APPENDIX 10

Bango Wind Farm Environmental Noise Assessment

Bango Wind Farm Cumulative Environmental Noise Assessment

Sonus Pty Ltd

UPDATES TO THE ENVIRONMENTAL IMPACT STATEMENT

During the preparation of this Environmental Impact Statement, a number of changes occurred.

Please consider these changes while reviewing this Appendix.

- The Assessment Type of the Bango Wind Farm has transitioned from Part 3A, after its repeal, and is now being assessed as a State Significant Development under Part 4 of the EP&A Act. Any reference to a Part 3A assessment in attached technical assessments may be disregarded, and considered as State Significant Development;

- Rugby Wind Farm, a wind farm that was proposed to the north of the Project has been withdrawn. Where references are made to cumulative impacts with the Rugby Wind Farm, please disregard these;

- Slight changes have occurred to the Rye Park Wind Farm layout, a wind farm under development to the east of the Project. The changes made to the layout are not significant and therefore sit within the cumulative impact assessment undertaken for this EIS. The revised layout has been considered in the Environmental Noise Assessment and Landscape Visual Impact Assessment. Where further references are made to the Rye Park Wind Farm layout, these will be incorporated into future documentation where required;

- Four turbines at the south east extent of the Project, situated in the Mt Buffalo cluster have been removed through consultation with landowners. This change has been highlighted in maps and a review of all technical assessments has deemed that the removal of the four turbines has resulted in a reduced. This change will be incorporated into future documentation. These wind turbines are identified as “removed wind turbines” in the Project maps in Volume 2; and

- A number of changes were made to the residence information for the Project, as a result of construction of houses and change in occupancy status of existing buildings. These changes have been incorporated into the EIS.

Sonus Pty Ltd
17 Ruthven Avenue
ADELAIDE SA 5000
Phone: 08 8231 2100
Facsimile: 08 8231 2122
www.sonus.com.au
ABN: 67 882 843 130

Bango Wind Farm

Environmental Noise Assessment

Prepared For

CWP Renewables
41/45 Hunter Street, Newcastle NSW 2300

S3958C8
May 2016

EXECUTIVE SUMMARY

An environmental noise assessment has been made of the construction and operation of the proposed Bango Wind Farm. The proposal considers two planning layouts, which comprise up to either 118 or 92 wind turbine generators.

The assessment considered the Secretary's Environmental Assessment Requirement's (SEARs) 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* (2009) (SA Guidelines) with a base level of 35 dB(A;
- Substation - *NSW Industrial Noise Policy* (EPA 2000);
- Site Establishment and Construction - *Interim Construction Noise Guideline* (DECC 2009);
- Traffic Noise – *NSW Road Noise Policy* (DECCW, 2011); and,
- Vibration – *Assessing Vibration: A Technical Guideline* (DECC, 2006).

Based on predictions, the noise from both layouts will achieve the environmental noise criteria established in accordance with the SA Guidelines with a base level of 35 dB(A) for non-involved residences and the WHO Guidelines for involved residences with treatment measures applied to involved residence BAN0100.

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

Further analysis that extends beyond the requirements of the SA Guidelines has also been conducted to assist in considering the proposed wind farm, including:

- considering the cumulative effect of other wind farms, and;
- providing further information on special audible characteristics.

An assessment of the cumulative noise from the Bango Wind Farm and Rye Park Wind Farm has been conducted and is referenced in this report.

Notwithstanding the conclusions of this report, the assessment of operational noise from the proposed Bango Wind Farm will be repeated during the procurement stage to demonstrate that the final turbine selection and final layout will achieve compliance with the project criteria prior to construction.

Based on the above, the construction and operation of the proposed Bango Wind Farm achieves the Secretary's Environmental Assessment Requirement's.

GLOSSARY

A-weighting	Frequency adjustment applied to measured noise levels to replicate the frequency response of the human ear.
AGL	Above ground level.
Ambient noise level	The noise level with the presence of all existing noise sources in the environment.
Background noise level	The noise level in the absence of intermittent noise sources.
Day	The period defined by the INP as 7am to 6pm Monday to Saturday, and 8am to 6pm on Sunday.
dB(A)	A-weighted noise or sound power level in decibels.
DECC	Department of Environment and Climate Change
SEARs	Secretary's Environmental Assessment Requirements
DPI	NSW Department of Planning and Infrastructure.
EPA	Environment Protection Authority
Evening	The period defined by the INP as 6pm to 10pm Monday to Sunday.
Equivalent noise level	Energy averaged noise level.
INP	New South Wales Environment Protection Authority's Industrial Noise Policy 2000.
L_{A90}	A-weighted noise level exceeded 90% of the time measured in decibels, representing the background noise level.
L_{Aeq}	A-weighted equivalent noise level measured in decibels.
Night	The period defined by the INP as 10pm to 7am Monday to Saturday, and 10pm to 8am on Sunday.
NSW	New South Wales.
RBL	Rating Background Level.
SA Guidelines	Wind Farms – Environmental Noise Guidelines (2009) SA EPA
Sound power level	A measure of the sound energy emitted from a source of noise.
Worst-case	Conditions resulting in the highest noise level at or inside residences.

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INTRODUCTION

Sonus Pty Ltd has been engaged by CWP Renewables to conduct an environmental noise assessment of the proposed Bango Wind Farm, located 20 km north of Yass, 7 km south-east of Boorowa and 80 km west of Goulburn in New South Wales (NSW).

Sonus has previously prepared an environmental noise assessment for the Bango Wind Farm, detailed in report "S3958C5". Since this original assessment, the requirements previously known as the "Director General's Requirements" have been replaced by the "Secretary's Environmental Assessment Requirements" (SEARs). In this time, new wind turbine models have also become available and have been used for this assessment.

The environmental noise assessment was commissioned to address the new SEARs relating to operational noise and construction noise and vibration. The SEARs 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* (2009) with a base level of 35 dB(A) (operational noise);
- Substation - *NSW Industrial Noise Policy* (EPA 2000) (operational noise);
- Site Establishment and Construction - *Interim Construction Noise Guideline* (Department of Environment and Climate Change (DECC 2009) (construction noise);
- Traffic Noise – *NSW Road Nosie Policy (DECCW 2011*); and
- Vibration – *Assessing Vibration: A Technical Guideline* (DECC, 2006) (construction vibration).

The assessment of operational noise from the proposed Bango Wind Farm has been based on 118 Senvion MM92 turbines with a hub height of 80m for Layout Option 1, and 92 GE 3.4-130 turbines with a hub height of 120m for Layout Option 2. The proposed locations of the turbines for both layouts and the associated substations are provided in Appendix A.

Noise levels at residences within approximately 5km from the wind farm have been predicted. The locations of the residences and their relative distance to the closest turbine are provided in Appendix B. Appendix B also provides the status of the landowner with respect to involvement in the project as advised by CWP Renewables.

The assessment of operational noise from the proposed Bango Wind Farm will be repeated during the procurement stage to demonstrate that the final turbine selection and final layout will achieve compliance with the project criteria prior to construction.

SECRETARY'S ENVIRONMENTAL ASSESSMENT REQUIREMENTS

The noise related SEARs for the project provide the key issues to be addressed in the environmental noise assessment. The SEARs specify the relevant guidelines for each aspect of noise from the project to be considered. These requirements are discussed below and the relevant section of the SEARs is provided in Appendix C.

Wind Turbines

The SEARs require operational noise to be assessed against the South Australian Environment Protection Authority's *Wind Farms – Environmental Noise Guidelines 2009* (the SA Guidelines) with a baseline criterion of 35 dB(A). The SA Guidelines were developed with the core objective to balance the advantage of developing wind energy projects with protecting the amenity of the surrounding community from adverse noise impacts.

Criteria – Non-Involved Landowners

Based on the SEARs, noise from the wind farm at non-involed landowners should achieve a noise level no greater than the higher of the following;

- 35 dB(A) , or
- the background noise level ($L_{A90,10}$) by more than 5 dB(A).

Where the wind farm noise exhibits a tonal characteristic, a 5 dB(A) penalty is to be applied to the criteria, in accordance with the SA Guidelines.

Criteria – Involved Landowners

The landowners of a number of residences have been defined as involved by CWP Renewables (identified in Appendix B).

For involved landowners, a contemporary approach by authorities has been to reference the World Health Organisation (WHO) *Guidelines for Community Noise*[1] (the WHO Guidelines). The WHO Guidelines recommend an indoor noise level of 30 dB(A) to protect against sleep

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

disturbance. The indoor limit of 30 dB(A) equates to an outdoor noise level of 45 dB(A) with windows open.

Based on the above, it is proposed that the noise at residences of involved landholders achieves the recommendations of the WHO Guidelines of:

- 45 dB(A) , or
- the background noise level ($L_{A90,10}$) by more than 5 dB(A).

Background Noise Monitoring and Resultant Criteria

To determine the background noise level at various wind speeds, background noise levels were measured at fourteen locations in the vicinity of the proposed wind farm between the 16th of August and the 5th of December, 2012. The measurements were conducted in accordance with the SA Guidelines and current NSW practice, including:

- wind speed referenced to hub height;
- an average of approximately 6 weeks of monitoring per location; and
- consideration of noise data collected at night but correlation of noise and wind over the 24 hour period (rather than separation into time periods).

The fourteen monitoring locations, summarised in Table 1, were selected based on initial predictions of the wind farm noise. Preference was given to non-involved residences with the highest predicted noise levels, subject to permission being granted by the landowner to place a noise logger.

Table 1: Monitoring locations and periods.

Residence ID	Residence Name	Coordinates (WGS84 map datum)		Monitoring Period
		Easting	Northing	
BAN009	Noongah	658993	6177998	16/08/2012 - 10/09/2012 & 08/11/2012 - 05/12/2012
BAN0032	Taree	672634	6174096	17/08/2012 - 30/08/2012 & 8/11/2012 - 5/12/2012
BAN0034	Dovers Flat	658196	6178590	16/08/2012 - 28/08/2012 & 7/11/2012 - 5/12/2012
BAN0048	Glenwood	674793	6177078	16/08/2012 - 25/08/2012 & 8/11/2012 - 5/12/2012
BAN0060	Montalta	668961	6166711	16/08/2012 - 1/09/2012 & 8/11/2012 - 5/12/2012
BAN0076	Laverstock	663853	6169306	16/08/2012 - 11/09/2012 & 7/11/2012 - 3/12/2012

BAN0115	Banksia Downs	673902	6168649	16/08/2012 - 9/09/2012 & 8/11/2012 - 5/12/2012
BAN0136	Bobbys Hill	674134	6169504	16/08/2012 - 11/09/2012 & 8/11/2012 - 5/12/2012
BAN0144	Letona	668769	6167707	16/08/2012 - 1/09/2012 & 8/11/2012 - 5/12/2012
BAN0152	Eversleigh	674474	6171888	16/08/2012 - 11/09/2012 & 8/11/2012 - 5/12/2012
BAN0155	Rocky Springs	666730	6176414	16/08/2012 - 1/09/2012 & 7/11/2012 - 5/12/2012
BAN0158	Uundurba	667043.	6175213	16/08/2012 - 31/08/2012 & 7/11/2012 - 5/12/2012
BAN0159	Danebank	667506	6168917	16/08/2012 - 3/09/2012 & 7/11/2012 - 4/12/2012
BAN0170	Back Creek	669036	6176903	16/08/2012 - 6/09/2012 & 7/11/2012 - 5/12/2012

The background noise was measured with Rion type 1 & 2 sound level meters, calibrated at the beginning and end of the measurement period with a Rion NC74 Calibrator. All microphones were fitted with weather proof windshields, with the microphone positioned approximately 1500mm above ground level. Each noise logger was located in accordance with the SA Guidelines (e.g., at an equivalent distance from the facade of the dwelling as any significant trees whilst minimising the influence of fixed noise sources such as air conditioning units) and placed on the wind farm side of the dwellings.

The background noise level was measured in 10 minute intervals at each of the monitoring locations. Photographs of the noise monitoring equipment at each location are provided in Appendix D.

During the background noise monitoring regime, CWP Renewables measured the wind speed at a wind mast located within the wind farm site. The wind speed was measured in 10 minute intervals at various measurement heights. Table 2 provides details of the wind mast.

Table 2: Wind mast details.

Mast ID	Coordinates (WGS84 map datum)		Measurement Heights
	Easting	Northing	
BAN01	676798	6163601	30m, 61m

The SA Guidelines specify that the background noise should be correlated with wind speeds at hub height. The wind speeds at hub height were determined by CWP Renmewables based on the wind mast data. As two layouts are to be assessed with different hub heights (80m and 120m) and the ultimate hub height is not yet known, the background noise assessment has been conducted based on the higher hub height of 120m. This results in conservative (more onerous) criteria for the 80m hub height option. When the final hub height is known, the background noise correlations should be repeated with wind speed referenced to the final hub height and the criteria should be adjusted accordingly.

Local weather loggers were also deployed which measured rainfall and wind speed at approximately 1.5m above ground level. The rainfall and wind speed data were collected to determine the periods when weather directly on the microphone may have influenced the measured background noise levels in the vicinity. Table 3 summarises the location and monitoring period of the local weather loggers.

Table 3: Weather logger details.

Residence ID	Monitoring Period
BAN0158	16/08/2012 - 12/09/2012
BAN0155	7/11/2012 - 5/12/2012

The noise data corresponding to any periods of measured rainfall and/or measured wind speed exceeding 5 m/s at the microphone height for more than 90% of the measurement period were discarded.

Table 4 summarises the number of data points at each monitoring location following the removal of wind data which may have had an influence from weather. Data below the cut-in wind speed (3m/s for the purposes of this assessment) have also been removed in accordance with the SA Guidelines.

Table 4: Useable data points.

Residence ID	Number of Data Points
BAN009	6361
BAN0032	5138
BAN0034	5168
BAN0048	4556
BAN0060	5571
BAN0076	6399
BAN0115	5405
BAN0136	6418
BAN0144	5389
BAN0152	6432
BAN0155	5367
BAN0158	5367
BAN0159	5770
BAN0170	6041

Following data removal, the background noise data were correlated with the wind speed referenced to a height of 120m. 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 the regression analysis, the background noise level ($L_{A90,10}$) at a range of wind speeds within the operating range of the turbines is provided in Table 5. The correlation co-efficient provided for each regression curve in Appendix E indicates the relationship between the background noise at the dwelling and the wind speed at the wind farm site. A low correlation co-efficient indicates a limited relationship, as will naturally occur in many circumstances including for locations that are shielded from the winds across the wind farm site, rather than indicating any deficiency in the data analysis. The detailed background noise measurement methodology and data analysis (as outlined above) is the same for each location.

Table 5: Background noise levels (dB(A))

Residence ID	Background Noise Level (dB(A)) for integer wind speeds at Hub Height (120m AGL)											
	3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s	11m/s	12m/s	13m/s	14m/s
BAN009	29	30	31	32	32	32	32	32	32	33	35	38
BAN0032	27	28	29	29	29	29	29	29	30	31	33	35
BAN0034	31	32	33	33	33	33	34	34	35	36	37	40
BAN0048	28	30	32	33	34	35	36	36	37	38	39	40
BAN0060	28	28	29	29	29	29	30	31	32	33	36	39
BAN0076	31	31	31	32	32	32	32	33	33	34	36	37
BAN0115	31	31	31	32	32	33	34	35	36	37	38	39
BAN0136	26	27	27	28	28	29	30	31	32	34	36	38
BAN0144	25	26	27	27	28	29	30	31	32	35	37	40
BAN0152	29	30	31	31	32	32	33	34	35	37	39	41
BAN0155	23	23	24	25	25	26	27	29	30	32	34	37
BAN0158	25	26	28	29	30	30	31	33	34	37	40	43
BAN0159	25	26	27	28	29	30	32	33	35	37	39	41
BAN0170	25	26	27	28	28	28	29	30	31	32	34	37

The background noise levels in Table 5 have been used to establish noise criteria for each residence in accordance with the SA Guidelines. Where background noise monitoring has not occurred at a residence, the measured background levels at the closest monitoring location, on the same side of the wind farm as the residence, have been used to derive the criteria.

Substation

The SEARs reference the New South Wales Environment Protection Authority's *Industrial Noise Policy 2000* (the INP) for the assessment of substation noise levels.

The INP establishes objective criteria based on the existing ambient noise environment and the envisaged amenity of the area. The most onerous criteria provided by the two methods are then selected. In a rural environment with low background noise levels, the criteria based on background noise levels are the most onerous and are therefore used in this assessment.

In accordance with the INP, the Rating Background Level (RBL) is used to characterise the existing noise environment for each of the day, evening and night periods. The RBL is determined from the lower tenth percentile of the background noise level (L_{A90}) in the environment and effectively represents the "lulls". That is, the RBL effectively "selects" the quietest periods at the monitoring locations. Where the RBL is measured to be below 30 dB(A), then it is set to 30 dB(A). The RBL requires a different procedure to the SA Guidelines background noise data analysis.

The ambient noise environment was monitored at fifteen residences in the vicinity of the wind farm, as described for the SA Guidelines. Based on the measured ambient noise levels, the RBLs were calculated to be less than 30 dB(A) at all monitoring locations. Therefore, in accordance with the INP, an RBL of 30 dB(A) was considered for all residences in this assessment.

The INP requires that noise from industrial sources should not exceed the measured RBL by more than 5 dB(A). Therefore the most onerous criterion in accordance with the INP's ambient noise method is 35 dB(A).

It is noted that if noise assessed under the INP is found to have a character that has the potential to be annoying, such as tonality, modulation or dominant low-frequency content, a modifying correction factor is to be applied to the measured level. A substation has the potential to exhibit tonality if it is audible and a 5 dB(A) correction has been applied, which effectively reduces the criterion to 30 dB(A). Therefore, in order to achieve the criteria provided by the INP, it is recommended that noise from the proposed substation achieves a level of 30 dB(A) at all residences.

Construction

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

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

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 in Table 6.

Table 6: The ICN 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 SEARs, traffic noise associated with the construction of the wind farm is to be assessed against the *NSW Road Noise Policy (the RNP*).

Traffic noise criteria are provided for a range of scenarios. The most appropriate classification for the Bango Wind Farm construction site and its associated traffic is considered to be “Local Roads - Existing residences affected by additional traffic on existing local roads generated by land use developments” However, it should be noted that this criterion applies to an ongoing operation, as distinct to a temporary construction process and as such provides a conservative approach.

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

Construction Vibration

To assess construction vibration levels in accordance with the SEARs, 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 vibration 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 vibration criteria in Table 7 at the dwellings, based on the core document used as the technical basis for the Technical Guideline, the British Standard BS 6472-1992 “Evaluation of human exposure to vibration in buildings (1-80Hz)”.

Table 7: 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 effectively an average. The “rms” value for acceleration is expressed in millimetres per second squared (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

Operational Wind Farm Noise

Turbine Layout and Details

Operational noise from the wind farm has been assessed based on two layout options, consisting of 118 and 92 turbines, with coordinates of each layout option provided in Appendix A.

The predictions of the turbine noise for Layout Option 1 have been based on 118 Senvion MM92 turbines with a hub height of 80m AGL and sound power level data provided in Table 8 below. It is recommended that the sound power levels be warranted to CWP Renewables if the Senvion M92 turbine is selected.

Table 8: Senvion MM92 Sound Power Levels

Hub Height Wind Speed (m/s)	Octave Band Sound Power Level (dB(A))									Total Sound Power (dB(A))
	32	63	125	250	500	1000	2000	4000	8000	
3	64	75	80	85	86	84	82	75	61	91.1
4	64	75	80	85	86	84	82	75	61	91.1
5	64	75	80	85	86	84	82	75	61	91.1
6	70	80	85	91	92	91	86	79	65	97.0
7	74	84	90	95	97	96	91	84	71	101.5
8	75	85	91	96	98	97	93	87	73	103.0
9	76	85	92	97	99	98	93	88	74	103.8
10	76	86	92	97	99	98	94	88	75	104.2
11	77	87	93	96	99	99	95	90	77	104.2
12	76	86	92	97	99	99	94	90	77	104.2
13-Rated Power	77	87	93	96	98	99	96	91	78	104.2

The predictions of the turbine noise for Layout Option 2 have been based on 92 GE 3.4-130 turbines with a hub height of 120m AGL and sound power level data provided in Table 9 below. It is recommended that the sound power levels be warranted to CWP Renewables if the GE 3.4-130 turbine is selected.

Table 9: GE 3.4-130 Sound Power Levels

Hub Height Wind Speed (m/s)	Octave Band (Hz) Sound Power Level (dB(A))									Total Sound Power (dB(A))
	32	63	125	250	500	1000	2000	4000	8000	
3	65	78	87	89	89	90	87	78	60	95.7
4	65	78	87	89	89	90	87	78	60	95.7
5	65	77	87	90	90	90	88	81	62	96.3
6	68	80	89	93	92	92	90	83	64	98.7
7	71	83	92	96	96	96	93	86	68	102
8	73	85	94	99	99	98	96	88	70	104.7
9	76	87	96	100	101	101	98	90	70	106.4
10	76	88	96	100	101	101	98	90	69	106.5
11	76	88	96	99	101	101	98	90	69	106.5
12	76	88	96	99	101	101	99	89	68	106.5
13	76	88	96	99	101	101	98	88	67	106.5
14-Rated Power	76	88	96	99	101	101	98	88	66	106.5

The predictions have been conducted without a penalty for the presence of tonal characteristics. To provide certainty, it is recommended that a guarantee is sought from the manufacturer as part of the procurement process. The general form of the guarantee should be that a penalty for tonality is not applicable at any residence when tested using a 1/3 octave band analysis method based on the NSW INP.

Substation Layout and Details

The noise from the proposed substations at the wind farm has been considered for assessment against the INP. It is understood that 3 collector substation locations are being considered and that transformer capacities at each location will comprise either two 100MVA transformers, or a single 200MVA transformer.

The sound power level of the transformer has been derived from the Australian/New Zealand Standard AS/NS60076.10:2009[2]. Under the Standard, the single 200MVA transformer has a higher noise level than the two 100MVA transformers combined and has therefore been used as a conservative assessment of the noise from the collector substation options. The

[2] Australian/New Zealand Standard AS/NZS60076.10:2009, *Power transformers - Determination of sound levels (IEC 60076-10, Ed. 1(2001) MOD).*

octave band sound power levels assumed for the substations are provided in Table 10 below.

Table 10: Transformer Sound Power Levels.

Transformer Capacity	Sound Power Level (dB(A)) for each Octave Band Centre Frequency								Total dB(A)
	63Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	
200 MVA	77	85	93	95	88	85	78	73	98

Noise Propagation Model - CONCAWE

The predictions of environmental noise from the proposed wind farm have been made using the CONCAWE[3] noise propagation model and SoundPLAN noise modelling software. The sound propagation model considers the following influences:

- sound power levels and locations of noise sources;
- separation distances between noise sources and receivers;
- topography of the area;
- influence of the absorption provided by the ground;
- air absorption; and,
- meteorological conditions.

The CONCAWE system divides meteorological conditions into six separate “weather categories”, depending on wind speed, wind direction, time of day and level of cloud cover. Weather Category 1 provides the weather conditions associated with the “lowest” propagation of noise, whilst Weather Category 6 provides “worst-case” (i.e. highest noise level) conditions. Weather Category 4 provides “neutral” weather conditions for noise propagation (that is, conditions which do not account for the effects of temperature inversion or wind on propagation).

[3] CONCAWE - The oil companies’ international study group for conservation of clean air and water – Europe, ‘The propagation of noise from petrochemical complexes to neighbouring communities’, May 1981.

The assessment of the wind farm has been based on the following input conditions:

- weather category 6 (night with no clouds and wind from the wind farm to the dwelling under consideration);
- atmospheric conditions at 10°C and 80% relative humidity;
- wind direction from all WTGs to the particular residence under consideration, even in circumstances where WTGs are located in opposite directions from the residence;
- acoustically soft ground to reflect the pastoral nature of the land; and,
- maximum barrier attenuation from topography of 2 dB(A).

Turbine Noise

The noise levels at the residences in the vicinity of the wind farm from turbines have been predicted for each layout option and relevant wind speeds. Where the predicted noise level is 25 dB(A) or greater for either layout, the environmental noise criteria and predictions have been provided in Table 11 for Layout Option 1 and Table 12 for Layout Option 2. Appendix H (Layout 1) and Appendix I (Layout 2) provide the predicted noise level contours at the integer wind speed associated with the highest predicted noise level.

Table 11: Layout Option 1 - Comparison of Predicted Noise Levels with Noise Criteria.

Name	Representative Logging Location	3m/s		4m/s		5m/s		6m/s		7m/s		8m/s		9m/s		10m/s		11m/s		12m/s		13m/s	
		Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction
BAN0009	BAN009	45	24	45	24	45	24	45	30	45	34	45	36	45	37	45	37	45	37	45	37	45	37
BAN0018	BAN0170	35	11	35	11	35	11	35	16	35	21	35	22	35	23	35	23	36	23	37	23	39	23
BAN0019	BAN0170	35	16	35	16	35	16	35	22	35	27	35	28	35	29	35	29	36	29	37	29	39	29
BAN0020	BAN0170	45	21	45	21	45	21	45	27	45	31	45	32	45	33	45	34	45	33	45	34	45	33
BAN0021	BAN0158	45	23	45	23	45	23	45	29	45	34	45	35	45	36	45	36	45	36	45	36	45	36
BAN0022	BAN0152	35	10	35	10	36	10	36	16	37	21	37	22	38	23	39	23	40	23	42	23	44	23
BAN0025	BAN0048	35	11	35	11	37	11	38	16	39	21	40	22	41	23	41	24	42	23	43	23	44	23
BAN0026	BAN0159	35	16	35	16	35	16	35	22	35	27	35	28	37	29	38	29	40	29	42	29	44	29
BAN0032	BAN0032	45	28	45	28	45	28	45	34	45	38	45	40	45	41	45	41	45	41	45	41	45	41
BAN0034	BAN0034	36	19	37	19	38	19	38	25	38	30	38	31	39	32	39	32	40	32	41	32	42	32
BAN0035	BAN0048	35	15	35	15	37	15	38	21	39	25	40	27	41	27	41	28	42	28	43	28	44	27
BAN0036	BAN0034	36	14	37	14	38	14	38	20	38	24	38	26	39	27	39	27	40	27	41	27	42	27
BAN0041	BAN0032	45	30	45	30	45	30	45	36	45	41	45	42	45	43	45	43	45	43	45	43	45	43
BAN0042	BAN0076	36	14	36	14	36	14	37	20	37	25	37	26	37	27	38	27	38	27	39	27	41	27
BAN0043	BAN009	35	12	35	12	36	12	37	18	37	22	37	24	37	24	37	25	37	25	38	25	40	24
BAN0048	BAN0048	35	13	35	13	37	13	38	19	39	24	40	25	41	26	41	26	42	26	43	26	44	26
BAN0055	BAN0115	45	13	45	13	45	13	45	18	45	23	45	24	45	25	45	26	45	25	45	25	45	25
BAN0056	BAN009	35	10	35	10	36	10	37	16	37	20	37	21	37	22	37	23	37	22	38	22	40	22
BAN0060	BAN0076	36	18	36	18	36	18	37	24	37	28	37	30	37	31	38	31	38	31	39	31	41	31
BAN0061	BAN0170	35	10	35	10	35	10	35	16	35	20	35	22	35	23	35	23	36	23	37	23	39	23
BAN0062	BAN0076	36	18	36	18	36	18	37	24	37	28	37	30	37	31	38	31	38	31	39	31	41	31
BAN0066	BAN0170	35	14	35	14	35	14	35	20	35	24	35	26	35	26	35	27	36	27	37	27	39	26
BAN0075	BAN0076	36	11	36	11	36	11	37	17	37	21	37	23	37	24	38	24	38	24	39	24	41	24
BAN0076	BAN0076	36	20	36	20	36	20	37	26	37	31	37	32	37	33	38	33	38	33	39	33	41	33
BAN0077	BAN009	35	11	35	11	36	11	37	16	37	21	37	22	37	23	37	23	37	23	38	23	40	23
BAN0087	BAN0158	45	24	45	24	45	24	45	30	45	35	45	36	45	37	45	37	45	37	45	37	45	37

Name	Representative Logging Location	3m/s		4m/s		5m/s		6m/s		7m/s		8m/s		9m/s		10m/s		11m/s		12m/s		13m/s	
		Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction
BAN0096	BAN0034	45	20	45	20	45	20	45	26	45	30	45	32	45	32	45	33	45	33	45	33	45	32
BAN0097	BAN0170	35	17	35	17	35	17	35	23	35	27	35	28	35	29	35	30	36	29	37	30	39	29
BAN0100	BAN0158	45	34	45	34	45	34	45	40	45	45	45	46	45	47	45	47	45	47	45	47	45	47
BAN0101	BAN0155	45	27	45	27	45	27	45	33	45	37	45	39	45	40	45	40	45	40	45	40	45	40
BAN0102	BAN0034	36	11	37	11	38	11	38	17	38	21	38	22	39	23	39	24	40	23	41	23	42	23
BAN0105	BAN0048	35	12	35	12	37	12	38	17	39	22	40	23	41	24	41	24	42	24	43	24	44	24
BAN0106	BAN0152	35	16	35	16	36	16	36	22	37	27	37	28	38	29	39	29	40	29	42	29	44	29
BAN0108	BAN0076	45	17	45	17	45	17	45	22	45	27	45	28	45	29	45	30	45	29	45	29	45	29
BAN0115	BAN0115	45	27	45	27	45	27	45	33	45	37	45	39	45	40	45	40	45	40	45	40	45	40
BAN0117	BAN0076	45	23	45	23	45	23	45	29	45	33	45	35	45	36	45	36	45	36	45	36	45	35
BAN0119	BAN0034	45	28	45	28	45	28	45	34	45	38	45	39	45	40	45	41	45	40	45	41	45	40
BAN0126	BAN0076	36	14	36	14	36	14	37	19	37	24	37	25	37	26	38	27	38	26	39	26	41	26
BAN0128	BAN0136	35	12	35	12	35	12	35	18	35	22	35	24	35	24	36	25	37	25	39	25	41	24
BAN0136	BAN0136	45	24	45	24	45	24	45	30	45	34	45	36	45	37	45	37	45	37	45	37	45	37
BAN0138	BAN0115	36	12	36	12	36	12	37	18	37	23	38	24	39	25	40	25	41	25	42	25	43	25
BAN0139	BAN0048	35	10	35	10	37	10	38	16	39	21	40	22	41	23	41	23	42	23	43	23	44	23
BAN0141	BAN0170	35	12	35	12	35	12	35	18	35	22	35	23	35	24	35	25	36	24	37	25	39	24
BAN0142	BAN0155	35	18	35	18	35	18	35	24	35	28	35	30	35	30	35	31	35	31	37	31	39	30
BAN0144	BAN0144	35	19	35	19	35	19	35	25	35	29	35	31	35	32	36	32	37	32	40	32	42	32
BAN0152	BAN0152	35	18	35	18	36	18	36	24	37	29	37	30	38	31	39	31	40	31	42	31	44	31
BAN0154	BAN0155	45	22	45	22	45	22	45	28	45	32	45	34	45	35	45	35	45	35	45	35	45	34
BAN0155	BAN0155	45	24	45	24	45	24	45	30	45	35	45	36	45	37	45	37	45	37	45	37	45	37
BAN0158	BAN0158	45	22	45	22	45	22	45	28	45	32	45	34	45	35	45	35	45	35	45	35	45	34
BAN0159	BAN0159	45	17	45	17	45	17	45	23	45	27	45	29	45	29	45	30	45	30	45	30	45	29
BAN0160	BAN009	45	22	45	22	45	22	45	28	45	32	45	34	45	35	45	35	45	35	45	35	45	35
BAN0161	BAN009	45	14	45	14	45	14	45	19	45	24	45	25	45	26	45	27	45	26	45	26	45	26
BAN0162	BAN0034	45	18	45	18	45	18	45	24	45	28	45	30	45	31	45	31	45	31	45	31	45	31
BAN0164	BAN0159	45	17	45	17	45	17	45	23	45	27	45	28	45	29	45	30	45	29	45	30	45	29
BAN0165	BAN0159	35	17	35	17	35	17	35	22	35	27	35	28	37	29	38	30	40	29	42	29	44	29
BAN0166	BAN0159	35	16	35	16	35	16	35	22	35	26	35	28	37	29	38	29	40	29	42	29	44	29
BAN0170	BAN0170	35	17	35	17	35	17	35	23	35	28	35	29	35	30	35	30	36	30	37	30	39	30
BAN0172	BAN0060	45	25	45	25	45	25	45	31	45	35	45	36	45	37	45	38	45	37	45	37	45	37
BAN0173	BAN0115	45	17	45	17	45	17	45	23	45	27	45	29	45	30	45	30	45	30	45	30	45	29
BAN0175	BAN0048	35	10	35	10	37	10	38	16	39	21	40	22	41	23	41	23	42	23	43	23	44	23
BAN0176	BAN0170	35	15	35	15	35	15	35	21	35	26	35	27	35	28	35	28	36	28	37	28	39	28
BAN0177	BAN0159	35	13	35	13	35	13	35	18	35	23	35	24	37	25	38	26	40	25	42	25	44	25
BAN0179	BAN0076	36	16	36	16	36	16	37	22	37	26	37	28	37	28	38	29	38	29	39	29	41	28
BAN0181	BAN0076	36	15	36	15	36	15	37	21	37	25	37	26	37	27	38	28	38	27	39	28	41	27
BAN0182	BAN0076	45	17	45	17	45	17	45	23	45	27	45	28	45	29	45	30	45	29	45	29	45	29
BAN0187	BAN0076	36	16	36	16	36	16	37	22	37	26	37	28	37	28	38	29	38	29	39	29	41	28
BAN0189	BAN0034	45	18	45	18	45	18	45	24	45	28	45	29	45	30	45	31	45	30	45	31	45	30
BAN0222	BAN009	35	13	35	13	36	13	37	19	37	23	37	24	37	25	37	26	37	25	38	26	40	25
BAN0225	BAN0155	45	30	45	30	45	30	45	36	45	41	45	42	45	43	45	43	45	43	45	43	45	43
BAN0235	BAN0076	36	21	36	21	36	21	37	27	37	32	37	33	37	34	38	34	38	34	39	34	41	34
BAN0238	BAN0060	45	25	45	25	45	25	45	31	45	35	45	37	45	38	45	38	45	38	45	38	45	38
BAN0243	BAN0152	35	15	35	15	36	15	36	21	37	26	37	27	38	28	39	29	40	28	42	28	44	28
BAN0260	BAN0076	36	19	36	19	36	19	37	24	37	29	37	30	37	31	38	32	38	31	39	31	41	31
BAN0282	BAN0170	35	20	35	20	35	20	35	25	35	30	35	31	35	32	35	32	36	32	37	32	39	32
BAN0283	BAN0155	35	13	35	13	35	13	35	19	35	23	35	25	35	26	35	26	35	26	37	26	39	26

Table 12: Layout Option 2 - Comparison of Predicted Noise Levels with Noise Criteria.

Name	Representative Logging Location	3m/s		4m/s		5m/s		6m/s		7m/s		8m/s		9m/s		10m/s		11m/s		12m/s		13m/s		14m/s	
		Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction
BAN0009	BAN009	45	28	45	28	45	28	45	31	45	34	45	37	45	38	45	38	45	38	45	38	45	38	45	38
BAN0018	BAN0170	35	16	35	16	35	16	35	19	35	22	35	25	35	26	35	26	36	26	37	26	39	26	42	26
BAN0019	BAN0170	35	21	35	21	35	22	35	24	35	28	35	30	35	32	35	32	36	32	37	32	39	32	42	32
BAN0020	BAN0170	45	26	45	26	45	27	45	29	45	32	45	35	45	37	45	37	45	37	45	37	45	37	45	37
BAN0021	BAN0158	45	29	45	29	45	29	45	31	45	35	45	37	45	39	45	39	45	39	45	39	45	39	48	39
BAN0022	BAN0152	35	15	35	15	36	16	36	18	37	21	37	24	38	25	39	26	40	25	42	25	44	25	46	25
BAN0025	BAN0048	35	16	35	16	37	16	38	18	39	22	40	24	41	26	41	26	42	26	43	26	44	26	45	26
BAN0026	BAN0159	35	21	35	21	35	22	35	24	35	27	35	30	37	32	38	32	40	32	42	32	44	31	46	31
BAN0032	BAN0032	45	33	45	33	45	33	45	36	45	39	45	42	45	43	45	43	45	43	45	43	45	43	45	43
BAN0034	BAN0034	36	23	37	23	38	24	38	26	38	30	38	32	39	34	39	34	40	34	41	34	42	34	45	34
BAN0035	BAN0048	35	20	35	20	37	20	38	23	39	26	40	29	41	30	41	30	42	30	43	30	44	30	45	30
BAN0036	BAN0034	36	18	37	18	38	19	38	21	38	25	38	27	39	29	39	29	40	29	41	29	42	29	45	29
BAN0041	BAN0032	45	33	45	33	45	33	45	36	45	39	45	42	45	43	45	44	45	44	45	44	45	43	45	43
BAN0042	BAN0076	36	19	36	19	36	19	37	22	37	25	37	28	37	29	38	29	38	29	39	29	41	29	42	29
BAN0043	BAN009	35	17	35	17	36	17	37	20	37	23	37	26	37	27	37	27	37	27	38	27	40	27	43	27
BAN0048	BAN0048	35	18	35	18	37	18	38	21	39	24	40	27	41	28	41	28	42	28	43	28	44	28	45	28
BAN0055	BAN0115	45	16	45	16	45	17	45	19	45	23	45	25	45	27	45	27	45	27	45	27	45	27	45	27
BAN0056	BAN009	35	15	35	15	36	16	37	18	37	21	37	24	37	25	37	25	37	25	38	25	40	25	43	25
BAN0060	BAN0076	36	22	36	22	36	23	37	25	37	29	37	31	37	33	38	33	38	33	39	33	41	33	42	33
BAN0061	BAN0170	35	15	35	15	35	16	35	18	35	21	35	24	35	25	35	25	36	25	37	25	39	25	42	25
BAN0062	BAN0076	36	22	36	22	36	23	37	25	37	29	37	31	37	33	38	33	38	33	39	33	41	33	42	33
BAN0066	BAN0170	35	19	35	19	35	19	35	22	35	25	35	28	35	29	35	29	36	29	37	29	39	29	42	29
BAN0075	BAN0076	36	16	36	16	36	16	37	19	37	22	37	25	37	26	38	26	38	26	39	26	41	26	42	26
BAN0076	BAN0076	36	25	36	25	36	25	37	28	37	31	37	34	37	35	38	35	38	35	39	35	41	35	42	35
BAN0077	BAN009	35	16	35	16	36	16	37	18	37	22	37	24	37	26	37	26	37	26	38	26	40	26	43	26
BAN0087	BAN0158	45	29	45	29	45	30	45	32	45	36	45	38	45	40	45	40	45	40	45	40	45	40	48	40
BAN0096	BAN0034	45	24	45	24	45	25	45	27	45	30	45	33	45	35	45	35	45	35	45	35	45	35	45	35
BAN0097	BAN0170	35	20	35	20	35	21	35	23	35	27	35	29	35	31	35	31	36	31	37	31	39	31	42	31
BAN0100	BAN0158	45	37	45	37	45	38	45	40	45	44	45	46	45	48	45	48	45	48	45	48	45	48	48	48
BAN0101	BAN0155	45	31	45	31	45	32	45	34	45	38	45	40	45	42	45	42	45	42	45	42	45	42	45	42
BAN0102	BAN0034	36	16	37	16	38	16	38	18	38	22	38	24	39	26	39	26	40	26	41	26	42	26	45	26
BAN0105	BAN0048	35	17	35	17	37	17	38	19	39	23	40	25	41	27	41	27	42	27	43	27	44	27	45	27
BAN0106	BAN0152	35	21	35	21	36	22	36	24	37	28	37	30	38	32	39	32	40	32	42	32	44	32	46	32
BAN0108	BAN0076	45	21	45	21	45	21	45	24	45	27	45	30	45	31	45	32	45	31	45	31	45	31	45	31
BAN0115	BAN0115	45	30	45	30	45	31	45	33	45	36	45	39	45	41	45	41	45	41	45	41	45	40	45	41
BAN0117	BAN0076	45	27	45	27	45	28	45	30	45	34	45	36	45	38	45	38	45	38	45	38	45	38	45	38
BAN0119	BAN0034	45	32	45	32	45	33	45	35	45	38	45	41	45	43	45	43	45	43	45	43	45	43	45	43
BAN0126	BAN0076	36	18	36	18	36	19	37	21	37	24	37	27	37	29	38	29	38	29	39	29	41	29	42	29
BAN0128	BAN0136	35	16	35	16	35	17	35	19	35	22	35	25	35	26	36	26	37	26	39	26	41	26	43	26
BAN0136	BAN0136	45	28	45	28	45	29	45	31	45	34	45	37	45	39	45	39	45	39	45	39	45	39	45	39
BAN0138	BAN0115	36	16	36	16	36	17	37	19	37	22	38	25	39	26	40	27	41	26	42	26	43	26	44	26
BAN0139	BAN0048	35	16	35	16	37	16	38	18	39	22	40	24	41	26	41	26	42	26	43	26	44	26	45	26
BAN0141	BAN0170	35	16	35	16	35	16	35	19	35	22	35	25	35	26	35	26	36	26	37	26	39	26	42	26
BAN0142	BAN0155	35	22	35	22	35	22	35	25	35	28	35	31	35	32	35	32	35	32	37	32	39	32	42	32
BAN0144	BAN0144	35	24	35	24	35	24	35	27	35	30	35	33	35	34	36	34	37	34	40	34	42	34	45	34
BAN0152	BAN0152	35	23	35	23	36	24	36	26	37	29	37	32	38	34	39	34	40	34	42	34	44	34	46	34
BAN0154	BAN0155	45	27	45	27	45	28	45	30	45	33	45	36	45	38	45	38	45	38	45	38	45	38	45	38
BAN0155	BAN0155	45	29	45	29	45	29	45	32	45	35	45	38	45	39	45	40	45	39	45	39	45	39	45	39
BAN0158	BAN0158	45	28	45	28	45	28	45	31	45	34	45	37	45	38	45	38	45	38	45	38	45	38	48	38
BAN0159	BAN0159	45	22	45	22	45	22	45	25	45	28	45	31	45	32	45	32	45	32	45	32	45	32	46	32
BAN0160	BAN009	45	26	45	26	45	27	45	29	45	32	45	35	45	37	45	37	45	37	45	37	45	37	45	37
BAN0161	BAN009	45	19	45	19	45	19	45	22	45	25	45	28	45	29	45	29	45	29	45	29	45	29	45	29
BAN0162	BAN0034	45	23	45	23	45	24	45	26	45	29	45	32	45	34	45	34	45	34	45	34	45	33	45	33
BAN0164	BAN0159	45	22	45	22	45	22	45	25	45	28	45	31	45	32	45	32	45	32	45	32	45	32	46	32
BAN0165	BAN0159	35	22	35	22	35	22	35	24	35	28	35	30	37	32	38	32	40	32	42	32	44	32	46	32

Name	Representative Logging Location	3m/s		4m/s		5m/s		6m/s		7m/s		8m/s		9m/s		10m/s		11m/s		12m/s		13m/s		14m/s	
		Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction	Criteria	Prediction
BAN0166	BAN0159	35	21	35	21	35	22	35	24	35	27	35	30	37	31	38	32	40	31	42	31	44	31	46	31
BAN0170	BAN0170	35	23	35	23	35	23	35	26	35	29	35	32	35	33	35	33	36	33	37	33	39	33	42	33
BAN0172	BAN0060	45	28	45	28	45	28	45	31	45	34	45	37	45	38	45	38	45	38	45	38	45	38	45	38
BAN0173	BAN0115	45	20	45	20	45	21	45	23	45	27	45	29	45	31	45	31	45	31	45	31	45	31	45	31
BAN0175	BAN0048	35	15	35	15	37	15	38	18	39	21	40	24	41	25	41	25	42	25	43	25	44	25	45	25
BAN0176	BAN0170	35	21	35	21	35	21	35	24	35	27	35	29	35	31	35	31	36	31	37	31	39	31	42	31
BAN0177	BAN0159	35	17	35	17	35	18	35	20	35	24	35	26	37	28	38	28	40	28	42	28	44	28	46	28
BAN0179	BAN0076	36	21	36	21	36	21	37	23	37	27	37	29	37	31	38	31	38	31	39	31	41	31	42	31
BAN0181	BAN0076	36	19	36	19	36	20	37	22	37	26	37	28	37	30	38	30	38	30	39	30	41	30	42	30
BAN0182	BAN0076	45	21	45	21	45	22	45	24	45	27	45	30	45	32	45	32	45	32	45	32	45	32	45	32
BAN0187	BAN0076	36	20	36	20	36	21	37	23	37	27	37	29	37	31	38	31	38	31	39	31	41	31	42	31
BAN0189	BAN0034	45	23	45	23	45	23	45	26	45	29	45	32	45	33	45	33	45	33	45	33	45	33	45	33
BAN0222	BAN009	35	17	35	17	36	18	37	20	37	23	37	26	37	28	37	28	37	28	38	28	40	28	43	28
BAN0225	BAN0155	45	35	45	35	45	35	45	37	45	41	45	44	45	45	45	45	45	45	45	45	45	45	45	45
BAN0235	BAN0076	36	26	36	26	36	26	37	29	37	32	37	35	37	36	38	36	38	36	39	36	41	36	42	36
BAN0238	BAN0060	45	28	45	28	45	29	45	31	45	34	45	37	45	39	45	39	45	39	45	39	45	39	45	39
BAN0243	BAN0152	35	20	35	20	36	21	36	23	37	27	37	29	38	31	39	31	40	31	42	31	44	31	46	31
BAN0260	BAN0076	36	23	36	23	36	23	37	26	37	29	37	32	37	33	38	33	38	33	39	33	41	33	42	33
BAN0282	BAN0170	35	25	35	25	35	25	35	28	35	31	35	34	35	35	35	35	36	35	37	35	39	35	42	35
BAN0283	BAN0155	35	18	35	18	35	18	35	21	35	24	35	27	35	28	35	28	35	28	37	28	39	28	42	28

Based on the predictions, the noise from both Layout Option 1 and Layout Option 2 will comply with the criteria established in accordance with the SA Guidelines with a base level of 35 dB(A) at all non-involved residences.

At involved residences, the external noise levels provided by the WHO Guidelines will be achieved with the exception of BAN0100. At this residence, the WHO Guidelines can be achieved by assessing the acoustic performance of the facade and considering potential acoustic treatment if required. This treatment might take the form of mechanical ventilation to allow windows to be closed and/or sealing any gaps around doors and windows.

Substation Noise

The noise levels at the residences in the vicinity of the collector stations have been predicted. Where the noise level is predicted to be greater than 20 dB(A), the predictions have been compared against the conservative criterion of 30 dB(A) developed under the INP and provided in Table 13 below. It is noted that the noise level at all other locations is predicted to be 20 dB(A) or less.

Table 13: Comparison of Prediction Noise Levels with Environmental Noise Criterion.

Residence ID	Criterion dB(A)	Predicted Noise Level dB(A)
BAN0021	30	26
BAN0158	30	23

Based on the predictions, the criterion of 30 dB(A) will be achieved at all locations and as such will not adversely impact the amenity of residences in the locality of the substations.

Other Considerations

Cumulative Impacts

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.*

Notwithstanding the above, Sonus has prepared an independent assessment of the cumulative impacts of the Bango and Rye Park Wind Farms. The assessment is detailed within report S4889C2 and will be submitted in conjunction with this report.

Modulation

Amplitude modulation (which is variation in the emitted noise level) is a fundamental characteristic of wind turbine noise and is therefore a characteristic which is taken into account in the objective criteria specifically developed for wind farms. A higher than usual level of amplitude modulation has been reported at a small number of wind farm sites in other countries. Due to its limited occurrence, a methodology for the objective assessment of "excessive" amplitude modulation is not well defined. If excessive modulation is found to be a feature of the noise from the Bango wind farm, measures should be taken to correct the noise characteristic.

Van Den Berg Effect

The Van Den Berg effect is a term that is used to describe "excessive" amplitude modulation as discussed above. The term has also been applied to a meteorological condition that produces a high wind shear whereby low wind speeds are experienced at ground level at the wind farm site with high wind speeds at hub height. Where the noise criteria are derived from background noise levels correlated with wind speeds measured close to ground level, there is the potential that the noise criteria could be exceeded in such a meteorological condition. The potential is resolved by correlating noise levels with wind speed at hub height as has been conducted fotr this assessment.

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. For example, this is evident in the octave band sound power levels for the turbines provided in Tables 8 and 9.

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.

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 of those 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.

Notwithstanding, predictions of the C-weighted noise level (the C-weighting is used to indicate the low frequency content) at residences have been made based on the worst-case (highest noise level) sound power level spectra for the turbines. The predictions have considered the available sound power level data for frequencies down to the 31.5Hz Octave Band.

Based on the predictions, the low frequency noise from the wind farm will be no greater than 60 dB(C) at all non-involved residences. These levels are below low frequency noise limits considered by the NSW authorities for recent developments.

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 will be audible provided that the sound level is sufficiently high. The thresholds of hearing for infrasound have been determined in a range of studies. In addition, it has been found that the 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 rotating turbine blades 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). The level of Infrasound will further reduce at greater distances from the turbines, therefore the infrasound at dwelling is expected to be even lower as the separation distances between wind farms and dwellings are well in excess of 200m.

It is noted that there are natural sources of infrasound including wind and breaking waves, and of man-made sources such as industrial processes, vehicles movements and air conditioning and ventilation systems that make infrasound at a similar or greater level than what has been measured at distances of 200m of a modern wind turbine.

A South Australian Government study by the Environment Protection Authority into infrasound (*Infrasound levels near windfarms and in other environments*, January 2013) provided findings for both G and un-weighted measurement data at very low frequencies that were consistent with a wide range of national and international peer reviewed studies, including:

- the measured levels of infrasound from wind farms are well below the threshold of perception; and
- the measured infrasound levels around wind farms are no higher than levels measured at other locations where people live, work and sleep; and
- the characteristics of noise produced by wind farms are not unique and are common in everyday life.

It is for the above reasons that infrasound from wind farms is not required to be assessed in contemporary standards and guidelines used by Australian and International authorities.

Corona and Aeolian Noise

Corona and Aeolian noise can be generated from the transmission lines. Corona noise is electrically-induced and occurs under specific conditions when the transmission lines are operational, whereas Aeolian noise is wind-induced and occurs under specific conditions regardless of the transmission lines are operational or not.

Corona noise is infrequent and typically occurs in specific conditions of rain or high humidity when the air adjacent to a conductor of high voltage lines is ionised and becomes a conductor of electricity. The noise that is produced is typically a low level of hissing that is rarely a problem at distances greater than 50 to 100m from the transmission lines.

Aeolian noise is infrequent and only occurs at times when there is a specific wind speed and direction to generate the mechanism of air passing over thin structures. The Aeolian noise generally only occurs on rare occasions and at times when there are high wind speeds and high background noise levels. There are mitigation measures available to reduce Aeolian noise if necessary.

Contingency Strategy

The SEARs require that a contingency strategy exists in the event of commissioned turbine noise exceeding the noise predictions. It is noted that modern turbines typically have multiple operating modes which produce lower noise levels.

Therefore, in the event of commissioned turbine noise exceeding the criteria, opportunities exist to reduce the noise of the turbines using lower noise modes that can be implemented under certain operating conditions. Notwithstanding, the predictions are based on conservative (higher noise level) modelling assumptions as a means of reducing the potential for commissioned turbine noise levels exceeding the predictions.

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 presented as 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 an overcast day with a breeze from the construction activity to the receiver. Other weather conditions would result in lower noise levels than those predicted for day-time construction.

The separation distance of 1700m is approximately that of the closest non-associated dwelling to a proposed WTG. A separation distance greater than 1700m will result in lower noise levels than that presented below in Table 13. The required separation distance in order to achieve the criterion of 40 dB(A)), which is 10 dB(A) above the RBL, is provided in Table 13 below.

Table 13: Predicted construction noise levels.

Phase	Main Plant and Equipment	Predicted Noise Level at 1650m	Separation to Achieve 40 dB(A) Criterion
Site Set-Up and Civil Works	Generator Transport truck Excavator Low loader	40 dB(A)	1650m
Road and Hard Stand Construction	Mobile crushing and screening plant Dozer Roller Low loader Tipper truck Excavator Scraper Transport truck	46 dB(A)	2400m
Excavation and foundation construction	Excavator Front end loader Concrete batching plant Mobile crushing and screening plant Truck-mounted concrete pump Concrete mixer truck Mobile crane Transport truck Tipper truck	46 dB(A)	2400m
Electrical Installation	Rock trencher Concrete mixer truck Low loader Tipper truck Mobile crane	46 dB(A)	2400m
Turbine Delivery and Erection	Extendable trailer truck Low loader Mobile crane	41 dB(A)	1800m

Based on the predicted noise levels, it is expected that construction noise will potentially be greater than 40 dB(A) for some activities at a distance of 1700m. The predicted noise levels are significantly less than the 75 dB(A) upper limit provided in the ICN Guideline.

Based on the above, it is possible that a dwelling located between 1700m and up to 2400m from construction activity may be defined as “noise affected” but not “highly noise affected” by the ICN Guideline. Such a definition under the ICN Guideline requires the developer to apply all feasible and reasonable work practices, and to inform the 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 and provide the framework for the development of a Construction Management Plan by the construction team once the final construction methods, timing, locations and equipment has been determined.

Scheduling

Construction works, including heavy vehicle movements into and out of the site, restricted to the hours 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 relevant New South Wales authority.

Location of Fixed Noise Sources

Locate fixed noise sources such as crushing and screening plant, concrete batching plant, 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 fixed noise source and the dwelling.

Provide Acoustic Screens around Fixed Noise Sources

Provide acoustic screens or mounding for fixed crushing and screening plant, and concrete batching plant wherever these noise sources are located within 2400m of a non-associated dwelling and do not have direct line of sight blocked to that dwelling, in accordance with the following requirements:

- Locate the screen 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, or use purpose built transportable sound barriers such as the Peace “Sound Barriers”;
- Construct to a minimum height that blocks direct line of sight between the noise source and any receiver within 2400m;
- 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;

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 for increased shielding when locating fixed noise sources within the 2400m distance.

Enclose Generators and Compressors

Provide proprietary acoustic enclosures for site compressors and generators located within 2400m of a non-associated dwelling.

Alternative Processes

Investigate and implement alternative processes where feasible and reasonable, 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 a 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 (or better) 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

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;
- 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 authorities to assist in complaint management if necessary;
- Contact details of the project manager and/or site "Environmental Representative".

In addition, prior to any construction activity occurring within 2400m of a dwelling of a non-involved landowner, or significant construction traffic periods or impacts on local road conditions:

- Contact the local community potentially affected by the proposed works and inform them of the proposed work, the location of the work, the day(s) and date(s) of the work and the hours involved[4];
- This contact shall be made a reasonable time before the proposed commencement of the work; and
- Contact details of the project manager and / or site "Environmental Representative" should be provided.

The above measures should be incorporated and implemented through a Construction Noise Management Plan for the site. The Plan should be developed by the construction team once the actual construction activities have been determined.

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

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.

The day-time 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. It is noted that care should be taken to avoid excessive acceleration of trucks and the use of truck engine brakes in close proximity to dwellings.

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 day-time operating hours for the construction site, subject to the scheduling caveats in the Construction Noise Management Plan.

Construction Vibration

It is expected that the main sources of vibration will be the 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 Guideline are in the order of 20m. At 100m distance, vibration from these activities is unlikely to be detectable to humans.

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

If construction activities producing high levels of vibration occur within 100m of a dwelling, it is recommended that a monitoring regime is implemented during these times to ensure compliance with the Technical Guideline.

APPENDIX A: COORDINATES OF BANGO NOISE SOURCES

Layout Option 1

Turbine ID	Coordinates (WGS84 map datum)	
	Easting	Northing
1	671618	6174752
2	672551	6169350
3	671220	6172725
4	661436	6181108
5	672506	6168805
6	661266	6181406
7	671261	6169917
8	661038	6179320
9	661656	6178780
11	664944	6171739
12	672635	6169745
13	671656	6173805
14	664721	6172733
16	661717	6180555
17	672377	6168142
18	663601	6172799
19	664006	6171605
20	660319	6178696
21	662281	6173305
22	670581	6170580
24	671306	6169580
25	671131	6168379
26	669892	6171233
27	664756	6172455
28	670262	6173541
29	662856	6171305
30	660342	6178460
31	660339	6178953
32	672716	6167943
33	672070	6170045
34	672357	6170336
35	663756	6172505
36	672238	6168456
37	660889	6178505
38	663206	6171055
41	664931	6176230
44	664806	6174230
45	671006	6168951
46	671465	6170340
47	671217	6169267
48	669615	6171540
49	664831	6175855

Turbine ID	Coordinates (WGS84 map datum)	
	Easting	Northing
50	671015	6173890
51	661500	6180824
52	661572	6177598
53	670056	6172655
54	671370	6174593
55	669956	6172305
56	665381	6176955
57	670581	6170855
58	671287	6174189
59	670190	6172964
60	671481	6173130
61	672625	6168300
62	671668	6167651
63	663056	6174030
64	661781	6178105
65	663781	6172005
67	672228	6170535
68	662976	6171569
69	669424	6173513
71	669565	6173814
72	663856	6171405
73	665140	6172054
74	660806	6177880
75	661106	6180380
76	665306	6176655
77	662230	6180655
78	661383	6181745
79	663431	6171805
80	671402	6173443
81	669706	6171830
83	669931	6172005
85	670956	6171280
86	665621	6171497
87	663831	6172255
88	663806	6174730
89	663681	6173030
91	669715	6174088
92	671306	6166980
93	671981	6176330
94	664806	6174530
95	670351	6173243
96	664131	6173380

Turbine ID	Coordinates (WGS84 map datum)	
	Easting	Northing
97	664781	6175530
98	665231	6176430
99	671631	6175455
100	670756	6171080
101	672131	6176005
102	672301	6167831
103	671281	6175230
104	664806	6173505
107	672458	6168591
108	661531	6179905
109	660931	6179955
110	671328	6172413
111	671558	6167971
112	671931	6175805
113	661456	6182005
114	663956	6173205
115	664704	6175039
116	661174	6179613
117	662631	6178280
118	664806	6173805
119	662440	6173814
120	671606	6167380
121	665471	6177230
122	672508	6169040
123	671431	6167205
124	661881	6180255
125	662139	6178525
126	661100	6177474
127	660985	6177199
128	661000	6176924
129	661775	6176851
130	661729	6177247
131	662136	6176984
132	662336	6177256

Layout Option 2

Turbine ID	Coordinates (WGS84 map datum)	
	Easting	Northing
1	670056	6172655
2	671370	6174593
3	669956	6172305
4	665381	6176955
5	671287	6174189
6	670581	6170855
7	671618	6174752
8	671402	6173443
9	672551	6169350
10	669706	6171830
11	671220	6172725
12	671606	6167380
13	669456	6173580
15	662281	6173305
16	672506	6168980
17	665484	6177302
18	661436	6181108
19	672625	6168300
20	671370	6167089
21	661881	6180255
22	665289	6176593
23	671631	6175455
24	671481	6173130
25	664806	6173805
26	671281	6175230
27	664806	6174230
28	672301	6167831
29	664931	6176230
30	672131	6176005
31	671261	6169917
32	670859	6171115
33	671656	6173805
34	670190	6172964

Turbine ID	Coordinates (WGS84 map datum)	
	Easting	Northing
35	661038	6179320
37	661341	6181554
38	661656	6178780
39	664944	6171739
41	671006	6168951
42	663781	6172005
43	664756	6173455
44	671506	6167805
45	664721	6172733
47	661531	6179905
48	664831	6175855
49	663856	6171405
50	671054	6173944
51	671465	6170340
52	672310	6168689
53	662230	6180655
54	671217	6169267
55	663656	6172955
56	665621	6171497
57	663806	6174730
58	660806	6177880
59	663756	6172505
61	663056	6174030
62	660319	6178696
63	669634	6173944
64	669615	6171540
65	661031	6179755
66	672635	6169745
68	663431	6171805
70	661106	6180380
71	662631	6178280
72	669756	6174180
73	662976	6171569

Turbine ID	Coordinates (WGS84 map datum)	
	Easting	Northing
74	671031	6171355
75	661781	6178105
76	663956	6173205
77	661537	6180733
78	664021	6173610
79	662139	6178525
80	670331	6173405
81	671328	6172413
82	672228	6170535
83	664781	6175530
85	661572	6177598
86	661437	6181941
87	664704	6175039
89	663206	6171055
92	669892	6171233
93	671295	6169503
94	664131	6173380
95	660889	6178505
96	661100	6177474
97	661000	6176924
98	661845	6177173
99	662336	6177256
100	664803	6174672
101	663965	6174234
102	662538	6173952
103	671131	6168379

Substations

Coordinates (WGS84 map datum)	
Easting	Northing
667395	6173951
667752	6173705
666668	6174189

APPENDIX B: RESIDENTIAL STATUS (Within 5km of a turbine)

Name	Coordinates (WGS84 map datum)		Type	Land Owner Status	Distance to Closest Turbine	
	Easting	Easting			Layout 1	Layout 2
BAN0003	662891	6166146	House	Not Involved	4919	4919
BAN0006	675091	6178459	Hall	Not Involved	3768	3844
BAN0009	658993	6177998	House	Involved	1426	1498
BAN0013	658618	6184656	House	Not Involved	3883	3914
BAN0018	666322	6181952	House	Not Involved	4293	4293
BAN0019	663726	6182989	House	Not Involved	2474	2517
BAN0020	665722	6178761	House	Involved	1552	1479
BAN0021	667884	6172737	House	Involved	1725	1784
BAN0022	676792	6171940	House	Not Involved	4701	4701
BAN0025	675914	6175959	House	Not Involved	3783	3783
BAN0026	667373	6168710	House	Not Involved	3292	3292
BAN0029	671867	6179910	House	Not Involved	3582	3914
BAN0030	674948	6179296	House	Not Involved	4195	4331
BAN0031	671008	6179913	House	Not Involved	3712	4066
BAN0032	672635	6174096	House	Involved	1021	1021
BAN0033	670386	6180864	House	Not Involved	4807	5163
BAN0034	658197	6178590	House	Not Involved	2124	2124
BAN0035	674957	6174740	House	Not Involved	3097	3097
BAN0036	657131	6178310	House	Not Involved	3211	3211
BAN0041	672598	6175449	House	Involved	726	726
BAN0042	661039	6169519	House	Not Involved	2548	2656
BAN0043	658490	6173393	House	Not Involved	3792	3792
BAN0048	674793	6177078	House	Not Involved	2870	2870
BAN0051	674146	6179210	House	Not Involved	3603	3785
BAN0052	675116	6178602	Church	Not Involved	3872	3957
BAN0055	675055	6165317	House	Involved	3516	3729
BAN0056	658577	6171343	House	Not Involved	4192	4192
BAN0057	666011	6182925	House	Not Involved	4410	4410
BAN0060	668962	6166711	House	Not Involved	2360	2438
BAN0061	664553	6184148	House	Not Involved	3766	3818
BAN0062	661390	6169789	House	Not Involved	2109	2214
BAN0063	660407	6185777	House	Not Involved	3915	3972
BAN0064	674960	6178313	School	Not Involved	3578	3651
BAN0065	675204	6178852	House	Not Involved	4093	4189

Name	Coordinates (WGS84 map datum)		Type	Land Owner Status	Distance to Closest Turbine	
	Easting	Easting			Layout 1	Layout 2
BAN0066	663372	6183982	House	Not Involved	2753	2813
BAN0069	659322	6186499	House	Not Involved	4975	5025
BAN0070	675864	6179390	House	Not Involved	4944	5039
BAN0074	674830	6178965	House	Not Involved	3881	4006
BAN0075	661551	6167881	House	Not Involved	3579	3579
BAN0076	663854	6169306	House	Not Involved	1865	1865
BAN0077	657450	6174477	House	Not Involved	4311	4311
BAN0078	672080	6180287	House	Not Involved	3958	4282
BAN0079	671424	6180018	House	Not Involved	3730	4075
BAN0080	674831	6178687	House	Not Involved	3699	3806
BAN0082	675000	6179146	House	Not Involved	4128	4254
BAN0087	668133	6171952	House	Involved	1538	1538
BAN0089	656447	6181992	House	Not Involved	4855	4914
BAN0092	667886	6181395	House	Not Involved	4814	4745
BAN0093	676507	6178176	House	Not Involved	4885	4885
BAN0094	663687	6185968	House	Not Involved	4548	4613
BAN0096	659252	6175930	House	Involved	2011	2011
BAN0097	671321	6178301	House	Not Involved	2079	2435
BAN0100	673030	6169297	House	Involved	482	482
BAN0101	666370	6176268	House	Neighbour Agreement	1132	1129
BAN0102	660877	6185232	House	Not Involved	3278	3338
BAN0104	675305	6179057	House	Not Involved	4299	4403
BAN0105	675804	6175406	House	Not Involved	3721	3721
BAN0106	674765	6172626	House	Not Involved	3288	3288
BAN0108	660693	6170275	House	Involved	2396	2624
BAN0111	672994	6179558	House	Not Involved	3384	3657
BAN0114	675025	6179593	House	Not Involved	4463	4610
BAN0115	673902	6168649	House	Neighbour Agreement	1323	1323
BAN0117	664596	6169872	House	Involved	1702	1702
BAN0119	663003	6180058	House	Involved	977	977
BAN0126	660701	6169270	House	Not Involved	2964	3076
BAN0128	676659	6168997	House	Not Involved	4081	4093
BAN0129	677616	6169758	House	Not Involved	4981	4981
BAN0135	675341	6163994	House	Not Involved	4741	4896
BAN0136	674135	6169504	House	Neighbour Agreement	1519	1519
BAN0138	674728	6164928	House	Not Involved	3624	3785

Name	Coordinates (WGS84 map datum)		Type	Land Owner Status	Distance to Closest Turbine	
	Easting	Easting			Layout 1	Layout 2
BAN0139	674830	6177838	House	Not Involved	3223	3263
BAN0140	674863	6178411	House	Not Involved	3555	3641
BAN0141	671520	6179339	House	Not Involved	3044	3390
BAN0142	670364	6177556	House	Not Involved	2029	2351
BAN0143	666680	6165798	House	Not Involved	4774	4864
BAN0144	668769	6167707	House	Not Involved	2456	2456
BAN0146	676430	6177906	House	Not Involved	4701	4701
BAN0151	668634	6180610	House	Not Involved	4629	4568
BAN0152	674475	6171888	House	Not Involved	2623	2623
BAN0154	667088	6176107	House	Neighbour Agreement	1865	1864
BAN0155	666730	6176414	House	Neighbour Agreement	1445	1452
BAN0156	667971	6181512	House	Not Involved	4958	4890
BAN0157	671165	6180690	House	Not Involved	4436	4784
BAN0158	666936	6175290	House	Neighbour Agreement	2052	2101
BAN0159	667506	6168917	House	Involved	3195	3195
BAN0160	659484	6176196	House	Involved	1682	1682
BAN0161	659100	6172993	House	Involved	3196	3196
BAN0162	660074	6173884	House	Involved	2281	2281
BAN0164	667492	6168869	House	Involved	3226	3226
BAN0165	667447	6168827	House	Not Involved	3234	3234
BAN0166	667440	6168580	House	Not Involved	3437	3437
BAN0170	669036	6176903	House	Not Involved	2800	2800
BAN0172	670575	6166155	House	Neighbour Agreement	1102	1226
BAN0173	674209	6165923	House	Involved	2511	2698
BAN0175	675807	6176676	House	Not Involved	3737	3737
BAN0176	665662	6180278	House	Not Involved	3054	2982
BAN0177	664441	6167689	House	Not Involved	3586	3586
BAN0179	663462	6168501	House	Not Involved	2567	2567
BAN0181	661493	6168919	House	Not Involved	2738	2738
BAN0182	660693	6170348	House	Involved	2365	2589
BAN0186	663707	6167018	House	Not Involved	4068	4068
BAN0187	661093	6169533	House	Not Involved	2500	2604
BAN0189	660065	6173665	House	Involved	2245	2245
BAN0192	674757	6179117	House	Not Involved	3934	4072
BAN0193	674918	6179085	House	Not Involved	4027	4154
BAN0194	675167	6179174	House	Not Involved	4270	4388

Name	Coordinates (WGS84 map datum)		Type	Land Owner Status	Distance to Closest Turbine	
	Easting	Easting			Layout 1	Layout 2
BAN0195	675226	6179171	House	Not Involved	4313	4427
BAN0196	675140	6178992	House	Not Involved	4131	4239
BAN0197	675044	6178926	House	Not Involved	4015	4125
BAN0199	675173	6178904	House	Not Involved	4101	4202
BAN0200	675001	6178881	House	Not Involved	3953	4063
BAN0201	674855	6178911	House	Not Involved	3863	3983
BAN0202	674747	6178931	House	Not Involved	3797	3925
BAN0203	675110	6178839	House	Not Involved	4011	4112
BAN0204	675108	6178813	House	Not Involved	3993	4092
BAN0205	675089	6178767	House	Not Involved	3950	4047
BAN0206	675075	6178725	House	Not Involved	3913	4009
BAN0207	675074	6178680	Empty House	Not Involved	3885	3978
BAN0208	675135	6178723	House	Not Involved	3959	4051
BAN0209	675153	6178822	House	Not Involved	4034	4131
BAN0211	675151	6178659	House	Not Involved	3933	4020
BAN0212	674876	6178540	House	Not Involved	3642	3737
BAN0213	675036	6178487	House	Not Involved	3740	3821
BAN0214	675071	6178610	House	Not Involved	3840	3928
BAN0215	674828	6178554	House	Not Involved	3613	3711
BAN0216	675205	6178610	House	Not Involved	3948	4029
BAN0217	674575	6178684	House	Not Involved	3503	3626
BAN0218	674771	6179018	House	Not Involved	3874	4006
BAN0219	675138	6178783	House	Not Involved	3998	4094
BAN0220	674826	6178902	House	Not Involved	3835	3957
BAN0222	657693	6175627	House	Not Involved	3552	3552
BAN0225	662546	6179407	House	Involved	972	972
BAN0226	659597	6185218	House	Not Involved	3712	3758
BAN0235	663846	6169475	House	Not Involved	1705	1705
BAN0238	670657	6166162	House	Neighbour Agreement	1044	1169
BAN0240	670166	6180328	House	Not Involved	4390	4748
BAN0242	674817	6178853	House	Not Involved	3796	3915
BAN0243	674789	6172958	House	Not Involved	3246	3246
BAN0244	661532	6186855	House	Not Involved	4850	4915
BAN0260	661457	6169844	House	Not Involved	2023	2127
BAN0261	675543	6178452	House	Not Involved	4147	4199

Name	Coordinates (WGS84 map datum)		Type	Land Owner Status	Distance to Closest Turbine	
	Easting	Easting			Layout 1	Layout 2
BAN0268	676122	6178072	House	Not Involved	4493	4495
BAN0269	675576	6178658	House	Not Involved	4283	4348
BAN0270	675143	6178758	House	Not Involved	3987	4081
BAN0271	674973	6178572	House	Not Involved	3739	3830
BAN0272	674943	6178864	House	Not Involved	3898	4010
BAN0273	675057	6178877	House	Not Involved	3994	4100
BAN0274	674876	6178488	House	Not Involved	3611	3702
BAN0275	674880	6178577	House	Not Involved	3668	3765
BAN0279	675053	6178552	House	Not Involved	3792	3876
BAN0280	664102	6166698	New Cabin	Not Involved	4448	4448
BAN0282	666714	6178407	House - DA	Not Involved	1711	1653
BAN0283	661980	6184698	House - DA	Not Involved	2743	2810

APPENDIX C: SECRETARY'S ENVIRONMENTAL ASSESSMENT REQUIREMENTS

Noise and Vibration – the EIS must:

- include a comprehensive noise assessment of all phases and components of the project taking into account cumulative impacts from surrounding approved or operational wind farms in the locality including: turbine operation, the operation of the electrical substation, corona and / or Aeolian noise from the transmission line, construction noise (focusing on high noise-generating construction scenarios and works 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 (e.g. tonality, impulsiveness, low frequency 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 (ie. 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 at background noise levels higher than 30 dB(A);
- consider special audible characteristics, including tonality, amplitude modulation, and low frequency noise (apply penalties where relevant), and identify any risks with respect to tonal, low frequency or infra-noise;
- clearly outline the noise mitigation, monitoring and management measures that would be applied to the project, including an assessment of the feasibility, effectiveness and reliability of proposed measures and any residual impacts after these measures have been incorporated;
- 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 matters are covered by any such agreements; and
- include a contingency strategy that provides for additional noise attenuation should higher noise levels than those predicted result following commissioning and / or should noise agreements with landowners not eventuate.

The noise assessment must be undertaken in a manner that is consistent with the following guidelines:

- Wind Turbines – the South Australian Environment Protection Authority's *Wind Farms: Environmental Noise Guidelines (2009)* with a base criteria of 35 dB(A) or background plus 5 dB, whichever is greater;
- Substation – *NSW Industrial Noise Policy* (EPA, 2000);
- Site Establishment and Construction – *Interim Construction Noise Guidelines* (DECC, 2009);
- Traffic Noise – *NSW Road Noise Policy* (DECCW 2011); and
- Vibration – *Assessing Vibration: A Technical Guideline* (DECC, 2006).

APPENDIX D: PHOTOGRAPHS OF LOGGING EQUIPMENT

Noise Logger at BAN009

Noise Logger at BAN0032

Noise Logger at BAN0034

Noise Logger at BAN0048

Noise Logger at BAN0060

Noise Logger at BAN0076

Noise Logger at BAN0115

Noise Logger at BAN0136

Noise Logger at BAN0144

Noise Logger at BAN0152

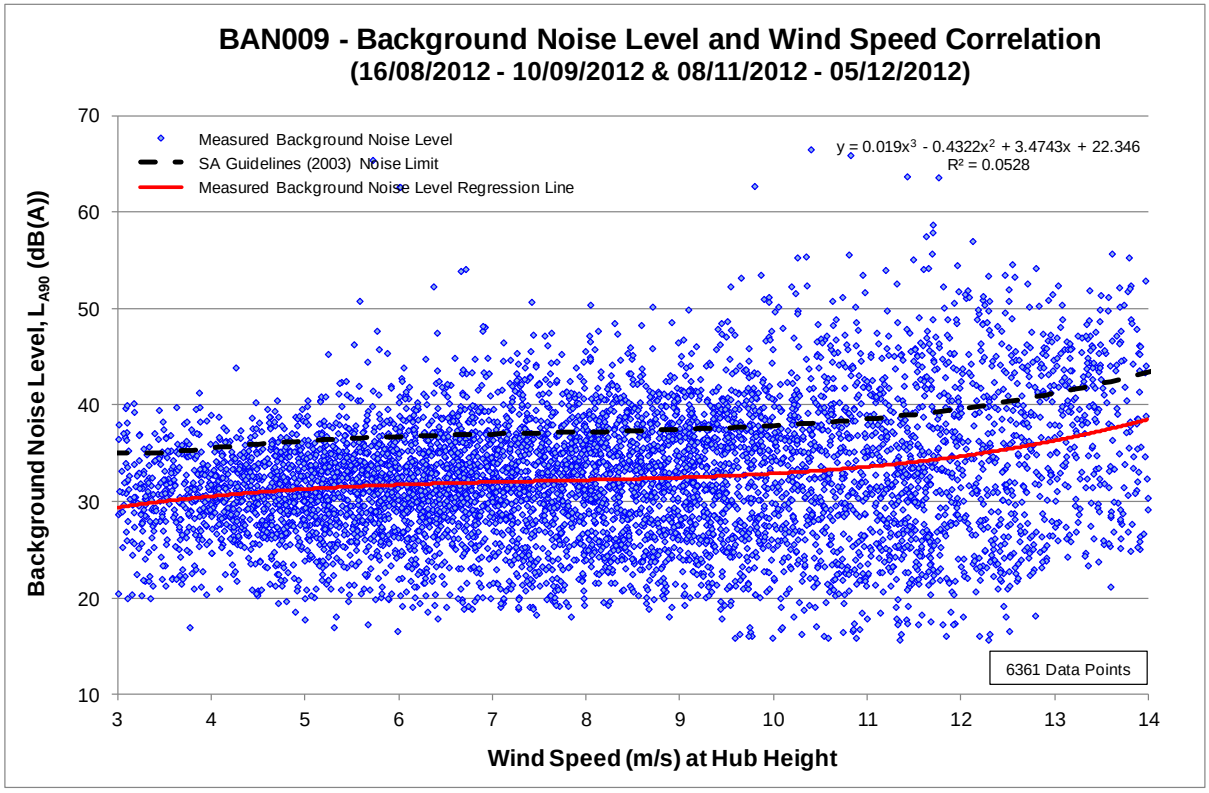
Noise Logger at BAN0155

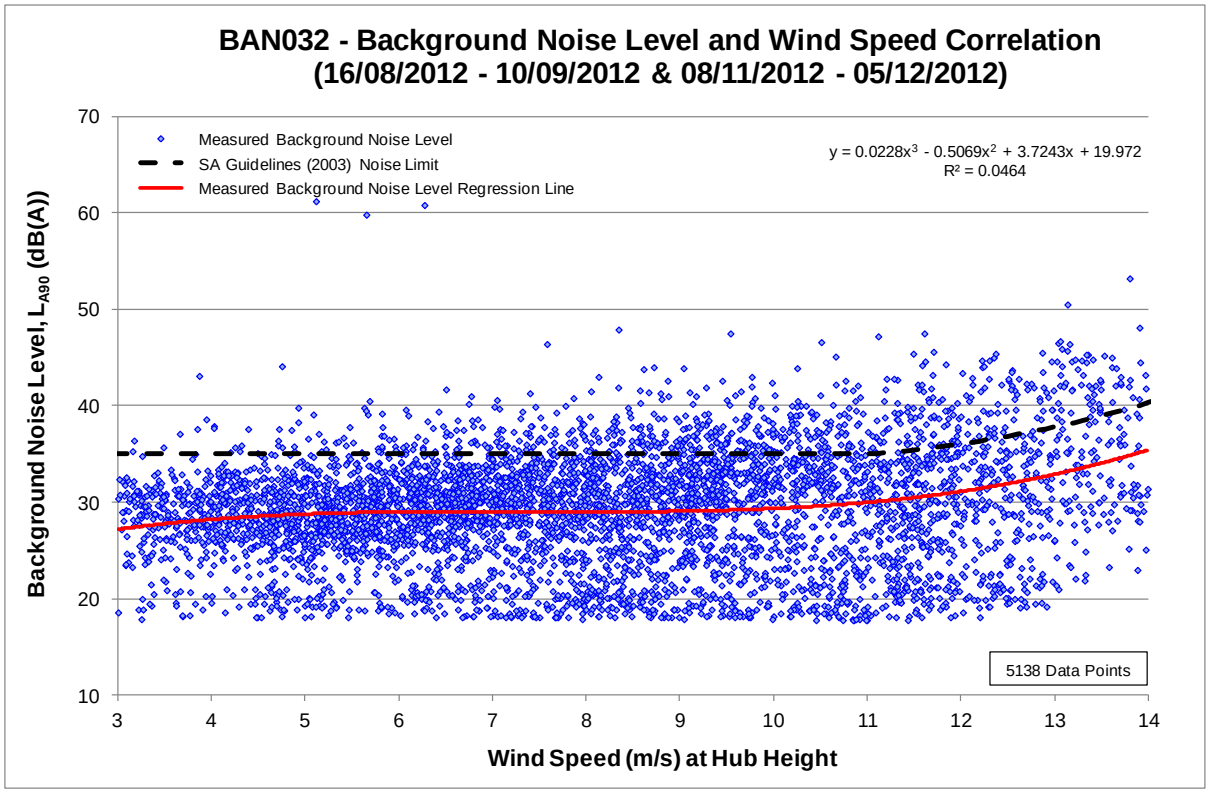
Noise Logger at BAN0158

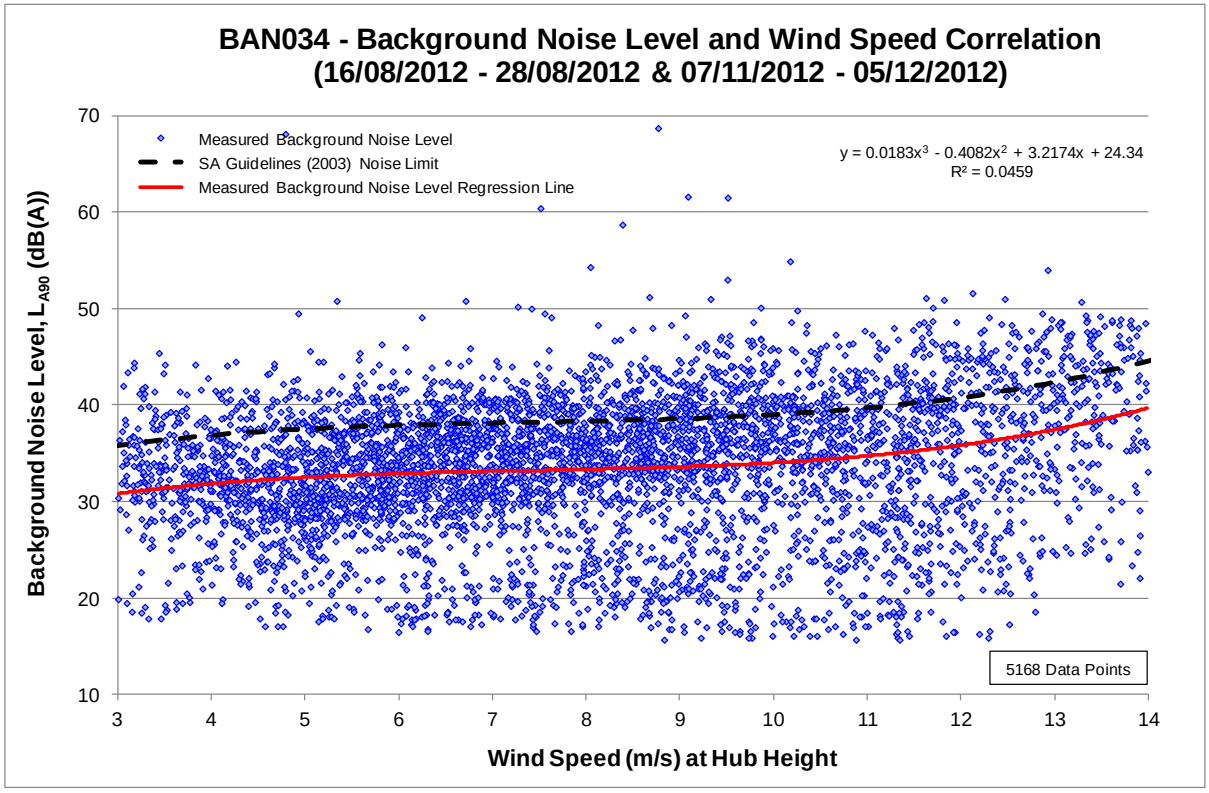
Noise Logger at BAN0159

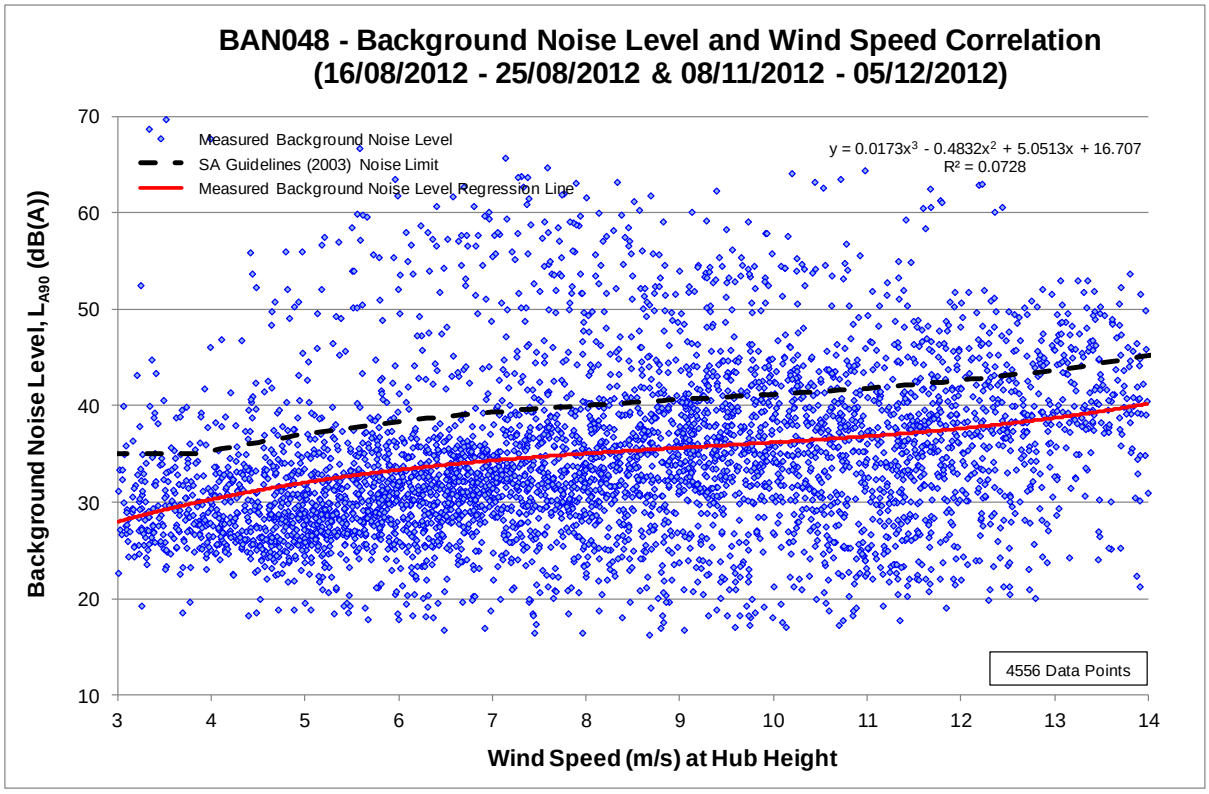
Noise Logger at BAN0170

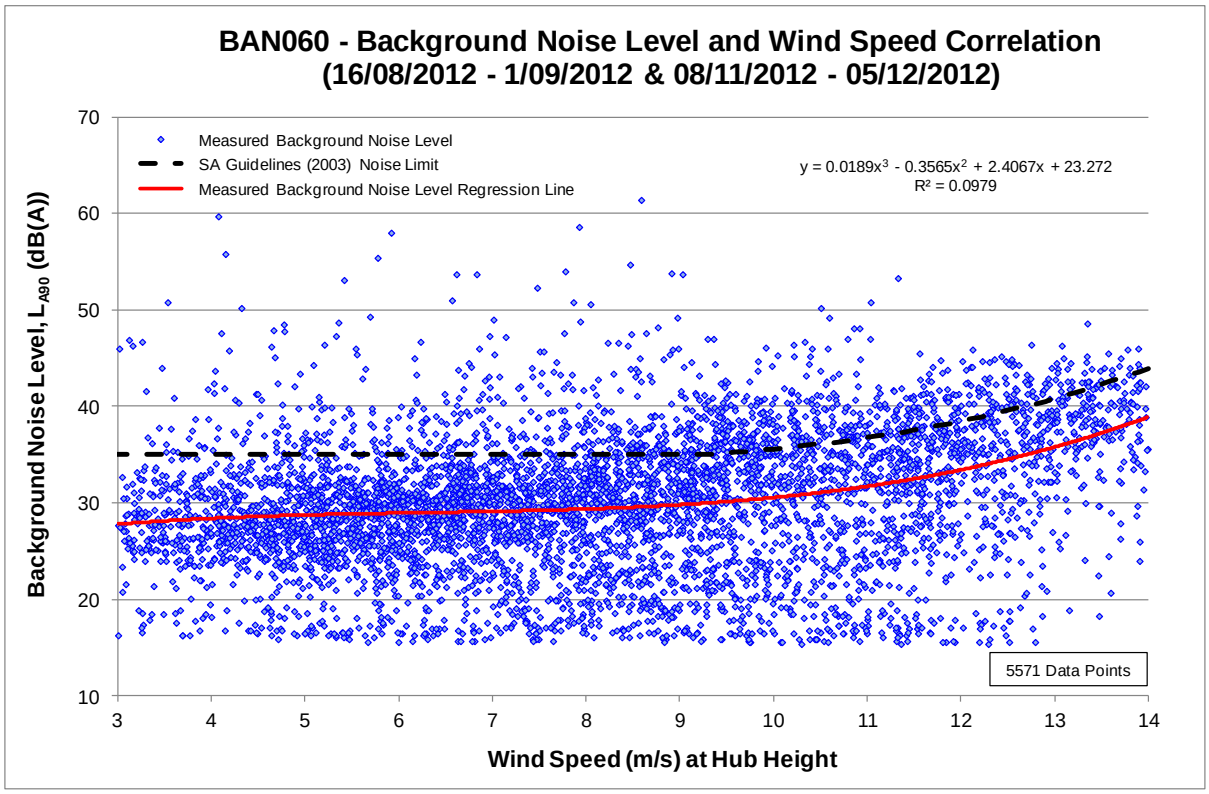
APPENDIX E: REGRESSION ANALYSIS – SA GUIDELINES

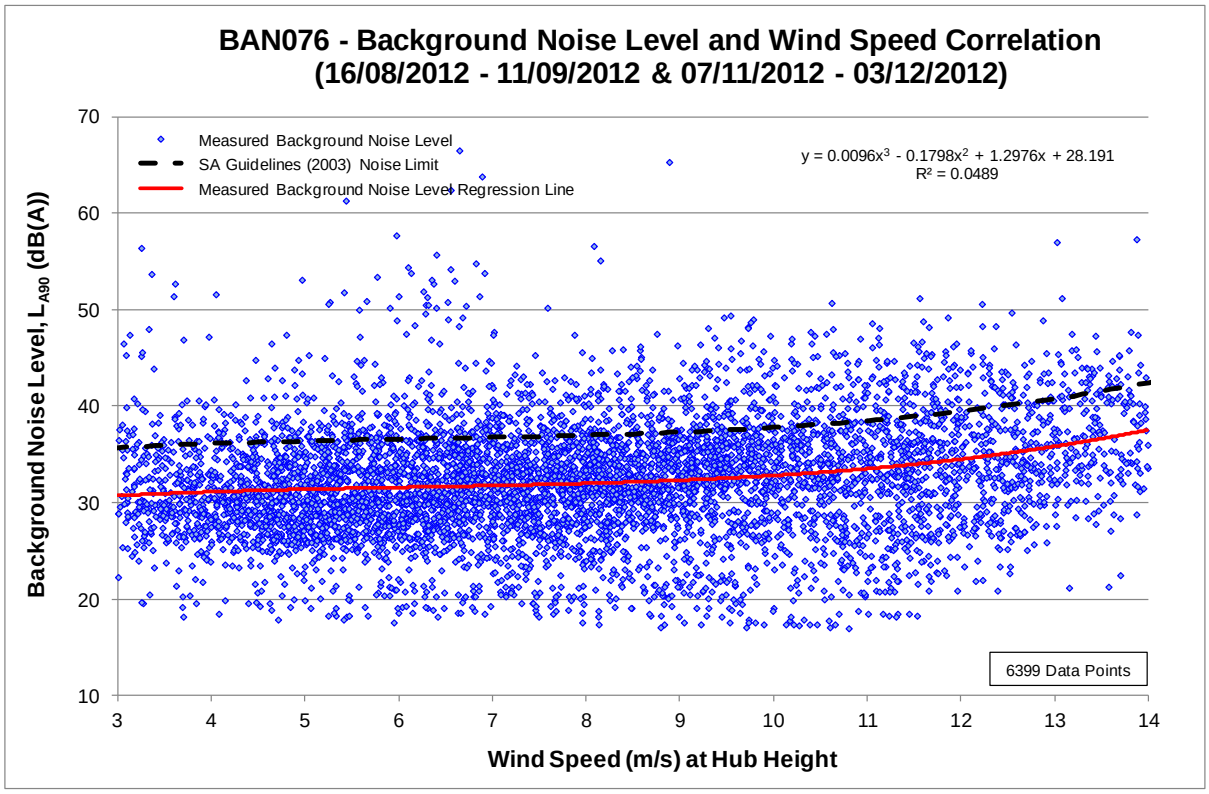


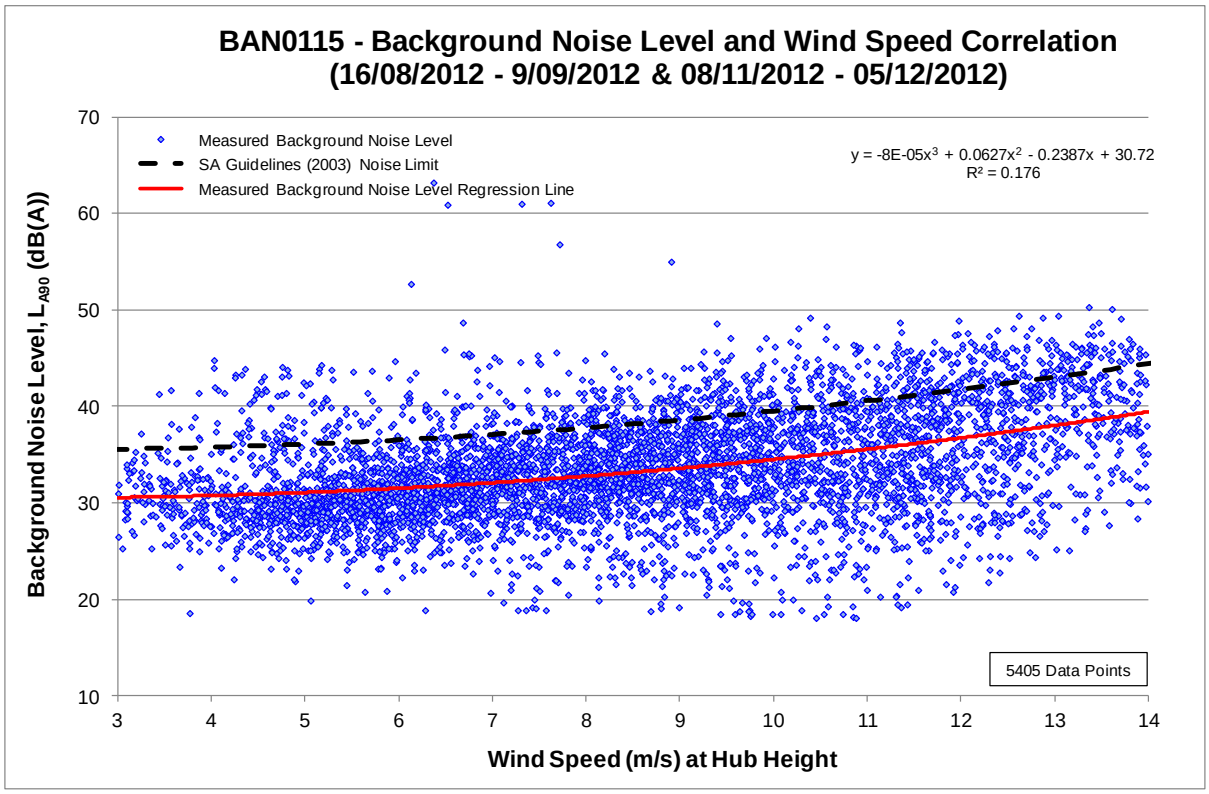


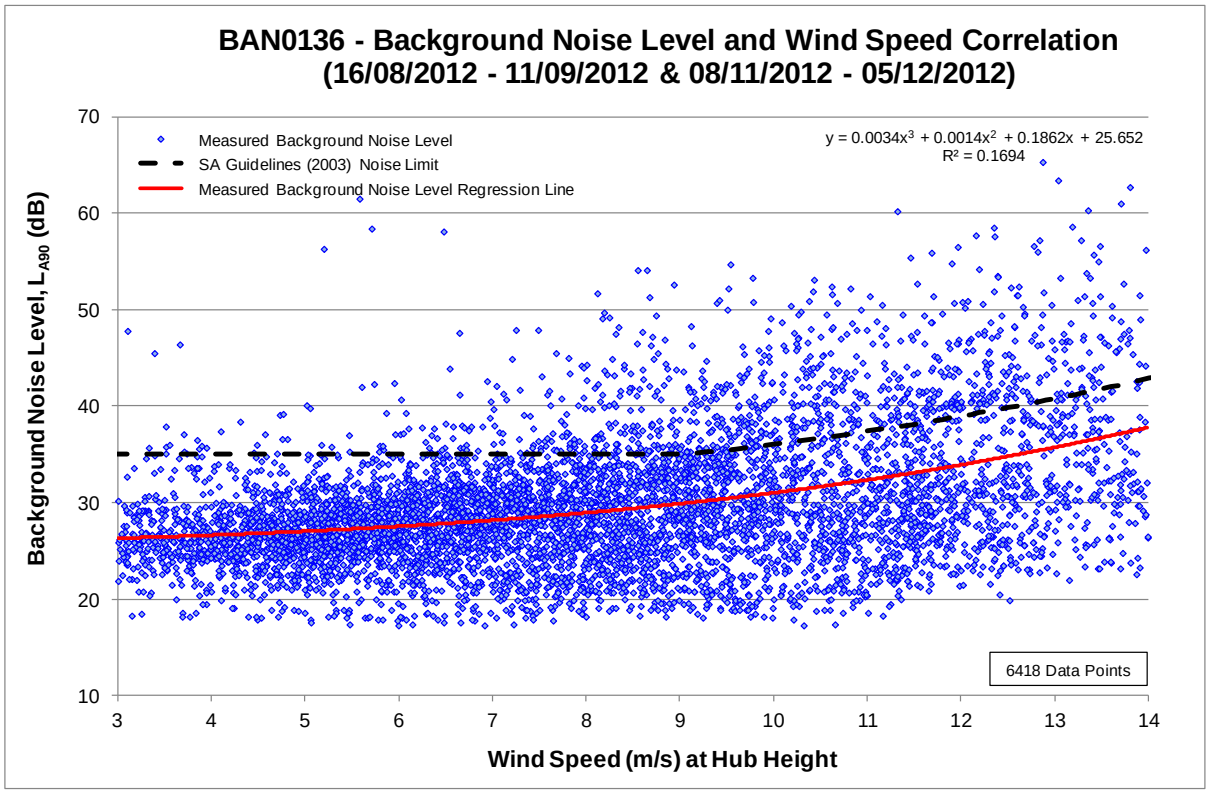

BAN034 - Background Noise Level and Wind Speed Correlation
(16/08/2012 - 28/08/2012 & 07/11/2012 - 05/12/2012)
Measured Background Noise Level
SA Guidelines (2003) Noise Limit
Measured Background Noise Level Regression Line
y = 0.0183x3 - 0.4082x2 + 3.2174x + 24.34
R² = 0.0459
5168 Data Points
Background Noise Level, LA90 (dB(A))
Wind Speed (m/s) at Hub Height
70
60
50
40
30
20
10
3
4
5
6
7
8
9
10
11
12
13
14

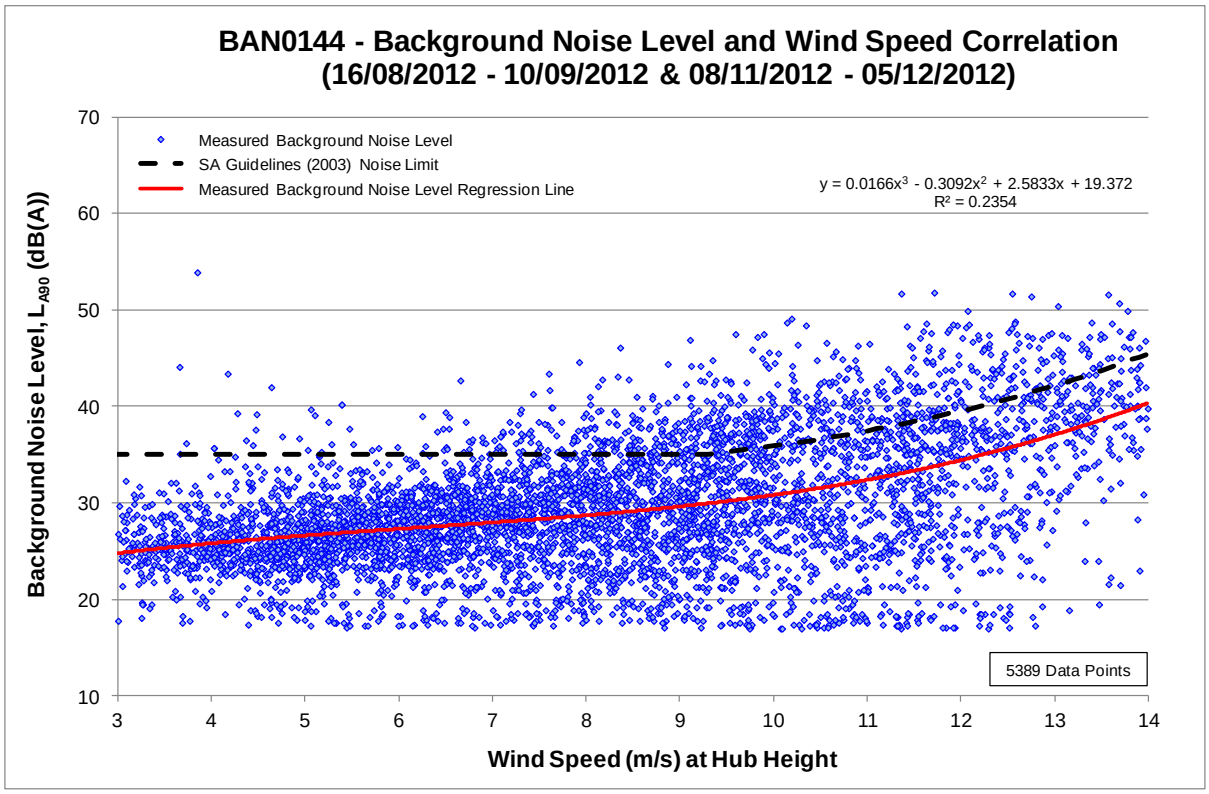

BAN048 - Background Noise Level and Wind Speed Correlation
(16/08/2012 - 25/08/2012 & 08/11/2012 - 05/12/2012)
Measured Background Noise Level
SA Guidelines (2003) Noise Limit
Measured Background Noise Level Regression Line
y = 0.0173x3 - 0.4832x2 + 5.0513x + 16.707
R² = 0.0728
4556 Data Points
Background Noise Level, LA90 (dB(A))
Wind Speed (m/s) at Hub Height
70
60
50
40
30
20
10
3
4
5
6
7
8
9
10
11
12
13
14

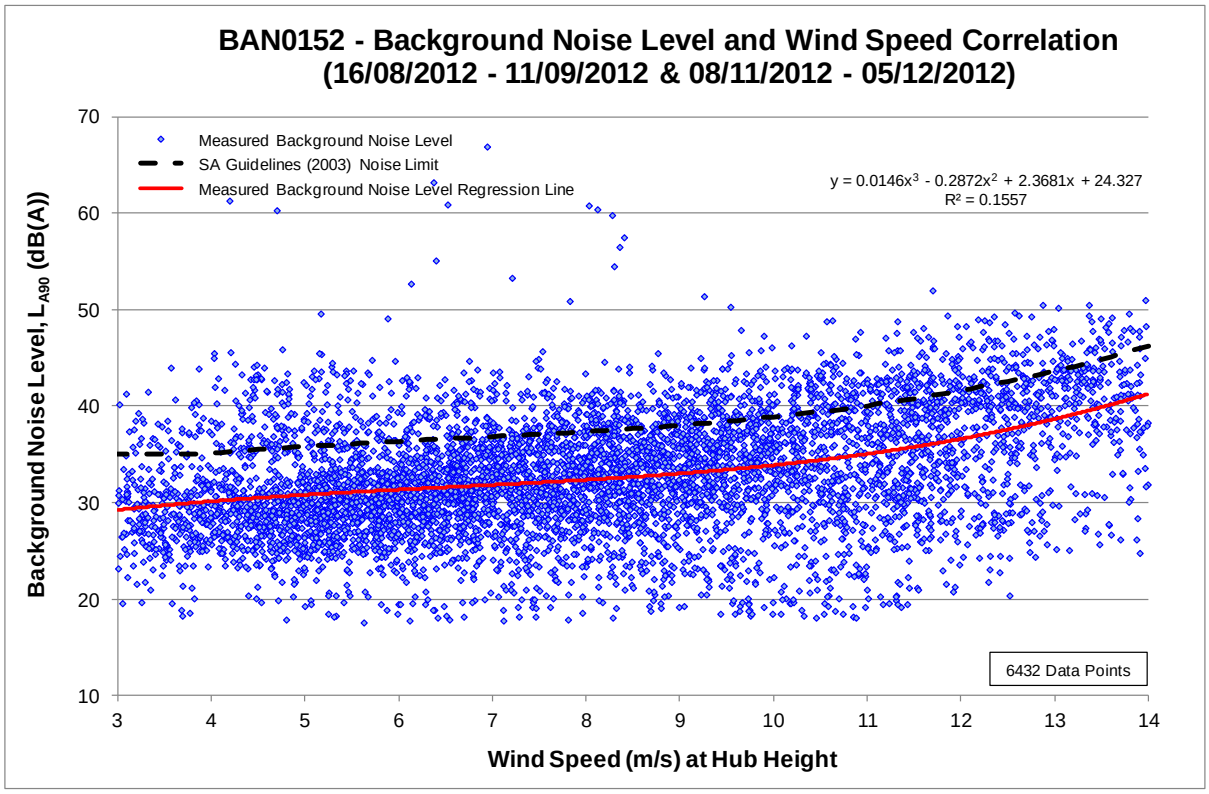

BAN060 - Background Noise Level and Wind Speed Correlation
(16/08/2012 - 1/09/2012 & 08/11/2012 - 05/12/2012)
Measured Background Noise Level
SA Guidelines (2003) Noise Limit
Measured Background Noise Level Regression Line
y = 0.0189x3 - 0.3565x2 + 2.4067x + 23.272
R² = 0.0979
5571 Data Points
Background Noise Level, LA90 (dB(A))
Wind Speed (m/s) at Hub Height

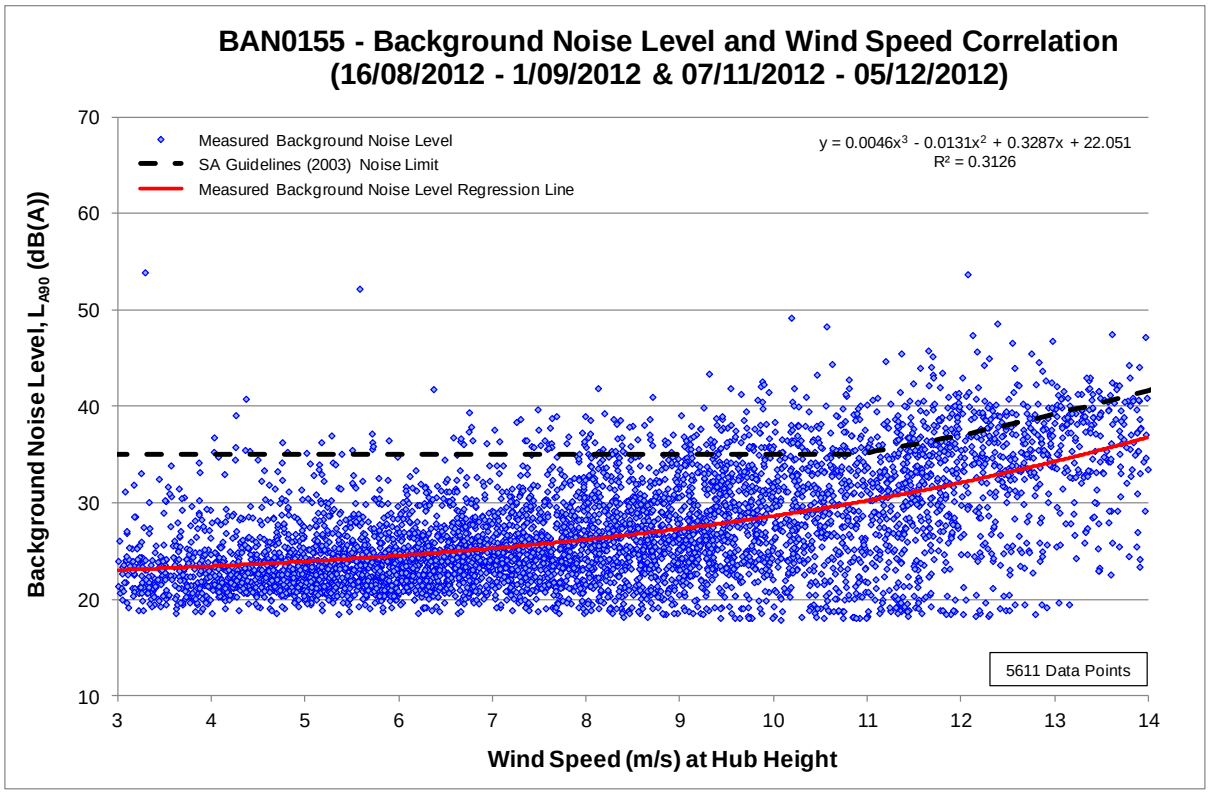

BAN076 - Background Noise Level and Wind Speed Correlation
(16/08/2012 - 11/09/2012 & 07/11/2012 - 03/12/2012)
Measured Background Noise Level
SA Guidelines (2003) Noise Limit
Measured Background Noise Level Regression Line
y = 0.0096x3 - 0.1798x2 + 1.2976x + 28.191
R² = 0.0489
6399 Data Points
Background Noise Level, LA90 (dB(A))
Wind Speed (m/s) at Hub Height

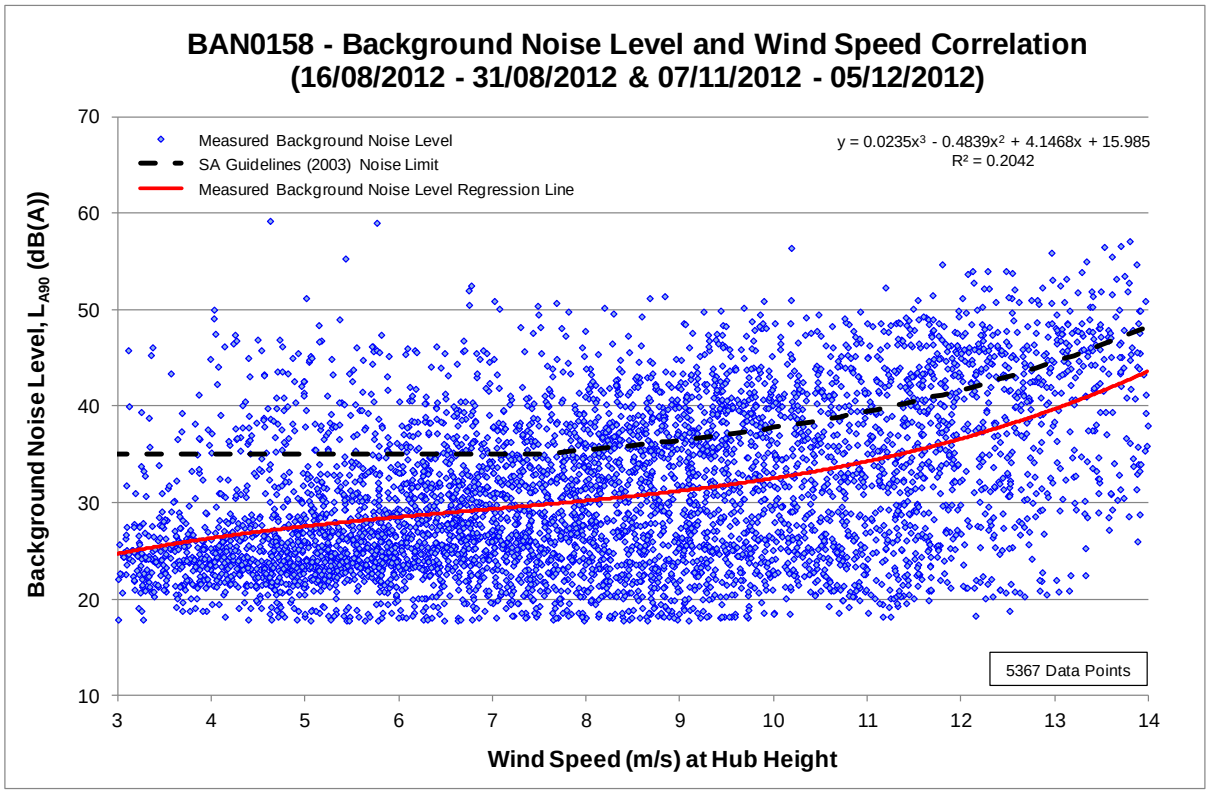

BAN0115 - Background Noise Level and Wind Speed Correlation
(16/08/2012 - 9/09/2012 & 08/11/2012 - 05/12/2012)
Measured Background Noise Level
SA Guidelines (2003) Noise Limit
Measured Background Noise Level Regression Line
y = -8E-05x³ + 0.0627x² - 0.2387x + 30.72
R² = 0.176
5405 Data Points
Background Noise Level, LA90 (dB(A))
Wind Speed (m/s) at Hub Height
70
60
50
40
30
20
10
3
4
5
6
7
8
9
10
11
12
13
14

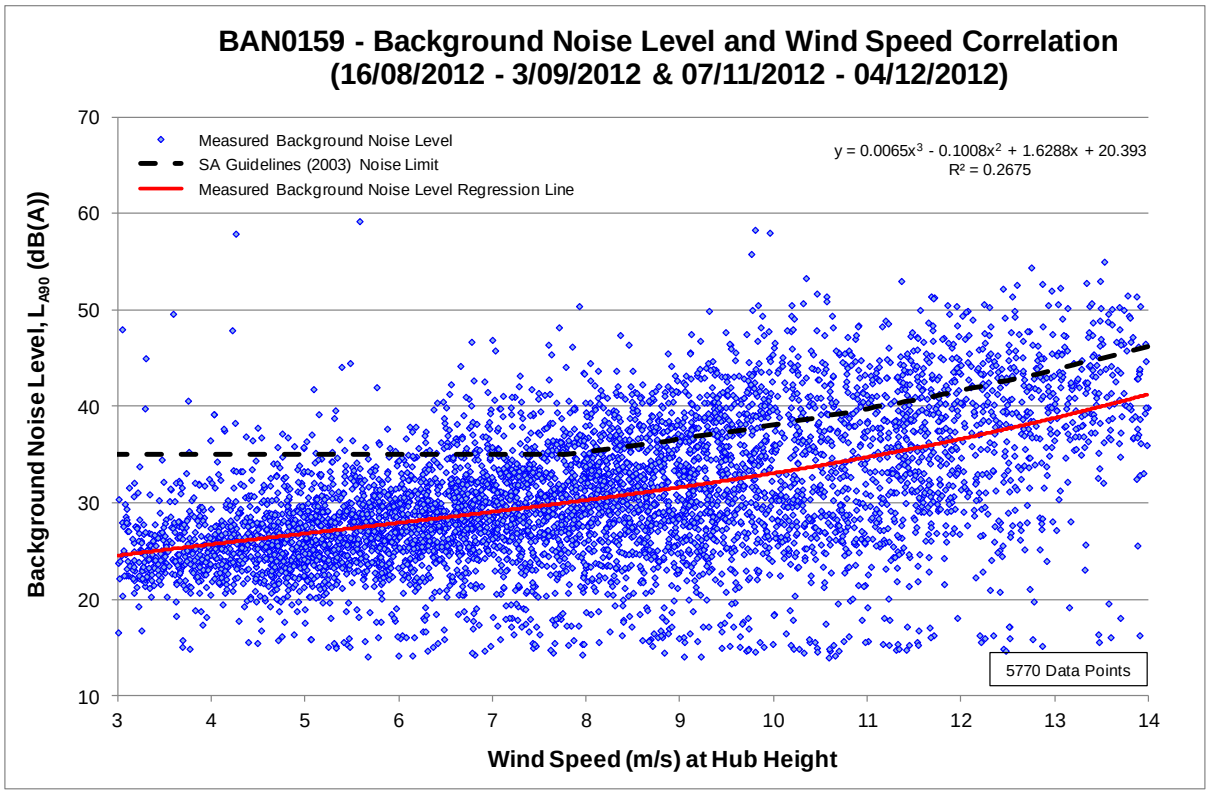

BAN0136 - Background Noise Level and Wind Speed Correlation
(16/08/2012 - 11/09/2012 & 08/11/2012 - 05/12/2012)
Measured Background Noise Level
SA Guidelines (2003) Noise Limit
Measured Background Noise Level Regression Line
y = 0.0034x³ + 0.0014x² + 0.1862x + 25.652
R² = 0.1694
6418 Data Points
Background Noise Level, LA90 (dB)
Wind Speed (m/s) at Hub Height
70
60
50
40
30
20
10
3
4
5
6
7
8
9
10
11
12
13
14

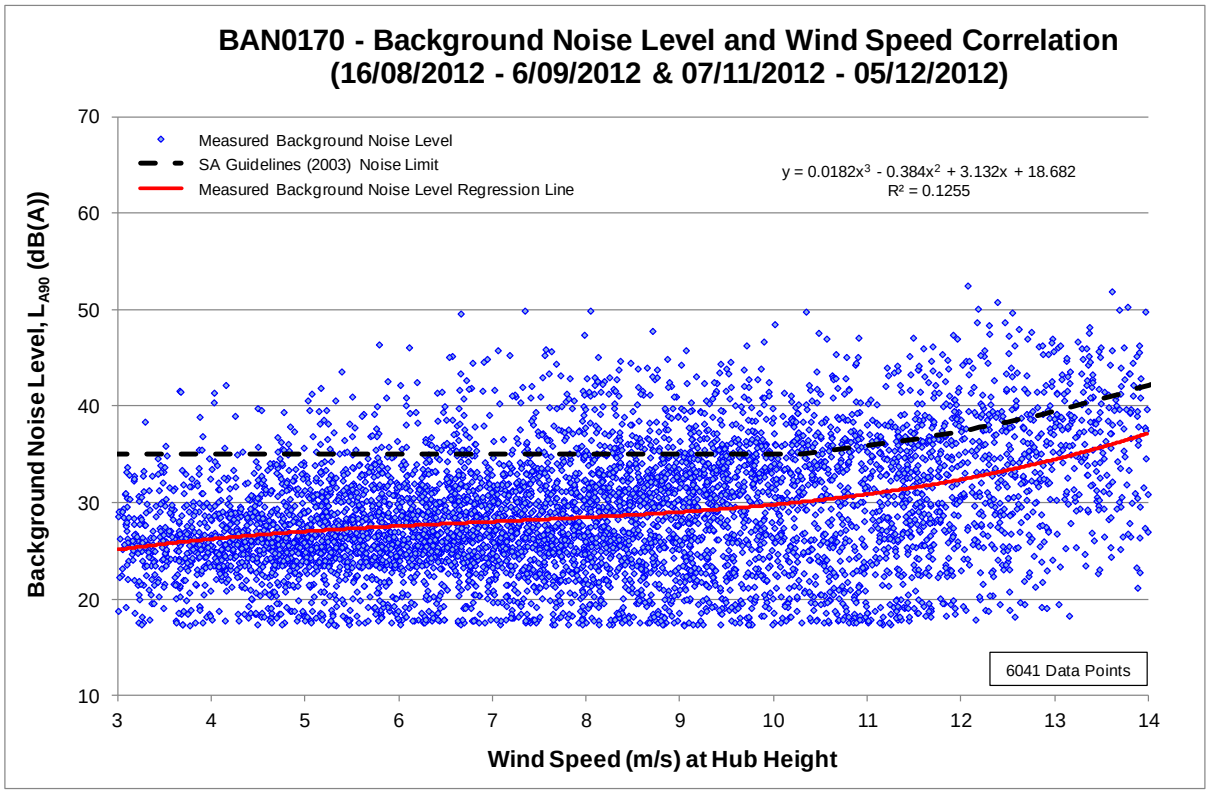

BAN0144 - Background Noise Level and Wind Speed Correlation
(16/08/2012 - 10/09/2012 & 08/11/2012 - 05/12/2012)
Measured Background Noise Level
SA Guidelines (2003) Noise Limit
Measured Background Noise Level Regression Line
y = 0.0166x3 - 0.3092x2 + 2.5833x + 19.372
R² = 0.2354
5389 Data Points
Background Noise Level, LA90 (dB(A))
Wind Speed (m/s) at Hub Height

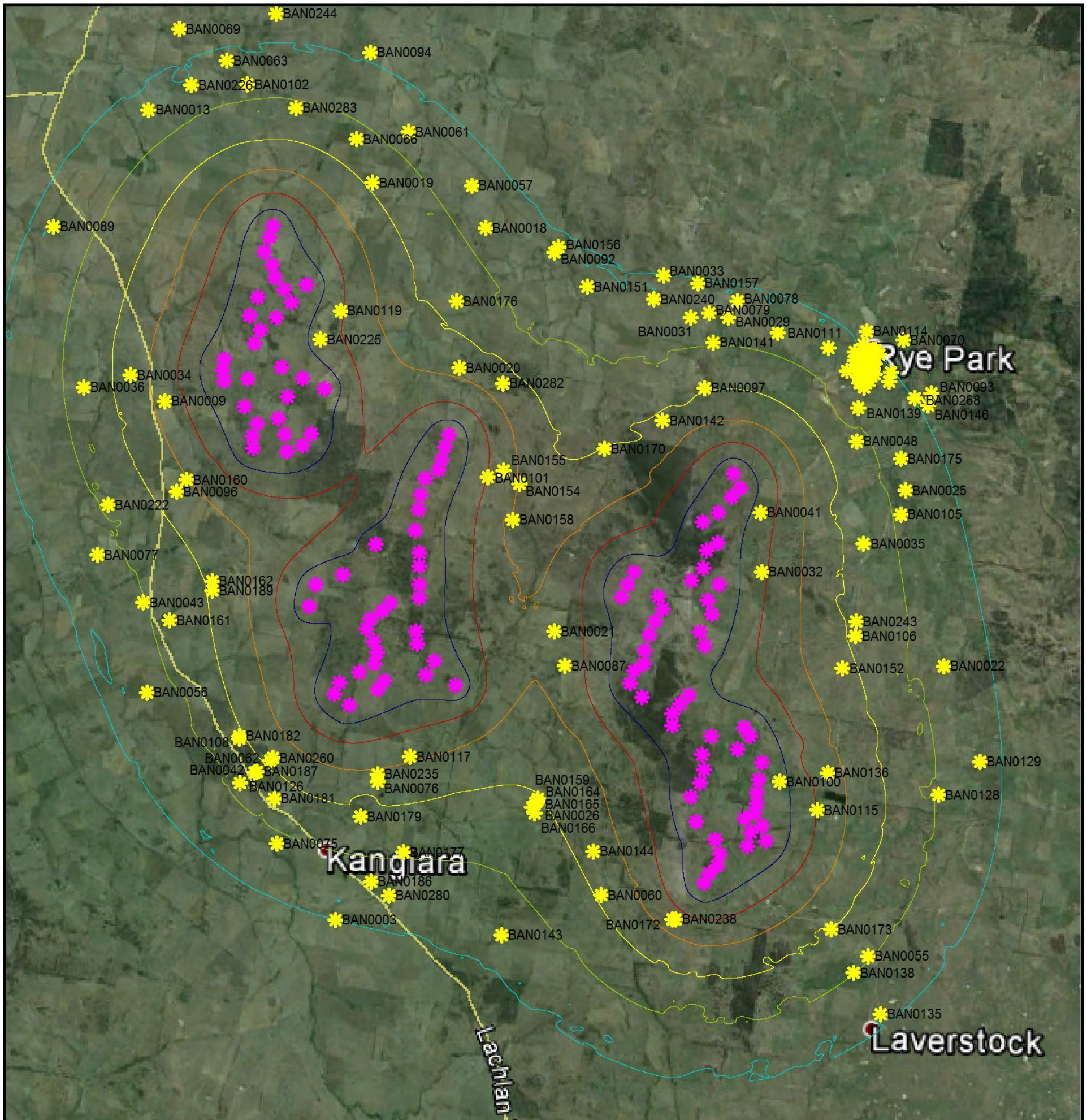

BAN0152 - Background Noise Level and Wind Speed Correlation
(16/08/2012 - 11/09/2012 & 08/11/2012 - 05/12/2012)
Measured Background Noise Level
SA Guidelines (2003) Noise Limit
Measured Background Noise Level Regression Line
y = 0.0146x3 - 0.2872x2 + 2.3681x + 24.327
R² = 0.1557
6432 Data Points
Background Noise Level, LA90 (dB(A))
Wind Speed (m/s) at Hub Height


BAN0155 - Background Noise Level and Wind Speed Correlation
(16/08/2012 - 1/09/2012 & 07/11/2012 - 05/12/2012)
Measured Background Noise Level
SA Guidelines (2003) Noise Limit
Measured Background Noise Level Regression Line
y = 0.0046x3 - 0.0131x2 + 0.3287x + 22.051
R² = 0.3126
5611 Data Points
Background Noise Level, LA90 (dB(A))
Wind Speed (m/s) at Hub Height
70
60
50
40
30
20
10
3
4
5
6
7
8
9
10
11
12
13
14


BAN0158 - Background Noise Level and Wind Speed Correlation
(16/08/2012 - 31/08/2012 & 07/11/2012 - 05/12/2012)
Measured Background Noise Level
SA Guidelines (2003) Noise Limit
Measured Background Noise Level Regression Line
y = 0.0235x3 - 0.4839x2 + 4.1468x + 15.985
R² = 0.2042
5367 Data Points
Background Noise Level, LA90 (dB(A))
Wind Speed (m/s) at Hub Height
70
60
50
40
30
20
10
3
4
5
6
7
8
9
10
11
12
13
14


BAN0159 - Background Noise Level and Wind Speed Correlation
(16/08/2012 - 3/09/2012 & 07/11/2012 - 04/12/2012)
Measured Background Noise Level
SA Guidelines (2003) Noise Limit
Measured Background Noise Level Regression Line
y = 0.0065x³ - 0.1008x² + 1.6288x + 20.393
R² = 0.2675
5770 Data Points
Background Noise Level, LA90 (dB(A))
Wind Speed (m/s) at Hub Height
70
60
50
40
30
20
10
3
4
5
6
7
8
9
10
11
12
13
14


BAN0170 - Background Noise Level and Wind Speed Correlation
(16/08/2012 - 6/09/2012 & 07/11/2012 - 05/12/2012)
Measured Background Noise Level
SA Guidelines (2003) Noise Limit
Measured Background Noise Level Regression Line
y = 0.0182x³ - 0.384x² + 3.132x + 18.682
R² = 0.1255
6041 Data Points
Background Noise Level, LA90 (dB(A))
Wind Speed (m/s) at Hub Height
70
60
50
40
30
20
10
3
4
5
6
7
8
9
10
11
12
13
14



Noise Level
dB(A)

= 20
= 25
= 30
= 35
= 40
= 45

Legend

Wind Turbines

Residences

Scale
0 1 2 4 km

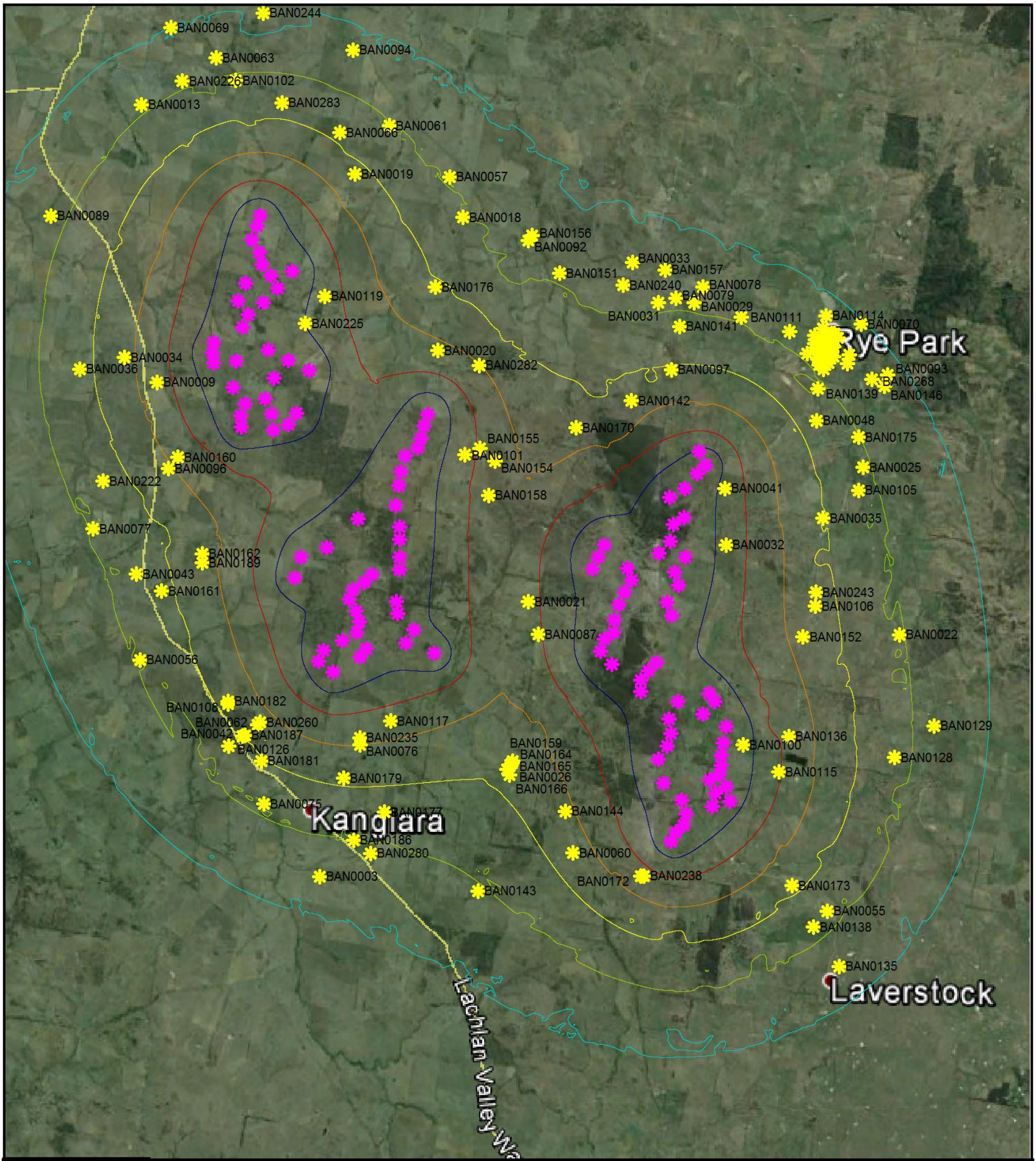
N

Bango Wind Farm Layout 1

10m/s Hub Height Wind Speed Grid Noise Map

CONCAWE
Worst Case
Weather Conditions

Sonus


BAN0244
BAN0069
BAN0094
BAN0063
BAN0226
BAN0102
BAN0013
BAN0283
BAN0066
BAN0061
BAN0019
BAN0057
BAN0089
BAN0018
BAN0156
BAN0092
BAN0033
BAN0157
BAN0151
BAN0240
BAN0078
BAN0079
BAN0029
BAN0031
BAN0111
BAN0114
BAN0070
BAN0141
Rye Park
BAN0119
BAN0176
BAN0225
BAN0020
BAN0282
BAN0034
BAN0036
BAN0009
BAN0097
BAN0093
BAN0268
BAN0139
BAN0146
BAN0142
BAN0048
BAN0170
BAN0175
BAN0155
BAN0101
BAN0154
BAN0160
BAN0096
BAN0222
BAN0025
BAN0158
BAN0041
BAN0105
BAN0035
BAN0077
BAN0032
BAN0162
BAN0189
BAN0043
BAN0161
BAN0243
BAN0106
BAN0021
BAN0087
BAN0152
BAN0022
BAN0056
BAN0182
BAN0108
BAN0062
BAN0260
BAN0117
BAN0042
BAN0187
BAN0235
BAN0126
BAN0076
BAN0159
BAN0164
BAN0165
BAN0026
BAN0166
BAN0136
BAN0100
BAN0129
BAN0128
BAN0115
BAN0181
BAN0179
BAN0075
BAN0177
Kangiara
BAN0144
BAN0186
BAN0280
BAN0060
BAN0003
BAN0172
BAN0238
BAN0143
BAN0173
BAN0055
BAN0138
BAN0135
Laverstock
Lachlan Valley Way
Noise Level
dB(A)
= 20
= 25
= 30
= 35
= 40
= 45
Legend
Wind Turbines
Residences
Scale
0 1 2 4 km
N
Bango
Wind Farm
Layout 2
12m/s Hub Height
Wind Speed
Grid Noise Map
CONCAWE
Worst Case
Weather Conditions
Sonus

Sonus Pty Ltd
17 Ruthven Avenue
ADELAIDE SA 5000
Phone: +61 8 8231 2100
Mobile: +61 417 845 720
ct@sonus.com.au
www.sonus.com.au
ABN: 67 882 843 130

Bango Wind Farm
&
Rye Park Wind Farm

Cumulative Environmental Noise Assessment

S4889C2
April 2016

TABLE OF CONTENTS

INTRODUCTION

Sonus has prepared environmental noise assessments for both the Bango Wind Farm for CWP Renewables and the Rye Park Wind Farm for Trustpower. These are detailed in reports “S3958C5” and “S3200C9” respectively. The wind farms are both located north of Yass and east of Boorowa, New South Wales (NSW).

Sonus has now been engaged to conduct a cumulative environmental noise assessment of these two wind farms.

The environmental noise assessment was commissioned to address the Secretary’s Environmental Assessment Requirements (SEARs) relating to operational noise for each project. The SEARs specify that the assessment of operational noise must be conducted in accordance with the South Australian Environment Protection Authority’s Wind Farms – Environmental Noise Guidelines (2009), with modified criteria used in New South Wales.

The assessment of operational noise has been based on a GE 3.4-130 wind turbine selection proposed for the Bango Wind Farm and Vestas V112 - 3.0 MW turbines being proposed for the Rye Park Wind Farm. The proposed locations of the turbines for each of the wind farms are provided in Appendix A, the sound power levels from the proposed turbines are provided in Appendix B and a description of the noise model is provided in Appendix C.

APPROACH

The SEARs for each project require operational noise to be assessed against the South Australian Environment Protection Authority's *Wind Farms – Environmental Noise Guidelines 2009* (the SA Guidelines) with a baseline criterion of 35 dB(A). That is, the noise from each wind farm should be no greater than:

- 35 dB(A) or
- 5 dB(A) above the background noise level

at each integer hub height wind speed when measured at a sensitive receptor.

In addition to considering the noise from each project, the SEARs require that a cumulative assessment be conducted to determine if the noise from one project, when added to the noise from the second project, would result in the criteria being exceeded.

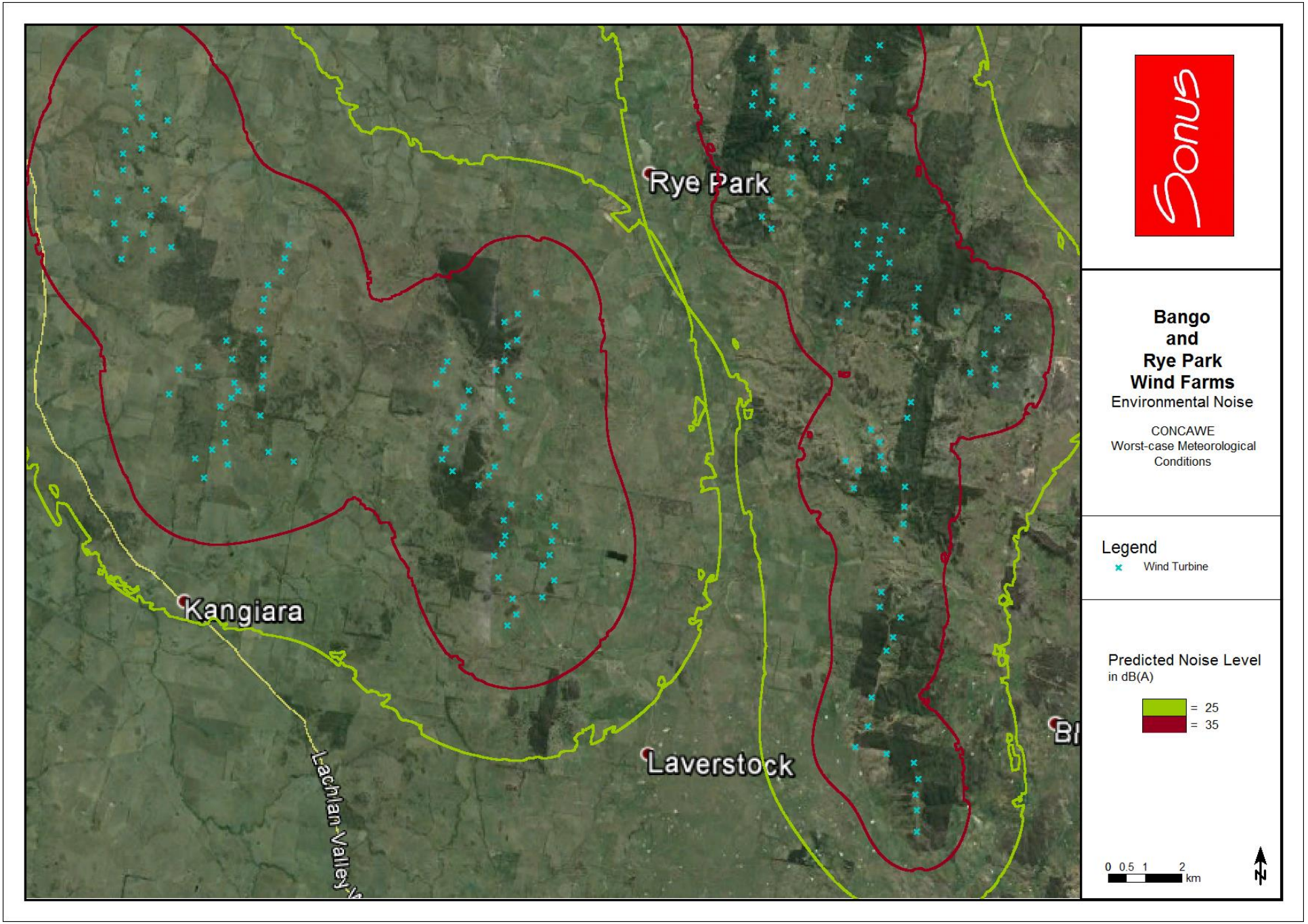
In circumstances where both projects have the same hub height, the cumulative noise can be predicted for each hub height integer wind speed and compared with the criteria developed for each project. However, where the hub heights of the projects are different, the criteria (which are based on the hub height wind speed) for each project would also be different, resulting in a potentially difficult interpretation of compliance.

A conservative approach (resulting in a potential overestimate of cumulative noise levels) is to predict the noise based on the highest sound power level produced by the turbines of each project and assume that a resiodence located between the two wind farms can be downwind from both wind farms at the same time. The conservative cumulative effect can then be considered by determining how much the noise from one project increases the predicted noise from the other, and vice versa. By way of example only, the table below shows the logarithmic addition of the predicted noise from one arbitrary project (at the limit of 35 dB(A)) with the noise from a second arbitrary project:

Example predicted noise level		Cumulative noise level
Project 1	**Project 2**	
35 dB(A)	35 dB(A)	38 dB(A)
35 dB(A)	34 dB(A)	38 dB(A)
35 dB(A)	33 dB(A)	37 dB(A)
35 dB(A)	32 dB(A)	37 dB(A)
35 dB(A)	31 dB(A)	36 dB(A)
35 dB(A)	30 dB(A)	36 dB(A)
35 dB(A)	29 dB(A)	36 dB(A)
35 dB(A)	28 dB(A)	36 dB(A)
35 dB(A)	27 dB(A)	36 dB(A)
35 dB(A)	26 dB(A)	36 dB(A)
35 dB(A)	25 dB(A)	35 dB(A)
35 dB(A)	24 dB(A)	35 dB(A)
35 dB(A)	23 dB(A)	35 dB(A)
35 dB(A)	22 dB(A)	35 dB(A)
35 dB(A)	21 dB(A)	35 dB(A)
35 dB(A)	20 dB(A)	35 dB(A)

The table shows that if the noise from one project is at the limit of 35 dB(A) then a second project must contribute 25 dB(A) or less in order to conservatively maintain the cumulative level at 35 dB(A).

Based on the above, a 35 dB(A) and a 25 dB(A) contour has been produced for each wind farm and overlaid on a single aerial image. Provided the 25 dB(A) contour of one wind farm does not cross over the 35 dB(A) contour of the other wind farm, and each individual wind farm is compliant, then the cumulative noise will also be compliant.


Rye Park
Kangiara
Laverstock
Lachlan Valley
Sonus
Bango
and
Rye Park
Wind Farms
Environmental Noise
CONCAWE
Worst-case Meteorological
Conditions
Legend
Wind Turbine
Predicted Noise Level
in dB(A)
= 25
= 35
0 0.5 1 2
km
N

DISCUSSION

The predicted 35 dB(A) contour from the Bango Wind Farm is shown as a red contour on the western side and the 35 dB(A) contour from the Rye Park Wind Farm is shown as a red contour on the eastern side. The 25 dB(A) contours from each of the wind farms are shown as green contours.

The 25 dB(A) contour from the Rye Park Wind Farm does not cross the 35 dB(A) contour from the Bango Wind Farm and therefore the Rye Park Wind Farm will not add to the predicted noise from the Bango Wind Farm inside the 35 dB(A) contour. Therefore a compliant environmental noise assessment for the Bango Wind Farm will not be modified by the noise from the Rye Park Wind Farm.

The 25 dB(A) contour from the Bango Wind Farm does not cross the 35 dB(A) contour from the Rye Park Wind Farm and therefore the Bango Wind Farm will not add to the predicted noise from the Rye Park Wind Farm inside the 35 dB(A) contour. Therefore the environmental noise assessment for the Rye Park Wind Farm will not be modified by the noise from the Bango Wind Farm.

APPENDIX A: WIND TURBINE COORDINATES

Bango Wind Farm

Turbine ID	Coordinates (UTM WGS84 H44)	
	Easting	Northing
1	670,056	6,172,655
2	671,370	6,174,593
3	669,956	6,172,305
4	665,381	6,176,955
5	671,287	6,174,189
6	670,581	6,170,855
7	671,618	6,174,752
8	671,402	6,173,443
9	672,551	6,169,350
10	669,706	6,171,830
11	671,220	6,172,725
12	671,606	6,167,380
13	669,456	6,173,580
15	662,281	6,173,305
16	672,506	6,168,980
17	665,484	6,177,302
18	661,436	6,181,108
19	672,625	6,168,300
20	671,370	6,167,089
21	661,881	6,180,255
22	665,289	6,176,593
23	671,631	6,175,455
24	671,481	6,173,130
25	664,806	6,173,805
26	671,281	6,175,230
27	664,806	6,174,230
28	672,301	6,167,831
29	664,931	6,176,230
30	672,131	6,176,005
31	671,261	6,169,917
32	670,859	6,171,115

Turbine ID	Coordinates (UTM WGS84 H44)	
	Easting	Northing
33	671,656	6,173,805
34	670,190	6,172,964
35	661,038	6,179,320
37	661,341	6,181,554
38	661,656	6,178,780
39	664,944	6,171,739
41	671,006	6,168,951
42	663,781	6,172,005
43	664,756	6,173,455
44	671,506	6,167,805
45	664,721	6,172,733
47	661,531	6,179,905
48	664,831	6,175,855
49	663,856	6,171,405
50	671,054	6,173,944
51	671,465	6,170,340
52	672,310	6,168,689
53	662,230	6,180,655
54	671,217	6,169,267
55	663,656	6,172,955
56	665,621	6,171,497
57	663,806	6,174,730
58	660,806	6,177,880
59	663,756	6,172,505
61	663,056	6,174,030
62	660,319	6,178,696
63	669,634	6,173,944
64	669,615	6,171,540
65	661,031	6,179,755
66	672,635	6,169,745
68	663,431	6,171,805

Turbine ID	Coordinates (UTM WGS84 H44)	
	Easting	Northing
70	661,106	6,180,380
71	662,631	6,178,280
72	669,756	6,174,180
73	662,976	6,171,569
74	671,031	6,171,355
75	661,781	6,178,105
76	663,956	6,173,205
77	661,537	6,180,733
78	664,021	6,173,610
79	662,139	6,178,525
80	670,331	6,173,405
81	671,328	6,172,413
82	672,228	6,170,535
83	664,781	6,175,530
85	661,572	6,177,598
86	661,437	6,181,941
87	664,704	6,175,039
89	663,206	6,171,055
92	669,892	6,171,233
93	671,295	6,169,503
94	664,131	6,173,380
95	660,889	6,178,505
96	661,100	6,177,474
97	661,000	6,176,924
98	661,845	6,177,173
99	662,336	6,177,256
100	664,803	6,174,672
101	663,965	6,174,234
102	662,538	6,173,952
103	671,131	6,168,379

Rye Park Wind Farm

Turbine ID	Coordinates (UTM WGS84 H44)	
	Easting	Northing
1	676629	6186672
2	676471	6186291
3	676320	6185897
4	676320	6185509
5	677805	6185279
6	676377	6185158
7	677490	6184967
9	677384	6184591
11	677266	6184203
12	677322	6183750
16	677936	6182318
17	681368	6182678
18	678502	6182471
20	681054	6182312
21	678588	6181965
22	679549	6181989
25	679389	6181591
26	678511	6181575
28	678484	6181184
29	678385	6180840
30	679009	6180754
31	680367	6180463
32	678570	6180428
34	678899	6180032
35	679581	6180032
36	680242	6180109
37	678987	6179642
38	679645	6179648
39	680098	6179394
41	680008	6179119
42	680994	6179015
43	679027	6179114
44	678960	6178706
45	678438	6178498
47	678190	6178066
48	681515	6177825
49	681955	6177678

Turbine ID	Coordinates (UTM WGS84 H44)	
	Easting	Northing
50	681372	6177446
51	681355	6177078
52	681625	6176824
53	681153	6176713
56	681509	6176441
58	682400	6176161
61	680965	6176347
62	680830	6175999
63	682309	6175645
64	683431	6175508
65	684812	6175374
66	682384	6175319
67	680267	6175231
68	684506	6175044
69	682302	6174979
71	682195	6173075
72	682099	6172655
73	681120	6172346
74	681358	6172003
75	681388	6171634
76	680446	6171508
77	681464	6171283
78	680782	6171250
79	680673	6170767
80	682014	6170267
82	682004	6169806
83	681810	6169398
84	681373	6167591
85	681917	6167300
86	681730	6166773
87	681536	6166404
90	681137	6165157
93	681045	6164377
94	680716	6163813
95	681550	6163639
96	682288	6163400
97	682410	6162959

Turbine ID	Coordinates (UTM WGS84 H44)	
	Easting	Northing
98	682319	6162534
99	682358	6162122
101	682364	6161546
102	686233	6156685
103	685997	6156377
104	686150	6156084
119	683654	6152722
120	684987	6152789
122	683572	6152343
124	685103	6152217
125	684396	6152175
127	684307	6151723
128	683138	6151393
129	684402	6151298
130	683127	6151016
131	683001	6150684
133	678003	6181399
134	677946	6181062
135	679301	6180383
136	680809	6181821
137	680652	6181414
138	680607	6181022
139	680934	6177688
140	680771	6177337
141	680488	6175710
142	684592	6152523
143	681415	6167988
144	678465	6177749
145	686104	6154215
146	684178	6174388
147	684451	6173978
148	684474	6173545
149	683804	6173875
150	682052	6170803
151	677325	6185689

APPENDIX B: TURBINE SOUND POWER LEVELS

Bango Wind Farm – GE3.4-130 with a hub height of 120m

Hub Height Wind Speed (m/s)	SWL (dB(A)) for each Octave Band Centre Frequency								Total SWL (dB(A))
	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	
3	78	87	89	89	90	87	78	60	96
4	78	87	89	89	90	87	78	60	96
5	77	87	90	90	90	88	81	62	96
6	80	89	93	92	92	90	83	64	99
7	83	92	96	96	96	93	86	68	102
8	85	94	99	99	98	96	88	70	105
9	87	96	100	101	101	98	90	70	106
10	88	96	100	101	101	98	90	69	107
11	88	96	99	101	101	98	90	69	107
12	88	96	99	101	101	99	89	68	107
13	88	96	99	101	101	98	88	67	107
14 (rated power)	88	96	99	101	101	98	88	66	107

Rye Park Wind Farm - Vestas V112 - 3.0 MW with a hub height of 80m

Hub Height Wind Speed (m/s)	SWL (dB(A)) for each Octave Band Centre Frequency								Total SWL (dB(A))
	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	
5	74	85	88	91	91	87	81	70	96
6	76	87	91	93	93	89	84	72	98
7	79	90	93	96	95	92	86	75	101
8	81	92	96	98	98	94	89	77	103
9	83	94	97	100	100	96	90	79	105
10	86	95	99	101	100	96	94	86	106
11	89	96	98	100	101	99	94	85	107
12	89	94	97	99	101	101	95	86	107
13	89	94	97	99	101	101	95	86	107
14	89	94	96	98	101	101	97	91	107
15	89	94	96	98	101	101	97	91	107
16	89	94	96	98	101	101	97	91	107
17	89	94	96	98	101	101	97	91	107
18 (rated power)	89	94	96	98	101	101	97	91	107

APPENDIX C: NOISE MODEL

The predictions of environmental noise from the proposed wind farm have been made using the CONCAWE[1] noise propagation model and SoundPLAN noise modelling software. The sound propagation model considers the following influences:

- sound power levels and locations of noise sources;
- separation distances between noise sources and receivers;
- topography of the area;
- influence of the absorption provided by the ground;
- air absorption; and,
- meteorological conditions.

The CONCAWE system divides meteorological conditions into six separate "weather categories", depending on wind speed, wind direction, time of day and level of cloud cover. Weather Category 1 provides the weather conditions associated with the "lowest" propagation of noise, whilst Weather Category 6 provides "worst-case" (i.e. highest noise level) conditions. Weather Category 4 provides "neutral" weather conditions for noise propagation (that is, conditions which do not account for the effects of temperature inversion or wind on propagation).

The assessment of the wind farm has been based on the following input conditions:

- weather category 6 (night with no clouds and wind from both wind farms to the dwelling under consideration);
- atmospheric conditions at 10°C and 80% relative humidity;
- wind direction from all WTGs to the particular residence under consideration, even in circumstances where WTGs are located in opposite directions from the residence;
- acoustically soft ground to reflect the pastoral nature of the land; and,
- maximum barrier attenuation from topography of 2 dB(A).

[1] CONCAWE - The oil companies' international study group for conservation of clean air and water – Europe, 'The propagation of noise from petrochemical complexes to neighbouring communities', May 1981.