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WHITE ROCK WIND FARM

ENVIRONMENTAL NOISE ASSESSMENT

S3486C2

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EXECUTIVE SUMMARY

The White Rock Wind Farm is a proposed wind farm to the west of Glen Innes with a layout comprising up to 119 turbines.

The White Rock Wind Farm has been assessed against the Director General's requirements (DGRs) for operational noise and construction noise and vibration.

The operational noise has been assessed against the stringent *South Australian Environmental Noise Wind Farm Guidelines 2003 (the SA Guidelines)*. The SA Guidelines require the predicted noise levels from the wind farm to be compared against criteria developed from the measured background noise levels in the area.

Two turbines have been considered in the assessment, the REPower MM92 2050kW turbine and the larger Vestas V90 3MW turbine. The MM92 turbine is predicted to achieve the SA Guidelines at all dwellings for the proposed layout. In order for the V90 turbine to achieve the SA Guidelines at all dwellings, two of the turbines will need to operate in "low noise mode" at a designated wind speed.

Based on the above, for any turbine with a sound power level and hub height that is equal to or less than that assessed for the MM92 and V90 turbines, the proposed layout can achieve the stringent requirements of the SA Guidelines.

A construction noise and vibration framework has also been developed in this assessment to achieve the relevant Director General's requirements for general construction activity, transport and potential blasting activity.

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INTRODUCTION

Sonus Pty Ltd has been engaged by Epuron Pty Ltd to conduct an environmental noise assessment of the proposed White Rock Wind Farm, located near Glen Innes, New South Wales.

The Director-General's Requirements (DGRs) dated 13th of October, 2010, specify that the assessment must be conducted in accordance with the following guidelines:

- Wind Turbines – the South Australian Environment Protection Authority's *Wind Farms – Environmental Noise Guidelines* (2003);
- Substation - *NSW Industrial Noise Policy* (EPA 2003);
- Site Establishment and Construction - *Interim Construction Noise Guideline* (DECC 2009)
- Traffic Noise – *Environmental Criteria for Road Traffic Noise* (NSW EPA, 1999)
- Vibration – *Assessing Vibration: A Technical Guideline* (DECC, 2006); and,
- Blasting – *Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration* (ANZECC 1990).

Noise from the proposed wind farm has been predicted to residences in the vicinity based on the ISO 9613[1] noise propagation model and sound power level data provided by the proposed wind turbine generator manufacturers. The applicable environmental noise criteria were determined based on the relevant guidelines and background noise monitoring conducted at seven residences in the vicinity of the wind farm. The locations of the turbines and relevant receivers are provided in appendices A and B respectively.

[1] ISO 9613-2:1996 "Acoustics – Attenuation of sound during propagation outdoors"

DIRECTOR GENERALS REQUIREMENTS

The Director-General's Requirements (DGRs) dated 13th of October, 2010, specify the relevant guidelines for which each aspect of wind farm noise is to be assessed against. A copy of the DGRs is provided in Appendix C.

Wind Farms - Environmental Noise Guidelines (2003)

In accordance with the DGRs, wind turbine noise is to be assessed against the South Australian Environment Protection Authority's *Wind Farms – Environmental Noise Guidelines* (the SA Guidelines).

Criteria

The SA Guidelines state:

> *The predicted equivalent noise level ($L_{Aeq,10}$), adjusted for tonality in accordance with these guidelines, should not exceed:*
>
> - *35 dB(A), or*
> - *The background noise level ($L_{A90,10}$) by more than 5 dB(A)*
>
> *Whichever is the greater, at all relevant receivers for each integer wind speed[2] from cut-in to rated power of the WTG.*

It is noted that if the wind farm noise contains tonal characteristics a 5 dB(A) penalty is to be applied. In addition the SA Guidelines note that:

> *The criteria have been developed to minimise the impact on the amenity of premises that do not have an agreement with the wind farm developers.*

[2] Where wind speed is referenced in this report, it is taken to be the wind speed measured 10m above the ground in accordance with the SA Guidelines, unless specifically noted otherwise

Landowners with Commercial Agreements

The landowners of a number of residences have entered into commercial agreements with the developers of the wind farm. These landowners are listed in appendix B.

As each of these landowners has an agreement with the wind farm developer, suitable noise criteria for each residence will be agreed between the developer and the landowner. However, to protect landholders with an agreement in this project from unreasonable interference to amenity, reference is also made to the WHO Guidelines[3]. The WHO Guidelines recommend an indoor level of 30 dB(A) is achieved to protect against sleep disturbance. The indoor limit of 30 dB(A) equates to an outdoor noise level of 45 dB(A) with windows open or 52 dB(A) with windows closed.

It is proposed that the noise at residences of landholders with an agreement will achieve the recommendations of the WHO Guidelines.

Background Noise Monitoring

To determine the background noise level at various wind speeds, the background noise levels were measured at 7 locations in the vicinity of the proposed wind farm between the 23rd of September and the 14th of October, 2010. The measurements were conducted in accordance with the SA Guidelines.

The 7 monitoring locations (R56, R1, R44, R64, R35, R21, R27) were selected based on initial predictions of the wind farm noise, where preference was given to houses with the highest predicted noise levels.

[3] "WHO Guidelines for Community Noise" World Health Organisation, 1999

The background noise was measured with a combination of Rion NL21 and Rion NL22 type 2 sound level meters, calibrated onsite at the beginning and end of the measurement period with a Rion NC74 Calibrator. All microphones were fitted with 90mm weather proof windshelds, with the microphone approximately 1500mm above ground level. Each noise logger was positioned at an equivalent distance from the facade of the dwelling as any significant trees at that location. Photographs of the noise monitoring equipment at each location are provided in Appendix D.

The background noise level was measured in 10 minute intervals at each of the monitoring locations. During the background noise monitoring campaign Epuron measured the wind speed in 10 minute intervals at a height of 10m above ground in accordance with the SA Guidelines.

During the background noise measurement periods, rainfall and wind speed at the microphone (approximately 1.5m above ground level) were also measured at Residence R27, using a HOBO Micro Station Logger H21-002. The rainfall and wind speed data collected were used to determine the periods when weather directly on the microphone may potentially have affected the background noise measurement. Hence, measured background noise data were discarded before further analysis. The discarded data is for periods where rainfall was measured and/or where the measured wind speed exceeded 5 m/s at the microphone for more than 90% of the measurement period.

After data removal, the resultant background noise data collected at the monitoring locations were correlated with the wind speed measured by the wind mast, and a least squares regression analysis of the data was undertaken to determine the line of best fit for the correlations in accordance with the SA Guidelines. The data and the regression curves are shown in Appendix E. Based on this regression analysis, the background noise level ($L_{A90,10}$) at a range of wind speeds within the operating range of the turbines is shown in Table 1 below.

Table 1: Background Noise Levels (dB(A))

Wind Speed (m/s)	5	6	7	8	9	10
R1	38	38	39	39	40	41
R21	36	38	39	41	43	45
R27	38	38	38	38	39	40
R35	37	37	38	39	40	42
R44	35	35	36	38	40	42
R56	35	36	38	40	43	45
R64	39	40	42	44	46	49

From the above, the assessment criteria at each residential location have been determined for both non-associated land holders and for land holders with an agreement, these are summarised in Appendix F. To provide a conservative assessment approach, where background noise monitoring has not occurred at a dwelling, the lowest measured background level at any of the 7 locations has been used to derive the criteria.

Construction Noise

The construction of a wind farm comprises activities such as road construction, civil works, excavation and foundation construction, electrical infrastructure works and turbine erection requiring processes such as heavy vehicle movements, crushing and screening, concrete batching, rock trenches, loaders, excavators, generators, cranes and, subject to local conditions, possibly blasting.

To assess construction noise in accordance with the DGRs, the Department of Environment & Climate Change, *Interim Construction Noise Guideline 2009* (the ICN Guideline), is referenced.

Noise monitoring was carried out at seven residences in the vicinity of the wind farm as described for the SA Guidelines. The most relevant descriptor of noise for comparison with the ICN Guideline is the Rating Background Level (RBL). The RBL is determined from the lower tenth percentile of the L_{A90} noise level in the environment and effectively represents the “lulls”. That is, the RBL is representative of the quietest periods at the monitoring locations. The RBL for each monitoring location and for each time period is provided in Table 2 below.

Table 2: RBL at Background Monitoring Locations

RBL	R1	R21	R27	R35	R44	R56	R64
Day	33	29	32	31	27	29	30
Evening	31	34	32	31	31	30	40
Night	25	29	32	26	26	25	34

The ICN Guideline provides an emphasis on implementing “feasible” and “reasonable” noise reduction measures and does not set mandatory objective criteria. However, the ICN Guideline does establish a quantitative approach, whereby “management levels” are defined based on the existing RBL. The management levels as defined by the ICN Guideline are provided below in Table 3.

Table 3: Interim Construction Noise Guideline – Management Levels

Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. • The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. • Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: 1. times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences 2. if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dB	• A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the noise affected level. • Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community.

Traffic Noise

In accordance with the DGRs, traffic noise associated with the construction of the wind farm is to be assessed against the NSW Environment Protection Authority, *Environmental Criteria for Road Traffic Noise* (ECRTN).

Traffic noise criteria are provided for a range of scenarios. The most appropriate classification for the White Rock wind farm construction site and its associated traffic is considered to be "land use developments with the potential to create additional traffic on local roads". However, it should be noted that this criteria applies to an ongoing operation, as distinct to a temporary construction process.

The criteria are equivalent ($L_{Aeq,\ 1hour}$) noise levels of no greater than 55 dB(A) during the daytime (7am to 10pm) and 50 dB(A) during the night (10pm to 7am). This noise level is to be achieved outside, at a distance of 1.5m from the facade of a dwelling.

Blasting

The DGRs specify that blasting should be assessed against the *Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration,* ANZECC 1990, (the Blasting Guidelines).

The Blasting Guidelines provide the following recommended criteria:

- Peak sound pressure level of 115 dBL for 95% of blasts over a 12 month period, and a maximum level of 120 dBL.
- Peak particle velocity of 5mm/s for 95% of blasts over a 12month period, and a maximum velocity of 10mm/s
- Blasting should generally only be permitted during the hours of 9am to 5pm Monday to Saturday. Blasting should not take place on Sundays or Public Holidays.

Construction Vibration

To assess construction vibration levels in accordance with the DGRs, the DECC document "Assessing Vibration: A Technical Guideline", February 2006 (the Technical Guideline) is referenced.

The Technical Guideline provides an emphasis on construction activity implementing feasible and practicable vibration reduction measures and does not set mandatory standards or objective criteria.

The Technical Guideline does establish a quantitative approach, whereby goal vibrations levels are established based on human response to continuous, intermittent and impulsive vibration. Continuous vibration is uninterrupted for an extended period of time. Intermittent vibration is an interrupted form of continuous vibration, and impulsive vibration is a sudden event or events.

For construction activity occurring during the day time, the Technical Guideline can be interpreted to provide the following vibration criteria at the dwellings, based on the core document used as the technical basis for the Guideline, the British Standard BS 6472-1992 "Evaluation of human exposure to vibration in buildings (1-80Hz)":

Table 4: Vibration Criteria

Continuous mm/s^2 Vertical (rms)	Impulsive mm/s^2 Vertical (rms)	Intermittent $m/s^{1.75}$ Vibration Dose Value
10-20	30-60	0.2-0.4

Continuous and impulsive vibration criteria are provided as "rms" values for acceleration. The term "rms" relates to a mathematical process that is regularly performed on varying noise and vibration signals to assist in their expression, quantification and comparison. The "rms" value for acceleration is expressed in millimeters per second per second (mm/s^2). The intermittent vibration criterion is derived from a prescribed mathematical process performed on the results and therefore its quantity and units ($m/s^{1.75}$) differ from those for continuous and intermittent vibration.

ASSESSMENT

Wind Farm Noise

Noise from the wind farm has been predicted based on two different turbine models, Vestas V90 3MW and REpower MM92 2050kW. The proposed wind farm consists of 119 turbines with the coordinates of each given in Appendix A.

The predictions of the turbine noise have been based on manufacturers warranted sound power level data. The data provided contains octave band sound power levels for low wind speeds, where low background noise levels result in the most stringent criteria. Tables 5 and 6 contain the warranted sound power levels for the Vestas V90 and REpower MM92 turbines respectively.

Table 5: Vestas V90 Sound Power Levels (dB(A))

Octave Band Centre Frequency (Hz)	Wind Speed (m/s)						
	4	5	6	7	8	9	10
63	82.7	85.7	89	90.9	91.8	91.7	90.4
125	84.9	87.9	91.2	93.1	94	93.9	92.6
250	88.2	91.2	94.5	96.4	97.3	97.2	95.9
500	90.5	93.5	96.8	98.7	99.6	99.5	98.2
1000	92.7	95.7	99	100.9	101.8	101.7	100.4
2000	91.4	94.4	97.7	99.6	100.5	100.4	99.1
4000	87.6	90.6	93.9	95.8	96.7	96.6	95.3
Total	**97.9**	**100.9**	**104.2**	**106.1**	**107.0**	**106.9**	**105.6**

Table 6: REpower MM92 Sound Power Levels (dB(A))

Octave Band Centre Frequency (Hz)	Wind Speed (m/s)					
	5	6	7	8	9	10
63	81.4	83.3	84.3	84.3	84.3	84.3
125	89.7	91.6	92.5	92.5	92.5	92.5
250	95.3	97.2	98.1	98.1	98.1	98.1
500	97	98.9	99.8	99.8	99.8	99.8
1000	95	96.9	97.8	97.8	97.8	97.8
2000	89.3	91.2	92.1	92.1	92.1	92.1
4000	82.6	84.5	85.4	85.4	85.4	85.4
Total	**101.4**	**103.3**	**104.2**	**104.2**	**104.2**	**104.2**

It is not expected that the proposed turbines will contain tonal characteristics as this is required to be reported on as part of the sound power level testing procedure conducted in accordance with the relevant international standard. To provide certainty, the developer may seek the manufacturer to guarantee against turbines containing tonal characteristics. The predictions have been performed without a penalty for the presence of tonal characteristics.

Noise from the substation associated with the wind farm has been included in the noise predictions. It is proposed that 2, 100-120MVA transformers (33-132kV) are to be installed at the substation which is to be located at either of the options listed in Appendix A. The sound power levels of the transformers have been derived from the Australian Standard AS2374.6-1994[4]. Table 7 lists the octave band sound power levels of the transformers.

Table 7: 100-120MVA (33-132kV) Transformer, Sound Power Levels (dB(A))

Octave Band Centre Frequency (HZ)	63	125	250	500	1000	2000	4000	8000	Total
SWL (dB(A))	82.0	90.1	97.6	100.0	92.2	89.4	82.2	78.1	102.9

ISO 9613-2:1996

Noise predictions were conducted using the propagation model, ISO 9613-2:1996 “Acoustics – Attenuation of sound during propagation outdoors” (ISO 9613). This noise propagation model is widely accepted as an appropriate model for the assessment of wind farms when appropriate inputs are used. The ISO 9613 model has the ability to take into account the distance between the source and receiver, topography, hardness of the ground and atmospheric absorption at different frequencies.

[4] Australian Standard AS2374.6-1994, *Power Transformers Part 6: Determination of transformer and reactor sound levels.*

The assessment has been based on the following inputs, agreed upon by UK experts[5] in a joint paper:

- Warranted sound power levels
- 10°C temperature
- 70% relative humidity
- 50% acoustically hard ground and 50% acoustically soft ground
- Barrier attenuation of no greater than 2 dB(A)
- 4m receiver height

Predicted Turbine Noise Levels

The predicted noise from the wind farm has been assessed against the relevant criteria according to the SA Guidelines. Appendix F lists the predicted noise from both turbine models and the criteria for each residence at each relevant wind speed. Appendix E includes a graphical representation of the predicted noise from both turbine models and the relevant criteria at each of the monitoring locations.

Based on the predicted noise levels shown in Appendix F, the REpower MM92 turbines are predicted to comply with the relevant criteria at all residences for all wind speeds. The Vestas V90 turbines will also comply at all residences with the exception of one residence (R27) at one wind speed (8m/s). Appendix F incorporates an operating strategy that enables compliance with the SA Guidelines at R27 comprising the operation of turbines T2 and T112 in a low noise mode ("mode 2") at a wind speed of 8m/s. The low noise mode reduces the sound power level of these turbines by 2 dB(A). With the low noise mode implemented for these turbines, predictions indicate the wind farm will comply with the relevant criteria at all residences as for the REpower assessment.

[5] Institute of Acoustics Vol 34 No2 March/April 2009, "Prediction and Assessment of Wind Turbine Noise – Agreement about relevant factors for noise assessment from wind energy projects"

To supplement the assessment summary in Appendix F, Appendix G has been included to provide noise contours for both the V90 and MM92 model turbines at the wind speed associated with the highest sound power level for each turbine, being 7m/s for the MM92 and 8m/s for the V90.

Substation

Noise from the substation has been included into the wind farm predictions. At the worst case residence (closest to either of the proposed substation locations) the predicted substation noise is 21 dB(A). This level is 14 dB(A) below the base level of the SA Guidelines and as such will not adversely impact on the amenity of residences in the locality of the wind farm.

Cumulative Impacts

The SA Guidelines have been widely described as one of the most stringent assessment approaches of any jurisdiction in the World. The baseline criterion of 35 dB(A) is set at least 5 dB(A) less than the New Zealand Standard 1998 baseline used in Victoria and 10 dB(A) less than the World Health Organisation's (WHO) recommendation for the prevention of sleep disturbance effects.

Due to their stringency, the SA Guidelines explicitly account for the cumulative effect of other wind farms. The baseline criterion specified by the SA Guidelines accounts for cumulative impacts according to the following:

> *The base noise level is typically 5 dB(A) lower than the level considered to reflect the amenity of the receiving environment. Designing new developments at a lower level accounts for the cumulative effect of noise from other similar development and for the increased sensitivity of receivers to a new noise source.*

Section 2.5 of the SA Guidelines is titled "Cumulative Development", this section is repeated below:

> *Separate wind farm developments in close proximity to each other may impact on the same relevant receiver.*
>
> *Therefore, as for staged development, any additional wind farm that may impact on the same relevant receiver as an existing wind farm should meet the criteria using the background noise levels as they existed before the original wind farm site development. The noise generated by existing WTGs from another wind farm should not be considered as part of the background noise in determining criteria for subsequent development.*

It is noted that the nearby Glen Innes Wind Farm has been granted planning approval, but has not yet been constructed. Therefore, background noise monitoring carried out for the purposes of this assessment is not influenced by an existing wind farm, and is in accordance with the cumulative development requirements of the SA Guidelines.

Modulation

Amplitude modulation, or "swish", is an inherent noise character associated with wind farms. The SA Guidelines explicitly account for "swish" as a fundamental characteristic of noise from a wind farm regardless of its depth, provided that it is generated by a properly maintained and operated wind turbine or wind farm.

The ability to hear "swish" depends on a range of factors. It will be most prevalent when there is a stable environment (temperature inversion) at the wind farm and the background noise level at the listening location is low. In addition, "swish" is greater when located cross wind from a wind turbine. It is noted that whilst the amplitude modulation is greater at a cross wind location, the actual noise level from the wind farm will be lower than at a corresponding downwind location (the predicted noise levels conservatively assume that each residence is located downwind of all turbines).

The conditions noted above are most likely to occur when wind speeds at the wind farm are low under a clear night sky. The Van Den Berg effect is an increase of the modulation depth from a wind farm under very specific meteorological and operational conditions which include those conditions described above.

The Van Den Berg effect was observed on a flat site in Europe under specific conditions and in the two matters before the NSW Land and Environment Court (Gullen Range wind farm NSW LEC 41288 of 2008 and Taralga wind farm NSW LEC 11216 of 2007), it has been determined by the relevant meteorological experts that the required meteorological conditions to trigger the effect were not a feature of the environment. In Gullen Range (NSW LEC 41288 of 2008), the meteorological analysis prepared by Dr Chris Purton concluded that suitable conditions for this effect are not a feature of the area because of the elevated ridgeline location of the wind farm (Purton, evidence NSW LEC 41288 of 2008).

If suitable conditions did exist to regularly generate high levels of swish, then there is no scientific research to indicate that the stringent SA Guidelines do not adequately account for it. Indeed, given the conditions are more likely to occur at night, then sleep disturbance would be the main issue to address, and the noise standards applied by the SA Guidelines to wind farms are significantly more stringent than limits established for the potential onset of sleep disturbance.

In the first draft of the National Wind Farm Development Guidelines (EPHC, 2009), excessive swish is referred to as one of the potential Special Audible Characteristics (or SACs) along with low frequency, infrasound and tonality. It recommends that:

> *With the exception of tonality, the assessment of SACs will not be carried out during the noise impact assessment phase, that is, pre-construction. This arrangement reflects two key issues:*
>
> 1. *There are, at present, very few published and scientifically-validated cases of any SACs of wind farm noise emission being problematic at receivers. The extent of reliable published material does not, at this stage, warrant inclusion of SACs other than tonality into the noise impact assessment planning stage.*
> 2. *In the case that reliable evidence did demonstrate merit in assessing such factors during the pre-construction phase, there is a gap in currently available techniques for assessing SACs as part of the noise impact assessment. In part this is due to the causes of most SACs in wind turbine noise emission not yet being clearly understood.*

The SA Guidelines are consistent with the above, inherently accounting for “swish” and therefore the Van Den Berg effect (increased “swish”). Compliance with the SA Guidelines will provide an adequate level of protection for the amenity of the surrounding area due to their stringency.

Low Frequency Noise

Noise sources that produce low frequency content, such as a freight train locomotive or diesel engine; have dominant noise content in the frequency range between 20 and 200 Hz. Low frequency noise is often described as a “rumble”.

Aerodynamic noise from a wind turbine is not dominant in the low frequency range. The main content of aerodynamic noise generated by a wind turbine is often in the area known generically as the mid-frequencies, being between 200 and 1000Hz.

Noise reduces over distance due to a range of factors including atmospheric absorption. The mid and high frequencies are subject to a greater rate of atmospheric absorption compared to the low frequencies and therefore over large distances, whilst the absolute level of noise in all frequencies reduces, the relative level of low frequency noise compared to the mid and high frequency content increases. For example, when standing alongside a road corridor, the mid and high frequency noise from the tyre and road interaction is dominant, particularly if the road surface is wet. However, at large distances from a road corridor in a rural environment, the remaining audible content is the low frequency noise of the engine and exhaust.

This effect is exacerbated in an environment that includes masking noise in the mid and high frequencies, such as that produced by wind in nearby trees.

At a distance from a wind farm, in an ambient environment where wind in the trees is present, it is therefore possible that only low frequencies remain audible and detectable.

Low frequency sound produced by wind farms is not unique in overall level or content. Low frequency sound can be easily measured and heard at a range of locations at levels well in excess than in the vicinity of a wind farm. Compliance with the SA Guidelines will therefore inherently provide an adequate level of protection of amenity in the surrounding area from low frequency noise impacts.

Infrasound

Infrasound is generally defined as noise at frequencies less than 20 Hz. The generation of infrasound was detected on early turbine designs, which incorporated the blades 'downwind' of the tower structure. The mechanism for the generation was that the blade passed through the wake caused by the presence of the tower.

Modern turbines locate the blades upwind of the tower and it is found that turbines of contemporary design produce much lower levels of infrasound.

Infrasound is often described as inaudible, however, sound below 20 Hz remains audible provided that the sound level is sufficiently high. The thresholds of hearing for infrasound have been determined in a range of studies. Non-audible perception of infrasound through felt vibrations in various parts of the body only occurs at levels well above the threshold of hearing.

Weighting networks are applied to measured sound pressure levels to adjust for certain characteristics. The A-weighting network (dB(A)) is the most common, and it is applied to simulate the human response for sound in the most common frequency range. The A-weighting network is used by the SA Guidelines. The G-weighting network has been standardised to determine the human perception and annoyance due to noise that lies within the infrasound frequency range.

A common audibility threshold from the range of studies is an infrasound noise level of 85 dB(G) or greater. This is used by the Queensland Department of Environment and Resource Management's (DERM's) draft Guideline for the assessment of low frequency noise as the acceptable level of infrasound in the environment from a noise source to protect against the potential onset of annoyance and is consistent with other approaches, including the UK Department for Environment, Food and Rural Affairs (DEFRA).

Whilst the aerodynamic noise from a rotating turbine blade produces energy in the infrasound range, a large range of measurements of infrasound noise emissions from modern upwind turbines indicates that at distances of 200 metres, infrasound is in the order of 25 dB below the recognised perception threshold of 85 dB(G). A 25 dB difference is significant and represents at least a 100 fold difference in energy content. Infrasound also reduces in level when moving away from the source, and separation distances between wind farms and dwellings are well in excess of 200m.

Notwithstanding the above, there are natural sources of infrasound including wind and breaking waves, and a wide range of man-made sources such as industrial processes, vehicles and air conditioning and ventilation systems that make infrasound prevalent in the natural and urban environment at a similar or greater level than that regularly measured within 200m of a modern wind turbine.

Construction Noise

The equipment and activities on site will vary throughout the project, depending on various stages of construction. The predicted noise from construction activity is a worst case (highest noise level) scenario, where it is assumed all equipment is present and operating simultaneously on site for each stage of construction.
The weather conditions used for the predictions are the most conducive for the propagation of noise, comprising of an overcast day with a breeze from the construction activity to the receiver that is greater than 3 meters per second. Any other weather conditions would result in lower noise levels than those predicted.

The separation distance is approximately that of the closest non-associated dwelling to a proposed WTG. Greater distances than 1000m will result in lower noise levels than that presented below in Table 8.

Table 8: Predicted Construction Noise Levels at 1000m

Phase	Main Plant and Equipment	Predicted Noise Level
Site Set-Up and Civil Works	Generators Transport trucks Excavators Low Loaders	42 dB(A) at 1000m
Road and Hard Stand Construction	Mobile crushing and screening plant Dozers Rollers Low loaders Tipper trucks Excavators Scrapers Transport trucks	49 dB(A) at 1000m
Excavation and foundation construction	Concrete batching plant Mobile crushing and screening plant Truck-mounted concrete pumps Concrete mixer trucks Excavators Front End Loaders Mobile Crane Transport trucks Tipper trucks	48 dB(A) at 1000m
Earthing	Percussion drilling rig	47 dB(A) at 1000m
Electrical Installation	Concrete trucks Low loaders Tipper trucks Mobile Crane Rock trenchers	47 dB(A) at 1000m
Turbine Delivery and Erection	Extendable trailer trucks Low loaders Mobile crane	42 dB(A) at 1000m

Based on the predicted noise levels, it is expected that construction noise will be greater than 10 dB(A) above the RBL and less than 75 dB(L_{Aeq}) at a distance of 1000m. In accordance with the ICN Guideline it is expected that a dwelling 1000m from construction activity may be "noise affected" but not "highly noise affected". Therefore, the developer *should apply all feasible and reasonable work practices to meet the noise affected level*, and should inform any impacted residents of the proposed construction work.

"Feasible and reasonable" noise control strategies to minimise noise during construction may include engineering measures such as the construction of temporary acoustic barriers, the use of proprietary enclosures around machines, the use of silencers, the substitution of alternative construction processes and the fitting of broadband reversing signals. It may also include administrative measures such as inspections, scheduling and providing training to establish a noise minimisation culture for the works.

The following mitigation measures are recommended to be implemented for the construction works:

Scheduling

Construction works, including heavy vehicle movements into and out of the site, restricted to between 7am and 6pm Monday to Friday, and between 8am and 1pm on Saturdays. Works carried out outside of the hours will only entail:

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

If any other works are required outside of the specified hours, they will only be carried out with the prior consent of the New South Wales Department of Environment and Climate Change (DECC).

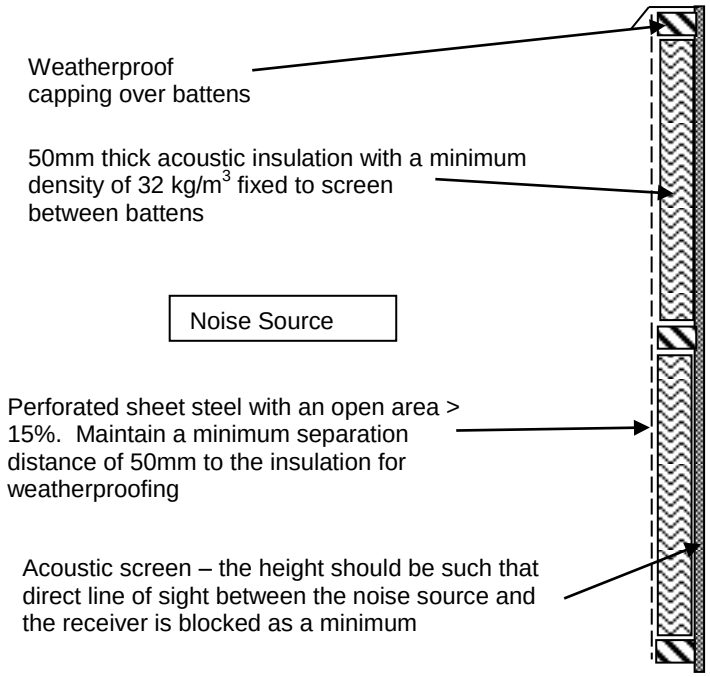
Location of Fixed Noise Sources

Locate fixed noise sources such as crushing and screening plant, concrete batching plant, percussion drilling rigs and generators and compressors at the maximum practicable distance to the nearest dwellings, and where possible, use existing landforms to block line of sight between the equipment and the dwelling.

Provide Acoustic Screens Around Fixed Noise Sources

Provide acoustic screens or mounding for fixed crushing and screening plant, concrete batching plant and percussion drilling rigs wherever these noise sources are located within 1000m of a non-associated dwelling and do not have direct line of sight blocked to that dwelling, in accordance with the following requirements:

- Locate as close as practicable to the noise source;
- Construct from mounding using excavated soil from the site, or a material with a minimum surface density of 10 kg/m^2, such as 1.2mm thick sheet steel or 9mm thick compressed fibre cement sheeting;
- Construct to a minimum height that blocks direct line of sight between the noise source and any receiver within the 1000m limit;
- Construct such that there are no air gaps or openings at joints;
- Extend such that the length is at least 5 times greater than its height or so that it is bent around the noise source;
- If barriers (rather than mounding from excavated soil) are constructed, then include acoustic insulation facing into the noise source in accordance with the following detail.



In addition, the site topography, and other shielding features (e.g. large stationary machines, mounds of topsoil and piles of materials) should be used to an advantage in terms of increased shielding when locating fixed noise sources within the 1000m distance.

Enclose Generators and Compressors

Provide proprietary acoustic enclosures for site compressors and generators.

Alternative Processes

Investigate and implement alternative processes where feasible and practicable, such as hydraulic or chemical splitters as an alternative to impact rock breaking, or the use of broadband reversing alarms in lieu of the high pitched devices. A broadband reversing alarm emits a unique sound which addresses the annoyance from the high pitched devices. The fitting of a broadband alarm should be subject to an appropriate risk assessment, with the construction team being responsible for ensuring the alarms are installed and operated in accordance with all relevant occupational, health and safety legislative requirements.

Site Management

- Select and locate centralised site activities and material stores as far from noise-sensitive receivers as possible;
- Care should be taken not to drop materials such as rock, to cause peak noise events, including materials from a height into a truck. Site personnel should be directed as part of an off-site training regime to place material rather than drop it;
- Plant known to emit noise strongly in one direction, such as the exhaust outlet of an attenuated generator set, shall be orientated so that the noise is directed away from noise sensitive areas if practicable;
- Machines that are used intermittently shall be shut down in the intervening periods between works or throttled down to a minimum;
- Implement worksite induction training, educating staff.

Equipment and Vehicle Management

- Ensure equipment has Original Equipment Manufacturer (OEM) mufflers installed;
- Ensure equipment is well maintained and fitted with adequately maintained silencers which meet the OEM design specifications. This inspection should be part of a monitoring regime;
- Ensure silencers and enclosures are intact, rotating parts are balanced, loose bolts are tightened, frictional noise is reduced through lubrication and cutting noise reduced by keeping equipment sharp. These items should be part of a monitoring regime;
- Use only necessary power to complete the task;
- Inspect, as part of a monitoring regime, plant and equipment to determine if it is noisier than other similar machines, and replace or rectify as required.

Community Consultation

The developer should implement the following noise and vibration elements into the overall community consultation process. The aim of the consultation is to ensure adequate community awareness and notice of expected construction noise.
The minimum elements should include:

- Regular Community Information newsletters, providing details of the construction plan and duration of the construction phases;
- A site notice board in a community location providing copies of the newsletters, updated construction program details, and contact details of relevant project team members and an ability to register for email updates of the newsletter;
- A feedback mechanism for the community to submit questions to the construction team, and for the construction team to respond;
- Regular updates on the construction activities to Local Council and the local Police to assist in complaint management if necessary;
- Contact details of the project manager and / or site “Environmental Representative”.

In addition, prior to any blasting activity, or construction activity occurring within 1000m of a non-associated dwelling, or significant construction traffic periods or impacts on local road conditions:

- Contact the local community potentially affected by the proposed works and inform them by letter of the proposed work, the location of the work, the day(s) and date(s) of the work and the hours involved[6]
- This contact shall be made a reasonable time before the proposed commencement of the work; and
- The letter should provide the contact details of the project manager and / or site "Environmental Representative".

Project Mitigation Measures in Context

It is unlikely that the above measures will result in meeting the construction noise goals at all times due to the stringency of these goals, and the variable nature of construction activity. However, they will serve to reduce the impacts and are considered to represent the extent of feasible and practicable noise reduction measures in accordance with the ICN Guidelines.

The above measures should be incorporated and implemented through a Construction Noise Management Plan for the site. The Plan should include the following elements and associated control provisions:

Construction Traffic

Construction activity will incorporate passenger vehicle and heavy vehicle movements to and from the site along local roads in the vicinity of the wind farm. These vehicles will include semi-trailers, low loaders, haulage trucks, mobile cranes, water tankers, four-wheel-drive vehicles and passenger vehicles.

[6] It is preferable to overestimate the hours of work, rather than extending the work hours for longer than anticipated.

The daytime criterion provided by the ECRTN is an equivalent ($L_{Aeq,\ 1hour}$) noise level of 55 dB(A) during any given hour. It is predicted that a distance of 10m from the road side the criterion can be achieved for 10 passenger vehicle movements and 3 heavy vehicle movements in one hour. The number of vehicle movements can double for every doubling of distance from the roadside and continue to achieve the 55 dB(A) criterion. That is, 20 passenger vehicles and 6 heavy vehicle movements could be accommodated in an hour at a dwelling that is 20m from the roadside.

In accordance with the general principles of dealing with temporary construction noise impacts as compared to permanent operational noise, where the ECRTN is exceeded, the following mitigation measures should be employed to reduce construction traffic noise:

- Communicate with the affected community in accordance with the provisions above;
- Establish and maintain a route into the site so that heavy vehicles do not enter noise sensitive areas for access where practicable;
- Incorporate information regarding the route to all drivers prior to accessing the site and the need to minimise impacts through driver operation at certain locations;
- Schedule construction traffic deliveries such that it is as evenly dispersed as practicable;
- Restrict construction to the daytime operating hours for the construction site, subject to the scheduling caveats in the Construction Noise Management Plan.

Blasting

It is understood that blasting is unlikely to occur during construction of the White Rock Wind Farm. Notwithstanding, the separation distances between the potential blasting activity and the nearest dwellings are of the order of magnitude for which ground vibration and airblast levels have been adequately controlled at other sites.

Given the range of factors associated with both the generation and control of blasting, it is recommended that in the event of blasting occurring, a monitoring regime is implemented to ensure compliance with the Blasting Guidelines.

Construction Vibration

It is expected that the main sources of vibration will be the drilling rigs where required, rock trenching equipment and roller operation during the road and hard stand construction. The level of vibration at a distance will be subject to the energy input of the equipment and the local ground conditions. Typically, the distances required to achieve the construction vibration criteria provided in the Technical Guidelines are in the order of 20m to 100m. The 100m is a conservative estimate, with vibration from these activities unlikely to be detectable to humans at such a distance.

Based on the separation distances between the construction activities and the nearest dwellings being well in excess of the conservative distance of 100m, vibration levels are expected to easily achieve the criteria.

If construction activities do occur within 100m of a dwelling, as might occur with some limited areas of new road construction, it is recommended that a monitoring regime is implemented during these times to ensure compliance with the Technical Guidelines.

CONCLUSION

An environmental noise and vibration assessment of the construction and operation of the White Rock Wind Farm, comprising up to 119 turbines, has been made.

The assessment considered the Director General's requirements (DGRs) for noise and vibration and compared the proposal against the following:

- Wind Turbines – the South Australian Environment Protection Authority's *Wind Farms – Environmental Noise Guidelines* (2003);
- Substation - *NSW Industrial Noise Policy* (EPA 2003);
- Site Establishment and Construction - *Interim Construction Noise Guideline* (DECC 2009)
- Traffic Noise – *Environmental Criteria for Road Traffic Noise* (NSW EPA, 1999)
- Vibration – *Assessing Vibration: A Technical Guideline* (DECC, 2006); and,
- Blasting – *Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration* (ANZECC 1990).

Construction activity is addressed through the establishment of a construction noise and vibration framework, developed to achieve the relevant DGRs for the adequate control of noise and vibration from general construction activity, transport and potential blasting activity.

The operation of the wind farm has been considered against the stringent SA EPA Guidelines (the SA Guidelines) for two turbine types, the REPower MM92 turbine and the larger Vestas V90 3MW turbine. The MM92 turbine is predicted to achieve the Guidelines at all dwellings for the proposed layout. In order for the V90 turbine to achieve the Guidelines at all dwellings, two of the turbines will need to operate in "low noise mode" at a designated wind speed.

Based on the above, for any turbine with a sound power level and hub height that is equal to or less than that assessed for the MM92 and V90 turbines, the proposed layout can achieve the stringent requirements of the SA Guidelines.

In addition, through compliance with the SA Guidelines, the cumulative impacts of other wind farms in the vicinity and impacts from special characteristics such as “swish” and low frequency noise will be adequately addressed, as detailed in this report.

Based on the above, with the implementation of a construction noise and vibration management plan and for the proposed 119 turbine layout as considered in this assessment, the construction and operation of the proposed White Rock Wind Farm achieves the Director General’s requirements.

APPENDICES

Appendix A: Location of Operational Noise Sources

Turbine ID	Easting	Northing	Turbine ID	Easting	Northing	Turbine ID	Easting	Northing
WRK_002	367454	6693821	WRK_044	361428	6696617	WRK_089	360166	6702721
WRK_003	367104	6697104	WRK_046	361405	6696366	WRK_090	359600	6703621
WRK_004	367115	6697506	WRK_047	361291	6691510	WRK_091	359686	6703353
WRK_005	366017	6694076	WRK_048	361031	6691291	WRK_092	359665	6704433
WRK_006	365568	6694819	WRK_049	361311	6691035	WRK_093	359664	6704162
WRK_007	365618	6694558	WRK_050	361440	6695213	WRK_094	359658	6703876
WRK_008	365710	6694283	WRK_051	361422	6695759	WRK_095	359247	6704867
WRK_009	366144	6693813	WRK_053	361320	6696046	WRK_096	359203	6702484
WRK_010	365150	6695285	WRK_054	360956	6697318	WRK_097	359170	6702205
WRK_011	364716	6695348	WRK_055	361202	6697069	WRK_098	359422	6701317
WRK_012	361628	6698554	WRK_056	360825	6697677	WRK_099	359469	6700831
WRK_013	361818	6698225	WRK_057	360437	6693254	WRK_100	359176	6701055
WRK_014	366558	6698405	WRK_058	360405	6692984	WRK_101	359253	6701580
WRK_015	366869	6698144	WRK_059	360810	6692794	WRK_102	359455	6700147
WRK_016	363005	6695984	WRK_060	360248	6698187	WRK_103	359377	6705707
WRK_017	363030	6695661	WRK_061	360513	6697920	WRK_104	359186	6705126
WRK_018	364655	6695616	WRK_062	360201	6698468	WRK_105	359243	6704577
WRK_019	362954	6696287	WRK_063	359822	6699193	WRK_106	362683	6690796
WRK_020	362880	6696841	WRK_064	360175	6699010	WRK_107	359210	6705405
WRK_021	362829	6696560	WRK_065	360166	6698737	WRK_108	359853	6703104
WRK_022	364715	6696372	WRK_066	360061	6699431	WRK_109	359024	6701878
WRK_023	364727	6696088	WRK_067	361695	6703606	WRK_110	361431	6695495
WRK_024	363366	6694909	WRK_068	361718	6703255	WRK_111	362969	6695085
WRK_025	362982	6695387	WRK_069	361686	6702678	WRK_112	366959	6693853
WRK_027	362597	6690521	WRK_070	361725	6702938	WRK_114	367053	6698762
WRK_028	362373	6690279	WRK_071	361645	6702414	WRK_115	366767	6696860
WRK_029	362546	6697147	WRK_072	361545	6702150	WRK_116	365256	6695022
WRK_030	362645	6697511	WRK_073	361127	6701687	WRK_117	364365	6695828
WRK_031	362612	6697810	WRK_074	361423	6701163	WRK_118	362015	6697924
WRK_032	362413	6698645	WRK_075	361206	6700913	WRK_119	366976	6698466
WRK_033	362470	6698378	WRK_076	361287	6701426	WRK_120	360405	6701025
WRK_034	362561	6698100	WRK_077	361251	6703057	WRK_122	364442	6697003
WRK_035	362185	6695344	WRK_078	360319	6702379	WRK_123	364627	6696645
WRK_036	362238	6695085	WRK_080	359909	6701419	WRK_124	364459	6697276
WRK_037	362003	6697628	WRK_081	360345	6702053	WRK_125	368091	6696553
WRK_038	362176	6697369	WRK_082	360236	6701775	WRK_135	359319	6699188
WRK_039	361548	6699357	WRK_083	359906	6700772	WRK_136	358792	6699215
WRK_040	361525	6699085	WRK_084	359993	6701137	**Substation**		
WRK_041	361552	6698814	WRK_085	359908	6700489	Option 1	359700	6699270
WRK_042	361754	6692603	WRK_086	359863	6699736	Option 2	359100	6701410
WRK_043	361382	6692765	WRK_087	359899	6700199			

Appendix B: Residence Locations

Residence ID	Epuron ID	Associated	Property Name	Easting	Northing	Closest Turbine
R1	H40	No	Adavale	359518	6707472	WRK_103, 1771(m)
R2	I221	No	Arranmore	360557	6689424	WRK_049, 1779(m)
R3	I222	No	Arranmore 2	360415	6689339	WRK_049, 1918(m)
R4	K50	Yes	Balaclava	362492	6706495	WRK_067, 2997(m)
R5	K51	Yes	Balaclava Cottage	362295	6706272	WRK_067, 2733(m)
R6	S200	No	Bonnie Doon	370686	6691157	WRK_002, 4188(m)
R7	L101	Yes	Caloola	363793	6701734	WRK_071, 2253(m)
R8	L90	Yes	Caloola Cottage	363455	6702193	WRK_071, 1823(m)
R9	P190	No	Cranbrook	367851	6692510	WRK_002, 1370(m)
R10	L170	Yes	Eden Brae	363945	6694206	WRK_024, 911(m)
R11	S130	No	Eungay South	370450	6698230	WRK_125, 2894(m)
R12	H20	No	Evergreen	359709	6709459	WRK_103, 3767(m)
R13	P170	Yes	Ferndale	367913	6694693	WRK_002, 985(m)
R14	R130	Yes	Furracabad Cottage	369325	6698674	WRK_114, 2274(m)
R15	R120	Yes	Furracabad Station	369137	6699967	WRK_114, 2407(m)
R16	R121	Yes	Furracabad Station 2	368997	6699803	WRK_114, 2205(m)
R17	H140	Yes	Glen Moriston	359559	6697134	WRK_061, 1236(m)
R18	T200	No	Glenara	371557	6691769	WRK_002, 4588(m)
R19	M60	No	Glengyle	364355	6705265	WRK_067, 3135(m)
R20	N100	Yes	Green Valley	365123	6700979	WRK_114, 2939(m)
R21	L200	Yes	Hedgeroy	363850	6691139	WRK_106, 1216(m)
R22	M80	No	Ilparran 1	364667	6703481	WRK_068, 2958(m)
R23	N90	No	Ilparran 2	365363	6702583	WRK_070, 3655(m)
R24	D121	No	Kakoda	355780	6699540	WRK_136, 3029(m)
R25	L71	Yes	Kalanga	363591	6704528	WRK_067, 2108(m)
R26	L70	Yes	Kalanga Cottage	363219	6704876	WRK_067, 1984(m)
R27	O191	No	Kia Ora	366820	6692884	WRK_112, 979(m)
R28	S180	No	Kilara	370470	6693418	WRK_002, 3043(m)
R29	Q110	No	Klossie	368815	6700757	WRK_114, 2662(m)
R30	N251	No	Koala	365476	6686345	WRK_028, 5010(m)
R31	O190	Yes	Lyona	366233	6692984	WRK_009, 834(m)
R32	L180	Yes	Marinka	363264	6693915	WRK_024, 999(m)
R33	S160	No	Marsden	370275	6695891	WRK_125, 2282(m)
R34	J181	Yes	Melrose	361471	6693658	WRK_043, 897(m)
R35	L82	No	Minamurra	363807	6703132	WRK_070, 2091(m)
R36	L83	No	Minamurra 2	363876	6703488	WRK_068, 2171(m)
R37	L80	No	Minamurra 3	363607	6703260	WRK_068, 1889(m)
R38	K260	No	Mosgiel	362217	6685533	WRK_028, 4749(m)
R39	N180	Yes	Mountview 1	365055	6693027	WRK_009, 1343(m)

Residence ID	Epuron ID	Associated	Property Name	Easting	Northing	Closest Turbine
R40	N190	Yes	Mountview 2	365068	6692882	WRK_009, 1423(m)
R41	N191	Yes	Mountview 3	365498	6692663	WRK_009, 1319(m)
R42	E50	No	Mt Buckley	356197	6706634	WRK_107, 3254(m)
R43	N230	No	Netherley	365246	6688696	WRK_027, 3217(m)
R44	I180	Yes	Novar 1	360723	6693926	WRK_057, 730(m)
R45	J180	Yes	Novar 2	361093	6693979	WRK_057, 978(m)
R46	F120	Yes	Numarella	357051	6699521	WRK_136, 1768(m)
R47	T170	No	Park Ridge	371103	6694729	WRK_125, 3521(m)
R48	R190	No	Peak Hill	369053	6692845	WRK_002, 1873(m)
R49	I40	No	Quabedee	360953	6707433	WRK_103, 2337(m)
R50	F132	No	Robindale	357381	6697991	WRK_136, 1868(m)
R51	N250	No	Sherwood	365114	6686962	WRK_028, 4303(m)
R52	M220	Yes	Springfield	364048	6689542	WRK_027, 1750(m)
R53	M221	Yes	Springfield	363892	6689530	WRK_027, 1631(m)
R54	L230	Yes	Springwood	363561	6688540	WRK_028, 2106(m)
R55	L100	Yes	Talarook	363073	6701858	WRK_071, 1532(m)
R56	F131	No	Try Again	357575	6698604	WRK_136, 1362(m)
R57	K30	No	Willow Glen	362059	6708102	WRK_103, 3596(m)
R58	N240	No	Woodlands	365745	6687549	WRK_027, 4329(m)
R59	S210	No	Yallaroo	370464	6690008	WRK_002, 4858(m)
R60	S220	No	Yallaroo 2	370357	6689917	WRK_002, 4865(m)
R61	K170	Yes	-	362176	6694170	WRK_036, 917(m)
R62	K260	No	-	362097	6685889	WRK_028, 4399(m)
R63	Q170	No	-	368433	6694233	WRK_002, 1062(m)
R64	I210	No	-	360464	6690120	WRK_049, 1247(m)
R65	E140	No	-	356553	6697896	WRK_136, 2599(m)
R66	S170	No	-	370142	6695258	WRK_125, 2426(m)

Appendix C: Director General's Requirements

Director-General's Requirements

Section 75F of the *Environmental Planning and Assessment Act 1979*

Project	Construction and operation of a wind farm with between 80 and 100 turbines. Associated infrastructure includes access tracks, local road infrastructure upgrades, electrical connections between the turbines (both underground cable and aboveground power lines), temporary concrete batching plant, on-site control buildings and equipment storage facilities, an on-site substation and transmission connection from the substation to either the TransGrid 132 kV transmission line to the north of the site, or the TransGrid 330kV transmission line to the west of the site, permanent monitoring masts, and possible subdivision.
Site	Generally in the area from Grahams Valley Road to the Gwydir Highway, approximately 15 km west of Glen Innes in the Glen Innes Severn and Inverell local government areas.
Proponent	Epuron Pty Ltd
Date of Issue	13th October 2010
Date of Expiration	13th October 2012
General Requirements	The Environmental Assessment (EA) must include: • an **executive summary**; • a **detailed description** of the project for both the wind farm and transmission line including: → construction, operation and decommissioning details; → the location and dimensions of all project components including the wind turbines (including map coordinates and AHD heights), underground and above ground cabling between turbines, electrical substation and transmission line linking the wind farm to the grid (TransGrid lines, including easement width and height), on-site control room and equipment storage, temporary concrete batching plant(s), construction compounds, access roads/road upgrades (including access tracks), any obstacle lighting, relation to Crown roads, and any subdivision proposals; → a timeline identifying the proposed construction and operation of the project components, their envisaged lifespan and arrangements for decommissioning and staging; → supporting maps/plans clearly identifying existing environmental features (e.g. watercourses, vegetation), infrastructure and land use (including nearby residences and approved residential developments or subdivisions) and the location/ siting of the project (including associated infrastructure) in the context of this existing environment; and → resourcing requirements (including, but not limited to, water supply and gravel). • consideration of any **relevant statutory provisions** including the consistency of the project with the objects of the *Environmental Planning and Assessment Act 1979* and any relevant development control plans. Consideration should be given to the Border Rivers-Gwydir Catchment Action Plan; • an **assessment of the key issues** outlined below, during construction, operation and decommissioning (as relevant). The Environmental Assessment must assess the worst case as well as representative impact for all key issues taking into account cumulative impacts from surrounding approved or proposed wind farms (Ben Lomond, Glen Innes and Sapphire), as relevant; • a **draft Statement of Commitments** detailing measures for environmental mitigation, management and monitoring for the project; • a **conclusion justifying the project** taking into consideration the environmental,

	social and economic impacts of the project; the suitability of the site; and the public interest; and • **certification by the author** of the EA that the information contained in the Assessment is neither false nor misleading. The EA should present, with respect to each relevant transmission line impact, a considered overview of potential impacts along the length of the line, to identify areas of potentially significant impact for further, more detailed assessment. In addition to detailed assessment of areas of potentially significant impact, other areas along the length of the line should be assessed in a more general manner, with a particular focus on the development of frameworks for the mitigation, management and monitoring of more minor and generic environmental issues.
Key Assessment Requirements	The EA must include assessment of the following key issues for both the wind farm and transmission line: • **Strategic Justification** - the EA must: → include a strategic assessment of the need, scale, scope and location for the project in relation to predicted electricity demand, predicted transmission constraints and the strategic direction of the region and the State in relation to electricity supply, demand and electricity generation technologies, and its role within the Commonwealth's Renewable Energy Target Scheme. The EA must clearly demonstrate that the existing transmission infrastructure has sufficient capacity to accommodate the project as well as approved and proposed wind farms which also envisage the use of this infrastructure; → include a clear demonstration of quantified and substantiated greenhouse gas benefits, taking into consideration sources of electricity that could realistically be replaced and the extent of their replacement. Reference should be made to *Estimating Greenhouse Gas Emissions Abatement from Wind Farms in NSW*, McLennan Magasanik Associates, July 2010, Report to the Department of Environment, Climate Change and Water (DECCW) and the associated *NSW Wind Farm Greenhouse Gas Savings Tool* developed by DECCW; → include an analysis of the suitability of the project with respect to potential land use conflicts with existing and future surrounding land uses (including rural residential development, building entitlement and subdivision potential, land of significant scenic or visual value, land of high agricultural value, other water users, mineral reserves (with particular reference to Exploration Licences EL7301 & 7302, and Petroleum Special Prospecting Authority (PSPAUTH) 34), forestry and conservation areas), taking into account local and strategic land use objectives, and the potential cumulative effects of other wind farm development in the area; and → describe the alternatives considered (location and/or design) for all project components, and provide justification for the preferred project demonstrating its benefits including community benefits (for example community enhancement programmes) on a local and strategic scale and how it achieves stated objectives. • **Visual Impacts** - the EA must: → provide a comprehensive assessment of the landscape character and values and any scenic or significant vistas of the area potentially affected by the project, including both the wind farm and the transmission line, and taking into consideration cumulative impacts from surrounding approved or proposed wind farms in the locality. This should describe community and stakeholder values of the local and regional visual amenity and quality, and perceptions of the project based on surveys and consultation; → assess the impact of shadow "flicker", blade "glint" and night lighting from the wind farm; → identify the zone of visual influence of the wind farm (no less than 10 kilometres) and assess the visual impact of all project components on this landscape; → include an assessment of the visual impacts associated with the transmission

line, including impacts on local and regional views. Alternative pole designs should be presented and assessed and the potential for undergrounding in sensitive locations should also be assessed;

→ include photomontages of the project taken from potentially affected residences (including approved but not yet developed dwellings or subdivisions with residential rights), settlements and significant public view points, and provide a clear description of proposed visual amenity mitigation and management measures for both the wind farm and the transmission line;

→ provide an assessment of the feasibility, effectiveness and reliability of proposed mitigation measures and any residual impacts after these measures have been implemented.

- **Noise Impacts** - the EA must:

→ include a comprehensive noise assessment of all phases and components of the project taking into account potential cumulative impacts from surrounding approved or proposed wind farms in the locality including, but not limited to turbine operation, the operation of the electrical substation, corona and/or aeolian noise from the transmission line, construction noise (focusing on high noise-generating activities and any works proposed outside of standard construction hours), traffic noise during construction and operation, and vibration generating activities (including blasting) during construction and/ or operation. The assessment must identify noise/vibration sensitive locations (including approved but not yet developed dwellings), baseline conditions based on monitoring results, the levels and character of noise (eg. tonality, impulsiveness etc.) generated by noise sources, noise/vibration criteria, modelling assumptions and worst case and representative noise/vibration impacts;

→ in relation to wind turbine operation, determine the noise impacts under operating meteorological conditions (i.e. wind speeds from cut in to rated power), including impacts under meteorological conditions that exacerbate impacts (including varying atmospheric stability classes and the van den Berg effect for wind turbines). The probability of such occurrences must be quantified;

→ include monitoring to ensure that there is adequate wind speed/profile data and ambient background noise data that is representative for all sensitive receptors;

→ provide justification for the nominated average background noise level used in the assessment process, considering any significant difference between daytime and night time background noise levels;

→ identify any risks with respect to low frequency or infra-noise;

→ if any noise agreements with residents are proposed for areas where noise criteria cannot be met, provide sufficient information to enable a clear understanding of what has been agreed and what criteria have been used to frame any such agreements;

→ clearly outline the noise mitigation, monitoring and management measures that would be applied to the project. This must include an assessment of the feasibility, effectiveness and reliability of proposed measures and any residual impacts after these measures have been incorporated; and

→ include a contingency strategy that provides for additional noise attenuation should higher noise levels than those predicted result following commissioning and/or noise agreements with landowners not eventuate.

The assessment must be undertaken consistent with the following guidelines:

→ Wind Turbines - the South Australian Environment Protection Authority's *Wind Farms - Environmental Noise Guidelines* (2003);

→ Substation – *NSW Industrial Noise Policy* (EPA, 2000);

→ Site Establishment and Construction – *Interim Construction Noise Guidelines* (DECC, 2009);

→ Traffic Noise – *Environmental Criteria for Road Traffic Noise* (NSW EPA, 1999);

→ Vibration – *Assessing Vibration: A Technical Guideline* (DECC, 2006); and
→ Blasting – *Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration* (ANZECC 1990).

- **Flora and Fauna** - the EA must:
  - → include an assessment of all project components on flora and fauna (both terrestrial and aquatic, as relevant) and their habitat consistent with the *Draft Guidelines for Threatened Species Assessment* (DEC 2005), including details on the existing site conditions and likelihood of disturbance (including quantifying the worst case extent of impact on the basis of vegetation type and total native vegetation disturbed (hectares of clearing));
  - → The EA must specifically consider impacts on threatened species and communities listed under both State and Commonwealth legislation that have been recorded on the site and surrounding land, impacts to riparian and/ or instream habitat in the case of disturbance of waterways (including potential impacts on the purple-spotted gudgeon *mogurnda adspersa*), and to biodiversity corridors. In addition, impact of the project on birds and bats from blade strikes, low air pressure zones at the blade tips (barotrauma, including the potential nature/extent of impacts, significance of such impacts on threatened species and mitigation measures), and alteration to movement patterns/flight paths resulting from the turbines must be assessed, including demonstration of how the project has been sited to avoid and/ or minimise such impacts. The EA must also consider roosting and nesting sites for aerial species. If any of the bat and bird species likely to be impacted by the wind turbines are also listed species under State and Commonwealth legislation, then the significance assessment for each of these species must consider impacts from the wind turbines as well as impacts from habitat loss. The cumulative impacts from other wind farms are to be identified ;
  - → details of how flora and fauna impacts would be managed during construction and operation including adaptive management and maintenance protocols (including the mitigation and/or management of weeds); and
  - → measures to avoid, mitigate or offset impacts consistent with "improve or maintain" principles. Sufficient details must be provided to demonstrate the availability of viable and achievable options to offset the impacts of the project (including in relation to water quality, salinity, soils and biodiversity).

- **Indigenous Heritage** - the EA must include an assessment of the potential impact of the project components on indigenous heritage values (archaeological and cultural). The EA must demonstrate effective consultation with indigenous stakeholders during the assessment and in developing mitigation options (including the final recommended measures) consistent with *Guidelines for Aboriginal Cultural Impact Assessment and Community Consultation* (DEC, July 2005).

- **Traffic and Transport** – the EA must assess the construction and operational traffic impacts of the project including:
  - → details of the nature of traffic generated, transport routes, traffic volumes and potential impacts on local and regional roads (including impacts on the structural integrity of the road network), bridges and intersections, including any proposed road upgrades and repairs and taking account of relevant Council road policies;
  - → details of measures to mitigate and/or manage the potential impacts, including measures to control soil erosion and dust generated by traffic volumes;
  - → details of site access roads including how these would connect to the existing road network and any operational maintenance or handover requirements.

- **Hazard/Risks**– the EA must include an assessment of the potential impacts on aviation safety, taking into account cumulative impacts from surrounding approved or proposed wind farms in the locality, including the need for aviation hazard lighting considering nearby aerodromes and aircraft landing areas, defined air traffic routes, aircraft operating heights, radar interference, communication systems, and navigation aids. Aerodromes within 30 km of the turbines should be