. On steep slopes, topsoil would need to be stabilised using, for example, jute matting. Any excess subsoil would be removed from the site and disposed of at an appropriate fill storage site
- Any material stockpiled as would be covered with plastic, seeded or otherwise bound to reduce dust. Dust levels at stockpile sites would be visually monitored. Dust suppression (eg. water sprays) would be implemented if required
- Product stockpiles would be protected from prevailing weather conditions
- During dry, windy periods a water cart or alternative chemical dust suppression would be available and applied to works areas generating dust. Means to determine when action is required would be detailed in the **Construction Management Plan**
- Should blasting be required, it would be carried out in accordance with all relevant statutory requirements
- Residences within 1km of blasting activities would be informed prior to blasting
- Dust filters would be installed on silos, where required
- Sediment and erosion would be controlled as part of a formal **Sediment / Erosion Control Plan**. This plan would include the following provisions:
    - Sediment traps would be installed wherever there is potential for sediment to collect and enter waterways

  - On the steeper slopes check banks would be installed across the trenchline, approximately 50 metres apart, following closure of the trench. These would discharge runoff to areas of stable vegetation
  - Stabilisation would be undertaken as soon as practicable during construction. Furthermore, rehabilitation of disturbed ground would be carried out at the completion of construction works
  - Stockpiles generated as a result of construction activities would be bunded with silt fencing, (hay bales or similar) to reduce the potential for runoff from these areas
  - Soil and water management practices would be guided by the Best Practice guidelines contained within *Soils and Construction Vol. 1* (Landcom 2004)
- A **Traffic Management Plan** would be developed and would include strategies to reduce the number of vehicle movements to, from and across the sites. These would include:
  - Only machinery compliant with emission standards would be used
  - Vehicles and motorised equipment would be maintained so that emissions are minimised
  - Machinery and vehicles would not be left running or idling when not in use

Central to controlling dust are means to determine when dust suppression is required and having adequate access to water or alternative chemicals to control dust. These specifications would be included in the **Construction Environmental Management Plan** prepared for the project prior to construction.

Operational impacts

The operation of the wind farm would require minimal traffic on roads/tracks that would have been upgraded to accommodate heavy loads during the construction phase. Additionally, none of the wind farm infrastructure would generate emissions that would impact air quality. Therefore, negligible air quality impacts are anticipated to be generated during the operational phase of the wind farm.

8.8.3 Soils and landforms

Existing environment

The CANRI database (Department of Natural Resources, accessed August 2007) shows that the site is situated on stable land forms, suitable for cultivation. Areas considered to have severe limitations occur to the north and south of the site. These areas would not be impacted by works.

The Soil Landscapes of the Goulburn 1:250,000 mapsheet (Hird C. 1991) indicate three soil units; '**mi'** (Midgee), '**mc'** (Macalister), **'bc'** (Blackney Creek) and **'mc'** Macalister (Figure 8-2) are found across the proposed development envelope.

'**mi'** (Midgee) occurs at Pomeroy. Landscapes are rolling to low hills on Ordovician and Devonian and Silurian metasediments. Soils are commonly acid stony yellow earths and yellow podsolic soils on side-slopes and crests, in association with lithosols, red podzolic soils and red earths with soloths on lower slopes.

This soil unit is naturally infertile, many areas are left under timber with the remainder being used for light grazing. It is known for widespread minor to moderate sheet erosion. Gullying of drainage lines also occurs (Soil Conservation Service of NSW 1991).

'mc' (Macalister) occurs at Gurrundah and Kialla. It consists of remnant basalt plateaux and exposed underlying metasediments and granites. The Macalister soils group consist of chocolate soils, and minimal Krasnozems can be found in association with the basalts.

This soil unit is primarily used for cattle grazing and the production of fodder crops, some stands of natural forest remain. Little erosion occurs on the basalt remnants; gully and sheet erosion are present on other soil types.

'bc' (Blackney Creek) occurs at Bannister. The landscapes consist of footslopes and valley floors on undifferentiated Ordovician and early Silurian metasediments. The soils consist of acid to neutral yellow duplex soils and minor solodic soils on footslopes and lower slopes. Stony yellow earths and red podsolic soils can be expected on higher slopes.

This soil unit is used for grazing sheep and cattle with some fodder cropping near Crookwell. Moderate to severe gullying and moderate sheet erosion occur extensively. Saline areas occur on many valley flats (Soil Conservation Service of NSW 1991).

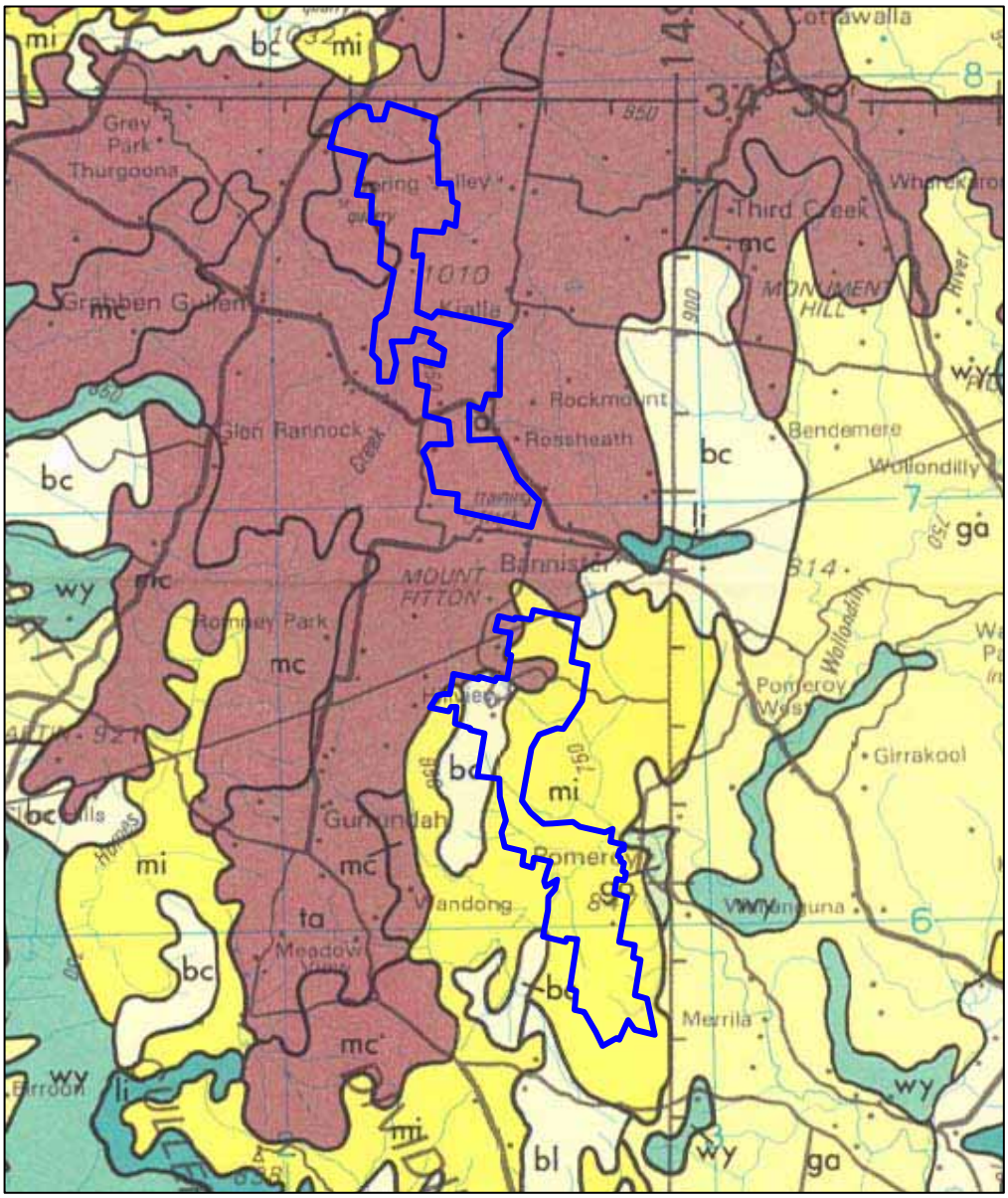

Figure 8-2 Soil types for the local area

The site boundary is overlaid in blue. The relevant soil units are described below.

The State of Environment Report for the Upper Lachlan Shire (2005-2006), drought declared in 2005-06, described the potential effect of drought in all subcatchments as involving:

- Increased erosion
- Reduced vegetation vigour
- Increased pressure on native vegetation
- Increased environmental stress on waterways
- A shift from grazing to cropping and mixed farming
- Decreased availability of surface and ground water
- Dryland salinity outbreaks
- Severe to extreme gully erosion

Impact assessment

Construction and decommissioning impacts

The three differing soil types that occur onsite range in erosion potential from low, 'Macalister', to very high in the 'Midgee'. As such, managing potential erosion and associated landform stability and sediment mobilisation impacts are serious issues during the construction and decommissioning phases.

Soil compaction and soil erosion are likely to occur during excavation works, road works and the transport of machinery. There is also a risk of potential soil contamination from the use of hydrocarbon fuels and toilet facilities during construction of the turbines.

As construction works would take approximately 12 - 24 months to complete, impacts are expected to be temporary, during the construction period. As the construction would occur within a specific time and area, the potential for impact, would be limited. Additionally, the application of mitigation measures would reduce the potential for cascading impacts (such as transport of sediment in drainage lines and resultant impacts offsite).

Impacts of the proposal to the local soils and landforms are considered manageable. Mitigation strategies that would be employed during construction to manage the potential for adverse environmental impacts are outlined below.

Mitigation measures:

- Machinery would be operated and maintained in a manner that minimises risk of hydrocarbon spill
- Maintenance or re-fuelling of machinery would be carried out on hard-stand areas (i.e. existing or proposed road surface or hard-stand areas beneath turbines, not on areas that either contain native vegetation, or would be revegetated)
- Concrete wash would be deposited in an excavated area, below the level of the topsoil, or in an approved landfill site. Where possible, waste water and solids would be reused onsite
- Tracks would be graded to enhance their stability
- Access routes and tracks would be confined to already disturbed areas, where possible
- ANZECC guidelines for control of blasting impact at residences would be adhered to if blasting is required
- Sediment and erosion would be controlled as part of a formal **Sediment / Erosion Control Plan**, as a sub plan of the **Construction Environmental Management Plan**. This plan would include the following provisions:

  - Sediment traps would be installed wherever there is potential for sediment to collect and enter waterways
  - Stockpiles generated as a result of construction activities would be bunded with silt fencing, (hay bales or similar) to reduce the potential for runoff from these areas
  - Soil and water management practices would be guided by the Best Practice guidelines contained within *Soils and Construction Vol. 1* (Landcom 2004)
- A **Site Restoration Plan** would be prepared as part of the **Construction Environmental Management Plan**. This would set out protocols for restoration works including:
  - Site preparation
  - Stabilisation
  - Revegetation
  - Monitoring
- The contractor would prepare and implement a **Spill Control Plan,** as a sub-plan of the **Construction Environmental Management Plan.** It would:
  - Identify persons responsible for implementing the plan if a spill of a dangerous or hazardous chemical/waste should occur
  - Material Safety Data Sheets (MSDS) for all chemical inventories would be located on site and readily available
  - Where chemicals are used, their application and disposal would comply with manufacturers recommendations
  - Any spill that occurs, regardless of size or type of spill, would be reported to the Construction Manager
  - The event and clean up processes would be recorded. Information that would be recorded in the event of spill would include time and date of spill, type of chemical or waste spilt, approximate volume spilt, general area in which the spill occurred, corrective actions applied, and disposal of spilt material
  - Spill protocols in this plan would dictate when the EPA would be notified
  - Chemical / fuel storage areas would be identified, and be bunded to prevent loss of any pollutants
  - Hydrocarbon spill kits would be stored at the site. A number of site staff are to be trained in the use of the spill kits

Operational impacts

The operation of the wind farm is likely to require minimal traffic, as discussed in Section 7.10. By this time, the roads/tracks that would have been upgraded to accommodate heavy loads during the construction phase. No soil or landform impacts are anticipated to be generated during the operational phase.

8.9 Resource impacts

Life cycle analysis

Life cycle analysis (LCA) is based on careful accounting of energy and material flows associated with a system or process. This approach covers the whole project life cycle, from the extraction of raw materials to the disposal of materials at the completion of projects. LCA is particularly relevant for renewable technologies, where it is often argued that the energy used to produce the technology is not 'paid back' during the lifetime of the technology

(Schleisner 2000). LCA estimates of energy and emissions based on the total life cycle of materials used for a project, i.e. the total amount of energy consumed in procuring, processing, working up, transporting and disposing of the respective materials (Schleisner 2000).

In Schleisner's (2000) analysis of two wind farms in Denmark, the energy 'payback' time was modelled to be 0.26 years for a wind farm on land. That is, in approximately 3 months, the energy produced by the wind farm had 'paid back' the energy consumed in producing, installing and decommissioning that wind farm. It was found that 94% of the materials used for construction of a wind turbine could be recycled (Schleisner 2000). Additionally, the value of the materials able to be sold for reuse can be used to offset the cost of decommissioning the wind farm and rehabilitating disturbed areas to pre-existing or better condition.

A life-cycle assessment has been conducted by Vestas for a Vestas V90-3.0MW wind turbine, the maximum sized turbine being considered for the Gullen Range proposal. Vestas divided the life-cycle into four phases: production, transportation, operation and disposal. This assessment looked only at the turbines and did not consider associated infrastructure such as transmission lines, substation and control building.

The study identified that the greatest consumption of energy and resources occurred during the production phase. Raw materials required include iron ore for the construction of steel components and their casings as well as crude oil to make the epoxy materials used in blade construction. These resources are limited and considered non-renewable. In contrast, energy consumption during the transportation, operation and disposal phases was relatively minor.

During the operational phase (based on a 20-30 year life-span and taking into account the maintenance required over this period) the costs of construction and decommissioning begin to be offset by the operational capacity of the turbines. Disposal encompasses the fuels required to dismantle and transport the turbines as well as the disposal of materials.

Using a functional unit of 1 kW hour as a basis for comparison, Vestas provide the following comparisons between phases of the 3MW wind turbine life-cycle and CO_2 emissions between other energy producing power stations (Tables 8.10 and 8.11).

Table 8-5 Break down of the energy consumed during phases of the life cycle of a Vestas V90-3MW.

A Vestas V90-3MW turbine is expected to generate 157,800MWh during a 20 year lifetime, repaying energy required to produce the turbine in approximately 6.6 months. Energy required to produce, transport, operate and dispose of the turbine has been converted to MWhs to facilitate comparison with total energy produced.

Phase	Onshore Vestas V90-3MW
Production phase	7,795.00 MWh
Transport phase	74.00 MWh
Operation phase	14.00 MWh
Disposal phase	*-3,572.00 MWh
Total	4.311 MWh

** the negative figure indicates the value of the material for reuse or recycling.*

Table 8-6 Comparison of CO_2 emissions produced per kilowatt hour.

Using energy output (kWh) to compare emissions, the wind turbine produces a small fraction of the CO_2 emissions of coal or gas-fired power stations.

Generation Method	CO_2 produced
Onshore Vestas V90-3MW turbine	8 grams per kWh
Gas-fired power station	467 grams per kWh
Coal-fired power station	826 grams per kWh

Hence, by comparison to major electricity generating methods employed in Australia, wind farms rate favourably based on:

- CO_2 emissions generated per kilowatt hour of energy produced
- Potential to reuse and recycle component parts, and
- Energy payback time in comparison to the life span of the project.

Impact assessment

Construction and decommissioning impacts

It is considered that the majority of resource use and waste generation would occur during the construction and decommissioning phases.

Use of resources

The construction of the proposed wind farm, including associated infrastructure, would require the use of various resources, such as concrete and other masonry products (footing, slabs, hardstand areas, building elements), materials associated with the operation of machinery, and motor vehicles (fuels and lubricants) and other construction materials (metals, glass, plastics). These materials are not currently depleted or restricted in supply however; increasing scarcity and environmental impacts are becoming apparent from the use of fossil fuels, mineral resources and other non-renewable resources. As such, the proposal is unlikely to place significant pressure on the availability of local or regional resources.

Generation of waste

Solid waste is one of the major pollutants caused by construction. Solid waste would be generated from a number of activities construction activities including:

- Limited vegetation clearing
- Material from packaging
- Building materials
- Scrap metals
- Sanitary wastes
- Plastic and masonry products

Hazardous wastes would be present onsite; these include sanitary wastes, hydrocarbons, fertilisers and herbicides. Some of these would represent flammable materials and biohazards. During decommissioning it is likely that similar wastes would be generated.

A key strategy of construction and decommissioning works would be to avoid and minimise waste from the construction site, reuse and recycle waste where possible and dispose

appropriately of waste which cannot be managed in any other way. This is the application of the Waste Hierarchy which states that:

1. Strategies which try to avoid products becoming waste are generally preferable to
2. Strategies which seek to find a use for waste, which are in turn generally preferable to
3. Strategies for disposal which should be used as a last resort

Mitigation measures:

- Waste would be reused or recycled whenever possible. Separate recyclable materials receptacles would be provided (eg. For glass, plastics and aluminium)
- Packaging materials and general construction wastes would be disposed of, with Council's approval, at Council operated waste disposal centres
- Toilet facilities would be provided for onsite workers and sullage from contractor's pump out toilet facilities would be disposed at the local sewage treatment plants or other suitable facility agreed to by Council
- Surplus topsoil would be stockpiled on site during construction, and following construction would be spread on the site (particularly over former hardstand areas and access roads) to assist with revegetation
- Excavated material would be used in road base construction and as aggregate for footings where possible. Surplus material would be disposed of in appropriate locations on site (on agreement with the landowner), finished with topsoil, and revegetated
- Risk of chemical spills would be minimised and protocols would be in place to ensure prompt and effective clean up of any accidental spills
- No permanent waste disposal would be utilised onsite
- The contractor would implement a Spill Control Plan as part of its Erosion and Sediment Control Plan. Spill Control Plans would identify persons responsible for implementing the plan if a spill of a dangerous or hazardous waste should occur. Any spill that occurs, regardless of size or type of spill, would be reported to the Construction Manager. The event and clean up processes would be recorded. Spill protocols in the plan would dictate when the EPA should be notified

Operational impacts

Resources required during the operational phase include fuel for construction and maintenance vehicles, lubricants for oil changes in the turbines and replacement parts if required that may consist of metal and plastic based products. The discussion and safeguards above apply equally to this phase, although resource requirements and wastes are anticipated to be much lower. All wastes would be removed by contractors and maintenance staff. No local garbage service would be required.

8.10 Cumulative impacts

Existing environment

Cumulative impacts, for the purpose of this assessment, relate to the combined potential effects of different impact areas of the proposal (i.e. construction traffic combined with visual impact) as well as the potential interaction with other proposals in the local area (e.g.. the combined effects of two adjacent wind farms, during construction, operation and decommissioning).

The Goulburn - Yass region has high wind speeds and good access to electricity and transport corridors. Therefore, there is potential for other wind farms or similarly large scaled infrastructure to be proposed and developed in the future. In this area currently, one wind farm has been constructed (Crookwell I), two are commencing construction (Capital and Cullerin) and five have been granted Planning Approval (Woodlawn, Crookwell II, Taralga, Gunning and Conroys Gap). (Refer to *Table 4-7 NSW wind farms, proposed and operational* which outlines the characteristics and locations of these developments). These projects are located on Figure 3-6.

Cumulative impacts can occur concurrently or sequentially. They are assessed in this section under the broad headings of visual impacts, noise impacts, ecological impacts, air hazard impacts, traffic and infrastructure impacts, economic and resource impacts, social impacts and greenhouse gas emissions and air quality impacts. Mitigation measures are then summarised separately for the construction and decommissioning phase, and the operational phase of the proposal.

Visual impacts

Visual impact relates to the operational phase of the wind farm. The potential for cumulative visual impact was addressed in Section 7.2 and considers the view of turbines and night lighting of the wind farm, including hazard lights on turbines. It considered also, the impact to town residents, residents on property and travellers using minor and major road through the area.

This section found that There are limited locations within townships where one could perceive multiple wind farms (including those approved but not yet constructed). Travelers on the Hume Highway, due to limited views, would perceive the Gullen Range wind farm as a small additional element in the landscape (views of the Cullerin wind farm would be at much closer range). The cumulative impact while traveling through this area in the Southern Highlands was assessed to be minimal.

There may be a cumulative visual impact for users of local roads, including Crookwell Road, Range Road and Grabben Gullen Road. However, these are local roads with lower visitor numbers with limited viewing opportunities due to topography and vegetation. The cumulative impact would be only slightly greater than the impact of the Gullen Range wind farm alone. The assessment of the cumulative visual impact of the Gullen Range wind farm concluded 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.

Considering the cumulative impact of night lighting, residents may be able to see the hazard identification lighting of multiple wind farms. This would affect few houses and would be a relatively small visual impact, taking into account that when people are at home at night with inside lights are on, windows become mirrors, reflecting the interior of the house and reducing the visibility of external lights at distance. Whilst night lighting may be visible to road users, it will only be one further element in a traveler's experience which includes the frequent presence of other necessary lighting (rear tail lights, headlights and lights from nearby houses and farms). For these reasons, the cumulative impact of night lighting has been assessed to be negligible.

No measures additional to those stated in Section 7.2 are considered necessary to mitigate against potential cumulative visual impact.

Noise impacts

Construction noise impacts could have a cumulative impact if similar large scale developments are proposed to overlap the construction of the Gullen Range proposal. No similar large scale developments are anticipated at the time of writing to be constructed at the same time as the proposal.

If an additional project proposed concurrent construction timing on access routes nominated by or near to the Gullen Range wind farm, the Proponent would enter into liaison to ensure that additional construction noise issues were addressed.

Operational noise impacts are restricted to very close proximity of the proposal. No cumulative operational noise impacts are anticipated.

Ecological impacts

The foremost concerns with regard to cumulative ecological impacts are related to fauna movement corridors (particularly flight paths and migration routes) during the operational phase. The biodiversity assessment, summarised in Section 7.4 of this EA has identified potential movement corridors for native fauna in the locality. This proposal is not anticipated to affect use of these routes, which occur outside the proposed site boundaries. Cumulative impacts could result however, if fauna on these routes were diverted onto the Gullen Range site by additional developments. Mitigation of this impact is outside the scope of this assessment. It is anticipated that approval of such additional development would be conditional on not affecting local movement corridors.

Resident species may be affected by cumulative collision impacts, if a wind farm were proposed in close proximity (relative to species range) to the Gullen Range proposal. Monitoring collision impacts is a feature of the Gullen Range proposal. Such monitoring would be able to detect collision impacts and trigger adaptive management of such impacts so that significant mortality levels are avoided. Should collisions be influenced by another nearby development, this program would similarly detect collision numbers and mitigate significant impact. The monitoring program is unlikely to be able to attribute the cause of the collision to a specific proposal (should more than one wind farm be constructed within the species' range) nonetheless, detection and mitigation measures would be undertaken by Gullen Wind Farm Pty. Ltd. for collisions onsite, regardless of the cause. It is anticipated that approval of any other wind farm nearby would be conditional on similarly detecting and responding to collision impacts.

Limited clearing is proposed, hence direct modification of flora and fauna habitat is not considered to be a relevant issue. Indirect impacts that come as a consequence of soil disturbance however, such as pollution of waterways, can have cascading effects that impact areas at great distance from the site through a number of impact pathways. Sections 7.12 and 8.8.3 have described the hydrology and soil parameters of the site. It has been established that local waterways have generally poor water quality and that the soils are susceptible to gully erosion. Mitigation of these cumulative impacts is best undertaken on a case by case basis, through rigorous implementation of erosion and sediment controls to address all soil disturbing and dust generating activities.

No measures additional to those described in Sections 7.12 and 8.8.3 are considered to be required.

Air hazard impacts

There is potential for cumulative air hazard impacts during the operational stage of the wind farm. Increasing numbers of wind farm developments will create increasing numbers of hazards to avoid.

The mitigation of this risk is via strategic notification of CASA, local airstrips and the Department of Defence as to the exact location of turbines prior to their construction. The turbines are then added to local maps held by these bodies. This is required for all such developments and would therefore mitigate against the risk of cumulative impacts. No measures additional to those stated in Section 7.6 are considered to be required.

Traffic and infrastructure impacts

There is low potential for cumulative impacts during the construction phase, as no similar large scale developments are anticipated at the time of writing to be constructed at the same time as the proposal.

If future development scheduling should change such that one or more wind farms or large infrastructure projects is constructed at the same time as the Gullen Range wind farm, an increase vehicle congestion and traffic safety risks would result. Traffic and transport mitigations measures in Section 7.10 of this EA require the preparation of a Traffic Management Plan. Measures in Section 8.4 cover notification of the timing of works to local events managers. If an additional project proposed concurrent construction timing on access routes nominated by the Gullen Range wind farm, the Proponent would enter into liaison to ensure that additional traffic and transport issues were addressed. Similarly, liaison would be required to verify road pavement impacts and adequately assess each projects responsibility to the road authority.

No operational impacts are anticipated, due to the low vehicle requirements of this stage (refer to Section 7.10)

Economic and resource impacts

The potential for positive cumulative economic effects of the proposal is very real during the construction of the project. Particularly, if several local wind farms are constructed within reasonably close timing of each other, there is potential to increase the skills of the local area and the area's ability to manufacture a larger proportion of project infrastructure. Liaison will continue with local economic development bodies to ensure this potential is maximised.

Social impacts

Aside from economic impacts, social impacts may result from wind farm development, as discussed in Sections 8.2, 8.3 and 8.4 of this EA. In some ways, the cumulative effect of multiple wind farm developments in the region will be positive. Public perception studies have shown that more realistic and positive perceptions accompany actual physical experience of wind farms; fear of the unknown can exaggerate perceptions of visual and noise impacts particularly (Warren *et al.* 2005).

Additionally, while it is certain that not all members of the community will view the proposal favourably, in some communities, investment in clean energy production can become a point of pride to residents. During wind farm community consultation in Berridale, NSW, many participants spoke with pride about the Snowy Hydro Scheme and the appropriateness of similar clean energy developments in their shire (B. Marshall pers. obs 2005). The southern tablelands region looks well placed to become a leader in the Australian wind industry. The results of the NSW Southern Tablelands Survey 2007 (refer to Section 4.2.2) indicate that support for renewables is high. Residents may come to take pride in the contribution made by their region.

Adverse cumulative impacts post construction may result from the altered perception of the character of the area. Rural views were considered a highlight of the area by respondents to a questionnaire compiled for the proposal. As discussed in the visual impact section above,

evaluation of the visibility of the proposal, sensitivity of the landscape and the number of viewers determined the Gullen Range Wind Farm would have a low cumulative visual impact on the surrounding landscape, both at a regional and at a local level.

The requirement of a 'community fund' (described for this proposal in Section 4.4.2 *Community Enhancement Program*) for wind farm developments in the Upper Lachlan Shire ensures that the benefits of individual wind farms are spread beyond site boundaries to the broader community. This is an annual investment funded by the Proponent and managed by the community. The cumulative impact of several developments in the region would therefore represent a substantial economic investment, ideally in local social and environmental programs.

Mitigation of social impacts has been discussed in Sections 8.2, 8.3 and 8.4 of this EA. Additionally, mitigation of visual impact, as set out in Section 7.2, will address the potential for cumulative social impacts. No further measures are considered to be required.

Greenhouse gas emissions and air quality impacts

As outlined in Section 4, for each megawatt-hour of electricity generated by a renewable energy generator (e.g. the Gullen Range wind farm or similar proposals in the region) would reduce coal fired generation by approximately 1 megawatt-hour. For each megawatt-hour of electricity consumed in the NSW electricity pool, approximately 1,000 kilograms of greenhouse gases are currently emitted, primarily from coal fired power stations. Therefore, every megawatt-hour of electricity generated by the wind farm would prevent one megawatt-hour of electricity being generated at a coal fired power station, as well as preventing losses within the electricity transmission system.

The cumulative impact of additional wind farms in the region would have positive impacts for NSW in terms of provision of electricity to meet increasing demand as well as the reduction of coal fired electricity generation with the associated environmental benefits (refer to Section 4.3.2 of this EA for detailed discussion).

Additional impact areas

There may also be potential for cumulative impacts in the areas of Aboriginal archaeology, communications, land value, bushfire and fire, mineral exploration and historic heritage. Considering the discrete development envelope and the compatibility of the wind farm with the existing agricultural use of the site, these issues are considered to be amply mitigated by measures stated under each of these separate sections.

It is anticipated that approval of additional developments would be conditional on similarly addressing these impacts and thereby reducing the potential for cumulative impacts.

Impact assessment

Construction and decommissioning impacts

As discussed above, potential for cumulative impacts exists in the construction and decommissioning phases, on account of construction noise, traffic and infrastructure requirements and economic considerations. Positive cumulative impacts would result in the local economy, primarily distributed in the construction and decommissioning phases.

In the main, cumulative impacts are more appropriately addressed and mitigated on an individual basis, thereby addressing the cumulative impact pre-emptively. Additional measures required to address the potential for cumulative impacts include:

Mitigation measures:

- Construction noise

  If an additional project proposes concurrent construction timing as the proposed Gullen Range wind farm, the Proponent would enter into liaison to ensure that additional construction noise issues were addressed

- Traffic and infrastructure

  If an additional project proposed concurrent construction timing on access routes nominated by the Gullen Range wind farm, the Proponent would enter into liaison to ensure that additional traffic and transport issues were addressed

- Economic

  Liaison will continue with local economic development bodies to ensure the potential for local skill use and manufacturing is maximised

Operational impacts

Most cumulative impacts relate to the operational phase of the proposal. The discussion above has demonstrated that these potential cumulative impacts are more appropriately addressed and mitigated on an individual basis, thereby addressing the cumulative impact pre-emptively. No additional measures are considered to be required.

9 ENVIRONMENTAL MANAGEMENT

The environmental impacts related to the proposal would be managed by the Proponent's commitment to the Draft *Statement of Commitments* (Section 9.2). These commitments include all mitigation measures recommended in previous sections of this EA as well as several additional measures. The framework for the implementation of these measures is discussed below (Section 9.1).

9.1 Implementation of environmental mitigation measures

The implementation of all mitigation measures would be by way of a **Project Environmental Management Plan** (PEMP), comprising a **Construction Environmental Management Plan** (CEMP) and an **Operation Environmental Management Plan** (OEMP). This process is illustrated in Figure 9-1. The PEMP would include performance indicators, timeframes, implementation and reporting responsibilities, communications protocols, a monitoring program, auditing and review arrangements, emergency responses, induction and training and complaint/dispute resolution procedures. The monitoring program would clearly identify any residual impacts after mitigation. Adaptive management would ensure that improvements were consolidated in the updated EMPs.

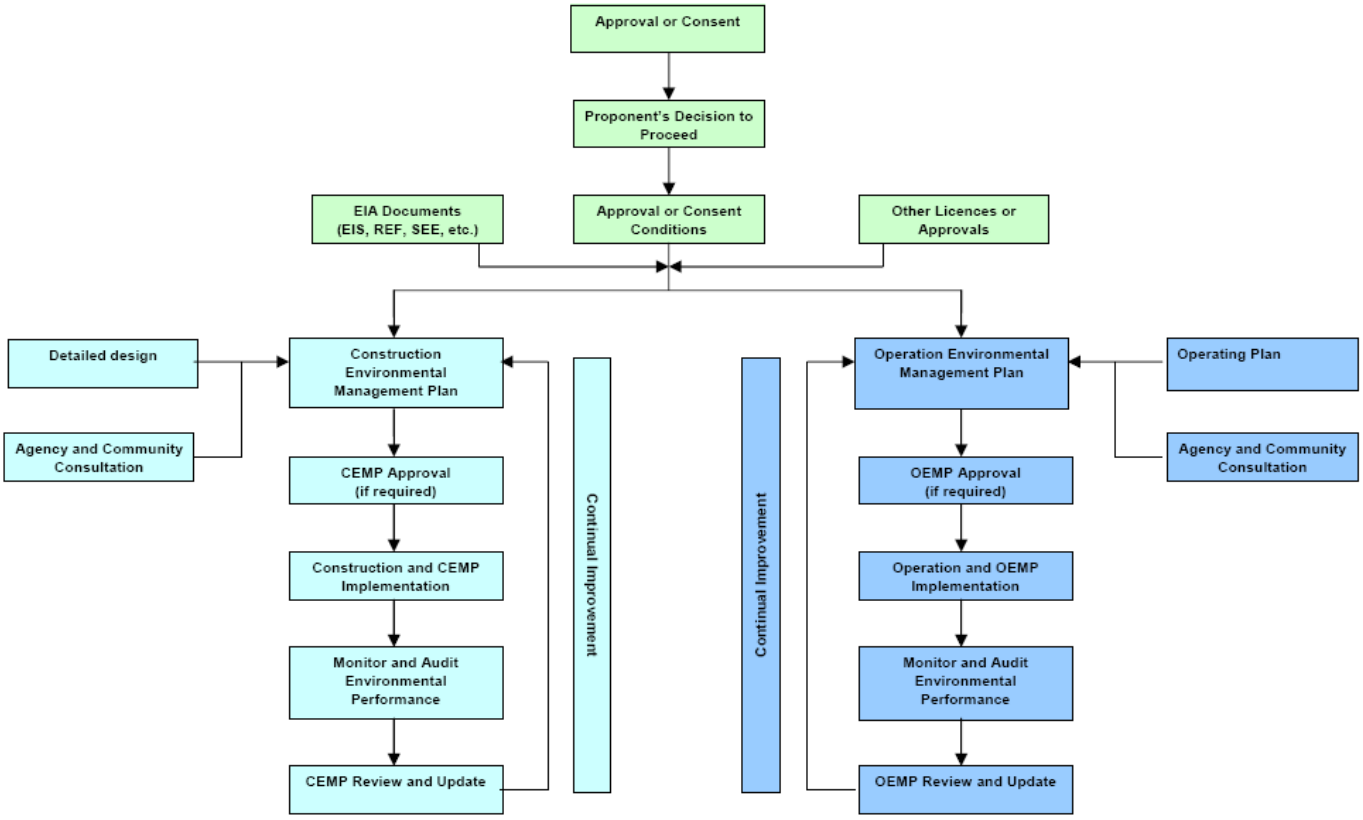

Figure 9-1 Post approval Project Environmental Management Plan (PEMP) process

9.2 Draft Statement of Commitments

Under the Part 3A reforms, Proponents are required to provide a *Statement of Commitments* on how they propose to manage the project to minimise, and where possible avoid, impacts. Avoidance and mitigation measures have been developed for the design, construction, operation and decommissioning phases of the project within this EA.

The commitments in this section have been developed into a comprehensive set of environmental impact avoidance and mitigation measures which incorporate:

- Specific recommendations contained in the specialist reports;
- Additional measures identified during the preparation of this Environmental Assessment (in consultation with the community and government agencies).

To avoid duplication in this section, mitigation measures are located under the most appropriate heading only and are not repeated in subsequent tables.

9.2.1 Visual

	Impact	Objective	Mitigation tasks	By	Timing	Auditing	Criteria
1.	Visual impact to nearby properties	Minimise the view of infrastructure	• The Proponent would determine the extent of planting with residents of properties within 3km of a wind turbine. This would include a site visit. Any such offer would remain in place for a period of 1 year after project construction. Screening options are detailed in Attachment 3.1	The Proponent	During Construction and Operation	CEMP and OEMP	Minimise complaints by residents within 3km

9.2.2 Noise

	Impact	Objective	Mitigation tasks	By	Timing	Auditing	Criteria
2.	Construction noise exceedance	Minimisation	• Limit hours of high noise generating activities	The Proponent	Construction	CEMP	Minimise noise complaints
3.	Construction noise exceedance	Minimisation	• Establish communication with relevant authorities and local residents	The Proponent	Construction	CEMP	Minimise noise complaints
4.	Construction noise exceedance	Minimisation	• Adoption of a site representative responsible for noise and vibration issues	The Proponent	Construction	CEMP	Fast response to all complaints
5.	Construction noise exceedance	Minimisation	• The contractor would select appropriate machinery for the proposed works. This machinery would have low inherent potential for noise generation where practicable	The Proponent	Construction	CEMP	Compliance with DECC *Environmental Noise Control Manual*

	Impact	Objective	Mitigation tasks	By	Timing	Auditing	Criteria
6.	Construction noise exceedance	Minimisation	• Where necessary, barriers would be erected around potentially high noise generating areas including generator and high duty compressors	The Proponent	Construction	CEMP	Minimise noise complaints
7.	Construction noise exceedance	Minimisation	• Appropriate siting of noisy machinery. This siting would be as far away from the nearest receiver as possible	The Proponent	Construction	CEMP	Minimise noise complaints
8.	Operational noise exceedance	Compliance	• Further noise assessment would be required to be carried out on the turbine ultimately selected for construction and on the final layout proposed taking into account any minor changes in turbine location to ensure compliance with SA EPA noise guidelines	Noise consultant	Post final site layout and turbine selection	DoP DECC	Compliance with SA EPA noise guidelines
9.	Noise exceedance	Compliance	• Develop and implement an operational noise compliance testing program.	Noise consultant	Once all turbines are operational	DoP DECC	Compliance with SA EPA noise guidelines
10.	Noise exceedance	Compliance	• If operational monitoring identifies exceedances, the Proponent would give consideration to providing mechanical ventilation (to remove requirement for open windows), building acoustic treatments (improved glazing) or using turbine control features to manage excessive noise under particular conditions.	The Proponent	Once all turbines are operational	DoP DECC	Compliance with SA EPA noise guidelines

9.2.3 Biodiversity

	Impact	Objective	Mitigation tasks	By	Timing	Auditing	Criteria
11.	Loss of biodiversity value	Avoid direct and indirect impact	• Wherever practical, infrastructure would be confined to cleared areas, avoiding woodland patches. A buffer around mature woodland patches would be established to ensure indirect impacts (such as noise and dust) are minimised where practical.	The Proponent	Development of site layout	DoP DECC	Minimise clearing

	Impact	Objective	Mitigation tasks	By	Timing	Auditing	Criteria
12.	Loss of biodiversity value	Minimise impact	• An electricity easement would be required through woodland at the south of the Pomeroy site. The Proponent would locate the easement where vegetation has been previously thinned. Suitable power line clearance would be achieved so as to avoid the more mature gully vegetation. The width of the easement would be minimised	The Proponent	During construction	DoP DECC	Minimise clearing of mature vegetation
13.	Loss of biodiversity value	Avoid direct and indirect impact	• Wherever practical, isolated mature trees (>60cm diameter at breast height) in cleared areas would be retained	The Proponent	Development of site layout	DoP DECC	Minimise clearing of mature vegetation
14.	Loss of biodiversity value	Avoid direct and indirect impact	• The final infrastructure layout would avoid areas identified as constraints (refer to constraints maps, Figures 7-6 – 7-9 this EA, and Attachment 3.3)	The Proponent	Development of site layout	DoP DECC	Adherence to biodiversity constraints maps
15.	Loss of biodiversity value	Avoid direct and indirect impact	• A flora assessment would be conducted as part of the construction environmental management plan, to microsite infrastructure such as tracks away from better quality patches of understorey.	The Proponent	During construction	ER	Adherence to flora assessment recommendations
16.	Loss of biodiversity value	Compensate for biodiversity impact	• The Proponent would commit to offsets determined by suitably qualified experts on the basis of the quantum of vegetation to be removed, pending development of the final infrastructure layout	The Proponent	During construction	DoP DECC	Biodiversity Assessment used as guidance to determine appropriate offsets
17.	Loss of biodiversity value	Minimise impact	• Weed and sediment erosion controls would be implemented to prevent onsite habitat degradation during and following the proposed works. A Construction Environmental Plan would be the appropriate vehicle for these controls. Weeds such as serrated tussock would be treated before the commencement of works to avoid spreading the infestation	The Proponent	During construction	DoP DECC	Minimise indirect biodiversity impacts

	Impact	Objective	Mitigation tasks	By	Timing	Auditing	Criteria
18.	Loss of biodiversity value	Minimise impact	• All areas of disturbed soil would be rehabilitated progressively as soon as practicable after disturbance, in order to resist erosion and colonisation by weeds. This may require restricting stock access and implementing revegetation activities	The Proponent	During construction	DoP DECC	Rapid rehabilitation of disturbed areas
19.	Loss of biodiversity value	Minimise impact	• Wherever practical, and where the initial monitoring program demonstrates a need, the Proponent will liaise with landowners to fill in dams within 100m of a turbine on involved properties to reduce the potential to attract birds and bats which might collide with turbines. Dams removed due to site development would be reinstated in more appropriate locations to retain this habitat resource onsite.	The Proponent	During construction	DoP DECC	Minimise bird and bat collisions
20.	Loss of biodiversity value	Avoid or minimise impact	• Final site inspections would be undertaken for the electricity easement between Pomeroy and Gurrundah to allow micro-siting of the easement in areas of least vegetation, if the alternative access off Prices Lane to Pomeroy becomes the preferred option and also if the western access option (a paper road) to Gurrundah becomes the preferred option	Ecological consultant	Prior to construction	DoP DECC	Minimise direct biodiversity impact
21.	Loss of biodiversity value	Minimise impact	Implementation of design measures: • Aviation lighting would be minimised in number and fitted to reduce their ability to attract migrating birds and insects. Red lights are preferred, with the least number of flashes per minute. Cowls may also shield the light when viewed from the ground and reduce potential to attract wetland birds taking off at dusk • Guy lines would not be fitted to towers or associated structures, where practical • The turbine towers would not provide perching opportunities • Electrical connection lines would be installed underground where practical • Power poles and overhead powerlines would be bird-safe using flags or marker balls, large wire size, wire insulation, wire and conductor spacing	The Proponent	During infrastructure and materials selection	DoP DECC	Minimise bird and bat collisions

	Impact	Objective	Mitigation tasks	By	Timing	Auditing	Criteria
22.	Loss of biodiversity value	Minimise impact	Pest Animal Control Program • To reduce the attractiveness of the site to foraging raptors, rabbits would be controlled on the turbine ridges, carrion would be removed from the site as quickly as possible	The Proponent	During operation	DoP DECC	Minimise bird and bat collisions
23.	Loss of biodiversity value	Minimise impact	Bird and Bat Monitoring Program • A monitoring program would be designed to document mortalities, remove carcasses and assess the effectiveness of controls in accordance with Section 9.3.1 • If mortalities exceed a pre-determined threshold (set out in the monitoring program), additional mitigation measures would be considered, such as diversion structures, turning off turbines at critical times, further habitat modification and enhancement of off-site habitats	Ecological consultant	Designed prior to operation Implemented during operation	DoP DECC	Minimise bird and bat collisions
24.	Loss of biodiversity value	Avoid or minimise impact	• A flora and fauna assessment would be undertaken prior to decommissioning to identify biodiversity constraints	Ecological consultant	Prior to decommissioning	DoP DECC	Minimise biodiversity impact
25.	Loss of biodiversity value	Avoid or minimise impact	• Weed and sediment erosion control principles would be developed and implemented	Ecological consultant and the Proponent	Prior to decommissioning	DoP DECC	Minimise indirect biodiversity impacts
26.	Loss of biodiversity value	Avoid or minimise impact	• Disturbed ground would be stabilised and rehabilitated as soon as practicable after works	The Proponent	After decommissioning	DoP DECC	Rapid rehabilitation of disturbed areas

9.2.4 Aboriginal archaeology

	Impact	Objective	Mitigation tasks	By	Timing	Auditing	Criteria
27.	Loss of Aboriginal	Minimise impact	• The Pejar LALC propose to collect artefacts located within proposed impact areas as a form of mitigation prior to the	Pejar LALC in	Prior to construction	DoP	Liaison with Pejar LALC

	Impact	Objective	Mitigation tasks	By	Timing	Auditing	Criteria
	heritage items		commencement of construction	consultation with the Proponent			
28.	Loss of Aboriginal heritage items	Minimise impact	• An Aboriginal Heritage Management Plan would be prepared, pending Project Approval and prior to any impact, which outlines the strategy of artefact collection, s85A NPW Act (transfer of Aboriginal objects) procedures, and contingencies for unexpected finds such as skeletal remains.	The Proponent	Prior to construction	DoP	Liaison with Archaeologist

9.2.5 Aircraft hazards

	Impact	Objective	Mitigation tasks	By	Timing	Auditing	Criteria
29.	Creation of hazard	Minimise risk	• The Proponent would install obstacle marking as required by CASA.	The Proponent	During construction	DoP in consultation with CASA	CASA signoff
30.	Creation of hazard	Minimise risk	• The Proponent would provide to the RAAF Aeronautical Information Service (AIS), CASA and Air Services Australia the location and height details once the final position of the wind turbines have been determined and before construction commences. After construction is complete, “as constructed” details would also be provided to AIS	The Proponent	Prior to construction	DoP in consultation with RAAF	Signoff by AIS and Air Services Australia
31.	Creation of hazard	Minimise risk	• The Proponent would notify known users of the Crookwell and Ashwell Airstrips of the location of the wind turbines and any changes to operational procedures	The Proponent	Prior to construction	DoP	Direct notification of users
32.	Creation of hazard	Minimise risk	• The Proponent would notify other operational information providers such as the Aircraft Owners and Operators Association and Flight Ace of the location of wind turbines in close proximity to Crookwell and Ashwell Airstrips	The Proponent	Prior to construction	DoP	Direct notification of operational information providers

	Impact	Objective	Mitigation tasks	By	Timing	Auditing	Criteria
33.	Creation of hazard	Minimise risk	• A briefing sheet including a description and an aerial view of the proposed development, expected construction times, extent of the development, lighting, likely operational impacts and contact details of the developer would be distributed widely.	The Proponent	Prior to construction	DoP	Advertised through local channels
34.	Creation of hazard	Minimise risk	The Proponent would provide the following advice to the relevant stakeholders, prompting them to undertake the specified actions: • That Crookwell Airstrip consider formalising guidance to airstrip users regarding takeoff and landing procedures giving due consideration to the location of wind turbines and other obstacles, surrounding terrain, aircraft performance, prevailing conditions, runway physical characteristics, regulatory requirements and any other operational limitations • That Upper Lachlan Shire Council's Information Sheet for Crookwell Airstrip be updated to include reference to the location of wind turbines in close proximity to the airstrip	The Proponent	Prior to construction	DoP	Direct communication

9.2.6 Communications

	Impact	Objective	Mitigation tasks	By	Timing	Auditing	Criteria
35.	Deterioration of signal strength	No deterioration of signal strength	Television and radio broadcast services • Use of primarily non-metallic turbine blades • Use, wherever practical, of equipment complying with the Electromagnetic Emission Standard, AS/NZS 4251.2:1999	The Proponent	Prior to construction	DoP	Adherence to standard

	Impact	Objective	Mitigation tasks	By	Timing	Auditing	Criteria
36.	Deterioration of signal strength	No deterioration of signal strength	Television and radio broadcast services • Undertake a monitoring program of houses within 5km of the wind farm to determine any loss in television signal strength if requested by the owners. • In the event that television interference (TVI) is experienced by existing receivers in the vicinity of the wind farm, the source and nature of the interference would be investigated by the Proponent. • Should investigations determine that the cause of the interference can be reasonably attributable to the wind farm, the Proponent would put in place mitigation measures at each of the affected receivers in consultation and agreement with the landowners. Specific mitigation measures may include: • Modification to, or replacement of receiving antenna • Provision of a land line between the effected receiver and an antenna located in an area of favourable reception • Improvement of the existing antenna system • Installation of a digital set top box or • In the event that interference cannot be overcome by other means, negotiating an arrangement for the installation and maintenance of a satellite receiving antenna at the Proponents cost	The Proponent	At the commencement of operation	DoP	No detected deterioration in signal strength, post mitigation
37.	Deterioration of signal strength	No deterioration of signal strength	Mobile phone (and wireless broadband) services • The Proponent will consult with Wirefree to avoid impacts to wireless broadband service	The Proponent	At the commencement of construction	DoP	Direct consultation

	Impact	Objective	Mitigation tasks	By	Timing	Auditing	Criteria
38.	Deterioration of signal strength	No deterioration of signal strength	Radio communications services • The Proponent has made provisions for a 100m corridor for the RFS links from Mt Martin to Mt Gray. In the event that any issues with license links are identified as a result of the wind farm, whether prior to or post construction, the proponent would consult with the operator and undertake appropriate remedial measures, which may include: • Modifications to or relocation of the existing antennae • Installation of a directional antennae and/or • Installation of an amplifier to boost the signal	The Proponent	At the commencement of operation	DoP	No detected deterioration in signal strength, post mitigation

9.2.7 Electromagnetic fields (EMFs)

	Impact	Objective	Mitigation tasks	By	Timing	Auditing	Criteria
39.	Exposure from EMFs	Minimise exposure	• The substation would be designed in accordance with all applicable codes and industry best practice standards in Australia	The Proponent	Pre construction design phase	DoP	Adherence to standard
40.	Exposure from EMFs	Minimise exposure	• The turbines, control building, substation and transmission lines would be located at appropriate distances from residences, farm shed and yards in order to reduce the potential for both chronic and acute exposure	The Proponent	Pre construction design phase	DoP	Adherence to ARPANSA guidelines

9.2.8 Traffic and transport

	Impact	Objective	Mitigation tasks	By	Timing	Auditing	Criteria
			General measures:				
41.	Safety and asset protection	Minimise risks	• Use of a licensed haulage contractor with experience in transporting similar loads, to be responsible for obtaining all required approvals and permits from the RTA and Councils and for complying with conditions specified in the approvals	The Proponent	Prior to construction	CEMP	Written confirmation of license and experience, including referees
42.	Safety and asset protection	Minimise risks	• Development of a **Traffic Management Plan** to include scheduling of deliveries, managing timing of transport through Goulburn and Crookwell to avoid peak hours (beginning/end of the school day), limiting the number of trips per day, undertaking community consultation before and during all haulage activities (including with neighbouring landowners and landowners adjoining access roads), designing and implementing temporary modifications to intersections and street furniture , restoring all changes to their original condition and managing the haulage process	The Proponent	Prior to construction	CEMP	Develop TMP in accordance with Traffic Impact Study, Attachment 3.7
43.	Safety and asset protection	Minimise risks	• Implementation of all aspects of the **Traffic Management Plan** in coordination with the Councils and RTA	The Proponent	During construction	CEMP	Adherence to TMP
44.	Safety and asset protection	Minimise risks	• Providing a dedicated telephone contacts list to enable any issues or concerns to be rapidly identified and addressed	The Proponent	Prior to construction	CEMP	Rapid response to queries
45.	Safety and asset protection	Minimise risks	• Installing required signage to direct traffic flows appropriately during haulage through Goulburn and Crookwell	The Proponent	During construction	CEMP	Timely provision of signage
46.	Safety and asset protection	Minimise risks	• Reinstating pre-existing conditions after temporary modifications to the roads and pavement along the route.	The Proponent	During construction	CEMP	Dilapidation report adhered to

	Impact	Objective	Mitigation tasks	By	Timing	Auditing	Criteria
47.	Safety and asset protection	Minimise risks	• Undertaking forward planning to ensure equipment transportation complies with requirements of the management plan, RTA and Council	The Proponent	Prior to construction	CEMP	Minimise complaints from road users and risks associated with transport
48.	Safety and asset protection	Minimise risks	• The extent of road upgrades, including realignments and paving upgrades, would be determined by a qualified traffic consultant, in consultation with the RTA and Council	The Proponent	During construction	CEMP	Minimise complaints from road users and risks associated with transport
49.	Safety and asset protection	Minimise risks	• The Proponent would prepare road dilapidation reports covering pavement and drainage structures in consultation with Council, for the construction (and decommissioning) route prior to the commencement of construction (and decommissioning) and after construction (and decommissioning) is complete. Any damage resulting from the construction (or decommissioning) traffic, except that resulting from normal wear and tear, would be repaired at the Proponent's cost. Alternatively, the Proponent may negotiate an alternative for road damage with the relevant roads authority. The decision to provide a seal needs to be balanced against the cost of maintenance on the gravel surface. • Road condition would be inspected throughout construction to ensure that impacts are addressed as they occur. This would be undertaken at regular intervals by the site manager and council roads engineer	The Proponent in consultation with Council	Prior to construction	CEMP	Dilapidation report adhered to Ongoing contact with roads authorities
50.	Safety and asset protection	Minimise risks	• A speed limit would be placed on some of the roads near dwellings or sub standard junctions. The speed restriction would be included in the **Traffic Management Plan** to be submitted to Council	The Proponent in consultation with Council and RTA	Prior to construction	CEMP	Adherence to TMP

	Impact	Objective	Mitigation tasks	By	Timing	Auditing	Criteria
51.	Safety and asset protection	Minimise risks	• A procedure would be established to monitor the traffic impacts during construction, such as noise, dust nuisance and travel times and work methods modified to reduce the impacts	The Proponent	Prior to construction	CEMP	Minimise complaints from road users and risks associated with transport
52.	Safety and asset protection	Minimise risks	• A procedure would be established to inform vehicle operators on the precise timing of school buses	The Proponent	Prior to construction	CEMP	Protocols set out in CEMP
53.	Safety and asset protection	Minimise risks	• Regular monitoring and scheduled maintenance of gravel pavements such as grading, dust suppression and drainage control would take place during the construction period	The Proponent	Constructio n	CEMP	Protocols set out in CEMP
54.	Safety and asset protection	Minimise risks	• Signposting to warn horse riders of construction traffic and slashing of vegetation from verges on the Bi-Centennial Route to allow horses to move off the road when vehicles approach	The Proponent in consultation with Council	Prior to construction	CEMP	Timely provision of signage
			Additional location specific measures				
55.	Safety and asset protection	Minimise risks	*Hume Highway Junction at Breadalbane* • Speed controls. The Roads and Traffic Authority are generally not in favour of speed restrictions on the Hume Highway because of the loss in efficiency of the route. However, the use of speed controls for specific short-term activities may be included in a traffic control plan or other temporary traffic control measures	The Proponent in consultation with RTA	Prior to construction	CEMP	Adherence to TMP
56.	Safety and asset protection	Minimise risks	*Crookwell Road* • The business owners, retailers etc in the main street of Crookwell would be made aware of the timing for heavy, over-mass and over-dimensional vehicles	The Proponent	Prior to construction	CEMP	Timely notification

	Impact	Objective	Mitigation tasks	By	Timing	Auditing	Criteria
57.	Safety and asset protection	Minimise risks	*Grabben Gullen Road* • The junction is to be designed and constructed in consultation with Upper Lachlan Shire Council and the Roads and Traffic Authority	The Proponent	Prior to construction	CEMP	Adherence to TMP
58.	Safety and asset protection	Minimise risks	*Range Road* • The new junction required to be constructed on Range Road would be designed and constructed in consultation with Upper Lachlan Shire Council	The Proponent in consultation with RTA	Prior to construction	CEMP	Adherence to TMP
59.	Safety and asset protection	Minimise risks	*Gurrundah Road* The new junction required to be constructed on Range Road would be designed and constructed in consultation with Upper Lachlan Shire Council	The Proponent in consultation with RTA	Prior to construction	CEMP	Adherence to TMP
60.	Safety and asset protection	Minimise risks	*Range Road* • Consideration would be given to the reconstruction and sealing of the 1.8km length of unsealed pavement which would include the proposed junctions	The Proponent in consultation with RTA	Prior to construction	CEMP	Adherence to TMP
61.	Safety and asset protection	Minimise risks	*Range Road* • The shadow flicker effects would be monitored following commissioning and any remedial measures to address concerns would be developed in consultation with the RTA and the Department of Planning	The Proponent	Operation	CEMP	Shadow flicker controlled (via roadside planting if required)
62.	Safety and asset protection	Minimise risks	*Bannister Lane, Storriers Lane, Prices Lane* • A program would be established to consult with all of the road users and residents in the area particularly those living in the residences close to the roads	The Proponent in consultation with RTA and Council	Prior to construction	CEMP	Timely notification and consultation
63.	Safety and asset protection	Minimise risks	*Gurrundah Road* • The junction is to be designed and constructed in consultation with Upper Lachlan Shire Council	The Proponent in consultation with Council	Prior to construction	CEMP	Adherence to TMP

	Impact	Objective	Mitigation tasks	By	Timing	Auditing	Criteria
64.	Safety and asset protection	Minimise risks	*Breadalbane to Gurrundah Road* • A procedure would be established for all over-dimensioned vehicles associated with the Gullen Range wind farm project to make contact with a railway service to establish approximate timing of trains so that crossings could be made during the safer periods. The need to always visually check for the approach of trains would be stressed to vehicle operators	The Proponent	Prior to construction	CEMP	Adherence to TMP

9.2.9 Fire and bushfire impacts

	Impact	Objective	Mitigation tasks	By	Timing	Auditing	Criteria
65.	Increase risk of fire ignition or spread	Minimise risks	• The Rural Fire Service and NSW Fire Brigade would be consulted in regard to the adequacy of bushfire prevention measures to be implemented on site during construction, operation and decommissioning. These measures would in particular cover hot-work procedures, asset protection zones, safety, communication, site access and response protocols in the event of a fire originating in the wind farm infrastructure, or in the event of an external wildfire threatening the wind farm or nearby properties	The Proponent	Prior to construction	DoP	Timely notification and consultation
66.	Increase risk of fire ignition or spread	Minimise risks	• Flammable materials and ignition sources brought onto the site, such as hydrocarbons, would be handled and stored as per manufacturer's instructions	The Proponent	During construction	CEMP	Adherence to safety protocols set out in CEMP
67.	Increase risk of fire ignition or spread	Minimise risks	• During the construction phase, appropriate fire fighting equipment would be held onsite when the fire danger is very high to extreme, and a minimum of one person on site would be trained in its use. The equipment and level of training would be determined in consultation with the local RFS	The Proponent	During construction	CEMP	Adherence to safety protocols set out in CEMP

	Impact	Objective	Mitigation tasks	By	Timing	Auditing	Criteria
68.	Increase risk of fire ignition or spread	Minimise risks	• The substation facility would be bunded with a capacity exceeding the volume of the transformer oil to contain the oil in the event of a major leak or fire. The facility would be regularly inspected and maintained to ensure leaks do not present a fire hazard, and to ensure the bunded area is clear (including removing any rainwater)	The Proponent	During construction	CEMP	Adherence to safety protocols set out in CEMP
69.	Increase risk of fire ignition or spread	Minimise risks	• The substation would be surrounded by a gravel and concrete area free of vegetation to prevent the spread of fire from the substation and reduce the impact of bushfire on the structure. The substation area would also be surrounded by a security fence as a safety precaution to prevent trespassers and stock ingress	The Proponent	During construction	CEMP	Adherence to safety protocols set out in CEMP
70.	Increase risk of fire ignition or spread	Minimise risks	• Asset protection zones, based on the RFS *Planning for Bushfire Protection*, would be maintained around the control room, sub-station and in electricity transmission easements. Workplace health and safety protocols would be developed to minimise the risk of fire for workers during construction and during maintenance in the control room and amenities	The Proponent	During construction	CEMP	Adherence to RFS *Planning For Bushfire Protection*
71.	Increase risk of fire ignition or spread	Minimise risks	• Fire extinguishers would be stored onsite in the control building and within the substation building	The Proponent	During construction	CEMP	Adherence to safety protocols set out in CEMP
72.	Increase risk of fire ignition or spread	Minimise risks	• Shut down of turbines would commence if components reach critical temperatures or if directed by the RFS in the case of a nearby wildfire being declared (an all hours contact point would be available to the RFS during the bushfire period). Remote alarming and maintenance procedures would also be used to minimise risks	The Proponent	Operation	OEMP	All hours contact point provided to RFS. Remote alarming installed

	Impact	Objective	Mitigation tasks	By	Timing	Auditing	Criteria
73.	Increase risk of fire ignition or spread	Minimise risks	• Overhead transmission easements would be periodically inspected to monitor regrowth of encroaching vegetation	The Proponent	Operation	OEMP	Compliance with Transgrid easement maintenance protocols.

9.2.10 Hydrology

	Impact	Objective	Mitigation tasks	By	Timing	Auditing	Criteria
74.	Water extraction	Not deplete local supplies	• Water would be sourced from an onsite bore (Pomeroy) as well as other local sources including onsite dams. It would be reused where possible to reduce the total amount required. No water would be sourced from creeks or rivers without relevant permits being sought. No water would be or discharged into creeks, rivers or drainage lines without relevant permits	The Proponent	Construction	CEMP	Minimise water use, maximise reuse onsite,
75.	Deterioration of water quality	Minimise risk	• All vehicles onsite would follow established trails and minimise onsite movements	The Proponent	Construction and operation	CEMP and OEMP	Protocols set out in CEMP and OEMP
76.	Deterioration of water quality	Minimise risk	• Machinery would be operated and maintained in a manner that minimises risk of hydrocarbon spills	The Proponent	Construction and operation	CEMP and OEMP	Protocols set out in CEMP and OEMP
77.	Deterioration of water quality	Minimise risk	• Maintenance or re-fuelling of machinery would be carried out on hard-stand areas (i.e. existing or proposed road surface or hard-stand areas beneath turbines). Where possible, maintenance and re-fuelling would not occur on areas that either contain native vegetation, or would be revegetated	The Proponent	Construction and operation	CEMP and OEMP	Protocols set out in CEMP and OEMP
78.	Deterioration of water quality	Minimise risk	• The concrete batching plants would contain settling ponds sufficient to capture all concrete wash. Wash water would be recycled onsite (in cement mix, road base and dust control) and would not be released	The Proponent	Construction	CEMP	Protocols set out in CEMP

	Impact	Objective	Mitigation tasks	By	Timing	Auditing	Criteria
79.	Deterioration of water quality	Minimise risk	• Waste sludge would be recovered from the settling pond and used in the production of road base manufactured onsite. The waste material would be taken from the batching plant to be blended in the road base elsewhere onsite	The Proponent	Construction	CEMP	Minimise waste, maximise reuse
80.	Deterioration of water quality	Minimise risk	• The concrete batching plant areas would be fully remediated at the completion of the construction phase	The Proponent	Completion of construction	CEMP	Stable and revegetated
81.	Deterioration of water quality	Minimise risk	• Dust suppression would be carried out where required. Central to controlling dust are means to determine when dust suppression is required and having adequate access to water or chemical dust suppression alternatives to control dust. These specifications would be included in the **Construction Environmental Management Plan** prepared for the project prior to construction	The Proponent	Construction	CEMP	Minimise dust complaints
82.	Deterioration of water quality	Minimise risk	Sediment and erosion would be controlled as part of a formal **Sediment / Erosion Control Plan (SECP)**, as a sub plan of the **Construction Environmental Management Plan**. This plan would include the following provisions: • Sediment traps would be installed wherever there is potential for sediment to collect and enter waterways • Stockpiles generated as a result of construction activities would be bunded with silt fencing, (hay bales or similar) to reduce the potential for runoff from these areas • Soil and water management practices would be guided by the Best Practice guidelines contained within *Soils and Construction Vol. 1* (Landcom 2004)	The Proponent	Construction	CEMP	Adherence to SECP

	Impact	Objective	Mitigation tasks	By	Timing	Auditing	Criteria
83.	Deterioration of water quality	Minimise risk	• A **Water Management Strategy** would be developed for the site as part of the Construction and Operational Environmental Management Plans. This would aim to integrate the total water cycle of the site in terms of water supply, stormwater and wastewater, and maximise the use of best management practice techniques for stormwater and wastewater management. Devices such as swales to disperse rather than concentrate runoff would be implemented. Water use would be minimised by maximising reuse. Detailed measures would be devised in conjunction with the development of the construction drawings.	The Proponent	Construction and Operation	CEMP and OEMP	Best practice water management devices
84.	Deterioration of water quality	Minimise risk	A **Site Restoration Plan (SRP)** would be prepared as part of the **Construction Environmental Management Plan**. This would set out protocols for restoration works including: • Site preparation • Stabilisation • Revegetation • Monitoring	The Proponent	Construction	CEMP	Adherence to SRP

	Impact	Objective	Mitigation tasks	By	Timing	Auditing	Criteria
85.	Deterioration of water quality	Minimise risk	The contractor would prepare and implement a **Spill Control Plan,** as a sub-plan of the **Construction Environmental Management Plan.** It would: • Identify persons responsible for implementing the plan if a spill of a dangerous or hazardous chemical/waste would occur • Material Safety Data Sheets (MSDS) for all chemical inventories would be located on site and readily available • Where chemicals are used, their application and disposal would comply with manufacturers recommendations • Any spill that occurs, regardless of size or type of spill, would be reported to the Construction Manager • The event and clean up processes would be recorded. Information that would be recorded in the event of spill would include time and date of spill, type of chemical or waste spilt, approximate volume spilt, general area in which the spill occurred, corrective actions applied, and disposal of spilt material • Spill protocols in this plan would dictate when the EPA would be notified • Chemical / fuel storage areas would be identified, and be bunded to prevent loss of any pollutants • Hydrocarbon spill kits would be stored at the site. A number of site staff are to be trained in the use of the spill kits	The Proponent	Construction	CEMP	Adherence to Spill Control Plan. Minimise spills. Rapid response to spill, involving the EPA as required.
86.	Deterioration of water quality	Minimise risk	• Infrastructure would be bunded to ensure that the amounts of oil could be fully contained in the event of a leak. Bunding provisions would be regularly inspected	The Proponent	Operation	OEMP	Bunding adequate to contain fluids
87.	Deterioration of water quality	Minimise risk	• Septic systems, if installed, would meet Upper Lachlan Council standards	The Proponent	Operation	OEMP	Adherence to Council standards

9.2.11 Mineral exploration

	Impact	Objective	Mitigation tasks	By	Timing	Auditing	Criteria
88.	Conflict with mineral exploration	Minimise conflict	• The Proponent would liaise with the current mineral lease holders, providing a final turbine and infrastructure layout, prior to the construction phase	The Proponent	Prior to construction	DoP	Timely notification and liaison
89.	Conflict with mineral exploration	Minimise conflict	• The Proponent would liaise with the current mineral lease holders during the construction phase, to ensure that where possible, the works program does not unnecessarily interfere with planned exploration activities	The Proponent	Construction	DoP	Timely notification and liaison
90.	Conflict with mineral exploration	Facilitate access	• The Proponent would liaise with the involved land owners and current mineral lease holders prior to rehabilitation, to ensure that any project access roads that they may wish to retain are retained. Several of these access roads are likely to be of benefit both to routine agricultural activities as well as to exploration activities onsite	The Proponent	Construction	DoP	Timely notification and liaison

9.2.12 Economic

	Impact	Objective	Mitigation tasks	By	Timing	Auditing	Criteria
91.	Affect on local economy	Maximise positive effect of proposal	• The Proponent would liaise with local industry representatives to maximise the use of local contractors and manufacturing facilities in the construction and decommissioning phases of the project	The Proponent	Prior to construction	DoP	Timely notification and liaison
92.	Affect on local activities	Minimise disruption	• Co-ordinate construction activities with local events. Gullen Range Wind Farm Pty Ltd would liaise with the local visitor information centres to ensure that construction and decommissioning timing and haulage routes are known well in advance of works	The Proponent	Prior to construction	DoP	Timely notification and liaison

9.2.13 Community wellbeing

	Impact	Objective	Mitigation tasks	By	Timing	Auditing	Criteria
93.	Community division	Provide accurate information	• Dissemination of accessible and independent information on wind farm impacts	The Proponent	Prior to construction	DoP	Timely dissemination of information
94.	Community division	Provide accurate information	• Monitoring information collected during the operation of the wind farm would be made publicly available	The Proponent	Operation	DoP	Timely dissemination of information
95.	Community division	Equitable distribution of benefits	• Gullen Range wind farm would address the potential for wider adverse community impacts by way of a Community Enhancement Program as presented in Section 4.4.2.	The Proponent	Prior to construction	DoP in consultation with the Upper Lachlan SC	Agreement on amount and conditions of fund achieved, in accordance with Council policy

9.2.14 Tourism

	Impact	Objective	Mitigation tasks	By	Timing	Auditing	Criteria
96.	Affect on local activities	Minimise disruption	• Co-ordinate construction activities with local events. Gullen Range Wind Farm Pty Ltd would liaise with the local visitor information centres to ensure that construction and decommissioning timing and haulage routes are known well in advance of works	The Proponent	Prior to construction	DoP	Timely notification and liaison
97.	Affect on local activities	Maximise benefits	• The Proponent would work with the involved landowners, the community and Upper Lachlan Shire Council to allow for the development of the wind farm as a tourist attraction, if this option becomes desirable to these three parties.	The Proponent	Operation	DoP	Liaison as required

9.2.15 Agricultural impacts

	Impact	Objective	Mitigation tasks	By	Timing	Auditing	Criteria
98.	Affect on current local land use	Minimise disruption	• A **Traffic Management Plan** would be developed and would include provisions for construction traffic on access roads where stock may be grazing. These may include specifications for safe speed limits and provision of a construction timetable to affected landowners	The Proponent	Construction	CEMP	Adherence to TMP
99.	Affect on current local land use	Minimise disruption	• Stock would be restricted from works areas where there is a risk stock injury. For example, near excavated trenches and within high traffic areas	The Proponent	Construction	CEMP	Adherence to TMP
100.	Affect on current local land use	Maximise benefits	• Liaison would be undertaken with involved landowners to explore the possibility of enhancing the native component of the understorey in pasture production. This could be incorporated into the site restoration plan which would dictate protocols for the rehabilitation of areas disturbed during construction	The Proponent	Construction	CEMP	Liaison as required
101.	Affect on current local land use	Maximise benefits	• Stock would be restricted from areas being rehabilitated, until surfaces are able to withstand resumed grazing	The Proponent	Construction	CEMP	Protocols set out in SRP
102.	Affect on current local land use	Minimise risks	• Liaison would be undertaken with involved landowners to restrict stock access within construction zones during the construction and decommissioning phases. This is aimed at reducing potential for collision and ensuring stock are not able to escape during construction	The Proponent	Construction	CEMP	Timely notification and liaison
103.	Affect on current local land use	Minimise disruption	• Liaison would be undertaken with neighbouring landowners and landowners adjoining access roads, to provide information about the timing and routes to be used during construction and decommissioning. This could be in the form of advertising and provision of a contact point for further inquiries. The aim would be to reduce the risk of interference with agricultural activities on affected roads and road verges.	The Proponent	Construction	CEMP	Timely notification

	Impact	Objective	Mitigation tasks	By	Timing	Auditing	Criteria
104.	Affect on current local land use	Minimise risks	• The **Traffic Management Plan (TMP)** would contain procedures to manage horse riders using the Bicentennial National Trail during the construction period including keeping the verge of the road clear for riders to allow riders to move off the road. This would include ongoing consultation and liaison with the BNT co-ordinator	The Proponent	Operation	OEMP	Adherence to TMP

9.2.16 Health and safety: construction activities

	Impact	Objective	Mitigation tasks	By	Timing	Auditing	Criteria
105.	Safety of persons or stock	Minimise risks	A detailed **Health and Safety Plan (H&SP)** would be prepared, as a sub plan of the **Construction Environmental Management Plan**, identifying hazards associated with construction works, the risks of the identified hazards occurring and appropriate safeguards would be prepared prior to the commencement of construction works. Additionally: • The plan would incorporate standard work place practices, such as restraints, fall arrest systems, protective clothing and procedures that enable infrastructure to remain stationary during specific activities • Emergency response protocols and equipment and reminders of the requirement for workers to take responsibility for their safety would be implemented • All site workers are to be inducted to the site on their first day of employment. The induction would include a detailed briefing of the health and safety plan • Workplace health and safety protocols would be developed to minimise the risk as a result of the ignition of fire from and to workers during construction and during maintenance in the control room and amenities	The Proponent	Construction	CEMP	Adherence to H&SP
106.	Safety of persons or stock	Minimise risks	• Liaison would occur between property owners and construction staff in relation to land and stock management during construction (during construction and decommissioning, stock would be excluded from the works area - this would exclude road works)	The Proponent	Construction	CEMP	Timely notification and liaison

	Impact	Objective	Mitigation tasks	By	Timing	Auditing	Criteria
107.	Safety of persons or stock	Minimise risks	• Site fencing would be installed where there is a risk to the safety of the general public (i.e. when the trench is left open for extended periods)	The Proponent	Construction	CEMP	Adherence to H&SP
108.	Safety of persons or stock	Minimise risks	• Employee safety would be managed through the application a **Health and Safety Plan**	The Proponent	Operation	OEMP	Adherence to H&SP

9.2.17 Health and safety: shadow flicker

	Impact	Objective	Mitigation tasks	By	Timing	Auditing	Criteria
109.	Safety / nuisance to persons or stock	Minimise risks	• If shadow flicker is found to be a nuisance to residents, conditions would be pre-programmed into the control system and individual wind turbines automatically shut down whenever these conditions are present	The Proponent	Operation	OEMP	Minimise complaints
110.	Safety of persons or stock	Minimise risks	• Shadow flicker effects on motorists using Range Road would be monitored following commissioning and any remedial measures to address concerns would be developed in consultation with the RTA and the Department of Planning	The Proponent	Operation	OEMP in consultation with the RTA and the Department of Planning	Minimise shadow flicker on this section of road

9.2.18 Health and safety: stability of turbines

	Impact	Objective	Mitigation tasks	By	Timing	Auditing	Criteria
111.	Safety of persons or stock	Minimise risks	• Obtain and implement sound geotechnical advice during construction, choice of a reliable turbine and proper installation and maintenance of the turbines	The Proponent	Construction	DoP	Adherence to geotechnical report conclusions

9.2.19 Historic heritage

	Impact	Objective	Mitigation tasks	By	Timing	Auditing	Criteria
112.	Deterioration of heritage items	Minimise risks	• Inform the Upper Lachlan Shire Council, Goulburn-Mulwaree Council and the NSW Heritage Office of the proximity of final access routes	The Proponent	Construction	DoP	Timely notification and liaison
113.	Deterioration of heritage items	Minimise risks	• Building design, materials and colour would be appropriate to the heritage values of the area	The Proponent	Prior to construction	DoP	Signoff from Landscape Architect
114.	Deterioration of heritage items	Minimise risks	• Underground rather than overhead transmission would be used where possible and where it would not result in inappropriate risks to soils and land forms. Although extensive existing electricity transmission infrastructure is present on the site and to the south, the cumulative impact of the development would be reduced where possible	The Proponent	Prior to construction	DoP	Minimal overhead transmission

9.2.20 Physical impacts: air quality

	Impact	Objective	Mitigation tasks	By	Timing	Auditing	Criteria
115.	Air quality	Minimise risks	• Subsoil would be separated from topsoil for rehabilitation purposes. All topsoil from the excavation sites would be stockpiled and replaced to its original depth for seeding and fertilising. On steep slopes, topsoil would need to be stabilised using, for example, jute matting. Any excess subsoil would be removed from the site and disposed of at an appropriate fill storage site	The Proponent	Construction	CEMP	Protocols set out in CEMP
116.	Air quality	Minimise risks	• Any material stockpiled as would be covered with plastic, seeded or otherwise bound to reduce dust. Dust levels at stockpile sites would be visually monitored. Dust suppression (eg. water sprays) would be implemented if required	The Proponent	Construction	CEMP	Protocols set out in CEMP
117.	Air quality	Minimise risks	• Product stockpiles would be protected from prevailing weather conditions	The Proponent	Construction	CEMP	Protocols set out in CEMP

	Impact	Objective	Mitigation tasks	By	Timing	Auditing	Criteria
118.	Air quality	Minimise risks	• During dry, windy periods a water cart or alternative chemical dust suppression would be available and applied to works areas generating dust. Means to determine when action is required would be detailed in the **Construction Management Plan**	The Proponent	Construction	CEMP	Protocols set out in CEMP
119.	Air quality	Minimise risks	• Should blasting be required, it would be carried out in accordance with all relevant statutory requirements	The Proponent	Construction	CEMP	Adherence to ANZECC guidelines
120.	Air quality	Minimise risks	• Residences within 1km of blasting activities would be informed prior to blasting	The Proponent	Construction	CEMP	Timely notification
121.	Air quality	Minimise risks	• Dust filters would be installed on silos, where required	The Proponent	Construction	CEMP	Minimal dust complaints
122.	Air quality	Minimise risks	Sediment and erosion would be controlled as part of a formal **Sediment / Erosion Control Plan (SECP)**. This plan would include the following provisions: • Sediment traps would be installed wherever there is potential for sediment to collect and enter waterways • On the steeper slopes check banks would be installed across the trenchline, as appropriate, following closure of the trench. These would discharge runoff to areas of stable vegetation • Stabilisation would be undertaken as soon as practicable during construction. Furthermore, rehabilitation of disturbed ground would be carried out at the completion of construction works • Stockpiles generated as a result of construction activities would be bunded with silt fencing, (hay bales or similar) to reduce the potential for runoff from these areas • Soil and water management practices would be guided by the Best Practice guidelines contained within *Soils and Construction Vol. 1* (Landcom 2004)	The Proponent	Construction	CEMP	Adherence to SECP

	Impact	Objective	Mitigation tasks	By	Timing	Auditing	Criteria
123.	Air quality	Minimise risks	A **Traffic Management Plan (TMP)** would be developed and would include strategies to reduce the number of vehicle movements to, from and across the sites. These would include: • Only machinery compliant with emission standards would be used • Vehicles and motorised equipment would be maintained so that emissions are minimised • Machinery and vehicles would not be left running or idling when not in use	The Proponent	Construction	CEMP	Adherence to TMP

9.2.21 Physical impacts: soils and landforms

	Impact	Objective	Mitigation tasks	By	Timing	Auditing	Criteria
124.	Soil loss or stability of landform loss	Minimise risks	• Concrete wash would be deposited in an excavated area, below the level of the topsoil, or in an approved landfill site. Where possible, waste water and solids would be reused onsite	The Proponent	Construction	CEMP	No effect on waterways or top soil
125.	Soil loss or stability of landform loss	Minimise risks	• Tracks would be graded to enhance their stability	The Proponent	Construction	CEMP	Adherence to SECP
126.	Soil loss or stability of landform loss	Minimise risks	• Access routes and tracks would be confined to already disturbed areas, where possible	The Proponent	Construction	CEMP	Minimise disturbance area
127.	Soil loss or stability of landform loss	Minimise risks	• ANZECC guidelines for control of blasting impact at residences would be adhered to if blasting is required	The Proponent	Construction	CEMP	Adherence to ANZECC guidelines

9.2.22 Resource impacts

	Impact	Objective	Mitigation tasks	By	Timing	Auditing	Criteria
128.	Waste generation	Minimise waste and maximise recycling of materials	• Waste would be reused or recycled whenever possible. Separate recyclable materials receptacles would be provided (eg. For glass, plastics and aluminium)	The Proponent	Construction and operation	CEMP and OEMP	Waste streams identified, Waste Hierarchy implemented
129.	Waste generation	Appropriate disposal of waste	• Packaging materials and general construction wastes would be disposed of, with Council's approval, at Council operated waste disposal centres	The Proponent	Construction and operation	CEMP and OEMP	Waste streams identified, Waste Hierarchy implemented
130.	Waste generation	Appropriate disposal of waste	• Toilet facilities would be provided for onsite workers and sullage from contractor's pump out toilet facilities would be disposed at the local sewage treatment plants or other suitable facility agreed to by Council	The Proponent	Construction and operation	CEMP and OEMP	Council approved disposal
131.	Waste generation	Minimise waste and maximise recycling of materials	• Surplus topsoil would be stockpiled on site during construction, and following construction would be spread on the site (particularly over former hardstand areas and access roads) to assist with revegetation	The Proponent	Construction	CEMP	SRP adhered to
132.	Waste generation	Minimise waste and maximise recycling of materials	• Excavated material would be used in road base construction and as aggregate for footings where possible. Surplus material would be disposed of in appropriate locations on site (on agreement with the landowner), finished with topsoil, and revegetated	The Proponent	Construction	CEMP	Maximum reuse of excavated material

	Impact	Objective	Mitigation tasks	By	Timing	Auditing	Criteria
133.	Waste generation	Appropriate disposal of waste	• Risk of chemical spills would be minimised and protocols would be in place to ensure prompt and effective clean up of any accidental spills	The Proponent	Construction and operation	CEMP and OEMP	Adherence to Spill Control Plan. Minimise spills. Rapid response to spill, involving the EPA as required.
134.	Waste generation	Appropriate disposal of waste	• No permanent waste disposal would be utilised onsite	The Proponent	Construction and operation	CEMP and OEMP	Waste disposal protocols set out in CEMP and OEMP adhered to
135.	Waste generation	Appropriate disposal of waste	• The contractor would implement a Spill Control Plan as part of its Erosion and Sediment Control Plan. Spill Control Plans would identify persons responsible for implementing the plan if a spill of a dangerous or hazardous waste should occur. Any spill that occurs, regardless of size or type of spill, would be reported to the Construction Manager. The event and clean up processes would be recorded. Spill protocols in the plan would dictate when the EPA should be notified	The Proponent	Construction and operation	CEMP and OEMP	Adherence to Spill Control Plan. Minimise spills. Rapid response to spill, involving the EPA as required.

9.2.23 Cumulative impact

	Impact	Objective	Mitigation tasks	By	Timing	Auditing	Criteria
136.	Cumulative noise	Minimise risk of construction noise criteria exceedence	Construction noise • If an additional project proposes concurrent construction timing as the proposed Gullen Range wind farm, the Proponent would enter into liaison to ensure that additional construction noise issues were addressed	The Proponent	Construction and operation	CEMP and OEMP	Rapid response to complaints, adherence to SA EPA guidelines
137.	Cumulative traffic and infrastructure	Minimise disruption	Traffic and infrastructure • If an additional project proposed concurrent construction timing on access routes nominated by the Gullen Range wind farm, the Proponent would enter into liaison to ensure that additional traffic and transport issues were addressed	The Proponent	Construction and operation	CEMP and OEMP	Timely notification and liaison with road authorities and second proponent
138.	Cumulative economic	Maximise local skill use	Economic • Liaison would continue with local economic development bodies to ensure the potential for local skill use and manufacturing is maximised	The Proponent	Construction and operation	DoP	Timely notification and liaison

9.3 Monitoring example

Monitoring and adaptive management mechanisms would be in place to reduce the operational impact of the proposal, should unforseen impacts result. The proposal has a degree of flexibility to address unforeseen impacts to biodiversity or social values. Specific management responses would be determined by the nature and extent of impacts, but could include adjustments or enhancements to turbine and associated infrastructure, periodic shutdown, vegetation screening and other impact mitigation measures, or indirect compensatory measures such as contribution to community resources and services and off-site habitat protection or enhancement.

The OEMP would employ adaptive management in response to monitoring results and other inputs. For example, specific monitoring activities may include:

- Bird and bat collision monitoring, bird and bat habitat utilisation monitoring
- Shadow flicker monitoring
- TV reception monitoring

Due to the level of detail and site specific investigation required, monitoring programs would not be designed prior to Project Approval. However, an indicative outline is provided below that would assess the impact of the operational wind farm on birds and bats.

9.3.1 Bird and bat impact monitoring

General principles

A monitoring program would be designed to document mortalities, remove carcasses and assess the effectiveness of controls to reduce collision and avoidance for birds and bats. Standardised and publicly available data would be collected to increase the knowledge base on this subject.

Bat collision rates would be monitored in summer and autumn. This is the time of year when many species migrate and therefore would provide information on the upper level of impact generated by the proposal. The southern-most Pomeroy turbine suggests itself as an appropriate monitoring point to investigate movement corridor impacts

If mortalities exceed a pre-determined threshold (set out in the monitoring program), additional mitigation measures would be considered, such as diversion structures, blade painting (refer Hodos *et al.* 2001), turning off turbines at critical times, further habitat modification and enhancement of off-site habitats

Threshold mortality rates for threatened or sensitive bird and bat species would be determined for each of the three monitoring periods. The thresholds would trigger a management response, which would vary depending on the nature and extent of the impact.

The OEMP would contain details of a three-tiered monitoring program for bird and bat mortalities and habitat utilisation impacts:

1. First six months of operation

- An intensive period of monitoring required because birds and bats are in the process of habituating to the new development, and sensitive species may experience higher levels of mortality during this period.
- During this period all turbine sites would be surveyed to determine variation in impact over the study area. Surveys would include monthly dead bird searches, bird utilisation

surveys, observation of avoidance/diversion behaviour and targeted surveys for species of concern (such as raptor nest sites).

- Monitoring would examine collision mortalities and habitat utilisation, targeting potentially vulnerable species (such as threatened species, waterbirds and raptors).

2. First two years of operation

- Monitoring to assess mortality rates and trends over several seasons and longer term changes to local species abundance, habitat use patterns and possibly breeding success.
- The survey may be limited to representative or higher risk turbine sites, based on the results of the first six months of monitoring.
- Surveys could include monthly dead bird searches (with scavenging trials which assess the influence of seasonal scavenger activity on collision data), bird utilisation surveys, observation of avoidance/diversion behaviour and targeted surveys for species of concern (such as raptor nest sites).
- Dead bird searches may be extended beyond two years if thresholds are exceeded and adaptive management responses are required to be implemented.

3. Ongoing monitoring

- Mortality inspection and reporting to be continued for the life of the wind farm. The inspection regime would be linked to turbine inspection and maintenance cycles. Mortalities of any significant species would be reported to DECC.
- Monitoring methods and data standards for dead bird searches, indirect disturbance impact assessment and habitat avoidance studies would be based on protocols in the Interim Standards for Assessing the Risks to Birds from Wind Farms in Australia (Brett Lane and Associates 2005).

10 CONCLUSION

This Environmental Assessment (EA) has assessed the likely environmental impacts that may result from the proposed Gullen Range wind farm; a proposal that would be capable of generating up to 278 MW of greenhouse gas emission free electricity.

The proposal has incorporated the environmental constraints identified in an iterative manner throughout the project design to arrive at the most appropriate site layout. It has also incorporated measures to proactively address identified environmental risks throughout the construction, operation and decommissioning of the project. All measures to which the proponent would commit are detailed in the draft Statement of commitments, Section 9.2.

This EA considers the key issues of the proposal relate to visual impact, operational noise, biodiversity, communications, traffic and transport impact and a range of issues relating to the local community, including wellbeing, lifestyle values and tourism. These impacts must be considered in balance with the public benefits of the proposal.

Benefits of the proposal have been identified at the global, regional and local scale. These include (based upon an 84 turbine layout):

- Production of approximately 588,000 MWh of renewable electricity per annum, sufficient for the average consumption of up to 73,500 homes
- Reduction in greenhouse gas emissions of approximately 588,000 tonnes of carbon dioxide (equivalent) per annum, the equivalent of taking 117,600 cars off our roads
- Savings in water consumption of approximately 774 Million litres per annum of potable water (this is the amount of water required to produce the same amount of electricity from coal fired power stations)
- Annual savings in pollution from coal fired power stations of up to 3,150,000 kilograms of sulfur dioxide, 1,405,000 kilograms of nitrogen oxides, and 88,200 kilograms of particulates
- Provision of a community fund of $75,000 per annum for local community and environmental projects including a Clean Energy Program
- Provision of local jobs and injection of up to $200 Million into the Australian economy and approximately $60 - $90 Million into the local economy
- Improved security of electricity supply through diversification

The success of the proposal in mitigating environmental impacts hinges on the development and implementation of the Project Environmental Management Plan and its associated Construction and Operation Environmental Management Plans. The Proponent is committed to ensuring the measures developed in these plans are best practice and is committed to working to ensure the best possible result is achieved for the Gullen Range site. This not only has immediate benefits for the site and locality which would house the project, it would also set a high standard for the development of wind energy resources in the region.

11 GLOSSARY AND ACRONYMS

ABARE	Australia Bureau of Resource Economics
AHD	Australian Heritage Database
AHIMS	Aboriginal Heritage Information Management System
AIS	Aeronautical Information Service
APANSA	Australian Radiation Protection and Nuclear Safety Agency
APZ	Asset Protection Zone (for bushfire compliance)
ARL	Acoustic Research Laboratories
AusWEA	Australian Wind Energy Association
CANRI	Community Access to Natural Resource Information
CASA	Civil Aviation Safety Authority
CEMP	Construction Environmental Management Plan
CMA	Catchment Management Authority
DCP	Development Control Plan
DEC	NSW Department of Environment and Conservation, now the Department of Environment and Climate Change
DECC	NSW Department of Environment and Climate Change, formerly the Department of Environment and Conservation
DEH	Commonwealth Department of Environment and Heritage, now the Department for Environment and Water Resources
DEWR	Commonwealth Department for Environment and Water Resources, formerly the Department of Environment and Heritage
DGRs	NSW Department of Planning's Director Generals Requirements. The Environmental Assessment report must address issues as directed in the DGRs
DoP	NSW Department of Planning
DPI	Department of Primary Industries
EA	Environmental Assessment report, format dictated by the NSW Department of Planning's Director Generals Requirements
EEC	Endangered Ecological Community
EMF	Electromagnetic fields
EPA	Environmental Protection Agency
ER	Environmental Representative, appointed during the environmental management of the construction and operational phases, appointment must be approved by the Department of Planning
ERM	Environment Resources Management (visual impact consultants for this project)
ESC	Effective Survey Coverage (referred to in Aboriginal Archaeology survey methods and results)
ESD	Ecologically Sustainable Development

GWh	gigawatt-hour
HN	Hawkesbury Nepean
IBRA bioregions	Interim Biogeographic Regionalisation for Australia
kV	kilovolt
LALC	Local Aboriginal Land Council
LEP	Local Environmental Plan
mG	milligaus
MW	megawatt
MWh	megawatt-hour
Mitchell landscape	Landscapes classified for IBRA bioregions
MOS	Manual of Standards
NES	National Environmental Significance
NPI	National Pollutant Inventory
OEMP	Operational Environmental Management Plan
PEMP	Project Environmental Management Plan
PFM	Planning Focus Meeting
Proponent	Gullen Range Wind Farm Pty. Ltd.
REP	Regional Environmental Plan
RFS	Rural Fire Service
RNE	Register of the National Estate
SC	Shire Council
SEPP	State Environmental Planning Policy
SHI	State Heritage Inventory
TMP	Traffic Management Plan
TVI	Television Interference
V	volt
W	watt

12 ASSESSMENT PERSONNEL

This report was prepared by **ngh**environmental. Specific sections were drawn from consultants reports and from the Proponent, as detailed in the table below.

Table 12-1 Preparation of this document

Section		Author
1	**Executive summary**	**ngh**environmental
2	**Introduction**	**ngh**environmental
3	**Description of the proposal**	Epuron
4	**Project justification**	Epuron
5	**Planning context**	**ngh**environmental
6	**Consultation**	**ngh**environmental
7	**Assessment of key issues**	
7.1	Scoping and prioritisation of issues	**ngh**environmental
7.2	Visual impact	Environmental Resources Management
7.3	Operational and construction noise	Marshall Day Acoustics
7.4	Biodiversity	**ngh**environmental
7.5	Aboriginal archaeology	NSW Archaeology
7.6	Air hazard impacts	Aviation Projects
7.7	Communication impacts	Epuron
7.8	Electromagnetic fields (EMFs)	**ngh**environmental
7.9	Land value impacts	**ngh**environmental and Henderson and Horning Property Consultants
7.10	Traffic and transport	Bega Duo Designs
7.11	Fire and bushfire impacts	**ngh**environmental
7.12	Hydrology	**ngh**environmental
7.13	Mineral exploration impacts	**ngh**environmental
8	**Assessment of additional issues**	
8.1	Economic impacts	**ngh**environmental
8.2	Community wellbeing	**ngh**environmental
8.3	Lifestyle impacts	**ngh**environmental
8.4	Tourism impacts	**ngh**environmental
8.5	Agricultural impacts	**ngh**environmental
8.6	Health and safety	**ngh**environmental
8.6.1	Construction activities	**ngh**environmental
8.6.2	Shadow flicker	Epuron, Garrad Hassan and ERM

Section		Author
8.6.3	Stability of turbines	**ngh**environmental
8.7	Historic heritage	**ngh**environmental
8.8	Physical impacts	**ngh**environmental
8.8.1	Climate	**ngh**environmental
8.8.2	Air quality impacts	**ngh**environmental
8.8.3	Soils and landforms	**ngh**environmental
8.9	Resource impacts	**ngh**environmental
8.5	Cumulative impacts	**ngh**environmental
9	**Environmental management**	**ngh**environmental
10	**Conclusion**	**ngh**environmental

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