Flyers Creek Wind Farm Pty Ltd

Flyers Creek WIND FARM

Environmental Assessment

CHAPTER 12
Noise

12. Noise Issues

This chapter of the Environmental Assessment summarises the findings of a comprehensive assessment of the potential noise impacts arising from the construction and operation of the proposed Flyers Creek Wind Farm. The specialist assessment reports prepared by ViPAC Engineers and Scientists (ViPAC) are attached as Appendices G1 and G2. A summary of the key aspects of the assessments are included in the following sections together with the proposed measures to be incorporated in the project to ensure that noise impacts comply with the acceptability criteria specified in the Director General's Requirements for the Environmental Assessment.

12.1 Introduction

The ambient noise environment in rural areas may include noise contributions from a variety of sources, including the wind, rain, vehicles, machinery, animals and activities such as mining. Ambient noise levels can exhibit both diurnal (time of day) and seasonal variability. A wind farm can add to existing rural noise levels in the near vicinity of the wind farm. Whether the additional noise is regarded as significant or disturbing will depend on a range of factors, including subjective factors, as well as on measurable aspects. These could include how loud the sound is, the distance between the source and receiver, how long the noise lasts, the tone of the sound and the time of day or night and the prevailing weather conditions at which it occurs.

The following sections describe the nature of the existing acoustic environment, the nature of the noise arising from the proposed development, the potential acoustic impacts of the development, and how the proposed wind farm will comply with the noise criteria specified by the NSW government which are the strictest wind farm noise limits in the country.

12.2 Overview of noise impacts and their assessment

Potential noise impacts associated with the wind farm may be related to the construction or operational stages. The operational noise sources include:

- Rotating electrical and mechanical parts
- Aerodynamic noise as the blades pass through the air
- Transformer related noise
- Maintenance activities

Construction noise sources include transport vehicles, excavators, earth moving activities and cranes.

The ViPAC noise assessment included review of background noise and derivation of criteria (Appendix G1) and review of the potential impacts of the noise sources on the identified noise sensitive receiver locations surrounding the wind farm site (Appendix G2). Aspects of the noise assessment included:

- Identification of noise source locations
- Identification of noise sensitive receiver locations (predominantly residences)
- Measurement of existing background sound levels at five representative residence locations
- Development of noise criteria based on existing measured background sound levels and the specified noise standard
- Identification of construction noise sources and prediction of potential sound levels at residential locations
- Identification of potential wind turbine sound power levels and spectra
- Modelling to derive predicted sound levels of the wind turbine array at residential receiver locations
- Comparison of predicted sound levels and the applicable noise criteria for all receiver locations
- Assessment of noise impact of the total project
- Identification of measures to ensure compliance of the project to the relevant standards

The method used in the assessment of the operational impacts of the wind farm was guided by the Director-General's assessment requirements (Appendix A), which required the use of the South Australian EPA (SA EPA's) Guidelines entitled "*Wind Farms, Environmental Noise Guidelines: February 2003*". While the SA EPA released an updated version of their Noise Guidelines in 2009, the Department of Planning has not advised the proponent to use the newer version which includes, amongst other changes, less strict noise criteria for residences in rural areas. The 2009 guidelines specify that wind speeds for background noise monitoring be measured at hub height rather than at 10 metres as was the case for the 2003 guidelines. The application of the guidelines to the noise assessment undertaken by ViPAC is explained in Appendices G1 and G2.

12.3 Project components relative to noise impacts

The assessment of the operating wind farm's noise impacts has been based on the use of 44 wind turbines and a 33 kV to 132 kV substation each of which will have specific noise characteristics. Associated electrical works including the underground cables, generator transformers and grid connection will have negligible operational noise impacts. During operations the access roads will be used by a small number of site staff for inspection and maintenance. The turbines will be located along elevated ridges about 10 kilometres west of Blayney and six kilometres south of Forest Reefs (Figure 12.1).

The proposed layout has been designed to achieve acceptable impacts at neighbouring residences primarily through ensuring sufficient setback of turbines from the closest residences. The noise assessment has derived the predicted noise levels for each of the residences within three kilometres from the nearest wind turbine to ensure that the selected layout enables compliance with the noise level criteria. For the purpose of the noise assessment the noise characteristics of the GE 2.5xl 2.5 MW turbine have been used. This turbine was selected for the noise assessment as being the turbine with the noise levels typical of the turbines that are under consideration for the project.

The substation will include two 33 kV/132 kV transformer(s) that will have a total rating in the range of 60 to 80 MVA for each transformer or up to 160 MVA for the whole substation. Associated electrical equipment will include items such as switchgear, circuit breakers and metering devices. The actual rating of the transformers used will depend on the number of turbines to be installed, their capacity and the technical and commercial considerations for transformer design and acquisition. The noise arising from the substation transformers may increase with the wind farm output (and electrical loading) and can also be associated with tones of 100 Hz or multiples of 100 Hz.

12.4 Noise sensitive receivers

The wind farm site is located in an area of rural land on generally moderate to large size properties. Figure 12.1 shows the location of residences surrounding the wind farm and Table 12.1 shows the distribution of residences in terms of distance from the nearest turbine, occupancy status and ownership status relative to the land leased for the wind farm and as described below.

12.4.1 Residences

The residences are distinguished by whether they are on properties where the landowners have lease agreements with the proponent for the operation of the wind farm, referred to as 'wind farmer' residences, or if they are neighbours, in which case they are regarded as 'non-wind farmer' residences. For the purpose of noise impact assessment, residences are generally classified as follows:

- **Relevant receivers:** Neighbouring residences to the wind farm site. These are also referred to as non-wind farmer residences and are shown in Red in Figure 12.1.
- **Non-relevant receivers**: These are also referred to as wind farmer residences. A wind-farmer residence is one that is located on land that the owner has leased for the wind farm development and the residences are shown in blue in Figure 12.1.

- **Non relevant receivers outside the project area:** These neighbouring residences are owned by wind farmers that have leased part or all of their lands for the wind farm development. A noise agreement may be established between the landowner and the proponent if noise criteria developed in accordance with SA EPA Guidelines have the potential to be exceeded.

Overall, there are 100 residences within three kilometres of the wind farm as measured between the residence and the closest wind turbine. The residence locations are shown on Figure 12.1 together with contours showing the distance from the nearest turbine. Table 12.1 also indicates the distribution of the relevant and non-relevant residences relative to the wind farm site.

Table 12.1 – Distribution of residences within three kilometres of Flyers Creek Wind Farm

Distance of residence from nearest turbine	Total Number of residences	Wind farmer [(1)] (non-relevant receiver)	Neighbours (relevant receiver)
0 to 1 kilometres	7	7	0
1 to 2 kilometres	43	19	24 [(2)]
2 to 3 kilometres	50	4	46
Total	**100**	**30**	**70**

Note: [(1)] A wind farmer residence in Table 12.1 is one where the owner has leased part, or all of their land for the wind farm
[(2)] Includes the school – "Residence 57".

Only seven residences are within one kilometre of the wind farm and these are all wind farmer (non-relevant) receiver locations.

A further 43 residences (including 19 wind farmer residences) are located within one to two kilometres of the wind farm. The closest neighbouring residence (relevant receiver) is at 1.1 kilometres from the nearest wind turbine.

A further 50 residences, are located at distances between two and three kilometres from the nearest turbine (Table 12.1). Only four of these are wind farmer receivers.

Residences within one kilometre of the nearest turbine

Seven non-relevant (windfarmer) residences are located at distances less than one kilometre from the wind farm. Residence 52 is the closest non-relevant residence at 790 metres from Turbine 17. Where predicted noise levels exceed the criteria developed using the SA EPA guidelines, noise agreements consistent with the SA EPA guidelines will be established with the owners of the residences.

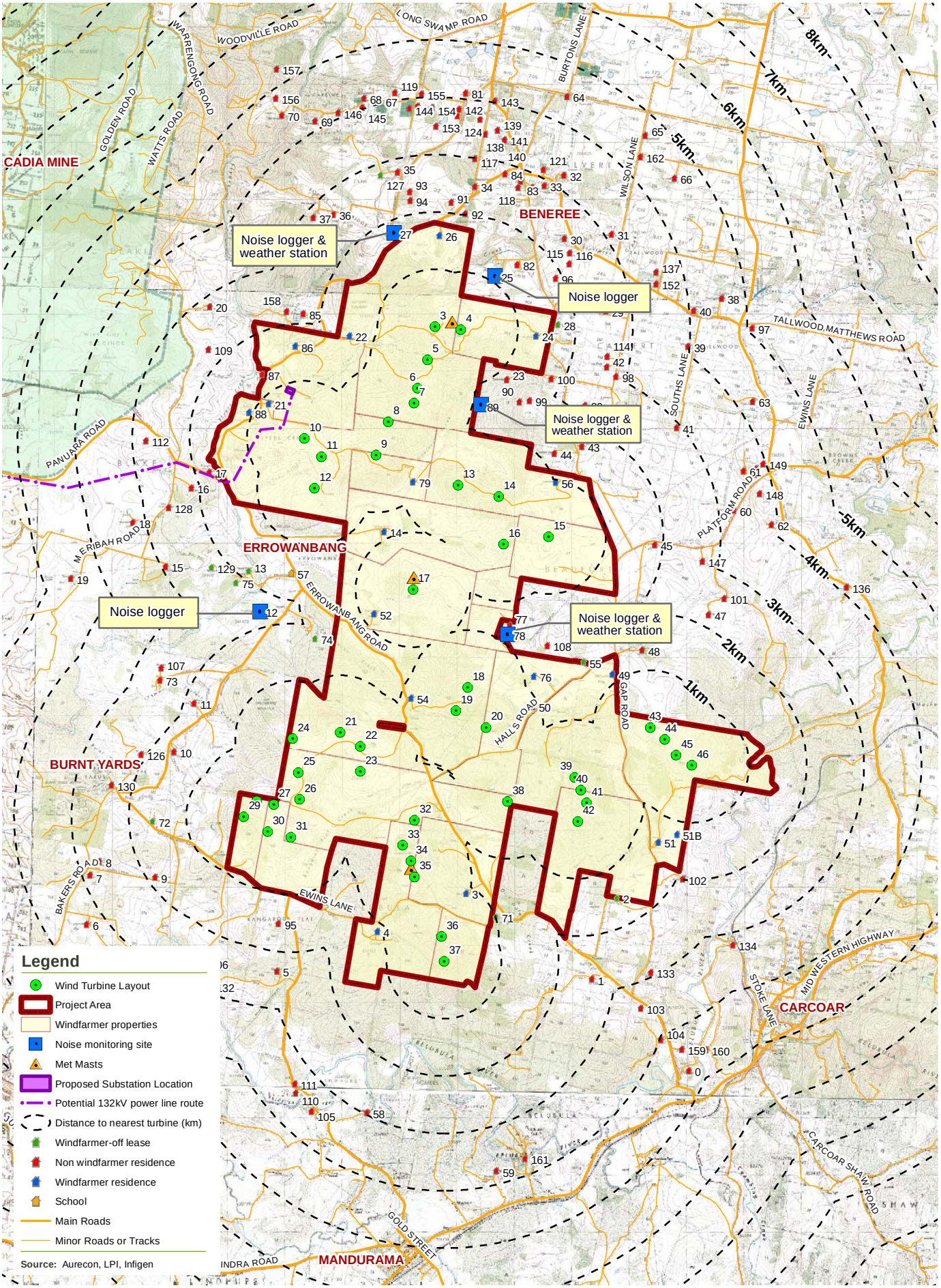
Residences greater than one kilometre and less than two kilometres from the nearest turbine

There are 43 residences located greater than one kilometre and less than two kilometres from the nearest wind turbine. Details of these 43 residences are indicated on (Figure 12.1) and summarised below:

- 24 (relevant receivers) on neighbouring properties and unconnected to the wind farm project
- 19 residences owned by landowners involved in the wind farm project (non relevant receivers)

Of the 24 relevant receivers within one to two kilometres of a turbine, the majority are over 1.5 kilometres from the nearest wind turbine. Nine are from 1.1 to 1.5 kilometres from the nearest turbine.

Adjustments to the array were undertaken following community information days held in November 2010 and two turbine sites (Turbines 1 and 2) at the northern part of the wind farm site were removed as described in Section 6.4. While both of these turbine sites had excellent wind energy potential, the proponent has responded to concerns of a number of neighbours by deleting these turbines from the project. Turbine 31 was also relocated after a request to move the turbine to the other side of the hill to reduce its visual impact at a neighbouring residence.



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1:90,000

0 1 2 kilometres

Projection: GDA 1994 MGA Zone 55

Flyers Creek Wind Farm **Environmental Assessment**

FIGURE 12.1: Noise monitoring sites and receiver locations

Residences within a distance of two to three kilometres of the nearest turbine:

The remaining 50 relevant receiver residences on neighbouring properties are at distances greater than two kilometres from the nearest turbine and will encounter progressively lower levels of wind farm noise with distance. The assessment of operational noise impact for relevant and non-relevant receivers up to three kilometres from the wind farm is described in Appendix G2 and is summarised in Section 12.7.

12.4.2 Errowanbang School

Errowanbang School is located in the Flyers Creek Valley near the intersection of Carcoar-Errowanbang Road and Burnt Yards-Errowanbang Road and is located to the west of the wind farm and about 90 metres below the elevation of the closest wind turbine locations. The school fronts the Errowanbang to Carcoar Road that has low levels of traffic. A parking area is located between the school and the road.

The school is considered to be a relevant receiver, the same as a neighbouring residence, even though the noise criteria are based on avoidance of sleep disturbance which is not really applicable for a school. Background noise monitoring has been conducted at a nearby residence location (Residence 12) and is considered representative for the school location.

12.5 Cadia Mine Site

The operating Cadia Mine site is located to the northwest of the Flyers Creek Wind Farm site. Mining operations typically occur 24 hours a day and include extraction of ore, crushing, separation of mineral content and transport of rock and other material using large haul trucks. The Cadia Mine is also undergoing a significant expansion associated with the Cadia East underground mining development that gained planning approval in 2010 and is currently under construction.

12.6 Background sound levels and derivation of noise amenity criteria

12.6.1 Details of background noise monitoring

The assessment of potential noise impacts for new developments such as wind farms requires consideration of the existing acoustic environment and development of criterion for acceptable levels of noise amenity. In setting noise amenity criteria pertinent to wind farm projects, it is recognised that, whilst background sound levels can be relatively low at low wind speeds, the wind turbines do not operate at these speeds. Also, as wind speed increases the background sound levels tend to increase. Criteria therefore need to consider the background sound levels over the range of wind speeds in which the turbines will operate. The South Australian EPA's "*Wind farms Environmental Noise Guidelines*" recommends that criteria be determined by a regression analysis of the receiver L_{A90} sound levels for each ten minute period, with the reference wind speeds occurring for the same period at the proposed wind turbine sites.

For this purpose, sound levels were measured at five representative residential receiver locations listed in Table 12.2 and with locations as shown on Figure 12.1.

Table 12.2 – Details of background noise monitoring locations

#	Receiver location	Residence status	Distance from nearest turbine	Valid noise measurements	Weather station
27	Watersons Lane (south end)	Relevant	1.8 km	2471	Yes
25	Beneree-locality	Relevant	1.1 km	2874	No
89	Off Dicksons Lane	Relevant	1.2 km	2573	Yes
78	Dunstaffage Lane (west end)	Relevant	1.2 km	3387	Yes
12	Errowanbang	Relevant	2.3km	2811	No

Measurements at the five representative receiver locations included continuous monitoring of sound levels at locations close to the residences over the period 13 November 2009 to 24 December 2009. Type 1 sound level meters were used for the noise measurements and over 2,470 valid measurements were obtained for each monitoring location (the SA EPA Guideline requires 2,000). Background noise monitoring sites south of the project area was not undertaken due to the lower density of neighbouring residences and predicted low level of noise impact at relevant receivers.

Weather stations were installed at three of the five representative receiver locations. The weather stations were used to identify strong winds or rain at the noise monitoring locations that could invalidate the noise data recorded. The assessment by ViPAC included rejection of unsuitable data and the number of valid noise measurements for each site shown in Table 12.3 is after deletion of unsuitable data. The number of weather stations was determined by ViPAC to be adequate for the purpose of criteria development.

The background sites are in rural locations distant from towns and busy main roads. Appendix G1 provides details of the locations of the noise monitoring and weather station equipment including photographs of the installations and a discussion of the measured noise levels.

The typical noise sources at these locations include the residents' normal activities, stock noises, birds, frogs and crickets in wet areas, wind in vegetation, distant transport noises (mostly motor vehicles). Farm equipment such as pumps, generators, machinery and windmills can also contribute to the noise environment in rural areas; however, the monitoring devices were located away from such equipment and within close proximity to residences while observing setbacks from walls of residences or sheds.

Noise assessments for wind farm projects take into account the variation of both turbine noise levels and background noise levels with wind speed. Variation in turbine sound power levels with wind speed is described in Section 12.7.1. The following sections describe the analysis of background noise levels in respect of wind speed and the development of noise criteria as specified by the SA EPA Environmental Noise Guidelines.

12.6.2 Reference wind speeds for background noise analysis

The proponent has installed three 80 metre meteorological (met) masts at southern, central and northern locations within the project area (See Figure 12.1) and has undertaken wind speed monitoring since 2008.

The background noise levels at the receiver locations are correlated to hub height (or 10 metre height) wind speeds at the wind farm site (based on the existing wind monitoring masts). ViPAC's assessment was that the central wind monitoring mast provided the best data set and was therefore used for regression of noise and wind speed data.

A review of wind speeds at the central and northern masts showed a difference in average wind speed of only 0.2 metres per second, so there was very little difference between the two. The southern mast was more distant from the noise monitoring sites and therefore less suitable. Accordingly, it was not necessary to use data from the northern and southern met masts other than to compare variation in mean wind speeds across the project area.

Wind speed data from the central wind monitoring mast was obtained for the period of the background monitoring and synchronised with the background noise monitoring results at the five respective receiver locations. Measurement intervals of 10 minutes were used for background noise levels and weather condition monitoring to match the 10 minute regime routinely used for wind monitoring. The selection of 10 minute intervals is based on the wind industry's standard use of 10 minute intervals for collecting wind data and the SA EPA's acceptance of the 10 minute period as part of its noise assessment guidelines.

The 80 metre wind monitoring (met) masts are located on the ridgelines where the turbines will be located, and therefore wind speeds at these locations are representative of the wind speeds that will be encountered by the proposed wind turbines.

12.6.3 Derivation of noise amenity criteria

The regression analyses for the background noise levels for each of the five monitoring sites relative to the reference integer wind speeds (hub height at the central met mast) are shown in Figures 12.2 to 12.6 and Appendix G1. Third-order polynomial curves were used for each of the regression analyses.

Figures 12.2 to 12.6 also show criteria derived by ViPAC in accordance with the SA EPA Environmental Noise Guidelines and having the form shown below.

- where the regression line (shown in black) was less than 30 dB(A), then the criterion (shown in red) was set at 35 dB(A)
- where the regression line was greater than 30 dB(A) then the criterion is set at background plus 5 dB(A)

Noise amenity criteria were initially developed with respect to hub height reference wind speeds but were subsequently also determined in respect of reference wind speeds based on 10 metres height at the central mast location.

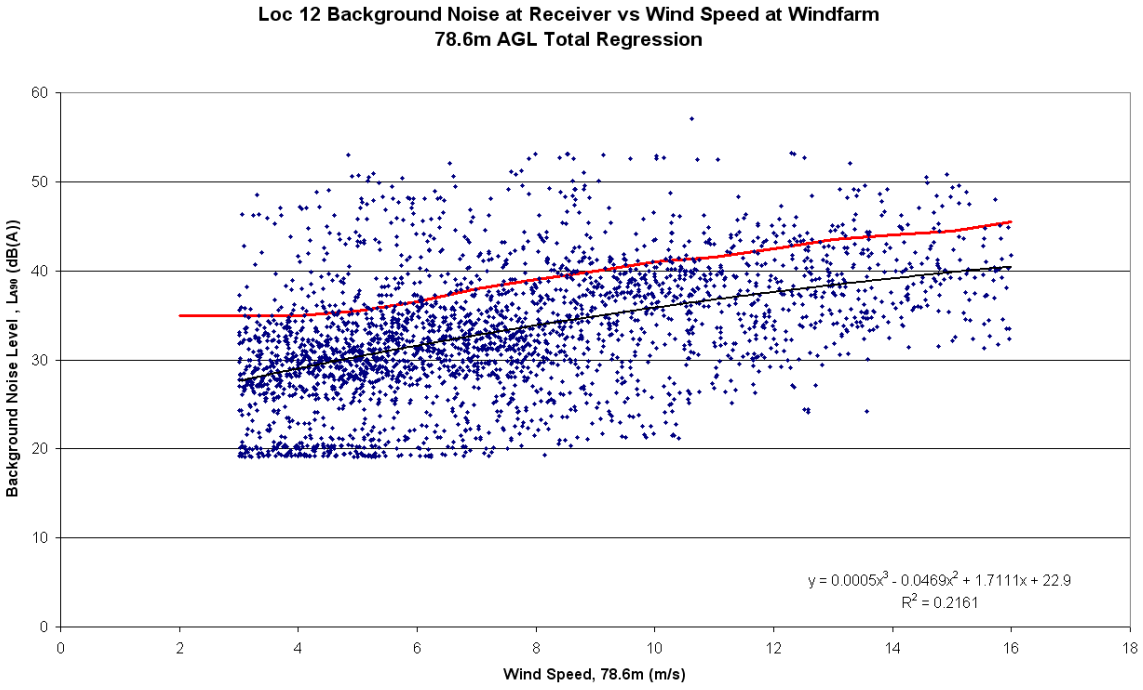


Figure 12.2 – Background noise at receiver (Residence 12) versus reference wind speed at wind farm

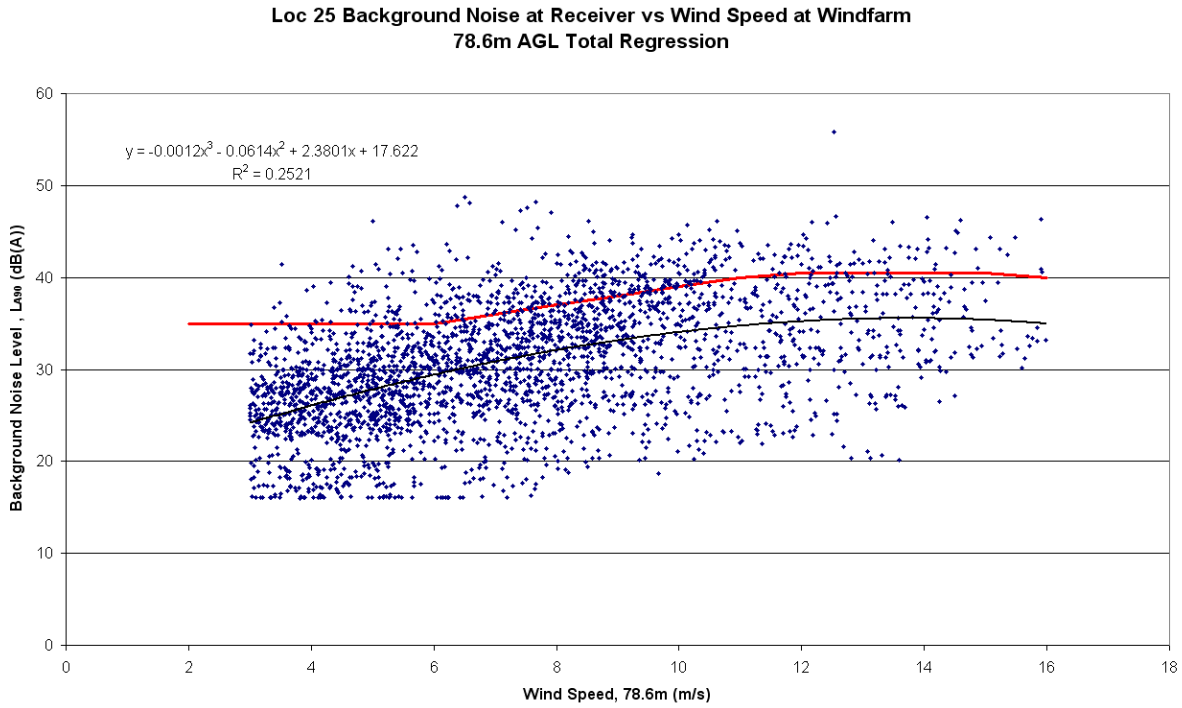


Figure 12.3 – Background noise at receiver residence 25 versus reference wind speed at wind farm

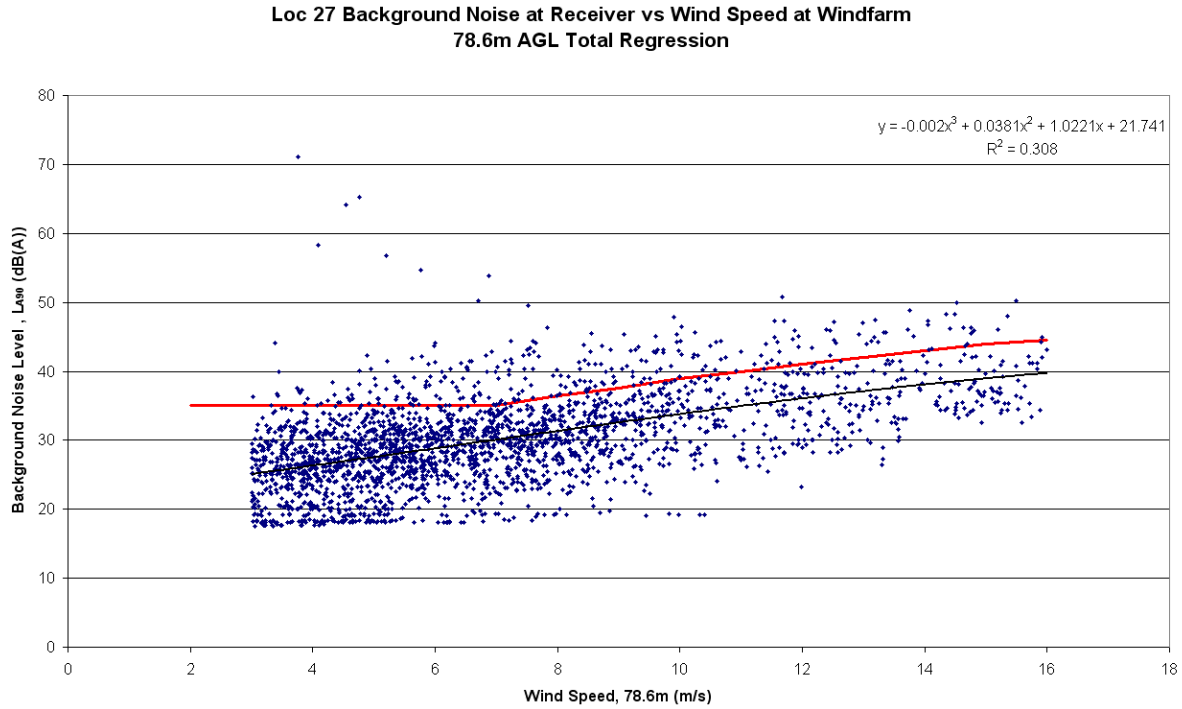


Figure 12.4 – Background noise at receiver Residence 27 versus wind speed at wind farm

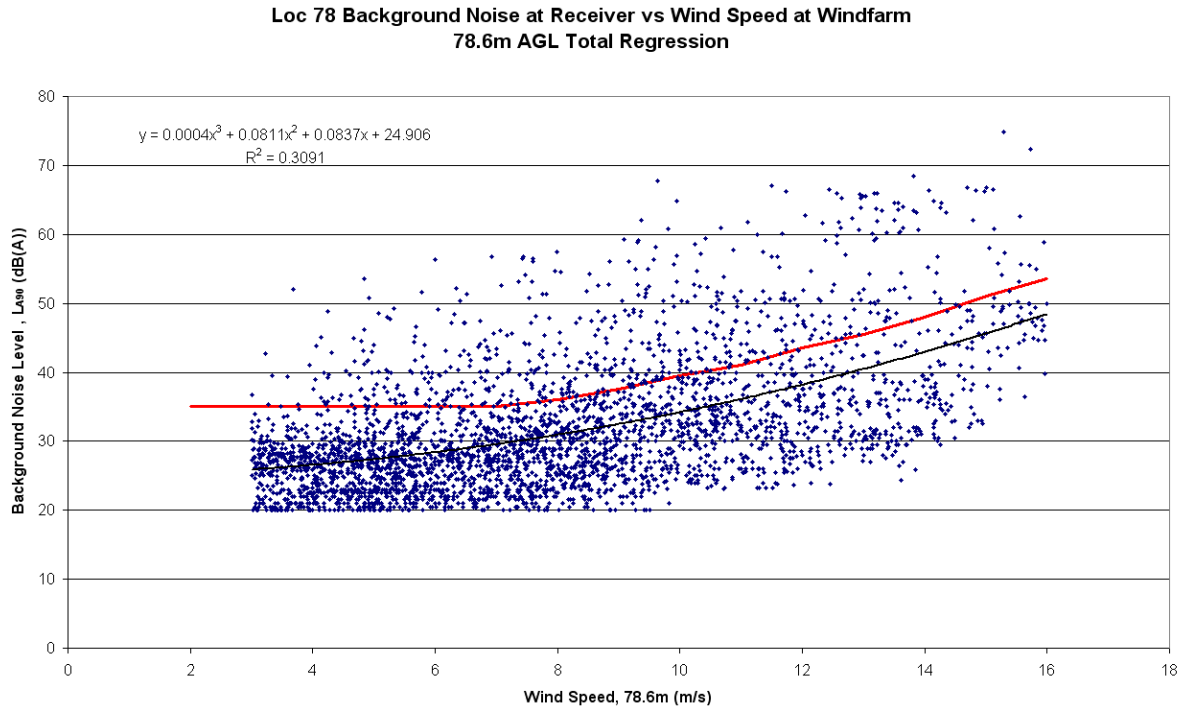


Figure 12.5 – Background noise at receiver Residence 78 versus wind speed at wind farm

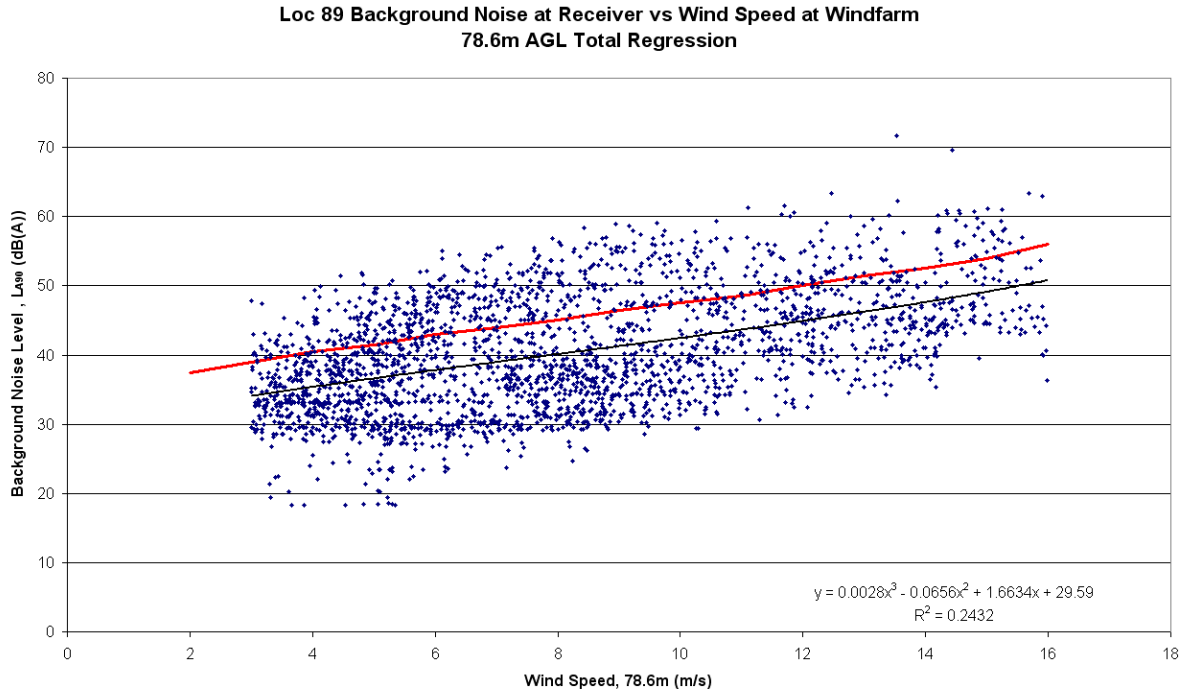


Figure 12.6 – Background noise at Receiver Residence 89 versus wind speed at wind farm

12.6.4 Results of background noise analysis and derivation of criteria

In all cases, background noise levels increased with wind speeds as expected. The regression analyses for the background monitoring data of the five receiver locations showed that the criteria range from 35 dB(A) at three metres per second (the cut-in wind speed of the turbine) to up to 50 dB(A) at 12 metres per second. The criteria, for each of the integer wind speeds at the five representative background monitoring sites, are shown in Table 12.3.

Table 12.3 – Background noise criteria at the representative receiver locations (L_{A90} 10 min dB(A))

Relevant Receiver Location	Number of valid data points	Noise levels for reference wind speed (metres per second) (central met mast at 78.6 metres AGL)									
		3	4	5	6	7	8	9	10	11	12
R012	2811	35	35	35.5	36.5	38	39	40	41	41.5	42.5
R025	2874	35	35	35	35	36	37	38	39	40	40.5
R027	2471	35	35	35	35	35	36.5	37.5	39	40	41
R078	3387	35	35	35	35	35	36	37.5	39.5	41	43.5
R089	2573	39	40.5	41.5	43	44	45	46.5	47.5	48.5	50

Note: The reference wind speed data has been obtained from the proponent's central meteorological mast at a height of 78.6 metres and used for correlation with the background noise data obtained at each receiver location for the same time period.

Criteria for receiver sites in Table 12.3 are based on reference wind speeds for the 78.6 metres AGL (representing turbine hub height). However, in the analysis contained in Appendix G1, the 78.6 metre wind monitoring mast data is slightly extrapolated up to 85 metres, the hub height of the indicative GE 2.5MW wind turbine.

For the purpose of the noise assessment, the GE 2.5xl-2.5 MW wind turbine has been used as the indicative wind turbine. The GE2.5xl-2.5MW noise specification provides sound power measures with a reference to 10 metres AGL as has historically been the practice for the wind industry. As the above noise criteria (Table 12.3) were developed based on hub height reference wind speeds (which is preferable where turbines have the corresponding reference), it was necessary to adjust the derived noise amenity criteria to the 10 metre height reference. The adjusted criteria for the 10 metre AGL reference wind speed are provided in Table 12.4. These criteria, referenced to 10 metre height wind speeds, are used for the noise impact assessment.

Table 12.4 – Derived noise criteria at representative receiver locations at 10 metres AGL (dB(A))

Location	Noise levels for reference wind speed (metres per second) (10 metres AGL central met mast)						
	3	4	5	6	7	8	9
R012	35	36	38	39.5	40.5	41.5	42.5
R025	35	35	36	37.5	38.5	40	40.5
R027	35	35	35	37	38.5	40	41
R078	35	35	35	36.5	39	41.5	43.5
R089	40.5	42.5	44	45.5	47	48.5	50

While the pattern of increase in the criteria derived in accordance with the SA EPA Noise Guideline varied at individual locations, the results for four of the five receiver locations (12, 25, 27 and 28) are very similar. Differences between the criteria for these four locations vary by up to only 3 dB(A) for wind speeds from 6 to 9 metres/second (at 10 metres height).

Criteria derived for Residence 89 are the highest of the five sites. For various integer wind speeds the criterion for Residence 89 are 5 to 8dB above the average of the values for the other four background sites. This is considered to be due to Residence 89 being located in a narrow valley with a large number of mature trees situated on the steep sides of the valley. This appears to result in high ambient noise levels as the wind blows through the valley.

The same circumstances may apply to nearby neighbouring residences e.g. R023, R090, R099 and R100 which may also have elevated background noise levels relative to the other four background sites. In general, the background noise levels identified during the monitoring period are considered to be typical of rural environments and suitable for development of noise criteria for protecting the acoustic amenity. Table 12.5 and Appendix G1 indicate how the criteria have been applied to locations where noise monitoring was not undertaken. A conservative approach of not utilising the background noise readings from R089 has been applied for R023, R090, R099 and R100 and would only be varied if further background noise monitoring was undertaken at one or more of these other locations.

Table 12.5 – Representative background sites with similar noise criteria

Background monitoring site	Sites considered to have a similar background noise characteristic to the indicated background noise monitoring site
R012	R001, R003, R004, R005, R009, R010, R011, R012, R013, R014, R015, R016, R017, R021, R051, R052, R057, R071, R073, R074, R075, R079, R085, R086, R087, R088, R095, R102, R106, R107, R095, R109, R51B, R022, R112, R126, R128, R129, R130, R131, R132, R158
R025	R023, R024, R025, R034, R042, R043, R080, R082, R098, R114, R115, R116, R137, R152
R027	R020, R026, R027, R028, R036, R037, R044, R045, R092, R093, R094, R096, R117, R118, R119, R120, R121, R122, R123, R124, R125, R127, R138, R139, R140, R141, R142, R143, R144, R145, R146, R153, R154, R155, R156, R157
R078	R002, R046, R047, R048, R049, R050, R054, R055, R056, R072, R076, R077, R078, R090, R099, R100, R101, R108, R110, R111, R133, R134, R136, R147, R148, R149, R150, R151
R089	R089

12.7 Source sound characteristics

12.7.1 Wind turbine noise characteristics

The wind turbine generator referenced for the purpose of the noise assessment is the GE 2.5xl 2.5 MW model. While a number of turbine models are being considered for the project, the GE 2.5xl 2.5 MW model has noise levels generally typical of those under consideration for the project at the time of the assessment. The GE 2.5xl 2.5 MW turbine has a stated sound power level of 105 dB(A) when measured according to the standard IEC 61400-11 at the reference condition of 8 metres per second wind speed at 10 metres height (approximately equivalent to 12.2 metres per second at 80 metres (hub height)). Background monitoring undertaken prior to obtaining the turbine acoustic specification referenced the 80 metre height wind speed data and has since been adjusted to the 10 metre height reference to enable comparison of criteria with predicted noise data.

As described in Appendix G2, the operation of the GE 2.5xl 2.5MW turbine can be varied to reduce its associated sound levels by utilising one of five noise reduction modes. However, it should be realised that these noise reduction options achieve their results by also diminishing the electricity generated by the wind turbine. If a large number of wind turbines were operated in noise reduction mode, the decrease in electricity generation would be significant. Accordingly, only turbines that have the potential to contribute to an exceedance at one or more wind speeds are operated in noise reduction mode to achieve compliance with the noise criteria.

Current wind turbine designs are not a significant source of low frequency noise or infrasound. Even at distances of 500 metres, any infrasound is indicated to be well below the threshold of human perception and would not cause health effects as discussed in Appendix G1. Further discussion of the potential health effects is found in Section 16.10.

A preliminary report for the GE turbine indicates that a tone at wind speeds of seven metres per second has a $\Delta L_{A,K}$ of 0.82 which represents an undesirable noise characteristic that, in some instances, could result in greater noise impact at receiver locations within about 500 metres of a turbine. The manufacturer has indicated that they are actively working on eliminating any measurable tonality in their GE 2.5xl 2.5 MW model. While the tonality characteristic identified by ViPAC is likely to have a negligible impact at receiver locations, the proponent has advised that the turbine model selected for the Flyers Creek wind farm project will not exhibit tonality characteristics as defined by the SA EPA Guidelines.

12.7.2 Substation noise characteristics

The electrical substation located at the north-western end of the project area will contain two 33 kV/132 kV power transformers each rated at 50 to 80 MVA (100 to 160MVA combined), depending on the total wind farm output. The transformers are indicated to have a conservative sound power level of 94 dB(A). Based on this, the conservative sound power level of both transformers combined is expected to be 97 dB(A). The substation will be about 1.1 kilometres to the nearest residence and with an intervening ridgeline. A review of the potential noise levels at this residence is predicted to be 30 dB(A) and up to 32 dB(A) at certain meteorological conditions. The maximum sound levels emitted by the substation will occur at times of maximum wind farm generation when the wind is blowing strongly and when background noise levels are likely to be elevated. During periods of low wind speed the transformer noise is expected to be less than the maximum levels.

12.7.3 Construction noise sources

During construction, there will be movements of various types of vehicles, cranes, earthmoving plant and use of portable power equipment (air-compressors, generators and electrical power tools), as well as noise from activity areas such as a site office, workshop, laydown area and storage sheds. The noise from these equipment and facilities will be variable, intermittent and temporary. While the more significant construction works may occur over a period of 12 months, the locations of the active works for the turbine sites and access roads will vary across the site and often be distant from residences. The actual construction time at a particular turbine site time for excavation of a turbine footing through to erection of a turbine will typically take less than three months for a number of relatively short tasks. Appendix G2 and Table 12.10 indicate noise levels of the type of equipment to be used for construction and how the construction noise levels will diminish with distance.

12.8 Sound Level Prediction Modelling for Wind Turbines

12.8.1 Methodology

Sound levels from noise sources can be predicted at receiver locations if a number of parameters are known. These include:

- Sound power levels and frequency spectra of the source over its operating range (Section 12.7)
- Meteorological conditions (ie wind speed and direction, temperature, humidity, and atmospheric absorption)
- Ground surface conditions between source and receivers (topography, distance, ground surface sound absorption and any other physical barrier)

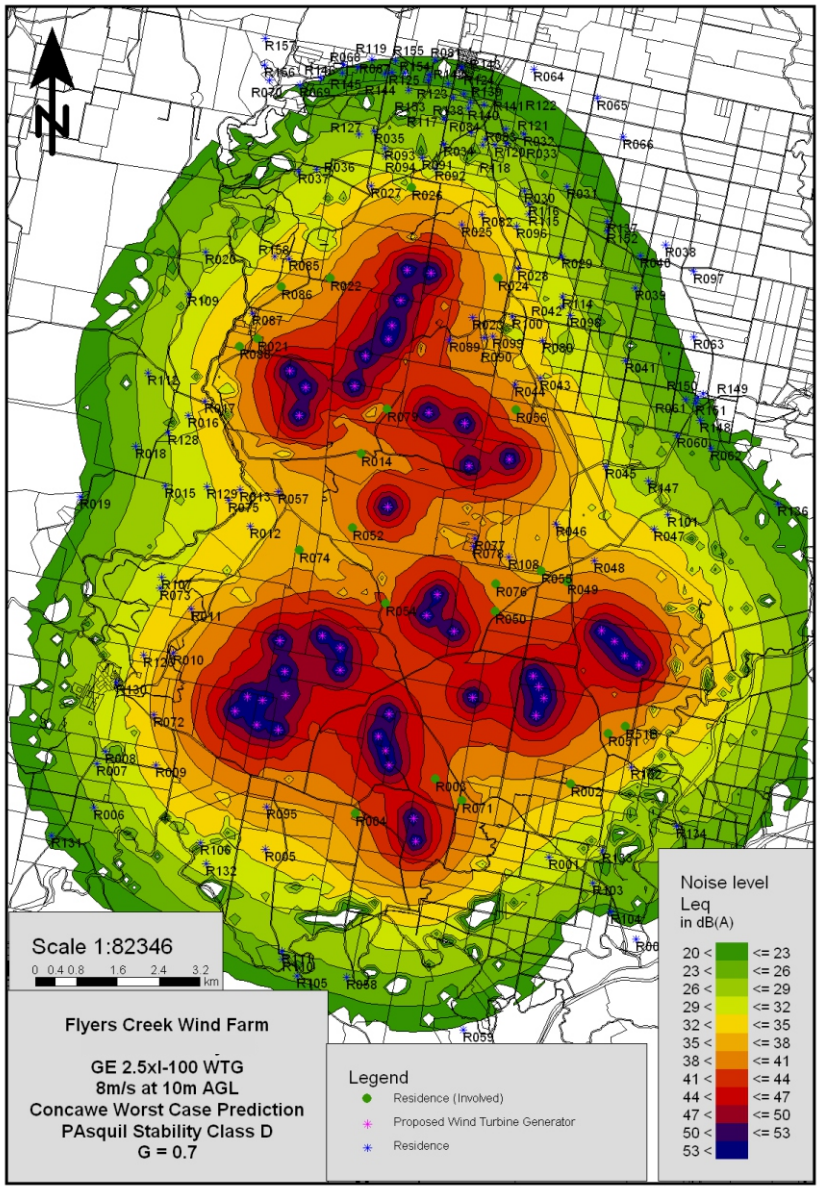
12.8.2 Predicted wind farm noise levels

An accurate predictive noise model was used to assess the resultant noise levels at residences surrounding the wind farm. 'SoundPlan' noise modelling software was used, using the IS0 9613 and Concawe algorithms. The algorithms used for modelling take into account atmospheric absorption, ground absorption, reflection, diffraction and attenuation by topographic features, and the propagation effect of wind speed and directions. ViPAC state that the accuracy of the noise model is likely to be at least $\pm$ 2dB(A).

The Concawe algorithm was also used for comparison and the results were compared to the ISO 9613 results. Overall the model runs produced similar results, with the Concawe model predicting generally slightly lower noise levels..

It is acknowledged that the noise models involve the incorporation a range of variables that are not precisely defined and that the inherent complexity of noise assessment and the variations in atmospheric conditions leads to a degree of uncertainty in predicted values. ViPAC indicated that both the ISO 9613 and Concawe noise models gave similar results and should include enough conservatism to account for inaccuracies. The proponent understands the potential for variation in predicted and actual noise levels and will allow for a conservative approach in the final wind farm design to ensure that the installed wind farm will comply with the relevant criteria for noise sensitive receivers.

Contours of predicted noise levels for areas surrounding the wind farm and with all wind turbines operating at maximum output derived using the Concawe worse case prediction and also the ISO 9613 prediction methods are shown in Figure 12.7 (taken from Appendix G2).



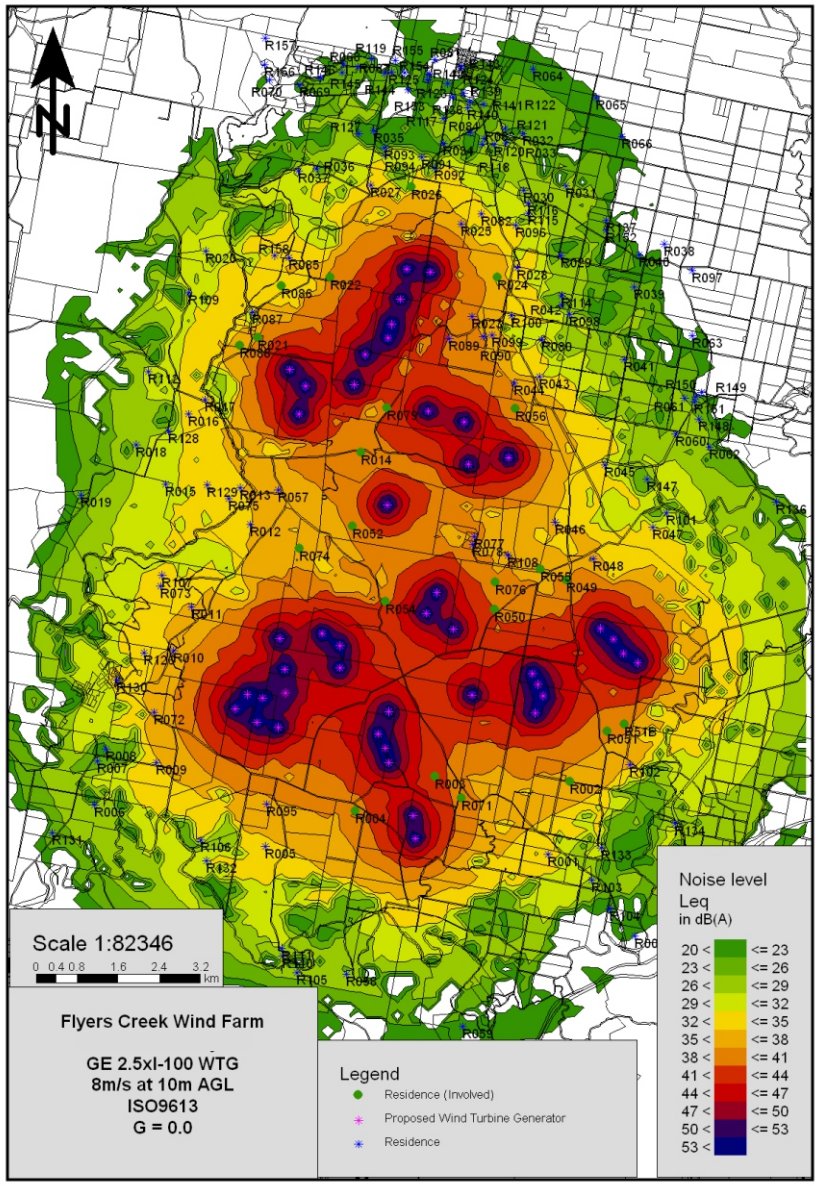


FIGURE 12.7: Contours of predicted noise levels for normal operating conditions

12.8.3 Predicted noise levels at relevant receivers

Preliminary predicted noise levels at three residences (using the ISO 9613 algorithm) and one residence (using the Concawe algorithm) were 0.5 dB(A) above the noise criteria at 1 or 2 wind speeds with the wind turbines operating at their maximum output. As a point of reference, as discussed in Appendix G2, a 3 dB(A) change in sound pressure level is just perceptible to the average human ear; therefore, a 0.5 dB(A) exceedance of the noise criteria would not be noticeable.

However, to ensure the noise levels generated by the wind turbines are below the relevant criteria, the noise model analysis was performed with four wind turbines operating in noise reduction mode for one or two integer wind speeds as required to ensure compliance. ViPAC utilised the ISO9613 algorithm in order to calculate noise levels and confirm compliance.

Results of these sound level predictions at integer wind speeds for 'relevant receivers' within three kilometres of the wind farm are given in Table 12.6 using the ISO9613 algorithm, and in Appendix G2. Criteria derived from the analysis of background monitoring are also included in Table 12.6 enabling comparison of the predicted noise levels against the relevant criterion.

The results shown in Table 12.6 indicate that for all receivers, at all wind speeds, the predicted noise levels are less than the criteria.

Table 12.6 – Predicted ISO 9613 Noise Levels and Criteria at Relevant Receiver Locations (with four turbines in noise reduction modes at one or two wind speeds)

Relevant Receiver	Nearest Turbine	Distance (km)	Wind speed at 10 metres AGL (metres per second)									
			3	4	5	6	7	8	9	10	11	12
Criteria Set: R012 – Errowanbang			35	36	38	39.5	40.5	41.5	42.5			
R001	37	2.6	21.5	24.5	27.5	30.5	33	33	33	33	33	33
R005	31	2.2	23	26	29	32	34.5	34.5	34.5	34.5	34.5	34.5
R007	29	2.9	12.5	15.5	18.5	21.5	24	24	24	24	24	24
R008	29	2.6	11.5	14.5	17.5	20.5	23	23	23	23	23	23
R009	29	1.9	23	26	29	32	34.5	34.5	34.5	34.5	34.5	34.5
R010	29	1.7	25	28	31	34	36.5	36.5	36.5	36.5	36.5	36.5
R011	24	1.8	24	27	30	33	35.5	35.5	35.5	35.5	35.5	35.5
R012	24	2.3	23.5	26.5	29.5	32.5	35	35	35	35	35	35
R013	12	1.8	23.5	26.5	29.5	32.5	35	35	35	35	35	35
R015	12	2.9	20	23	26	29	31.5	31.5	31.5	31.5	31.5	31.5
R016	12	2.1	21	24	27	30	33	33	33	33	33	33
R017	10	1.8	22	25	28	31	33.5	33.5	33.5	33.5	33.5	33.5
R057	12	1.5	25	28	31	34	36.5	36.5	36.5	36.5	36.5	36.5
R073	28	2.5	21.5	24.5	27.5	30.5	33.5	33.5	33.5	33.5	33.5	33.5
R075	12	2.1	23	26	29	32	34.5	34.5	34.5	34.5	34.5	34.5
R085	10	2.1	22.5	25.5	28.5	31.5	34	34	34	34	34	34
R087	10	1.3	21	24	27	30	33	33	33	33	33	33
R095	31	1.4	25.5	28.5	31.5	34.5	37	37	37	37	37	37
R102	46	2.0	24	27	30	33	35.5	35.5	35.5	35.5	35.5	35.5
R106	31	2.5	21	24	27	30	32.5	32.5	32.5	32.5	32.5	32.5
R107	28	2.6	21	24	27	30	32.5	32.5	32.5	32.5	32.5	32.5
R109	10	2.3	11	14	17	20	22.5	22.5	22.5	22.5	22.5	22.5
R112	10	2.8	17.5	20.5	23.5	26.5	29.5	29.5	29.5	29.5	29.5	29.5
R126	29	2.1	22.5	25.5	28.5	31.5	34	34	34	34	34	34

Relevant Receiver	Nearest Turbine	Distance (km)	Wind speed at 10 metres AGL (metres per second)									
R128	12	2.6	18.5	21.5	24.5	27.5	30	30	30	30	30	30
R129	12	2.3	22	25	28	31	33.5	33.5	33.5	33.5	33.5	33.5
R130	29	2.4	21	24	27	30	32.5	32.5	32.5	32.5	32.5	32.5
R131	29	4.3	13	16	19	22	25	25	25	25	25	25
R132	31	2.9	20.5	23.5	26.5	29.5	32	32	32	32	32	32
R158	3	2.2	22.5	25.5	28.5	31.5	34	34	34	34	34	34
Wind Speed (metres per second)			3	4	5	6	7	8	9	10	11	12
Criteria set: R025 – Bromley			35	35	36	37.5	38.5	40	40.5			
R023	4	1.2	27.5	30.5	33.5	36.5	38	39	39	39	39	39
R025	4	1.1	25	28	31	34	36.5	36.5	36.5	36.5	36.5	36.5
R029	4	2.6	14.5	17.5	20.5	23.5	26	26	26	26	26	26
R030	4	2.4	17	20	23	26	28.5	28.5	28.5	28.5	28.5	28.5
R033	4	2.9	15.5	18.5	21.5	24.5	27	27	27	27	27	27
R034	4	2.5	14.5	17.5	20.5	23.5	26	26	26	26	26	26
R042	4	2.6	12	15	18	21	24	24	24	24	24	24
R043	15	4.7	23.5	26.5	29.5	32.5	35	35	35	35	35	35
R080	14	2.2	20.5	23.5	26.5	29.5	32	32	32	32	32	32
R082	4	1.5	21.5	24.5	27.5	30.5	33	33	33	33	33	33
R098	4	2.8	16	19	22	25	27.5	27.5	27.5	27.5	27.5	27.5
R114	4	2.6	12	15	18	21	23.5	23.5	23.5	23.5	23.5	23.5
R115	4	2.2	18.5	21.5	24.5	27.5	30	30	30	30	30	30
R116	4	2.3	18	21	24	27	29.5	29.5	29.5	29.5	29.5	29.5
R137	4	3.6	14	17	20	23	25.5	25.5	25.5	25.5	25.5	25.5
R152	44	3.5	13.5	16.5	19.5	22.5	25	25	25	25	25	25
Wind Speed (metres per second)			3	4	5	6	7	8	9	10	11	12
Criteria set: R027 –Willow Creek			35	35	35	37	38.5	40	41			
R020	10	2.8	19	22	25	28	30.5	30.5	30.5	30.5	30.5	30.5
R027	3	1.8	22.5	25.5	28.5	31.5	34	34	34	34	34	34
R028	4	1.7	22.5	25.5	28.5	31.5	34	34	34	34	34	34
R035	3	2.8	9.5	12.5	15.5	18.5	21	21	21	21	21	21
R036	3	2.6	15.5	18.5	21.5	24.5	27.5	27.5	27.5	27.5	27.5	27.5
R037	3	2.8	19	22	25	28	30.5	30.5	30.5	30.5	30.5	30.5
R044	14	1.2	26	29	32	35	38	38	38	38	38	38
R045	15	1.9	21	24	27	30	33	33	33	33	33	33
R091	3	2.2	16	19	22	25	27.5	27.5	27.5	27.5	27.5	27.5
R092	4	2.1	13	16	19	22	24.5	24.5	24.5	24.5	24.5	24.5
R093	3	2.4	11	14	17	20	23	23	23	23	23	23
R094	3	2.2	20	23	26	29	31.5	31.5	31.5	31.5	31.5	31.5
R096	4	1.9	20.5	23.5	26.5	29.5	32	32	32	32	32	32
R117	4	3.0	17	20	23	26	28.5	28.5	28.5	28.5	28.5	28.5
R118	4	2.7	13.5	16.5	19.5	22.5	25	25	25	25	25	25
R119	3	4.2	11.5	14.5	17.5	20.5	23.5	23.5	23.5	23.5	23.5	23.5
R120	4	2.8	16	19	22	25	27.5	27.5	27.5	27.5	27.5	27.5
R121	4	2.1	14.5	17.5	20.5	23.5	26	26	26	26	26	26
R122	4	3.4	14	17	20	23	25.5	25.5	25.5	25.5	25.5	25.5
R123	4	3.6	10	13	16	19	21.5	21.5	21.5	21.5	21.5	21.5

Relevant Receiver	Nearest Turbine	Distance (km)	Wind speed at 10 metres AGL (metres per second)									
R124	4	3.7	10	13	16	19	21.5	21.5	21.5	21.5	21.5	21.5
R125	4	3.7	11.5	14.5	17.5	20.5	23	23	23	23	23	23
R127	3	2.8	9.5	12.5	15.5	18.5	21	21	21	21	21	21
R138	4	3.4	11	14	17	20	22.5	22.5	22.5	22.5	22.5	22.5
R139	4	3.5	10.5	13.5	16.5	19.5	22	22	22	22	22	22
R140	4	3.2	15.5	18.5	21.5	24.5	27	27	27	27	27	27
R141	4	3.4	14.5	17.5	20.5	23.5	26	26	26	26	26	26
R142	4	3.8	9.5	12.5	15.5	18.5	21	21	21	21	21	21
R143	4	4.0	3	6	9	12	15	15	15	15	15	15
R144	3	3.8	12.5	15.5	18.5	21.5	24.5	24.5	24.5	24.5	24.5	24.5
R145	3	4.0	13	16	19	22	24.5	24.5	24.5	24.5	24.5	24.5
R146	3	4.1	12.5	15.5	18.5	21.5	24.5	24.5	24.5	24.5	24.5	24.5
R153	3	3.4	6	9	12	15	18	18	18	18	18	18
R154	3	3.8	4.5	7.5	10.5	13.5	16	16	16	16	16	16
R155	3	4.0	3	6	9	12	14.5	14.5	14.5	14.5	14.5	14.5
R156	3	4.9	5.5	8.5	11.5	14.5	17.5	17.5	17.5	17.5	17.5	17.5
Wind Speed (metres per second)			3	4	5	6	7	8	9	10	11	12
Criteria set: R078			35	35	35	36.5	39	41.5	43.5			
R046	15	1.5	24.5	27.5	30.5	33.5	36	36	36	36	36	36
R047	43	2.2	21	24	27	30	32.5	32.5	32.5	32.5	32.5	32.5
R048	43	1.4	24	27	30	33	35.5	35.5	35.5	35.5	35.5	35.5
R072	29	1.6	24.5	27.5	30.5	33.5	36	36	36	36	36	36
R077	18	1.3	27.5	30.5	33.5	36	38.5	39	39	39	39	39
R078	18	1.2	28	31	34	36	38.5	39.5	39.5	39.5	39.5	39.5
R090	4	1.6	26.5	29.5	32.5	35.5	38	38	38	38	38	38
R099	4	1.7	26	29	32	35	37.5	37.5	37.5	37.5	37.5	37.5
R100	4	1.8	23	26	29	32	34.5	34.5	34.5	34.5	34.5	34.5
R101	43	2.6	18.5	21.5	24.5	27.5	30	30	30	30	30	30
R108	18	1.6	26.5	29.5	32.5	35.5	38	38	38	38	38	38
R110	37	3.5	16.5	19.5	22.5	25.5	28	28	28	28	28	28
R111	37	3.4	15.5	18.5	21.5	24.5	27	27	27	27	27	27
R133	42	2.9	19.5	22.5	25.5	28.5	31	31	31	31	31	31
R134	46	3.2	17	20	23	26	28.5	28.5	28.5	28.5	28.5	28.5
R136	43	4.1	13.5	16.5	19.5	22.5	25	25	25	25	25	25
R147	15	2.7	11.5	14.5	17.5	20.5	23	23	23	23	23	23
R148	15	3.8	15	18	21	24	26.5	26.5	26.5	26.5	26.5	26.5
R149	15	4	2.5	5.5	8.5	11.5	14	14	14	14	14	14
R150	15	4.0	9.5	12.5	15.5	18.5	21	21	21	21	21	21
R151	5	3.8	14	17	20	23	25.5	25.5	25.5	25.5	25.5	25.5
Wind Speed (metres per second)			3	4	5	6	7	8	9	10	11	12
Criteria set: R089			40.5	42.5	44	45.5	47	48.5	50			
R089	6	1.2	29.5	32.5	35.5	38.5	41	41	41	41	41	41

Note: (1) Predicted noise values that equal or exceed criteria are shown in bold/shaded.
(2) Distance is from the receiver to the closest turbine

The actual noise level at the receiver location due to the wind farm operation can only be definitely determined once the wind farm is operational and compliance testing undertaken. Due to the

conservative assumptions involved in the modelling, ViPAC is confident the actual turbine acoustic levels will not exceed the noise criteria. In the unlikely event that compliance testing demonstrates exceedance of criteria, the turbine operation can be adjusted, if required, to ensure compliance using the various noise reduction operation modes available for modern wind turbines.

12.8.4 Predicted noise level at non-relevant receivers

Results of sound level predictions at integer wind speeds for 'non-relevant receivers' are given in Table 12.7. As for the relevant receivers, the noise levels were predicted using the standard ISO 9613 algorithm.

All of the landowners associated with the wind farm that have residences adjacent to the lands leased for the wind farm have predicted noise levels that are below the relevant World Health Organisation criteria of 45 dB(A).

Table 12.7 – Predicted Noise Levels and Criteria at Non-Relevant Receiver Locations

Relevant Receiver	Nearest Turbine	Distance (km)	Wind speed at 10 metres AGL (metres per second)									
			3	4	5	6	7	8	9	10	11	12
Non-Relevant Receiver Criteria			45	45	45	45	45	45	45	45	45	45
R002	42	1.5	27	30	33	36	39	39	39	39	39	39
R003	36	0.9	32	35	38	41	43.5	43.5	43.5	43.5	43.5	43.5
R004	35	1.1	30	33	36	39	41.5	41.5	41.5	41.5	41.5	41.5
R014	17	1.1	30.5	33.5	36.5	39.5	42	42	42	42	42	42
R021	10	0.9	28.5	31.5	34.5	37.5	40	40	40	40	40	40
R022	5	1.4	29	32	35	38	41	41	41	41	41	41
R024	4	1.3	26	29	32	35	37.5	37.5	37.5	37.5	37.5	37.5
R026	3	1.6	23.5	26.5	29.5	32.5	35	35	35	35	35	35
R049	43	1.1	29	32	35	38	40.5	40.5	40.5	40.5	40.5	40.5
R050	20	0.9	31	34	37	40	43	43	43	43	43	43
R051	46	1.4	29	32	35	38	41	41	41	41	41	41
R051B	46	1.2	29.5	32.5	35.5	38.5	41	41	41	41	41	41
R052	17	0.8	29	32	35	38	41	41	41	41	41	41
R054	19	0.8	30.5	33.5	36.5	39.5	42	42	42	42	42	42
R055	43	1.6	27.5	30.5	33.5	36.5	39.5	39.5	39.5	39.5	39.5	39.5
R056	15	1.0	29.5	32.5	35.5	38.5	41.5	41.5	41.5	41.5	41.5	41.5
R071	36	1.0	30	33	36	39	42	42	42	42	42	42
R074	21	1.6	27	30	33	36	38.5	38.5	38.5	38.5	38.5	38.5
R076	18	1.2	30	33	36	39	41.5	41.5	41.5	41.5	41.5	41.5
R079	13	0.8	32.5	35.5	38.5	41.5	44	44	44	44	44	44
R086	10	1.6	25.5	28.5	31.5	34.5	37	37	37	37	37	37
R088	10	1.1	27	30	33	36	38.5	38.5	38.5	38.5	38.5	38.5

Table 12.8 – Predicted Noise Levels and Criteria at Wind farmers off lease

Relevant Receiver	Nearest Turbine	Distance (km)	Wind speed at 10 metres AGL (metres per second)									
			3	4	5	6	7	8	9	10	11	12
Criteria set: R025 – Bromley			35	35	36	37.5	38.5	40	40.5			
R031	4	3.1	15.5	18.5	21.5	24.5	27.5	27.5	27.5	27.5	27.5	27.5
Criteria Set: R012 – Errowanbang			35	36	38	39.5	40.5	41.5	42.5			
R001	37	2.6	21.5	24.5	27.5	30.5	33	33	33	33	33	33
R075	12	2.1	23	26	29	32	34.5	34.5	34.5	34.5	34.5	34.5
Criteria set: R027 –Willow Creek			35	35	35	37	38.5	40	41			
R028	4	1.7	22.5	25.5	28.5	31.5	34	34	34	34	34	34
R035	3	2.8	9.5	12.5	15.5	18.5	21	21	21	21	21	21
Criteria set: R078			35	35	35	36.5	39	41.5	43.5			
R046	15	1.5	24.5	27.5	30.5	33.5	36	36	36	36	36	36
R072	29	1.6	24.5	27.5	30.5	33.5	36	36	36	36	36	36

12.9 Substation Noise

The substation will include two large transformers, switchgear and circuit breakers that can each contribute to noise at the substation site to some extent. The two 33 kV/132 kV transformers each rated between 50 to 80 MVA capacity can emit maximum noise levels up to 94 dB(A), with a combined conservative sound power level of 97 dB(A), particularly at the harmonic frequencies of the line around 100 Hz.

There is one relevant receiver residence (R87) and three non-relevant receivers in the vicinity of the substation site (Figure 12.1) at distances of less than one kilometre. However, there is a low ridge between the relevant receiver (R87) and the proposed substation providing some noise mitigation. A ridge also exists between the non-relevant residences of 21 and 88 and the substation such that the acoustic amenity impact will also be mitigated at these residences.

A review of the potential noise levels at the closest residences based on the combined conservative sound power level of 97 dB(A) has indicated that the predicted noise levels would be about 30 dB(A) and up to 32 dB(A) (at the receiver locations) in certain 'worst case' meteorological conditions as explained in Appendix G2.

The noise from the two transformers typically increases with the wind farm output while background noise levels will also be increasing at the same time. With the same atmospheric conditions used for the wind turbine noise prediction calculations, the noise levels with the wind farm operating at maximum output would be less than 35 dB(A) at a time when the naturally occurring background noise would be significantly above 35 dBA . Therefore, substation noise at surrounding neighbouring residences is likely to be inaudible at most times.

12.10 Construction Noise

12.10.1 Construction noise criteria

The assessment of potential noise impacts arising from construction of the Flyers Creek Wind Farm including the wind turbines, substation underground cables and access tracks is governed by the guidelines laid out in the NSW Department of Environment, Climate Change and Water's (DECCW) Environmental Noise Control Manual (ENCM). The ENCM noise criteria for construction works are as follows:

- Construction within acceptable construction hours: $L_{Aeq,\ 15\ minutes} \leq$ Background L_{A90} + 10 dB(A)

- Construction outside acceptable construction hours $L_{Aeq,\ 15\ minutes} \leq$ Background L_{A90} + 5 dB(A)

Based on the ENCM criteria, Table 12.9 provides the construction noise criteria for the representative noise monitoring sites less than two kilometres from the Flyers Creek Wind Farm.

Table 12.9 – Construction Noise Criterion Levels

Location	Closest Turbine	Distance km	Average Daytime Background Noise Level L_{A90} dB(A)	Construction Noise Criterion Level L_{Aeq} dB(A)	Average Daytime Ambient Noise Level L_{Aeq} dB(A)
R012	24	2.3	35	45	44
R025	4	1.1	33	43	41
R027	3	1.8	40	50	52
R078	18	1.2	33	43	46
R089	6	1.2	40	50	51

The closest occupied relevant residence to a turbine site is R025 at about 1.1 kilometres from Turbine 4 and to the northeast of the wind farm.

It is noted that while the construction works for the wind farm will continue over a period up 12 to 18 months that the works are spread over a large area involving about 11 kilometres from north to south and about 10 kilometres east to west. In addition, the nature of works at any particular turbine location will vary in time, with the noisier activities, namely excavation for the turbine footing (several days), pouring of the concrete for each footing (one day) and erection of the supporting tower and turbine (several days), being a small proportion of the overall construction period.

The consequence of the wide geographic distribution of the construction works and short-term noisier activities for turbine installation is that for a particular receiver location surrounding the wind farm, any noise impacts arising from the construction of the wind farm and the closest turbines will be for only a small part of the full construction period and will not be continuous but rather an irregular series of short term day time activities with varying noise characteristics.

In addition, it is worth noting in Table 12.9 that the construction noise criteria is very close to, and sometimes less than, the average background noise recorded at the five residences.

12.10.2 Construction noise sources

During the wind farm construction there will be noise during the daytime from vehicle movements to and from the site, and noise from construction and earthmoving machinery. Initial construction activities will involve earthmoving relating to construction of access tracks to the turbine sites and the substation. This activity will progress across the site to complete the necessary access system and will be of a similar nature to that undertaken for maintenance of local roads but will include some excavation in rock.

Construction at each turbine site will typically involve excavators, earth-moving machinery, cranes and portable power tools and supporting equipment. Noise from the operation of these activities may occasionally be discernible at the residences on the properties close to where the wind turbines are being constructed. However, noise impacts from construction works will be a short-term impact for any residence during daytime hours and unlikely to cause noise levels to exceed EPA criteria for the area, or to cause significant annoyance at any residence. The actual construction noise could be similar to rural agricultural activities such as aerial distribution of fertilisers or operation of tractors in fields. Examples of potential noise impacts are discussed below.

Table 12.10 provides a list of equipment that could be used on site during construction and their predicted worst case noise levels at various distances. It is very unlikely that all of the equipment

below will be operating simultaneously for extended periods of times in the same area. As mentioned earlier, the nature of activities will vary at each site during the course of the construction. Also the closest relevant receiver is at 1.1 kilometres and all others are at greater distance.

Table 12.10 – Worse case predicted noise level at various receiver distances for construction equipment

Equipment to be used	Noise Level at indicated distances in dB(A) (L_{Aeq})			
	500 m	1,000 m	1,500 m	2,000 m
Compactor	45-52	38-45	33-40	29-36
Concrete mixer truck	35-44	28-37	23-32	<30
Concrete pump	<30	<30	<30	<30
Large Crane	46-50	39-41	34-36	30-32
Crushing plant	45-52	38-45	33-40	29-36
Front end loader / dozer	46-50	39-41	34-36	30-32
Excavator	42-46	35-39	30-34	26-30
Grader	42-46	35-39	30-34	26-30
Piling	44-49	37-42	32-37	28-33
Roller	<30	<30	<30	<30

The actual noise levels and their duration for the earthworks will be proportional to the strength of the rock involved. Preliminary indications are that conditions are likely to be variable across the site and geotechnical testing will be required once the contractor has been appointed. If harder rock is encountered, limited blasting may be required. However, this would only take place during daytime hours and under strict conditions set out in the construction environmental management plan.

As indicated in Table 12.10, construction noise levels for the listed equipment/activities at a distance of 1,500 metres have a maximum of 40dB(A) in two instances with the rest of the activities being less than 40 dB(A). Comparing the predicted noise levels in Table 12.10 with the criteria in Table 12.9, resulted in ViPAC concluding, in Section 7.2 of their Appendix G2, that,

> *"As distances from the nearest turbine to each relevant receiver are all greater than 1000 metres, the noise criteria for construction noise is likely to be achieved at all relevant receivers"*

ViPAC also provided an indication of the likely noise levels for a combination of noise sources for a specific group of activities and this is provided in Appendix G2. The duration of time different construction activities would be occurring at the same time and at the same place would be quite limited, in any case.

The project application does not include provision for an on-site batch plant which, if used, would represent an additional noise source. If the contractor wished to operate a batch plant on site, the contractor would need to identify a suitable location for the batch plant, undertake an impact assessment and obtain the required approvals for that activity. Typically the noise associated with a batch plant would include front end loaders, trucks, unloading and loading activities and the normal operational noise of the batch plant. If used, a batch plant would therefore need to be located away from residences to avoid noise impact from its associated activities at the nearest residences and to comply with any approval conditions.

For the delivery of concrete to site during pouring of the footings for each wind turbine and at the substation, concrete trucks will operate between the concrete supply site and the respective work location over a period of up to 8 hours. These movements may marginally increase the sound levels at any residences adjoining the route, with one loaded truck passing on average every 15 to 20 minutes. Due to the distributed nature of the wind farm in hilly terrain a number of different access routes may be used to access different parts of the site, as outlined in Chapter 13.

The pouring of the turbine footings will only occur on up to 44 days, spread over the period for construction of footings that may extend for approximately 3 to 4 months. The footings for the substation and temporary facilities at the site office may require concrete deliveries on several additional days. Minor amounts of concrete will also be required for other purposes including drains, footings for buildings etc.

There will also be additional road traffic during construction associated with the workforce attending the site. These traffic movements (up to 40 vehicles per day or less with car pooling) will add marginally to the total number of vehicle movements along the roads in the area. There will be a lesser number of 'overmass' and 'oversize' vehicles delivering plant and materials to the site; however their impact has potential for more disruption. As most residences in the area are distant from the local roads and because of the rural nature of the area, traffic noise levels are not expected to exceed EPA policy levels. The traffic movements will be primarily during daylight hours consistent with the approved construction work hours and for any particular vehicle will be a short term temporary impact.

12.10.3 Construction noise management

As indicated above there will be some periods of construction activities that will be associated with higher construction noise levels but these will be for limited periods and at varying locations. Despite the shorter duration of such events (as compared to the full construction period), it is proposed that noise management control measures will be incorporated in the Project Construction Environmental Management Plan (CEMP) implemented for the construction stage of the project. The CEMP will identify aspects such as operating hours and noise controls and provide a system for responses to any complaints raised by the community. The anticipated construction working hours are provided in Table 12.11.

Table 12.11 – Flyers Creek Wind Farm - Construction phase working hours

Days on which construction occurs	Acceptable construction times	Excursions beyond acceptable construction times
Monday to Friday	7:00 am to 6:00 pm	Subject to approval, certain work outside approved hours as indicated in Table 12.12 and associated text
Saturday	7:00 am to 1:00 pm if inaudible	
	8:00 am to 1:00 pm if audible	
Sunday	Nil	

For construction of wind farm projects, some excursions from the normal acceptable working hours may be necessary to address issues of safety and practicality of construction. These aspects are indicated in Table 12.12 and would be of limited duration and to address, safety and/or efficiency of construction.

Table 12.12 – Proposed allowance for excursions from standard working hours

Construction activity	Reason for occasional excursion from standard hours in Table 12.11
Erection of the turbine structures (tower, nacelle and rotor) (Mostly in daylight hours for up to 44 turbines and involving up to four days per site with the actual lifts able to be completed in a shorter time)	To take advantage of low wind conditions to ensure the safety of the turbine erection operation. Due to the high wind energy at a wind farm site and the substantial cost and demands on the equipment used for the turbine construction it is necessary to utilise times of suitable wind speeds as they arise.
Pouring concrete footings (to occur on up to 44 days and provided there are no unforeseen problems will occur within standard hours)	The pouring of a concrete footing for a turbine site can take up to eight hours and needs to be completed within a single operation. The ability to do this is impacted by the number of agitator trucks available, return travel times from the concrete supplier to the turbine site and any incidents occurring during the pour that may delay the completion of the pour in the optimal time or the approved construction hours.
Delivery of wind farm components by oversize or overmass vehicles as directed by Police, Council or RTA	The large or heavy items of the turbine structures will be delivered by Restricted Access Vehicles (oversize or oversize). To avoid conflict from these vehicle movements with normal traffic flows, relevant agencies, Police, RTA or Council may direct movement of these vehicles outside the normal construction hours.

The proponent seeks the opportunity for limited excursions to the normal operating hours to allow for the operations indicated in Table 12.12. Due to the small proportion of the total construction period allocated to the erection of the turbines and the likelihood that much of it can be undertaken within standard hours, the number of excursions related to turbine erection is expected to be limited. Due to height of the wind turbine structures and the high wind energy regime it is very difficult to schedule lifting operations and some flexibility is required to optimise safety.

In the case of the pouring of turbine footings this activity will occur on up to 44 days at sites spread across a large project area. Pouring of footings can normally be undertaken in the day time, commencing as early as practicable, within the acceptable hours. It is important that concrete for the footing be placed in a single operation. Extension of a pour, beyond the latest acceptable time may be needed to complete the footing if unforeseen difficulties occur during the day. It is expected that the sites with least travel time are least likely to have any significant exceedance of the acceptable working hours while the more distant sites with greater travel time could be more prone to excursions if unforseen events delay progress.

The occurrence of the need for excursions from acceptable operating hours is expected to represent a minor component of the construction works as many of the situations will be able to occur in standard hours. Nevertheless, provision is sought for such departures from the normal construction operations. Also due to the distributed nature of the development as mentioned above, construction noise impacts associated with any excursions from standard hours would be expected to represent a short duration at any particular receiver location.

12.11 Mitigation of potential noise impacts

This chapter provides details of the potential noise impacts arising from the construction and operation of the Flyers creek Wind Farm including identification of the noise sources and the noise sensitive receivers. The management of potential noise impacts is seen as a key element of the project's environmental management plans and will be achieved through noise management sub-plans for the construction and operations phases. The noise management sub-plans will form the components of the respective Construction and Operational phase Environmental Management Plans (CEMP and OEMP).

12.11.1 Design Phase

The proposed turbine layout of the wind farm has considered the potential noise impacts of its operation and incorporates set backs from neighbouring residences to achieve acceptable noise levels at surrounding residence locations. In addition, Flyers Creek Wind Farm Pty Ltd also has varied the wind farm design following community consultation to delete two turbine sites and to relocate a third to increase the distance between turbines and neighbouring residences. These adjustments were primarily undertaken for reasons other than noise compliance, but will nevertheless reduce the noise impact of the wind farm on some receivers near the project.

Flyers Creek Wind Farm Pty Ltd will select a turbine model and associated turbine layout that will ensure the wind farm is operated in a manner that enables compliance with the applicable noise requirements, in this case, the SA EPA Guidelines.

Given the complexity involved in the use of noise models and a degree of uncertainty in the precision of the derived noise predictions, it is reasonable to incorporate a degree of conservatism into the final design to ensure that the installed wind farm will be able to achieve compliance. To that end, Flyers Creek Wind Farm Pty Ltd is committed to ensuring that the installed wind farm complies with the criteria developed in accordance with the SA EPA guidelines.

For instances when the compliance criteria are based on the predicted noise levels, Flyers Creek Wind Farm Pty Ltd proposes that compliance criteria recognise the potential variation involved with predicted and actual noise levels and that an uncertainty level of 2dB(A) be added to the predicted noise levels of the wind farm compliance criteria as follows:

- Where predicted noise levels are more than 2 dB(A) below the criteria derived in accordance with the SA EPA Guidelines, then to address the uncertainty in the prediction, 2dB(A) will be added to the predicted level as the compliance level that must be achieved
- Where the predicted noise level is less than the 2 dB(A) below the SA EPA criteria value, then the SA EPA criteria level becomes the compliance level that must not be exceeded.

The above assignment of noise compliance criteria recognises the uncertainty inherent in noise predictions while ensuring that the noise levels of the wind farm are no greater than those specified under the SA EPA guidelines.

This compliance criteria has been applied to the values in Table 12.6 to arrive at a compliance criteria table for the Flyers Creek project which is shown below as Table 12.13.

Table 12.13 – Flyers Creek Wind Farm Compliance Criteria

Relevant Receiver	Nearest Turbine	Distance (km)	Wind speed at 10 metres AGL (metres per second)									
			3	4	5	6	7	8	9	10	11	12
Criteria Set: R012 – Errowanbang			35	36	38	39.5	40.5	41.5	42.5			
R001	37	2.6	23.5	26.5	29.5	32.5	35	35	35	35	35	35
R005	31	2.2	25	28	31	34	36.5	36.5	36.5	36.5	36.5	36.5
R007	29	2.9	14.5	17.5	20.5	23.5	26	26	26	26	26	26
R008	29	2.6	13.5	16.5	19.5	22.5	25	25	25	25	25	25
R009	29	1.9	25	28	31	34	36.5	36.5	36.5	36.5	36.5	36.5
R010	29	1.7	27	30	33	36	38.5	38.5	38.5	38.5	38.5	38.5
R011	24	1.8	26	29	32	35	37.5	37.5	37.5	37.5	37.5	37.5
R012	24	2.3	25.5	28.5	31.5	34.5	37	37	37	37	37	37
R013	12	1.8	25.5	28.5	31.5	34.5	37	37	37	37	37	37
R015	12	2.9	22	25	28	31	33.5	33.5	33.5	33.5	33.5	33.5
R016	12	2.1	23	26	29	32	35	35	35	35	35	35

Relevant Receiver	Nearest Turbine	Distance (km)	Wind speed at 10 metres AGL (metres per second)									
			3	4	5	6	7	8	9	10	11	12
R017	10	1.8	24	27	30	33	35.5	35.5	35.5	35.5	35.5	35.5
R057	12	1.5	27	30	33	36	38.5	38.5	38.5	38.5	38.5	38.5
R073	28	2.5	23.5	26.5	29.5	32.5	35.5	35.5	35.5	35.5	35.5	35.5
R075	12	2.1	25	28	31	34	36.5	36.5	36.5	36.5	36.5	36.5
R085	10	2.1	24.5	27.5	30.5	33.5	36	36	36	36	36	36
R087	10	1.3	23	26	29	32	35	35	35	35	35	35
R095	31	1.4	27.5	30.5	33.5	36.5	39	39	39	39	39	39
R102	46	2	26	29	32	35	37.5	37.5	37.5	37.5	37.5	37.5
R106	31	2.5	23	26	29	32	34.5	34.5	34.5	34.5	34.5	34.5
R107	28	2.6	23	26	29	32	34.5	34.5	34.5	34.5	34.5	34.5
R109	10	2.3	13	16	19	22	24.5	24.5	24.5	24.5	24.5	24.5
R112	10	2.8	19.5	22.5	25.5	28.5	31.5	31.5	31.5	31.5	31.5	31.5
R126	29	2.1	24.5	27.5	30.5	33.5	36	36	36	36	36	36
R128	12	2.6	20.5	23.5	26.5	29.5	32	32	32	32	32	32
R129	12	2.3	24	27	30	33	35.5	35.5	35.5	35.5	35.5	35.5
R130	29	2.4	23	26	29	32	34.5	34.5	34.5	34.5	34.5	34.5
R131	29	4.3	15	18	21	24	27	27	27	27	27	27
R132	31	2.9	22.5	25.5	28.5	31.5	34	34	34	34	34	34
R158	3	2.2	24.5	27.5	30.5	33.5	36	36	36	36	36	36
Wind Speed (metres per second)			3	4	5	6	7	8	9	10	11	12
Criteria set: R025 – Bromley			35	35	36	37.5	38.5	40	40.5			
R023	4	1.2	29.5	32.5	35.5	37.5	38.5	40	40.5	40.5	40.5	40.5
R025	4	1.1	27	30	33	36	38.5	38.5	38.5	38.5	38.5	38.5
R029	4	2.6	16.5	19.5	22.5	25.5	28	28	28	28	28	28
R030	4	2.4	19	22	25	28	30.5	30.5	30.5	30.5	30.5	30.5
R033	4	2.9	17.5	20.5	23.5	26.5	29	29	29	29	29	29
R034	4	2.5	16.5	19.5	22.5	25.5	28	28	28	28	28	28
R042	4	2.6	14	17	20	23	26	26	26	26	26	26
R043	15	4.7	25.5	28.5	31.5	34.5	37	37	37	37	37	37
R080	14	2.2	22.5	25.5	28.5	31.5	34	34	34	34	34	34
R082	4	1.5	23.5	26.5	29.5	32.5	35	35	35	35	35	35
R098	4	2.8	18	21	24	27	29.5	29.5	29.5	29.5	29.5	29.5
R114	4	2.6	14	17	20	23	25.5	25.5	25.5	25.5	25.5	25.5
R115	4	2.2	20.5	23.5	26.5	29.5	32	32	32	32	32	32
R116	4	2.3	20	23	26	29	31.5	31.5	31.5	31.5	31.5	31.5
R137	4	3.6	16	19	22	25	27.5	27.5	27.5	27.5	27.5	27.5
R152	44	3.5	15.5	18.5	21.5	24.5	27	27	27	27	27	27
Wind Speed (metres per second)			3	4	5	6	7	8	9	10	11	12
Criteria set: R027 –Willow Creek			35	35	35	37	38.5	40	41			
R020	10	2.8	21	24	27	30	32.5	32.5	32.5	32.5	32.5	32.5
R027	3	1.8	24.5	27.5	30.5	33.5	36	36	36	36	36	36
R028	4	1.7	24.5	27.5	30.5	33.5	36	36	36	36	36	36
R035	3	2.8	11.5	14.5	17.5	20.5	23	23	23	23	23	23
R036	3	2.6	17.5	20.5	23.5	26.5	29.5	29.5	29.5	29.5	29.5	29.5

Relevant Receiver	Nearest Turbine	Distance (km)	Wind speed at 10 metres AGL (metres per second)									
			3	4	5	6	7	8	9	10	11	12
R037	3	2.8	21	24	27	30	32.5	32.5	32.5	32.5	32.5	32.5
R044	14	1.2	28	31	34	37	38.5	40	40	40	40	40
R045	15	1.9	23	26	29	32	35	35	35	35	35	35
R091	3	2.2	18	21	24	27	29.5	29.5	29.5	29.5	29.5	29.5
R092	4	2.1	15	18	21	24	26.5	26.5	26.5	26.5	26.5	26.5
R093	3	2.4	13	16	19	22	25	25	25	25	25	25
R094	3	2.2	22	25	28	31	33.5	33.5	33.5	33.5	33.5	33.5
R096	4	1.9	22.5	25.5	28.5	31.5	34	34	34	34	34	34
R117	4	3	19	22	25	28	30.5	30.5	30.5	30.5	30.5	30.5
R118	4	2.7	15.5	18.5	21.5	24.5	27	27	27	27	27	27
R119	3	4.2	13.5	16.5	19.5	22.5	25.5	25.5	25.5	25.5	25.5	25.5
R120	4	2.8	18	21	24	27	29.5	29.5	29.5	29.5	29.5	29.5
R121	4	2.1	16.5	19.5	22.5	25.5	28	28	28	28	28	28
R122	4	3.4	16	19	22	25	27.5	27.5	27.5	27.5	27.5	27.5
R123	4	3.6	12	15	18	21	23.5	23.5	23.5	23.5	23.5	23.5
R124	4	3.7	12	15	18	21	23.5	23.5	23.5	23.5	23.5	23.5
R125	4	3.7	13.5	16.5	19.5	22.5	25	25	25	25	25	25
R127	3	2.8	11.5	14.5	17.5	20.5	23	23	23	23	23	23
R138	4	3.4	13	16	19	22	24.5	24.5	24.5	24.5	24.5	24.5
R139	4	3.5	12.5	15.5	18.5	21.5	24	24	24	24	24	24
R140	4	3.2	17.5	20.5	23.5	26.5	29	29	29	29	29	29
R141	4	3.4	16.5	19.5	22.5	25.5	28	28	28	28	28	28
R142	4	3.8	11.5	14.5	17.5	20.5	23	23	23	23	23	23
R143	4	4	5	8	11	14	17	17	17	17	17	17
R144	3	3.8	14.5	17.5	20.5	23.5	26.5	26.5	26.5	26.5	26.5	26.5
R145	3	4	15	18	21	24	26.5	26.5	26.5	26.5	26.5	26.5
R146	3	4.1	14.5	17.5	20.5	23.5	26.5	26.5	26.5	26.5	26.5	26.5
R153	3	3.4	8	11	14	17	20	20	20	20	20	20
R154	3	3.8	6.5	9.5	12.5	15.5	18	18	18	18	18	18
R155	3	4	5	8	11	14	16.5	16.5	16.5	16.5	16.5	16.5
R156	3	4.9	7.5	10.5	13.5	16.5	19.5	19.5	19.5	19.5	19.5	19.5
Wind Speed (metres per second)			3	4	5	6	7	8	9	10	11	12
Criteria set: R078			35	35	35	36.5	39	41.5	43.5			
R046	15	1.5	26.5	29.5	32.5	35.5	38	38	38	38	38	38
R047	43	2.2	23	26	29	32	34.5	34.5	34.5	34.5	34.5	34.5
R048	43	1.4	26	29	32	35	37.5	37.5	37.5	37.5	37.5	37.5
R072	29	1.6	26.5	29.5	32.5	35.5	38	38	38	38	38	38
R077	18	1.3	29.5	32.5	35	36.5	39	41	41	41	41	41
R078	18	1.2	30	33	35	36.5	39	41.5	41.5	41.5	41.5	41.5
R090	4	1.6	28.5	31.5	34.5	36.5	39	40	40	40	40	40
R099	4	1.7	28	31	34	36.5	39	39.5	39.5	39.5	39.5	39.5
R100	4	1.8	25	28	31	34	36.5	36.5	36.5	36.5	36.5	36.5
R101	43	2.6	20.5	23.5	26.5	29.5	32	32	32	32	32	32
R108	18	1.6	28.5	31.5	34.5	36.5	39	40	40	40	40	40

Relevant Receiver	Nearest Turbine	Distance (km)	Wind speed at 10 metres AGL (metres per second)									
			3	4	5	6	7	8	9	10	11	12
R110	37	3.5	18.5	21.5	24.5	27.5	30	30	30	30	30	30
R111	37	3.4	17.5	20.5	23.5	26.5	29	29	29	29	29	29
R133	42	2.9	21.5	24.5	27.5	30.5	33	33	33	33	33	33
R134	46	3.2	19	22	25	28	30.5	30.5	30.5	30.5	30.5	30.5
R136	43	4.1	15.5	18.5	21.5	24.5	27	27	27	27	27	27
R147	15	2.7	13.5	16.5	19.5	22.5	25	25	25	25	25	25
R148	15	3.8	17	20	23	26	28.5	28.5	28.5	28.5	28.5	28.5
R149	15	4	4.5	7.5	10.5	13.5	16	16	16	16	16	16
R150	15	4	11.5	14.5	17.5	20.5	23	23	23	23	23	23
R151	5	3.8	16	19	22	25	27.5	27.5	27.5	27.5	27.5	27.5
Wind Speed (metres per second)			3	4	5	6	7	8	9	10	11	12
Criteria set: R089			40.5	42.5	44	45.5	47	48.5	50			
R089	6	1.2	31.5	34.5	37.5	40.5	43	43	43	43	43	43

It is important to note that the Flyers Creek wind farm compliance criteria does not exceed the SA EPA noise limits at any relevant receiver at any wind speed.

12.11.2 Construction Phase

Construction noise impacts will be managed through a noise management sub-plan of the CEMP. Key components of the construction noise management plan will include:

- Prior to commencement of construction, neighbours to the wind farm site will be informed of the construction works, the nature and duration of components of the construction phase, the potential impacts and contact details for registering complaints or enquiries.
- Adherence to standard construction hours (Table 12.11) for the great majority of construction activities with limited excursions for the potential events defined in Table 12.12.
    - occasional lifting of turbine components with large cranes during low wind periods outside normal working hours to ensure safety of turbine erection
    - extension of hours to complete a concrete pour for a turbine footing that has experienced delays (beyond the contractors control) and where the footing needs to be completed in a single operation
    - delivery of turbine components using Restricted Access Vehicles as directed by Police, RTA or Council or in accordance with the approved Traffic Management Plan.
- All vehicles to have the required noise control devices suitable for use on public roads.
- Blasting operations will be avoided where practicable, but if required will only take place between 9:00am and 5:00pm Monday to Friday inclusive, and between 9:00am and 1:00pm Saturday; and at such other times or frequency as may be approved by the DECCW and will comply with the following:
    - The air-blast overpressure level from blasting when assessed at the closest occupied residential sites surrounding the wind farm will not exceed 115 dB (Lin Peak) for more than 5% of the total number of blasts during each reporting period; and 120dB (Lin Peak) at any time.

- The ground vibration peak particle velocity from blasting operations when assessed at the closest occupied residential sites surrounding the wind will not exceed 5mm/s for more than 5% of the total number of blasts carried out on the Site during each reporting period; and 10mm/s at any time.

- Should any instances of elevated noise levels arising from construction works impact surrounding relevant receivers as indicated by receipt of complaints, then the matter will be investigated by the proponent and where practicable measures will be implemented to reduce the impact. A response will be provided to the complainant as to the findings and any modifications to reduce the impact.

- If the contractor wishes to install a batch plant or quarry activity on site then the contractor will be responsible for undertaking the required environmental assessment and gaining all approvals for the concrete batch plant.

12.11.3 Operations Phase

Once the wind farm is operational, there will be a low level of traffic to and from the site and the main noise sources for the wind farm will relate to the operation of the turbines and the substation. The substation is located such that noise mitigation measures are not required to achieve compliance. The turbines will be spread around an area extending 11 kilometres from north to south and about eight kilometres from west to east. The turbine sites are at distances from relevant occupied residences such that the turbines can be operated in a manner where the noise criteria will not be exceeded.

To ensure that the noise impacts of the operations phase of the Flyers Creek Wind Farm complies with the applicable noise criteria as outlined in the Environmental Assessment the following measures will be integrated in the project's Noise sub plan included in the OEMP.

- Prior to commencement of operation, the proponent will develop a noise compliance assessment protocol to be implemented following completion of commissioning of the wind farm. The protocol will be developed by an acoustic engineer as part of the OEMP and require the approval of the Department of Planning.

- Prior to commissioning of the wind farm, neighbours to the wind farm (relevant receivers) will be provided with details of the commissioning and contact details in the event that disturbance occurs at their residence

- Within three months of commissioning of the wind farm, compliance checks will be undertaken for the closest relevant receiver residences to confirm that wind farm noise levels do not exceed criteria at these locations and to verify reliability of predictions.

- If the measured noise levels arising from the compliance checks exceed the SA EPA noise standard at the closest relevant residences, additional compliance checks will also be undertaken at other relevant receiver residences to confirm that wind farm noise levels do not exceed the criteria at these locations

- If complaints in respect of noise impact are received from more distant relevant receivers following the wind farm commissioning, then these complaints will also be investigated

- In the extremely unlikely event that the compliance assessment checks identify exceedance of criteria for specific wind speeds and/or wind directions, then the proponent will limit the operation of the contributing turbines and provide a management plan to the Department of Planning indicating how compliance will be ensured for the operation where exceedance occurs

- Subject to Department of Planning approval of the plan for mitigation of a confirmed exceedance, Flyers Creek Wind Farm Pty Ltd will implement the necessary measures to achieve compliance and demonstrate the effectiveness of the measures implemented and that compliance has been achieved

- If agreeable to an owner of a relevant receiver residence, Flyers Creek Wind Farm Pty Ltd may provide improvements to the affected residence in place of, or in addition to, modification to the wind farm operation, to achieve compliance with the SA EPA Guideline.

- For the closest wind farmer residences to the wind farm, Flyers Creek Wind Farm Pty Ltd will establish an agreement with the landowner in respect of predicted noise impacts that are above criteria established in accordance with the SA EPA Guideline. This will include a statement of the likely noise impacts and an agreement by the landowner accepting the predicted impacts.

The process for compliance assessment may include consultation to determine whether an exceedance, if it occurred, is annoying or disturbing. Where an exceedance is measured but the affected landowner does not regard this as disturbing or annoying, then the plan should allow for that exceedance to be managed in accordance with an agreement between the proponent and the respective landowners.

12.12 Conclusions

This chapter, along with Appendix G, has reviewed the potential noise impact of the proposed Flyers Creek Wind Farm on residential receivers during the construction and operational stages.

Noise criteria for the operating wind farm have been developed using the requirements of the South Australian EPA Noise Assessment Guidelines for wind farms as specified in the project's Director Generals Requirements (Appendix A). Prediction of sound levels from the operation of the wind farm has been based on the GE 2.5xl 2.5 MW turbine noise specification with four turbines operating in noise reduction mode for one or two integer wind speeds using two accurate and conservative predictive noise models. When the entire wind farm is operating, the Flyers Creek wind farm is predicted to meet the applicable noise criteria at all relevant residences and at every wind speed as shown in ViPAC's report in Appendix G2. Should the turbine selected at the final design stage have a higher noise specification than the GE 2.5xl-2.5 MW wind turbine used in the noise assessment described here, the proponent will undertake a new noise impact assessment, the results of which will be provided to the Department of Planning. Such a noise assessment will demonstrate full compliance with the EPA SA's *Wind Farms, Environmental Noise Guidelines: February 2003*.

A noise management plan is proposed to address any noise impacts that arise once the wind farm is operational. Should noise impacts and disturbance occur at the relevant receivers then the proponent will undertake one or more the following elements to resolve the issue.

- investigate the nature of the impacts through discussion with the affected resident(s)
- confirm the turbine's compliance with the relevant noise specification
- undertake monitoring to assess noise impacts, if necessary

In the very unlikely instance that compliance testing demonstrates the wind farm is exceeding the SA EPA criteria, the proponent will undertake one or more of the following measures:

- identify any control measures necessary to ensure compliance including applying turbine operational controls (noise reduction modes) for specific wind speeds and/or directions
- implement noise control measures at residences, if agreeable to landowner

During the construction period, noise from construction machinery may be discernible on occasions at residences on the various neighbouring properties, but these will be short-term impacts that occur at different parts of the site over the course of the project and predominantly during daytime. These impacts will not cause an increase in long-term sound levels.

A construction noise management plan will be implemented as part of the CEMP to mitigate any adverse construction noise impacts. Traffic generated by the construction workforce movements and delivery of materials may increase sound levels at residences adjoining the main access routes for short periods of time. These traffic noise impacts will be temporary and limited to site working hours.