UNION FENOSA WIND AUSTRALIA

Crookwell 3 Wind Farm

Chapter 3

THE SITE AND CONTEXT

3 The Site and Context

3.1 Site Locality

The site is located in the NSW region known as the Southern Tablelands, approximately;

- 17km south-east of Crookwell township;
- 25km north-west of Goulburn;
- 90km north – east of Canberra.

Following a recent amalgamation of Local Government boundaries, the site now falls entirely within the Upper Lachlan Shire Council Local Government Area.

Land use in the locality is predominantly rural with agricultural industries including wool, lambs, beef cattle and seed potatoes. Smaller plot vineyards and other boutique rural uses, such as flower farms, have been established more recently in the region.

Please refer to **Figure 3 – Location Plan** and **Figure 4 – Regional Plan**.

The surrounding area is undulating with some steeper slopes around incised valleys. The site is located on a system of ridges and low hills that are separated by the Wollondilly River and Goulburn – Crookwell Road corridor.

At approximately 2,500 people, the Crookwell Township is the closest significant population centre to the site. Goulburn, 25km south east of the site, is a small city of approximately 22,000 people and is known for its contribution to the Australian wool and agricultural industry.

3.2 Site Details

The site covers an area of approximately 1,500 ha. It includes two separate development parcels to the east and south of the existing Crookwell 1 and approved Crookwell 2 Wind Farms.

These parcels are referred to separately as 'Crookwell 3 East' and 'Crookwell 3 South' and collectively as the site. Please refer to **Figure 5 – Site Analysis** and the accompanying site photos at **Figure 6 – Site Photos**. Crookwell 3 South comprises 400 ha of rural land with access from Crookwell Road. Crookwell 3 East comprises 1,100 ha of rural land and is accessed from Woodhouselee Road. The site consists of approximately 15 individual titles amongst three separate landowners.

Crookwell 3 East is bounded by Bolton's Lane to the north, Woodhouselee Road to the west and the Upper Lachlan Shire / Goulburn-Mulwaree Council border to the south east. Crookwell 3 South is bounded by Crookwell Road to the east and private property to the north, south and west.

The MGA coordinates for the outer boundary of Crookwell 3 East are;

- NW: N: 739788 E: 6175530
- NE: N: 746017 E: 6174059
- SW: N: 742458 E: 6171657
- SE: N: 743881 E: 6171394

The MGA coordinates for the outer boundary of Crookwell 3 South are;

- NW: N: 733759 E: 6171784
- NE: N: 736887 E: 6171217
- SW: N: 733817 E: 6170109
- SE: N: 735537 E: 6169858

CROOKWELL

ROSLYN

WOODHOUSELEE ROAD

CROOKWELL ROAD

330Kv Transmission Line

Crookwell 1 Operating Wind Farm (8 Turbines)

Approved Crookwell 2 Wind Farm (46 Turbines)

MIDDLE ARM ROAD

GULLEN

CROOKWELL 3 EAST

UPPER LACHLAN SHIRE

GOULBURN MULWAREE SHIRE

CROOKWELL 3 SOUTH

BANNISTER

GUNNING ROAD

UPPER LACHLAN SHIRE

WAYO

GOULBURN MULWAREE SHIRE

MIDDLE ARM

RANGE ROAD

GURRUNDAH ROAD

66Kv Transmission Line

POMEROY

HUME HWY

GOULBURN

Scale 1:150000 @ A3

0 1500 3000 7500m

FIGURE 3 - LOCATION PLAN

CROOKWELL 3 WIND FARM

PROJ./DRG.NO. 309447-PD P 02 REV. 02 DRAWN MH APP'D. AT DATE 03-03-2011

Tract

Crookwell Approx. 6 km

Oberon Approx. 126 km

WOODHOUSELEE ROAD

CROOKWELL ROAD

MIDDLE ARM RD

Crookwell 1 Operating Wind Farm (8 Turbines)

Approved Crookwell 2 Wind Farm (46 Turbines)

PEJAR DAM

PEJAR RD

UPPER LACHLAN SHIRE

GOULBURN MULWAREE

Goulburn Approx. 17 km

Canberra Approx. 85 km

LEGEND

- Activity Area
- Major Road
- Secondary Road
- Vegetation - Site Only
- Shire Boundary
- Rail Line (Unused)
- Transmission Line
- Rail Siding/Station
- Dwelling
- Crookwell 1 Operating Turbines
- Crookwell 2 Approved Turbines

Scale 1:80000 @ A3

0 800 1600 4000m

FIGURE 4 - REGIONAL PLAN

CROOKWELL 3 WIND FARM

PROJ./DRG.NO. 309447-PD SA 01 REV. 09 DRAWN MH APP'D. AT DATE 03-03-2011

Tract

Crookwell
Approx. 12 km

Oberon
Approx. 132 km

Approved Crookwell 2
Wind Farm (46 Turbines)

X=739788
Y=6175530

X=741196
Y=6173616

X=746017
Y=6174059

X=745923
Y=6172670

X=743881
Y=6171394

X=742458
Y=6171657

X=733759
Y=6171784

X=736887
Y=6171217

X=733817
Y=6170109

X=735537
Y=6169858

PIGMANS HILL

PEJAR DAM

330kv

66kv

ELMGROVE ROAD

CROOKWELL ROAD

PEJAR RD

WOODHOUSELEE ROAD

ST STEPHENS ROAD

STEEVES

PEJAR

FIRST

WOLGHOLLY RIVER

UPPER LACHLAN SHIRE

GOULBURN MULWAREE

Canberra
Approx. 90 km

Goulburn
Approx. 22 km

Goulburn
Approx. 22 km

LEGEND

- Activity Area
- Major Road
- Secondary Road
- 2WD/4WD Road
- Locality Boundary
- Rail Line
- Rail Station
- Dwelling Stakeholder
- Dwelling Non-Stakeholder
- Transmission Line
- Photo Points

SCALE 1:40000 @ A3

0 400 800 2000m

FIGURE 5 - SITE ANALYSIS

CROOKWELL 3 WIND FARM

PROJ./DRG.NO. 309447-PD SA 03 REV. 01 DRAWN M.H. APP'D. A.T. DATE 03-03-2011

Tract

SITE PHOTOS - Crookwell 3 South

1. View east to Pejar Dam from landowners dwelling

2. Typical landscape of Crookwell 3 South

3. Drainage line

4. Planted wind break

5. Rocky Hilltop

6. Transmission line from highest point

FIGURE 6 - SITE PHOTOS

SITE PHOTOS - Crookwell 3 South

7. Looking north from centre of Crookwell 3 South

8. Wind mill and shed

9. Yellow Box (remnant vegetation)

SITE PHOTOS - Crookwell 3 East

1. View to Dam from Boltons Road

2. Leeston Homestead

3.Typical landscape from hilltop

4. Pigman's Hill from hilltop

5. View east with Dam in foreground

FIGURE 6 - SITE PHOTOS

SITE PHOTOS - Crookwell 3 East

6. Intersection of Bolton's Road and property boundary

7. View south along drainage line to Dam

8. Hillview Homestead

9. Site from western access point

FIGURE 6 - SITE PHOTOS

SITE PHOTOS - Crookwell 3 East

10. Fenced reserve

11. View south from northern boundary

12. Dam with Willowvale Hill in background

FIGURE 6 - SITE PHOTOS

SITE PHOTOS - Crookwell 3 East

13. View to non-participating dwellings from northern boundary

14. Potential access road at eastern boundary

15. View west from central southern portion of site

FIGURE 6 - SITE PHOTOS

For a list of lot details compromising the subject site, refer to **Appendix 3 – Lot Details.**

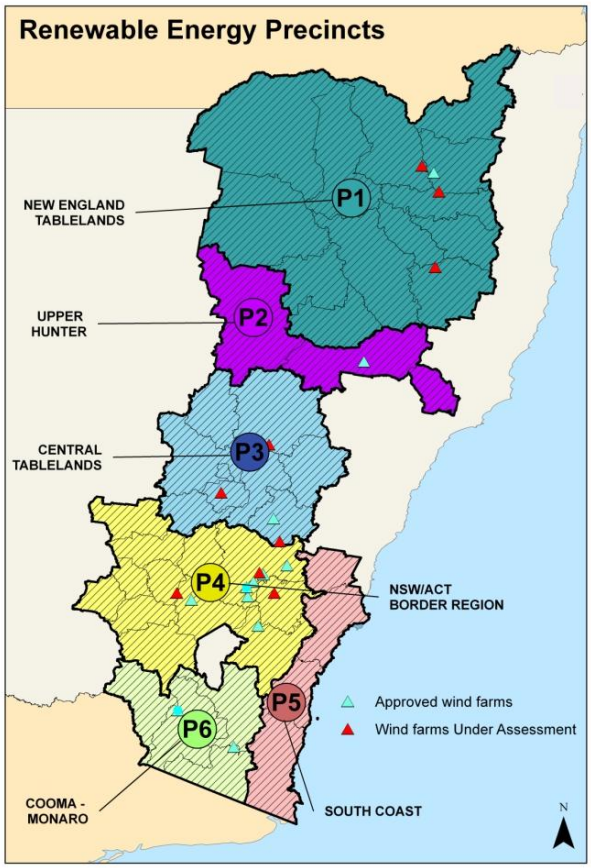
Some works, such as powerlines, access track crossings and road works, are also proposed within the adjacent road reserves and nearby private property. **Chapter 5** details the elements of the project and includes plans showing their location relative to property boundaries.

3.3 Site Suitability

The Southern Tablelands region is known for its strong wind resource and includes several other wind farms in various stages of planning and development. The area is located within one of six designated Renewable Energy Precincts established by the NSW Government. The six designated precincts are known as the New England Tablelands, Upper Hunter, Central Tablelands, NSW/ACT Cross Border Region, Snowy-Monaro and the South Coast. These precincts have been established as locations for the State's future wind power investment due to their suitability for the technology. The precincts are a community partnership initiative in areas where significant future renewable energy development is expected (especially wind farms), designed to give local communities a voice and a stake in renewable energy development.

The proposed Crookwell 3 Wind Farm is located in Renewable Energy Precinct 4 - ACT/NSW Border Areas. This precinct has a distinct concentration of wind farms in comparison to other Renewable Energy Precincts (refer to **Figure 7** below).

Figure 7 – Renewable Energy Precincts



Source: http://www.environment.nsw.gov.au/climatechange/renewableprecincts.htm

The average wind speed tested across the Crookwell region is approximately 6.5 to 7.0 metres per second which is considered a good wind resource. Available data from several years of wind testing at the site and from Crookwell 2 Wind Farm confirms that there is sufficient wind resource for the turbines under consideration to achieve an acceptable capacity factor.

There are several other factors that are important in establishing a site as suitable for a wind energy facility. These have been taken into account in choosing the site as a location for a wind farm. These include;

- Distance from coastline;
- Population density and buffers to residential settlements;
- Willingness of land owners;
- Size of land holdings;
- Proximity to existing electricity grid;
- Strength of wind resource;
- Minimal impacts on;
  - Flora and fauna;
  - Heritage (including Aboriginal);
  - Non-stakeholder dwellings; and
  - Vistas and viewlines;
- Appropriate terrain and land capability; and
- Access to existing infrastructure (ports, good quality roads etc).

3.4 Land Use

The current land use of the site is primarily agricultural across medium sized land holdings. Common agricultural activities include grazing of sheep and cattle, with limited cropping due to the steep topography.

Human infrastructure associated with the current land use includes:

- Residences, usually associated with a surrounding farm;
- Agricultural structures (silos, sheds, etc);
- High voltage power lines;
- Dams;
- Farm tracks; and,
- Fencing and stockyards.

Smaller landholdings exist to the south of the site near the corner of Woodhouselee and Crookwell Roads. A variety of alternative agricultural pursuits are conducted in this area.

3.5 Demographic Profile

Based on the Australian Bureau of Statistics (ABS) 2006 Census Data, the demographic profile of Crookwell's local population has following key characteristics:

- rurally based with very low population density;
- a high proportion of population of working age (57.9%) with 35.4% of the population aged 55 years or over;
- English speaking and Australian born;
- educated;

- high proportion of persons in the labour force and in full time employment, with 4.1% unemployed persons seeking work;
- lower than average income; and
- high rates of home ownership.

3.6 Dwellings

The proposed wind farm is not located close to any significant population centres, with the closest centre being Crookwell, located 17km away. This lack of housing concentration is a significant determinant in the site's viability for a wind farm.

There are a number of dwellings within and neighbouring the site, dispersed across the agricultural landscape at a low dwelling density. Houses are generally located along the major roads of Crookwell and Woodhouselee.

Within the site there are four dwellings which have owners with a declared interest in the project, having entered into commercial arrangements with CDPL.

Surrounding the wind farm site there are many houses as shown in **Figure 5 – Site Analysis**. The majority of these houses are located a significant distance from any turbines proposed as part of the project. Most houses are associated with medium sized agricultural properties on which they sit, with some smaller hobby type farms present.

There are few houses in the more remote areas east of Crookwell 3 East and south west of Crookwell 3 South, as these areas are poorly served by roads.

3.7 Topography and Soils

The surrounding area is an undulating to hilly landscape with small areas of steeply sloping land generally near creeks. The site ranges between approximately 765 metres and 931 metres above sea level, with Crookwell 3 South on average 100 metres lower than Crookwell 3 East.

A ground investigation undertaken as part of the geotechnical analysis indicates that the general geology of the Crookwell 3 East site comprises Ordovician siltstones, sandstones and shales with associated residual soils which are distributed over the southern part of the site and the areas of lower elevation. The northern part of the Crookwell 3 East site is also underlain by Ordovician siltstones, sandstones and shales as well as Tertiary basalt flows which form caps at the peaks of the areas of high elevation and are generally overlain by variable thicknesses of residual clayey soils.

The general geology of the Crookwell 3 South site is found to comprise Siluro-Devonian Granites with associated residual soils. The surface soils were determined as a mix of silty sands, clayey sands and sandy clays.

The geotechnical investigation concluded that due to the generally hilly topography of the site, drainage during rain events is expected to occur relatively quickly, the local creeks would be expected to rise rapidly and that erosion of non-vegetated surfaces is likely to occur.

3.8 Hydrology

The site is located within the Sydney water catchment, and more particularly the Upper Wollondilly sub-catchment. The most significant hydrological features in the sub-catchment are the Wollondilly River and Pejar Dam.

The site includes a number of drainage lines and waterways. Steeves Creek runs through Crookwell 3 East and First Creek through Crookwell 3 South. There are several additional unnamed drainage lines which run through the site.

There are no natural wetland habitats within the site; however there are several dams on each of the properties constructed as stock watering holes and domestic water supply.

The Wollondilly River commences approximately 7 km east of the Crookwell Township, and eventually joins the Mulwaree and Wingecarribee Rivers. Ultimately the river flows into Lake Burragorang. It has a total length of over 150 km forming part of a major water supply for the Sydney region. Whilst the Upper Wollondilly River does not pass through the site directly, Crookwell 3 East and South are bisected by it, and parts of the site drain into it.

Pejar Dam, which is adjacent to Crookwell 3 South to the east, was constructed to supply water for Goulburn, and is used in conjunction with Sooley Dam and Rossi Weir. Pejar Dam completely dried out in April 2006, and is currently filling as a result of a wet spring in 2010.

The geotechnical investigation assessed groundwater on the site, and found that for most of the site the permanent groundwater is likely to be at least several metres below ground surface. Locally seasonal perched water tables can occur in the upper parts of the ground profile particularly in the alluvial soils surrounding creeks and drainage channels.

3.9 Transport and Infrastructure

Crookwell Road and Woodhouselee Road are the two major arterial roads servicing the site, which divide Crookwell 3 South and Crookwell 3 East. Crookwell Road is a Road Traffic Authority (RTA) managed main road, classified as a State Road in the RTA road hierarchy. Woodhouselee Road is managed by Upper Lachlan Shire Council. Crookwell Road is sealed and is the main thoroughfare between Crookwell and Goulburn. Woodhouselee Road has a 5 to 7 metre wide carriageway with a predominantly sealed asphalt surface. Approximately 2.3 km of Woodhouselee Road consists of an unsealed gravel surface, south of Roslyn Road. This road has scheduled upgrades arising out of the Crookwell 2 Wind Farm approval.

Other roads in the vicinity of the site are rural gravel roads with narrow shoulders.

There is a 330kV electricity transmission line running through the site from a north-easterly to south-westerly direction. This transmission line runs through both Crookwell 3 East and Crookwell 3 South. It is owned by TransGrid and operates from Yass (approximately 85km south-west of Crookwell) to Bannaby (approximately 60 km east of Crookwell).

A standard gauge railway line runs through Crookwell 3 East, but is disused.

3.10 Vegetation

The majority of the site is cleared sheep and cattle grazing country with only limited areas of native vegetation remaining. Crookwell 3 East contains some larger areas of remnant vegetation near the eastern boundary of the site, which has been fenced for protection from livestock.

The site has been highly modified from its pre-disturbance state and whilst several patches of remnant native vegetation remain, these are generally located in areas that are not subject to wind turbine infrastructure.

The vegetation across the site is represented for the most part by cleared grazing paddock, most of which is highly disturbed. Investigation by Anderson Environmental Consultants Pty Ltd found that most of the more fertile areas of the site have been extensively cleared for grazing, primarily sheep grazing but also cattle. Parts of these cleared areas (primarily at the lower altitudes) would have once represented the Endangered Ecological community of White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland. However, these areas are now largely cleared and pasture improved and no identifiable endangered ecological community remains.

There are areas of remnant native forest vegetation remaining within the site, as shown in **Figure 8 – Vegetation Plan**:

Approved Crookwell 2
Wind Farm (46 Turbines)

ELMGROVE ROAD
PEJAR RD
CROOKWELL ROAD
WOODHOUSELEE ROAD
ST STEPHENS ROAD
PEJAR DAM
PIGMANS HILL
330kv
66kv
PEJAR
STEEVES
FIRST
WOLLONDILLY RIVER
UPPER LACHLAN SHIRE
GOULBURN MULWAREE
A
B
C
D
E
F
G
H
I

LEGEND

- Activity Area
- Major Road
- Secondary Road
- 2WD/4WD Road
- Locality Boundary
- Rail Line
- Rail Station
- Dwelling Stakeholder
- Dwelling Non-Stakeholder
- Transmission Line
- Areas of Remnant Vegetation
- Anabat Sites

SCALE 1:40000 @ A3

0 400 800 2000m

FIGURE 8 - VEGETATION PLAN

CROOKWELL 3 WIND FARM

PROJ./DRG.NO. 309447-PD VP 04 REV. 00 DRAWN M.H. APP'D. A.T. DATE 03-03-2011

Tract

- Remnant A: 45 ha of remnant Western Tablelands Dry Forest on the property of Hillview Park.
- Remnant B: 171 ha of remnant of Western Tablelands Dry Forest on the property of Hillview Park. It is a very large remnant and represents the poorer country, which remains on many farms due to its poor soil type and low agricultural potential.
- Remnant C: 3-4 ha of Red Stringybark, Broad-leafed Peppermint, Brittle Gum, and Candlebark. . It is fully fenced and not used for grazing.
- Remnants D, E & F: These remnants have been quite disturbed in the past through some historical clearing. They contain Red Stringybark, Broad-leafed Peppermint, Brittle Gum, and Candlebark.
- Remnant G: This remnant, containing Red Stringybark, a few Yellow Box, Broad-leafed Peppermint, and Candlebark occurs on the Wollondilly property. It has been disturbed in the past through some historical clearing.
- Remnant H: This remnant occurs adjacent to Pejar Dam. It has been disturbed in the past through the road construction and use of this area as a recreational area, as well as some historical clearing. It contains Red Stringybark and Broad-leafed Peppermint.
- Remnant I: This remnant occurs adjacent to Pejar Dam. It has been disturbed in the past through the road construction and use of this area as a recreational area. Currently it is used as a public recreation area and is grazed under lease by the owner of Wollondilly. It contains Red Stringybark (Eucalyptus macrorhyncha) and Broad-leafed Peppermint (Eucalytus dives).

Refer to **Chapter 14 – Flora and Fauna** and **Appendix 8 – Flora and Fauna Assessment** for more information on the vegetation that exists in the site and the region.

3.11 Landscape and Visual Features

Crookwell 3 East and Crookwell 3 South are separated by the Wollondilly River and the Goulburn-Crookwell Road. The site is located on a system of broad ridges and low hills that are separated by a series of creeks generally flowing south.

The landscape within the site and its surrounds is generally rural, across cleared undulating hills with scattered rural dwellings and sheds present. The character of the site represents a landscape that is typical of landscape character areas that are commonly found in the surrounding regional area of the New South Wales Southern Tablelands and the NSW/ACT Border Region Renewable Energy Precinct.

The landscape consists of the following elements:

- Grassed areas, most commonly introduced pastures;
- Scattered trees and some larger clusters;
- Limited Rocky Hilltops;
- Drainage lines and creeks;
- Water bodies;
- Settlements;
- Flats; and
- Some planted wind breaks.

The existing Crookwell 1 Wind Farm is also present on the landscape and is visible from Crookwell Road during the site approach.

The landscape is highly modified and is predominately cleared for pastoral and agricultural uses. There are many instances of infrastructure including roads, rail,

power lines, communication towers and fences. Scattered around the subject site are agricultural and residential buildings set in a typically rural landscape.

Built elements within the landscape include the major 330kV High Voltage line of the state grid, the disused railway line which crosses Woodhouselee Road, Crookwell Road, the local road network and farmhouses and associated buildings scattered throughout the area.

Refer to **Chapter 9 – Visual Impacts** for more information on the landscape values of the site.

3.12 Climate

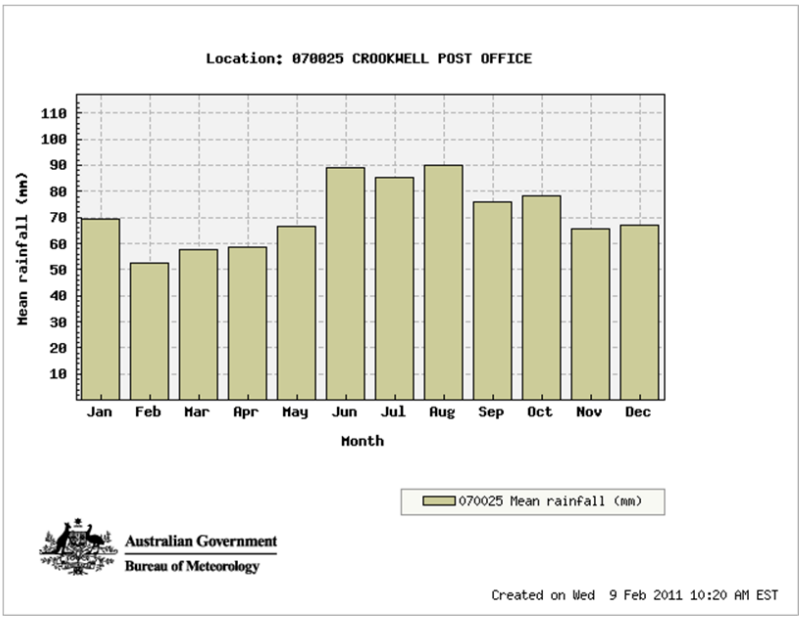
The Bureau of Meteorology (BOM) publishes climate data from the Crookwell Post Office on temperature and rainfall (refer to **Figures 9** and **10** below).

The Crookwell area has a temperate climate and receives rain all year round, peaking at 89mm in August, and having an annual average rainfall total of 852mm (BOM, 2011).

Temperatures peak in February with an average maximum of 26 degrees and drop in winter to a maximum of 9 degrees during the month of July. Frosts are common during the winter months, with an average overnight minimum temperature of 0 degrees (BOM 2011).

Over the last decade, the Crookwell region has experienced a severe drought, evidenced in 2006 by the low water levels in the surrounding lakes and creeks, some of which completely dried. In recent decades, the average maximum temperature of the Southern Tablelands region has increased, in line with wider global trends. The mean temperature of the Crookwell region is increasing at a rate of 0.3 degrees per decade, and the mean temperature of NSW is now 0.7 degrees warmer than average.

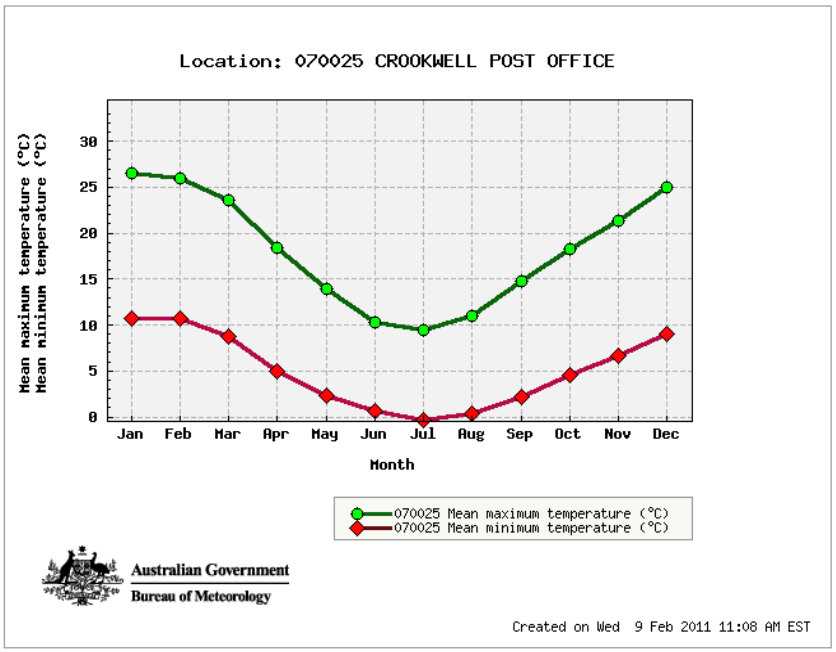
Figure 9 – Crookwell mean rainfall per month (1883-2011)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years
(mm)for years 1883	69.4	52.6	57.7	58.8	66.8	88.9	85.1	90.0	76.0	78.1	65.5	66.9	855.4	127

Source: www.bom.gov.au

Figure 10 – Crookwell mean maximum and minimum temperatures (°C) per month (1916-1975)



Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years
Mean maximum temperature (°C) for years 1916 to 1975	26.5	25.9	23.6	18.4	13.9	10.3	9.5	11.0	14.7	18.3	21.4	25.0	18.2	51
Statistics	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**	**Years**
Mean minimum temperature (°C) for years 1916 to 1975	10.7	10.7	8.8	5.0	2.3	0.6	-0.4	0.3	2.1	4.6	6.7	9.0	5.0	51

Source: www.bom.gov.au

3.13 Mineral Exploration

The proponent has undertaken an investigation to identify any relevant mineral stakeholders (including exploration and mining title holders) inside the site and along the path for connection to the approved Crookwell 2 Wind Farm substation.

The investigation was made using the TASMap application provided by the NSW Department of Primary Industries, Trade & Investment, Resources & Energy division (http://www.minerals.nsw.gov.au/tasmap/). TASMap enables the public to access and view frequently updated mapping of titles information across NSW.

The investigation, undertaken on 16 May, 2012, found that there is one (1) minerals title (EL 7912) within the site, in the northern section of Crookwell 3 East, as shown in **Figure 11** below.

Minerals Title EL7912 is currently held by ABX2 Pty Ltd. It was granted on 28 February 2012 and is due to expire on 28 February 2014.

The Proponent sent a letter to ABX2 Pty Ltd providing information about the project, requesting the company to examine the proposed development in relation to the existing mineral title and to raise any concerns or conflicts relating to the project. No formal response to the letter was provided by ABX2 Pty Ltd and no return call was received to follow up calls made by the proponent.

It is expected that, as a general rule, impacts to mining exploration would be minimal and limited to the small area of land required for wind farm infrastructure.

The proponent is committed to ongoing communication with the mineral title holder to ensure any potential impacts are minimised.

Figure 11 – Minerals Title EL 7912 Plan

Crookwell
Approx. 12 km

Oberon
Approx. 132 km

X=739788
Y=6175530

X=746017
Y=6174059

X=741196
Y=6173616

X=745923
Y=6172670

X=742458
Y=6171657

X=743881
Y=6171394

X=733759
Y=6171784

X=736887
Y=6171217

X=733817
Y=6170109

X=735537
Y=6169858

PEJAR DAM

PIGMANS HILL

Canberra
Approx. 90 km

Goulburn
Approx. 22 km

Goulburn
Approx. 22 km

LEGEND

Activity Area	Major Road	Locality Boundary	Dwelling Stakeholder
Mineral Title EL 7682	Secondary Road	Rail Line	Dwelling Non-Stakeholder
Mineral Title EL 7912	2WD/4WD Road	Rail Station	Transmission Line

SCALE 1:40000 @ A3

0 400 800 2000m

FIGURE 11 - MINERAL TITLES PLAN

CROOKWELL 3 WIND FARM

PROJ./DRG.NO. 309447-PD SA 04 REV. 01 DRAWN M.H. APP'D. A.T. DATE 12.07.2012

Tract

UNION FENOSA WIND AUSTRALIA

Crookwell 3 Wind Farm

Chapter 4

DESIGN RESPONSE

4 Design Response

Having established the site characteristics and its specific constraints and opportunities, this chapter details how the proposed wind farm has evolved through the design phase to minimise any negative impacts whilst maintaining the proposed wind farm as a viable generator of renewable energy.

4.1 Location Criteria

Chapter 3.3 of this report details the characteristics that make a region suitable for a wind farm. Early wind farms were often located along the coast but advances in turbine technology have allowed wind farm proponents to select inland areas away from sensitive coastline locations. The undulating topography rising out of generally flatter lands to the west and south provide Crookwell with a wind resource that is stronger than most inland regions. This is evidenced by the number of wind farms that are proposed, approved or constructed in the area.

The strengths of the region have been recognised by the NSW Government through the inclusion of Crookwell as part of the Renewable Energy Precinct 4: NSW/ACT Border, one of six such precincts across the state.

The subject site is also favoured by the presence of the existing 330kV high voltage transmission line, which runs through both components of the site. As a result, long distance overhead power line connections are not required. Furthermore, the subject site is able to share infrastructure with the approved Crookwell 2 Wind Farm.

4.2 Design Criteria

In designing the wind farm the consultant team and proponent has also had regard to the following site specific factors as described in **Chapter 3 – The Site and Context**;

- Site Details;
- Wind Resource;
- Land Use;
- Dwellings;
- Topography and Soils;
- Hydrology;
- Transport and Infrastructure;
- Vegetation; and,
- Landscape and Visual Features.

The design of the wind farm followed an iterative process whereby specialist inputs and consultation influenced the design at various stages. An initial wind farm layout was produced which was the subject of preliminary consultant studies. The results from these preliminary studies and the community consultation undertaken informed changes to the proposed layout of the wind farm. These changes included omitting turbines, increasing buffer distances to houses, increasing screening vegetation, and changes to the access tracks and access points.

Modern wind farms are also very different to older projects by having greater distance between turbines and therefore having fewer turbines per site through the use of taller turbine models. This has been reflected in the evolution of the proposed Crookwell 3 Wind Farm, where earlier proposals included more turbines.

In establishing the design of the wind farm the proponent has also had regard to the views of key stakeholders, including DoPI, DECCW, Road Traffic Authority and the Upper Lachlan Shire Council. The stakeholders were provided with the opportunity to express their views on the project at the Planning Focus Meeting organised by the

proponent, who was held on site in March 2010, and also a community door-knock consultation was conducted in April 2010.

The following principles guided the evolution of the wind farm layout.

Access to infrastructure - A 330kv transmission line runs through the site, enabling good transmission of energy to the grid. Connection to transport routes and destinations such as Crookwell Road to the Goulburn Highway are also readily available.

Balance impacts with energy production – The wind farm has been designed to minimise the following impacts, to the extent practicable, whilst retaining the viability of the project to substantially contribute to the generation of renewable energy;

- Economic and Social Impacts – Ensure the project minimises any negative impacts and maximises positive impacts
- Visual amenity – Ensure visual impact is minimised and where appropriate employ mitigation measures to reduce impact.
- Noise – Ensure noise impacts are acceptable with significant buffers to non-participating land holders.
- Flora and Fauna – Ensure that the project is designed so that native vegetation is avoided where possible and that any unavoidable loss of vegetation is minimised and mitigated through replanting of areas disturbed during the construction phase and other offset planting.
- Aviation – Ensure the safety of aircraft in the vicinity.
- Transport – Ensure the safe and efficient transportation of equipment to the site and the upgrading of roads to facilitate access and for the benefit of the community.
- Telecommunications – Ensure any disruption to telecommunication services is ameliorated.
- Fire – Ensure the potential risk of fire is managed appropriately.
- Shadow Flicker – Ensure the incidence of shadow flicker is managed to acceptable standards.
- Heritage – Ensure the protection of aboriginal and cultural heritage.
- Health and Safety – Ensure the safety and wellbeing of the community is preserved.
- Geotechnical – Ensure the design of turbine footings, access roads and other infrastructure is appropriate and minimises the impact of soil erosion and/or groundwater contamination.
- Hydrology – Ensure that site activities do not pollute local streams and water bodies.

Match turbines with the wind resource – The turbine selection has been made to respond to the good wind resource at Crookwell with low cut in speeds.

Separation to non-participating land holders – In order to manage the impacts of the development on neighbouring land holders, substantial distances from turbines to non- participating landholders have been employed.

UNION FENOSA WIND AUSTRALIA

Crookwell 3 Wind Farm

Chapter 5

THE PROPOSAL

5 The Proposal

This chapter details the project and all associated buildings and works that support the wind energy facility. It also details the major elements of the commissioning, operational and decommissioning phases.

5.1 Overview

Crookwell Development Pty Ltd (CDPL), the proponent, and its successors and assigns, is seeking project approval for the construction and operation of a wind energy facility known as the Crookwell 3 Wind Farm (the project). The project is to be located on two separate land parcels known as Crookwell 3 East, with an area of 1,100 ha, and Crookwell 3 South, with an area of 400 ha (the Site) (refer to **Figure 12 – Indicative Site Plan**).

The project comprises a number of elements, including:

- Up to 30 individual wind turbines standing up to 152 metres at top of blade tip with a capacity of up to 3.4MW each (some of the turbines may be fitted with obstacle lighting as required);
- Up to 30 individual kiosks for the housing of 33kV Transformers and 33kV Switchgears and associated control systems to be located in the vicinity of the wind turbine towers (in some turbine models the kiosk's equipment is integrated within the tower or nacelle);
- Internal unsealed tracks for turbine access;
- Upgrades to local road infrastructure as necessary to provide access to the site;
- An underground electrical and communication cable network linking turbines to each other within the site boundary and then utilising either an underground or overhead connection between the Crookwell 3 site boundaries and the Crookwell 2 site boundary to reach the substation approved as part of the Crookwell 2 Wind Farm;
- Up to three wind monitoring masts fitted with various instruments such as anemometers, wind vanes, temperature gauge and potentially other electrical equipment;
- Up to two temporary concrete batching plants during the construction phase only, to supply concrete for the foundations of the turbines and other associated structures;
- Vegetation removal to allow access to the turbines; and,
- Vegetation replanting to provide screening.

Grid connection would be achieved from a connection to the 330kV electricity transmission line which runs through the site. The project would utilise and be connected to the single substation, control room and facilities that form part of the Crookwell 2 Wind Farm. Please refer to **Figures 13** and **14 – Indicative Access & Infrastructure Plans**.

5.2 Turbine Specifications

The most important element in any wind farm is the wind turbine, often referred to as a Wind Turbine Generator (WTG). Turbines consist of a tall tower with 3 long blades mounted at the top that capture the wind.

The turbine manufacturing industry is dynamic, with new and updated models regularly released. Existing models are often made redundant only a few years after their release. The industry is rapidly growing and benefits from constant innovation and advancement in the efficiency of the turbines.

The major phase of a wind farm's cost is the initial construction, and turbine selection is a critical determinant of this cost. A turbines cost depends on a number of factors

Approved Crookwell 2 Wind Farm (46 Turbines)

C3 East Access Road Option 2

C3 East Access Road Option 3

C3 South Access Road Option 1

C3 South Access Road Option 2

C3 East Access Road Option 1 (Preferred)

PEJAR DAM

PIGMANS HILL

UPPER LACHLAN SHIRE

GOULBURN MULWAREE

ELMGROVE ROAD

PEJAR RD

CROOKWELL ROAD

DAWSONS CREEK RD

WOODHOUSELEE ROAD

ST STEPHENS ROAD

WOLLONDILLY RIVER

PEJAR RIVER

STEEVES

330kv

66kv

Lynross
Highland Park
106 Rosedale
70 Snowgum
69 Atholvale
68 Meadowvale
67 Little Vale (2)
66 Little Vale (1)
Windalee
79 Leeston
65
64 Valdarman Hill
63 Rocky Corner
80 Hillview Park
60 Pejar Park
62 Cottonwood
61 Wallaroobie
59
58
57 Kenrich
55
54 Ginmara
56 Mathlie
53
84 Nierrina Heights
52 Mount Wayo
51
50
83 Trappers Folly
49
117
21 Ahgunyah
22 Minnamurra
23 Gundowringa
24 Savannah
25 Cottage 1
26 Cottage 2
27 Cottage 3
28 Cottage 4
1 Evermore
2 Bendemere
3 D'Ambrosio
4
5
6
7 Emohruo
8 Narangi
20 Normaroo
19 Wombat Hollow
18 Wollondilly (2)
17 Wollondilly (1)
16 Calamondah
29
30 Airam
41
Middle Arm Fire
32
33 Whispering Pines
34 Kooloona
35 Clydesdale
36 Tyrendarra
37 Carinya
40 Tyrendarra
38
39
St Stephen's Pejar Anglican Church
A1
A2
A3
A4
A5
A6
A8
A9
A10
A12
A13
A15
A16
A17
A18
A19
A20
A21
A22
A23
A24
A25
A26
A27
A28
A29
A30
A31
A32
A33

LEGEND

Activity Area
Major Road
Secondary Road
Shire Boundary
Rail Line (Unused)
Transmission Line
Rail Station
Crookwell 2 Approved Turbines
Crookwell 3 Proposed Turbines
Dwellings Stakeholder
Dwellings Non-Stakeholder

A3

SCALE 1:40000 @ A3

0 400 800 2000m

FIGURE 12 - INDICATIVE SITE PLAN

CROOKWELL 3 WIND FARM

PROJ/DRG.NO. 0309-0447 SP-03 REV. 07 DRAWN M.H. APP'D. A.T. DATE 03-03-2011

Tract

70 Snowgum
69 Atholvale
68 Meadowvale
C3 East Access Road Option 2
PEJAR
A1
A2
A3
A4
A5
A6
A8
A9
A10
67 Little Vale (2)
66 Little Vale (1)
79 Leeston
Windalee
65
64 Valdarman Hill
C3 East Electricity Easement Option 1
C3 East Electricity Easement Option 2
C3 East Access Road Option 3
63 Rocky Corner
Approved Crookwell 2 Wind Farm (46 Turbines)
330kv
PIGMANS HILL
STEEVES
A12
A13
A15
A16
A17
A18
A19
A20
A21
A22
A23
A24
A25
80 Hillview Park
WOODHOUSELEE ROAD
PEJAR
60 Pejar Park
62 Cottonwood
61 Wallaroobie
59
58
C3 East Access Road Option 1 (Preferred)

LEGEND

- Crookwell 3 East Activity Area
- Major Road
- Existing Transmission Line
- Substation Crookwell 2
- Rail Line
- Access Tracks
  Cabling generally in accordance with access tracks (unless shown as a dashed line)
- Electricity Easement Options
- Access Roads Options
- Batching Plant
- Crookwell 2 Approved Turbines
- Crookwell 3 Proposed Turbines
- Dwellings Stakeholder
- Dwellings Non-Stakeholder
- Monitoring Mast
- Shire Boundary

Scale 1:20000 @ A3

0 200 400 1000m

FIGURE 13 - INDICATIVE ACCESS & INFRASTRUCTURE - EAST

CROOKWELL 3 WIND FARM

PROJ./DRG.NO. 0309-0447 AI 01 REV. 04 DRAWN M.H. APP'D. G.A. DATE 03-03-2011

Tract

Approved Crookwell 2
Wind Farm (46 Turbines)

PEJAR RD

CROOKWELL ROAD

WOLLONDILLY RIVER

PEJAR DAM

PEJAR RIVER

WOODHOUSELEE ROAD

FIRST

330kv

66kv

PIGMANS HILL

C3 South Electricity
Easement Option 1

C3 South Electricity Easement
Option 2 (Road Reserve)

C3 South Electricity Easement
Option 3 (Council Reserve)

C3 South Access
Road Option 1

C3 South Access
Road Option 2

22 Minnamurra
24 Savannah
27 Cottage 3
28 Cottage 4
20 Normaroo
8 Narangi
19 Wombat Hollow
18 Wollondilly (2)
17 Wollondilly (1)
A26
A27
A28
A29
A30
A31
A32
A33
39 St Stephen's Pejar Anglican Church
38
37 Carinya
40
57 Kenrich
60 Pejar Park
61
62
63 Rocky Corner
64 Valdarman Hill
65 Windalee
79 Leeston
80

LEGEND

Crookwell 3 East Activity Area
Major Road
Existing Transmission Line
Substation Crookwell 2
Rail Line
Access Tracks
Cabling generally in accordance with access tracks unless shown as a dashed line
Electricity Easement Options
Access Roads Options
Batching Plant
Crookwell 2 Approved Turbines
Crookwell 3 Proposed Turbines
Dwellings Stakeholder
Dwellings Non-Stakeholder
Monitoring Mast

Scale 1:20000 @ A3

0 200 400 1000m

FIGURE 14 - INDICATIVE ACCESS & INFRASTRUCTURE PLAN - SOUTH

CROOKWELL 3 WIND FARM

PROJ./DRG.NO. 0309-0447 AI 02 REV. 05 DRAWN M.H. APP'D. A.T. DATE 03-03-2011

Tract

including the current economic climate (i.e. whether other wind farms also require supply in the upcoming period) based on competition between suppliers. In order to maintain competition between suppliers of turbines, and that the most up to date turbines can be used, it is important that a project has flexibility to select from a number of different turbine models from alternative suppliers.

CDPL is currently considering turbines from the following suppliers:

- Vestas, Denmark
- Repower, Germany
- Nordex, Germany
- General Electric, USA
- Enercon, Germany
- Siemens, Germany

To provide this flexibility, the proponent is seeking approval for a maximum turbine 'envelope' rather than a single turbine model. This envelope represents the largest and widest of the eight turbine models under consideration.

Many of the turbine models under consideration are smaller than the maximum envelope. In general, if any of the smaller turbines are utilised for the Crookwell 3 Wind Farm, the impacts described and assessed in this report are likely to be less.

The proposed envelope contemplates that, as a maximum, the turbine would have an overall height of 152 metres when constructed. This envelope includes a tower of up to 105 m in height to the hub, coupled with a 51 metre long blade (excluding hub) and an approximate 2 metre wide hub.

Accordingly, for the purposes of this EA, the largest turbine model under consideration has been assessed in relation to all potential impacts other than noise impacts. For an illustration of the maximum wind turbine envelope under consideration refer to **Figure 15 – Wind Turbine Elevation**.

Whilst the majority of potential impacts of wind turbines are related to its height and length of blades, the noise produced by an individual turbine is a function of the various mechanical characteristics of the turbine, and not necessarily its height. Therefore, in assessing noise impacts, each of the 8 wind turbine models currently under consideration has been assessed based on the information provided by each of the turbine manufacturers on noise characteristics at various wind speeds.

Table 2 below illustrates the difference between the various models under consideration**.**

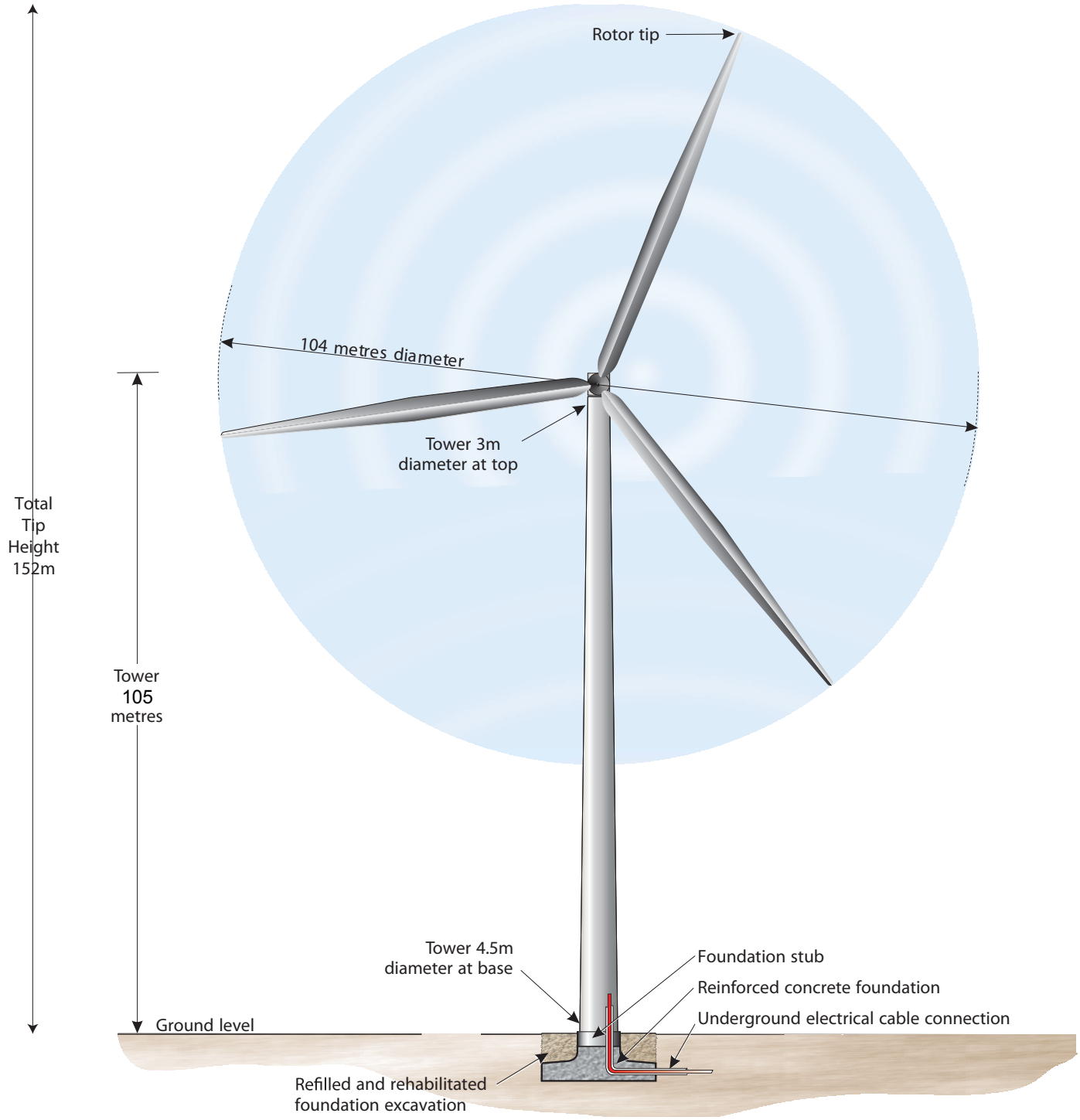


FIGURE 15 Wind Turbine Elevation

Source: Tract Consulatants based on URS 2006

Table 2 – Turbine Comparison

Turbine Options	1	2	3	4	5	6	7	8
Turbine Model	V90	MM92	V100	N100	2.5xl	E101	SWT101	M104
No of Turbines	30							
Tower Hub Heights Options (m)	80 95 105	80 100	80 95	80 100	75 85 100	99	80 90	80 100
Rotor Blade Length (m)	44	46	49	49	49	49	49	51
Rotor Diameter (m)	90	93	100	100	100	101	101	104
Total Height To Tip Options (m)	125 140 150	127 147	130 145	130 150	125 135 150	150	131 141	132 152
Turbine Capacity (MW)	2.0	2.0	1.8	2.5	2.5	3.0	2.3	3.3
Total Wind Farm Capacity (MW)	60	60	54	75	75	90	69	102

There are some slight differences in the electrical construction of the turbines under consideration. Some of the turbines under consideration have a 690V / 33kV transformer in the nacelle, and 33kV switchgear either in the base of the tower or next to the tower in a kiosk. Some turbines have the 690V / 33kV transformer and the 33kV switchgear in the base of the tower. Other turbines have the 690V / 33kV transformer and the 33kV switchgear on the ground in a kiosk next to the tower.

The components of each of the turbine models under consideration are as follows;

- Reinforced concrete 'gravity foundations' up to 20m x 20m and between 2m to 3m in depth depending on the prevailing ground conditions. A rock anchor foundation is being investigated which would require much smaller concrete footing areas.
- A tubular steel tower approximately 4.5 metres in diameter at the base, tapering to a diameter of approximately 3.0 metres at the top, with a total tower height of 80 to 105 metres, weighing between 160 and 250 tonnes. Some of the larger towers are either concrete precast towers or hybrid towers with the concrete precast base and an upper steel section. The towers are painted in a non-reflective light grey/off white paint;
- A nacelle at the top of the tower housing the gearbox (where a direct drive mechanism is not in operation) and electrical generator, ensuring that the turbine is always facing into the wind and adjusting the angle of the blades to ensure maximum output of electricity and minimum noise.
- A rotor comprising a hub (attached to the nacelle) with three blades, and a shaft that connects to the generator via the gearbox or direct drive mechanism.

– 3 blades up to 51 metres long (excluding hub), made of lightweight materials.

A safety component incorporated in all models under consideration is a lightning protection system. All blades are manufactured with an anti-lightning protection system which minimises the damage to the turbines in the event of an atmospheric discharge (lightning). In the event of a lightning strike, power is diverted from the lightning to the nacelle which is grounded to the earth.

Other safety components of the turbines include;

– Sufficient standing and working space

– Full containment of any leakage or spillage, by using dry-type transformers in the nacelle or using an oil-filled transformer in a kiosk adjacent to the tower with oil bunding built into the kiosk;

– Fibreglass weather protector

The proposed turbines would result in efficient transfer of electricity as they have been chosen to match the local conditions in Crookwell. As the height above the ground increases the wind resource generally increases and as a result the turbines under consideration are significantly more efficient than previous smaller models. The turbines under consideration are suited to the wind resource at Crookwell, allowing maximum output capacity to be achieved at significantly lower wind speeds.

The turbines under consideration have a low 'cut-in' speed at nominal wind speeds (i.e. maximum output capacity is achieved at lower wind speeds). Generally, the wind turbines commence operation at a wind speed of approximately 3 to 4 metres per second, gradually increasing to the maximum output rate at 12 to 15 metres per second (depending on the turbine model). From this rate to approximately 20-25 metres per second (depending on the turbine model) the turbine operates at maximum capacity. In order to prevent damage to the turbine and various components, the turbines employ automatic shutdown at speeds above 20-25 metres per second (depending on the turbine model).

As turbines are becoming more technologically advanced they now incorporate other features which assist in monitoring performance with relevant standards. For example, turbines can employ a low noise mode or wind sector management to reduce the noise output and avoid reaching critical noise levels. These systems act to mitigate any isolated occasions where noise output exceeds the permitted threshold. It should be noted that the wind farm has been designed to prevent the risk of such impacts occurring in the first place, however this offers an additional ability to address impacts created by unusual weather patterns or other circumstances.

5.3 Turbine Layout

An indicative wind turbine layout has been prepared that shows 30 turbines. Please refer to **Figures 13** and **14 – Indicative Access & Infrastructure Plans.** The indicative layout was prepared by the proponent using wind modelling software and the consideration of the issues detailed below.

The indicative locations shown reflect the current understanding of the best location for the turbines given the current knowledge of wind characteristics and presence of vegetation.

The indicative wind turbine layout was based on a number of inputs; principally;

– The site boundary;

– Topographical data;

– The location of significant native vegetation and native fauna;

– Noise assessments at key receiver points;

– Dwelling locations;

- Wind speed data collected on and off site;
- Visual amenity impacts (including shadow flicker at the nearby dwellings); and,
- Distance to adjacent turbines.

A number of draft layouts were provided and reviewed by the consultant team. The feedback provided by the consultant team was incorporated into the current indicative layout plan so as to mitigate the impacts of the proposal.

On a hilly terrain such as the Crookwell 3 site, the wind speeds vary across the site depending on the elevation and the location of hills around the site. The predominant winds in the area are from the west and south-west and therefore wind turbine sites are designed to take maximum advantage of these flows.

The indicative turbine layout is based on the eight turbines models shown in **Table 2 – Turbine Comparison**. If project approval is granted, this proposed layout will be refined at the detailed design stage and once the final turbine has been selected so as to achieve the best energy generation from the selected turbine model. It is estimated that this may result in individual turbines being moved approximately 25-100 metres from the currently nominated location on the site plan.

The determination of the final turbine locations during detailed design is required to address:

- the particular siting characteristics of the final turbine chosen;
- any additional site constraints discovered during detailed site investigations (e.g. a discovery of an unusual geotechnical issue);
- further wind speed analysis; and
- access issues determined during the detailed design phase.

Approval is sought on terms which allow the determination of the final turbine locations during detailed design subject to the following criteria:

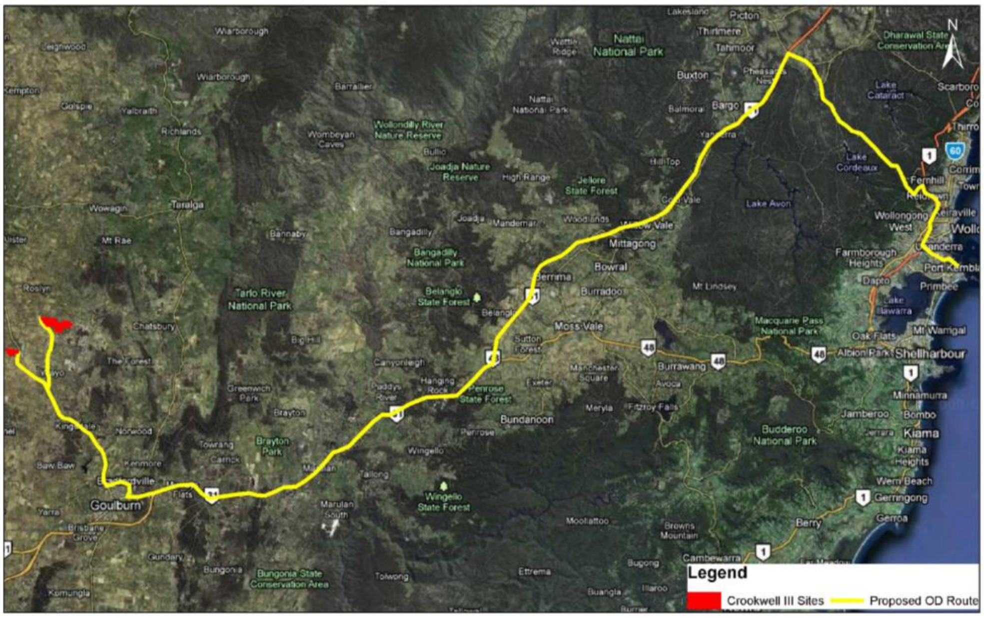
- turbines would not be moved by more than 100m from their indicative locations;
- turbines would not be moved closer to the nearest neighbouring dwelling or any closer than 1.0km to any non-participating dwelling;
- turbines would be located so as to avoid any unnecessary impacts on flora and fauna or heritage items (including items of Aboriginal heritage).

5.4 Access Points

Major access to the region for wind farm components would be achieved by Crookwell Road from the Goulburn Highway (via Goulburn), and raw construction materials and individual turbine components would likely be delivered from Port Kembla.

As the turbine components would be considered Over Dimensional (OD) loads, the route from Port Kembla to the site is of particular importance, and is shown in **Figure 16**. URS Australia Pty Ltd prepared a Traffic Impact Assessment (TIA) in July 2010, which identifies the preferred route for OD Vehicles to site (refer to **Appendix 10 – Traffic Impact Assessment**). This route is composed of three components: Port Kembla to Goulburn; Goulburn bypass; and Goulburn to the site. The preferred route was selected based on, road grade, road width, extent of works required for safe transportation of goods, costs, and appropriateness and directness of route.

Figure 16 – Proposed Over Dimensional Route



The roads from Port Kembla to Goulburn are generally national highways or state roads and are able to accommodate OD vehicles, such as the Hume Highway and Mount Keira Road. The Goulburn Bypass is a designated OD route between the Hume Highway and Goulburn. From Goulburn to the site, OD vehicles would continue along Crookwell Road, which is a major arterial road, to the T-intersection of Crookwell and Woodhouselee Roads.

From the Crookwell/Woodhouselee T-intersection, vehicles would turn right and continue in a northerly direction for another 11 kilometres and turn right into the Crookwell 3 East site. Access to Crookwell 3 South from Goulbourn would be achieved by continuing through the Crookwell/Woodhouselee intersection, travelling north-west for another 7 kilometres and turning left into the site.

For vehicles originating from the north, access to the Crookwell 3 East site would be achieved by continuing down Woodhouselee Road in a southerly direction and turning left at the t-intersection where the Crookwell 3 East site intersects Woodhouselee Road (approximately 4 kilometres south of Crookwell Road/Middle Arm Road intersection). To access Crookwell 3 South from the north, vehicles would continue along Crookwell Road in a south-easterly direction until it intersects with the site, and would turn right at this t-intersection (approximately 4 kilometres south of the Crookwell Road/Elmgrove Road intersection.

To allow some flexibility for access this EA presents three entry options to Crookwell 3 East and two options for Crookwell 3 South. These access options are detailed below:

Crookwell 3 East:

- Option 1 (preferred): Site access via Greywood Siding Road (Crown Road Reserve- not gazetted) and along existing corridor and then turn left and travel in a northerly direction towards the southeast corner of the proposed site;
- Option 2 (alternative): Site access via Boltons Lane 'existing privately used road' (Crown Road Reserve- not gazetted); and
- Option 3 (alternative): Site access via new access road through Leeston and Hillview Park properties on the opposite side of the road to the Rocky Corner property.

Crookwell 3 South:

- Option 1 (preferred): Site access via Crookwell Road, approximately 400 to 500 metres north of where Crookwell Road crosses Wollondilly Creek; and
- Option 2 (alternative): Site access via Crookwell Road on northeast corner of site where Crookwell 3 South abuts Crookwell Road along a horizontal curve and small escarpment.

These options are outlined in more detail in **Appendix 10 – Traffic Impact Assessment** and on **Figures 13** and **14 – Indicative Access & Infrastructure Plans**.

The adjacent Crookwell 2 Wind Farm has been approved and is under construction. The road and intersection upgrades between Port Kembla and the subject area that would be constructed as part of the approved Crookwell 2 Wind Farm include:

- All intersections that require upgrading on the route from Port Kembla to Crookwell, including the Crookwell Road/ Woodhouselee Road intersection.
- Crookwell Road (between Woodhouselee Road and Crookwell 3 South site access).
- Woodhouselee Road (between Crookwell Road and Crookwell 3 East site access).

Refer to **Chapter 16 – Transport** for more information.

5.5 Access Tracks

A network of access tracks would lead from the proposed access points from the public roads to the turbines. The access tracks would connect each turbine and allow the safe passage of vehicles to the base of the tower. These access tracks would only intersect with government roads at nominated access points, therefore reducing impacts on public roads. Please refer to **Figures 13 and 14 – Indicative Access & Infrastructure Plans.**

Existing farm tracks would be used where possible to reduce the need for additional soil disturbance. During the construction phase of the project, these would be widened to approximately 8 to 10m in width to support the extra load of trucks carrying equipment and cranes for the erection of the towers. This width would then be reduced during the operation phase of the project to approximately 5m. The tracks would continue to be used by the farmer to access the property and to attend to grazing livestock.

5.6 Substation, Control Rooms and Facilities Buildings

As the proposed Crookwell 3 Wind Farm would share most of the major infrastructure with Crookwell 2 Wind Farm, a separate substation, control room and facilities building are not required and do not form part of this proposal.

The Crookwell 2 substation and control room is located within the south-eastern corner of the Crookwell 2 site in accordance with **Figures 13** and **14**.

The proposed staging of works would allow the construction of the Crookwell 3 Wind Farm to immediately follow the completion of Crookwell 2 Wind Farm, with the potential for some overlap between the two projects.

5.7 Electrical works

Electrical works are required to link Crookwell 3 Wind Farm to the Crookwell 2 Wind Farm substation.

The electrical works comprise;

- 33 kV electrical cables linking the turbines to each other and the substation, installed generally underground. Overhead powerlines may be utilised to overcome access and terrain constraints in limited circumstances.
- Control cables linking the turbines to the control room, installed generally underground and adjacent to the 33kV electrical cabling.

The underground electrical cables are comprised of conductive wire surrounded by protective coating, and laid approximately 1m deep underground surrounded by soft sand with back fill. Cable markers would identify the path of the underground cabling to prevent accidental digging around the cable trenches.

All cables would generally follow the same alignment as the access tracks, thereby limiting the development footprint of the project. However, there may be several locations where the cable would diverge from the access tracks to reduce electrical losses and to overcome ground constraints.

In order to achieve connection to the proposed substation in Crookwell 2 Wind Farm, connection is required across Woodhouselee Road from Crookwell 3 East. There are two options for connection across Woodhouselee Road, as outlined on **Figure 13 – Indicative Access & Infrastructure Plan – East**.

To achieve connection to the substation from Crookwell 3 South, three options are proposed. These include a combination of easements running through neighbouring properties and linking back to the Crookwell 2 Wind Farm, and one option which incorporates an overland connection along Crookwell Road. Please refer to **Figure 14 – Indicative Access & Infrastructure Plan –South**.

These connection options are outlined below in more detail in **Table 3** below.

Table 3 – Cable Connection Options

Crookwell 3 East – Option 1	Landowner property, through the property hosting Crookwell 2 access road easement from Woodhouselee Road, through the Crookwell 2 property (provisions for easements with landowners in place)
Crookwell 3 East – Option 2	Landowner property, through the property hosting Crookwell 2 access road easement from Woodhouselee road, through the Crookwell 2 property (provisions for easements with landowners in place).
Crookwell 3 South – Option 1	Through the Crookwell Road reserve and then adjacent to the eastern boundary of the Normaroo property, then into the Crookwell 2 site (provisions for easement with Crookwell 2 landowner in place)
Crookwell 3 South – Option 2	Through the Crookwell Road reserve and into the Crookwell 2 property (provisions for easement with Crookwell 2 landowner in place).
Crookwell 3 South – Option 3	Through the Council land on the east of Crookwell road, through multiple properties and then into Crookwell 2 site (provisions for easement with Crookwell 2 landowner in place)

5.8 Vegetation Removal and Planting

5.8.1 Vegetation Removal

Some vegetation removed is required to facilitate access and allow construction of the turbines. The clearing is minimal as the site is already largely cleared and the proposal has been designed to avoid the need to remove native vegetation.

Approximately 2% of the total site area is required for the entire wind farm infrastructure during construction and less than 1% is required during the operation phase of the project.

The key reason for vegetation removal is for the provision of crossovers, access tracks and potentially electricity easements. The access tracks have been designed to avoid native vegetation; however, some vegetation removal is unavoidable. Vegetation removal would also be required for wind breaks in some areas to assist in efficient conversion of the wind resource. The wind breaks are predominantly planted or exotics and therefore do not constitute native vegetation. Where trees are removed the relevant land owner would be consulted and a suitable native species which does not affect the wind resource would be planted in place of the removed wind breaks.

The areas of identified remnant vegetation within the development area are shown in **Figure 8 – Vegetation Plan**. Please refer to **Chapter 14 – Flora and Fauna** for further details on the locations that would require native vegetation removal to facilitate the project.

5.8.2 Vegetation Planting

Vegetation screen planting can be an effective tool in mitigating the visual impact of wind turbines or other infrastructure. It is employed in the vicinity of nearby residences and along roadsides to screen potential views of turbines. Screen planting is only effective where the planting can occur in close proximity to the viewing location (i.e. at a nearby dwelling).

Many of the dwellings in the locality are already surrounded by vegetation that performs, at least to some extent, a screening role. Planting would involve a variety of dense native vegetation, including both trees and shrubs, to effectively screen views.

While the screening is proposed to be in close proximity to viewing locations, the exact area of screening would depend on detailed design and discussions between an affected land holder and the proponent following Development Consent for the project. The planting would be carried out at no cost to the landowner.

5.9 Wind Monitoring Equipment

Two wind monitoring masts have been previously installed on the site to confirm the wind resource and to provide wind speed and direction data.

The existing 60m monitoring masts are not permanent structures, and would be removed and reused elsewhere once the construction phase is complete. Up to three new permanent wind monitoring masts are proposed to be installed during construction of the wind farm. One new monitoring mast is proposed to be installed in Crookwell 3 South and two are proposed to be installed in Crookwell 3 East. The masts consist of a tall, thin tubular or lattice structure and guy wires for support. These masts are approximately 80-105m in height and are proposed to be located as shown in **Figures 13** and **14 – Indicative Access & Infrastructure Plans.**

The main purpose of the permanent wind monitoring masts is to provide an ongoing wind data source to assist with assessing the overall wind farm performance.

5.10 Hazard Lighting

Obstacle lighting consists of two flashing red lights mounted on the turbine nacelle to highlight their presence to nearby aircraft.

The obstacle marking and lighting assessment was conducted in accordance with the recently withdrawn guideline document - *Obstacle Marking and Lighting of Wind Farms (CASA Advisory Circular AC139-18(0))*. Although the document has been withdrawn by CASA for review purposes, it has been used for the purposes of risk mitigation for the proposed wind farm, as recommended by CASA.

An assessment under these guidelines shows that night lighting of approximately 12 of the proposed turbines may be required.

The characteristics of the lights would be consistent with CASA guidelines, which state;

- *Two flashing red medium intensity obstacle lights should be provided;*
- *Light fixtures to be mounted sufficiently above the surface of the nacelle so that the lights are not obscured by the rotor hub, and at a horizontal separation to ensure an unobstructed view of at least one of the lights by a pilot approaching from any direction.*
- *Both lights should flash simultaneously;*
- *Characteristics of the obstacle lights should be in accordance with MOS Pt 139;*
- *All obstacle lights on a wind farm are to be synchronised to flash simultaneously; and*
- *An appropriate monitoring, reporting and maintenance procedure is to be established to ensure outages are detected, reported and rectified.*

More information on aviation impacts can be found in **Chapter 15 – Aviation**. Visual impacts would be minimised by restricting the downward component of the light to either, or both, of the following:

- *Such that no more than 5% of the nominal intensity is emitted at or below 5° below the horizontal,*
- *Such that no light is emitted at or below 10° below the horizontal.*

More information in regard to visual impacts of the lighting can be found in **Chapter 9 – Visual Impacts.**

The need for obstacle lighting for structures of this height is currently under review. It is possible that before construction has commenced, the guidelines would have been revised such that obstacle lighting for structures of this height may no longer be required. The need for obstacle lighting would be reviewed at regular intervals by the proponent and, in the event that the CASA guidelines are revised such that night lighting is no longer required then night lighting would not be installed.

5.11 Temporary Construction Facilities

A temporary construction area would be required within both Crookwell 3 East and Crookwell 3 South. The temporary construction area would contain portable toilets, vehicle parking, assorted construction equipment, a concrete batching plant and vehicle wash down facilities. Please refer to **Figures 13** and **14 – Indicative Access & Infrastructure Plans** for the location of the temporary batching plants.

A temporary hardstand area of approximately 50m x 50m would be required to enable the construction of each tower. The hardstand area would be constructed of compacted soil and gravel to provide a stable platform for construction equipment and the crane. The hardstand area is only required for the construction phase and would be removed following construction.

Temporary concrete batching plants would be required for the construction stage of the project to supply concrete for the turbine foundations. Batching plants need to be central to the activity area and well removed from houses due to the occasional generation of noise and dust. In consideration of these matters, the concrete batching plants are proposed to be located near turbines A29 in Crookwell 3 South and near A17 in Crookwell 3 East. These locations are well removed from habitable dwellings

and central to the activity area which minimises travel distances to individual turbines. Refer to **Figures 13** and **14 – Indicative Access & Infrastructure Plans** for the batching plant locations.

The area for the batching plants would be approximately 50m x 50m. This area would incorporate loading bays, hoppers, silos, hardstand areas, water tanks and stockpile areas for the storage of the aggregates, sands and other raw materials.

The concrete batching plant is likely to produce between 250m^3 and 500m^3 of concrete on an average day.

Where possible, raw materials for the concrete batching plant would be sourced on site, with all materials brought in from external sources being as clean as possible to minimise the potential of introducing weeds to the site. The water for the concrete would either be sought on site subject to a separate licence issued by the NSW Office of Water, or transported to the site via tanker trucks.

Once complete, the areas affected by temporary construction activities would be rehabilitated to their former agricultural state on completion of the construction stage. Detailed Environmental Management Plans would be prepared prior to the grant of construction certificates for the project which would incorporate further detail to manage the impacts of construction activities including the temporary construction facilities.

5.12 Construction

If the project is approved, a number of further steps are required to prepare for construction. These include:

- Detailed design phase of the final wind farm layout, including determination of the final turbine locations in accordance with the principles set out at **Chapter 5.3** above;
- Finalisation of additional agreements with key agencies;
- Preparation of the Pre-Construction Compliance Report
- Finalisation and approval of the Construction Environmental Management Plan;
- Obtaining a construction certificate (if required by the conditions of approval, if granted);
- Tendering for wind turbine components and other key infrastructure; and
- Tendering for the contracts for construction of the wind farm.

These further steps would take approximately one year.

Following this period the full construction phase would commence. This phase would likely take 10 to 14 months subject to delays due to weather and unforeseen circumstances.

At the peak of construction, the project is likely to be employing 40 people, across the tasks detailed in **Table 4** below.

Table 4 – Construction Program

Activity	Works Involved
Site Establishment	Clearing of work areas, levelling and compaction, installation of portable buildings and installation / connection of utility services. Site Survey.
Internal Road Works	Removal of topsoil, levelling, sub-base compaction, gravel, drainage.
External Road Works	Upgrade existing roads where required. Provide new access roads to the site.
Foundations	Removal of topsoil, excavation, screed concrete, reinforcement steel bottom, installation of foundation ring, reinforcement steel top, concreting, concrete ring and conduits, backfilling.
Crane Pad Establishment	Removal of topsoil, base compaction, rock / gravel compaction.
Trenches and Cable Laying, Overhead Powerline	Excavation, sand infill, cable laying with protective covering, backfilling and compacting, installation of cable route markers, installation of overhead powerline for transferring electricity from Crookwell 3 sites to the Crookwell 2 site.
Electrical Works	Control building switchboards, communications, and Supervisory Control And Data Acquisition (SCADA) systems. Installation of cabling, switchgear, turbine control panels.
Turbine Supply	Transport of towers, nacelles, hubs and blades to site.
Turbine Erection	Erection of towers, nacelle, blades, installation of cabling.
Substation Electrical Works	Connection of Crookwell 3 Wind Farm cables to Crookwell 2 Substation, potential installation for an additional HV transformer and switchgear to provide redundancy for the total combined output of the projects.
Wind Farm Commissioning	Pre-commissioning of turbines, SCADA, cables testing, optical fibre. Testing and commissioning of turbines, switchgear, SCADA.
Electricity Grid Connection Commissioning	Final commissioning by the transmission network service provider (Currently TransGrid) prior to connecting the generated electricity on the national electricity grid.
Construction Closure	Site cleanup, revegetation, landscaping.

The majority of the early work in the construction period is to prepare the site for the arrival of turbine infrastructure. This involves road upgrades, access track and hardstand area preparation.

Once this stage is complete, the turbine components can be transported and erected on site, usually at the rate of one or two per week. This involves transportation to the hard stand area at the base of each turbine and using cranes to lift turbine components to assembly the structure. In most circumstances the turbine blades are assembled into the hub at ground level and are then lifted up to the nacelle by crane as a complete ensemble. In other circumstances the turbine blades are individually lifted and assembled into the hub.

The turbines are anchored using large concrete gravity footings. In areas where granite rocks lie at or just below the surface, the footing is directed attached to the rock which

would reduce the amount of concrete required. This may include the potential for rock blasting based on an assessment by the geotechnical engineer. Details of any rock blasting, and associated management techniques, would be provided in the Construction Environmental Management Plan (CEMP).

Temporary facilities within a construction area would include portable toilets, vehicle parking, assorted construction equipment, a concrete batching plant and vehicle wash-down facilities. All temporary facilities would be located so as to avoid vegetation loss and the land would be reinstated to its former state at the conclusion of the construction stage. Please refer to **Figures 13** and **14 – Indicative Access & Infrastructure Plans** for the batching plant locations.

While this section provides an overview of the construction process, the construction would be managed by a management plan, which would address matters such as;

- Erosion control
- Water quality protection
- Soil protection
- Vegetation protection
- Air and dust pollution
- Safety
- Public road network access

Standard construction hours would apply to the project, as outlined below,

- Monday to Friday: 7:00am to 6:00pm
- Saturdays: 7:00am to 1:00pm
- Sundays: No construction

The following activities may be carried outside of these hours as required:

- Any works that do not cause noise emissions to be audible at any nearby residence not located on the site;
- The delivery of materials as requested by authorities for safety reasons; and
- Emergency work to avoid the loss of lives, property and / or to prevent environmental harm.

In the event that it is required to undertake other works outside the above construction hours, prior approval would be obtained from the relevant authority.

5.13 Operation

The operation phase of the project reflects the leasing arrangement with landowners. Landowners have agreed to grant the proponent a 30 year lease with the option to extend for another 30 years. Whilst no plan of subdivision will need to be registered as a result of these proposed leases, the project includes the grant of these leases and any deemed subdivision arising as a result.

During operation of the wind farm, all infrastructure associated with the wind farm would remain the property and responsibility of the proponent.

All access tracks used by the proponent would be maintained by proponent as part of the operation of the wind farm, but would remain available for host landowners' use.

The wind farm would be controlled by a computerised system. The system would link each turbine by fibre-optic cables typically laid in the same trench as the electrical cables. The computerised system would log all operating parameters and initiate the most efficient functionality of the turbines according to prevailing atmospheric conditions. The computerised system would also enable the controller to stop the turbine if required.

The system would ensure that rotational speed and the wind turbine angle operate automatically within the wind speed design envelope. Turbines would be disconnected from the grid at very low and very high wind speeds.

Maintenance of the turbines and associated infrastructure would be conducted throughout the operation phase. Maintenance includes a number of activities over different time periods. These are outlined in **Table 5** below.

Table 5 – Typical Maintenance Schedule

Interval	Task
Monthly	Inspection of turbine generator and electrical infrastructure.
3-6 Monthly	Inspection of all machinery, greasing of bearings, checking of hydraulic oil.
As Required	Periodic painting of tower structure; Replacement of electronic and electrical components; Access track maintenance including erosion control; Substation maintenance inclusive of insulator cleaning, removal of debris and greasing of contacts.

As with any infrastructure project there is potential for equipment breakdown or failure during the lifetime of the project. Whilst most repairs would be likely occur without impacts outside the wind farm site, should any of the raised components (within the nacelle or the blades themselves) need to be replaced, construction equipment such as cranes and other heavy machinery may be required to access the site temporarily. Such equipment may have a temporary impact on the road network but the temporary impact would be likely to be minimal.

As part of the operation phase, a number of monitoring protocols would be implemented. These would include a program to ensure compliance with all approval conditions, including conditions relating to noise, flora and fauna and any other relevant potential impacts. This would also likely include a monitoring program on birds and bats in the vicinity of the site.

5.13.1 Potential refurbishment

Whilst the life of a turbine is more than 20 years and often extends to 30 years, the proposed wind farm has been designed to allow for the possible removal and replacement of turbines during the lifetime of the project. If a turbine needs to be replaced, this process would follow the construction stages outlined above and be consistent with any project approval granted for the project.

Where possible, the existing footings, access tracks and other infrastructure would be reused for any replacement turbine(s) during the operation phase.

5.14 Decommissioning

As noted above, CDPL has entered into agreements for lease of land with the landowners who own land within the site. Under these agreements CDPL will enter into leases of the site for a term of 30 years, with an option to extend the lease for a further 30 year term.

Any continuation of the wind farm beyond the first 30 year period may take the form of one of:

- Extended operation of the original turbines;
- Turbine replacement with the similar model that has newer and more efficient technology; or

– Turbine replacement with a different model that would be subject to the requisite approvals being obtained at that time.

Once the wind farm reaches the end of its useful economic life, the project would be decommissioned.

Decommissioning essentially involves the reverse process to construction. All materials would be removed from the site and recycled appropriately. Access tracks would remain where beneficial to the ongoing use of the land by the owner. Tracks considered surplus to the owners' requirements would be rehabilitated and revegetated by introducing soil, mulch and grass seeds of local provenance.

A Decommissioning and Rehabilitation Plan (DRP) has been prepared for the project by AECOM Australia Pty Ltd (AECOM) for CDPL. It is a requirement of the *Draft NSW Wind Farm Planning Guidelines* (December 2011) that the EA for the project includes a DRP.

The proponent is responsible and committed to the decommissioning of the wind farm infrastructure, and the landowner is not liable for this obligation (this is demonstrated in the land lease agreements with each of the wind farm participating landowners as shown in the DRP).

CDPL seeks to mitigate the potential impacts resulting from the cessation of operation of the facility. This DRP outlines the stakeholder and landowner consultation, expected operational life, dismantling, land rehabilitation, funding arrangements, timeframes and responsibility associated with the decommissioning of the proposed Crookwell 3 Wind Farm. The proponent has committed to implementing this plan.

In relation to consultation, the relevant landowners have been extensively consulted about the project and the issues of decommissioning and rehabilitation were discussed at the early stages of the project. In particular, the DRP was discussed and agreed with all landowners. Feedback from the landowners was generally positive with no objections to the project. A summary of the three landowners' responses follows:

– Two landowners were satisfied with the document and had no additional input; and

– One landowner was concerned about bare soil being left exposed during the decommissioning process. This issue has been addressed in the final DRP.

CDPL has also consulted with the Upper Lachlan Shire Council (ULSC) regarding the project in general and aspects of the construction, operation and decommissioning phases.

CDPL will undertake further consultation with stakeholders prior to and during the decommissioning process.

For further details refer to the Decommissioning and Rehabilitation Plan at **Appendix 4**.