Flyers Creek Wind Farm Pty Ltd

Flyers Creek WIND FARM

Environmental Assessment

CHAPTER 7
Existing Environment

7. Existing Environment

This chapter of the Environmental Assessment provides a review of selected aspects of the existing environment for the proposed Flyers Creek Wind Farm site and its surrounds, together with a review of potential impacts and proposed measures for their mitigation.

It is complemented by subsequent Chapters 9 to 15 which address the more significant aspects of the environment relative to the potential impacts arising from the development of the Flyers Creek Wind Farm. Those chapters and the associated Appendices C to H provide comprehensive assessments that have been undertaken for specific environmental aspects and include a review of the existing environment for those issues.

A guide to the location of the respective information is provided in Table 7.1.

Table 7.1 – Key to location of sections describing the existing environment

Chapter 7		Subsequent Chapters and Appendices		
Environmental Aspect	**Section**	**Environmental Aspect**	**Chapter**	**Appendix**
Regional setting	7.1	Visual & Shadow Flicker	9	C
Climate	7.2	Flora and Fauna (incl. Bats)	10	D & E
Air quality aspects	7.3	Heritage	11	F
Geology	7.4	Noise	12	G
Soils assessment	7.5	Traffic and transport	13	
Site drainage, water resources and water quality	7.6	Telecommunications	14	H
Land use	7.7	Greenhouse issues	15	--
Social aspects	7.8	Safety aspects	16	--
Economic aspects	7.9			

7.1 Regional setting and topography

The proposed Flyers Creek Wind Farm is located within the Central West Tablelands of New South Wales, about 20 kilometres to the south of Orange and about 200 kilometres west of Sydney. The topography of the project locality is typically undulating and rolling low hills, but also includes steep, densely vegetated ranges and extensively cleared, flat grazing lands. The surface elevations of the project locality range from around 650 metres (Australian Height Datum) in the south to 950 metres in the north, with valleys and creeklines up to 200 metres below ridges in some places. The general topographic variations in the immediate project area are shown in Figure 7.1.

Topography in the surrounding region varies, with peak elevations up to 1,397 metres at Mount Canobolas about 20 kilometres to the northwest and 1,200 metres at Mount Macquarie, approximately ten kilometres to south east of the project. There is elevated undulating land to the north and east of the site at general elevations of 900 to about 1,000 metres. Overall, elevations in the project area decrease to the south towards the Belubula River Valley.

The proposed wind farm comprises up to 44 wind turbine sites located on ridges at elevations of between 780 and 950 metres above sea level in the arrangement shown in Figure 7.1. The ridges where the wind farm will be located are between about 110 metres to 210 metres above the surrounding valleys. The substation site is at an elevation of 740 metres.

The proposed turbine placements are in several groupings: Calvert, Fern Hill, Hopkins and Halls-Gap Road, each on elevated ridges. The selected sites offer good potential in terms of wind energy, access for restricted access vehicles (RAVs) from the Mid Western Highway and flat to gently sloping sites

facilitating the turbine construction. The development does not significantly constrain existing land use and will only occupy a small part of the properties where it is located.

The highest topographic points within the wind farm site are in the vicinity of the Calvert Trig Station toward the northern extent of the site, at an elevation of about 960 metres above sea level, and for the southern extent at around 920 metres near Hopkins Trig Station.

The project area is entirely located within the Belubula River catchment. The ridges are dissected by intermittent creeks that drain ultimately to the south-west as described in Section 7.6.

The wind farm site has been mostly cleared for sheep and cattle grazing (Plates 7.1 to 7.10). However, there are a few areas of remnant woodland remaining as indicated in the air photo in Figure 10.1. The mixture of cleared grazing land and scattered woodland provides an element of visual diversity in the landscape.

The density of rural settlement is variable, from absent to very low density for the elevated and exposed properties where the turbines will be located, to low density for lower elevation holdings located in the adjacent valleys.

Plate 7.1 – View to Calvert Trig Station and sites of Turbine 3 and Turbine 4

Plate 7.2 – View from Calvert Site Office toward Turbine Site 4

Plate 7.3 – View to the northwest from Fern Hill Group – Calvert Group ridgeline in the distance

Plate 7.4 – View to the east to Calvert Group from Cadia Road to the west of the wind farm site

Plate 7.5 – View of Panuara Road locality near Cadia Mine.

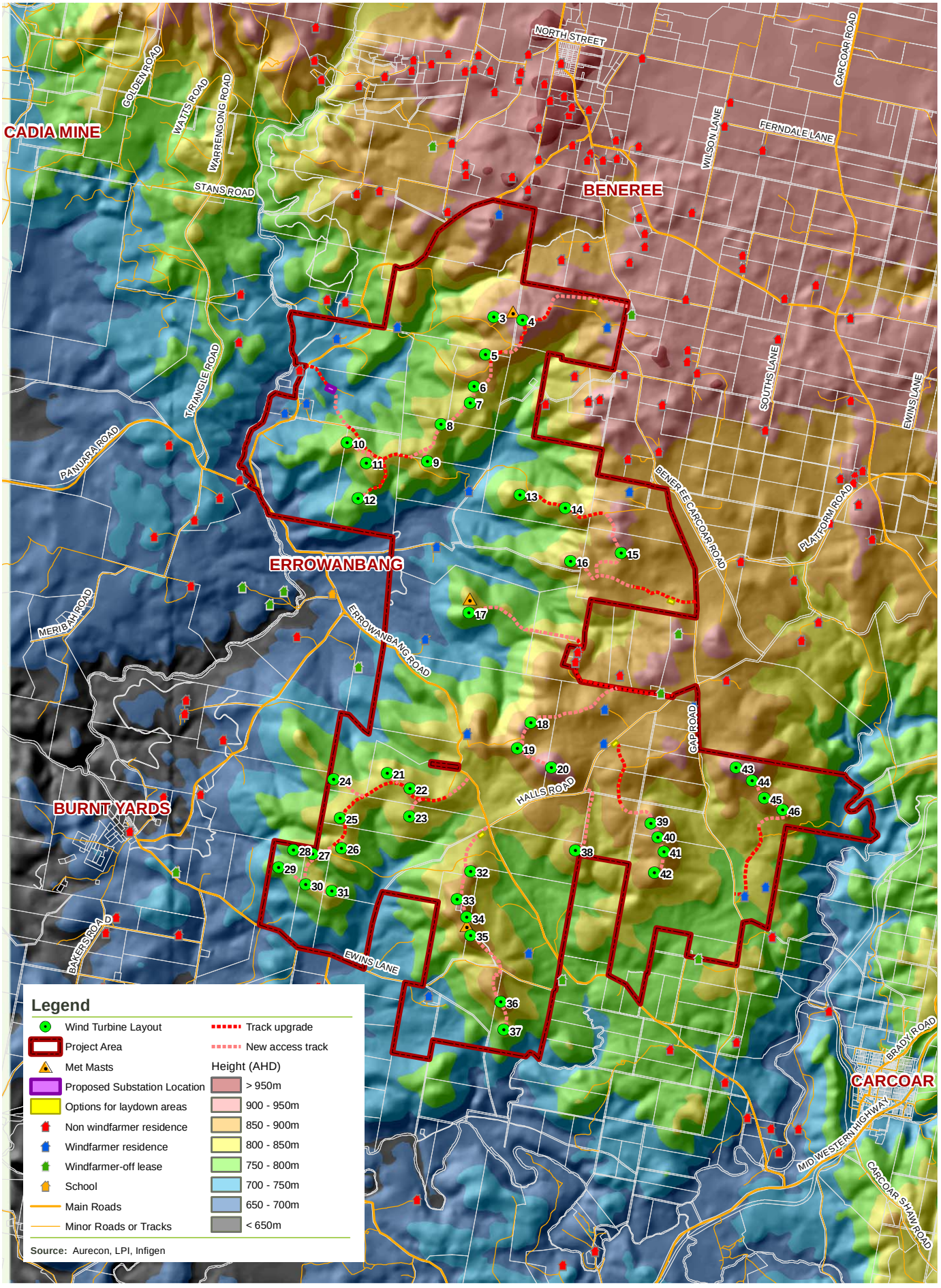
Plate 7.6 – View to the south within Fern Hill Group

Plate 7.7 – View to south towards Hopkins trig station from the Fern Hill Group

Plate 7.8 – View to the west from Fern Hill Group toward south western part of wind farm site

Plate 7.9 – View to the north east from Hopkins Group toward Fern Hill Group

Plate 7.10 – View of Gap Road locality at south-eastern part of the wind farm site



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Projection: GDA 1994 MGA Zone 55

Flyers Creek Wind Farm **Environmental Assessment**

FIGURE 7.1: Terrain Map

7.2 Climate

7.2.1 Climate data

This section provides an overview of climate characteristics for the Flyers Creek Wind Farm locality, based on the Bureau of Meteorology (BOM) climate data for the nearest monitoring stations and wind monitoring data for the wind farm site. Stations that have been referred to are identified in Table 7.2.

Table 7.2 – Locations of climate data stations

Station	Elevation (m)	Ref no.	Period of data	Distance from site
Canobolas State Forest	987	BOM – 063018	1949 - 2009	13 km north west of the site
Millthorpe	960	BOM – 063053	1899 to 2005	11 km north east of the site
Blayney Post Office	863	BOM – 063010	1885 to 1992	12 km east of the site

The climate characteristics summarised in this chapter should be regarded as indicative only, as the wind farm site is distant from and at differing elevations to the reference BOM monitoring stations.

The statistics for the BOM stations represent historical data over the period that the stations have operated. Future climate data may differ due to the effects of enhanced climate change or other causes. Considerable information is appearing in the media and scientific reports that indicate a trend towards global warming, an associated increase in erratic weather characteristics and, for parts of the east coast of Australia, drier conditions. The Australian Bureau of Meteorology has reported trends for changes to total annual rainfall and mean temperature for the period 1970 to 2010 (see examples over page). While it is difficult to quantify the extent of future changes, allowance should be made for variation beyond the climate ranges presented in the following sections.

7.2.2 Precipitation

As indicated in Tables 7.3, 7.4 and 7.5, mean annual precipitation at the Canobolas State Forest, Millthorpe and Blayney Post Office meteorological stations is in the range of 766 mm to 1054 mm. The 9th decile rainfall at the three sites is in the range of 1041 mm to 1434 mm whilst 1st decile rainfall is in the range of 517 mm to 707 mm.

There are minor differences in precipitation between the three meteorological stations nearest to the Flyers Creek site, likely influenced by the differences in elevation and localised topography around each station site. As the wider area contains many ridgelines and valleys, rainfall is influenced by these topographic features to a greater degree than if the region had less topographic relief. As such, precipitation across the wind farm site is likely to also be variable, depending on the elevation and topography of the particular area. However, it is expected to be similar to the precipitation ranges indicated by the three nearest meteorological stations and in the range of 750 mm to 950 mm a year.

Mean monthly rainfall values at the three Bureau of Meteorology (BOM) sites show a trend of higher winter rainfall than summer rainfall, with the period of June to October generally bringing the most number of rainy days as well as higher total precipitation.

The Mid West Region and much of NSW in general have been subject to extended drought conditions over the last decade. Around the Flyers Creek Wind Farm locality the drought was particularly severe in the period between 2002 and 2007, where rainfall was consistently below average, whilst 2008 brought a return to near average rainfall in the region.

Snow also occurs occasionally on the higher elevations of the Mid West ranges, including parts of the Flyers Creek Wind Farm site. Local residents have indicated that on the higher hills and ridgelines in the area snow commonly falls a few days each year.

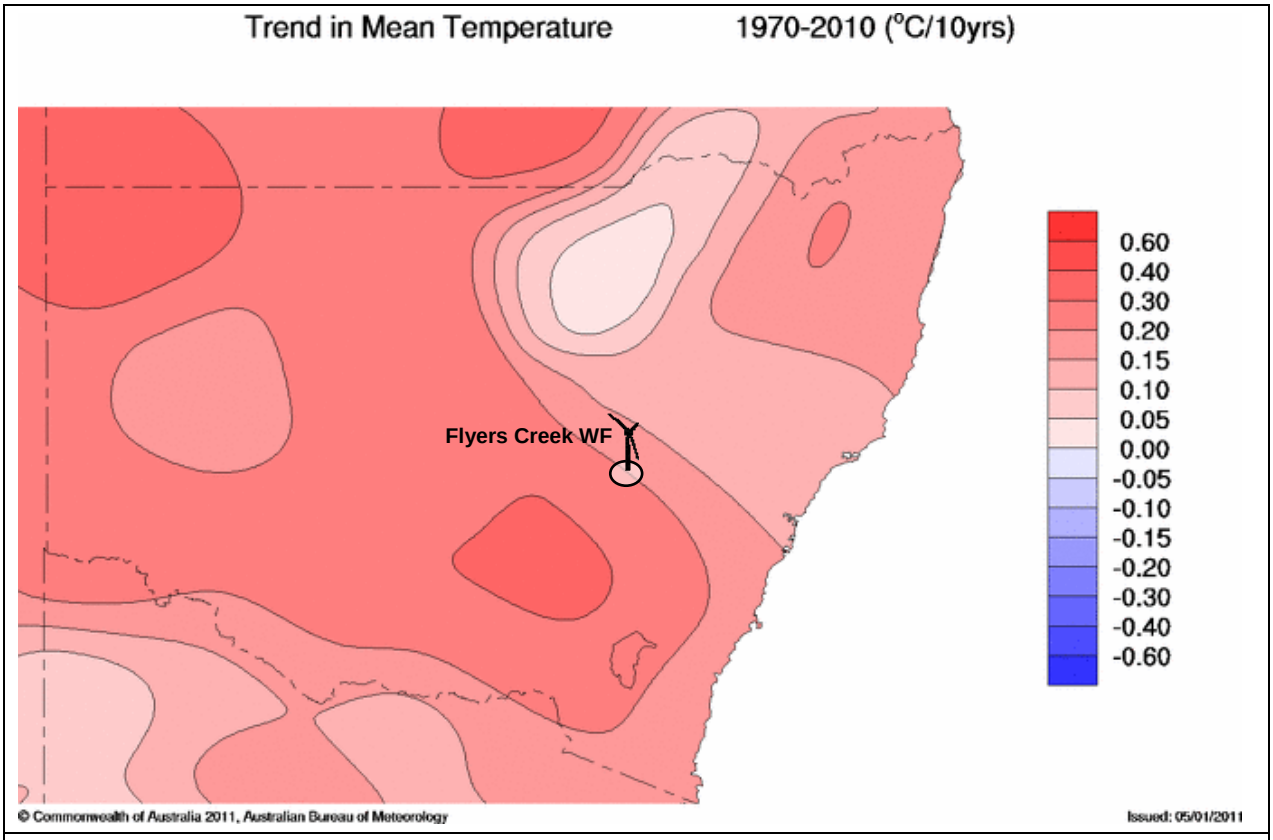


Figure showing trend for change in mean temperature for the period 1970 to 2010 in degrees centigrade (Source Australian Bureau of Meteorology, 2011)

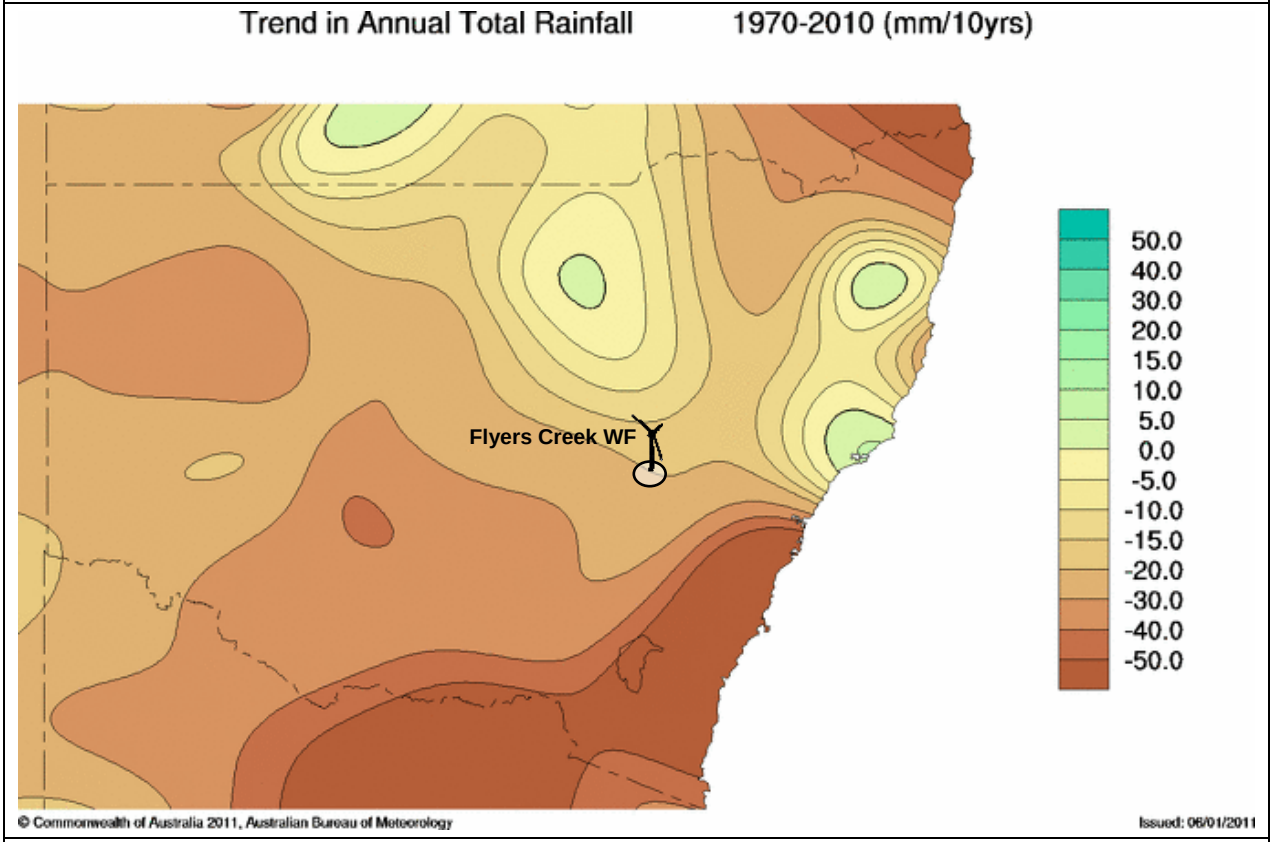


Figure showing trend for change in total annual rainfall for the period 1970 to 2010 in mm/year

Table 7.3 – Rainfall statistics for Canobolas State Forest

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Years of data	54	54	54	54	54	54	54	54	54	54	54	54	54
Mean (mm)	89	82	64	66	83	86	113	119	94	103	85	73	1054
Lowest (mm)	4	3	0	0	3	1	24	4	14	4	6	0	371
Highest (mm)	362	352	243	394	299	272	271	272	223	257	214	248	1823

Table 7.4 – Rainfall statistics for Millthorpe

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Years of data	102	102	102	102	102	102	102	102	102	102	102	102	102
Mean (mm)	72	62	55	53	60	73	76	79	66	78	65	68	806
Lowest (mm)	2	0	0	1	0	1	1	1	8	1	2	0	293
Highest (mm)	285	294	248	270	199	237	202	258	161	248	189	228	1464

Table 7.5 – Rainfall statistics for Blayney Post Office

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Years of data	107	107	107	107	107	107	107	107	107	107	107	107	**107**
Mean (mm)	71	56	53	50	56	72	74	77	64	72	60	64	766
Lowest (mm)	0	0	0	0	0	5	3	0	8	1	0	0	260
Highest (mm)	264	346	200	165	189	226	194	221	148	174	164	210	1327

7.2.3 Temperature

The mean minimum and maximum temperature data for each of the BOM weather stations for the respective record periods is outlined in Table 7.6.

Table 7.6 – Temperature statistics for relevant BOM stations

	Minimum mean daily temperature		Maximum mean daily temperature	
Station	Temperature (°C)	Month	Temperature (°C)	Month
Canobolas State Forest	0.2	July	26.0	Jan
Millthorpe	1.1	July	26.6	Jan
Blayney Post Office	-1.1	July	26.2	Jan

7.2.4 Solar incidence and evaporation

Although evaporation data is limited, data for evapotranspiration is available on the BOM website. Evapotranspiration is a collective term for the transfer of water, as water vapour, to the atmosphere from both vegetated and unvegetated land surfaces, It is affected by climate, availability of water and vegetation. Based on standard 30 year climatology data (1961 to 1990), the annual average actual evapotranspiration in the Flyers Creek Wind Farm locality is expected to be about 500 mm. Evapotranspiration rates in Australia range from about 300 mm in the south central to 1,100 mm in the north near Darwin, where greater moisture levels and warmer temperatures lead to higher rates of evapotranspiration (BOM website, 2011). In general, evaporation is expected to be greatest in summer and least in winter. Coupled with higher precipitation in the winter months, soil moisture is generally highest in winter months and lowest in summer.

7.2.5 Wind data collected at the site

Wind speed and direction data has been collected in the local area since 1995 when Pacific Power installed a 40 metre monitoring mast at the present site of the Blayney Wind Farm. Another wind monitoring mast was also installed near Orange as part of the NSW network of wind monitoring sites installed by the former Sustainable Energy Development Authority (SEDA). The matters addressed by SEDA have now been incorporated in the responsibilities of the Department of Industry and Investment (DII).

In mid 2008, the proponent installed three additional 80 metre wind monitoring masts at the wind farm site. Data gained from the new masts provides more detail of the wind resource to assist the final design of the wind farm layout and equipment specifications. The 80m monitoring level provides greater confidence in predicting wind energy for the type of wind turbine equipment being considered for the site. As discussed in Chapter 3, temporary and permanent masts are required for performance monitoring of the installed wind farm. The existing monitoring masts are likely to remain as permanent masts but if they prove to be unsuitable for performance verification or ongoing monitoring, for example if they are affected by the operation of an installed turbine, they may have to be relocated to alternate locations on site.

A photograph and a graphic representation of the distribution of wind speed and direction at the site based on the Southern mast is shown in Figure 7.2. As can be seen in Figure 7.2, the predominant wind direction (more than 30% of the time) at the Flyers Creek Wind Farm site is from the west. The next most prominent wind direction is from the north east and together with the westerly winds account for about 60% of the winds measured at the site. The contributions from the south are only about 10% of the wind at the site.

The wind turbine layout in this Environment Assessment has relied on the results of detailed analysis of the wind speed data and an energy model derived from data gained from the three on-site monitoring masts and long term correlation to the automatic weather station at the Orange Aerodrome.

7.2.6 Wind energy model

Modelling of wind energy data has confirmed the site's capability to sustain a viable wind farm. A wind energy map showing relative wind power distribution for the site is included as Figure 7.3. Turbine locations can be seen relative to the energy zones but the locations of turbine sites shown differ slightly from that in the proposed array. Some high energy locations have not been selected for the final array due to environmental and/or access constraints.

7.3 Air quality aspects

7.3.1 Existing air quality

Due to the moderate rainfall in the Flyers Creek area and good grass cover there is less likelihood of air borne dust than for other drier parts of the state. The existing air quality in the Flyers Creek area can vary with the seasons in response to airborne particulate matter associated with windy and dusty conditions and events such as bushfires. Visibility can also be affected by climatic factors such as low cloud cover on the ranges and fog and mist in the lower areas.

The southern end of the wind farm site is approximately five kilometres from the Mid Western Highway and it is unlikely that any impact from highway vehicle emissions on air quality at the wind farm site would be significant.

There are several small quarry sites within the vicinity of the wind farm site. One on the wind farm site is near the Crown Castle/Optus communications tower and accessible from Errowanbang Road. A second is adjacent to the Burnt Yards Mandurama Road to the south of the wind farm. They have been previously used as a source of gravel and are still open and potentially available subject to suitability of the material and approvals for removal of the required gravel. A second quarry is near the south western extent of the project area.

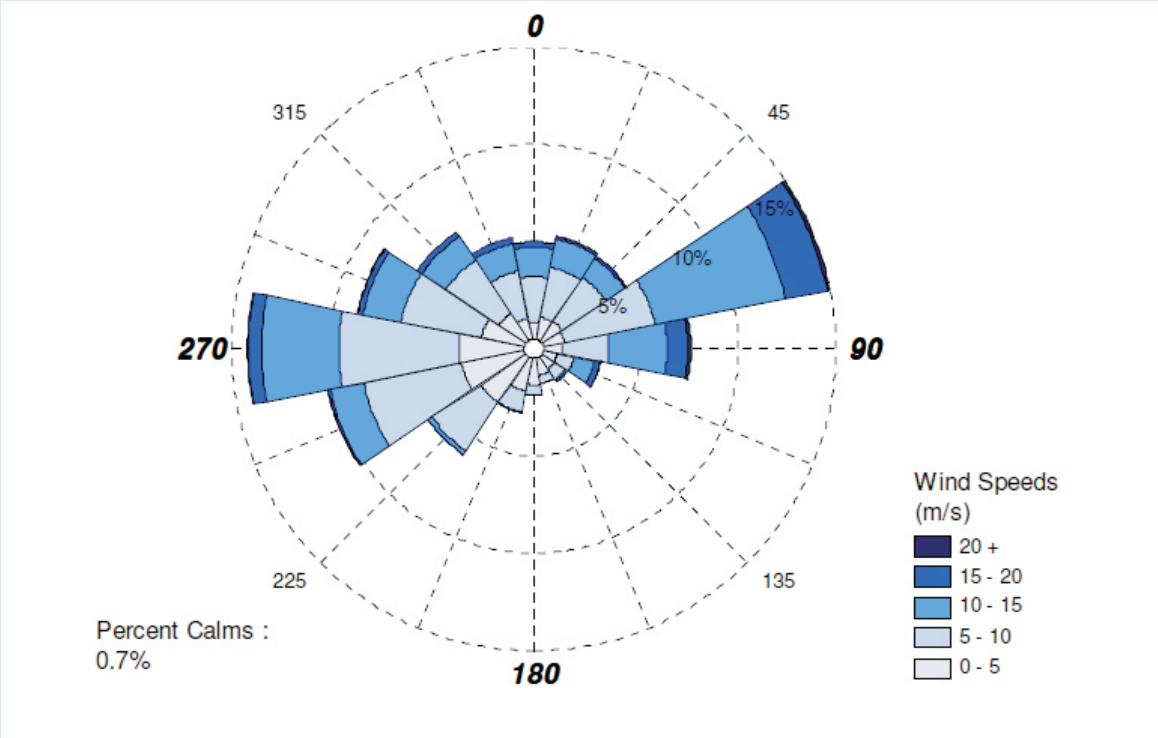
Agricultural activities such as ploughing of fields can also be associated with air borne dust during drier conditions.

7.3.2 Impacts of the operation wind farm on air quality

The wind farm represents a low emission form of electricity generation that will have very little impact on the air quality of the locality once operational. Other forms of electricity generation using fossil fuels such as coal and gas produce emissions of nitrogen oxides, carbon dioxide, sulfur dioxide and in the case of coal fired generation, particulate emissions and large volumes of ash.

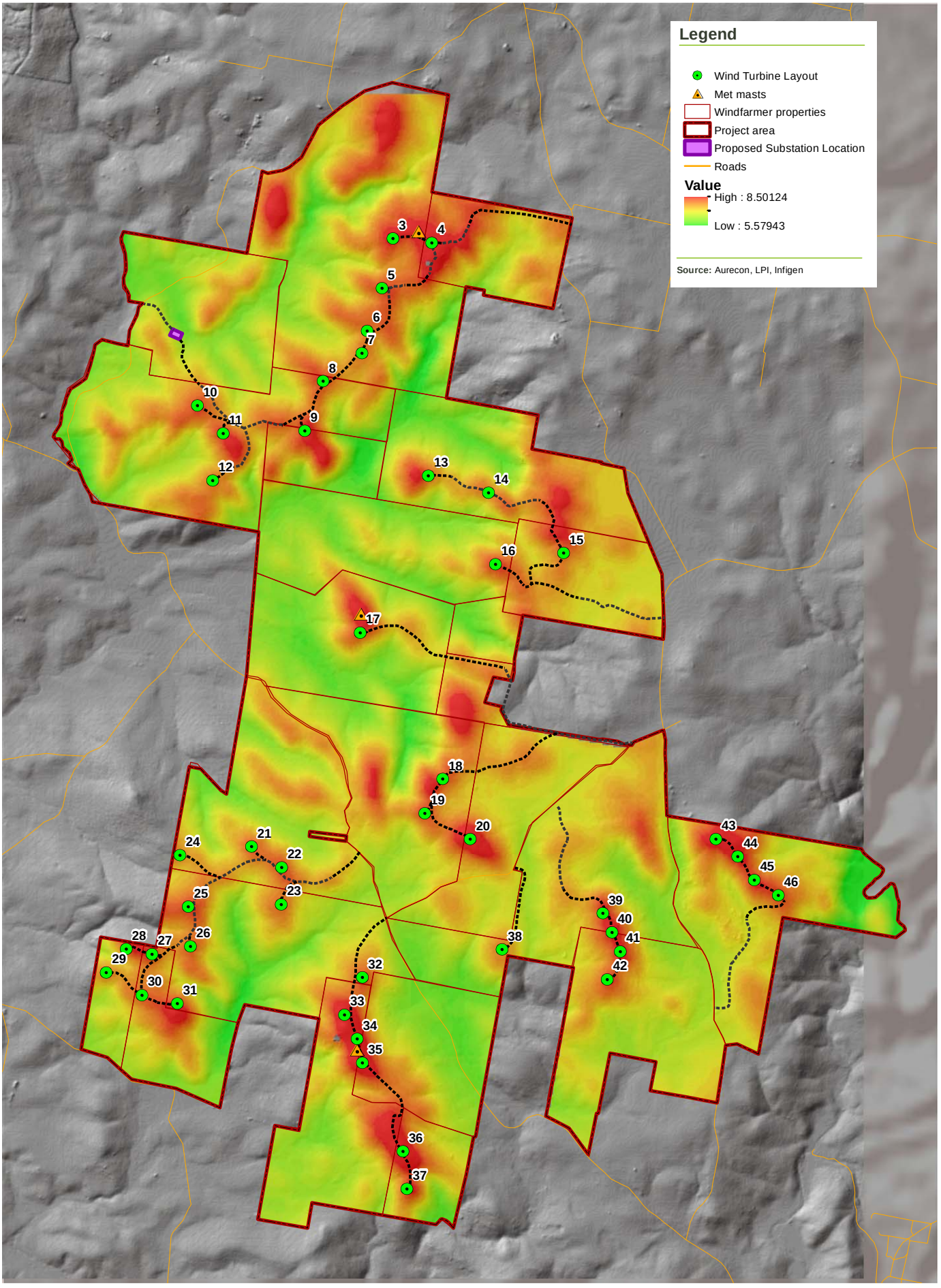
The turbines will not produce emissions at the site. The very low emissions associated with the project are mainly associated with the manufacturing of equipment at other locations and transport of equipment and materials to the site. When operational, vehicle emissions associated with the small number of operators and maintenance staff visiting the site will be negligible. Overall, there will be net savings in emissions for electricity generation associated with this renewable energy project to the extent that fossil fuelled electricity generation at other sites is displaced (See Chapter 15).

Dust generation can be associated with construction earthworks, and control measures will be employed to address this aspect (Section 7.3.3 below). Due to the small areas of earthworks required for the wind farm relative to local rural activities such as ploughing of fields, dust generation from the wind farm construction is likely to be relatively minor contribution to the overall dust generation in the region.



Southern Mast Wind Rose for representative 12 month period

Figure 7.2: Southern Mast and Wind Rose for representative 12 month period



Flyers Creek Wind Farm **Environmental Assessment**

Projection: GDA 1994 MGA Zone 55

FIGURE 7.3: Wind Energy Resource

7.3.3 Impacts on air quality during the construction stage

The construction stage involves a significant amount of earthworks and the transport of large amounts of equipment and materials to the site, as well as some drilling operations. These all have the potential to impact on the air quality of the site and management measures will be utilised to mitigate this, as described below.

Earthworks: Exposure of soils for foundations and access track construction and the formation of topsoil and weathered rock stockpiles means that there is potential for the wind to create airborne dust that could degrade local air quality, albeit temporarily. Control measures will be incorporated in the works to ensure that such impacts are minimised.

The controls could include:

- Rolling and possibly wetting of access tracks with water to compact loose soil exposed during initial track formation
- If necessary, application of approved wetting agent to exposed soil during dry and windy periods
- Capping of access tracks with gravel to suit the track usage requirements and limit dust generation
- stabilisation of exposed soils and stockpiles
- Where necessary, placement of stockpiles in locations sheltered from wind and surface water flows
- Restoration of disturbed areas as soon as possible

These measures will be integrated in the project Soil and Water Management Plan (see also Section 7.5.4). Where use of local water supplies is required for dust control the extent of water use can be balanced against water supply availability and severity of dust events in the context of other rural activities. This may require consultation with Blayney Shire Council and DECCW Guidelines to determine the approach that is acceptable for addressing air pollution while conserving local water resources.

Vehicle movements: All vehicles delivering equipment, materials and personnel to the site during the construction stage will be registered vehicles that are required to maintain the necessary emission controls. These vehicle movements will be confined to the construction period of twelve to eighteen months and their impact on local air quality is likely to be negligible.

Drilling for rock anchor installations: The turbine footings will involve a reinforced concrete block to which the tower will be attached. To ensure stability of the footing, rock anchors may be required. Air blast drilling is often used to prepare the hole into which the rock anchors will be inserted and can be associated with dust plumes if not subject to controls. Dust filters and/or mist sprays will be applied to control any dust resulting from the air blast drilling.

7.4 Geology

This section of the Environmental Assessment describes the geology of the project area, the associated mineral resources, geotechnical considerations and earthquake potential for the site. Measures incorporated in the project to address these aspects are outlined in the following sections.

7.4.1 Regional and site geology

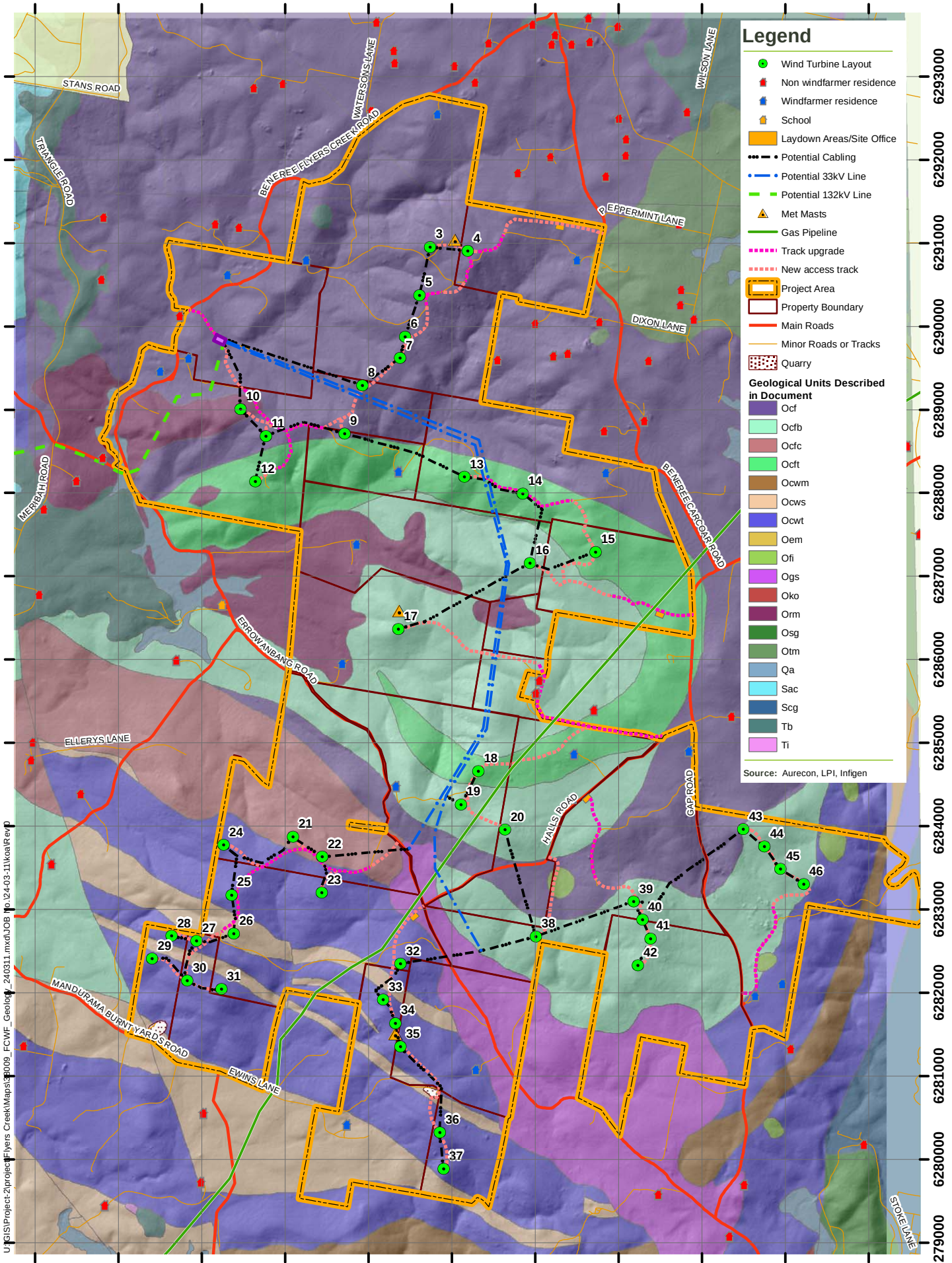
The wind farm site is within a geological domain comprising Ordivician volcanics and Silurian sediments and intrusives. To the north the dominant geology is the Tertiary Canobolas Volcanics, to the east Devonian sediments and the Carboniferous intrusives of the Bathurst Batholith. To the south are Ordivician turbidites whilst to the west the dominant formations are Devonian sediments, volcanics and intrusives.

The wind farm site itself predominantly comprises Ordivician volcanics known as the Forest Reefs Volcanics. These consist primarily of mafic volcanoclastics and siltstones with basaltic subvolcanic intrusives, volcanic conglomerates and latites. The wind farm site also contains small pockets of Later Ordivician Intrusions (monzonite/syenite/diorite) as well as shales, limestones, sandstones and siltstones of the Waugoola Group and feldspathic siltstone, sandstone and limestone of the Ashburnia Group. Alluvial sediments derived from generally volcanic rocks are present in the valleys along water courses

The geology of the area in the vicinity of the Flyers Creek Wind Farm site is illustrated on Figure 7.4. The geology map is based on the 1:250,000 Geological Map: Bathurst Geology second edition, 1998, published by the Australian Geological Survey Organisation. A description of the geological units that are displayed in Figure 7.4 are given in Table 7.7.

Table 7.7 – Geological Unit Description

Map Symbol	Group	Unit name	Description
Ocf	Cabonne Group	Forest Reefs Volcanics	Mafic volcaniclastics, volcanic conglomerate, siltstone
Ocfb	Cabonne Group	Forest Reefs Volcanics	Clinopyroxene basalt, agglomeratic in places, basaltic subvolcanic intrusives
Ocfc	Cabonne Group	Forest Reefs Volcanics	Volcanic conglomerate
Ocft	Cabonne Group	Forest Reefs Volcanics	Latite
Ocwm	Cabonne Group	Weemalla Formtion	Porphyritic trachybasalt, pillow lava
Ocws	Cabonne Group	Weemalla Formtion	Siltstone, sandstone, mudstone, chert, marble, calcareous mudstone
Ocwt	Cabonne Group	Weemalla Formtion	Mafic volcaniclastics, sandstone, conglomerate
Oem	Ordovician Intrusions	Tettenhall Monzodiorite	Porphyritic and aphyric monzonite and diorite
Ofi	Ordovician Intrusions		Diorite, monzonite, syenite
Ogs	Ordovician Intrusions	Glen Ayr Syenite	Biotite syenite, biotite clinopyroxene monzonite
Oko	Kenilworth Group	Coombing Formation	Feldspathic siltstone and sandstone, chert
Orm	Ordovician Intrusions	Errowan Monzonite	Biotite clinopyroxene monzonite, altered quartz syenite, pyritized monzonite
Osg	Ordovician Intrusions	Stokefield Metagabbro	Foliated plagioclase-phyric metagabbro
Otm	Ordovician Intrusions	Tallwood Monzonite	Porphyritic clinopyroxene monzonite and monzodiorite
Qa	Cainozoic Units		Alluvium; gravel, sand, silt, clay
Sac	Ahsburnia Group	Cadia Coach Formation	Feldspathic siltstone, mudstone, poorly sorted sandstone, limestone, conglomerate
Scg	Other Silurian Intrusions	Carcoar Granodiorite	Hornblende biotite granodiorite and tonalite
Tb	Cainozoic Units		Pyroxene olivine basalt, plagioclase basalt, alkali basalt, trachybasalt, trachyandesite
Ti	Cainozoic Units		Silcrete, silicified gravel



Flyers Creek Wind Farm **Environmental Assessment**

Projection: GDA 1994 MGA Zone 55

FIGURE 7.4: Geology and Project Layout

The access tracks for the project mostly follow the ridges but in places cross the lower topographic areas including slopes, saddles and creek crossings but are mainly located in the upper parts of the creek catchments where alluvial deposits are less well developed. Areas of alluvium are present along parts of the adjacent creeks, namely Flyers, Slatterys, Gooleys, Cheesemans, Kangaroo Flat, Dirt Hole and Cowriga Creeks.

The area has in the past been associated with prospecting and, in places, small mining operations are indicated and some traces of these activities can still be observed. Extensive exploration drilling has also occurred within the project area and the Department of Industry and Investment and relevant mining companies have been consulted regarding any land use conflict that may arise from the mining and wind farm development interests.

7.4.2 Geological structure

The geological domain in which the Flyer's Creek site occurs is known as Molong Wanga Zone and this sequence has been faulted and folded with several major generally north–south trending faults identified in the area, the largest of which are the Werribee fault to the west of the site and the Carcoar fault to the east. There are several other minor faults in the area, some of which occur within the Flyer's Creek Wind Farm site. The mineralisation associated with the Cadia Valley Operations appears to exhibit a generally northwest to southeast strike direction.

In many places there are strong and resistant rocks that form ridges with examples of rock exposures shown in Plates 7.11 to 7.14. Slatterys and Gooleys Creeks are associated with steep sided valleys and rocky slopes. Rock exposures are often jointed and blocky. In particular, the southern side of Fern Hill appears softer and more erodible than much of the site. The Gap Road area is also associated with some scouring and gullies along water courses. More elevated areas to the north of the site appear to have good vegetation cover and exhibit less tendency to erosion.

Plate 7.11 – Rocky knoll near Turbine 36 site on Hope Hill

Plate 7.12 – Rock exposure near Turbine site 32

	
Plate 7.13 – Rock outcrop east of Turbine Site 17	**Plate 7.14 – weathered rock from previous small scale mine workings**
	
Plate 7.15 – Quarry on Lot 201 on wind farmer land	**Plate 7.16 – Quarry near Optus Communications facility between Turbine sites 35 and 36.**

7.4.3 Mineral potential

There have been significant identified mineral deposits in the vicinity of the Flyers Creek Wind Farm site, the most prominent being the large Cadia copper/gold mining operations located five to ten kilometres north west of the proposed wind farm site. The Cadia Valley Operations includes three separate mining operations in that area, Cadia – Ridgeway, Cadia Hill and Cadia East all owned and operated by Newcrest Mining.

The Cadia Hll mine has been operational since 1998 and Cadia - Ridgeway commenced operation in 2002. The Cadia East underground mine received planning approval in 2010 and is currently under construction.

The Browns Creek Mine site is located between Blayney and the wind farm site but is understood to be no longer active and undergoing rehabilitation.

The area would be regarded as having high mineral prospectively. However, it is important to note that no “identified resources” (proven mineral deposits that can be economically extracted) have been discovered within the proposed wind farm boundary during many years of exploration activity using a variety of different technologies.

There are three exploration licences that overlap the Flyers Creek wind farm site. These are discussed in Section 4.4.5.

7.4.4 Geotechnical assessment

A preliminary field inspection of the site has assessed the nature of the ground in the vicinity of the turbine sites and the likely underground cable routes. This will be supplemented by a geotechnical investigation for the contract works to assess the subsurface characteristics. Initial assessment has revealed some variability in rock characteristics but no obvious geotechnical constraints that would preclude the proposed development. The preliminary survey found that:

- The potential turbine sites are located on stable ground on the ridge tops comprising various rock types and appear to have acceptable foundation conditions. Rock outcrops are not common in grass covered pasture areas but rock is observed to occur at shallow depth. A significant proportion of the turbine footings may intersect resistant rock requiring hydraulic rock breakers. It is not expected that any low level blasting will be required to remove the rock as it is expected to be jointed enabling removal with the hydraulic rock hammers and bulldozers or excavators.

- In the unlikely event that low level blasting is required, it is expected to be confined to small localised areas and performed in a controlled environment in accordance with all statutory and project approval requirements. Potential impacts from any blasting may include noise, ground vibrations and overpressure. Mitigation measures to address potential impacts include limits on hours when blasting may occur. In addition, DECCW requirements will be adhered to in respect to controlling blasting and the associated impacts for neighbouring residences, should low level blasting occur.

- As far as possible, the locations of the access tracks have been selected to avoid steep slopes and provide reasonable grades. Based on the initial observations, the existing ground surface is stable and in most cases appears to provide a solid sub-base material for access track construction. Some areas of high erodibility for steep sections of track may require special treatment to avoid erosion of the track. Suitable roadbase material could be obtained from within the project area or may be imported from outside the project area (subject to appropriate testing and any approvals required) or subject to gaining required approvals obtained from on-site quarries. Where access tracks cross any alluvium filled creek valleys it may be necessary to increase the thickness of road base material and provide suitable drainage measures.

- Installation of underground cables will require some excavation in rock and will encounter a range of conditions given the observed variation in the rocks present at the site.

Further geotechnical assessment will be undertaken by the appointed contractor prior to finalising specific aspects of the project design such as turbine and substation footings.

7.4.5 Geological hazards

The region in which the project is located is indicated by Geosciences Australia to have a low incidence of earthquake activity and a search of historical occurrences of earthquakes in the region shows no occurrences since 1840 (when Australian records began) of earthquakes within 50 kilometres of the wind farm site. The nearest relevant recorded earthquakes beyond 50 kilometres of the proposed wind farm site with a magnitude above 4.0 are shown in Table 7.8.

Table 7.8 – Recorded earthquakes with a magnitude above 4 and their location

Date	Magnitude	Location
18 October 1872	5.3	Approximately 30 kilometres south of Lithgow (120 kilometres east of Flyers Creek site)
25 September 1947	4.6	Approximately 25 kilometres south west of Cowra (90 kilometres south west of Flyers Creek site).
21 October 2006	4.2	Approximately 80 kilometres south of Flyers Creek site
23 November 1961	4.0	55 kilometres north of Flyers Creek site

There are no known major active volcanic or surface tectonic structures in the project area.

The structure of the basaltic rocks to the north of the site has produced a generally elevated rolling topography with low relief typical of the Forest Reefs to Millthorpe area. To the south, the Belubula River Valley and its tributaries have dissected the more elevated areas and exposed the underlying metasediments and metavolcanics. For areas of steeper slopes, slumping can be a hazard that may be initiated by heavy rain and exacerbated by poor drainage design. There is no evidence of any large scale landslides at the site which could influence tower or access track stability. Nevertheless, attention will need to be paid to formation of any tracks on the steeper slopes and formation of associated drainage.

Footings for the towers that support the wind turbines will be designed in accordance with the relevant engineering standards.

7.5 Soils assessment

This section of the Environmental Assessment provides a description of soils within the project area, the potential impacts of the project on the soils and measures to mitigate the impacts.

7.5.1 Soil landscapes

The NSW Natural Resource Atlas indicates that there are three main soil landscapes within the Flyers Creek Wind Farm site shown in Figure 7.5. The main features of these three soil landscape types are summarised in Table 7.9.

Table 7.9 – Summary of soil landscape characteristics at the wind farm locality

Soil Landscape	Parent rock	Soil Landscape – general characteristics	Erode-ability	Erosion Hazard	USCS Code
Vittoria-Blayney (Alluvial-colluvial) (REvb)	Various, many derived from older andesitic volcanics	Undulating to rolling low hills with drainage lines spaced from 800m – 1,000m apart. Red earths occur on well drained crests and sideslopes, with yellow earths on moderately to imperfectly drained footslopes. Elements of Panuara occur in this landscape.	Low to moderate	Slight to moderate	ML CL CH
Panuara (Alluvial-colluvial) (RPpu)	Andesite, tuff, limestone, siltstone and shale	Undulating low hills to rolling hills with drainage lines running west and spaced from 500m – 800m apart. Red podzolic soils are the main soils occurring on mid to upper slopes. Yellow podzolic soils occur on lower slopes with red earths or brown/red earths.	Low to moderate	Moderate to high	CL CH
Quarry (Colluvial) (SSqu)	Intermediate rocks including syenite and monzonite	Present in small areas within the Panuara district. Rolling low hills with drainage lines spaced 500 – 700m apart. Dominant soils are pale siliceous sands on midslopes, with yellow earths and podzolic soils on lower slopes. Shallow sands and red podzolic soils occur on upper slopes.	Low to moderate	Moderate to high	SP

Note: Unified Soils Classification Scheme (USCS) Codes: Group symbol / name, CL / clay, CH / clay of high plasticity, ML / silt, SP / poorly graded sand.

The typical landscape of the area is undulating low hills, becoming more rolling in the southern half of the project area. Along the ridgetops the soils are expected to be predominantly shallow, skeletal soils, with deeper soils expected on the lower slopes, valley floors and drainage lines.

Turbine sites are located on ridges that will have various soil characteristics, dependent on underlying rock characteristics, local topography, nature of weathering, disturbance by agriculture, mining or other activities. The substation and some turbine sites will be located in Vittoria-Blayney soil landscape, with the majority of the turbine sites located in Panuara soil landscape. Within each soil landscape there is scope for variation in the characteristics of any particular location based mainly on:

- the general physical variations within the underlying rock unit
- the degree of deformation, alteration, metamorphism or weathering that the rocks have undergone
- the aspect and slope of the location that influences drainage and weathering characteristics

Plate 7.17 to 7.20 show exposures of the soils at several locations within the project area. While soils are general thin on the rocky ridges and appear fertile there are a few locations that indicate higher levels of erodibility (eg Plate 7.17). Overall, existing instances of erosion are rare and for most parts of the site, substantial grass cover is present.

Plate 7.17 - Erosion of batter adjacent Gap Road exposing soil profile

Plate 7.18 – Large ploughed paddock to north of Turbine 38 showing dark red-brown soil

Plate 7.19 – Thin dark brown soil with exposed rock near Turbine 16

Plate 7.20 – Leached clayey soil near access track route to Turbine 16.