Cumulative visual impact assessment

Section 9

9.1 What is cumulative impact assessment?

A cumulative landscape and visual impact could result from a proposed wind farm development being constructed in conjunction with other existing or proposed wind farm developments, and could be either associated or separate to it.

Separate wind farm developments could occur within the established viewshed of the proposed wind farm, or be located within a regional context where visibility is dependent on a journey between each site or an individual project viewshed.

'Direct' cumulative visual impacts could occur where two or more winds farms have been constructed within the same locality, and could be viewed from the same view location simultaneously.

'Indirect' cumulative visual impacts could occur where two or more winds farms have been constructed within the same locality, and could be viewed from the same view location but not within the same field of view.

'Sequential' cumulative visual impacts could arise as a result of multiple wind farms being observed at different locations during the course of a journey (such as views from a vehicle travelling along a highway or from a network of local roads), which could form an impression of greater magnitude within the construct of short term memory.

There are a number of proposed, approved and operating wind farm developments within New South Wales which are illustrated in **Figure 18**. The general location of wind farms surrounding the project are illustrated in **Figure 19**. These figures illustrate the location of wind farms known at the time this LVIA was prepared. The number and location of wind farms is likely to change as more wind farm projects are announced or current approvals lapse.

9.2 Other wind farm developments

The DoP&I website identifies a small number of wind farm developments that are currently existing or proposed within the same locality as the project and are identified in **Table 19**.

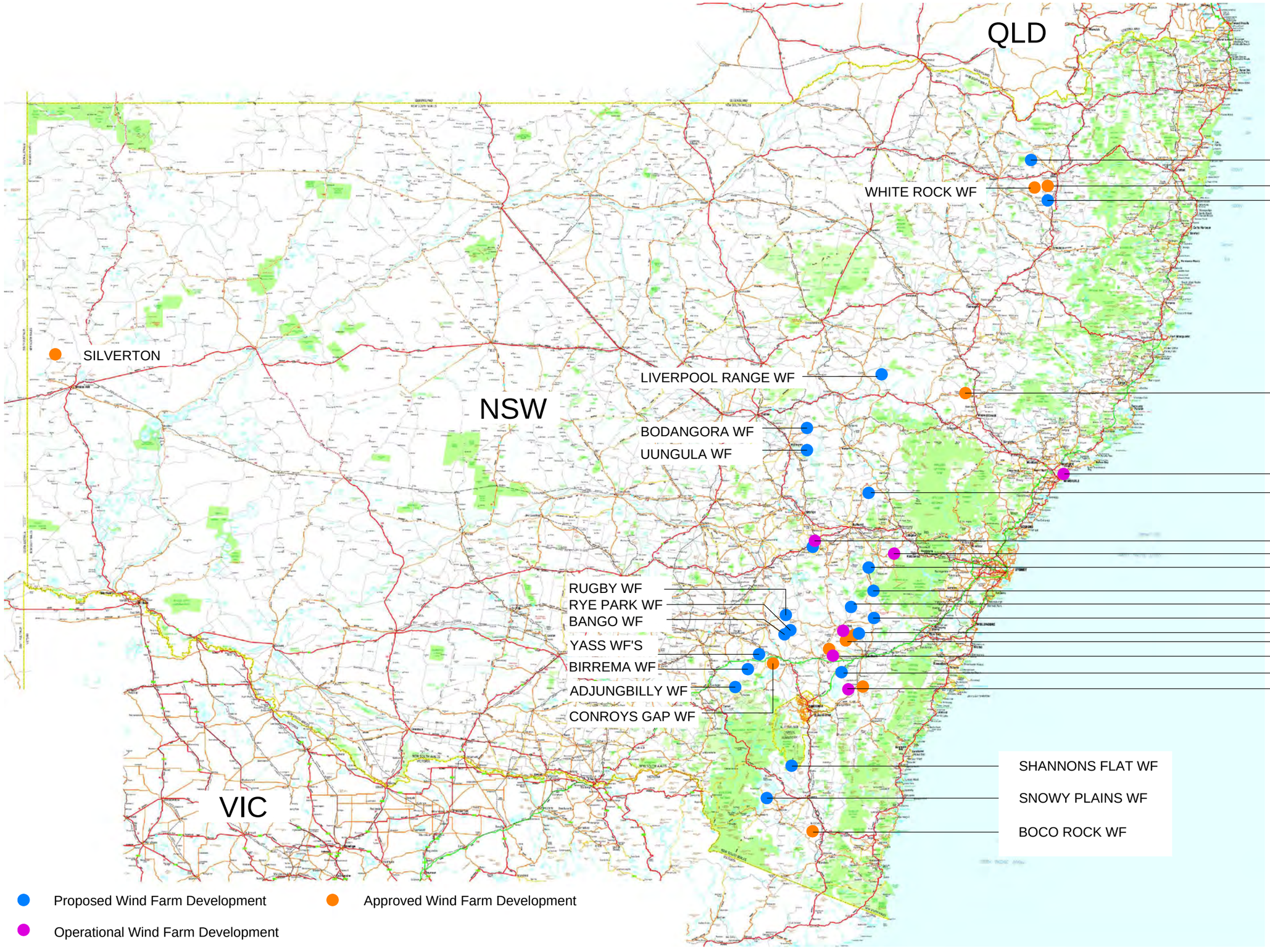

Figure 18
NSW Wind Farms
(as of October 2012)

Not to scale

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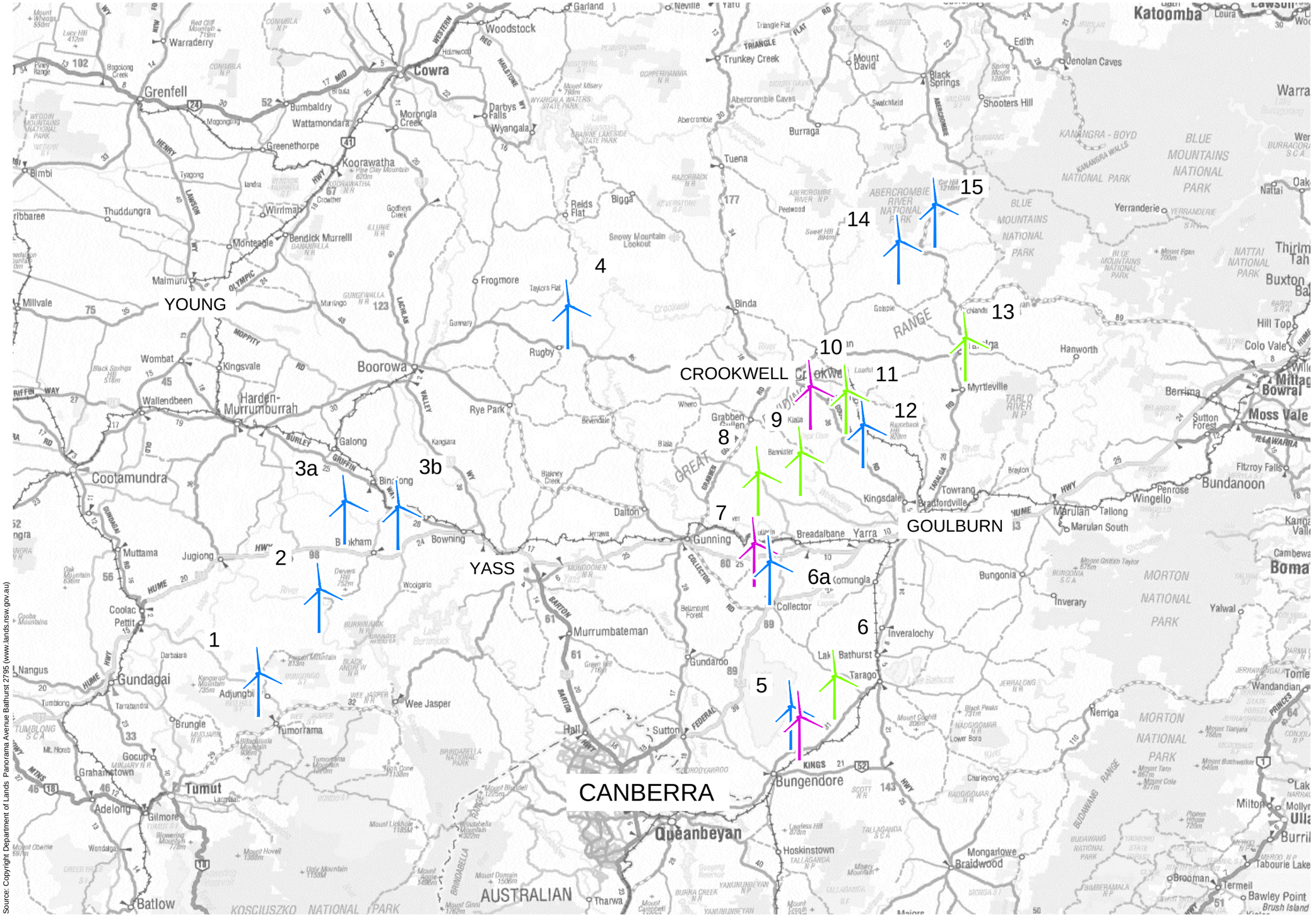
landscape architects

PALING YARDS WIND FARM



Source: Copyright Department of Lands Panorama Avenue Bathurst 2795 (www.lands.nsw.gov.au)

Legend

1 Adjunbilly Wind Farm

2 Birrema Wind Farm

3a Yass Wind Farm (Coppabella)

3b Yass Wind Farm (Marilba)

4 Rugby Wind Farm

5 Capital Wind Farm (I & II)

6 Woodlawn Wind Farm

6a Collector Wind Farm

7 Cullerin Wind Farm

8 Gunning Wind Farm

9 Gullen Range Wind Farm

10 Crookwell Wind Farm

11 Crookwell 2 Wind Farm

12 Crookwell 3 Wind Farm

13 Taralga Wind Farm

14 Golspie Wind Farm

15 Paling Yards Wind Farm

Proposed wind farm development

Approved wind farm development

Operational wind farm development

Figure 19
NSW Southern Tablelands Wind Farm Locations
(as of October 2012)

PALING YARDS WIND FARM

Not to scale

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Table 19 Other Wind Farm Developments

Wind Farm	Proponent or Owner	Status	Number of turbines	Approximate distance between wind farms
Crookwell 1	Eraring Energy Pty Ltd	Operational	8	40 km
Crookwell 2	Crookwell Development Pty Ltd	Approved – Construction Stage	46	41 km
Crookwell 3	Crookwell Development Pty Ltd	Planning stage – not yet approved	30	40 km
Gullen Range	Gullen Range Wind Farm Pty Ltd	Approved - Construction Stage	73	44 km
Golspie	Wind Prospect Pty Ltd	Planning stage – not yet lodged	up to 100	3 km
Taralga	CBD Energy Pty Ltd	Approved - Construction Stage	62	27 km

GBD is not aware of any smaller wind farm developments that are currently lodged, or being assessed by the Oberon Shire Council.

9.3 Cumulative visual impact summary

Intervisibility between the Paling Yards wind turbines and other proposed, approved and operating turbines would potentially occur from discrete elevated and cleared ridgeline areas to the east and south of the project.

The opportunity for ‘direct’ or ‘indirect’ views to other approved wind farms is limited for most of the residential dwellings within the Paling Yards wind farm 10 km viewshed. This is largely due to residential dwelling position and orientation relative to other approved wind farms as well as the distribution of dense and scattered tree cover and undulating topography between the approved wind farm developments.

Long distance views south toward the approved Taralga wind farm would potentially occur from elevated (but unoccupied) portions of land within the Paling Yards wind farm site. The Taralga wind farm is unlikely to result in any significant cumulative visual impacts.

Motorists travelling along the Abercrombie Road would not tend to experience 'indirect' cumulative impact as turbine visibility within and beyond the project site is limited by local landform, tree cover and the direction of travel relative to distant views beyond the project. There may be an opportunity for a 'direct' view between the Paling Yards wind turbines and those within the proposed Golspie wind farm area from vehicles travelling south along Abercrombie Road. It is not anticipated that this would result in a significant level of cumulative impact due to the potential distance between wind turbines and temporary nature of the view.

A 'sequential' view would occur for motorists travelling along the Abercrombie Road although the journey between wind farms would include a range of views extending toward and beyond turbines. The extent and overall visibility of turbines would be influenced by the direction of travel relative to the alignment of wind turbines as well as travel time along the highway and local road network alongside and between various wind farm turbines.

This LVIA has determined that the project is unlikely to result in any significant 'direct', 'indirect' or 'sequential' cumulative visual impact and is unlikely to significantly increase the level of visual impact that has been determined for the nominated view locations in relation to the project development.

Photomontages

Section 10

10.1 Photomontages

The DGR's state that the EA must "*include photomontages of the project taken from potentially affected residences (including approved but not yet developed dwellings or subdivisions with residential rights), settlements and significant public view points…*"

Whilst it is possible for any residence with a view toward the project turbines to be potentially affected (with a resultant high, moderate or low visual impact), it is not feasible or practical to prepare a photomontage for each and every residence within the project 10 km viewshed.

A total of eight photomontage locations (PM 1 to PM 8) were selected as representative of non associated residential dwellings and the public view locations from surrounding road corridors. Photomontages PM 1 to PM 6 illustrate the proposed wind turbine locations; PM 7 and PM 8 illustrates a typical view toward the assessed and proposed 500 kV transmission line. The photomontages locations are illustrated in **Figure 20**.

The photomontages locations were selected to represent a range of distances between the viewpoint and wind turbines (between 800 m and 4.6 km) to illustrate the potential influence of distance on visibility and resultant visual impact.

The photomontages have been prepared with regard to the general guidelines set out in the Scottish Natural Heritage (2006) Visual representation of windfarms: good practice guidance and British Landscape Institute Advice Note 01/11 (March 2011) Photography and photomontage in landscape and visual impact assessment.

Photography for the photomontages was undertaken by GH and GBD using a tripod mounted Nikon D700 digital single-lens reflex (SLR) camera. A 50 mm focal length prime lens was attached to the Nikon D700 SLR camera which, with a 35 mm equivalent a full frame censor (36 x 23.9 mm Nikon FX format) results in a single photograph image with a 46^{o} view angle.

Each photomontage was generated through the following steps:

- a digital terrain model (DTM) of the project site was created from a terrain model of the surrounding area using digital contours;

- the site DTM was loaded in the GH 'WindFarmer' software package;
- the layout of the wind farm and 3D representation of the wind turbine was configured in GH WindFarmer;
- the location of each viewpoint (photo location) was configured in WindFarmer – the sun position for each viewpoint was configured by using the time and date of the photographs from that viewpoint;
- the view from each photomontage location was then assessed in WindFarmer. This process requires accurate mapping of the terrain as modelled, with that as seen in the photographs. The photographs, taken from each photomontage location were loaded into WindFarmer and the visible turbines superimposed on the photographs;
- the photomontage were adjusted using Photoshop CS3 to compensate for fogging due to haze or distance, as well as screening by vegetation or obstacles; and
- the final image was converted to JPG format and imported and annotated as the final figure.

Table 20 identifies the eight photomontage locations, property names (where relevant), corresponding reference number identified in the residential view matrix (**Table 17)** as well as the status of each photomontage location.

Table 20 – Photomontage details

Photomontage Location	Figure Reference	Location name and View Location Matrix reference (R) – (Refer Tables 15 and 16)	Status: Residential (associated) Residential (non associated) Road corridor
PM 1 Levels Road	**Figure 21 Sheet 1** **Figure 22 Sheet 2**	n/a	Unsealed road corridor (minor local road)
PM 2 Rock Orchard (residential dwelling)	**Figure 23 Sheet 1** **Figure 24 Sheet 2**	R128	Non associated residential dwelling (photomontage location south of residential dwelling)

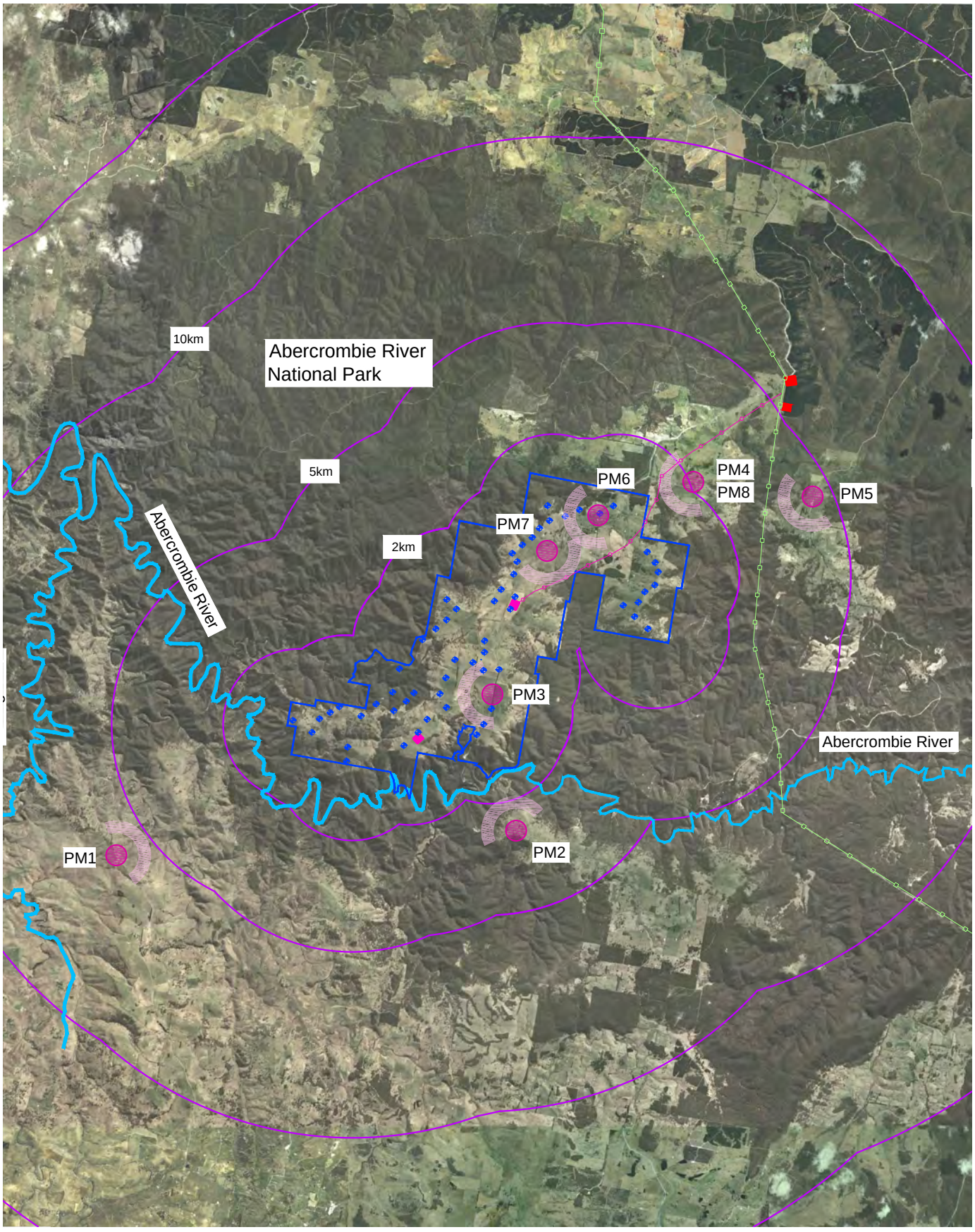
Table 20 – Photomontage details

Photomontage Location	Figure Reference	Location name and View Location Matrix reference (R) – (Refer Tables 15 and 16)	Status: Residential (associated) Residential (non associated) Road corridor
PM 3 Abercrombie Road	**Figure 25 Sheet 1** **Figure 26 Sheet 2**	n/a	Abercrombie Road
PM 4 Hilltop (residential dwelling driveway)	**Figure 27 Sheet 1** **Figure 28 Sheet 2**	R6A	Non associated residential dwelling (photomontage location south of residential dwelling from entrance driveway)
PM 5 Jerrong Road	**Figure 29 Sheet 1** **Figure 30 Sheet 2**	n/a	Jerrong Road
PM 6 Mount Hutton (private land)	**Figure 31 Sheet 1** **Figure 32 Sheet 2**	n/a	Hill top on associated property (private grazing land) –provides an elevated longitudinal view north to south along Abercrombie Road.
PM 7 Abercrombie Road	**Figure 42**	n/a	Abercrombie Road – view toward assessed and proposed 500 kV transmission line (turbines not illustrated).
PM 8 Hilltop (residential dwelling driveway)	**Figure 43**	n/a	Non associated residential dwelling (photomontage location south of residential dwelling from entrance driveway). View toward assessed and proposed 500 kV transmission line.

The horizontal and vertical field of view within the majority of the photomontages exceeds the parameters of normal human vision. However, in reality the eyes, head and body can all move and, under normal conditions, the human brain would 'see' a broad area of landscape within a panorama view. Accordingly, the photomontage have been prepared to represent both an extended panorama view as well as a single photographic image representing a static portion for the human field of view.

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

The British Landscape Institute states that '*it is also important to recognise that two-dimensional photographic images and photomontages alone cannot capture or reflect the complexity underlying the visual experience and should therefore be considered an approximate of the three-dimensional visual experiences that an observer would receive in the field'.*



Legend

Paling Yards proposed wind turbine indicative layout

Photomontage location

Existing 500 kV transmission line

Proposed 500 kV transmission line

Paling Yards wind farm site boundary

Distance offset to wind turbines as noted

Proposed collector substation

Proposed switchyard substation

0km 2km

Figure 20
Photomontage Location

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PALING YARDS WIND FARM

Figure 21 Photomontage PM 1 Sheet 1

Image Source GBD 2012

Photomontage Location PM 1 Levels Road - Existing view, panorama north to east (Bearing 350° to 110°)

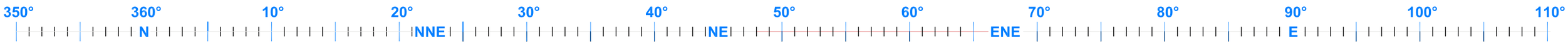

Image Source GBD 2012

Photomontage Location PM 1 Proposed view, Levels Road, Extended panorama north to east (Bearing 350° to 110°)

PALING YARDS WIND FARM

Refer Figure 20 for Photomontage Location.

Individual panorama photos taken with a Nikon D700 digital SLR camera with 50 mm prime lens.

Photo coordinates: Easting 742978 Northing 6210924 (MGA 94z55H). Approximate distance to nearest visible turbine 6 km

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Image Source GBD 2012

Photomontage Location PM 1, Levels Road - Proposed view

Indicative extent of single frame photo
(refer detail below)

Image Source GBD 2012

Photomontage Location PM 1 - Single frame photo detail, proposed view

Figure 22
Photomontage PM 1 Sheet 2

Refer Figure 20 for Photomontage Location

Individual panorama photos taken with a Nikon D700 digital SLR camera with 50 mm prime lens.

Photo coordinates:
Easting 742978
Northing 6210924 (MGA 94z55H)

Approximate distance to nearest visible turbine 6 km

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Image Source GBD 2012

Photomontage Location PM 2 Rock Orchard (residential dwelling) Existing view, extended panorama north west to east north east (Bearing 300° to 70°)

Image Source GBD 2012

Photomontage Location PM 2 Rock Orchard (residential dwelling) Proposed view, extended panorama north west to east north east (Bearing 300° to 70°)

PALING YARDS WIND FARM

Refer Figure 20 for Photomontage Location

Individual panorama photos taken with a Nikon D700 digital SLR camera with 50 mm prime lens.

Photo coordinates: Easting 753207 Northing 6211629 (MGA94z55H). Approximte distance to nearest visible turbine 2.6 km

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PALING YARDS WIND FARM

Image Source GBD 2012

Photomontage Location PM 2 - Rock Orchard (south of residential dwelling)
Proposed view

Indicative extent of single frame photo (refer detail below)

Image Source GBD 2012

Photomontage Location PM 2 - Single frame photo detail, proposed view

Figure 24
Photomontage PM 2 Sheet 2

Refer Figure 20 for Photomontage Location

Individual panorama photos taken with a Nikon D700 digital SLR camera with 50 mm prime lens.

Photo coordinates:
Easting 753207
Northing 6211629 (MGA 94z55H)

Approximate distance to nearest visible turbine 2.6 km

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Figure 25 Photomontage PM 3 Sheet 1

Abercrombie Road

Image Source GBD 2012

Photomontage Location PM 3 Abercrombie Road (south) Existing view, extended panorama south to west north west (Bearing 170° to 290°)

180° S 190° 200° SSW 210° 220° SW 230° 240° 250° WSW 260° 270° W 280° 290°

Image Source GBD 2012

Photomontage Location PM 3 Abercrombie Road (south) Proposed view, extended panorama south to west north west (Bearing 170° to 290°)

PALING YARDS WIND FARM

Refer Figure 20 for Photomontage Location

Individual panorama photos taken with a Nikon D700 digital SLR camera with 50 mm prime lens.

Photo coordinates: Easting 753068 Northing 6215581 (MGA94z55H). Approximate distance to nearest visible turbine 900 m

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PALING YARDS WIND FARM

Image Source GBD 2012

Photomontage Location PM 3 Abercrombie Road (south) - Proposed view

Indicative extent of single frame photo (refer detail below)

Image Source GBD 2012

Photomontage Location PM 3 - Single frame photo detail, proposed view

Figure 26
Photomontage PM 3 Sheet 2

Refer Figure 20 for Photomontage Location

Individual panorama photos taken with a Nikon D700 digital SLR camera with 50 mm prime lens.

Photo coordinates:
Easting 753068
Northing 6215581 (MGA94z55H)

Approximate distance to nearest visible turbine 900 m

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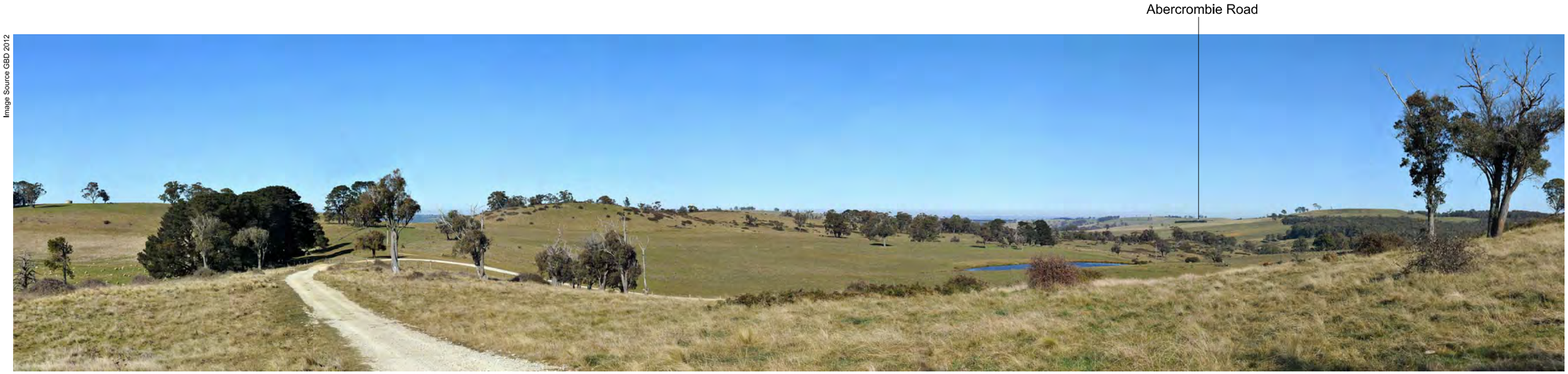
Figure 27 Photomontage PM 4 Sheet 1

Image Source GBD 2012



Photomontage Location PM 4 Hilltop (non associated residential dwelling - driveway) Existing view, extended panorama south south east to west (Bearing 150° to 270°)

Image Source GBD 2012

Photomontage Location PM 4 Hilltop (non associated residential dwelling - driveway) Proposed view, extended panorama south south east to west (Bearing 150° to 270°)

PALING YARDS WIND FARM

Refer Figure 20 for Photomontage Location

Individual panorama photos taken with a Nikon D700 digital SLR camera with 50 mm prime lens.

Photo coordinates: Easting 758731 Northing 6221170 (MGA94z55H) Approximate distance to nearest visible turbine 2.4km

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PALING YARDS WIND FARM

Image Source GBD 2012

Photomontage Location PM 4 Hilltop (non asociated residential dwelling - driveway)
Proposed view

Indicative extent of single frame photo
(refer detail below)

Image Source GBD 2012

Photomontage Location PM 4 - Single frame photo detail, proposed view

Figure 28
Photomontage PM 4 Sheet 2

Refer Figure 20 for Photomontage Location

Individual panorama photos taken with a Nikon D700 digital SLR camera with 50 mm prime lens.

Photo coordinates:
Easting 758731
Northing 6221170 (MGA94z55H)

Approximate distance to nearest visible turbine 2.4km

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Jerrong Road

Image Source GBD 2012

Photomontage Location PM 5 Jerrong Road, Existing view, extended panorama south south east to west (Bearing 150° to 270°)

Image Source GBD 2012

Photomontage Location PM 5 Jerrong Road, Proposed view, extended panorama south south east to west (Bearing 150° to 270°)

PALING YARDS WIND FARM

Refer Figure 20 for Photomontage Location

Individual panorama photos taken with a Nikon D700 digital SLR camera with 50 mm prime lens.

Photo coordinates: Easting 761861 Northing 6219775 (MGA94z55H) Approximate distance to nearest visible turbine 4.6 km

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PALING YARDS WIND FARM

Image Source GBD 2012

Photomontage Location PM 5 Jerrong Road Proposed view

Indicative extent of single frame photo
(refer detail below)

Image Source GBD 2012

Photomontage Location PM 5 - Single frame photo detail, proposed view

Figure 30
Photomontage PM 5 Sheet 2

Refer Figure 20 for Photomontage Location

Individual panorama photos taken with a Nikon D700 digital SLR camera with 50 mm prime lens.

Photo coordinates:
Easting 761861
Northing 6219775 (MGA94z55H)

Approximate distance to nearest visible turbine 4.6 km

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Figure 31 Photomontage PM 6 Sheet 1

Photomontage Location PM 6 Hutton Hill Existing view, extended panorama south south west to north west (Bearing 195° to 320°)

200° SSW 210° 220° SW 230° 240° WSW 250° 260° 270° W 280° 290° WNW 300° 310° NW

Photomontage Location PM 6 Hutton Hill Proposed view, extended panorama south south west to north west (Bearing 195° to 320°)

PALING YARDS WIND FARM

Refer Figure 20 for Photomontage Location

Individual panorama photos taken with a Nikon D700 digital SLR camera with 50 mm prime lens.

Photo coordinates: Easting 755957 Northing 6220228 (MGA94z55H) Approximate distance to nearest visible turbine 800 m

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PALING YARDS WIND FARM

Image Source GBD 2012

Photomontage Location PM 6 Hutton Hill (private land) Proposed view

Indicative extent of single frame photo
(refer detail below)

Image Source GBD 2012

Photomontage Location PM 6 - Single frame view photo, proposed view

Figure 32
Photomontage PM 6 Sheet 2

Refer Figure 20 for Photomontage Location

Individual panorama photos taken with a Nikon D700 digital SLR camera with 50 mm prime lens.

Photo coordinates:
Easting 755957
Northing 6220228 (MGA94z55H)

Approximate distance to nearest visible turbine 800 m

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Shadow flicker & blade glint assessment summary Section 11

11.1 Introduction

Due to their height, wind turbines can cast shadows on surrounding areas at a significant distance from the base of the wind turbine tower. 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.

A shadow flicker and blade glint assessment has been prepared by GH to determine and illustrate the potential impact of shadow flicker and blade glint on surrounding view locations. The detailed shadow flicker and blade glint assessment for the proposed project is included at **Appendix A**.

A shadow flicker assessment may over estimate the actual number of annual hours of shadow flicker at a particular location due to a number of reasons including:

- the probability that the wind turbines will not face into or away from the sun all of the time;
- the occurrence of cloud cover;
- the amount of particulate matter in the atmosphere (moisture, dust, smoke etc…) which may diffuse sunlight;
- the presence of vegetation; and
- periods where the wind turbine may not be in operation due to low winds, or high winds or for operational or maintenance reasons.

11.2 Residents

The results of the shadow flicker assessment for the proposed project determined that 7 residential view locations, each of which are associated residences, may be subject to some levels of shadow flicker. These associated residential view locations are:

- House ID 7;
- House ID 7A;
- House ID 8;

- House ID 8A;
- House ID 9;
- House ID 9A;and
- House ID 9B.

The GH shadow flicker results are detailed in the LVIA **Appendix A**.

11.3 Photosensitive Epilepsy

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

Epileptic seizures caused by photosensitive epilepsy may be triggered by a range of electronic devices including material broadcast by televisions, computer screens or strobing and flashing lights in nightclubs. Seizures may also be triggered by natural light shining off water, through tree leaves or by flickering caused by travelling past railings. Not all flashing or flickering light will trigger a seizure in people with photosensitive epilepsy, and the potential to trigger a seizure may also be dependent on the frequency of flashing or flicker, and the duration and intensity of light.

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

The majority of three bladed wind turbines are unlikely to create a flicker frequency greater than 1Hz (or 1 flicker per second). The flicker frequency for a three blade wind turbine can be calculated by multiplying the hub rotation frequency (in revolutions per second) by the number of blades. As the maximum rotational speed for the Paling Yards wind turbines would be around 20 revolutions per minute (rpm), the hub rotation frequency would be 20rpm divided by 60 seconds resulting in 0.3

revolutions per second. Multiplying 0.3 revolutions per second by three blades equals around 1Hz (or 1 flicker per second).

Given the low flicker frequency associated with the Paling Yards wind turbines, which falls below the range suggested by Epilepsy Action Australia as a potential trigger for photosensitive epileptic seizures, it is unlikely that the proposed Paling Yards wind turbines would present a risk to people with photosensitive epilepsy.

11.4 Motorists

Motorists can experience shadow flicker sensations whilst driving as a result of shadows cast on the road from roadside or overhead objects such as trees, poles or buildings. Under certain conditions the sensation of shadow flicker may cause annoyance and may potentially impact on a driver's ability to operate a motor vehicle safely.

The photograph in **Plate 6** illustrates a typical situation where shadow flicker may be experienced whilst driving along a road where trees cast shadows.

Plate 6 Potential shadow flicker created by trees filtering sunlight across road (Source GBD 2012)

There are no specific guidelines to address the potential impact of shadow flicker on motorists cast by wind turbines across roads, although there are lighting standards that can be applied to minimise the adverse effects of flicker caused by roadside or overhead objects. These standards include *AS 1158:5:2007 (Lighting for roads and public spaces – Part 5: Tunnels and underpasses), section 3.3.8 and CIE 88:2004 (Guide for lighting of roads tunnels and underpasses, 2nd ed.), section 6.14*. The

standards suggest that the flicker effect will be noticeable and possibly cause annoyance between 2.5 and 15Hz (2.5 to 15 flickers per second), and that a flicker effect between 4 and 11Hz should be avoided for longer than 20 seconds.

As the potential flicker frequency for the Paling Yards wind turbines is likely to be around 1Hz, it is unlikely that the flicker effect will cause annoyance or impact on a driver's ability to operate a motor vehicle safely whilst travelling along local roads surrounding the wind farm.

11.5 Blade glint

Glint is a phenomenon that results from the direct reflection of sunlight (also known as specular reflection) from a reflective surface that would be visible when the sun reflects off the surface of the wind turbine at the same angle that a person is viewing the wind turbine surface. Glint may be noticeable for some distance, but usually results in a low impact.

The surfaces of the wind turbines, including the towers and blades, are largely convex, which will tend to result in the divergence of light reflected from the surfaces, rather than convergence toward a particular point. This will reduce the potential for blade glint.

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

Night time lighting

Section 12

12.1 Introduction

The proposed Paling Yards wind turbines may require the installation of obstacle lighting. The requirement for obstacle lighting would be subject to the advice and endorsement of the Civil Aviation Safety Authority (CASA). CASA is currently undertaking a safety study into the risk to aviation posed by wind farms and may develop a new set of guidelines to replace the Advisory Circular with regard to lighting for wind turbines that was withdrawn by CASA in mid 2008.

However, in order to ensure that a full assessment was undertaken, the Proponent commissioned an independent aviation safety expert to conduct an Aeronautical Impact and Night Lighting Assessment, to first determine the risks posed to aviation activities by the project. The aeronautical assessment expert carried out an oobstacle llighting aassessment and recommended a turbine lighting layout which would mitigate risks to aviation. The aeronautical assessment recommended that up to 25 wind turbines be lit at night. The Paling Yards wind turbines have been lit to identify the perimeter of the wind farm at longitudinal intervals not greater than 900 m. The proposed lit turbines are illustrated in **Figure 3**. The aeronautical assessment notes that the lighting design would be subject to a final design and confirmation of the turbine model height.

In accordance with the CASA Advisory Circular two red medium intensity obstacle lights are required on specified turbines at a distance not exceeding 900 m with all lights to flash synchronously. To minimise visual impact some shielding of the obstacle lights below the horizontal plane is permitted.

Lighting for aviation safety may also be required prior to and during the construction period, including lighting for large equipment such as cranes.

Potential visual impacts associated with obstacle marking and lighting at night time have not been extensively researched or tested in New South Wales, although some site investigations have been carried out at existing wind farms in Victoria. Investigations have generally concluded that although night time lighting mounted on wind turbines may be visible for a number of kilometres from the wind farm project area, the actual intensity of the lighting appears no greater than other sources of night time lighting, including vehicle head and tail lights.

A series of night time photographs were taken toward the Cullerin wind farm in order to illustrate the visual effect of turbine mounted lighting. These were taken at distances of 500m, 3.5km and 17km and are illustrated in **Figures 33, 34** and **35**. Each night time view is presented below a corresponding day time photograph taken from the same location. It should be noted that following community consultation, and the preparation of an aviation risk assessment, Origin Energy have removed night time lighting from the Cullerin wind turbines.

12.2 Existing light sources

Existing night time light sources are limited in the vicinity of the project, and mostly associated with rural residential dwellings and vehicles travelling along the Abercrombie Road.

Existing lighting is unlikely to be visually prominent and does not emit any significant illumination beyond immediate areas surrounding residential and agricultural buildings.

Lights from vehicles travelling along the local roads provide dynamic and temporary sources of light.

12.3 Potential light sources

The main potential light sources associated with the project would include night time obstacle lights on wind turbines. The assessed and proposed substations will have low intensity security night lighting and additional lighting that may be required for scheduled or emergency maintenance around the wind turbine areas and substations.

12.4 Potential views and impact

The categories of potential views that may be impacted by night time lighting generally include residents and motorists.

Night time lighting associated with the wind farm is likely to have an impact on a number of the residential view locations surrounding the project.

Irrespective of the total number of visible lights, night time obstacle lights are more likely to be noticeable from a residential curtilage rather than building interiors, where night time room lights tend to reflect and mirror internal views in windows, or curtains and blinds tend to be drawn.

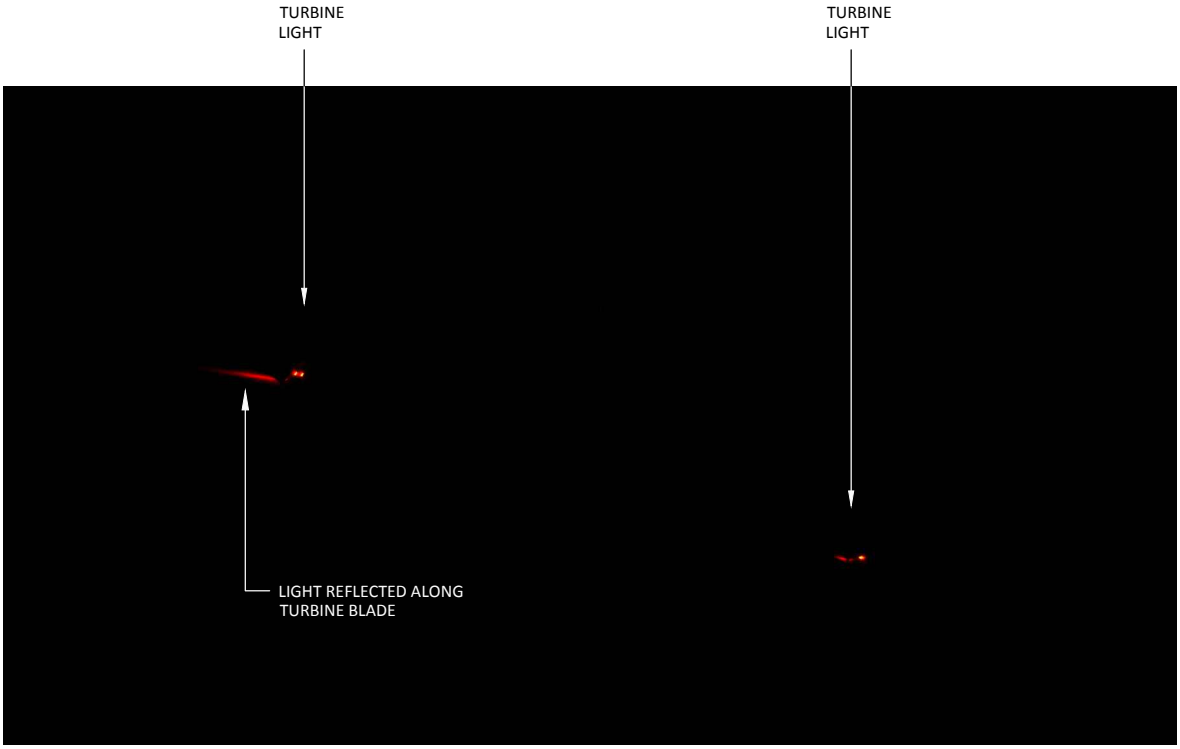
Although visible from distances which would exceed the project 10 km viewshed, the intensity of night time lighting would tend to diminish with distance from the lit turbines, and would be more

likely to be screened by the influence of topography beyond the site as well as vegetation where located around individual residential dwellings.

In the event that night time lighting were to be installed on the project turbines, a relatively small number of residential dwellings within 5 km of the lit turbines would experience some degree of potential visual impact, including the proximate associated residential dwellings. Night time lighting associated with the wind farm is unlikely to have a significant visual impact on the majority of public view locations. Whilst obstacle lighting would be visible to motorists travelling along the Abercrombie Road, the duration of visibility would tend to be very short and partially screened by undulating landform along sections of the road corridor.

Lighting associated with the assessed and proposed substation locations is unlikely to be significantly visible from surrounding residential dwellings and would not create a significant impact on motorists travelling along Abercrombie Road.

DAY TIME VIEW FROM HUME HIGHWAY TOWARD
CULLERIN WIND FARM AT AROUND 500M



NIGHT TIME VIEW FROM HUME HIGHWAY TOWARD
CULLERIN WIND FARM AT AROUND 500M

Figure 33
Night Lighting Cullerin wind farm at 500m

CULLERIN WIND FARM NIGHT TIME LIGHTING .
VIEW WEST FROM HUME HIGHWAY AT AROUND
500M DISTANCE.

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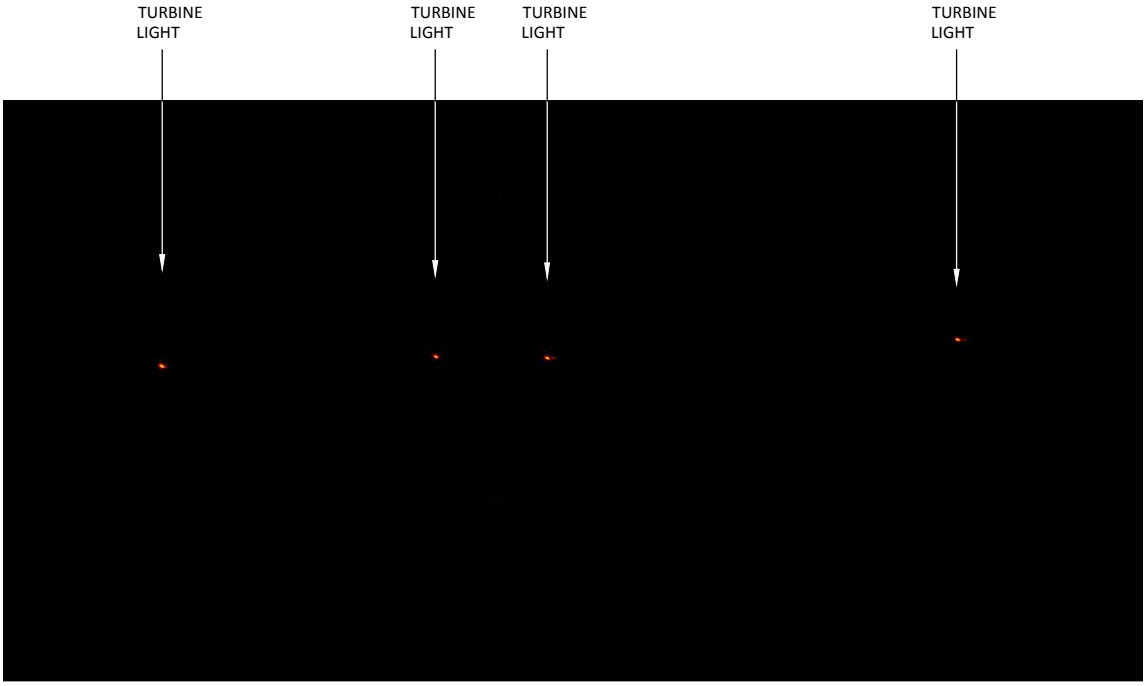
DAY TIME VIEW FROM HUME HIGHWAY TOWARD
CULLERIN WIND FARM AT AROUND 3.5KM



NIGHT TIME VIEW FROM HUME HIGHWAY TOWARD
CULLERIN WIND FARM AT AROUND 3.5KM

CULLERIN WIND FARM NIGHT TIME LIGHTING .
VIEW WEST FROM HUME HIGHWAY AT AROUND
3.5KM DISTANCE.

Figure 34
Night Lighting Cullerin
wind farm at 3.5km

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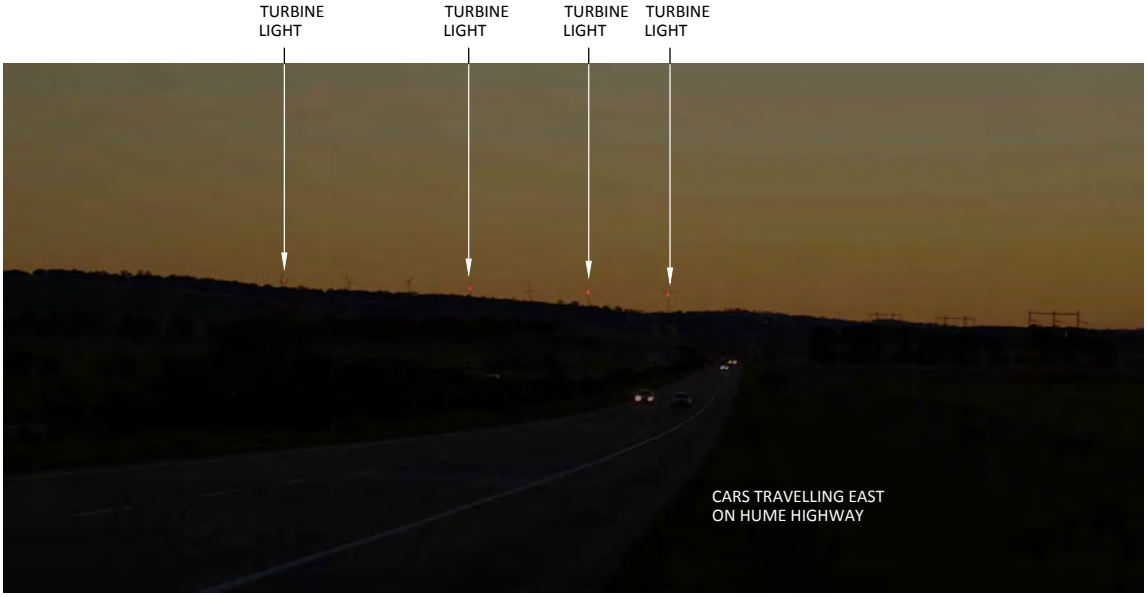
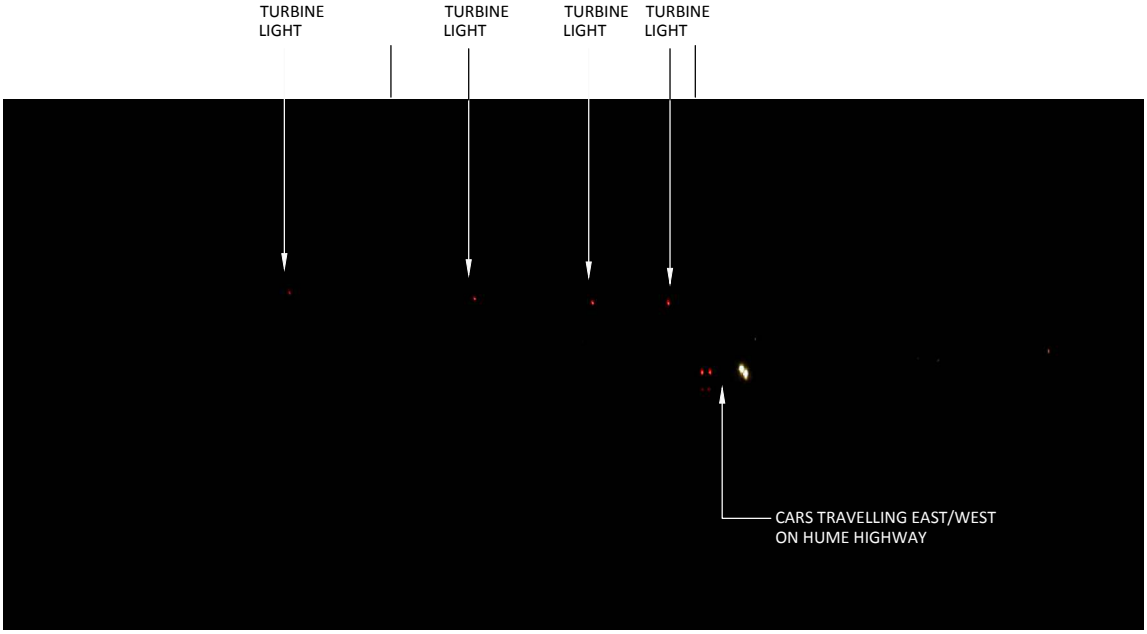


VIEW WEST AT DUSK FROM HUME HIGHWAY TOWARD CULLERIN WIND FARM AT AROUND 17KM



VIEW WEST AFTER DARK FROM HUME HIGHWAY TOWARD CULLERIN WIND FARM AT AROUND 17KM

CULLERIN WIND FARM NIGHT TIME LIGHTING . VIEW WEST FROM HUME HIGHWAY AT AROUND 17KM DISTANCE.

Figure 35
Night Lighting Cullerin wind farm at 17km

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Electrical infrastructure works

Section 13

13.1 Introduction

The project would incorporate a range of electrical infrastructure to collect and distribute electricity generated by the wind turbines to the grid such as:

- a high voltage transmission line;
- collector and switchyard substation;
- generator transformers (these may be located within the wind turbine nacelle or at the base of the tower);
- control cables (potentially located underground); and
- an operation facilities building.

The majority of internal electrical connections between the wind turbines would be via underground cabling within the project site.

The existing 500 kV transmission line and surrounding landscape context in the vicinity of the proposed 500 kV substation sites are illustrated in **Plate 7**.

Plate 7 - Existing view south from Abercrombie Road toward the existing 500 kV transmission (Source GBD 2010)

13.2 Potential transmission line corridors

Four potential transmission line corridors have been assessed as part of this LVIA and include:

- three southern 330 kV overhead transmission line corridors from the project site to the approved Crookwell 2 wind farm; and
- one northern 500 kV transmission line corridor to the existing Mt Piper to Bannaby 500 kV transmission line north east of the site..

The landscape along and surrounding the assessed southern 330 kV transmission line corridors is illustrated in **Figures 36** to **39** and the indicative corridors in **Figures 40** and **41**.

13.3 Assessed 330 kV transmission line corridors

The assessed 330 kV transmission line corridors (which include three options for three different potential central corridors) would extend north from the approved Crookwell 2 substation location along the Woodhouselee Road then turn east along Middle Arm Road, before turning north again along Carrabungla Road and Tyrl Tyrl Road to the Golspie Road intersection (around 30 km in length). From the Golspie Road intersection the assessed 330 kV transmission line corridor would continue to extend north along one of three potential corridors that would include:

- a north west route along Golspie Road then heading north across country to the south west corner of the project site (around 17 km in length):
- a north route across country to the south section of the project site (around 14 km in length); and
- a north east connection along Cockatoo Road and Craig's Road before turning north and following Abercrombie Road (around 24 km in length).

13.4 Assessed and proposed 500 kV transmission line connection

The assessed and proposed 500 kV transmission line option would extend around 9km north east from a collector substation (location B) in the central portion of the project site. The 500 kV transmission line would connect to a switchyard substation (location C or D) adjoining the existing Mount Piper to Bannaby 500 kV transmission line.

The 500 kV transmission line is the preferred corridor as, owing to its much shorter length, it will result in significantly lower impacts and improved constructability. Accordingly, the three 330 kV transmission line options are no longer proposed as part of the project.

Photo Location TL1-
View north west from Woodhouselee Rd

Photo Location TL2-
View north along Woodhouselee Rd

Photo Location TL3-
View south along Woodhouselee Rd

Photo Location TL4-
View north along Woodhouselee Rd

Photo Location TL5-
View west from Middle Arm Rd

Photo Location TL6-
View north along Carrabungla Rd

Figure 36
Assessed 330 kV transmission line corridor
Photo Sheet 1

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Photo Location TL7-
View north along Carrabungla Rd

Photo Location TL8-
View south along Carrabungla Rd

Photo Location TL9-
View north along Tyrl Tyrl Rd

Photo Location TL10-
View north along Tyrl Tyrl Rd

Photo Location TL11-
View south along Tyrl Tyrl Rd

Photo Location TL12-
View south east along Golspie Rd

Figure 37
Assessed 330 kV transmission line corridor
Photo Sheet 2

Photo Location TL13-
View north from unsealed road

Photo Location TL14-
View north from unsealed road

Photo Location TL15-
View north west along Golspie Rd

Photo Location TL16-
View north west along Golspie Rd

Photo Location TL17-
View east along Hillas Street, Taralga

Photo Location TL18-
View north along Taralga Rd

Figure 38
Assessed 330 kV transmission line corridor
Photo Sheet 3

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Photo Location TL19-
View north along Taralga Rd

Photo Location TL20-
View south along Taralga Rd

Photo Location TL21-
View south along Taralga Rd

Photo Location TL22-
View south along Taralga Rd

Photo Location TL23-
View north along Taralga Rd

Photo Location TL24-
View north along Taralga Rd

Figure 39
Assessed 330 kV transmission line corridor
Photo Sheet 4

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The preferred 500 kV transmission line would extend from a proposed substation within the Paling Yards site boundary to a proposed substation location at the existing Mt Piper to Bannaby 500 kV transmission line located around 6 km north east of the project site.

13.5 Transmission line structure

Electricity generated by the project would be connected to the grid via an overhead 500 kV transmission line. The key visual components of the proposed 500 kV transmission line would comprise:

- single tapered concrete poles 60 m high;
- aluminium alloy 500 kV conductors; and
- an aerial earth wire and communications link.

The design of supporting and tension structures is variable for 500 kV transmission lines and is largely dependent on technical engineering requirements as well as site specific conditions. 500 kV transmission conductors may be supported by single pole, however additional steel work may be required for structural integrity. This will be confirmed at the detailed design stage.

13.6 Substations

The assessed 300 kV substation (location A) and the assessed and proposed 500 kV collector and switchyard substation locations (location B and C or D) are illustrated in **Figure 3.** These locations are subject to the selection of the final connection option as well as a detail engineering design. The assessed 330 kV collector substation (location A) would be situated within the south portion of the project site boundary. The collector substation connection to the assessed and proposed 500 kV transmission line (location B) would be situated within the central portion of the wind farm site. The assessed and proposed 500 kV switchyard substation (location C or D) would be situated adjacent to the existing 500 kV transmission line to the north east of the project site either side of the Abercrombie Road corridor.

Plate 8 – Typical wind farm collector substation (Source Epuron 2009)

The layout of the proposed substation will be developed at the detailed design stage. However, the main visual components of a typical wind farm switchyard substation would likely comprise:

- a single storey control building;
- an access road (or road utilising wind turbine maintenance access track);
- various switch bays and transformers;
- a communications pole;
- lightning masts;
- water tank;
- lighting for security and maintenance; and
- security fencing including a palisade fence and internal chainmesh fence.

Plate 9- Typical 330 kV switchyard substation arrangement- Macarthur substation (Source GBD 2009)

Each of the alternative substation locations (A or B and C or D) would not be significantly visible from surrounding view locations, including residences and the Abercrombie Road, due to surrounding tree cover and undulating landform. In particular this LVIA notes that:

- the assessed 330 kV collector substation (location A) would be located away (and not readily visible) from residential dwellings within and beyond the project site;
- the assessed 330 kV collector substation (location A) would be largely screened by existing trees and not significantly visible to motorists travelling along the Abercrombie Road;
- the assessed and proposed 500 kV collector substation (location B) would be located to the east of the Abercrombie Road corridor within the central portion of the project site and subject to some partial filtering of views by existing roadside tree planting;
- the assessed and proposed 500 kV switchyard substation (locations C or D) would be located adjacent to the existing Mount Piper to Bannaby 500 kV transmission line, either to the north or south of Abercrombie Road and would not be visible from surrounding residential dwellings. The substation locations, and more likely location D, would be visible to motorists travelling along the Abercrombie Road; however, views would tend to be indirect and very short in duration.

13.7 Visual absorption capability – (transmission line infrastructure)

Visual Absorption Capability (VAC) is a classification system used to describe the relative ability of the landscape to accept modifications and alterations without the loss of landscape character or deterioration of visual amenity. The application of a VAC classification system is not particularly useful for large scale structures such as wind turbines and has not been applied to the assessment of the landscapes ability to accept the wind turbines; however, it can be applied to smaller ancillary structures, such as transmission line infrastructure, where scale and form is more readily absorbed by elements (topography and vegetation) within the surrounding landscape. VAC relates to physical characteristics of the landscape that are often inherent and often quite static in the long term.

Undulating areas with a combination of open views interrupted by groups of trees and small forested areas would have a higher capability to visually absorb the proposed substation and transmission lines without significantly changing its amenity.

On the other hand, areas of cleared vegetation on level ground with limited screening, or areas spanning across prominent ridgelines without significant vegetation, would have a lower capability to visually absorb the proposed substation and transmission lines without changing the visual character and potentially reducing visual amenity.

Given the extent and combination of existing natural and cultural character within the wind farm site, the capability of the landscape to absorb the key components of the electrical infrastructure would be primarily dependent upon vegetation cover and landform.

For the purpose of this LVIA, the VAC ratings have been determined as:

Low – electrical infrastructure components would be highly visible either due to lack of screening by existing vegetation or surrounding landform (e.g. open flat farmland cleared of vegetation, or steep hillside crossing ridgeline).

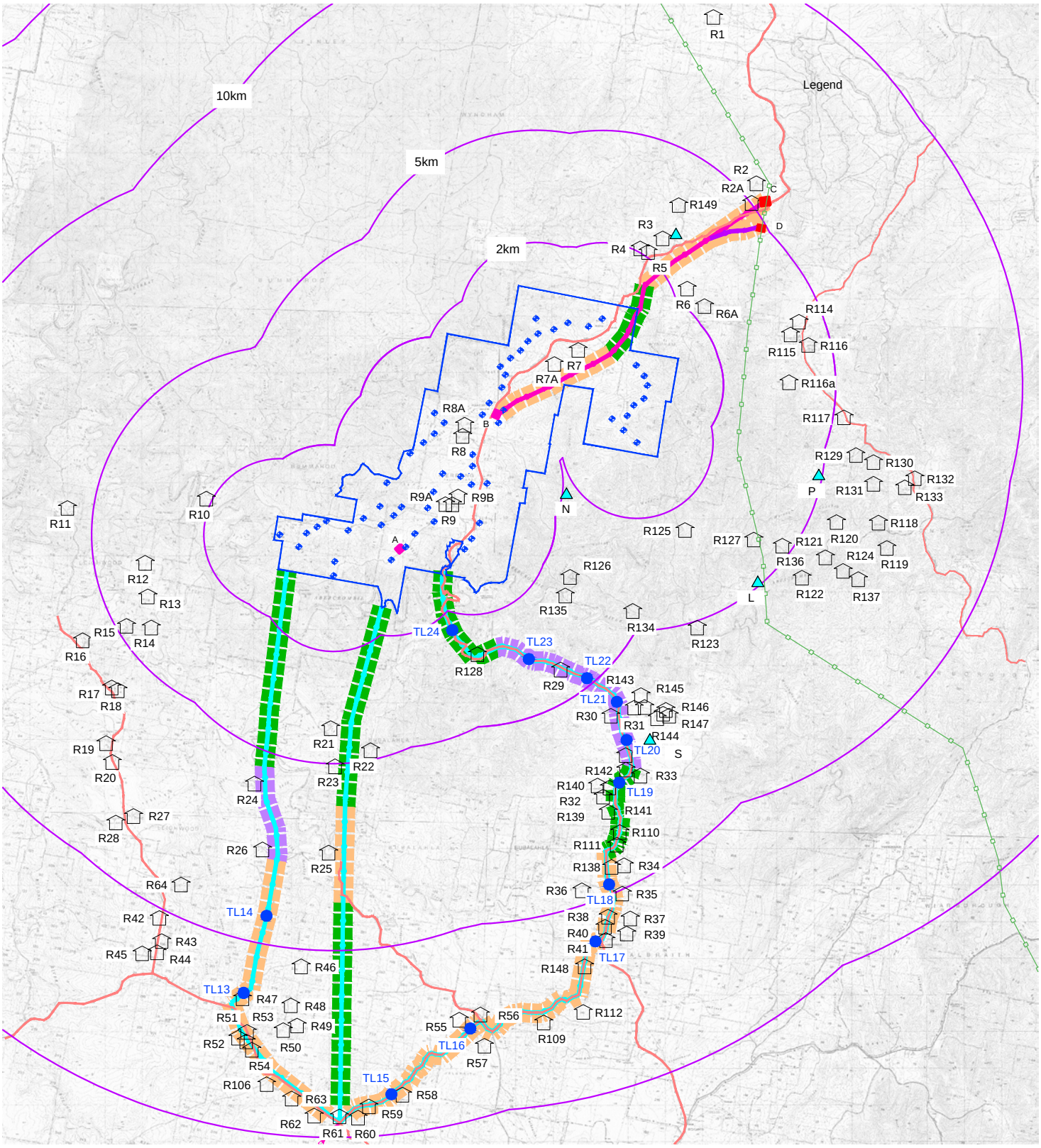
Medium – electrical infrastructure components would be visible but existing vegetation and surrounding landform would provide some screening or background to reduce visual contrast.

High – electrical infrastructure components would be extensively screened by surrounding vegetation and undulating landform.

The VAC of the landscape along and surrounding the assessed 330 kV and the assessed and proposed 500 kV transmission line corridors is illustrated in **Figures 40** and **41**.

The landscape along the majority of the assessed transmission line routes, including the potential substation sites and 330 kV and 500 kV transmission line connections to the grid, would be considered to have a relatively moderate VAC, with some ability to accept modifications and alterations without the loss of landscape character or deterioration of existing levels of visual amenity.

The overall moderate level of VAC would largely result from the location of the proposed transmission line routes relative to densely timbered hill sides, more gently undulating landforms and scattered tree cover, including tree planting alongside road corridors.



Legend

Residential dwelling

Non-residential structure

Local road

Existing 500kV transmission line

Assessed 330 kV transmission line corridor photo location TL13

Proposed on site substation location Options A & B

Proposed off site substation location Options C & D

Paling Yards proposed wind turbine indicative layout

Paling Yards wind farm site boundary

Distance from proposed wind turbine location

Assessed 330 kV transmission line corridors

Assessed and proposed 500 kV transmission line corridor

Visual Absorption Capability (VAC)

High

Medium

Low

0km 2km

Figure 40
Assessed 330 kV transmission line VAC north and central corridors

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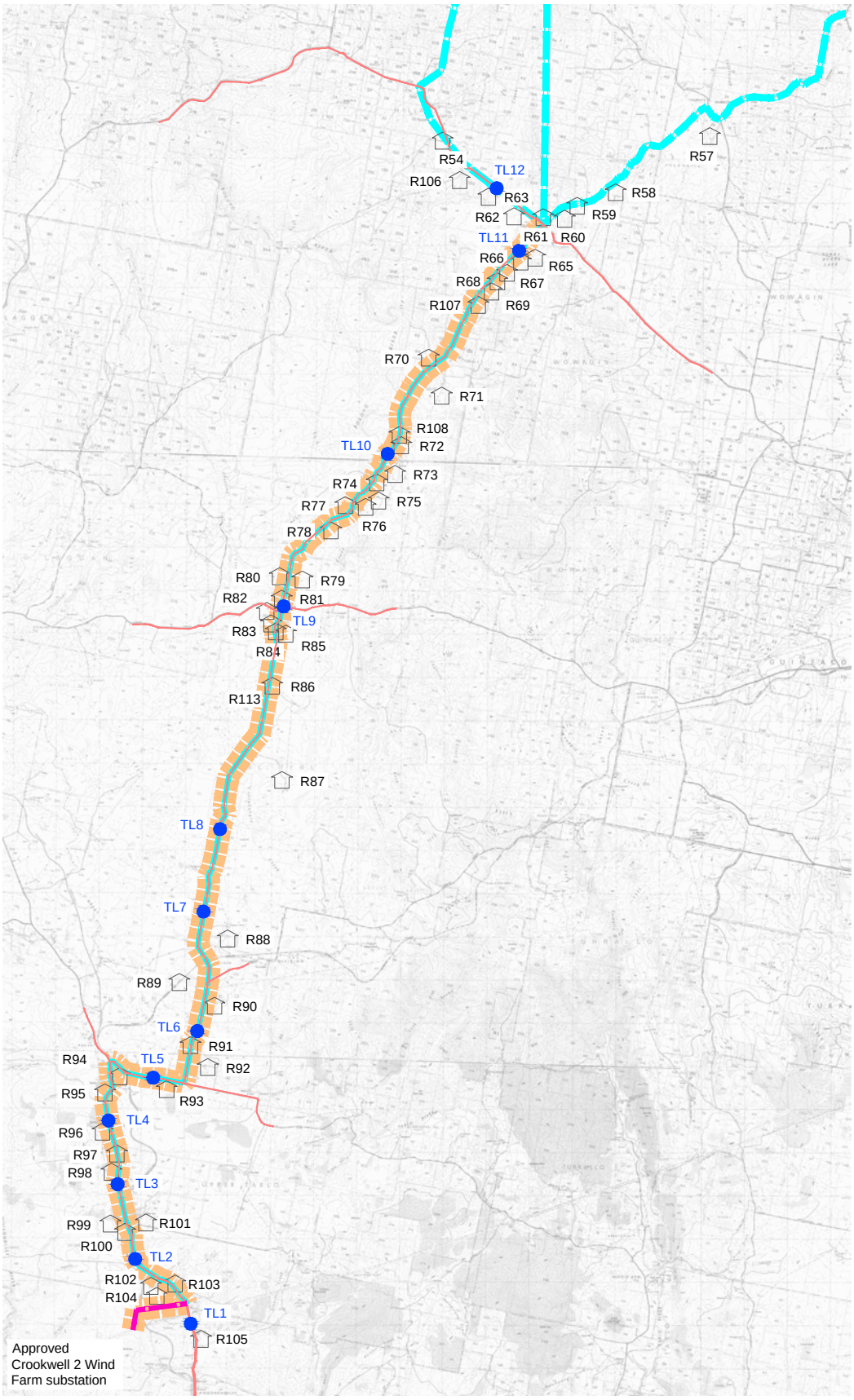

Legend

Residential dwelling

Local road

Assessed 330 kV indicative transmission corridors

Assessed 330 kV transmission line corridor photo location TL6

Visual Absorption Capability (VAC)

High

Medium

Low

0km 2km

Figure 41
Assessed 330 kV transmission line VAC south

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The moderate VAC would also tend to reduce the potential for cumulative impacts to occur where views toward the existing transmission line included views toward proposed electrical infrastructure elements.

13.8 Potential visual impact (transmission line infrastructure)

The potential visibility and resultant visual impact of the proposed transmission line would primarily result from the combination of two factors:

- The extent to which the transmission line would be visible from surrounding areas; and
- The degree of visual contrast between the transmission line and the surrounding landscape that would be visible from surrounding view locations.

The overall visual impact is generally determined by a combination of factors including:

- The category and type of situation from which people may view the components of the transmission line (e.g. resident or motorist);
- The potential number of people with a view toward components of the transmission line from any one view location;
- The distance between a person and components of the transmission line; and
- The duration of time that a person may view components of the transmission line.

13.9 Assessed 330 kV transmission line options potential visual impact

The three assessed 330 kV transmission line corridors would be visible from multiple residential dwellings along the south (Woodhouselee to Golspie Road) and central route options (Golspie Road to the project site), as well as from a number of road corridors adjoining the proposed transmission line routes. The assessed 330 kV transmission line corridors would be visible to a number of people residing in dwellings along the transmission line corridors, although a final design alignment would be required to determine actual numbers of viewers and their distance toward the transmission line. The duration of visibility would vary for residents and motorists, although the length of the assessed 330 kV transmission line would result in longer view periods when compared to the assessed and proposed 500 kV transmission line option.

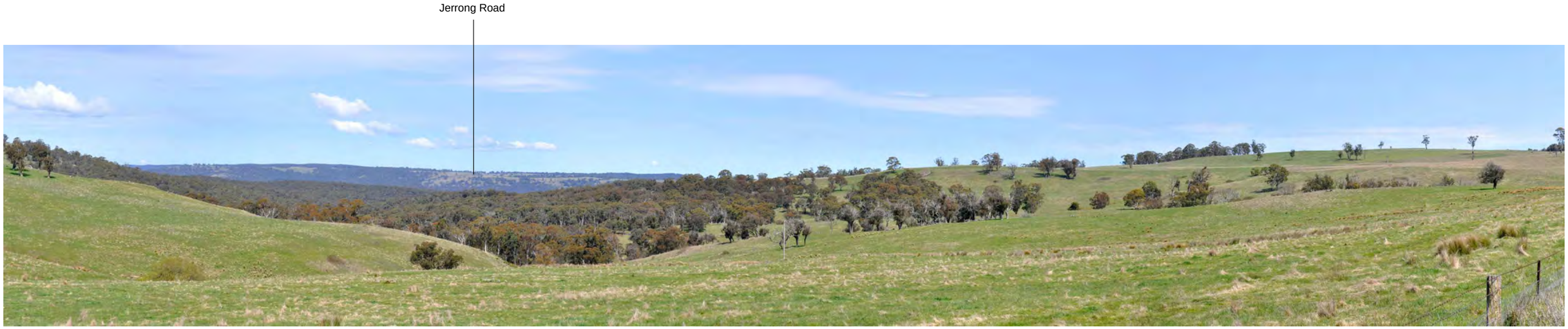
13.10 Assessed and proposed 500 kV transmission line potential visual impact

The assessed and proposed 500 kV transmission line would not be significantly visible from any surrounding associated or non associated residential dwellings within or beyond the project site due to a combination of topography and scattered tree cover. Whilst some sections of the transmission line would be visible to motorists travelling along the Abercrombie Road, there would be some potential for partial screening provided by roadside and scattered tree cover. Overall the assessed and proposed 500 kV transmission line corridors would result in a lesser degree of visual impact than the assessed 300 kV transmission line corridors due to:

- a shorter distance of constructed and visible transmission line;
- a significantly lower number of surrounding residential dwellings located within the vicinity of the transmission line; and
- a reduced requirement for vegetation clearing to establish a transmission line easement.

The assessed and proposed 500 kV transmission line corridor has been identified as the preferred option for this reason and the three alternative assessed 330 kV transmission line corridors are no longer proposed as part of the project.

Photomontages representing a view toward the assessed and proposal 500 kV transmission line are presented in **Figures 42** and **43**.



Photomontage Location PM 7 Abercrombie Road - Existing panorama view south east to south, south of Mingary Park (associated residential dwelling)

Photomontage Location PM 7 Abercombie Road - Proposed panorama view, south of Mingary Park (associated residential dwelling)

Figure 42
Photomontage PM 7

Typical view toward proposed 500 kV transmission line from Abercrombie Road

Refer Figure 19 for photomontage PM7 location. Wind turbines not shown.

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Photomontage Location PM 8 Hilltop (non associated residential dwelling - driveway) Existing view, extended panorama south south east to west.

Photomontage Location PM 8 Hilltop (non associated residential dwelling - driveway) Proposed view, extended panorama south south east to west.

Figure 43
Photomontage Location PM 8

Typical view toward proposed wind turbines and assessed and proposed 500 kV transmission line from Hilltop non associated residential dwelling driveway.

Refer Figure 19 for photomontage PM 8 location.

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Pre-construction and construction

Section 14

14.1 Potential visual impacts

There are potential visual impacts that could occur during both pre-construction and construction phases of the project. The wind farm construction phase is likely to occur over a period of around 18 months, although the extent and nature of pre-construction and construction activities would vary at different locations within the project area.

Plate 10 and **11 -** Illustrating typical general construction activities during turbine construction

Plate 12 - Illustrating general construction activities at the Capital wind farm site, including views toward cranes, partial construction of towers and laydown areas.

The key pre-construction and construction activities that would be visible from areas surrounding the proposed wind farm include:

- ongoing detailed site assessment including sub surface geotechnical investigations;
- various civil works to upgrade local roads and access point;
- construction facilities, including portable structures and laydown areas;
- various construction and directional signage;
- mobilisation of rock crushing and concrete batching plant (if required);
- excavation and earthworks; and
- various construction activities including erection of wind turbines, monitoring masts and substation with associated electrical infrastructure works.

The majority of pre-construction and construction activities, some of which would result in physical changes to the landscape (which have been assessed in this LVIA report), are generally temporary in nature and for the most restricted to various discrete areas within or beyond the immediate wind farm project area. The majority of pre-construction and construction activities would be unlikely to result in an unacceptable level of visual impact for their duration and temporary nature.

Perception and public consultation Section 15

15.1 Perception

People's perception of wind farms is an important issue to consider as the attitude or opinion of individual people adds significant weight to the level of potential visual impact.

The opinions and perception of individuals from the local community and broader area were sought and provided through a range of consultation activities. These included:

- door knocking within the Paling Yards wind farm 3 to 5 km viewshed;
- door knocking along the Paling Yards transmission line route options;
- leaflet drops and local media presentations;
- dedicated project web site including feedback provisions; and
- individual stakeholder meetings.

The attitudes or opinions of individuals toward wind farms can be shaped or formed through a multitude of complex social and cultural values. Whilst some people may accept and support wind farms in response to global or local environmental issues, others may find the concept of wind farms completely unacceptable. Some may support the environmental ideals of wind farm development as part of a broader renewable energy strategy but do not consider them appropriate for their regional or local area. It is unlikely that wind farm projects will ever conform or be acceptable to all points of view; however, research within Australia as well as overseas consistently suggests that the majority of people who have been canvassed do support the development of wind farms.

Wind farms are generally easy to recognise in the landscape and to take advantage of available wind resources are more often located in elevated and exposed locations. The geometrical form of a wind turbine is a relatively simple one and can be visible for some distance beyond a wind farm, and the level of visibility may be accentuated by the repetitive or repeating pattern of multiple wind turbines within a local area. Wind farms do have a significant potential to alter the physical appearance of the landscape, as well as change existing landscape values.

15.2 Public consultation

A door knock exercise was carried out by the proponent for all residential dwellings within a 3 to 5 km radius of the project. A public consultation 'Information Day' will be held once the EA is placed on public exhibition.

15.3 Quantitative research

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

A recent survey was conducted by ARM Interactive on behalf of the NSW Department of Environment, Climate Change and Water (September 2010). The survey polled 2,022 residents across the 6 Renewable Energy Precincts established by the NSW Government; including the NSW/ACT Border Region Renewable Energy Precinct. Key findings of the survey indicated that:

- *97% of people across the Precincts had heard about wind farms or turbines, and 81% had seen a wind farm or turbine (in person or the media);*
- *85% of people supported the construction of wind farms in New South Wales, and 80% within their local region; and*
- *79% supported wind farms being built within 10km of residences and 60% of people surveyed supported the construction of wind turbines within 1 to 2km from their residences.*

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

These general levels of support for wind farm developments have also been recorded for a number of wind farm developments around Australia as well as overseas.

Auspoll research carried out in February 2002 on behalf of a wind farm developer for a wind farm project in Victoria included just over 200 respondents. The results indicated that:

- *Over 92% of respondents agreed that wind farms can make a difference in reducing greenhouse emissions and mitigating the effects of global warming;*
- *Over 88% disagreed with the statement that wind farms are ugly;*
- *Over 93% of respondents identified 'interesting' as a good way to describe wind farms, over 73% nominating 'graceful' and over 55% selecting 'attractive';*
- *Over 79% of respondents thought that the wind farm would have a good impact on tourism, with 15% of respondents believing that the wind farm would make no difference; and*
- *Over 40% of respondents believed that the impact of the wind farm on the visual amenity of the area would be good, with 40% believing that it would make no difference.*

A September 2002 MORI poll of 307 tourists conducted in Argyll (United Kingdom) indicated that:

- *43% maintained that the presence of wind farms had a positive impression of Argyll as a place to visit;*
- *43% maintained that the presence of wind farms had an equally positive or negative effect;*
- *Less than 8% maintained it had a negative effect; and*
- *91% of tourists maintained that the presence of wind farms in Argyll made no difference to the likelihood of them visiting the area.*

There is no published Australian research on community attitudes to the impact of wind farms on landscape and visual issues before and after construction. However, overseas research in the United Kingdom conducted by MORI in 2003 indicated that:

- *Prior to construction 27% of people polled thought problems may arise from wind farm impact on the landscape; and*

- *Following construction the number of people who thought the landscape has been spoiled was 12%.*

The majority of research carried out to date has focussed on public attitudes to wind farms and does not provide any indication for acceptable or agreed thresholds in relation to numbers and heights of turbines, and the potential impact of distance between turbines and view locations.

15.4 The broader public good

Whilst visual perceptions and attitudes of local communities toward wind farm developments are an important issue, and need to be assessed locally in terms of potential landscape and visual impacts, there is also an issue of the greater potential public benefit provided by renewable energy production. Wind farms are expected to make a contribution toward meeting the Government's commitment that 20% of Australia's electricity supply comes from renewable energy sources by 2020.

In the 2006 Land and Environment Court decision to grant, on an amended basis, consent for the construction of a wind farm at Taralga, Chief Judge Justice Preston said in his prologue to the judgement:

"The insertion of wind turbines into a non-industrial landscape is perceived by many as a radical change which confronts their present reality. However, those perceptions come in different hues. To residents, such as members of the Taralga Landscape Guardians Inc. (the Guardians), the change is stark and negative. It would represent a blight and the confrontation is with their enjoyment of their rural setting.

To others; however, the change is positive. It would represent an opportunity to shift from societal dependence on high emission fossil fuels to renewable energy sources. For them, the confrontation is beneficial – being one much needed step in the policy settings confronting carbon emission and global warming.

Resolving this conundrum – the conflict between the geographically narrower concerns of the guardians and the broader public good of increasing the supply of renewable energy – has not been easy. However, I have concluded that, on balance, the broader public good must prevail".

Whilst the exact circumstances between the Taralga wind farm and the Paling Yards wind farm may differ, the comments provided by the Chief Judge make it clear that, in the circumstances of that case, there was a need for the broader public good to be put before the potential negative impacts on some members of the local community. Similar reasoning can be applied to the project.

Mitigation measures

Section 16

16.1 Mitigation measures

The British Landscape Institute states *'the purpose of mitigation is to avoid, reduce, or where possible remedy or offset any significant negative (adverse) effects on the environment arising from the proposed development' (2002).* In general mitigation measures would reduce the potential visual impact of the project in one of two ways:

- firstly, by reducing the visual prominence of the wind turbines and associated structures by minimising the visual contrast between the wind turbines and the landscape in which they are viewed; and
- secondly, by screening views toward the wind turbines from specific view locations.

In relation to the first form of mitigation, the design of the turbine structures has been highly refined over a number of years to maximise their efficiency. The height of the supporting towers and dimensions of the rotors are defined by engineering efficiency and design criteria. Consequently, modification of the turbine design to mitigate potential visual impacts is not considered a realistic option.

Colour is one aspect of the wind turbine design that does provide an opportunity to reduce visual contrast between the turbine structures and the background against which they are viewed. The white colour that is used on a majority of turbine structures provides the maximum level of visual contrast with the background. This maximum level of visual contrast could be reduced through the use of an appropriate off white or grey colour for the turbines where the visual contrast would be reduced when portions of the turbine were viewed against the sky as well as for those portions viewed against a background of landscape. The final colour selection would, however, be subject to the availability of turbine models on the market at the time of ordering and to aviation safety requirements.

The potential visual impact of the project from specific view locations could be mitigated by planting vegetation close to the view locations. For instance, tree or large shrub planting close to a residence

can screen potential views to individual or clusters of turbines. Similarly roadside tree planting can screen potential views of turbines from portions of road corridors.

The location and design of screen planting used as a mitigation measure is very site specific and requires detailed analysis of potential views and consultation with surrounding landowners. Planting vegetation would not provide effective mitigation in all circumstances and can reduce the extent of existing views available from residences or other view locations.

There is greater potential to mitigate the visual prominence for some of the ancillary structures and built elements associated with the wind farm through the appropriate selection of materials and colours, together with consideration of their reflective properties.

The potential visual impacts of vehicular tracks providing access for construction and maintenance can be mitigated by:

- minimising the extent of cut and fill in the track construction;
- re-vegetating disturbed soil areas immediately after completion of construction works; and
- using local materials as much as possible in track construction to minimise colour contrast.

16.2 Summary of mitigation measures

A summary of the mitigation measures available for the wind farm and transmission line infrastructure is presented in **Tables 21** and **22**.

Table 21 - Mitigation measures summary

Safeguard	Implementation			
	Design	Site Preparation	Construction	Operation
Consider options for use of colour to reduce visual contrast between project structures and visible background.	✓			
Avoid use of advertising, signs or logos mounted on turbine structures, except those required for safety purposes.			✓	✓

Table 21 - Mitigation measures summary

Safeguard	Implementation			
	Design	Site Preparation	Construction	Operation
If necessary, design and construct site control building and facilities building sympathetically with nature of locality.	✓		✓	
If necessary, locate substations away from direct views from roads and residential dwellings.	✓		✓	
Enforce safeguards to control and minimise fugitive dust emissions.		✓	✓	✓
Restrict the height of stockpiles to minimise visibility from outside the site.		✓	✓	
Minimise construction and operational activities that may require night time lighting, and if necessary use low lux (intensity) lighting designed to be mounted with the light projecting inwards to the site to minimise glare at night.		✓	✓	✓
Minimise cut and fill for site tracks and revegetate disturbed soils as soon as possible after construction.		✓	✓	
Maximise revegetation of disturbed areas to ensure effective cover is achieved.			✓	
Consider options for planting screening vegetation in vicinity of nearby residences and along roadsides to screen potential views of turbines. Such works to be considered in consultation with local residents and authorities.	✓	✓	✓	
Undertake revegetation and off-set planting at areas around the site in consultation and agreement with landholders.	✓	✓	✓	

Table 22 – Substation and transmission line summary of mitigation measures

Safeguard	Implementation			
	Design	Site Preparation	Construction	Operation
A careful and considered route selection process to avoid sensitive view locations and loss of existing vegetation where possible.	✓		✓	
Wherever possible, select angle positions in strategic locations to minimise potential visual impact (e.g. avoiding, where possible, skyline views) and to provide a maximum setback from residential dwellings and road corridors.	✓		✓	
Selection of suitable component materials with low reflective properties.	✓		✓	
Selection of suitable storage areas for materials or plant with minimum visibility from residences and roads with screening where necessary.			✓	
Design for strategic tree or shrub planting between view locations and the transmission line.	✓		✓	

Subject to any conditions of approval, the proponent would commit to implementing landscape treatments to screen and mitigate the potential visual impact of the wind farm for individual neighbouring properties within an appropriate distance from the wind farm project area, subject to consultation and agreement with individual property owners.

Conclusion Section 17

17.1 Summary

In summary, this LVIA concludes that the project would have an overall low significance of visual impact on the majority of non-associated residential view locations as well public view locations, including sections of the Abercrombie and Jerrong Roads. The project would have a medium to high impact on six associated residential view locations within the project site boundary.

This LVIA determined the overall landscape character sensitivity to be medium to high. Some recognisable characteristics of the LCA's will be altered by the proposed project, and result in the introduction of visually prominent elements that will alter the perceived characteristics of the LCA's but will be partially mitigated by existing landscape elements and features within the LCA's. The main characteristics of the LCA's, patterns and combinations of landform and landcover will still be visually evident from within and beyond the project site boundary.

The LCA's identified and described in this LVIA are generally well represented throughout the Oberon Shire Council and surrounding Local Government Areas and more generally within other regions across the NSW/ACT Border Region Renewable Energy Precinct. This LVIA has determined that the landscape surrounding the project will have some ability to accommodate the physical changes associated with the wind farm and its associated structures.

This LVIA determined that the project would have a medium to high visual impact on 6 associated residences out of the 78 residential view locations within the project 10 km viewshed. This medium to high visual impact would largely result from the proximity of wind turbines to the associated residential dwellings or orientation of dwellings relative to the wind turbines.

The majority of residential dwellings surrounding the wind farm are strategically situated within the landscape to mitigate exposure to inclement weather, or have adopted measures to reduce these impacts by planting and maintaining windbreaks around residential dwellings. The extent of windbreak planting reduces the potential visibility of the wind farm from a number of residential view locations in the surrounding landscape.

The project would be visible from a small number of local roads including the Abercrombie Road. This LVIA has determined that views toward the Paling Yards wind turbines would generally result in a low impact for the majority of motorists travelling through the area.

This LVIA has determined that the construction of the project would not result in significant 'direct', 'indirect' or 'sequential' cumulative impacts when considered against any existing or proposed wind farm developments, including the approved Taralga and Crookwell 2 and proposed Golspie wind farm projects. Intervisibility between approved and proposed wind farms is influenced by undulating landform and tree cover within and beyond the Paling Yards 10 km viewshed.

The potential substation locations and assessed transmission line options are unlikely to result in a significant visual impact for the majority of surrounding residential or public view locations. A combination of distance, undulating landform and tree cover between substation and transmission line components to surrounding view locations would tend to result in a moderate to high visual absorption capability and reduction in overall visibility.

This LVIA has determined that the assessed and proposed 500 kV transmission line connection option would have a lesser degree of visual impact than the assessed 330 kV transmission line connection options to the approved Crookwell 2 wind farm substation. The 500 kV transmission line corridor has been identified as preferred option and the assessed 330 kV transmission line corridors are no longer proposed for this reason.

Both pre-construction and construction activities are unlikely to result in an unacceptable level of visual impact due to the temporary nature of these activities together with proposed restoration and rehabilitation strategies. The preferred location for some of the construction activities, including the on-site concrete batch plant and rock crusher, would generally be located away from publicly accessible areas, with the closest residential view locations generally comprising associated landowners.

Night time obstacle lighting would have the potential to be visible from surrounding view locations, as well as areas beyond the project 10 km viewshed. The level of visual impact would diminish when viewed from more distant view locations, with a greater probability of night time lighting being

screened by landform and/or tree cover. It should also be noted that the night time lighting installed on the Cullerin wind farm (as illustrated in this LVIA) has been decommissioned by Origin Energy following a risk based aviation assessment. A number of recent wind farm developments in New South Wales have also been approved without a requirement for night time lighting, including the Gullen Range and Glen Innes wind farms. A number of other operational wind farm developments, including some in Victoria, have also had night lighting decommissioned.

Although some mitigation measures are considered appropriate to minimise the visual effects for a number of the elements associated with the wind farm, it is acknowledged that the degree to which the wind turbines would be visually mitigated is limited by their scale and position within the landscape relative to surrounding view locations.

The Proponent has engaged in ongoing consultation with local residents and made a number of adjustments to the location of individual turbines to minimise visual impacts where possible.

Subject to any conditions of approval, the proponent would commit to implementing landscape treatments to screen and mitigate the potential visual impact of the wind farm for individual neighbouring properties within an appropriate distance from the wind farm project area, subject to consultation and agreement with individual property owners.

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Limitations

GBD has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of Union Fenosa Wind Australia Pty Ltd and only those third parties who have been authorised in writing by GBD to rely on the report. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report. It is prepared in accordance with the scope of work and for the purpose outlined in the GBD Proposal dated 9th March 2011.

The methodology adopted and sources of information used are outlined in this report. GBD has made no independent verification of this information beyond the agreed scope of works and GBD assumes no responsibility for any inaccuracies or omissions. No indications were found during our investigations that information contained in this report as provided to GBD was false.

This report was prepared between March 2011 and May 2013 and is based on the conditions encountered and information reviewed at the time of preparation. GBD disclaims responsibility for any changes that may have occurred after this time.

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