CHAPTER 9

Noise Assessment

9. NOISE ASSESSMENT

The unique acoustic emissions from wind turbines can be a potential problem for residents located close to them. Noise assessments are carried out to predict the likely noise levels for comparison with the South Australian Environmental Protection Authority (SA EPA) *Noise Guidelines for Wind Farms* (February 2003) (SA EPA Guidelines, **Appendix 7**). This document was developed to assess and manage environmental noise impacts from wind farms in South Australia and has been adopted by the NSW Department of Planning (DoP). The SA EPA have since prepared revised noise guidelines (*Wind Farms Environmental Noise Guidelines (Interim)*, 2007), however these are yet to be implemented in New South Wales (NSW) and are not considered here.

This chapter begins with a summary of noise fundamentals and a description of the phenomena of turbine noise, and then presents the EPA compliance criteria contained in their guidelines. The methodology for predicting noise levels at nearby residences is discussed and the predicted results are presented. Noise associated with wind farm construction activities is also discussed and potential mitigation measures are outlined.

9.1 Noise Fundamentals

Hearing is a fundamental human sense and is used constantly for communication and awareness of the environment. Noise is generally described as being 'unwanted' or 'unfavourable' sound and, to some extent, is an individual or subjective response as what may be sound to one person, may be regarded as noise by another.

The measurement and assessment of sound has been developed steadily over the last century, taking into account human response measures such as hearing damage and other potential health affects such as stress. Complex sound measurement and analytical devices have also been developed.

A-weighting and 'dBA': The overall level of a sound is usually expressed in terms of dBA (decibels), which is measured using the 'A-weighting' filter incorporated in sound level meters. These filters have a frequency response corresponding approximately to that of human hearing. People's hearing is most sensitive to sounds at mid frequencies (typically 500 to 4,000 Hertz (Hz)) and less sensitive at lower and higher frequencies. The level of a sound in dBA is a considered a good measure of the loudness of that sound. Different sources having the same dBA level generally sound about equally as loud, although the perceived loudness can also be affected by the character of the sound (e.g. the loudness of human speech and a distant motorbike may be perceived differently, although they can be of the same dBA level).

A change of up to 3 dBA in the level of a sound is difficult for most people to detect, whilst a 3 dBA to 5 dBA change corresponds to a small but noticeable change in loudness. A 10 dBA change corresponds to an approximate doubling or halving in loudness. **Table 9.1** below presents examples of typical noise levels.

Table 9.1: Typical Noise levels

Sound Pressure Level (dBA)	Typical Sources	Subjective Evaluation
130	Threshold of pain	Intolerable
120 110	Heavy Rock Concert Grinding on Steel	Extremely noisy
100 90	Loud car horn at 3 m Construction site with pneumatic hammering	Very noisy
80 70	Kerbside of busy street Loud radio or television	Loud
60 50	Department Store General Office	Moderate to Quiet
40 30	Inside private office Inside bedroom	Quiet to very quiet
20	Unoccupied recording studio	Almost silent

Further aspects associated with the phenomena of noise including statistical indices, character, frequency analysis, vibration and air-blast over pressure are discussed in the Noise Impact Assessment report found in **Appendix 8**.

9.1.1 *Turbine Noise*

There are two main sources of noise emissions from wind turbines. The first is aerodynamic noise from the rotation of the blades. Noise is generated by the blades passing through the air and passing the tower creating a 'swishing' sound, with the noise primarily arising at the tip and back edge of the rotor blade. The noise level increases with increasing wind speed and thus rotation speed.

The second source of noise is mechanical noise from the operating components of the turbine located in the nacelle. Mechanical noise has virtually disappeared from modern wind turbines, due to improved engineering, with more concern about avoiding vibrations. Other technical improvements include elastically dampened fastenings and couplings of the major components in the nacelle, and a certain amount of sound insulation. The basic components themselves, including gearboxes, have developed considerably, with modern wind turbine gearboxes using 'soft' gearwheels; that is, toothed wheels with hardened surfaces and relatively ductile root material.

The noise emitted from turbines is a function of the wind speed, with higher wind speeds producing higher turbine noise levels up to a certain point. However, in a similar way, background noise levels also increase with increasing wind speed, with background noise generally increasing at a greater rate than turbine noise at high wind speeds (EPA 2007).

9.1.2 *Substation Noise*

Transformer substations form an integral part of the Project, converting the incoming low voltage power generated by each of the wind turbines to higher voltages suitable for export to the neighbouring electricity network. The collector substation located within the site would comprise two 150 MVA transformers suitable of exporting power via a double-circuit 132 kV power line. The transformers emit a characteristic 'hum' which has been assessed in the context of its proposed

location, c.2 km from the nearest inhabited dwelling, for the purposes of this Environmental Assessment.

9.1.3 *Background Noise*

Background noise is a feature of the ambient acoustic environment and in rural areas it is generated primarily by wind action on vegetation. The level of background noise will vary with wind speed and will vary over a site, depending on the surrounding topography, presence of vegetation and other sources of noise present in an agricultural environment. The ambient background noise of a site forms part of the noise assessment process of a wind farm.

9.1.4 *Construction and Decommissioning*

There will be some noise emissions from the construction and decommissioning of the Project, however such emissions will be localised and temporary. Sources of emissions during construction include vehicle traffic, cement batching and possibly rock crushing and compressors.

9.1.5 *Scope of SA EPA Guidelines*

The core objective of the SA EPA Guidelines is to balance the advantage of developing wind energy projects in South Australia (and adopting States) with protecting the amenity of the surrounding community from adverse noise impacts. The Guidelines were also developed to provide guidance for acceptable levels of noise generated from wind turbines on those residents that do not have an agreement with the Project developer; that is, neighbouring landowners which are not part of the wind farm development (i.e. a relevant receiver). However, this does not exempt developers of responsibilities regarding noise amenity for participating landowners who may be affected.

The Guidelines do not provide an assessment for the potential of low frequency noise or infrasound, but it does state that recent turbine designs do not appear to generate significant levels of infrasound, as the earlier turbine models did.

The guidelines provide that neighbouring dwellings require acoustic assessment of turbine noise. Dwellings further than 2 km from the nearest turbine are unlikely to experience sound emissions from any turbines.

9.1.6 *SA EPA Noise Criteria (February 2003)*

The SA EPA Guidelines state that:

"The predicted equivalent noise level ($L_{Aeq,\ 10min}$), adjusted for tonality in accordance with these guidelines, should not exceed:

- *35 dB(A) or*
- *the background noise level by more than 5 dBA; or*
- *whichever is the greater, at all relevant receivers for each integer wind speed from cut-in to rated power of the WTG."*

The Guideline explicitly states that the "swish" or modulation noise from wind turbines is a fundamental characteristic of such turbines. However, it specifies that tonal or annoying

characteristics of turbine noise should be penalised. If characteristics such as tonality are identified then the predicted noise level is penalised by the addition of 5 dBA.

9.1.7 *ETSU-R-97 and World Heath Organisation Guidelines*

The SA EPA Guideline criteria have been developed to minimise the impact on the amenity of those uninvolved with the Project. It is recognised however that where financial agreements exist, developers cannot absolve themselves of the responsibility of ensuring that an adverse effect on an area's amenity does not occur as a result of the operation of the Project.

In light of the aforementioned requirement, we have referred to the European Working Group on *Noise from Wind Turbines* document ETSU-R-97 (1996) in determining noise criteria for project involved residences. It states:

> *The Noise Working Group recommends that both day and night-time lower fixed limits can be increased to 45 dBA and that consideration should be given to increasing the permissible margin above background where the occupier of the property has some financial involvement in the wind farm.*

It should be noted that the Noise Working Group limit of 45 dBA is in agreement to the World Health Organisation (WHO) criteria (for protection of amenity and avoidance of sleep disturbance) as published in the document Guidelines for Community Noise.

The criterion for project involved residences within this assessment recognises the changed attitudinal response to noise from the wind farm for those financially involved with the Project. Furthermore, the implications of wind turbine noise have been discussed with each of the involved landowners in relation to their property. Therefore the assessment of the adopted external criteria of 45 dBA or the level given by the SA EPA Guideline criteria, where higher, will be adopted. Effectively this becomes 45 dBA or background plus 5 dBA, whichever is the higher.

9.1.8 *New South Wales Industrial Noise Policy*

The NSW Industrial Noise Policy (INP) requirements include site selection for background measurements, description of the site, the equipment used, graphing of results and amenity noise criteria during each of the three periods (Day, Evening and Night) as per the Industrial Noise Policy.

The proposed site for the Project is in a rural area and therefore the Amenity Criteria for rural residential receivers, as detailed in Table 2.1 in the NSW INP, is applicable.

The criteria vary as a function of time of day. The Day, Evening and Night Periods are defined as,

Day Period	7:00 am - 6:00 pm
	8:00 am - 6:00 pm (Sundays and Public Holidays)
Evening Period	6:00 pm - 10:00 pm
Night Period	10:00 pm - 7:00 am
	10:00 pm - 8:00 am (Sundays and Public Holidays)

The Amenity Criteria (L_{Aeq} level) for the residential noise sensitive locations for the Project are,

Day Period	50 dBA
Evening Period	45 dBA
Night Period	40 dBA

The Intrusiveness Criterion in the INP is based on the rating background level (RBL), where the Criterion is,

L_{Aeq}, 15 min ≤ RBL + 5 dBA

This is almost identical to the SA EPA Guidelines (**Section 9.1.6**), the difference being the measurement interval (15 and 10 minute) and the determination of the background noise level (rating level, based on the 10th percentile of measured background levels, or using a line of best fit through the data points).

The INP states where the measured RBL is less than 30 dBA, then the RBL is considered to be 30 dBA.

In summary it is evident that the non project related residential receivers assessed under the SA EPA Wind Farm Guideline will generally comply to INP amenity criteria. Furthermore, intrusiveness is covered by the SA EPA Wind Farm Guideline.

9.2 Methods

The Proponent commissioned Heggies Pty Ltd (Heggies) to conduct an acoustic assessment of the Project, and the full report can be seen in **Appendix 8**. In general the assessment procedure contains the following steps:

1. Predict and plot the L_{Aeq} 35 dBA noise level contour from the Project under reference conditions. Receivers outside the contour are considered to be within acceptable wind farm noise levels.
2. Establish the pre-existing background noise level at each of the relevant assessment receivers within the L_{Aeq} 35 dBA noise level contour through background noise monitoring.
3. Predict wind farm noise levels at all relevant assessment receivers for the wind range from cut-in to approximately 10 m/s.
4. Assess the acceptability of wind farm noise at each relevant assessment receiver to the established limits.

9.2.1 *Turbine Noise*

The noise propagation model used to predict wind farm noise levels at sensitive receptors has been based on ISO 9613 as implemented in the SoundPLAN computer noise model. The model predicts noise levels through geometric spreading and includes the effect of air absorption (as per ISO 9613), ground attenuation and shielding.

The noise character of Wind Turbine Generator (WTG) noise emissions have also been assessed for any special audible characteristics, such as tonality or low frequency content, which would be deemed more annoying or offensive.

Final selection of a WTG supplier is yet to be undertaken, therefore the assessed wind farm layouts include a 125 WTG layout consisting of REpower MM92 2.05 MW wind turbines and a 107 WTG layout consisting of Siemens SWT-2.3-101 2.3 MW wind turbines; both are three bladed, upwind, pitch-regulated, active yaw turbines.

Although the REpower 3.XM is the largest available machine, and was used for the visual impact assessment of the 107 WTG layout, the lack of available spectral sound power data for this turbine has necessitated noise modelling based on the Siemens SWT-2.3-101 turbine, which is of similar geometry to the REpower 3.XM. Furthermore, the available sound power data for the REpower 3.XM (sound power level vs. wind speed) is slightly lower than that of the Siemens SWT-2.3-101 and it is expected that noise modelling based on the Siemens turbine, is likely to be conservative relative to the REpower 3.XM.

The noise level contours from the Project under reference conditions, for both layouts, are presented in **Appendix 8**, however for consistency **Figure 9.1** below displays the predicted noise contour map for the proposed 125 WTG layout.

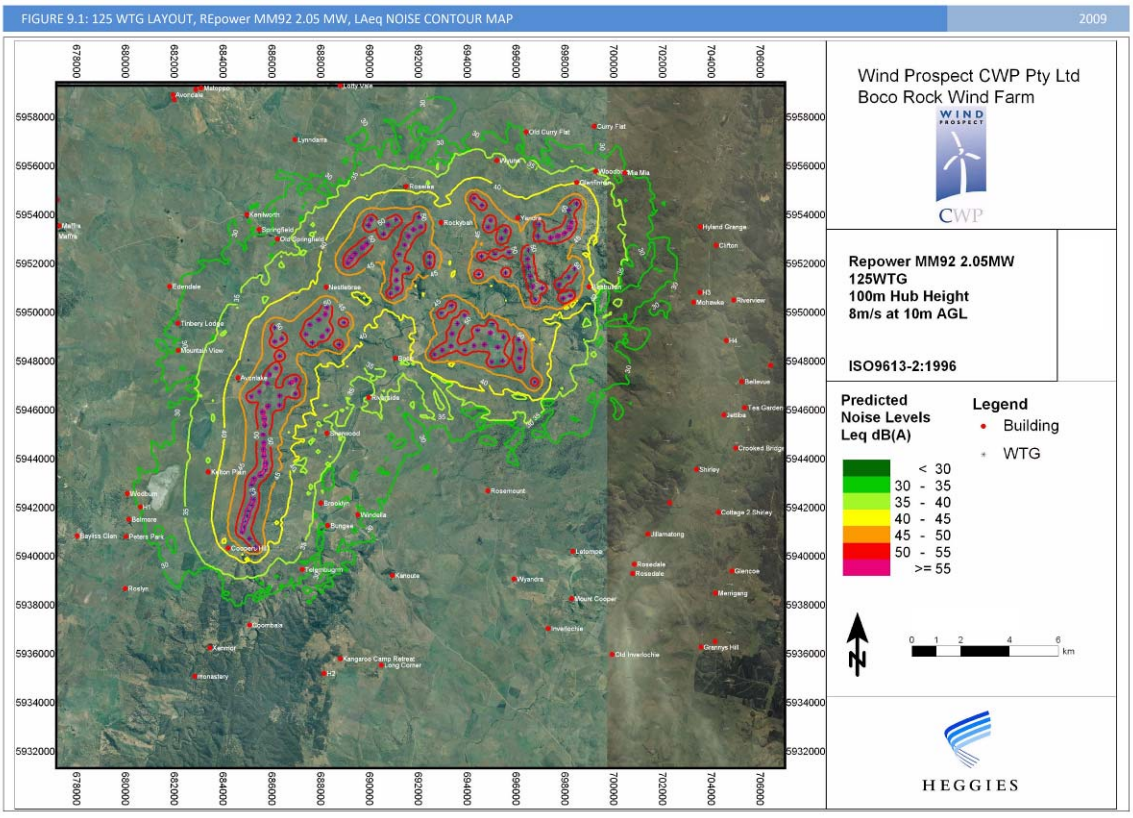

Figure 9.1 125 WTG Layout, REpower MM92 2.05 MW, LA_{eq} Noise Contour Map
(An A3 size version of this Figure is displayed in Volume 2)

9.2.2 *Substation Noise*

A collector substation location has been chosen to minimise access distance and electrical losses, and to reduce its visibility from surrounding public viewpoints. The substation will be 2 km from 'Boco', the nearest inhabited dwelling, which is central to the Project site.

Noise predictions for transformer substations have been made using CONCAWE algorithms assuming an absolute 'worst case' meteorology enhancement condition of downwind 3 m/s and Pasquill Stability Class F temperature inversion.

9.2.3 *Background Noise*

In order to establish the intrusive noise limit, background noise monitoring is required to establish the pre-existing ambient noise environment as a function of wind speed. As wind speed increases the ambient noise level at most receivers generally also increases as natural sources such as wind in trees, etc begin to dominate. The variation of background noise with wind speed is usually quite site specific and related to various physical characteristics such as topographic shielding and the extent and height of exposed vegetation.

Noise monitoring was completed for a period of approximately two weeks and correlated to synchronous wind speed and direction data at the Project monitoring mast. The captured data was screened for validity, with data monitored during periods of rain or where the average wind speed at the microphone position likely exceeded 5 m/s discarded from the data set. Other data that was obviously affected by external noise sources (eg. pond pumps, grass mowing, birds at dawn, etc) was also removed from the data set. A regression analysis of all valid data has been used to determine a line of 'best fit' from which the noise limit is established.

The local noise data is correlated to the wind speed at a reference wind monitoring mast normally at 10 m above ground level (AGL). Because original investigations were based on 80 m hub heights and no wind data was available at either 10 m or 80 m AGL, wind data was therefore extrapolated to 80 m based on simultaneous data available from anemometers at 45 m and 60 m using the wind profile power law.

For the final WTG layouts, a hub height of 100 m was proposed, however the reference height was left at 80 m for this assessment. The typical difference in wind velocities between 80 m and 100 m AGL is minimal (i.e. a maximum of 0.4 m/s, assuming a logarithmic wind profile) and as such this will have a negligible affect on the assessment.

9.2.4 *Construction and Decommissioning Noise*

Construction: Computer noise models of typical construction scenarios were developed which included all anticipated mobile equipment for the activity operating simultaneously at full load. To assess the possible worst case construction scenario for all nearby receivers, all four different construction activities were modelled at each turbine location and the highest noise levels for each receiver predicted.

A noise model was developed to assess noise from the different concrete batching plant locations. The modelled predicted noise levels for the five proposed batch plant sites located at the Collector Substation, Brechnoch Road, Avon Lake Road, Yandra Road, and South Yandra Road.

Blasting: Blasting may be required in some areas to clear large rock outcrops to prepare turbine foundations. The proposed wind farm site is a green field site where no previous blasting or blast monitoring has been conducted and therefore no specific site laws exist. Modelling has therefore adopted a site law derived from measurement data at a different site to give an indicative result.

Traffic Noise: Traffic generated by the Project during its construction phase has been evaluated in Traffic and Transport Study: Proposed Boco Rock Wind Farm (March 2009) prepared by Bega Duo Designs (**Appendix 12**). Traffic generated by the Project during its operational phase will be insignificant.

Project construction traffic for the Project will primarily utilise the local roads of Springfield Road, Avon Lake Road, Snowy River Way (Ando Road), Yandra Road, Bungarby Road and Boco Road. Beyond the Project area traffic will use the Monaro Highway and other National Highways.

9.3 Existing Situation

The Project is spread across 17 landowners although only 12 dwellings exist within 2 km of the proposed wind farm. Three of these dwellings are uninhabited, and of the nine remaining, only one is a neighbour to the development, located 1,550 m from the nearest turbine (the nearest landowner's residence being 730 m).

The Monaro Highway is sufficiently far away to the east of the Project site that background noise levels would not be affected by road traffic noise. All properties surrounding the proposed site have an ambient background noise environment that is determined by pre-dominantly natural sources which are largely wind influenced.

The prevailing wind is from the north through to the west and occasionally from the east. The district receives only marginal rainfall.

9.4 Potential Impacts

9.4.1 *Impacts from Turbine Noise*

The predicted noise levels for the 107 WTG layout (equipped with the Siemens SWT-2.3-101 (2.3 MW), 101 m Rotor, 100 m Hub Height wind turbine model) are slightly higher than those of the 125 WTG layout (equipped with the REpower MM92 (2.05 MW), 92.5 m Rotor, 100 m Hub Height wind turbine model).

For the 107 WTG layout, eight receptors are found to exceed SA EPA Guidelines of 'Background plus 5 dBA'. Of these, three are uninhabited or ruined dwellings and the five remaining are all Project involved. All receptors are within WHO criteria.

For the 125 WTG layout, seven receptors are found to exceed SA EPA Guidelines of 'Background plus 5 dBA'. Of these, three are uninhabited or ruined dwellings and the four remaining are all Project involved. All receptors are within WHO criteria.

The assessment figures contained in Appendix A1 to A4 of the Noise Impact Assessment report, **Appendix 8** depict the predicted WTG noise level curves and statistical results for both layouts assessed with respect to the SA EPA Guideline Criteria and WHO based limits.

Predicted external noise levels will be further mitigated by shielding effects of the building, with the anticipated internal noise levels similarly reduced by the façade of the dwelling. It should be further noted that all predicted noise levels are considered to be conservative with the model assuming 'hard ground', average downwind propagation from all WTG's to each receiver and a well developed moderate ground based temperature inversion, a scenario which cannot be re-created in reality.

9.4.2 *Low Frequency Noise*

Low frequency noise is not clearly defined but is generally regarded to mean noise in the range of 10-200 Hz. Noise occurring at frequencies below 20 Hz is often referred to as infrasound (**Appendix 9**). The range of human hearing is 20-20,000 Hz, with 1 dB being the smallest change in noise that humans can detect. Low frequency noise is almost always present in an ambient quiet background, produced for example by machinery, transport, structure-borne noise and natural sources such as wind, sea and thunder.

Older downwind turbines have had associated problems with low frequency noise, however this has been taken into consideration by the wind industry and large modern turbines use a well balanced upwind design. Research has been carried out on both audible and inaudible noise from wind turbines in the UK, USA and Europe. Studies in Germany found that wind turbines emit sound at extremely low levels in the infrasound range (less than 20 Hz). However, this is far below the human detection threshold and far below levels which can cause any impacts (Klug 2002, in **Appendix 9**).

The main impact of low frequency noise to humans is that of annoyance, however research to date has not shown any health effects at the levels normally associated with operational wind turbines. Furthermore, other research conducted into low frequency noise from modern wind turbines has shown that the levels of low frequency noise is below accepted thresholds and is therefore not considered to be a problem (British Wind Energy Association 2005).

9.4.3 *Temperature Inversions*

Temperature inversion is an atmospheric condition in which temperature increases with height above ground. Such conditions may increase noise levels by focussing sound wave propagation paths at a single point. Temperature inversions occurring within the lowest 50 m to 100 m of atmosphere can affect noise levels measured on the ground. Temperature inversions are most commonly caused by radiative cooling of the ground at night leading to cooling of the air in contact with the ground. Such conditions are especially prevalent on cloudless nights with little wind.

Conventional approaches to assessing noise propagation under temperature inversion conditions require knowledge of the temperature gradient and assume that the noise source is located below the temperature inversion, typically near to the ground. The effect of temperature inversions on noise propagation from WTG's is therefore not typical of other sources.

WTG's for the Project are located on top of elevated ridges. The hub height (assumed acoustic centre of the WTG) is located typically on average 160 m higher than receiver locations on the

surrounding area (not to be confused with the proposed maximum hub height of 100 m). It is therefore unlikely that conventional temperature inversion conditions, in the lower 100 m of the atmosphere, would affect noise propagation from such an elevated source.

A further consideration must be that temperature inversions require little to no wind in order to minimise atmospheric mixing and hence develop. During calm conditions the WTG's are unlikely to operate, as cut-in speed is at least 3 m/s.

9.4.4 *Atmospheric Stability and Wind Profile Impacts*

The wind velocity at a location can be represented by a vertical profile (gradient) that generally is at a minimum at ground level and increases with altitude. The wind velocity profile is primarily determined by physical factors such as surface roughness and topographic (relief) effects, which are reasonably constant over time, however can also be affected by more variable local atmospheric conditions including atmospheric stability and turbulence.

Atmospheric stability is determined by the total heat flux to the ground, primarily being the sum of incoming solar and outgoing thermal radiation and heat exchanged with the air. During clear summer days (incoming radiation dominates) air is heated from below and rises, causing significant thermal mixing, vertical air movements and turbulence. This process limits large variations in the vertical wind velocity profile.

During clear nights when outgoing radiation dominates, air is cooled from below, air density is greatest closer to the ground and minimal thermal mixing occurs. This leads to a stable atmosphere where horizontal layers of air are largely decoupled and allows for a higher wind velocity gradient.

The noise assessment methodology outlined in the SA EPA Guidelines, as do many other similar wind farm noise assessment methodologies, by necessity rely on the independently verified reference sound power data available for specific wind turbines measured at a manufacturer's test site. The measurement procedure has been standardised (IEC 61400-11) to require sound power data to be measured coincidentally with reference wind speed measurements at an altitude of 10 m.

For this assessment the SA EPA Guideline methodology has been adapted to the alternative reference wind speed at a height of 80 m AGL which is more representative of hub height wind speed. Accordingly the turbine sound power level data has been amended to the appropriate 80 m AGL wind speed. This approach goes some way to alleviating the variability that changing wind profiles has with respect to a 10 m reference height.

While the proposed layouts meet the requirements of the SA EPA Guidelines, some uncertainty remains as to the likely noise conditions that will result under specific atmospheric conditions over time. The SA EPA Guidelines noise limits are generally set within the requirements of the WHO Guidelines that relate to health impacts, and it is highly unlikely that the remaining uncertainty could lead to health impacts. However, it is possible that under certain conditions the amenity of existing dwellings could be reduced notwithstanding compliance with SA EPA Guidelines. These conditions are likely to be variable and intermittent, and not result in a long term loss in amenity.

9.4.5 *Substation Noise Impacts*

Predicted noise levels from the transformer installation are expected to be less than 28 dBA under worst case propagation conditions at the most exposed receiver location, Nestlebrae. The predicted noise level will generally be below the existing ambient background and predicted future WTG levels and as such would not effect the compliance assessment of the proposed wind farm.

9.4.6 *Impacts from Construction and Decommissioning*

Construction: The predicted 'worst case' construction noise impacts are for most receiver locations below the existing typical daytime rating background level.

Some nearby receivers may receive elevated construction noise levels when turbine foundation civil works are located nearby, however, due to the anticipated short period of localised works this would be considered satisfactory. Elevated noise levels predicted for Coopers Hill, Glenfinnan and Yandra during turbine foundation establishment are a result of the operation of a rock-breaker. Operation of the rock-breaker is dependent upon the geotechnical conditions of the foundation site and would be operated intermittently at most.

In consideration that the predicted levels represent 'worst case' construction scenarios and are within limits which would be considered acceptable, it is unlikely that construction noise will cause any unnecessary impact.

Predicted noise levels for concrete batch plants are anticipated to comply with the applicable noise limit for the NSW Industrial Noise Policy at all inhabited receptors. In most cases concrete batch plant noise will be below ambient background noise levels and likely be inaudible.

Blasting: The closest anticipated distance between blasting and residences would be approximately 730 m (WTG closest to Yandra). With a maximum instantaneous charge (MIC) of up to 36 kilograms (kg), the airblast overpressure is modelled to be below the acceptable level of 115 dB Linear for all existing residences. The anticipated blasting is likely to meet all human comfort limits and building damage assessment criteria. All other sources of vibration would be less than those above.

Traffic Noise: The projected increase in road traffic noise levels on all local roads are anticipated to meet the NSW Roads and Traffic Authority (RTA) *Environmental Criteria for Road Traffic Noise (ECRTN) 1999* target for a local road of daytime at modest setback distances. Being a rural farming community, most receptors are at much greater setback distances from their road frontage and therefore will easily meet the ECRTN requirement.

There could potentially be deliveries of equipment scheduled for out of hours, necessitated by traffic congestion considerations and safe passage of heavy vehicle convoys or especially long loads. Night-time traffic has the potential to cause sleep disturbance to residential receivers along the route. This potentially affects receivers situated closer to the road, such as in Nimmitabel.

Preliminary calculations indicate that maximum noise levels at a residence approximately 10 m from the road as a result of a heavy vehicle passing-by would be in the range 45 to 80 dBA. Night-time background noise levels along affected routes could be below 30 dBA and as such maximum noise levels from pass-bys may have the potential for sleep disturbance. However, the Monaro Highway is

already a major route and carries significant heavy vehicles so it is unlikely Project related night-time traffic would be of any greater impact than vehicles already using the route.

9.4.7 *Cumulative Impacts*

An assessment of cumulative environmental impacts considers the potential impact of a proposal in the context of existing developments and future developments to ensure that any potential environmental impacts are not considered in isolation. A development would need to be located within approximately 2 to 3 km of the proposed wind farm in order to present a possible cumulative influence on noise. The Project area is classified as rural and residencies are spread across the landscape. The main sources of current noise levels are from farming activities and large trucks on the roads moving stock and timber. No other wind farms currently exist or are proposed in the area that would interact with the Project to produce a further cumulative noise effect.

9.5 Management and Mitigation

9.5.1 *Turbine Noise*

If WTG noise impacts are non-compliant with stated criteria used for the assessment due to temperature inversion, atmospheric stability or other reasons, then an 'adaptive management' approach can be implemented to mitigate or remove the impact. This process could include:

- Investigating the nature of the reported impact;
- Identifying exactly what conditions or times lead to undue impacts;
- Consideration of operating WTG's in a reduced 'noise optimised' mode during offending wind directions and at night-time (sector management);
- Turning off WTG's that are identified as causing the undue impact; and
- Providing acoustic upgrades (glazing, façade, masking noise etc) to affected dwellings.

9.5.2 *Construction and Decommissioning*

Noise emissions from construction, major maintenance or decommissioning/refurbishment work can be minimised by continued adequate maintenance of construction vehicles, and by ensuring work activities occur within recommended working hours, according to the EPA, where practicable (i.e. 7.00 am to 6.00 pm, Monday to Saturday and 9.00 am to 6.00 pm Sundays). Any proposed work outside of these hours will entail close consultation with the affected community. Also, any noise emissions from construction activity will be localised and temporary.

To minimise potential noise impacts associated with night-time deliveries, there will be prior notification to the affected public and restricted use of exhaust/engine brakes in built up areas.

9.6 Summary

Wind turbine noise has been predicted and assessed against relevant criteria prescribed by the SA EPA Guideline and World Health Organisation (WHO) goals where appropriate. Layout Option 1 (125 WTG's), equipped with REpower MM92, 92.5 m rotor diameter, 100 m hub height, 2.05 MW turbines was predicted to comply to all relevant noise criteria, SA EPA Guideline and WHO limits, at all respective receivers. Layout Option 2 (107 WTG's), equipped with Siemens SWT-2.3-101, 101 m

rotor diameter, 100 m hub height, 2.3 MW turbines was predicted to comply with all relevant noise criteria, SA EPA Guideline and WHO limits, at all respective receivers.

Construction noise impact has been assessed and the 'worst case' scenarios modelled were found to be generally acceptable. Blasting impact has been assessed and found to be acceptable. Similarly, vibration levels are anticipated to be well within the acceptable criteria.

Construction traffic noise impact has been assessed and the 'worst case' maximum construction traffic generated scenario would increase existing traffic noise levels along local roads by up to 3 to 7 dBA but due to the typically large setback of dwellings from the road network would result in noise level that would be considered acceptable under the ECRTN.

9.7 Proposed Transmission Line

The proposed transmission line will be assessed apart from this EA under Part 5 of the *EP&A Act*. Possible impacts and mitigation strategies of the transmission line from construction impacts include:

- Carrying out all construction works during the standard daytime construction hours. Close consultation with the affected community is essential where construction works are proposed outside normal working hours;
- Scheduling construction to minimise the multiple use of the most noisy equipment or plant items near noise sensitive receptors;
- Strategic positioning of plant items to reduce the noise emission to noise sensitive receptors, where possible;
- Carrying out maintenance work away from noise sensitive receptors, where practicable;
- Awareness training of staff and contractors in environmental noise issues;
- Switching off any equipment not in use for extended periods during construction work;
- Restricting heavy vehicles' entry to site and departure from site to the nominated construction hours;
- Community consultation with local residents and building owners will be undertaken to assist in the alleviation of community concerns. Noise sensitive receptors may be prepared to endure higher construction noise levels for a short duration if they have been provided with sufficient warning in the place of intermittent but extended periods of construction noise at lower levels; and
- Maintaining a suitable complaint register. Should noise complaints be received, undertake noise monitoring at the locations concerned. Reasonable and feasible measures would need to be implemented to reduce noise impacts.

Operational noise associated with the proposed transmission line is expected to be negligible as transmission lines are typically silent in operation and are not normally a source of noise complaint. A slight crackling noise may be heard close to a line during some climate conditions due to corona effects, however it is anticipated that due to the diameter of the conductors likely to be used, noise impact would be negligible.

There would be a small number of vehicular movements and occasional helicopter patrols during inspections and routine maintenance along the easement. These practices have generally been

considered acceptable across other areas of Country Energy lines. In the unlikely event that Country Energy were to receive any complaints in relation to noise generation from maintenance activity, Country Energy would investigate and take appropriate action to reduce any excessive noise impact.

9.7.1 *Cumulative Impacts*

The proposed transmission line development will occur in parallel with the planned upgrade to the existing 66 kV network as described in **Chapter 3** Project Description and the Boco Rock Wind Farm. However with respect to the management and mitigation measures outlined above for construction works and negligible operational noise, cumulative impacts are not considered a significant impact. However, if necessary, an assessment will be included in the Review of Environmental Factors for the proposal.

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