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Noise and Vibration Impact Assessment

Noise and Vibration Impact Assessment

Environmental Impact Statement

Client: AGL Energy Limited

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Quality Information

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			Name/Position	Signature
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1	22-Apr-2016	Technical report for IAR - Draft Report - Updated Hub Heights	Mark Herod Principal Environmental Engineer	
2	10-Aug-2016	Technical report for EIS - Draft Report	Mark Herod Principal Environmental Engineer	
3	08-Sep-2016	Technical report for EIS - Updated Following Adequacy Review	Mark Herod Principal Environmental Engineer	
4	01-Dec-2016	Technical report for EIS - Updated Baseline Noise Data	Mark Herod Principal Environmental Engineer	

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1.0 Introduction

This report presents the Noise and Vibration Impact Assessment (NVIA) for the Coopers Gap Wind Farm Project (the Project). The NVIA was developed to address the noise and vibration assessment requirements from the Coopers Gap Wind Farm Project *Terms of Reference for an Environmental Impact Statement, dated July 2016.*

The assessment was conducted in general accordance with the Queensland Department of Infrastructure, Local Government and Planning (DILGP) *Wind Farm State Code Planning Guideline* (referred to in this report as the QLD Planning Guideline), dated July 2016.

The performance outcomes from the *Wind Farm State Code* (referred to in this report as the QLD Code), contained in the *State Development Assessment Provisions* (SDAP), version 1.9, effective 22 July 2016, were used as a basis to establish applicable operational noise limits at sensitive receptors.

Background noise measurements were undertaken at 12 representative locations near the Project site. In accordance with the QLD Planning Guideline, noise monitoring was conducted between 26 July 2016 and 17 November 2016 to measure background noise levels for a minimum of six weeks.

This report presents the analysis of the measurements conducted with respect to wind speeds measured at the Project site based on the performance outcomes specified in the QLD Code. Measurements were taken at the proposed turbine hub height to specify the applicable environmental noise limits at all the nearest residences to the Project. Wind speed data measured at the meteorological mast on the Project site for the duration of the noise monitoring periods was provided by AGL through their weather data supplier and was correlated with the noise data measured by AECOM to establish the applicable noise limits. Previous baseline noise monitoring conducted for the Project was not in strict accordance with the 2016 Wind Farm State Code Planning Guidelines. As such, the noise monitoring conducted in 2016 replaces the past baseline monitoring and is used here to present an updated background noise analysis.

A computational noise model was created to predict the noise levels from the operation of the Project at 87 noise sensitive receptors in the vicinity of the Project. The noise limits proposed in this report are expected to be complied with during operation of the Project, based on the results of noise modelling.

A preliminary Compliance Management Plan (CMP) has been developed to assist with determining compliance during the operational phase of the Project. The CMP is presented in Appendix H. Compliance measurements will be undertaken at a number of sensitive receptors adjacent to the Project site during operation of the Project in order to demonstrate that compliance with the relevant criteria has been achieved. A compliance methodology has been proposed in this report in lieu of specific compliance methodology specified in the QLD Code or QLD Planning Guideline.

Construction noise and vibration has been addressed in this report in order to meet the operational requirements for construction management of the QLD Code. Whilst there is no legislation in Queensland that specifically sets construction noise or vibration limits, it is anticipated that construction works may include the use of noisy machinery. As such, a detailed construction noise and vibration assessment may be conducted when construction methods are finalised, as per the Department of State Development *Terms of Reference for an Environmental Impact Statement*, effective August 2016. This will help to quantify the extent of the impacts and to incorporate the proposed mitigation options listed within this document.

It is expected that construction noise impacts can be controlled to acceptable levels and that dwelling occupants at distances of 200 metres and greater from the works area would not be impacted by construction noise or vibration.

The acoustic terminology used in this report is summarised in Appendix A.

2.0 Noise and Vibration Criteria

2.1 Wind Farm Operational Noise Limits

The acoustic amenity performance outcomes listed in the QLD Code, contained in the SDAP, were used as a basis to establish the applicable noise limits at sensitive receptors. The acoustic amenity material change of use outcomes, as per the QLD Code are presented in Table 1.

The QLD Code outlines acoustic amenity criteria for both host and non-host lots, where a host lot is defined as a parcel of land that accommodates any part of a wind farm development, and a non-host lot is defined as a lot no part of which is used for wind farm or part of a wind farm. The criteria applicable for these are outlined in Table 2 and Table 3.

For sensitive receptors to the Project that are located on either host lots, or non-host lots who have an agreed Deed of Release with AGL, are referred to in this report as "Participating Landowners". A free-field night-time A-weighted equivalent acoustic level (L_{Aeq}) of 45 dB(A) should not be exceeded at these receptors, as per the QLD Code. For all other sensitive receptors on non-host lots where landowners have not entered a commercial agreement with AGL, (referred to in this report as "Non-Participating Landowners") a baseline night time 35 dB(A) L_{Aeq} noise limit was conservatively applied in this assessment as the night-time noise limits are the most stringent noise limits for assessment.

The acoustic criteria from Table 2 and Table 3 were used to determine the noise limits from the measured background noise levels (see Section 3.0 for details).

A low frequency assessment was performed to address Information Requirement 10.5 of the Coopers Gap Wind Farm Project *Terms of Reference for an Environmental Impact Statement*, which states that impact predictions must address the potential impacts of any low frequency noise emissions below 200 Hz.

Wind farms are not a significant source of low frequency noise. Other guidelines use a noise limit of 60 dB(C) to assess low frequency noise. As there are no performance outcomes included in the QLD Code for low frequency noise emissions, a low frequency noise limit of 60 dB(C) $L_{Ceq,10}$ was used to assess the potential impacts of any low frequency noise emissions, as per the DILGP *Draft Wind Farm State Code*, *Draft Wind Farm State Code Planning Guideline (2015),* and the NSW Department of Planning and Infrastructure *Draft NSW Planning Guidelines: Wind Farms (2011)*.

In cases where non-host landowners do not agree to sign a Deed of Release allowing the noise level to be as per Table 1 of the Code (Table 2 below), then the wind farm proponent is required to relocate or remove turbines from the wind farm in order to meet the noise criteria as per Table 2 of the Code (Table 3 below) at the sensitive receptor.

The project assessed noise levels at 17 participating receptors and 70 non-participating sensitive receptors.

Table 1 SDAP Wind Farm Development Wind Farm State Code material change of use performance and acceptable acoustic amenity outcomes

Performance Outcomes	Acceptable Outcomes
PO11 The predicted acoustic level at all noise affected existing or approved sensitive land uses does not exceed the criteria stated in Table 1 of the QLD Code (Table 2 below).	No acceptable outcome is provided.
PO12 The predicted acoustic levels at all noise affected existing or approved sensitive land uses does not exceed the criteria stated in Table 2 of the QLD Code (Table 3 below). OR Where the acoustic levels stated in Table 2 of the QLD Code (Table 3 below) cannot be achieved at noise affected existing or approved sensitive land uses: 1. individual written agreements (deed of releases) from non-host lot	No acceptable outcome is provided.

Performance Outcomes	Acceptable Outcomes
owners are provided, and 2. the predicted acoustic level at all noise affected existing or approved sensitive land uses does not exceed the criteria stated in Table 1 of the QLD Code (Table 2 below).	
PO13 Construction activities associated with the development avoid, or minimise and mitigate, adverse impacts on environmental values, water quality objectives, amenity, local transport networks and road infrastructure.	No acceptable outcome is provided.

Table 2 Acoustic amenity criteria as per Table 1 of the QLD Code

Noise Description	Acoustic Level Does Not Exceed
The outdoor (free-field) night-time (10pm to 6am) A-weighted equivalent acoustic level (LAeq), assessed at all noise affected existing or approved sensitive land uses.	1. 45dB(A), or 2. the background noise (LA90) by more than 5dB(A), whichever is the greater, for wind speed from cut-in to rated power of the wind turbine and each integer wind speed in between referenced to hub height.

Table 3 Acoustic amenity criteria as per Table 2 of the QLD Code

Noise Description	Acoustic Level Does Not Exceed
The outdoor (free-field) night-time (10pm to 6am) A-weighted equivalent acoustic level (LAeq), assessed at all noise affected existing or approved sensitive land uses.	1. 35dB(A), or 2. the background noise (LA90) by more than 5dB(A), whichever is the greater, for wind speed from cut-in to rated power of the wind turbine and each integer wind speed in between referenced to hub height.
The outdoor (free-field) day-time (6am to 10pm) A-weighted equivalent acoustic level (LAeq), assessed at all noise affected existing or approved sensitive land uses.	1. 37dB(A), or 2. the background noise (LA90) by more than 5dB(A), whichever is the greater, for wind speed from cut-in to rated power of the wind turbine and each integer wind speed in between referenced to hub height.

2.2 Infrastructure Associated with the Operation of the Project

The Project will include an operation and maintenance building and other minor support infrastructure. An assessment of noise emission from this infrastructure has not been conducted as it is considered unlikely that this equipment will cause any significant noise impacts at the closest receptors due to the low potential for noise emissions from the equipment and the significant distances to the closest residences. Nevertheless, a requirement for suppliers to provide equipment that achieves the relevant steady-state noise emission criteria will be included in the specification and compliance with the relevant criteria will be confirmed with post construction noise monitoring.

The *Environmental Protection Act 1994* (EP Act), *Division 3 – Default Noise Standards* has been referred to for the determination of noise limits to specific noise sources, where applicable. The EP Act provides noise limits for noise sources of steady state nature, which can be applied to establish a noise criterion for steady-state noise emission of infrastructure related to the Project, other than the wind turbines.

2.3 Wind Farm Construction Noise and Vibration Limits

Performance outcome PO13 for construction management is outlined in Table 1 of the QLD Code (Table 1 above). The QLD Code Planning Guideline specifies that a construction management plan is to be prepared by a suitably qualified person, identifying potential construction impacts and the proposed measures to be undertaken to avoid, manage and mitigate the identified impacts.

This plan will include a:

- description and location of sensitive uses that may be affected by noise, vibration and dust emissions from the construction work
- description of the activities and equipment likely to generate noise, vibration and dust emissions
- description of the noise, vibration and dust impact control measures to be implemented to minimise noise, vibration and dust impacts at sensitive uses
- description of the methods to be used to monitor performance and receive, record and respond to complaints.

Construction of the Project has the potential to cause noise and/or vibration impacts. Criteria and goals relating to construction noise and vibration impacts and mitigation measures are further discussed in Section 7.0.

3.0 Background Noise Monitoring

The acoustic environment in the area was evaluated by undertaking a baseline background noise monitoring program within the vicinity of the Project. Noise monitoring locations were selected to represent areas that are expected to have the greatest noise impact from the Project.

The monitoring was conducted between 26 July 2016 and 17 November 2016 to measure background noise levels for a minimum six weeks, in accordance with the QLD Planning Guideline. Both wind speed and noise data was collected as 10 minute averages throughout the monitoring. In all cases, background noise was measured with a microphone at a height of 1.2-1.5 metres above ground level, and at least 5 metres from any significant vertical reflecting surface. Similarly, the noise monitors were placed as far as practicable from significant vegetation such as trees and potential sources of domestic noise.

The background noise data collected at each site was correlated with wind speed data measured at the only meteorological mast in operation on site during the measurements. The data measured by the mast at various heights was extrapolated to a hub height of 117 metres above the ground by the data supplier and provided to AECOM.

Data from the following meteorological mast was correlated with the noise data at all the monitoring locations:

- CG3 – Easting: 347293 / Northing: 7045709

The approximate noise monitoring locations are detailed in Table 4 and are shown in aerial view in Appendix B. Photographs of the noise monitors installed at these sites are provided in Appendix C.

Table 4: Background noise monitoring locations

Noise Monitoring Location (Receptor ID)	UTM Geographic coordinates (Zone 56), metres	
	Easting	Northing
AA	346806	7038244
AD	350484	7038550
AU/AV	342631	7048172
BB	340520	7050418
BF	335141	7050736
C	336787	7049674
CF	349690	7038151
F	341655	7047088
G	346202	7042899
J	341063	7045530
L	338303	7044539
Y	345849	7038512

3.1 Instrumentation

Details of the instrumentation used to record noise levels and weather are provided in Appendix D. All the sound level meters used carried a current calibration certificate from a National Association of Testing Authorities (NATA) accredited laboratory and were calibrated in the field at the start and end of the measurement periods using a Class 1 acoustic calibrator.

In addition, a portable weather station was used to measure wind speeds and rainfall at 10 minute intervals synchronised with the noise monitors. The weather station was installed at 2.0 metres above ground level.

4.0 Background Noise Levels and Project Noise Limits

From the monitored noise and the meteorological mast wind speed data at 117 metre hub height, regression curves were plotted and used to determine the $L_{Aeq,10min}$ noise criteria for the Project at various wind speeds at the sensitive receptors. The correlation between wind speed and background noise level was calculated by least-squares regression formulas (third order polynomials were used as specified in the QLD Planning Guideline). Data samples where the portable weather station recorded any rainfall or wind speeds greater than 5 m/s were discarded from the regression analysis.

The background noise levels at sensitive receptors determined using third order polynomials are summarised in Table 5 and Table 6. The regression curves and equations are presented in Appendix E.

It is noted that the typical operational range is between cut-in speed and a typical rated speed of 4 m/s and 10 m/s respectively and that for the majority of noise monitoring locations, a small data sample was collected at high wind speeds (approximately greater than 10 m/s). As such, obtaining noise limits above 10 m/s based on measured noise levels may not be accurate because of the irregularity of higher wind speeds at the Project Site.

The noise limits at sensitive receptors were determined by applying the noise criteria using the background noise levels measured at the closest measured sensitive receptor. The noise limits obtained through this process are presented in Table 7 and Table 8. These consider the different baseline $L_{Aeq,10min}$ 45 dB(A) and 35 dB(A) noise criteria for participating and non-participating noise sensitive receptors respectively (see noise criteria discussion in Section 2.0).

The noise limits at receptors where noise monitoring was not conducted were determined from the background noise levels measured at the closest sensitive receptor where noise levels were measured.

In addition to the $L_{Aeq,10min}$ noise limits, a low frequency noise limit of 60 dB(C) $L_{Ceq,10}$ has been applied in order to assess the potential impacts of any low frequency noise emissions.

Table 5: Background noise level, $L_{A90,10min}$ (6am-10pm), obtained as per the QLD Wind Farm Planning Guideline

Location ID	Background $L_{A90,10min}$ in dB(A), between 6am-10pm, measured at 1.2-1.5m above ground level, versus wind speed (m/s) at hub height of 117 metres																
	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s	11m/s	12m/s	13m/s	14m/s	15m/s	16m/s	17m/s	18m/s	19m/s	20m/s
AA	34	35	35	36	36	37	37	37	37	37	37	37	36	36	35	34	32
AD	33	34	34	35	35	36	37	37	38	39	39	40	41	42	43	44	45
AU/AV	31	32	32	33	34	35	36	37	38	40	41	43	44	46	49	51	54
BB	32	32	33	34	35	35	36	37	37	38	38	39	39	40	40	40	40
BF	31	32	33	34	35	36	36	37	38	38	38	39	39	39	38	38	38
C	25	27	28	29	31	32	33	34	35	35	35	34	33	31	28	24	20
CF	30	31	32	33	34	34	35	35	36	36	36	36	36	36	36	35	35
F	30	30	31	33	34	35	36	38	39	40	41	41	42	42	41	41	40
G	27	28	30	32	34	36	38	41	43	45	48	49	51	52	53	53	53
J	28	30	31	32	33	34	35	36	37	38	39	39	40	40	40	39	39
L	26	27	29	30	32	33	34	35	36	36	35	34	33	30	27	22	17
Y	28	29	30	31	32	33	34	34	35	35	34	34	32	30	27	24	20

Table 6: Background noise level, $L_{A90,10min}$ (10pm-6am), obtained as per the QLD Wind Farm Planning Guideline

Location ID	Background $L_{A90,10min}$ in dB(A), between 10pam-6am, measured at 1.2-1.5m above ground level, versus wind speed (m/s) at hub height of 117 metres																
	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s	11m/s	12m/s	13m/s	14m/s	15m/s	16m/s	17m/s	18m/s	19m/s	20m/s
AA	32	33	33	34	34	34	34	34	33	32	31	30	28	26	24	22	19
AD	32	32	32	32	32	32	33	33	33	34	34	35	36	37	39	41	43
AU/AV	29	28	28	28	28	29	31	32	34	35	37	38	39	41	41	42	42
BB	28	28	28	28	29	29	30	31	31	32	32	33	33	33	33	33	32
BF	26	27	29	30	30	31	31	32	31	30	29	27	25	22	18	13	7
C	22	24	25	26	27	28	29	29	29	29	29	29	28	28	27	26	25
CF	33	34	34	35	34	34	34	33	32	32	31	31	30	30	29	29	30
F	26	26	26	27	28	29	30	31	33	34	36	37	39	41	42	44	45
G	25	26	27	29	31	33	35	37	39	41	43	45	47	49	51	52	53
J	26	27	28	29	29	30	30	31	31	32	33	34	35	37	39	42	45
L	25	27	28	29	29	30	30	30	30	30	29	29	29	30	30	31	33
Y	26	27	28	29	30	30	30	30	30	29	29	28	28	28	27	27	27

Table 7: $L_{Aeq,10min}$ 6am-10pm noise limits at noise sensitive receptors

Location ID	Participating Landowner?	Host	Closest measured receptor	Minimum noise limit, dB(A)	6am-10pm $L_{Aeq,10min}$ noise limit in dB(A), versus wind speed (m/s) at hub height of 117 m															
				Base Criterion	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s	15 m/s	16 m/s	17 m/s	18 m/s	19 m/s	20 m/s
A	YES	YES	F	45	45	45	45	45	45	45	45	45	45	45	46	46	47	47	46	46	45
AA	NO	NO	AA	37	39	40	40	41	41	42	42	42	42	42	42	42	41	41	40	39	37
AB	YES	NO	AA	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
AC	YES	NO	AA	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
AD	NO	NO	AD	38	38	39	39	40	40	41	42	42	43	44	44	45	46	47	48	49	50
AE	NO	NO	AD	38	38	39	39	40	40	41	42	42	43	44	44	45	46	47	48	49	50
AF	NO	NO	AD	38	38	39	39	40	40	41	42	42	43	44	44	45	46	47	48	49	50
AG	NO	NO	AD	38	38	39	39	40	40	41	42	42	43	44	44	45	46	47	48	49	50
AH	NO	NO	AD	38	38	39	39	40	40	41	42	42	43	44	44	45	46	47	48	49	50
AI	NO	NO	AD	38	38	39	39	40	40	41	42	42	43	44	44	45	46	47	48	49	50
AJ	NO	NO	AD	38	38	39	39	40	40	41	42	42	43	44	44	45	46	47	48	49	50
AK	NO	NO	AD	38	38	39	39	40	40	41	42	42	43	44	44	45	46	47	48	49	50
AL	NO	NO	G	37	37	37	37	37	39	41	43	46	48	50	53	54	56	57	58	58	58
AM	NO	NO	G	37	37	37	37	37	39	41	43	46	48	50	53	54	56	57	58	58	58
AN	NO	NO	G	37	37	37	37	37	39	41	43	46	48	50	53	54	56	57	58	58	58
AO	NO	NO	G	37	37	37	37	37	39	41	43	46	48	50	53	54	56	57	58	58	58
AP	NO	NO	G	37	37	37	37	37	39	41	43	46	48	50	53	54	56	57	58	58	58
AQ	NO	NO	BB	37	37	37	38	39	40	40	41	42	42	43	43	44	44	45	45	45	45
AR	NO	NO	AU	37	37	37	37	38	39	40	41	42	43	45	46	48	49	51	54	56	59
AS	NO	NO	AU	37	37	37	37	38	39	40	41	42	43	45	46	48	49	51	54	56	59
AT	NO	NO	AU	37	37	37	37	38	39	40	41	42	43	45	46	48	49	51	54	56	59

Location ID	Participating Landowner?	Host	Closest measured receptor	Minimum noise limit, dB(A)	6am-10pm $L_{Aeq,10min}$ noise limit in dB(A), versus wind speed (m/s) at hub height of 117 m															
				Base Criterion	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s	15 m/s	16 m/s	17 m/s	18 m/s	19 m/s	20 m/s
AU	NO	NO	AU	37	37	37	37	38	39	40	41	42	43	45	46	48	49	51	54	56	59
AV	NO	NO	AU	37	37	37	37	38	39	40	41	42	43	45	46	48	49	51	54	56	59
AW	NO	NO	BB	37	37	37	38	39	40	40	41	42	42	43	43	44	44	45	45	45	45
AX	NO	NO	BB	37	37	37	38	39	40	40	41	42	42	43	43	44	44	45	45	45	45
AY	NO	NO	BB	37	37	37	38	39	40	40	41	42	42	43	43	44	44	45	45	45	45
AZ	NO	NO	BB	37	37	37	38	39	40	40	41	42	42	43	43	44	44	45	45	45	45
B	YES	YES	L	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
BA	NO	NO	BB	37	37	37	38	39	40	40	41	42	42	43	43	44	44	45	45	45	45
BB	NO	NO	BB	37	37	37	38	39	40	40	41	42	42	43	43	44	44	45	45	45	45
BD	NO	NO	BB	37	37	37	38	39	40	40	41	42	42	43	43	44	44	45	45	45	45
BE	NO	NO	BB	37	37	37	38	39	40	40	41	42	42	43	43	44	44	45	45	45	45
BF	NO	NO	BF	37	37	37	38	39	40	41	41	42	43	43	43	44	44	44	43	43	43
BG	NO	NO	L	37	37	37	37	37	37	38	39	40	41	41	40	39	38	37	37	37	37
BH	NO	NO	L	37	37	37	37	37	37	38	39	40	41	41	40	39	38	37	37	37	37
BI	NO	NO	L	37	37	37	37	37	37	38	39	40	41	41	40	39	38	37	37	37	37
BJ	NO	NO	L	37	37	37	37	37	37	38	39	40	41	41	40	39	38	37	37	37	37
BK	NO	NO	L	37	37	37	37	37	37	38	39	40	41	41	40	39	38	37	37	37	37
BL	NO	NO	L	37	37	37	37	37	37	38	39	40	41	41	40	39	38	37	37	37	37
BM	NO	NO	L	37	37	37	37	37	37	38	39	40	41	41	40	39	38	37	37	37	37
BN	NO	NO	L	37	37	37	37	37	37	38	39	40	41	41	40	39	38	37	37	37	37
BO	NO	NO	L	37	37	37	37	37	37	38	39	40	41	41	40	39	38	37	37	37	37

Location ID	Participating Landowner?	Host	Closest measured receptor	Minimum noise limit, dB(A)	6am-10pm $L_{Aeq,10min}$ noise limit in dB(A), versus wind speed (m/s) at hub height of 117 m																
				Base Criterion	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s	15 m/s	16 m/s	17 m/s	18 m/s	19 m/s	20 m/s
BP	NO	NO	L	37	37	37	37	37	37	38	39	40	41	41	40	39	38	37	37	37	37
BQ	NO	NO	L	37	37	37	37	37	37	38	39	40	41	41	40	39	38	37	37	37	37
BR	NO	NO	Y	37	37	37	37	37	37	38	39	39	40	40	39	39	37	37	37	37	37
BS	NO	NO	Y	37	37	37	37	37	37	38	39	39	40	40	39	39	37	37	37	37	37
BT	NO	NO	Y	37	37	37	37	37	37	38	39	39	40	40	39	39	37	37	37	37	37
BU	NO	NO	Y	37	37	37	37	37	37	38	39	39	40	40	39	39	37	37	37	37	37
BV	NO	NO	Y	37	37	37	37	37	37	38	39	39	40	40	39	39	37	37	37	37	37
BW	NO	NO	Y	37	37	37	37	37	37	38	39	39	40	40	39	39	37	37	37	37	37
BX	NO	NO	Y	37	37	37	37	37	37	38	39	39	40	40	39	39	37	37	37	37	37
BY	NO	NO	AA	37	39	40	40	41	41	42	42	42	42	42	42	42	41	41	40	39	37
BZ	NO	NO	AA	37	39	40	40	41	41	42	42	42	42	42	42	42	41	41	40	39	37
C	YES	YES	BF	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
CA	NO	NO	CF	37	37	37	37	38	39	39	40	40	41	41	41	41	41	41	41	40	40
CB	NO	NO	CF	37	37	37	37	38	39	39	40	40	41	41	41	41	41	41	41	40	40
CC	NO	NO	CF	37	37	37	37	38	39	39	40	40	41	41	41	41	41	41	41	40	40
CD	NO	NO	CF	37	37	37	37	38	39	39	40	40	41	41	41	41	41	41	41	40	40
CE	NO	NO	CF	37	37	37	37	38	39	39	40	40	41	41	41	41	41	41	41	40	40
CF	NO	NO	CF	37	37	37	37	38	39	39	40	40	41	41	41	41	41	41	41	40	40
CG	NO	NO	L	37	37	37	37	37	37	38	39	40	41	41	40	39	38	37	37	37	37
CH	NO	NO	Y	37	37	37	37	37	37	38	39	39	40	40	39	39	37	37	37	37	37
CHURCH 1	NO	NO	Y	37	37	37	37	37	37	38	39	39	40	40	39	39	37	37	37	37	37

Location ID	Participating Landowner?	Host	Closest measured receptor	Minimum noise limit, dB(A)	6am-10pm $L_{Aeq,10min}$ noise limit in dB(A), versus wind speed (m/s) at hub height of 117 m																
				Base Criterion	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s	15 m/s	16 m/s	17 m/s	18 m/s	19 m/s	20 m/s
CHURCH 2	NO	NO	Y	37	37	37	37	37	37	38	39	39	40	40	39	39	37	37	37	37	37
D	YES	YES	BF	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
E	YES	YES	F	45	45	45	45	45	45	45	45	45	45	45	46	46	47	47	46	46	45
F	YES	YES	F	45	45	45	45	45	45	45	45	45	45	45	46	46	47	47	46	46	45
G	YES	YES	G	45	45	45	45	45	45	45	45	46	48	50	53	54	56	57	58	58	58
H	YES	YES	G	45	45	45	45	45	45	45	45	46	48	50	53	54	56	57	58	58	58
I	NO	NO	G	37	37	37	37	37	39	41	43	46	48	50	53	54	56	57	58	58	58
J	YES	YES	J	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
K	NO	NO	L	37	37	37	37	37	37	38	39	40	41	41	40	39	38	37	37	37	37
L	NO	NO	L	37	37	37	37	37	37	38	39	40	41	41	40	39	38	37	37	37	37
M	NO	NO	L	37	37	37	37	37	37	38	39	40	41	41	40	39	38	37	37	37	37
N	NO	NO	L	37	37	37	37	37	37	38	39	40	41	41	40	39	38	37	37	37	37
O	NO	NO	L	37	37	37	37	37	37	38	39	40	41	41	40	39	38	37	37	37	37
P	YES	NO	L	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
Q	YES	NO	Y	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
R	YES	NO	Y	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
S	NO	NO	Y	37	37	37	37	37	37	38	39	39	40	40	39	39	37	37	37	37	37
T	NO	NO	Y	37	37	37	37	37	37	38	39	39	40	40	39	39	37	37	37	37	37
U	NO	NO	Y	37	37	37	37	37	37	38	39	39	40	40	39	39	37	37	37	37	37
V	NO	NO	Y	37	37	37	37	37	37	38	39	39	40	40	39	39	37	37	37	37	37
W	YES	YES	Y	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45

Location ID	Participating Landowner?	Host	Closest measured receptor	Minimum noise limit, dB(A)	6am-10pm $L_{Aeq,10min}$ noise limit in dB(A), versus wind speed (m/s) at hub height of 117 m															
				Base Criterion	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s	15 m/s	16 m/s	17 m/s	18 m/s	19 m/s	20 m/s
X	YES	NO	Y	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
Y	YES	NO	Y	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
Z	NO	NO	AA	37	39	40	40	41	41	42	42	42	42	42	42	42	41	41	40	39	37

Table 8: $L_{Aeq,10min}$ 10pam-6am noise limits at noise sensitive receptors

Location ID	Participating Landowner?	Host	Closest measured receptor	Minimum noise limit, dB(A)	10pm-6am $L_{Aeq,10min}$ noise limit in dB(A) versus wind speed (m/s) at hub height of 117 m															
				Base Criterion	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s	15 m/s	16 m/s	17 m/s	18 m/s	19 m/s	20 m/s
A	YES	YES	F	45	45	45	45	45	45	45	45	45	45	45	45	45	45	46	47	49	50
AA	NO	NO	AA	35	37	38	38	39	39	39	39	39	38	37	36	35	35	35	35	35	35
AB	YES	NO	AA	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
AC	YES	NO	AA	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
AD	NO	NO	AD	37	37	37	37	37	37	37	38	38	38	39	39	40	41	42	44	46	48
AE	NO	NO	AD	37	37	37	37	37	37	37	38	38	38	39	39	40	41	42	44	46	48
AF	NO	NO	AD	37	37	37	37	37	37	37	38	38	38	39	39	40	41	42	44	46	48
AG	NO	NO	AD	37	37	37	37	37	37	37	38	38	38	39	39	40	41	42	44	46	48
AH	NO	NO	AD	37	37	37	37	37	37	37	38	38	38	39	39	40	41	42	44	46	48
AI	NO	NO	AD	37	37	37	37	37	37	37	38	38	38	39	39	40	41	42	44	46	48
AJ	NO	NO	AD	37	37	37	37	37	37	37	38	38	38	39	39	40	41	42	44	46	48
AK	NO	NO	AD	37	37	37	37	37	37	37	38	38	38	39	39	40	41	42	44	46	48
AL	NO	NO	G	35	35	35	35	35	36	38	40	42	44	46	48	50	52	54	56	57	58

Location ID	Participating Landowner?	Host	Closest measured receptor	Minimum noise limit, dB(A)	10pm-6am $L_{Aeq,10min}$ noise limit in dB(A) versus wind speed (m/s) at hub height of 117 m																
				Base Criterion	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s	15 m/s	16 m/s	17 m/s	18 m/s	19 m/s	20 m/s
AM	NO	NO	G	35	35	35	35	35	36	38	40	42	44	46	48	50	52	54	56	57	58
AN	NO	NO	G	35	35	35	35	35	36	38	40	42	44	46	48	50	52	54	56	57	58
AO	NO	NO	G	35	35	35	35	35	36	38	40	42	44	46	48	50	52	54	56	57	58
AP	NO	NO	G	35	35	35	35	35	36	38	40	42	44	46	48	50	52	54	56	57	58
AQ	NO	NO	BB	35	35	35	35	35	35	35	35	36	36	37	37	38	38	38	38	38	37
AR	NO	NO	AU	35	35	35	35	35	35	35	36	37	39	40	42	43	44	46	46	47	47
AS	NO	NO	AU	35	35	35	35	35	35	35	36	37	39	40	42	43	44	46	46	47	47
AT	NO	NO	AU	35	35	35	35	35	35	35	36	37	39	40	42	43	44	46	46	47	47
AU	NO	NO	AU	35	35	35	35	35	35	35	36	37	39	40	42	43	44	46	46	47	47
AV	NO	NO	AU	35	35	35	35	35	35	35	36	37	39	40	42	43	44	46	46	47	47
AW	NO	NO	BB	35	35	35	35	35	35	35	35	36	36	37	37	38	38	38	38	38	37
AX	NO	NO	BB	35	35	35	35	35	35	35	35	36	36	37	37	38	38	38	38	38	37
AY	NO	NO	BB	35	35	35	35	35	35	35	35	36	36	37	37	38	38	38	38	38	37
AZ	NO	NO	BB	35	35	35	35	35	35	35	35	36	36	37	37	38	38	38	38	38	37
B	YES	YES	L	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
BA	NO	NO	BB	35	35	35	35	35	35	35	35	36	36	37	37	38	38	38	38	38	37
BB	NO	NO	BB	35	35	35	35	35	35	35	35	36	36	37	37	38	38	38	38	38	37
BD	NO	NO	BB	35	35	35	35	35	35	35	35	36	36	37	37	38	38	38	38	38	37
BE	NO	NO	BB	35	35	35	35	35	35	35	35	36	36	37	37	38	38	38	38	38	37
BF	NO	NO	BF	35	35	35	35	35	35	36	36	37	36	35	35	35	35	35	35	35	35
BG	NO	NO	L	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	36	38

Location ID	Participating Landowner?	Host	Closest measured receptor	Minimum noise limit, dB(A)	10pm-6am $L_{Aeq,10min}$ noise limit in dB(A) versus wind speed (m/s) at hub height of 117 m															
				Base Criterion	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s	15 m/s	16 m/s	17 m/s	18 m/s	19 m/s	20 m/s
BH	NO	NO	L	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	36	38
BI	NO	NO	L	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	36	38
BJ	NO	NO	L	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	36	38
BK	NO	NO	L	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	36	38
BL	NO	NO	L	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	36	38
BM	NO	NO	L	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	36	38
BN	NO	NO	L	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	36	38
BO	NO	NO	L	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	36	38
BP	NO	NO	L	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	36	38
BQ	NO	NO	L	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	36	38
BR	NO	NO	Y	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
BS	NO	NO	Y	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
BT	NO	NO	Y	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
BU	NO	NO	Y	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
BV	NO	NO	Y	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
BW	NO	NO	Y	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
BX	NO	NO	Y	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
BY	NO	NO	AA	35	37	38	38	39	39	39	39	39	38	37	36	35	35	35	35	35	35
BZ	NO	NO	AA	35	37	38	38	39	39	39	39	39	38	37	36	35	35	35	35	35	35
C	YES	YES	BF	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
CA	NO	NO	CF	35	38	39	39	40	39	39	39	38	37	37	36	36	35	35	35	35	35

Location ID	Participating Landowner?	Host	Closest measured receptor	Minimum noise limit, dB(A)	10pm-6am $L_{Aeq,10min}$ noise limit in dB(A) versus wind speed (m/s) at hub height of 117 m																
				Base Criterion	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s	15 m/s	16 m/s	17 m/s	18 m/s	19 m/s	20 m/s
CB	NO	NO	CF	35	38	39	39	40	39	39	39	38	37	37	36	36	35	35	35	35	35
CC	NO	NO	CF	35	38	39	39	40	39	39	39	38	37	37	36	36	35	35	35	35	35
CD	NO	NO	CF	35	38	39	39	40	39	39	39	38	37	37	36	36	35	35	35	35	35
CE	NO	NO	CF	35	38	39	39	40	39	39	39	38	37	37	36	36	35	35	35	35	35
CF	NO	NO	CF	35	38	39	39	40	39	39	39	38	37	37	36	36	35	35	35	35	35
CG	NO	NO	L	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	36	38
CH	NO	NO	Y	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
CHURCH 1	NO	NO	Y	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
CHURCH 2	NO	NO	Y	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
D	YES	YES	BF	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
E	YES	YES	F	45	45	45	45	45	45	45	45	45	45	45	45	45	45	46	47	49	50
F	YES	YES	F	45	45	45	45	45	45	45	45	45	45	45	45	45	45	46	47	49	50
G	YES	YES	G	45	45	45	45	45	45	45	45	45	45	46	48	50	52	54	56	57	58
H	YES	YES	G	45	45	45	45	45	45	45	45	45	45	46	48	50	52	54	56	57	58
I	NO	NO	G	35	35	35	35	35	36	38	40	42	44	46	48	50	52	54	56	57	58
J	YES	YES	J	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	47	50
K	NO	NO	L	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	36	38
L	NO	NO	L	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	36	38
M	NO	NO	L	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	36	38
N	NO	NO	L	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	36	38
O	NO	NO	L	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	36	38

Location ID	Participating Landowner?	Host	Closest measured receptor	Minimum noise limit, dB(A)	10pm-6am $L_{Aeq,10min}$ noise limit in dB(A) versus wind speed (m/s) at hub height of 117 m																
				Base Criterion	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s	15 m/s	16 m/s	17 m/s	18 m/s	19 m/s	20 m/s
P	YES	NO	L	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
Q	YES	NO	Y	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
R	YES	NO	Y	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
S	NO	NO	Y	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
T	NO	NO	Y	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
U	NO	NO	Y	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
V	NO	NO	Y	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
W	YES	YES	Y	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
X	YES	NO	Y	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
Y	YES	NO	Y	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
Z	NO	NO	AA	35	37	38	38	39	39	39	39	39	38	37	36	35	35	35	35	35	35

5.0 Wind Farm Operational Noise Modelling

A three-dimensional computer noise model of the Project site was created in SoundPLAN Version 7.4 acoustic modelling software to predict operational noise levels for the Project. Environmental noise predictions were carried out using the algorithms from ISO 9613.2:1996 *Acoustics – Attenuation of Sound during propagation outdoors – Part 2: General method of calculation*, as implemented within the SoundPLAN software package and allowed by the QLD Wind Farm Planning Guideline. Results from the model are discussed in Section 6.0.

5.1 Noise Model Inputs

The following data was used to create the computer model:

- Topographical ground contours for the wind farm site and surrounding area, received from AGL on 7 December 2010.
- Proposed project layout, developed in July 2016. The wind turbines were entered at hub height of 117 metres above ground level.
- Receptor locations, determined from aerial photograph and cadastral data overlaid on the ground contours.

An aerial view of the Project showing the location of turbines and sensitive receptors is provided in Appendix B.

The following parameters were entered in the computer model, in accordance with the QLD Planning Guideline:

- Atmospheric conditions at 10°C temperature and 70% relative humidity.
- 90% Hard ground (0.1 ground factor). The QLD Code Planning Guideline specifies an input of 50% acoustically hard ground and 50% acoustically soft ground and therefore the modelling takes a conservative approach.
- No penalty for tonality was applied (0.0 dB penalty): The QLD Planning Guideline states that:

  > *"A correctly operating wind turbine may exhibit sound with tonal characteristics. These characteristics can be minimised or avoided by careful design and/or mitigation measures. Wind farm developers should avoid installation of wind turbines which exhibit sound with tonal characteristics by specifying the supply of wind turbines from a manufacturer which guarantees that the supplied wind turbines will not exhibit tonal characteristics at residences."*

  Based on the statement above, it has been assumed that the turbines for the Project will not emit tonal behaviour and that appropriate maintenance will be conducted by the wind farm operator to ensure that the noise emission of the turbines is not adversely affected by turbine wear, resulting in audible tonality. Further, it is expected that tonality would not be an audible feature at the distances separating the turbines from the receptors.
- Barrier attenuation has not been altered in the noise model; however the majority of receptors already experience less than 1 dB of barrier attenuation.
- 4 m receptor height, as specified in the QLD Guideline when using ISO 9613 for conducting noise predictions.
- The conservative modelling approach and lack of significant concave ground profiles has meant that no application of a 3 dB(A) correction for a concave ground profile has been used. Areas where $h_m \geq (1.5 \times |h_s - h_r| \times 0.5)$ (as outlined in the QLD Code Planning Guideline) were not observed based on the current turbine layout.
- A sound power level (L_W) for a typical 3.6 MW turbine of 107 dB(A) has been assumed. This value was based on a typical 3.6 MW performance specification, for which the maximum sound

level for the turbine ranges from 104.9 dB(A) to 108 dB(A). The chosen value is therefore on the conservative end of the range.

A reference sound power spectra from a 3.0 MW Vestas V112 wind turbine with an overall level of 106.5 dB(A) has been used in noise predictions. The reference sound power level, as entered in the model, is presented in Table 7. The reference sound power was adjusted to an overall sound power of 107 dB(A). The sound power spectra used in modelling extends beyond the minimum sound power level reporting requirement between 63 Hz to 4 kHz stated in the QLD Wind Farm Planning Guideline. It is noted that ISO 9613-2 is based on empirical corrections to inverse square law that are generally valid only down to 63 Hz.

Table 9 Sound power level spectra used for the computer model

Overall dB(A)	1/3 octave frequency band (Hz) noise level, in dB(linear)														
	25	31	40	50	63	80	100	125	160	200	250	315	400	500	630
107	114	112	112	110	111	109	107	107	102	100	101	100	97	98	97
	800	1k	1.25k	1.6k	2k	2.5k	3.15k	4k	5k	6.3k	8k	10k	12.5k	16k	
	96	97	97	96	95	94	93	92	89	89	89	88	85	80	

It has been assumed that the wind turbines will be properly maintained by the wind farm operator to ensure that the noise emission of the turbines is not adversely affected by turbine wear, resulting in audible tonality. Similarly, should amplitude modulation be detected upon commissioning, the wind farm operator would be required to alter the operating parameters of some turbines to remove this effect.

The sound power level presented above is a physical property of a wind turbine, not a sound pressure level as experienced by a listener. At the base of a wind turbine the sound pressure level experienced would be approximately 60–65 dB(A), depending on the turbine.

The QLD Code Planning Guideline requires noise emissions from a wind turbine development to comply with an L_{Aeq} noise criteria. Wind farm noise emission cannot be measured with an L_{Aeq} descriptor so an L_{A90} descriptor will be used for compliance measurements. The QLD Code Planning Guideline has been interpreted such that compliance with an $L_{Aeq} = L_{A90}$ criteria is required.

Therefore, a relationship of $L_{Aeq} = L_{A90}$ was used to model the wind farm layout.

6.0 Wind Farm Operational Noise Impacts

Appendix F presents the results from the noise compliance assessment for the proposed turbine layout, during worst-case turbine noise emissions. These predicted outdoor noise levels were obtained through computational noise modelling, as outlined in Section 5.0. The noise levels presented are free field $L_{Aeq,10min}$ noise levels at the receptors, and have been conservatively assessed against the night time noise limits presented in Table 8. The noise predictions comply with the Project noise limits at all receptors.

Appendix F also presents the low frequency noise compliance assessment for the turbine layout during the worst-case turbine noise emission. The noise levels presented in the table are free-field $L_{Ceq,10min}$ noise levels at the receptors, assessed against a 60 dB(C) night time limit. The noise predictions comply with this noise limit at all but one receptor. This low frequency noise limit was exceeded by less than 1 dB(C) at receptor G. This receptor is a Participating Landowner and the likelihood of a complaint from this receptor is minimal. Furthermore the conservative assumptions made when building the model mean that the measured noise levels would likely be lower than those predicted as part of this assessment. As such, noise compliance at receptor G with a 60 dB(C) noise limit is expected.

Noise maps showing contours between 35 dB(A) $L_{Aeq,10min}$ and 45 dB(A) $L_{Aeq,10min}$, are provided in Appendix G. A noise map showing a 60 dB(C) contour is also provided in Appendix G. It is noted that the noise contour maps are generated based on a grid of calculations which are interpolated to

generate the contours. Single point calculations shown in Appendix F should be referred to for specific levels at each receptor.

6.1 Cumulative Impacts

No new or proposed developments have been identified within the Study Area that are likely to result in combined or successive noise impacts with the Project. Cumulative noise impacts to sensitive receptors are therefore considered to be unlikely.

7.0 Wind Farm Noise Compliance Measurements

Compliance noise measurements will be undertaken at a number of the sensitive receptors adjacent to the Project site once the wind farm is operational to demonstrate that compliance with the relevant criteria has been achieved.

A Preliminary CMP has been developed to incorporate an operational compliance measurement methodology. This plan is detailed in Appendix H. Since the QLD Wind Farm Planning Guideline does not establish a methodology for conducting compliance noise measurements on wind farms, the compliance measurement methodology was developed following guidance from the following documents:

- NSW Department of Planning & Infrastructure *Draft NSW Planning Guidelines – Wind Farms*, December 2011
- Victoria Department of Planning and Community Development *Policy and Planning Guidelines for development of wind energy facilities in Victoria, July 2012*
- New Zealand Standard NZS6808:2010 *Acoustics – Wind farm noise*

It is proposed that the CMP is approved by DILGP prior to commencement of construction of the Project. Testing should be undertaken once all noise sources associated with the Project are in operating mode, i.e. all turbines have been commissioned and are operating correctly.

8.0 Wind Farm Construction Noise and Vibration Impacts

This section addresses the noise and vibration impacts related to the construction of the Project as per the noise and vibration information requirements from the Department of State Development *Terms of Reference for an Environmental Impact Statement*, effective August 2016.

8.1 Construction Activities

This report addresses construction noise and vibration in general terms. Specific details of the construction methodology and equipment are not known at this early stage of the Project.

It is anticipated that the construction work may include excavation, rock hammering, drilling and bulldozing. Noise will be generated by mobile plant such as excavators, bulldozers, mobile cranes and semi-trailers delivering or removing material from construction sites. It is expected that the following typical equipment will be used:

- Excavators
- Tracked bulldozers
- Semi-trailers
- Tractors
- Mobile cranes
- Concrete trucks.

It is recommended that construction plant be selected on the basis of low noise emission. Noise emissions from construction plant can be reduced by fitting exhaust mufflers, using reversing alarms

that emit a broadband noise (e.g. white noise) rather than a beep, maintaining plant in good working order and following best practice construction methodologies. A Construction Environment Management Plan (CEMP) will be developed to manage possible noise and vibration impacts from construction.

8.2 Construction Phase Noise Criteria

There is no legislation in Queensland that specifically sets construction noise limits. For construction activity in Queensland, the *Environmental Protection Act 1994* states that:

"A person must not carry out building work in a way that makes an audible noise –

a. On a business day or Saturday, before 6:30am or after 6:30pm; or

b. On any other day, at any time."

Thus noise from construction activity is generally controlled through limiting the hours of operation, and through application of best practice management techniques.

A number of 'good practice' mitigation measures have been outlined below to reduce noise and vibration impacts associated with construction of the Project and to minimise the likelihood of adverse comment from nearby residents. Construction outside of the hours listed above typically requires permission from a governing authority (e.g. the Department of Environment and Heritage Protection) and advance warning to nearby locations.

The CEMP should outline the recommended hours of work and mitigation measures to be implemented.

8.3 Construction Vibration Guideline - Human Response to Vibration

To assess perceptible vibration to humans, AECOM recommends the use of vibration criteria from the Australian Standard AS 2670.2 - 1990 *Evaluation of human exposure to whole-body vibration - Part 2: Continuous and shock induced vibration in buildings (1 to 80 Hz).*

These criteria are summarised in Table 10. Both continuous and intermittent vibrations are assessed. Earthmoving construction equipment will typically operate between 6:30am and 6:30pm, Monday to Saturday. Accordingly only the daytime criterion is shown. Where out of hours construction is proposed, consultation with surrounding residences will need to be undertaken.

Table 10: AS2670.2 Extract - Human Comfort Vibration Limits (8Hz to 80Hz)

Space Occupancy	Time of Day	Peak Vibration Levels in mm/s over the frequency range 8 Hz to 80Hz likely to cause "adverse comment"			
		Continuous Vibration		Intermittent Vibration and Impulsive Vibration excitation with several occurrences per day	
		Vertical	Horizontal	Vertical	Horizontal
Residential	Day	0.6 mm/s	1.6 mm/s	12.6 mm/s	36 mm/s
Workshops	Day	1.2 mm/s	3.2 mm/s	18 mm/s	51 mm/s

8.4 Construction Vibration Guideline - Structural Response to Vibration

International standards exist for vibration-induced damage to structures and can provide guidance on acceptable limits. These documents are commonly used to assess structural response to vibration throughout Australia.

German standard DIN 4150, British Standard BS 5228 Part 4 and BS 7385 Part 2 recommend vibration criteria relating to structural damage of buildings. These standards are considered to be best practice in Australia. The criteria from the standards are summarised in Table 11 and Table 12.

Table 11: DIN 4150 Vibration Criteria, in PPV (mm/s)

Line	Structure Type	Guideline vibration values			
		Vibration at foundation			
		1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz	Vibration at horizontal plane of highest floor at all frequencies
1	Buildings used for commercial purposes, industrial buildings, and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design or occupancy	5	5 to 15	15 to 20	15
3	Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 or 2 and are of great intrinsic value (e.g. listed buildings under preservation order)	3	3 to 8	8 to 10	8

Table 12: BS 5228-4 Criteria, in PPV (mm/s)

Structure	Intermittent			Continuous		
	<10 Hz	10-50 Hz	> 50 Hz	<10 Hz	10-50 Hz	> 50 Hz
Soundly constructed residential properties	5	10	20	2.5	5	10
Industrial and commercial – light	10	20	40	5	10	20
Industrial and commercial – heavy	15	30	60	7.5	15	30

The criteria in BS 5228-4 are generally more stringent than those in DIN 4150. It is recommended that the Project adopts an objective of complying with the intermittent vibration levels specified in BS 5228-4 (i.e. Table 12), with the levels specified in DIN 4150 (i.e. Table 11) as an upper limit.

8.5 Construction Vibration Criteria Summary

The BS 5228-4 criteria for intermittent vibration in “Soundly constructed residential properties” apply to the construction area and will be used as the construction vibration guideline for this Project.

Table 13: BS 5228-4 Criteria, in PPV (mm/s)

Structure	Intermittent		
	<10 Hz	10-50 Hz	> 50 Hz
Soundly constructed residential properties	5	10	20

A summary of the vibration criterion in relation to human comfort is given below in Table 14.

Table 14: AS2670.2 Extract - Human Comfort Vibration Limits (8Hz to 80Hz)

Space Occupancy	Time of Day	Peak Vibration Levels in mm/s over the frequency range 8 Hz to 80Hz likely to cause "adverse comment"			
		Continuous Vibration		Intermittent Vibration and Impulsive Vibration excitation with several occurrences per day	
		Vertical	Horizontal	Vertical	Horizontal
Residential	Day	0.6 mm/s	1.6 mm/s	12.6 mm/s	36 mm/s
Workshops	Day	1.2 mm/s	3.2 mm/s	18 mm/s	51 mm/s

8.6 Proposed Mitigation Options: Construction Noise and Vibration

It is noted that there exists the potential for noise impacts to surrounding residents during the construction of the Project. Appropriate techniques need to be implemented to minimise these impacts. The CEMP will outline these measures.

8.6.1 Noise Mitigation Measures

To minimise the impacts of construction noise, the EPC Contractor will prepare a Construction Noise and Vibration Management Plan which outlines the proposed methodology and monitoring procedures to be put in place for the duration of the works. The Construction Noise and Vibration Management Plan may incorporate the following noise mitigations:

- Community Noise Consultation
  - Regular consultation with noise sensitive receptors to provide details of the construction plan and duration of predicted construction noise. For example advising noise sensitive receptors of the duration and activities they can expect (e.g. which turbine locations in their vicinity are having the concrete pads laid, expected time until the construction crews will return to commence installing towers, etc.)
  - Advanced notice of road works
  - Advise local councils of planned construction works to assist in complaint management
  - Preparation of a noise complaints procedure and register
  - Letterbox drops.
- Site Management
  - Limit construction hours to Monday to Saturday, 6.30am to 6.30pm, where it is practicable to do so. Construction activities undertaken outside of these hours are to be minimised, particularly those that are likely to have some noise impact such as earthworks activities
  - The contractor should keep residents informed of when any noisy construction works will occur
  - Where practicable, upgrade local roads both before and after the construction of the Project to minimise the effect of heavy vehicle movements
  - Selection and location of site access roads as far away from noise-sensitive receptors as possible. The contractor shall work closely with landowners who are affected by site roads and ensure minimal disruption to their operations
  - Careful selection of the main site office and turbine component stockpile to minimize disruption to sensitive receptors.
  - Vehicles and plant should not be left idling unnecessarily
  - All engine exhausts should be fitted with suitable and well maintained mufflers/silencers

- Any noisy fixed plant should be located in a suitable acoustic enclosure away from residential locations
- Care should be taken not to drop materials to cause peak noise events, including materials from a height into a truck
- Machines that are used intermittently should be shut down in the intervening periods between works, or throttled down to a minimum
- It is noted that the construction of the Project will involve progressively moving through the area as various construction activities are undertaken. Regularly moving particularly noisy pieces of equipment through the area during construction where practical can reduce the noise impact duration on surrounding residences
- The reversing of vehicles should be minimised to reduce the noise from reversing signals
- Truck operators should ensure that tailgates are cleared and locked at the point of unloading
- Vehicle warning devices such as horns should not be used as signalling devices
- Worksite induction training should be implemented, educating staff on noise sensitive issues and the need to make as little noise as possible
- Workers should avoid shouting and whistling
- When work is complete, the noise of packing up plant and equipment and departing from the site should be minimised.

· Equipment management

- Selection of low noise plant and equipment
- Equipment should be well maintained and fitted with adequately maintained silencers which meet the design specifications
- Silencers and enclosures should be kept intact, rotating plants should be balanced, loose bolts tightened, frictional noise reduced through lubrication and cutting noise reduced by keeping equipment sharp
- Only necessary power should be used to complete the task
- Only necessary equipment should be on site
- Loaders and bobcats fitted with articulated buckets should be rubber lined at the contact points to ensure that noise levels are minimised during the release of materials, where practicable
- Resonance should be avoided where possible e.g. changing the speed of machines; and
- Traffic practice controllers should be used to prevent vehicles and equipment queuing, idling or reversing near noise sensitive receptors.

· Noise Monitoring

- Monitoring of construction noise levels should be undertaken in response to complaints where this is considered an appropriate response. Noise measurements are to be conducted in accordance with the requirements of the *Noise Measurement Manual* (DERM 2013) or other equivalent guideline.

8.6.2 Vibration Mitigation Measures

Based on typical levels of vibration from construction activities, it is expected that dwelling occupants at distances of 200 metres and greater from the works area would not be able to perceive construction vibration; much less the buildings themselves experience vibration levels resulting in damage. Where adverse comment specifically arising from vibration is received after the commencement of construction it is recommended that the following measures be considered:

· Vibration levels be measured

- If high levels are recorded:
  - Increasing the distance between offending plant equipment
  - Replacing offending plant equipment with equipment that does not produce large levels of vibration
  - Building structure surveys

9.0 Conclusion

9.1 Operational Noise

A Noise and Vibration Impact Assessment (NVIA) was conducted for the operation of the Project in general accordance with the requirements of the Queensland Department of Infrastructure, Local Government and Planning (DILGP) *Wind Farm State Code Planning Guideline*.

The NVIA was developed to address the noise and vibration assessment requirements from the Coopers Gap Wind Farm Project *Terms of Reference for an Environmental Impact Statement, dated July 2016.*

The performance outcomes from the *Wind Farm State Code* (referred to in this report as the QLD Code), contained in the *State Development Assessment Provisions* (SDAP), version 1.9, effective 22 July 2016, were used as basis to establish applicable operational noise limits at sensitive receptors.

An environmental noise model of the site was created to predict noise levels at the nearest sensitive receptors to the Project. A noise-compliant wind turbine layout was generated for this EIS application, and has formed the basis of the Project site. The noise limits proposed in this report are expected to be complied with during operation of the Project, based on the results of noise predictions. On this basis, the recommended 'noise-compliant' wind turbine layout can be considered to protect the existing environmental values in the area from impacts by noise from the Project.

It has been assumed that the wind turbines will be properly maintained by the wind farm operator to ensure that the noise emission of the turbines is not adversely affected by turbine wear, resulting in audible tonality. Similarly, should amplitude modulation be detected upon commissioning, the wind farm operator would be required to alter the operating parameters of some turbines to remove this effect.

Compliance measurements will be undertaken at a selected number of the potentially most affected sensitive receptors following the commissioning of the Project. In lieu of a compliance methodology within the QLD Planning Guideline, a Preliminary Compliance Management Plan (CMP) has been developed to incorporate the compliance measurement methodology, and may be found in Appendix H. It is proposed that the final Compliance Management Plan is approved by DILGP prior to commencement of construction of the Project. Testing should be undertaken once all noise sources associated with the Project are in operating mode, i.e. all turbines have been commissioned and are operating correctly.

This report has also described how the achievement of the objectives will be monitored and audited through outlining the requirements for post-commissioning measurement and reporting.

9.2 Construction Noise and Vibration

Construction vibration limits were defined from BS 5228-4 and AS 2670.2. Whilst there is no legislation in Queensland that specifically sets construction noise limits, best practice noise and vibration mitigations measures to be adopted during construction of the Project were detailed in this report, as per the QLD Code and QLD Code Planning Guideline for construction management.

Appendix A

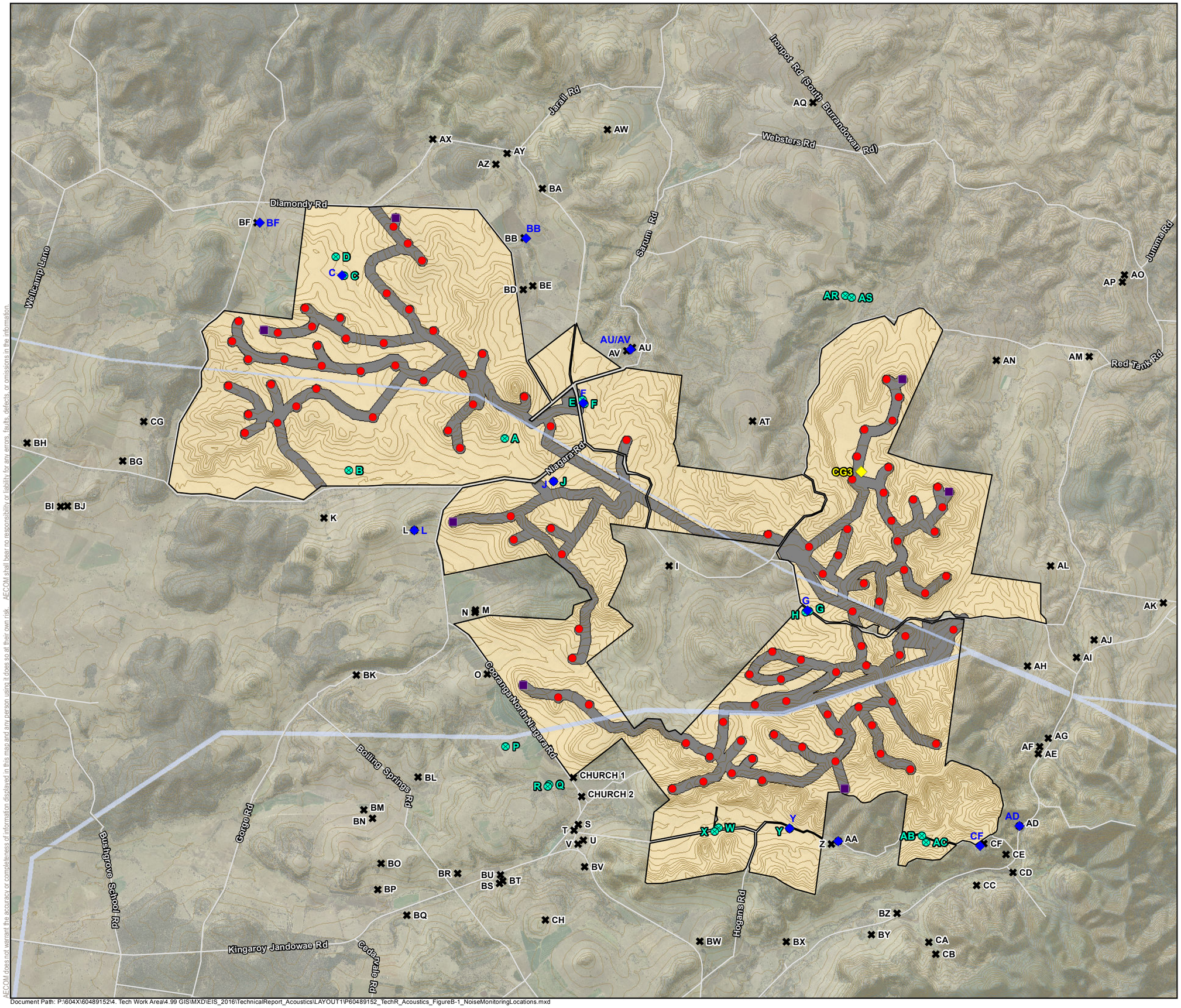
Acoustic Terminology

Appendix A Acoustic Terminology

'A' Weighted	Frequency filter applied to measured noise levels to represent how humans hear sounds.
Ambient Noise	Total noise at a site comprising all sources such as industry, traffic, domestic, and natural noises.
Attended Measurement	Measurements that are attended by a person and measured with a sound level meter.
dB(A)	'A' Weighted overall sound pressure level.
dB(G)	The G-weighting for the determination of weighted sound pressure levels of sound or noise, whose spectrum lies partly or wholly within the frequency range from 1 Hz to 20 Hz, has been standardised in ISO 7196, (1995). G-weighted sound pressure levels are denoted L_{pG} and are measured or estimated in dB(G)
Frequency	The number of cycles per second, where 1 cycle per second is equal to 1Hz. The human ear responds to sounds of frequency 20 Hz to 20,000 Hz.
Impulsiveness	Noise that comprises distinct impulses in the noise (bangs, clicks, clatters, or thumps) etc.
Intermittent	Stopping and starting at irregular intervals.
L_{Aeq}	The 'A' Weighted energy-averaged noise level over the measurement period.
$L_{Aeq,10min}$	The energy-averaged level of the total noise measured without adjustment for the character of the noise (e.g. tonal or impulsive), over a period of 10 minutes.
$L_{Ar,\ 1hour}$	The noise level of the component of the total noise that can be specifically identified by acoustical means which is associated with the noise from mining operations and shall be measured with an adjustment for the character of the noise (tonal or impulsive) over a period of 1 hour.
L_{max}	Maximum noise level of the measurement period.
L_{10}	Noise level exceeded for 10% of the measurement period. The L_{10} represents the intrusive noise level and is often used to represent traffic/ music noise.
L_{90}	Noise level exceeded for 90% of the measurement period. This represents the background noise level excluding nearby sources.
$L_{w(A)}$	'A' Weighted sound power level, measured in dB(A). The sound power level is a measure of the total acoustic energy produced by a source and is independent of distance and source location. The sound power level is expressed as a ratio against a reference level of 10^{-12} watts.
Least-squares regression	The method for finding a line that summarizes the relationship between the two parameters, e.g. wind speed and measured noise level.
Tonality	A characteristic of noise, describing a sound that contains a perceptible pitch or tone. As a general rule, a prominent tonal component may be detected in one-third octave spectra if the level of a one-third octave band exceeds the level of the adjacent bands by 5 dB or more.
Unattended Measurement	Measurements that are taken by a noise logger at a given location unattended.

Appendix B

Wind Farm Layout, Noise Monitoring and Receptor Locations



AGL Energy in action.

AECOM

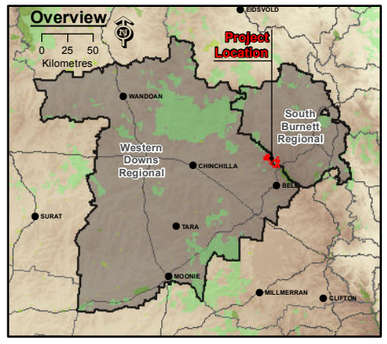
DATUM GDA 1994, PROJECTION MGA ZONE 56

0 1.5 3
Kilometres

1:72,500 (when printed at A3)

Legend

- Project Site
- Study Area
- Met Masts
- Existing Met Mast used during noise monitoring
- Turbines
- Participating Landowners
- Non-Participating Landowners
- Noise Monitoring Locations
- Contours 10m
- Road



Data Sources:
1. Project Site, Turbine Layout © 2016 AECOM Australia Pty Ltd.
2. Surat Basin 40 cm Imagery © SISP, 2013
3. Service Road, Transmission Lines © AGL 2014
4. Locality, Roads © StreetPro 2011
5. Cadastral Data (DCDB) © State of Queensland (Department of Natural Resources and Mines) 2016
6. Contours 10m © Department of Natural Resources and Mines, 2013.
7. Hillshade, based on the 25m DEM covering the SEQ; DNRM 2005
8. Local Government Area (LGA) boundaries © Australia Bureau of Statistic (ABS), 2011.
9. Vegetation Management Watercourse and Drainage feature map (1:100 000 and 1:250 000) - version 1.4 dataset © State of Queensland (Department of Natural Resources and Mines) 2016

COOPERS GAP WIND FARM
NOISE AND VIBRATION IMPACT ASSESSMENT

NOISE MONITORING LOCATIONS

PROJECT #:	60489152
CREATED BY:	BM
LAST MODIFIED:	BM: 25/11/2016
VERSION:	1

Figure B-1

A3 size

Document Path: P:\604X\604891524. Tech Work Area\4.99 GIS\MXD\EIS_2016\TechnicalReport_Acoustics\LAYOUT1\P60489152_TechR_Acoustics_FigureB-1_NoiseMonitoringLocations.mxd

Appendix C

Noise Monitor Photos

Appendix C Noise Monitor Photos

Figure 1: Location AA

Figure 2: Location AD

Figure 3: Location AU/AV

Figure 4: Location BB

Figure 5: Location BF

Figure 6: Location C

Figure 7: Location CF

Figure 8: Location F

Figure 9: Location G

Figure 10: Location J

Figure 11: Location L

Figure 12: Location Y

Appendix D

Noise Monitoring Instrumentation Details

Appendix D Noise Monitoring Instrumentation Details

Details of the sound level instrumentation used to record noise levels at the twelve residential locations are presented in Table 15. Class 1 sound level meters were used to measure noise at all sites. These instruments were calibrated in the field at the start and end of the measurement periods using a Class 1 acoustic calibrator.

No field calibration drift greater than 1 dB was observed in all monitors, as required by the QLD Planning Guideline, with the exception of Location C. As such, the data measured at this location is presented in this report for information purposes only, and the data measured al location BF is used for assessment in lieu of Location C, due to their close distance.

All the instrumentation used in monitoring carried a current calibration certificate from a National Association of Testing Authorities (NATA) accredited laboratory at the time of measurement.

In addition, a Davis Vantage Pro portable weather station was used to measure wind speeds and rain fall. The weather station was installed at 2.0 metres above ground level. Details are presented in Table 16.

Table 15: Noise measurement equipment details

Noise Monitoring Location (Receptor ID)	Equipment make & model	Serial number	NATA calibration date at time of measurement	Measurement start	Measurement Stop
AA	Larson Davis 831	2313	23-01-2015	29-09-2016	7-11-2016
AD	SVAN 957	27551	14-01-2016	22-09-2016	7-11-2016
AU/AV	Larson Davis 831	2375	09-04-2015	22-09-2016	7-11-2016
BB	SVAN 957	27539	18-07-2016	21-09-2016	8-11-2016
BF	SVAN 957	27537	17-12-2015	22-09-2016	7-11-2016
C	SVAN 957	27554	24-06-2015	26-07-2016	22-09-2016
CF	SVAN 957	27540 & 27551	20-06-2016 & 14-01-2016	21-09-2016	17-11-2016
F	Larson Davis 831	2375	09-04-2015	26-07-2016	21-09-2016
G	SVAN 977 and SVAN 957	45416 & 27539	18-07-2016 & 18-07-2016	26-07-2016	21-09-2016
J	SVAN 957	27537	17-12-2015	26-07-2016	22-09-2016
L	SVAN 957	27551	14-01-2016	26-07-2016	21-09-2016
Y	SVAN 957	27539 & 27540	18-07-2016 & 20-06-2016	26-07-2016	21-09-2019
All	Quest QC-20 Acoustic Calibrator	QF3020010	09-11-2015	N.A.	N.A.

Table 16 Ground level weather monitoring equipment details

Noise Monitoring Location (Receptor ID)	Equipment make & model	Measurement start	Measurement stop
L	Davis Vantage Pro	26-07-2016	21-09-2016
AD	Davis Vantage Pro	22-09-2016	17-11-2016

Appendix D Calibration Certificates

CERTIFICATE OF CALIBRATION

CERTIFICATE NO.: SLM 40747 & FILT 0706

Equipment Description:	Sound Level Meter		
Manufacturer:	Larson Davis		
Model No:	831	**Serial No:**	0002313
Microphone Type:	PCB377B02	**Serial No:**	117967
Filter Type:	1/3 Octave	**Serial No:**	0002313
Comments:	All tests passed for type 1. (See over for details)		
Owner:	AECOM Australia Pty Ltd Level 6, 420 George Street Sydney, NSW 2000		
Ambient Pressure:	995 hPa ±1.5 hPa		
Temperature:	23 °C ±2° C	**Relative Humidity:**	53% ±5%
Date of Calibration:	23/01/2015	**Issue Date:**	23/01/2015
Acu-Vib Test Procedure:	AVP05 (SLM) & AVP06 (Filters)		

CHECKED BY: ..... **AUTHORISED SIGNATURE:** .....

Jacob Kidd

Accredited for compliance with ISO/IEC 17025
The results of the tests, calibration and/or measurements included in this document are traceable to Australian/national standards.

NATA
ACCREDITATION

Accredited Lab. No. 9262
Acoustic and Vibration Measurements

ACU-VIB
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Mobile: 0413 809806
web site: www.acu-vib.com.au

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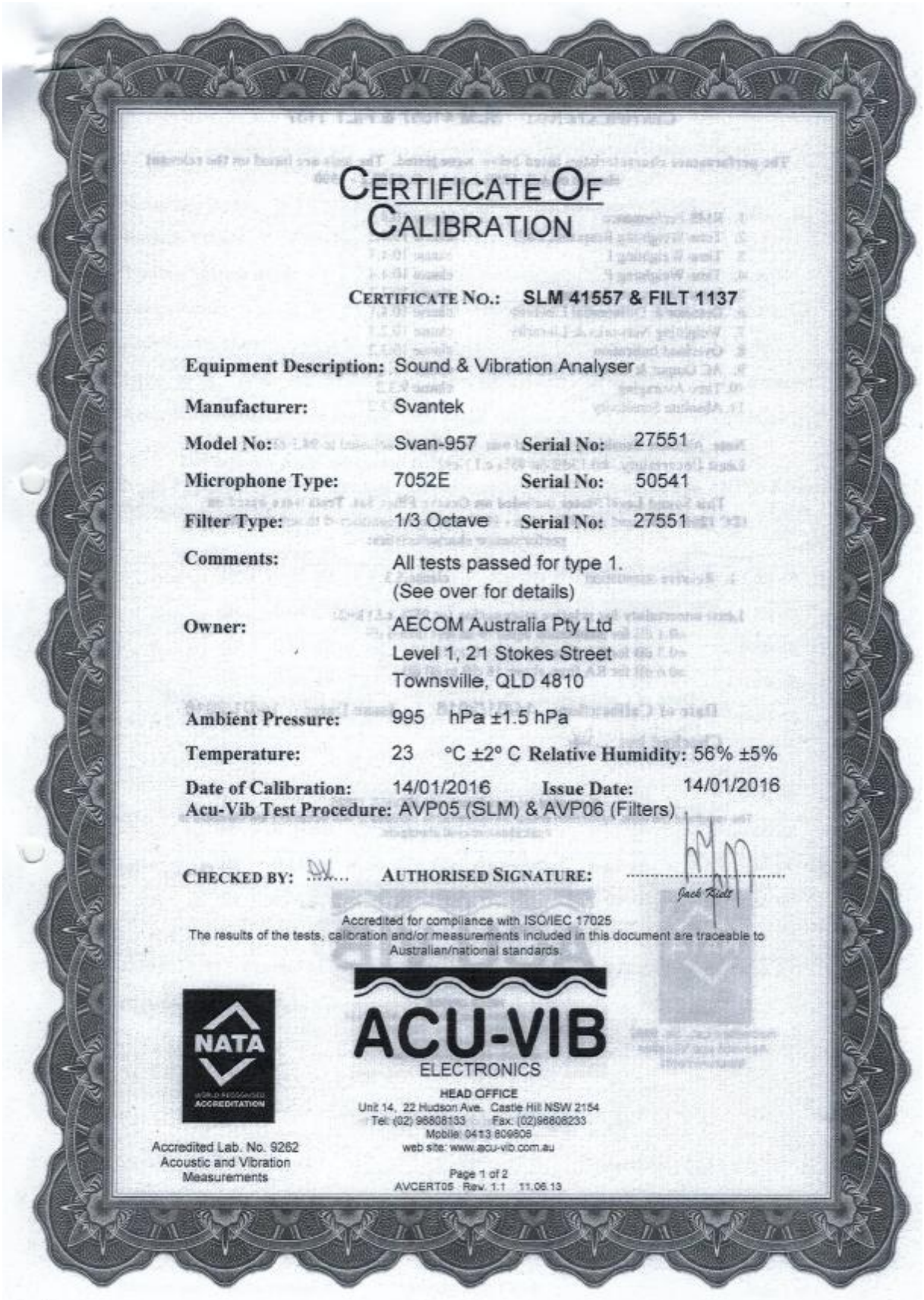
AVCERT05 Rev. 1.1 11.06.13



CERTIFICATE OF CALIBRATION

CERTIFICATE NO.: SLM 41557 & FILT 1137

Equipment Description:	Sound & Vibration Analyser		
Manufacturer:	Svantek		
Model No:	Svan-957	**Serial No:**	27551
Microphone Type:	7052E	**Serial No:**	50541
Filter Type:	1/3 Octave	**Serial No:**	27551
Comments:	All tests passed for type 1. (See over for details)		
Owner:	AECOM Australia Pty Ltd Level 1, 21 Stokes Street Townsville, QLD 4810		
Ambient Pressure:	995 hPa ±1.5 hPa		
Temperature:	23 °C ±2° C	**Relative Humidity:**	56% ±5%
Date of Calibration:	14/01/2016	**Issue Date:**	14/01/2016

Acu-Vib Test Procedure: AVP05 (SLM) & AVP06 (Filters)

CHECKED BY: ..... **AUTHORISED SIGNATURE:** .....

Jack Field

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The results of the tests, calibration and/or measurements included in this document are traceable to Australian/national standards.

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Calibration Certificate

Certificate Number 2015003237

Customer:
Thermo Fisher Scientific Australia Pty Ltd
5 Caribbean Drive Scoresby
Victoria, 3179, Australia

Model Number	831
Serial Number	0002375
Test Results	**Pass**
Initial Condition	AS RECEIVED same as shipped
Description	Larson Davis Model 831

Procedure Number	D0001.8384	
Technician	Ron Harris	
Calibration Date	9 Apr 2015	
Calibration Due	9 Apr 2016	
Temperature	23.59 °C	± 0.01 °C
Humidity	50.4 %RH	± 0.5 %RH
Static Pressure	86.44 kPa	± 0.03 kPa

Evaluation Method ***Tested with:***
PRM831, S/N 017088
377B02, S/N 120146

Data reported in dB re 20 µPa.

Compliance Standards Compliant to Manufacturer Specifications and the following standards when combined with Calibration Certificate from procedure D0001.8378:

IEC 60651:2001 Type 1	ANSI S1.4-2014 Class 1
IEC 60804:2000 Type 1	ANSI S1.4 (R2006) Type 1
IEC 61252:2002	ANSI S1.11 (R2009) Class 1
IEC 61260:2001 Class 1	ANSI S1.25 (R2007)
IEC 61672:2013 Class 1	ANSI S1.43 (R2007) Type 1

Issuing lab certifies that the instrument described above meets or exceeds all specifications as stated in the referenced procedure (unless otherwise noted). It has been calibrated using measurement standards traceable to the SI through the National Institute of Standards and Technology (NIST), or other national measurement institutes, and meets the requirements of ISO/IEC 17025:2005. **Test points marked with a ‡ in the uncertainties column do not fall within this laboratory's scope of accreditation.**

The quality system is registered to ISO 9001:2008.

This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances would be made by the customer as needed.

The uncertainties were computed in accordance with the ISO Guide to the Expression of Uncertainty in Measurement (GUM). A coverage factor of approximately 2 sigma (k=2) has been applied to the standard uncertainty to express the expanded uncertainty at approximately 95% confidence level.

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Standards Used

Description	Cal Date	Cal Due	Cal Standard
SRS DS360 Ultra Low Distortion Generator	07/08/2014	07/08/2015	006311
Hart Scientific 2626-S Humidity/Temperature Sensor	05/16/2014	05/16/2015	006943
Larson Davis CAL200 Acoustic Calibrator	08/06/2014	08/06/2015	007027
Larson Davis Model 831	03/05/2015	03/05/2016	007182
1/2 inch Microphone - P - 0V	03/11/2014	03/11/2015	007185
Larson Davis CAL291 Residual Intensity Calibrator	09/26/2014	09/26/2015	007287

Larson Davis, a division of PCB Piezotronics, Inc
1681 West 820 North
Provo, UT 84601, United States
716-684-0001

ACCREDITED Cert. #3822.01

LARSON DAVIS
A PCB PIEZOTRONICS DIV.

4/9/2015 12:26:20PM

Page 1 of 2

Certificate Number 2015003237

Acoustic Calibration

Measured according to IEC 61672-3:2013 10 and ANSI S1.4-2014 Part 3: 10

Measurement	Test Result [dB]	Lower Limit [dB]	Upper Limit [dB]	Expanded Uncertainty [dB]	Result
1000 Hz					
As Received Level: 114.18 Adjusted Level: 114.00					

-- End of measurement results--

Acoustic Signal Tests, C-weighting

Measured according to IEC 61672-3:2013 12 and ANSI S1.4-2014 Part 3: 12 using a comparison coupler with Unit Under Test (UUT) and reference SLM using S-time-weighted sound level

Frequency [Hz]	Test Result [dB]	Expected [dB]	Lower Limit [dB]	Upper Limit [dB]	Expanded Uncertainty [dB]	Result
125	-0.14	-0.20	-1.20	0.80	0.21	Pass
1000	0.12	0.00	-0.70	0.70	0.21	Pass
8000	-2.41	-3.00	-5.50	-1.50	0.21	Pass

-- End of measurement results--

Self-generated Noise

Measured according to IEC 61672-3:2013 11.1 and ANSI S1.4-2014 Part 3: 11.1

Measurement	Test Result [dB]
Low Range, 20 dB gain	63.79

-- End of measurement results--

-- End of Report--

Signatory: *Ron Harris*

Larson Davis, a division of PCB Piezotronics, Inc
1681 West 820 North
Provo, UT 84601, United States
716-684-0001

4/9/2015 12:26:20PM

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CERTIFICATE OF CALIBRATION

CERTIFICATE NO.: SLM 19200 & FILT 1354

Equipment Description:	Sound & Vibration Analyser		
Manufacturer:	Svantek		
Model No:	Svan-957	**Serial No:**	27539
Microphone Type:	7052E	**Serial No:**	50502
Filter Type:	1/3 Octave	**Serial No:**	27539
Comments:	All tests passed for class 1. (See over for details)		
Owner:	AECOM Australia Pty Ltd Level 21, 420 George Street Sydney NSW 2000		
Ambient Pressure:	1009 hPa ±1.5 hPa		
Temperature:	22 °C ±2° C	**Relative Humidity:**	52% ±5%
Date of Calibration:	18/07/2016	**Issue Date:**	18/07/2016
Acu-Vib Test Procedure:	AVP10 (SLM) & AVP06 (Filters)		

CHECKED BY: ..... **AUTHORISED SIGNATURE:** .....
Jack Rielt

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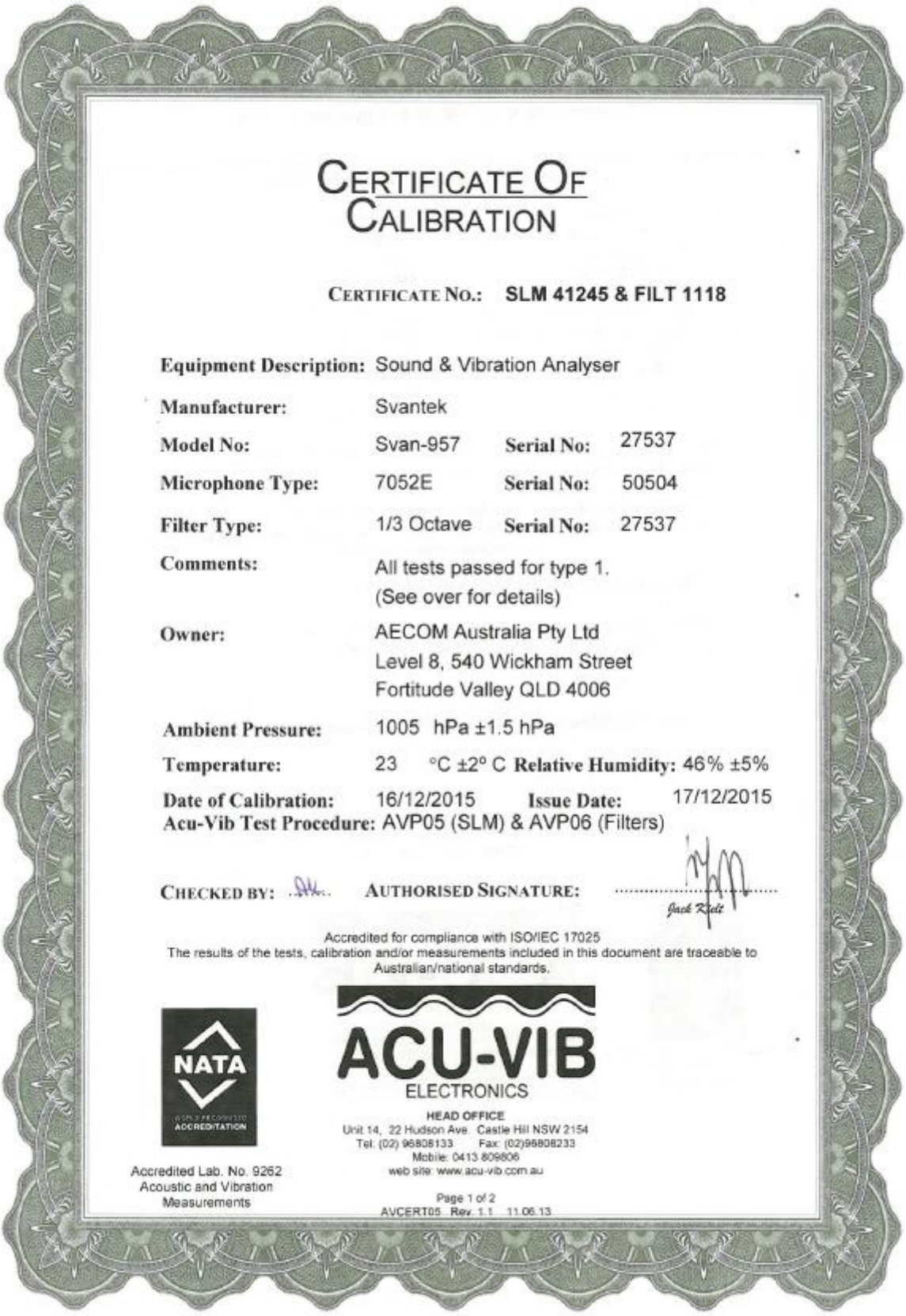

CERTIFICATE OF CALIBRATION

CERTIFICATE NO.: SLM 41245 & FILT 1118

Equipment Description:	Sound & Vibration Analyser		
Manufacturer:	Svantek		
Model No:	Svan-957	**Serial No:**	27537
Microphone Type:	7052E	**Serial No:**	50504
Filter Type:	1/3 Octave	**Serial No:**	27537
Comments:	All tests passed for type 1. (See over for details)		
Owner:	AECOM Australia Pty Ltd Level 8, 540 Wickham Street Fortitude Valley QLD 4006		
Ambient Pressure:	1005 hPa ±1.5 hPa		
Temperature:	23 °C ±2° C	**Relative Humidity:**	46% ±5%
Date of Calibration:	16/12/2015	**Issue Date:**	17/12/2015

Acu-Vib Test Procedure: AVP05 (SLM) & AVP06 (Filters)

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Jack Ziolt

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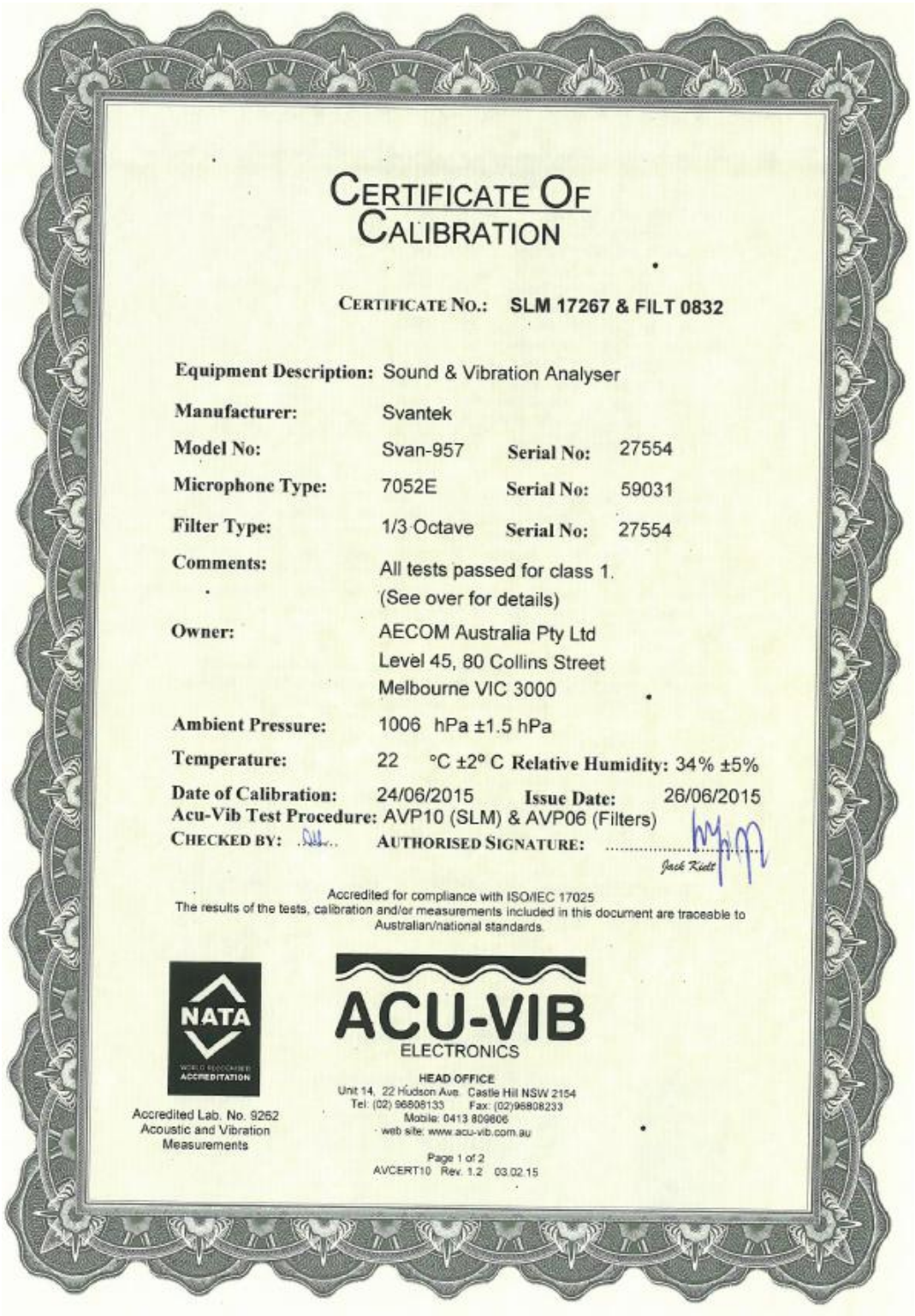

CERTIFICATE OF CALIBRATION

CERTIFICATE NO.: **SLM 17267 & FILT 0832**

Equipment Description:	Sound & Vibration Analyser		
Manufacturer:	Svantek		
Model No:	Svan-957	**Serial No:**	27554
Microphone Type:	7052E	**Serial No:**	59031
Filter Type:	1/3 Octave	**Serial No:**	27554
Comments:	All tests passed for class 1. (See over for details)		
Owner:	AECOM Australia Pty Ltd Level 45, 80 Collins Street Melbourne VIC 3000		
Ambient Pressure:	1006 hPa ±1.5 hPa		
Temperature:	22 °C ±2° C	**Relative Humidity:**	34% ±5%
Date of Calibration:	24/06/2015	**Issue Date:**	26/06/2015

Acu-Vib Test Procedure: AVP10 (SLM) & AVP06 (Filters)

CHECKED BY: ..... **AUTHORISED SIGNATURE:** .....

Jack Kidd

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Sound Level Meter
IEC 61672-3.2006
Calibration Certificate

Calibration Number C16298

Client Details AECOM Australia Pty Ltd
Level 8, 540 Wickham Street
Fortitude Valley QLD 4006

Equipment Tested/ Model Number : SVAN 957
Instrument Serial Number : 027540
Microphone Serial Number : 101859
Pre-amplifier Serial Number : 29799

Pre-Test Atmospheric Conditions		Post-Test Atmospheric Conditions	
Ambient Temperature :	22°C	**Ambient Temperature :**	22°C
Relative Humidity :	48%	**Relative Humidity :**	50%
Barometric Pressure :	99kPa	**Barometric Pressure :**	100kPa

Calibration Technician : Aaron Skeates-Udy
Calibration Date : 17/06/2016
Secondary Check: Riley Cooper
Report Issue Date : 20/06/2016
Approved Signatory : Ken Williams

Clause and Characteristic Tested	Result	Clause and Characteristic Tested	Result
10: Self-generated noise	*Pass*	14: Level linearity on the reference level range	*Pass*
11: Acoustical tests of a frequency weighting	*Pass*	15: Level linearity incl. the level range control	*Pass*
12: Electrical tests of frequency weightings	*Pass*	16: Toneburst response	*Pass*
13: Frequency and time weightings at 1 kHz	*Pass*	17: Peak C sound level	*Pass*
		18: Overload Indication	*Pass*

The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2006, for the environmental conditions under which the tests were performed.

However, no general statement or conclusion can be made about conformance of the sound level meter to the full requirements of IEC 61672-1:2002 because evidence was not publicly available, from an independent testing organisation responsible for pattern approvals, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2002 and because the periodic tests of IEC 61672-3:2006 cover only a limited subset of the specifications in IEC 61672-1:2002.

Least Uncertainties of Measurement -

Acoustic Tests		Environmental Conditions	
31.5 Hz to 8kHz	*±0.12dB*	*Temperature*	*±0.05°C*
12.5kHz	*±0.18dB*	*Relative Humidity*	*±0.46%*
16kHz	*±0.51dB*	*Barometric Pressure*	*±0.017kPa*
Electrical Tests			
31.5 Hz to 20 kHz	*±0.12dB*		

All uncertainties are derived at the 95% confidence level with a coverage factor of 2.

NATA ACCREDITATION

This calibration certificate is to be read in conjunction with the calibration test report.

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CERTIFICATE OF CALIBRATION

CERTIFICATE NO.: SLM 18391 & FILT 1158

Equipment Description:	Sound & Vibration Analyser		
Manufacturer:	Svantek		
Model No:	Svan-977	**Serial No:**	45416
Microphone Type:	7052E	**Serial No:**	61674
Filter Type:	1/1 Octave	**Serial No:**	45416
Comments:	All tests passed for class 1. (See over for details)		
Owner:	AECOM Australia Pty Ltd Level 8, 540 Wickham Street Fortitude Valley QLD 4006		
Ambient Pressure:	999 hPa ±1.5 hPa		
Temperature:	21 °C ±2° C	**Relative Humidity:**	52% ±5%
Date of Calibration:	04/02/2016	**Issue Date:**	05/02/2016

Acu-Vib Test Procedure: AVP10 (SLM) & AVP06 (Filters)

CHECKED BY: ...AW... **AUTHORISED SIGNATURE:** .....

Jack Rust

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CERTIFICATE OF CALIBRATION

CERTIFICATE NO: 18098

EQUIPMENT TESTED: Sound Level Calibrator

Manufacturer: Quest **Class:** 1
Type No: QC-20 **Serial No:** QF3020010
Owner: AECOM Australia Pty Ltd
Level 8, 540 Wickham Street
Fortitude Valley QLD 4006

Tests Performed: According to AS/IEC 60942 and procedure AVPO2

Parameter	Pre-Adj	Adj Y/N	Output: (db re 20 µPa)	Frequency: (Hz)	THD&N (%)
Level 1:	NA	N	94.28	994.63	0.89
Level 2:	NA	N	114.23	994.65	0.45
Level 1:	NA	N	94.35	249.50	1.12
Level 2:	NA	N	114.26	249.50	0.50
Uncertainty:			±0.11 dB	±0.05 Hz	±0.2 %
Uncertainty (at 95% c.l.) k=2					

TEST CONDITIONS:
Ambient Pressure: 1006 hPa ± 1.5 hPa **Relative Humidity:** 45% ± 5%
Temperature: 25 °C ± 2° C
Date of Calibration: 09/11/2015 **Issue Date:** 09/11/2015

CHECKED BY: ..... **AUTHORISED SIGNATURE:** ..... Jack Kiatt

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The uncertainties quoted are calculated in accordance with the methods of the ISO Guide to the Uncertainty of Measurement and quoted at a coverage factor of 2 with a confidence interval of approximately 95%.

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Appendix E

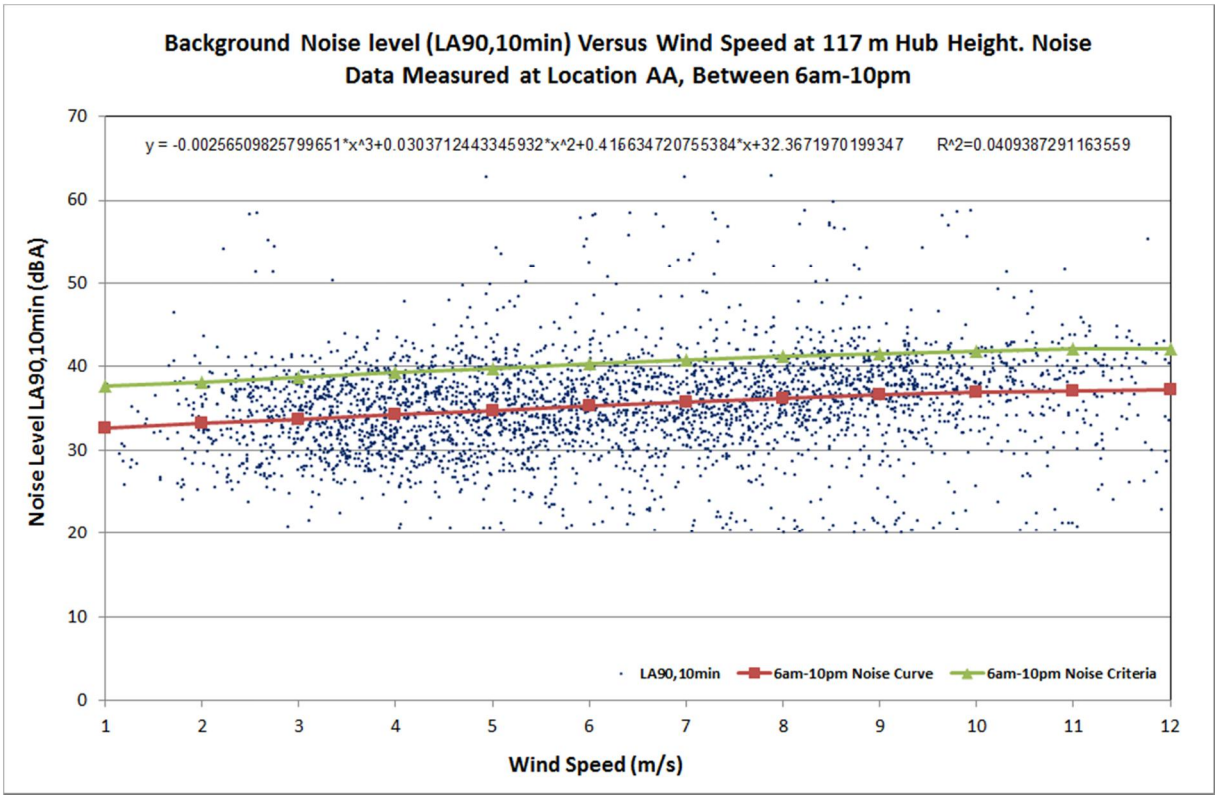
Noise Regression Curves

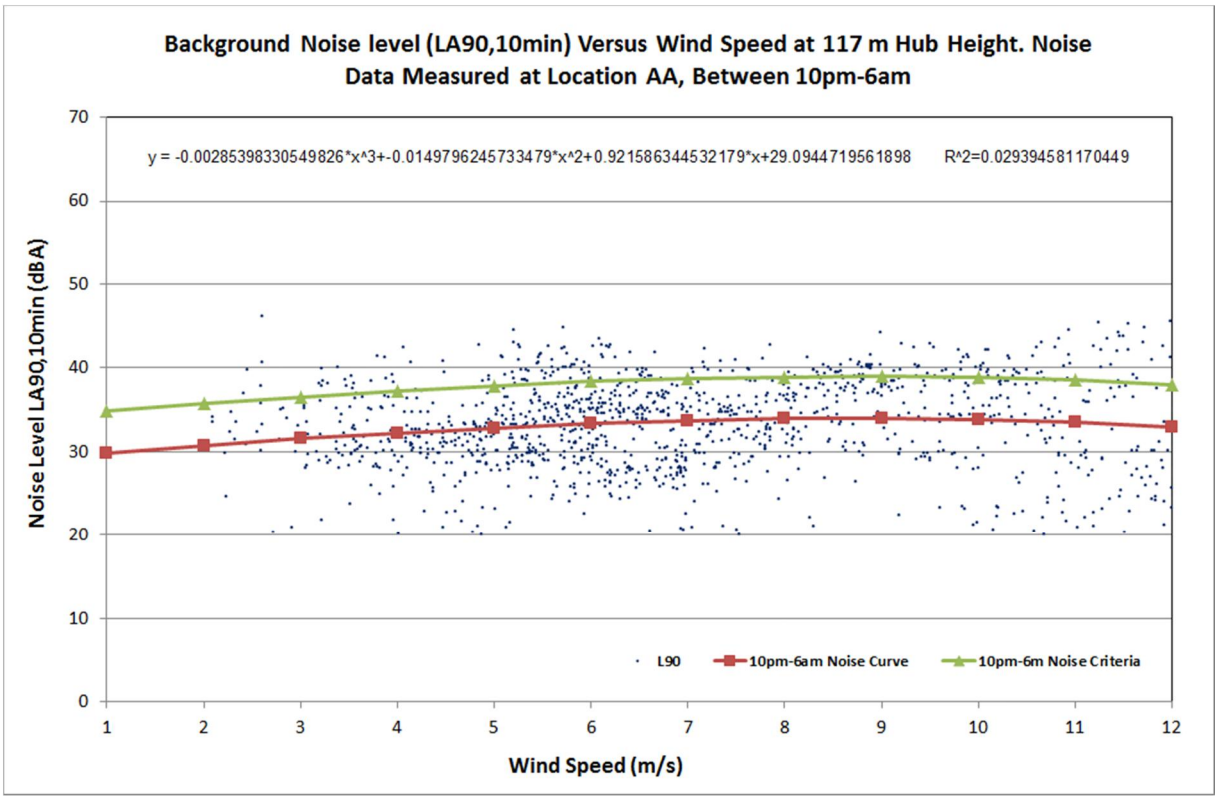
Appendix E Noise Regression Curves

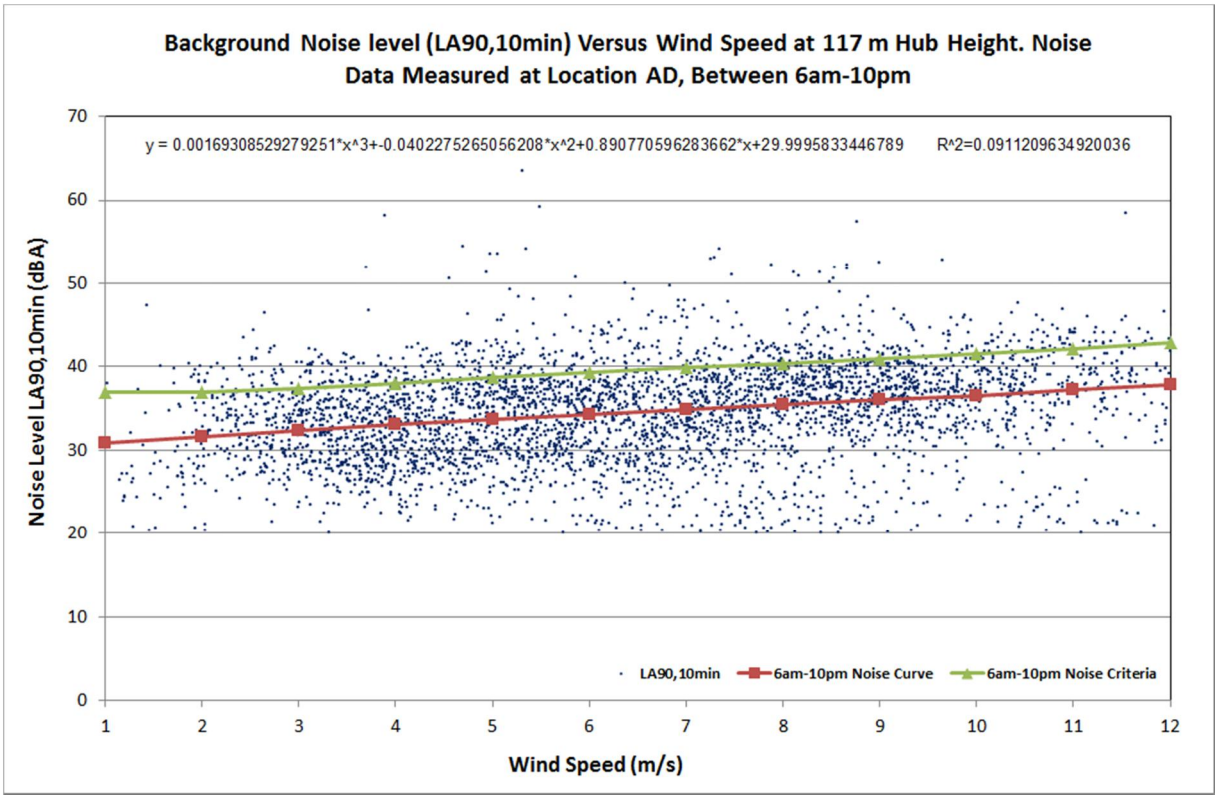
For all the noise monitoring sites, a third-order polynomial regression was calculated, as per the QLD Planning Guideline. The correlation coefficients (r) for each 3rd order of polynomial obtained for each monitoring location are presented in Table 17.

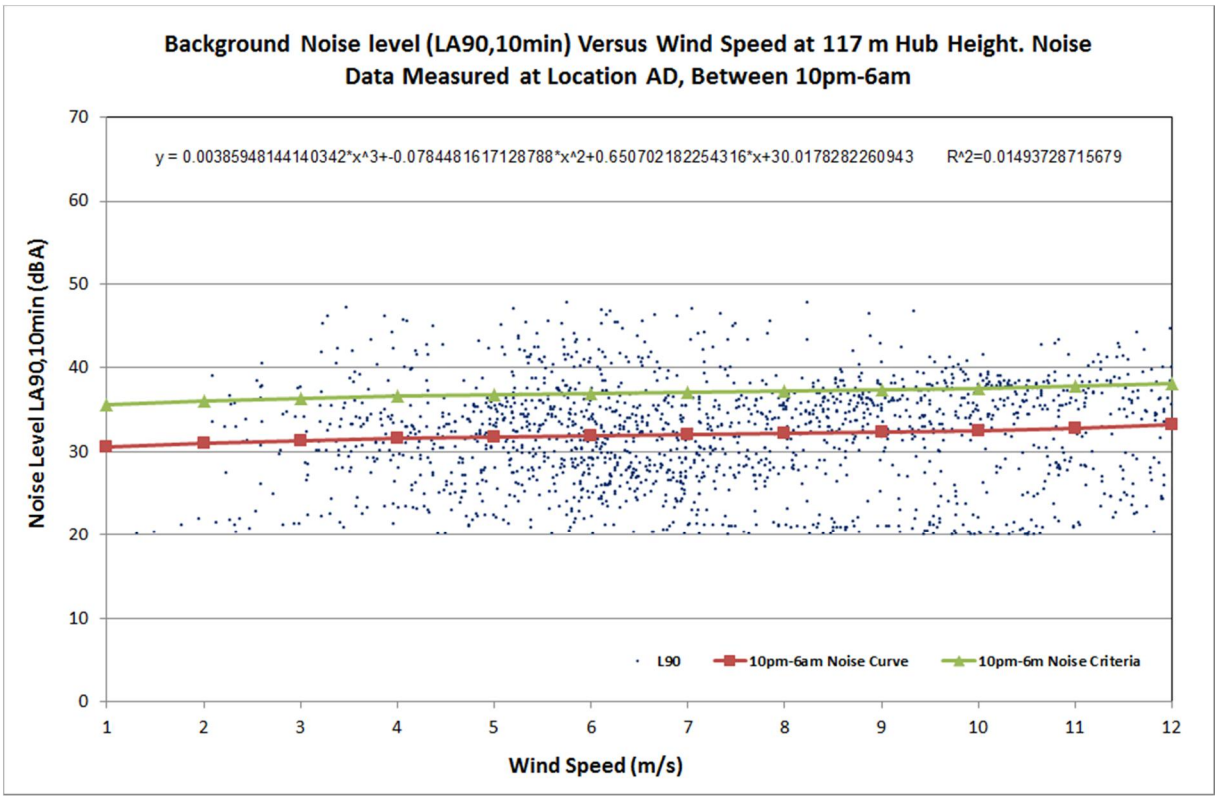
Table 17: Correlation coefficients for 3rd order polynomial regression lines

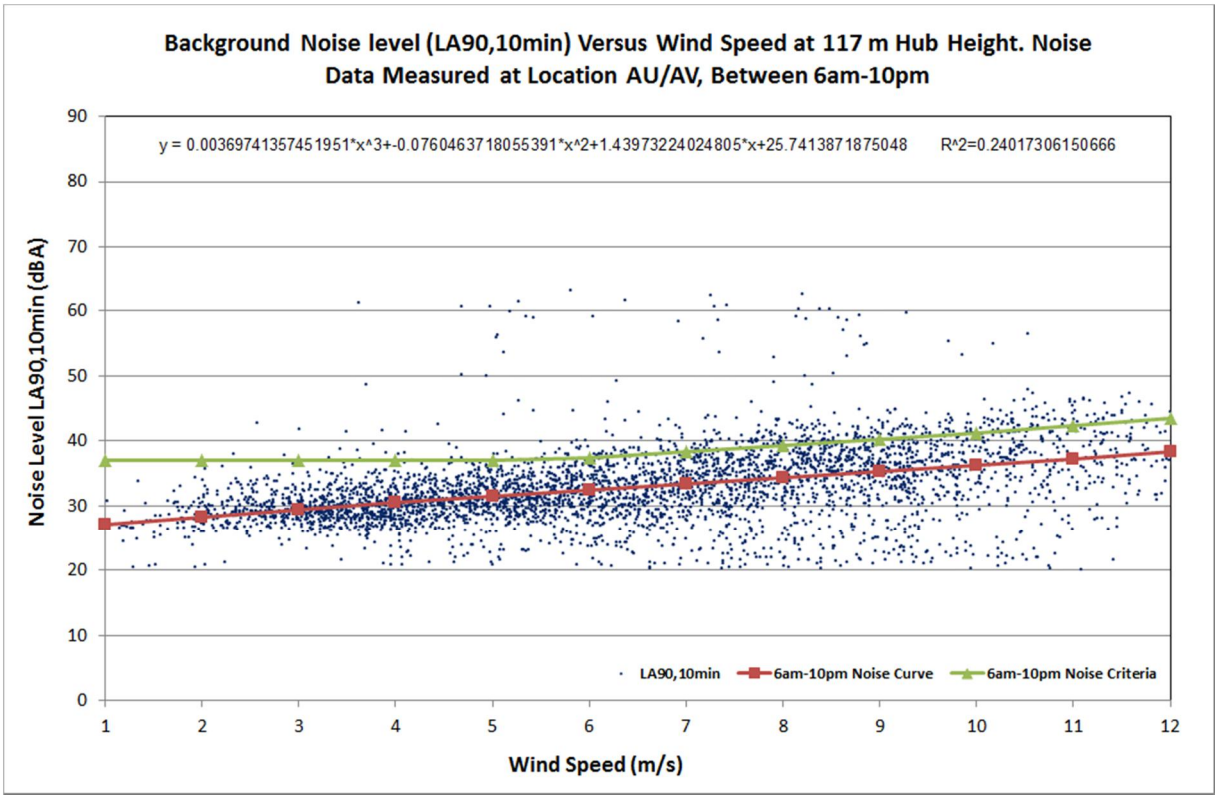
Location	Correlation coefficient (r) for 3rd order polynomial	
	6am-10pm	10pm-6am
AA	0.2022	0.1715
AD	0.3018	0.1221
AU/AV	0.4901	0.4192
BB	1.0799	0.2472
BF	0.3913	0.2903
C	0.5220	0.3799
CF	0.3947	0.1404
F	0.4579	0.5475
G	0.6780	0.6788
J	0.4741	0.3274
L	0.5618	0.3279
Y	0.4758	0.3068

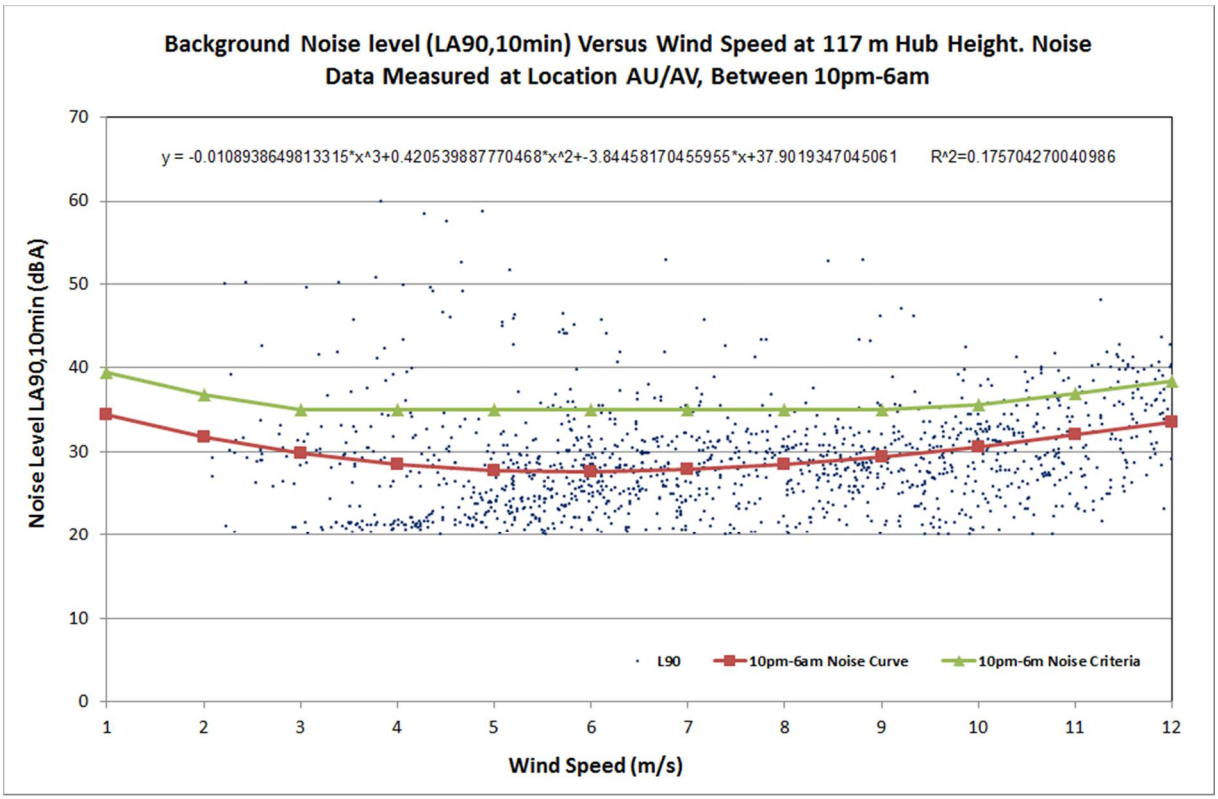

Background Noise level (LA90,10min) Versus Wind Speed at 117 m Hub Height. Noise Data Measured at Location AA, Between 6am-10pm
y = -0.0025650982579965 1*x^3+0.0303712443345932*x^2+0.416634720755384*x+32.3671970199347
R^2=0.0409387291163559
Noise Level LA90,10min (dBA)
Wind Speed (m/s)
LA90,10min
6am-10pm Noise Curve
6am-10pm Noise Criteria

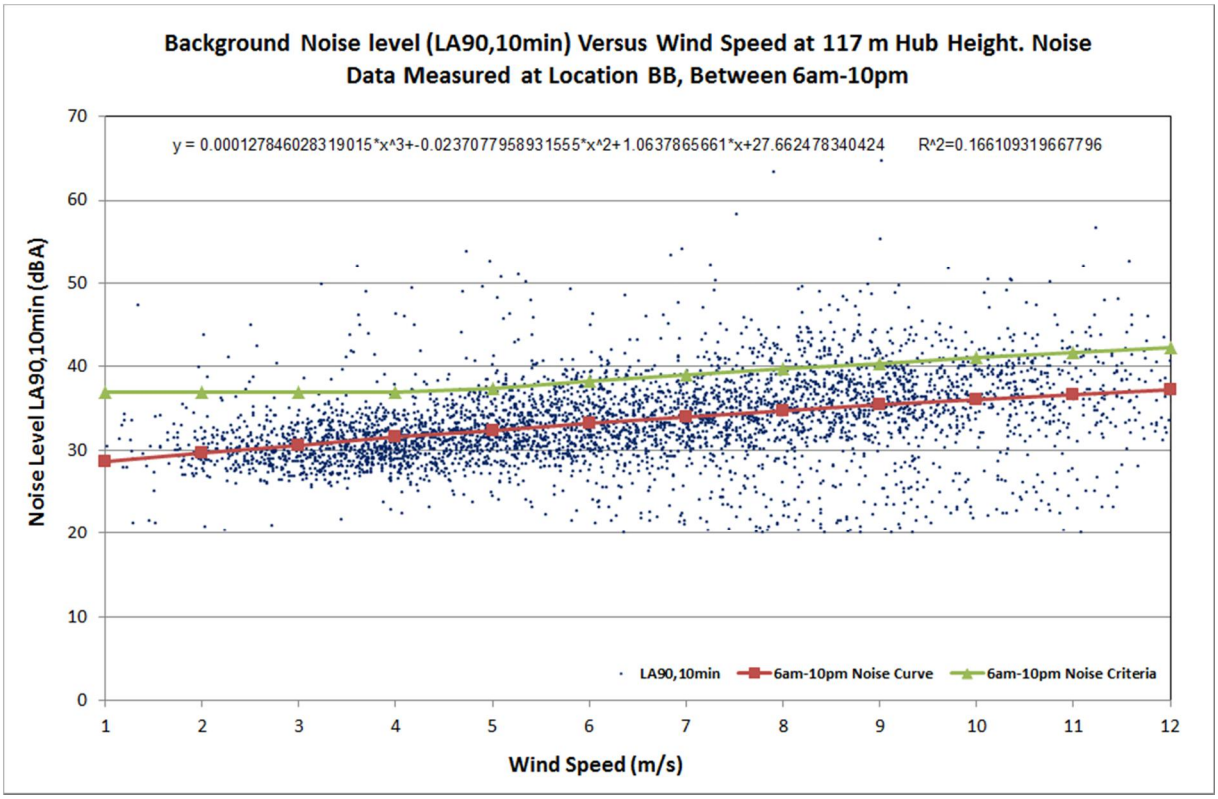

Background Noise level (LA90,10min) Versus Wind Speed at 117 m Hub Height. Noise Data Measured at Location AA, Between 10pm-6am
y = -0.0028539833054982 6*x^3+-0.0149796245733479*x^2+0.921586344532179*x+29.0944719561898
R^2=0.029394581170449
Noise Level LA90,10min (dBA)
Wind Speed (m/s)
L90
10pm-6am Noise Curve
10pm-6m Noise Criteria

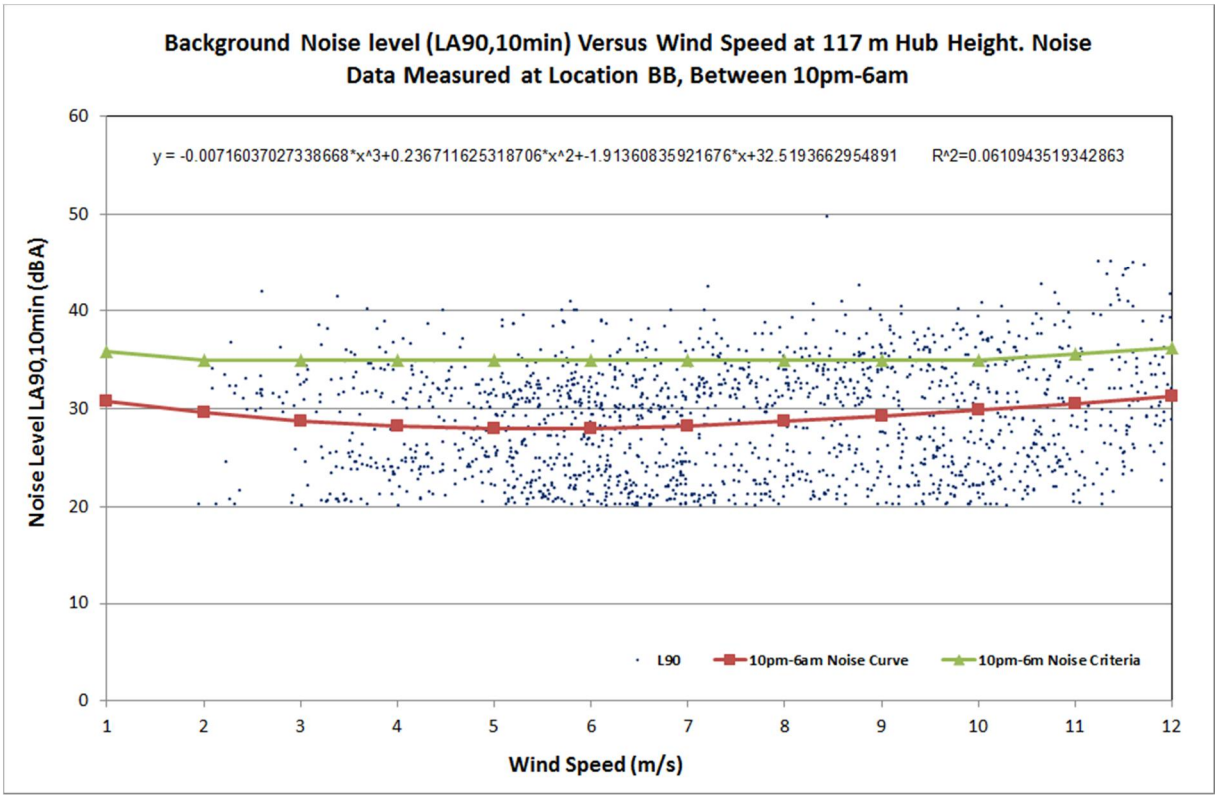

Background Noise level (LA90,10min) Versus Wind Speed at 117 m Hub Height. Noise Data Measured at Location AD, Between 6am-10pm
y = 0.0016930852927925 1*x^3+-0.0402275265056208*x^2+0.890770596283662*x+29.9995833446789
R^2=0.0911209634920036
Noise Level LA90,10min (dBA)
Wind Speed (m/s)
LA90,10min
6am-10pm Noise Curve
6am-10pm Noise Criteria

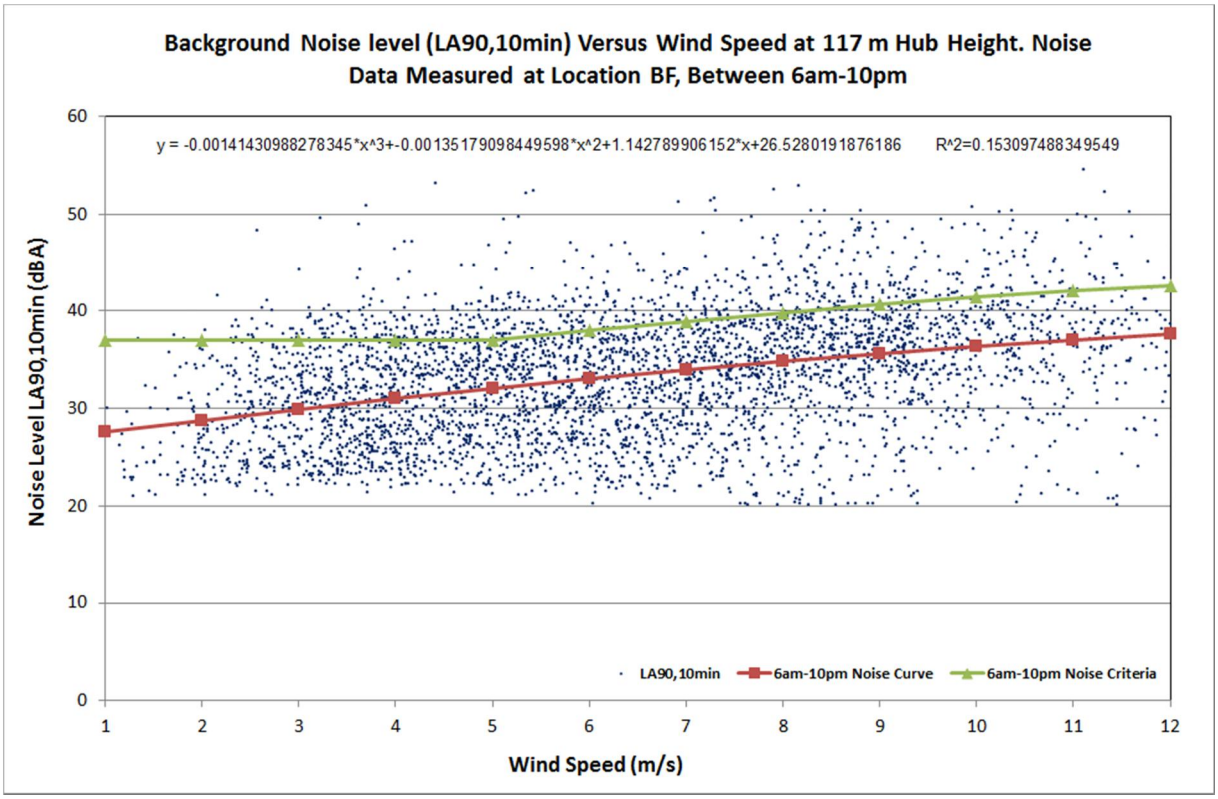

Background Noise level (LA90,10min) Versus Wind Speed at 117 m Hub Height. Noise Data Measured at Location AD, Between 10pm-6am
y = 0.0038594814414034 2*x^3+-0.0784481617128788*x^2+0.650702182254316*x+30.0178282260943
R^2=0.01493728715679
Noise Level LA90,10min (dBA)
Wind Speed (m/s)
L90
10pm-6am Noise Curve
10pm-6m Noise Criteria

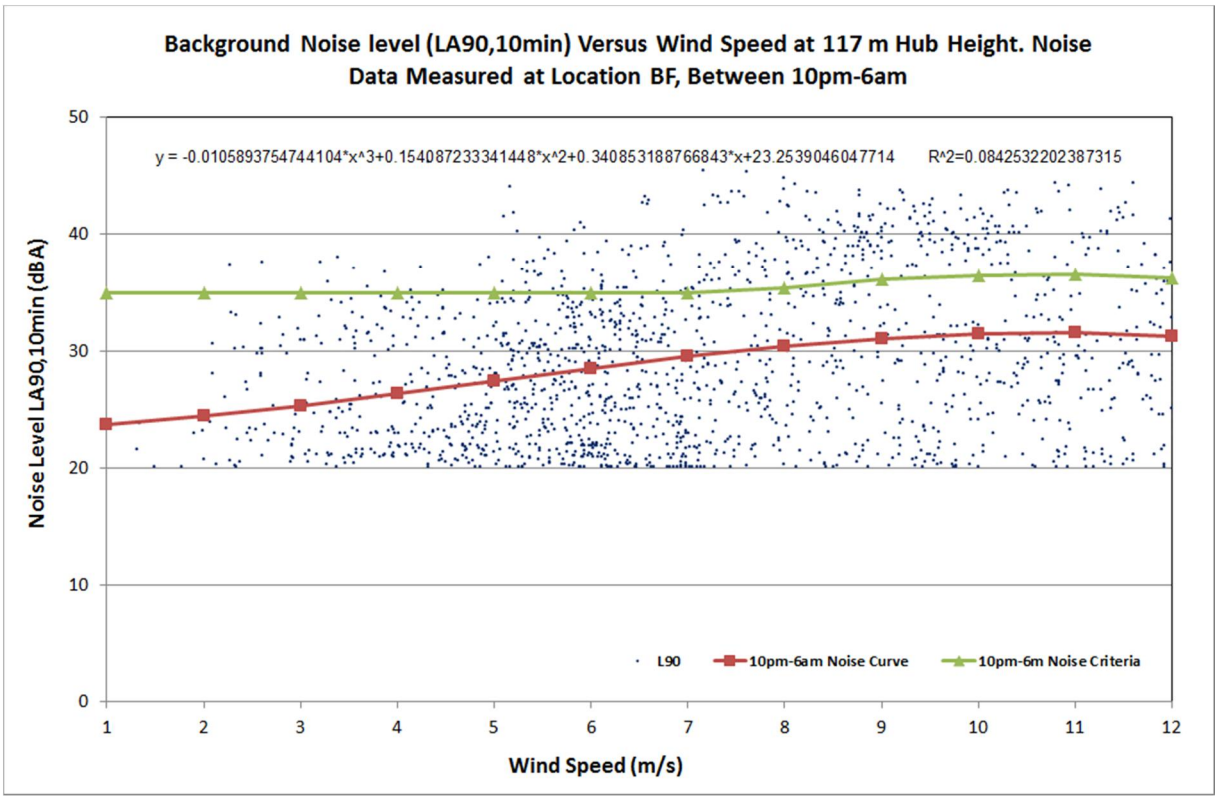

Background Noise level (LA90,10min) Versus Wind Speed at 117 m Hub Height. Noise Data Measured at Location AU/AV, Between 6am-10pm
y = 0.0036974135745195 1*x^3+-0.0760463718055391*x^2+1.4397322402480 5*x+25.7413871875048
R^2=0.24017306150666
Noise Level LA90,10min (dBA)
Wind Speed (m/s)
LA90,10min
6am-10pm Noise Curve
6am-10pm Noise Criteria

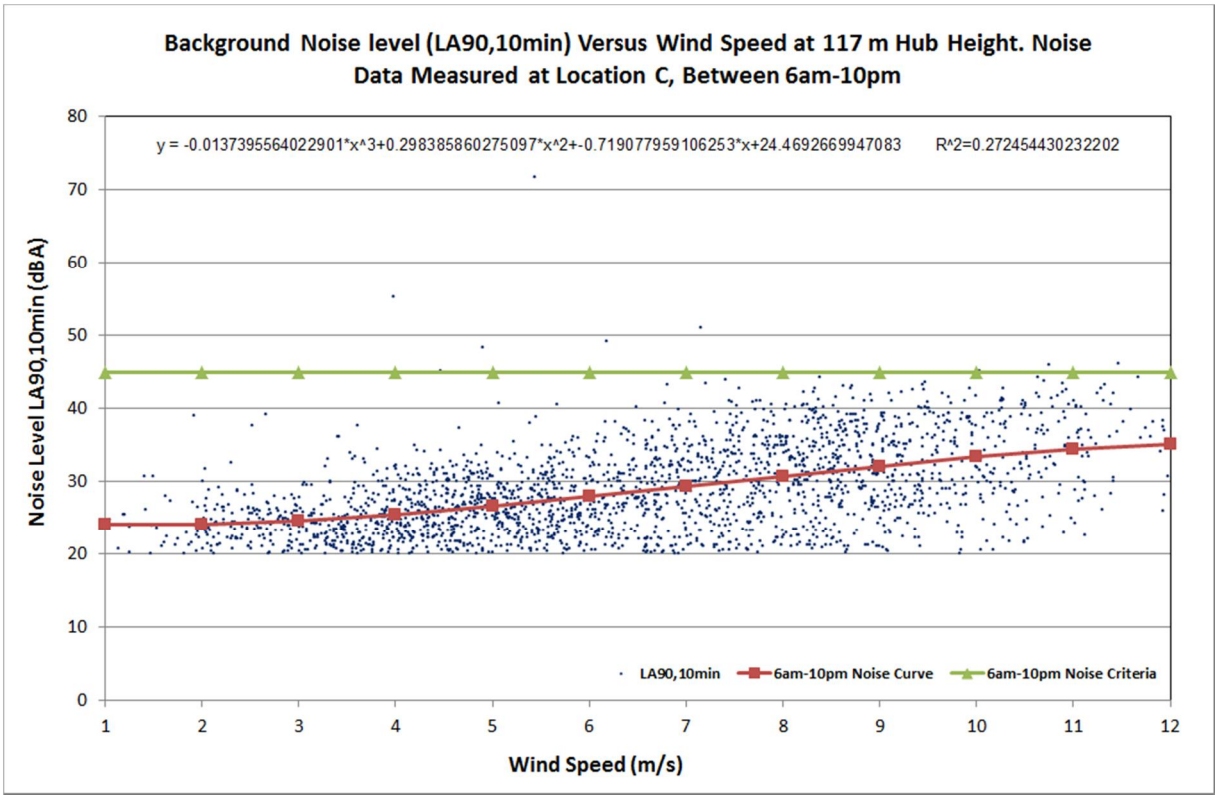

Background Noise level (LA90,10min) Versus Wind Speed at 117 m Hub Height. Noise Data Measured at Location AU/AV, Between 10pm-6am
y = -0.0108938649813315*x^3+0.420539887770468*x^2+-3.84458170455955*x+37.9019347045061
R^2=0.175704270040986
Noise Level LA90,10min (dBA)
Wind Speed (m/s)
L90
10pm-6am Noise Curve
10pm-6m Noise Criteria


Background Noise level (LA90,10min) Versus Wind Speed at 117 m Hub Height. Noise Data Measured at Location BB, Between 6am-10pm
y = 0.000127846028319015*x^3+-0.0237077958931555*x^2+1.0637865661*x+27.662478340424
R^2=0.166109319667796
Noise Level LA90,10min (dBA)
Wind Speed (m/s)
LA90,10min
6am-10pm Noise Curve
6am-10pm Noise Criteria

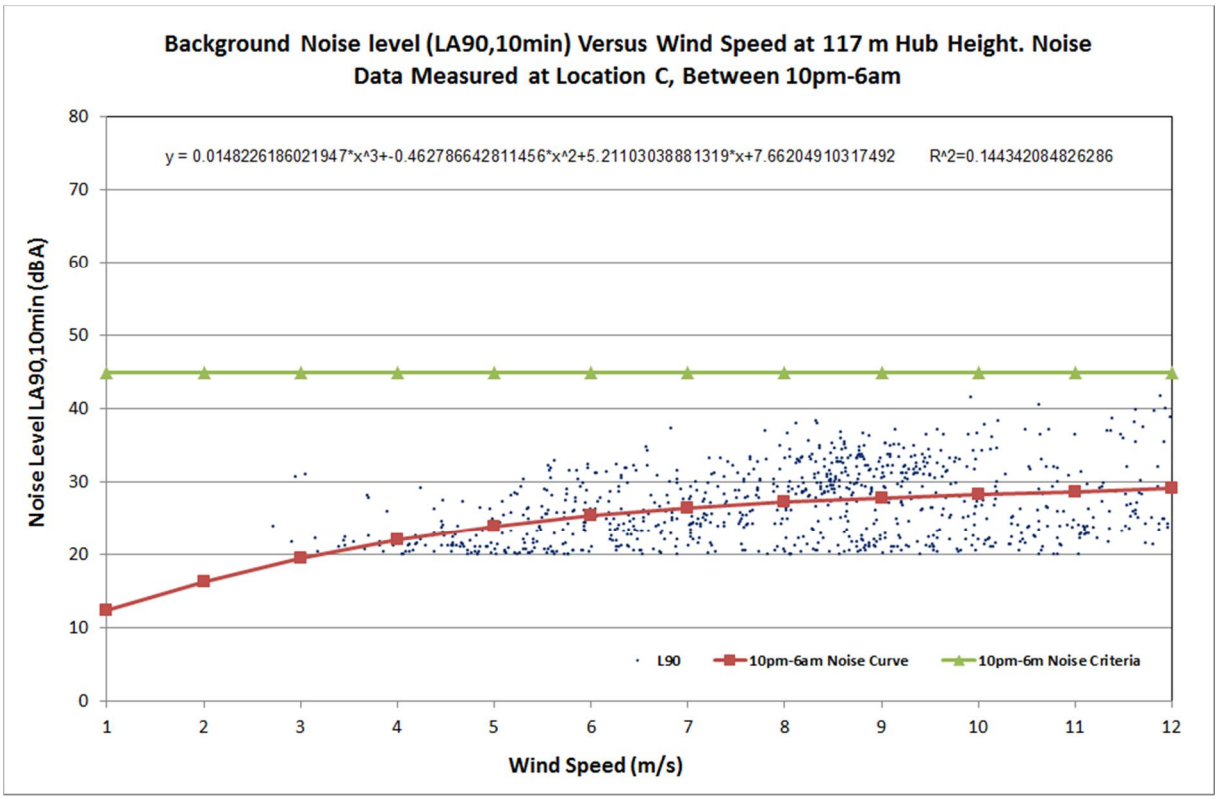

Background Noise level (LA90,10min) Versus Wind Speed at 117 m Hub Height. Noise Data Measured at Location BB, Between 10pm-6am
y = -0.00716037027338668*x^3+0.236711625318706*x^2+-1.91360835921676*x+32.5193662954891
R^2=0.0610943519342863
Noise Level LA90,10min (dBA)
Wind Speed (m/s)
L90
10pm-6am Noise Curve
10pm-6m Noise Criteria

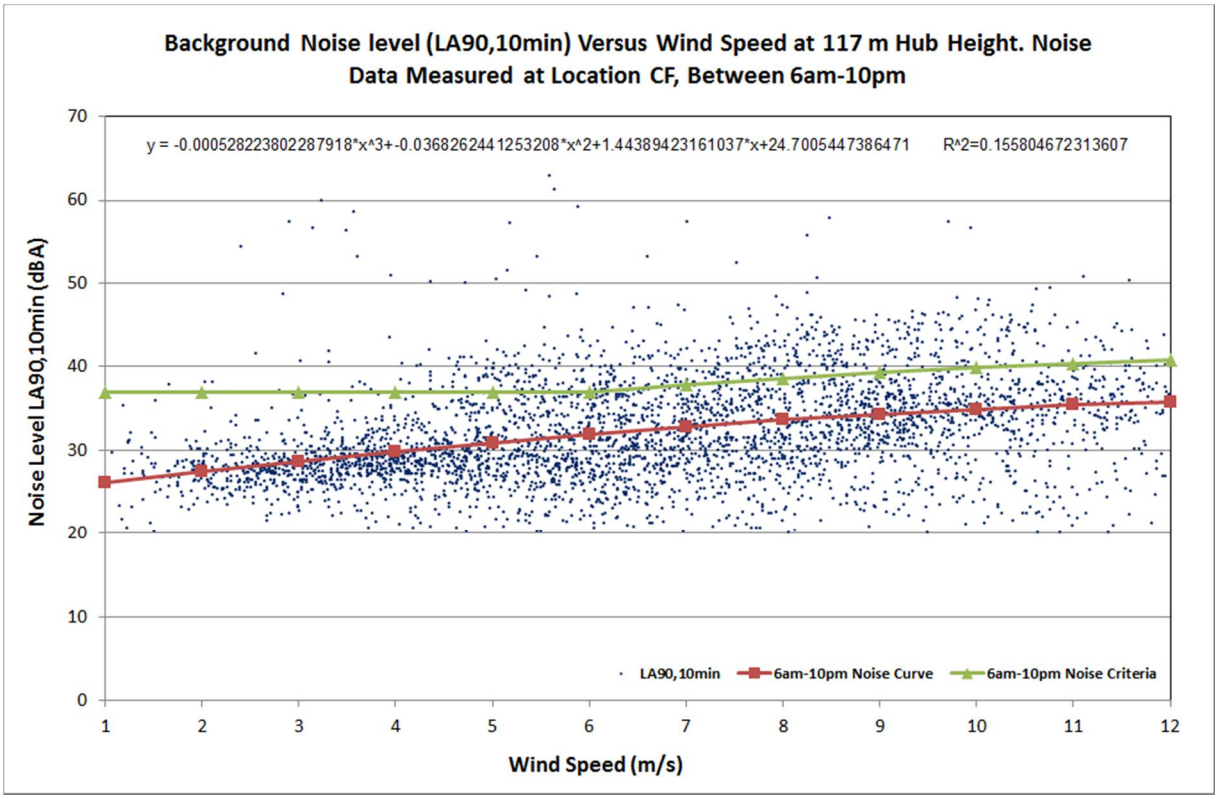

Background Noise level (LA90,10min) Versus Wind Speed at 117 m Hub Height. Noise Data Measured at Location BF, Between 6am-10pm
y = -0.00141430988278345*x^3+-0.00135179098449598*x^2+1.142789906152*x+26.5280191876186
R^2=0.153097488349549
Noise Level LA90,10min (dBA)
Wind Speed (m/s)
LA90,10min
6am-10pm Noise Curve
6am-10pm Noise Criteria

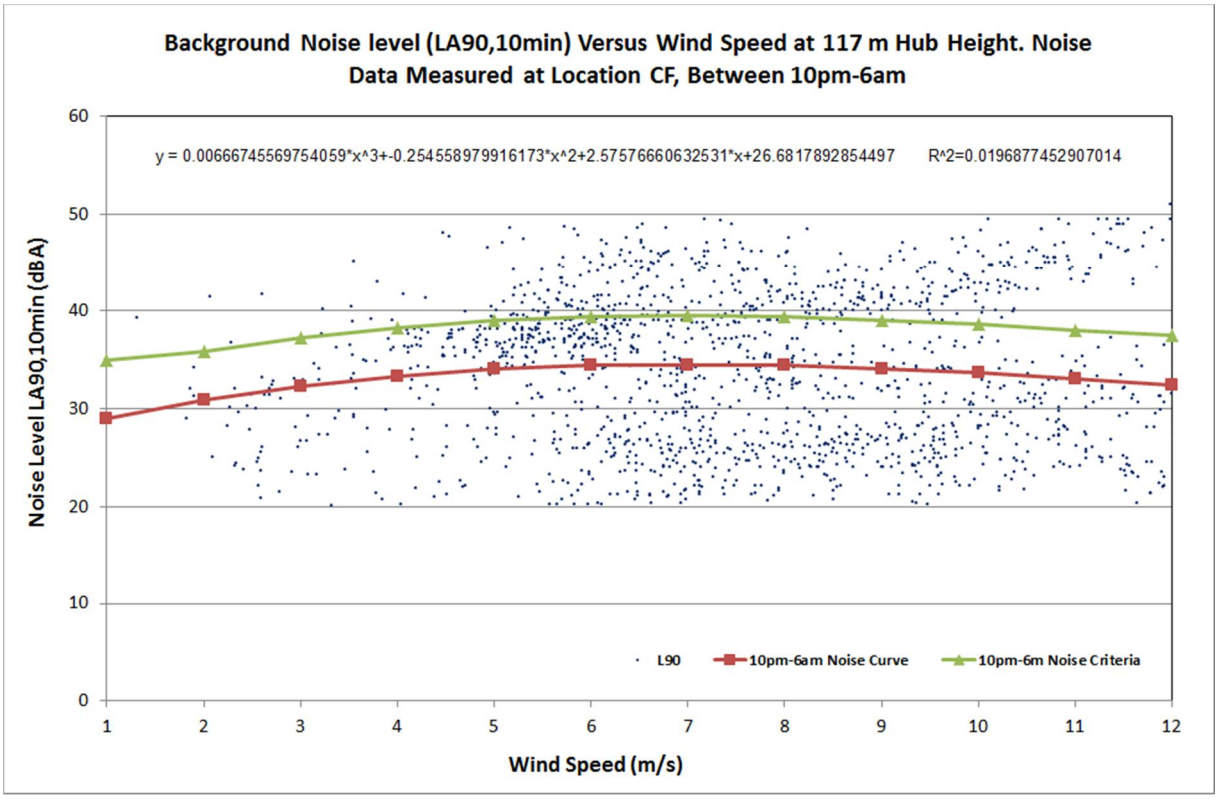

Background Noise level (LA90,10min) Versus Wind Speed at 117 m Hub Height. Noise Data Measured at Location BF, Between 10pm-6am
y = -0.0105893754744104*x^3+0.154087233341448*x^2+0.340853188766843*x+23.2539046047714
R^2=0.0842532202387315
Noise Level LA90,10min (dBA)
Wind Speed (m/s)
L90
10pm-6am Noise Curve
10pm-6m Noise Criteria

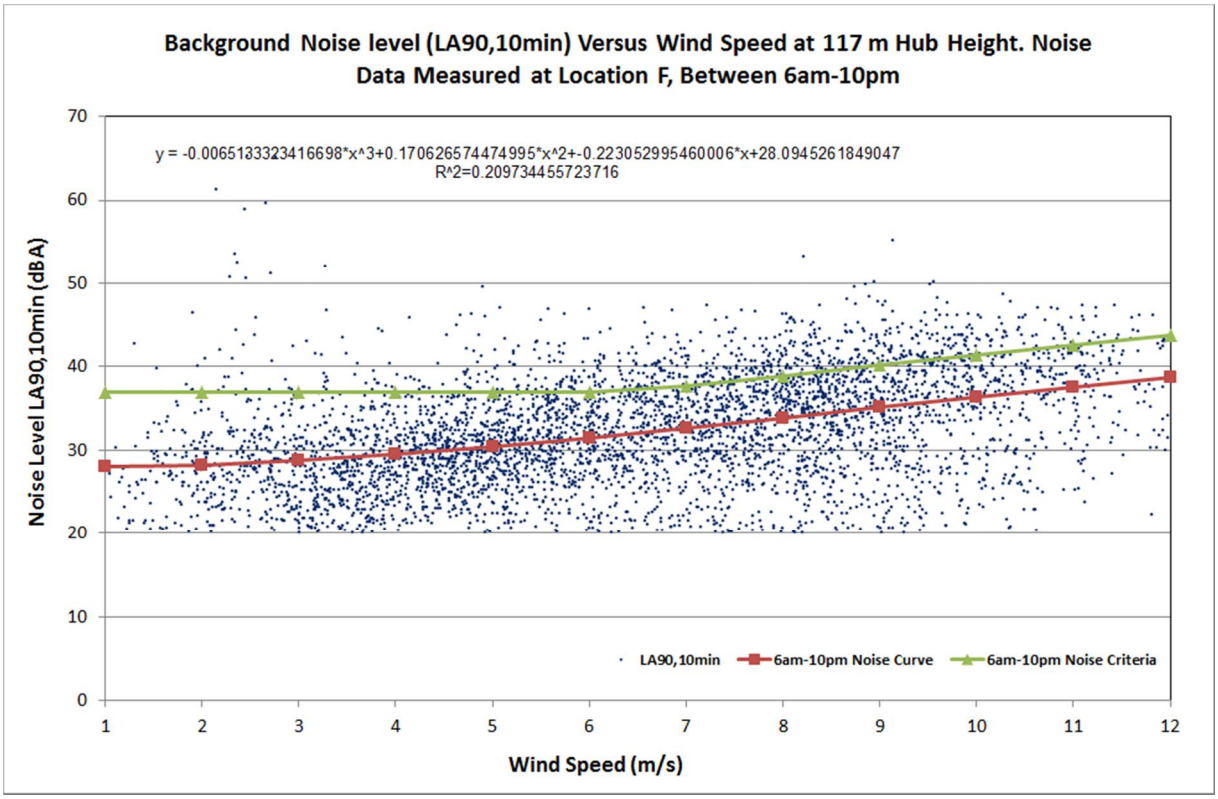

Background Noise level (LA90,10min) Versus Wind Speed at 117 m Hub Height. Noise Data Measured at Location C, Between 6am-10pm
y = -0.0137395564022901*x^3+0.298385860275097*x^2+-0.719077959106253*x+24.4692669947083
R^2=0.272454430232202
Noise Level LA90,10min (dBA)
Wind Speed (m/s)
LA90,10min
6am-10pm Noise Curve
6am-10pm Noise Criteria

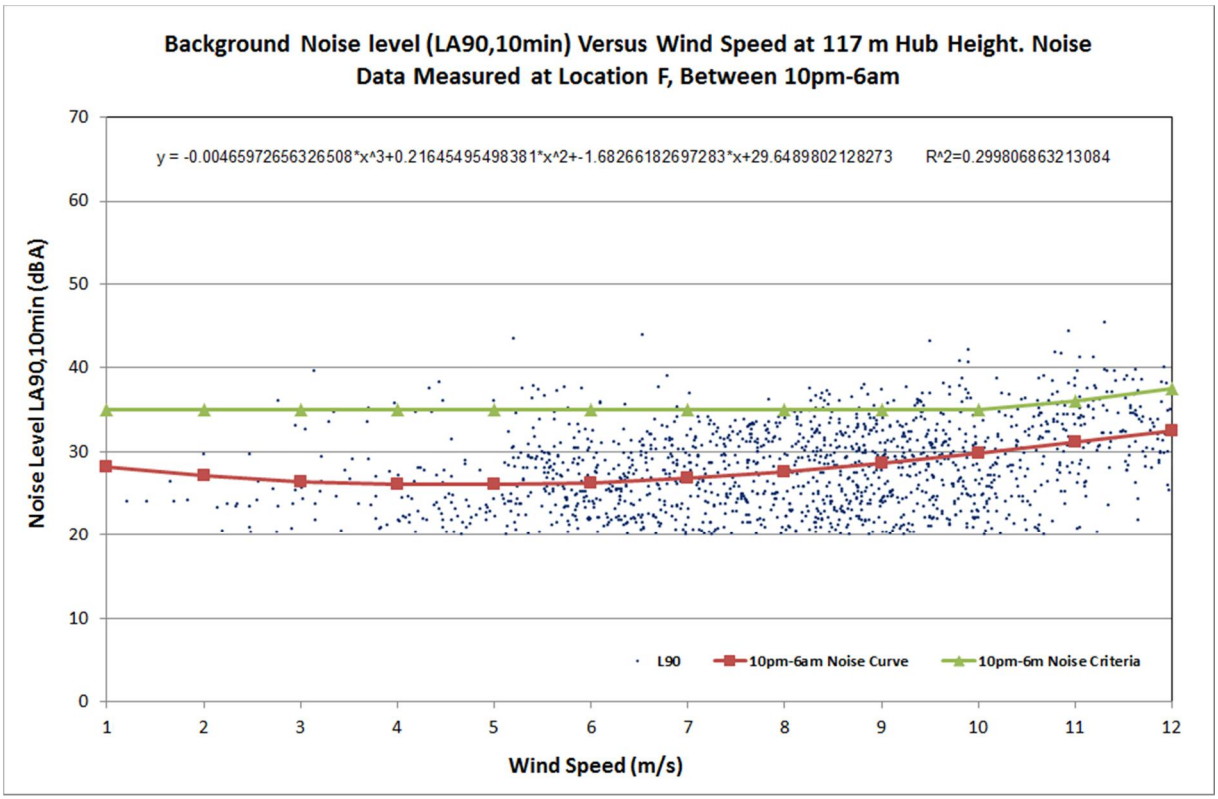
.

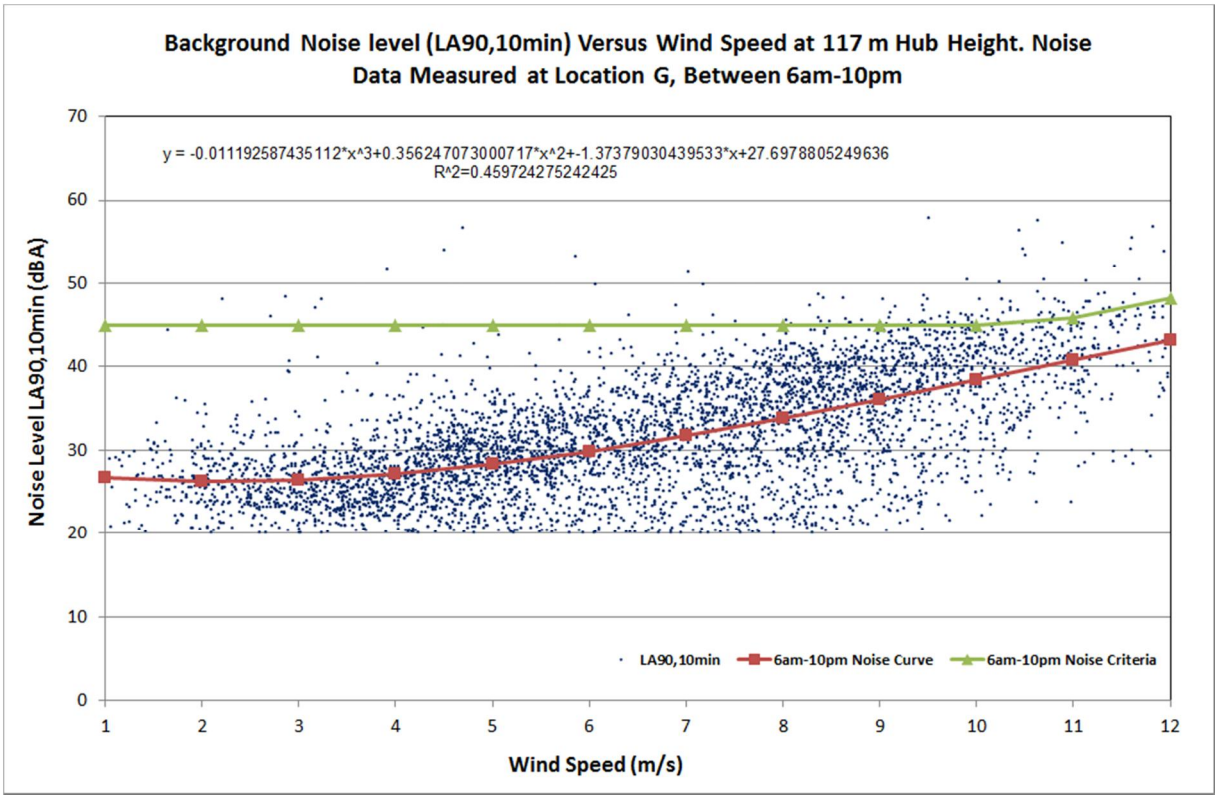

Background Noise level (LA90,10min) Versus Wind Speed at 117 m Hub Height. Noise Data Measured at Location C, Between 10pm-6am
y = 0.0148226186021947*x^3+-0.462786642811456*x^2+5.21103038881319*x+7.66204910317492
R^2=0.144342084826286
Noise Level LA90,10min (dBA)
Wind Speed (m/s)
L90
10pm-6am Noise Curve
10pm-6m Noise Criteria

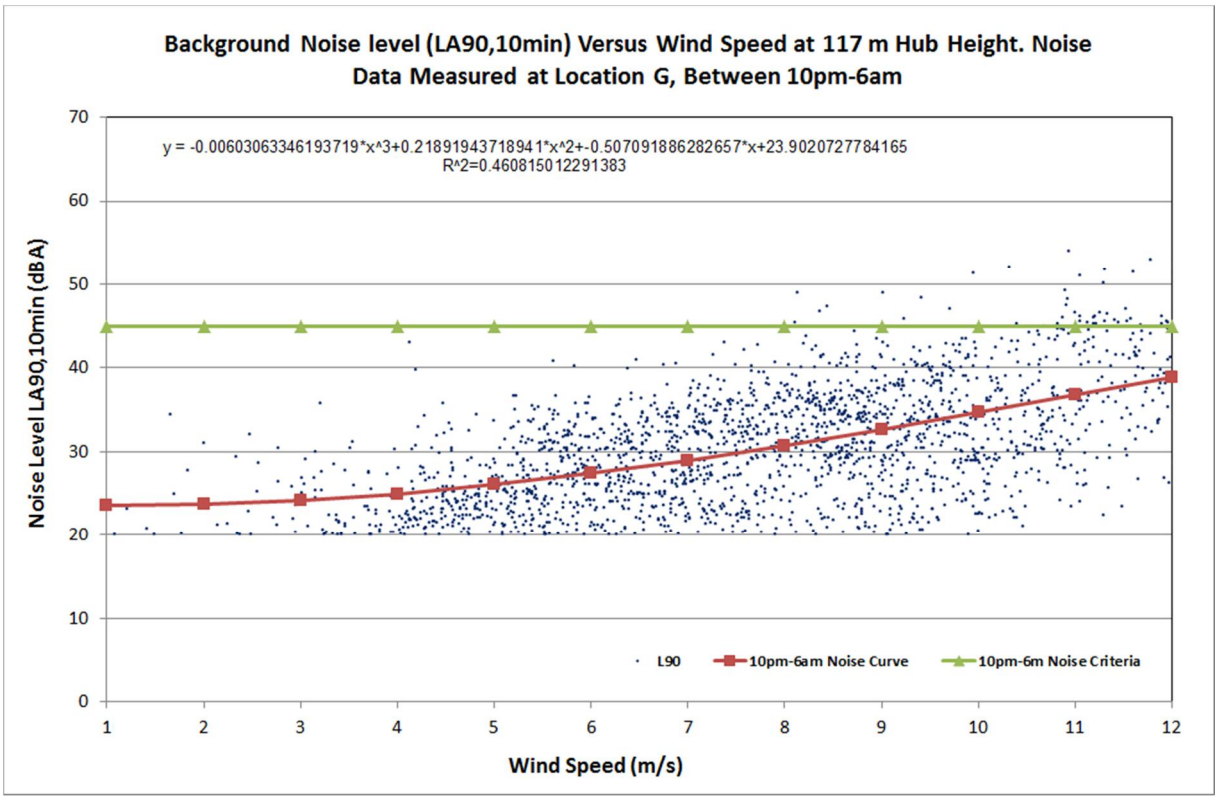

Background Noise level (LA90,10min) Versus Wind Speed at 117 m Hub Height. Noise Data Measured at Location CF, Between 6am-10pm
y = -0.0005282238022879 18*x^3+-0.036826244125320 8*x^2+1.44389423161037*x+24.7005447386471
R^2=0.155804672313607
Noise Level LA90,10min (dBA)
Wind Speed (m/s)
LA90,10min
6am-10pm Noise Curve
6am-10pm Noise Criteria

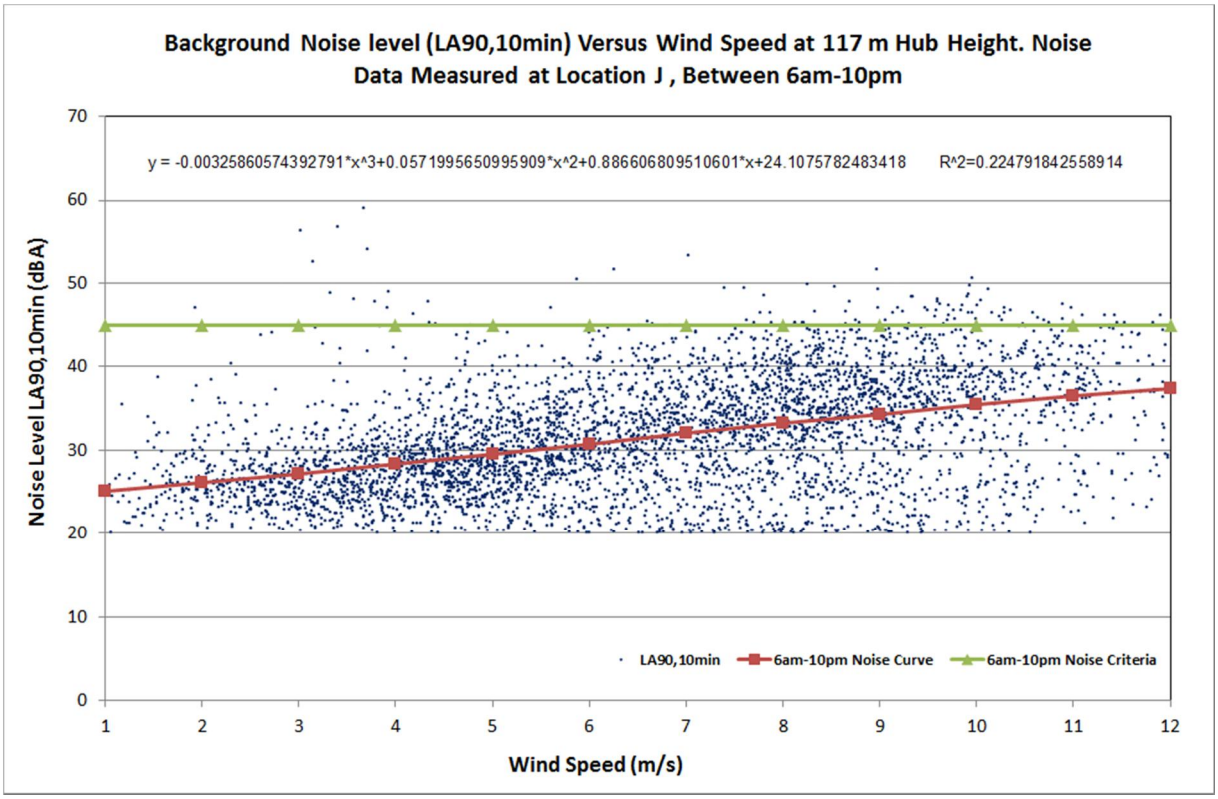

Background Noise level (LA90,10min) Versus Wind Speed at 117 m Hub Height. Noise Data Measured at Location CF, Between 10pm-6am
y = 0.0066674556975405 9*x^3+-0.254558979916173*x^2+2.57576660632531*x+26.6817892854497
R^2=0.0196877452907014
Noise Level LA90,10min (dBA)
Wind Speed (m/s)
L90
10pm-6am Noise Curve
10pm-6m Noise Criteria

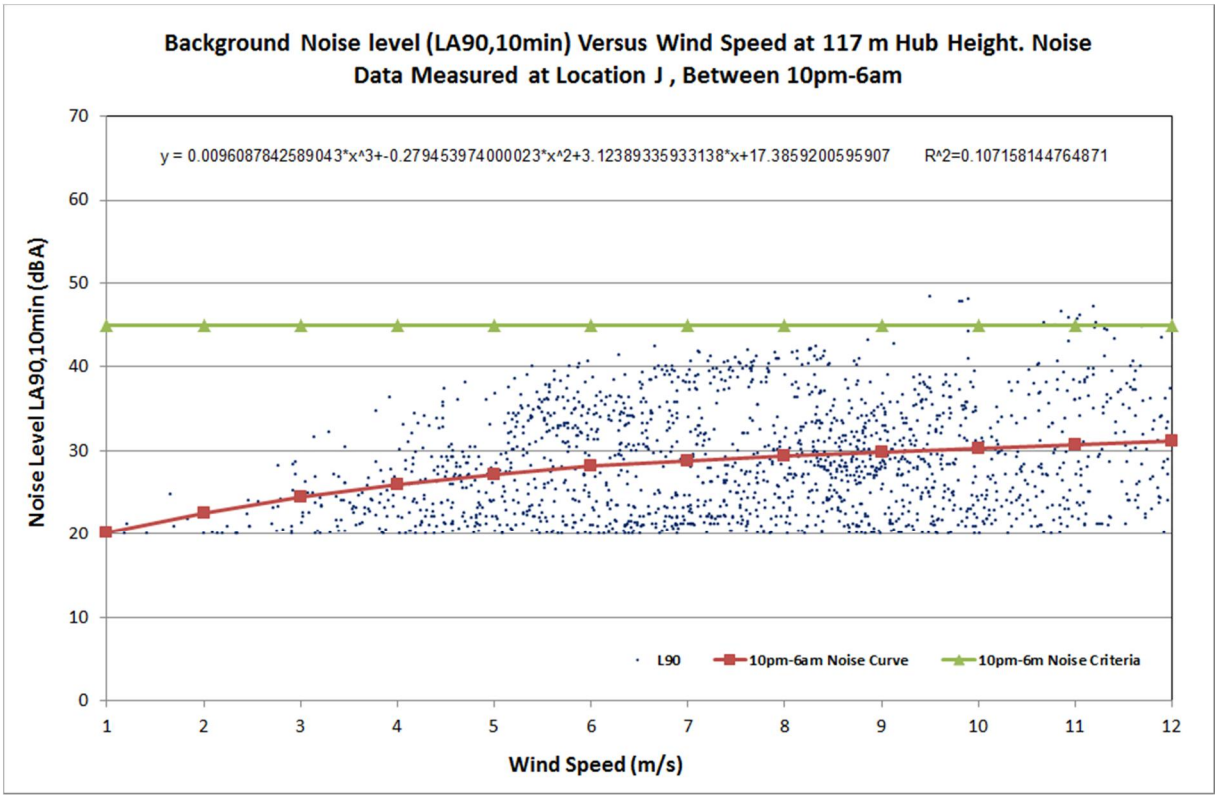

Background Noise level (LA90,10min) Versus Wind Speed at 117 m Hub Height. Noise Data Measured at Location F, Between 6am-10pm
y = -0.0065133323416698*x^3+0.170626574474995*x^2+-0.223052995460006*x+28.0945261849047
R^2=0.209734455723716
Noise Level LA90,10min (dBA)
Wind Speed (m/s)
LA90,10min
6am-10pm Noise Curve
6am-10pm Noise Criteria

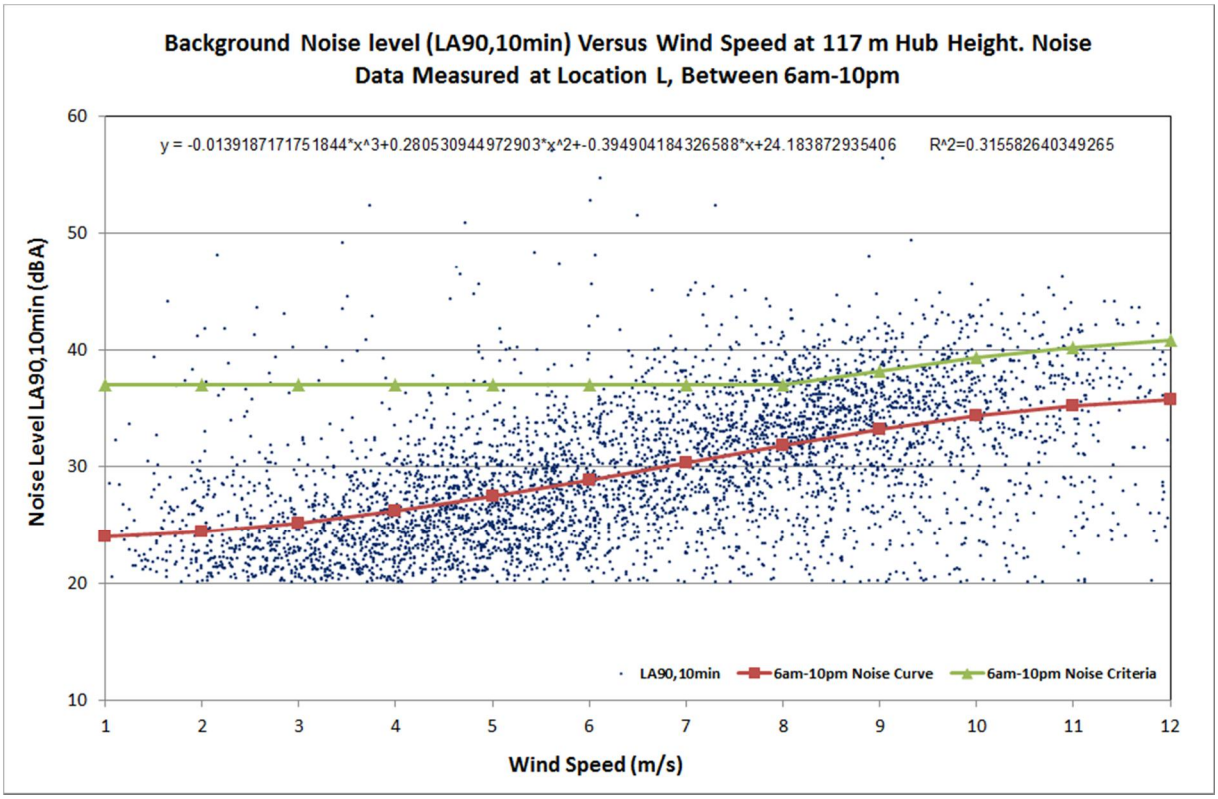

Background Noise level (LA90,10min) Versus Wind Speed at 117 m Hub Height. Noise Data Measured at Location F, Between 10pm-6am
y = -0.00465972656326508*x^3+0.216454954983 81*x^2+-1.68266182697283*x+29.6489802128273
R^2=0.299806863213084
Noise Level LA90,10min (dBA)
Wind Speed (m/s)
L90
10pm-6am Noise Curve
10pm-6m Noise Criteria

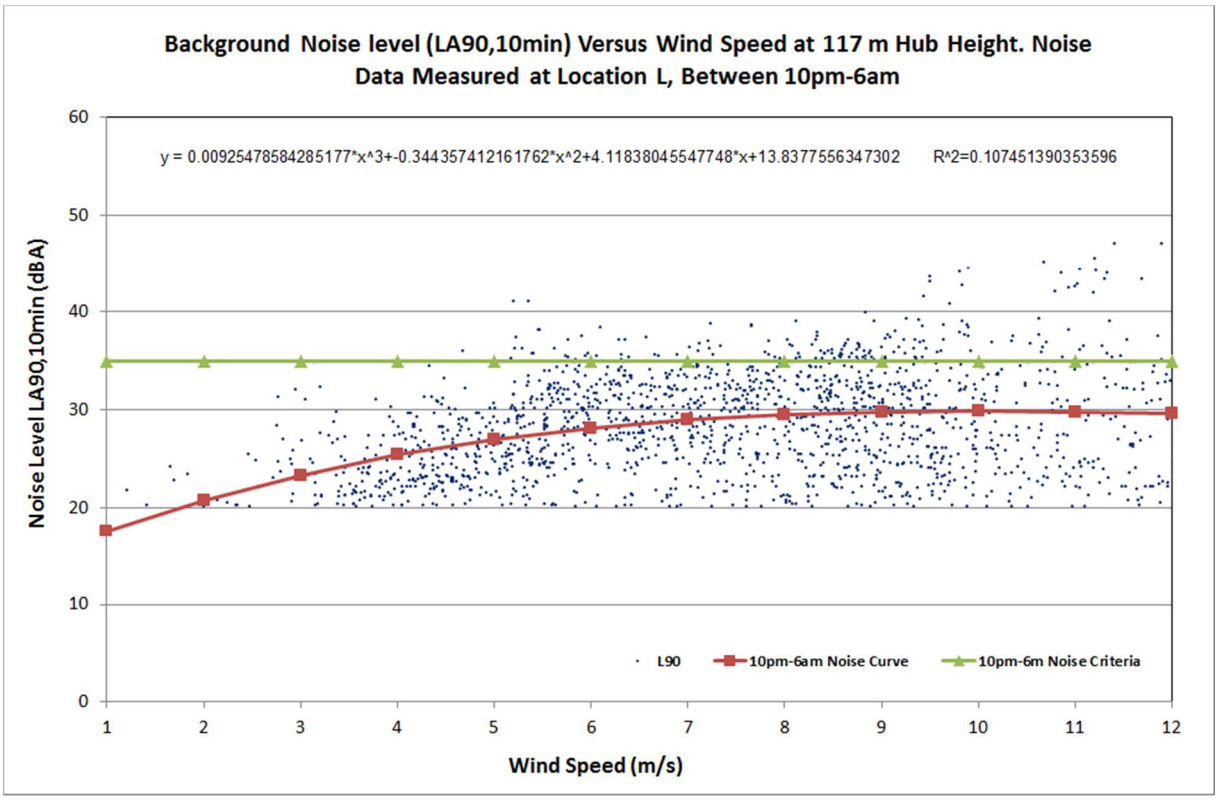

Background Noise level (LA90,10min) Versus Wind Speed at 117 m Hub Height. Noise Data Measured at Location G, Between 6am-10pm
y = -0.011192587435112*x^3+0.356247073000717*x^2+-1.37379030439533*x+27.6978805249636
R^2=0.459724275242425
Noise Level LA90,10min (dBA)
Wind Speed (m/s)
LA90,10min
6am-10pm Noise Curve
6am-10pm Noise Criteria

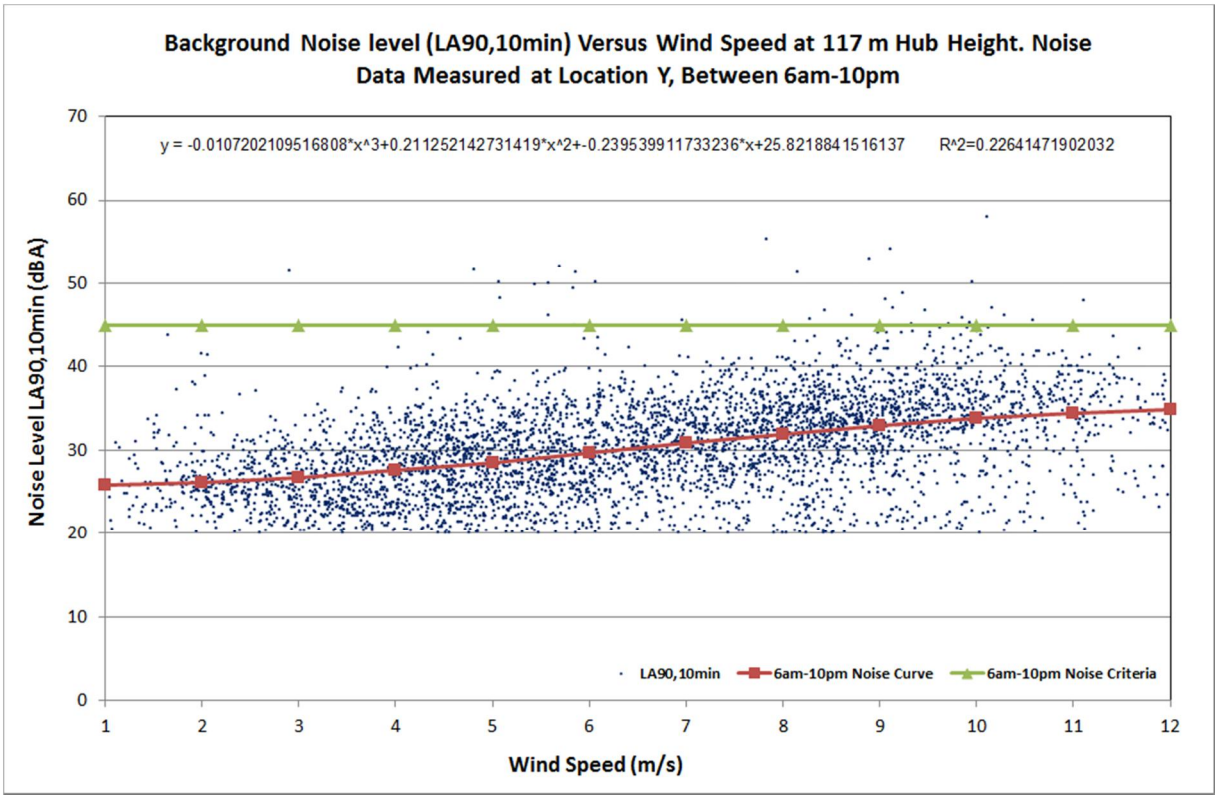

Background Noise level (LA90,10min) Versus Wind Speed at 117 m Hub Height. Noise Data Measured at Location G, Between 10pm-6am
y = -0.0060306334619371 9*x^3+0.218919437189 41*x^2+-0.507091886282657*x+23.9020727784165
R^2=0.460815012291383
Noise Level LA90,10min (dBA)
Wind Speed (m/s)
L90
10pm-6am Noise Curve
10pm-6m Noise Criteria

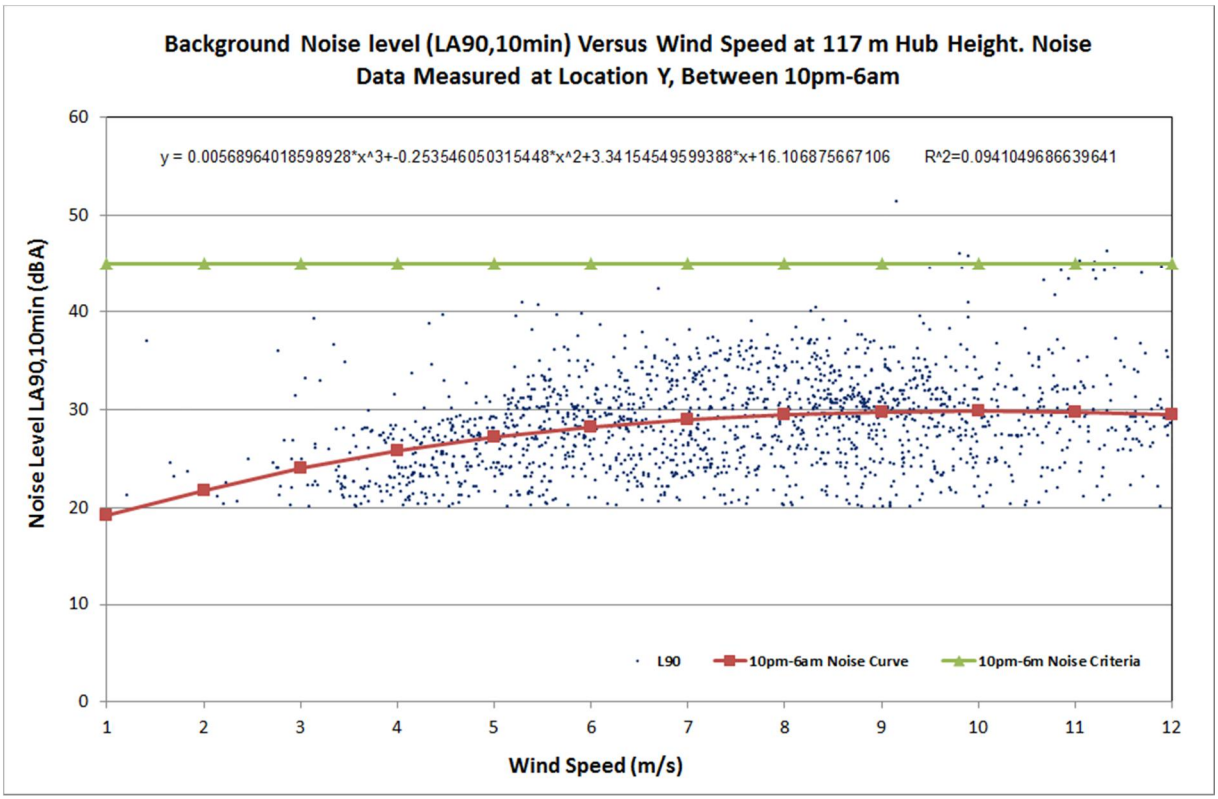

Background Noise level (LA90,10min) Versus Wind Speed at 117 m Hub Height. Noise Data Measured at Location J , Between 6am-10pm
y = -0.00325860574392791*x^3+0.0571995650995909*x^2+0.886606809510601*x+24.1075782483418
R^2=0.224791842558914
Noise Level LA90,10min (dBA)
Wind Speed (m/s)
LA90,10min
6am-10pm Noise Curve
6am-10pm Noise Criteria


Background Noise level (LA90,10min) Versus Wind Speed at 117 m Hub Height. Noise Data Measured at Location J , Between 10pm-6am
y = 0.0096087842589043*x^3+-0.279453974000023*x^2+3.12389335933138*x+17.3859200595907
R^2=0.107158144764871
Noise Level LA90,10min (dBA)
Wind Speed (m/s)
L90
10pm-6am Noise Curve
10pm-6m Noise Criteria


Background Noise level (LA90,10min) Versus Wind Speed at 117 m Hub Height. Noise Data Measured at Location L, Between 6am-10pm
y = -0.0139187171751844*x^3+0.280530944972903*x^2+-0.394904184326588*x+24.183872935406
R^2=0.315582640349265
Noise Level LA90,10min (dBA)
Wind Speed (m/s)
LA90,10min
6am-10pm Noise Curve
6am-10pm Noise Criteria


Background Noise level (LA90,10min) Versus Wind Speed at 117 m Hub Height. Noise Data Measured at Location L, Between 10pm-6am
y = 0.00925478584285177*x^3+-0.344357412161762*x^2+4.11838045547748*x+13.8377556347302
R^2=0.107451390353596
Noise Level LA90,10min (dBA)
Wind Speed (m/s)
L90
10pm-6am Noise Curve
10pm-6m Noise Criteria


Background Noise level (LA90,10min) Versus Wind Speed at 117 m Hub Height. Noise Data Measured at Location Y, Between 6am-10pm
y = -0.0107202109516808*x^3+0.211252142731419*x^2+-0.239539911733236*x+25.8218841516137
R^2=0.22641471902032
Noise Level LA90,10min (dBA)
Wind Speed (m/s)
LA90,10min
6am-10pm Noise Curve
6am-10pm Noise Criteria


Background Noise level (LA90,10min) Versus Wind Speed at 117 m Hub Height. Noise Data Measured at Location Y, Between 10pm-6am
y = 0.0056896401859892 8*x^3+-0.253546050315448*x^2+3.34154549599388*x+16.1068756671 06
R^2=0.0941049686639641
Noise Level LA90,10min (dBA)
Wind Speed (m/s)
L90
10pm-6am Noise Curve
10pm-6m Noise Criteria

Appendix F

Noise Prediction Results

Appendix F Noise Prediction Results

Table 18 presents the operational noise compliance assessment for the project layout during worst-case turbine noise emissions. The noise levels presented are $L_{Aeq,10min}$ noise levels, assessed conservatively against the night time noise limits presented in Table 8. The noise predictions comply with the Project noise limits at all receptors.

Table 19 presents the low frequency noise compliance assessment for the Project wind turbine layout during worst-case turbine noise emissions. The noise levels presented in the table are $L_{Ceq,10}$ noise levels at the receptors, assessed against a 60 dB(C) night time limit. The noise predictions comply with this noise limit at all but one receptor. The low frequency noise limit was exceeded by less than 1 dB(C) at receptor G. This receptor is a Participating Landowner, thus and the likelihood of a complaint from this receptor is minimal. Further, the conservative assumptions made when building the model mean that the measured noise levels would be lower than those predicted as part of this assessment. As such, noise compliance at receptor G with the 60 dB(C) noise limit is expected.

Table 18: $L_{Aeq,10min}$ Noise compliance assessment. $L_{Aeq,10min}$ noise prediction during worst-case wind turbine noise emission is assessed against the hub height wind speeds noise limits

Receptor ID	Participating Landowner	Easting[1]	Northing	Predicted $L_{Aeq,10m}$ noise level, dB(A)	10pm-6am $L_{Aeq,10min}$ noise limit in dB(A) versus wind speed (m/s) at hub height of 117 m																Complies at all wind speeds?
					4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s	15 m/s	16 m/s	17 m/s	18 m/s	19 m/s	20 m/s	
A	YES	340083.6	7046383.8	42	45	45	45	45	45	45	45	45	45	45	45	45	45	46	47	49	50	**YES**
AA	NO	346821.9	7038249.7	33	37	38	38	39	39	39	39	39	38	37	36	35	35	35	35	35	35	**YES**
AB	YES	348509.7	7038355.6	33	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	**YES**
AC	YES	348599.9	7038225.8	32	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	**YES**
AD	NO	350481.4	7038561.8	25	37	37	37	37	37	37	38	38	38	39	39	40	41	42	44	46	48	**YES**
AE	NO	350862.4	7040011.3	26	37	37	37	37	37	37	38	38	38	39	39	40	41	42	44	46	48	**YES**
AF	NO	350894.1	7040160.0	27	37	37	37	37	37	37	38	38	38	39	39	40	41	42	44	46	48	**YES**
AG	NO	351062.8	7040332.8	26	37	37	37	37	37	37	38	38	38	39	39	40	41	42	44	46	48	**YES**
AH	NO	350644.4	7041787.8	30	37	37	37	37	37	37	38	38	38	39	39	40	41	42	44	46	48	**YES**
AI	NO	351635.3	7041956.1	30	37	37	37	37	37	37	38	38	38	39	39	40	41	42	44	46	48	**YES**
AJ	NO	351992.9	7042313.9	31	37	37	37	37	37	37	38	38	38	39	39	40	41	42	44	46	48	**YES**
AK	NO	353390.6	7043055.3	28	37	37	37	37	37	37	38	38	38	39	39	40	41	42	44	46	48	**YES**
AL	NO	351111.7	7043812.2	33	35	35	35	35	36	38	40	42	44	46	48	50	52	54	56	57	58	**YES**
AM	NO	351892.9	7048035.2	29	35	35	35	35	36	38	40	42	44	46	48	50	52	54	56	57	58	**YES**
AN	NO	350015.2	7047959.0	31	35	35	35	35	36	38	40	42	44	46	48	50	52	54	56	57	58	**YES**
AO	NO	352602.5	7049683.8	18	35	35	35	35	36	38	40	42	44	46	48	50	52	54	56	57	58	**YES**
AP	NO	352560.0	7049534.0	26	35	35	35	35	36	38	40	42	44	46	48	50	52	54	56	57	58	**YES**

[1] Eastings and Northings are defined based on the GDA 1994 Projection MGA Zone 56 co-ordinate system.

Receptor ID	Participating Landowner	Easting[1]	Northing	Predicted $L_{Aeq,10m}$ noise level, dB(A)	10pm-6am $L_{Aeq,10min}$ noise limit in dB(A) versus wind speed (m/s) at hub height of 117 m																Complies at all wind speeds?
					4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s	15 m/s	16 m/s	17 m/s	18 m/s	19 m/s	20 m/s	
AQ	NO	346316.4	7053162.1	22	35	35	35	35	35	35	35	36	36	37	37	38	38	38	38	38	37	**YES**
AR	NO	346966.6	7049264.7	32	35	35	35	35	35	35	36	37	39	40	42	43	44	46	46	47	47	**YES**
AS	NO	347091.8	7049224.1	33	35	35	35	35	35	35	36	37	39	40	42	43	44	46	46	47	47	**YES**
AT	NO	345095.3	7046725.8	35	35	35	35	35	35	35	36	37	39	40	42	43	44	46	46	47	47	**YES**
AU	NO	342660.6	7048215.9	32	35	35	35	35	35	35	36	37	39	40	42	43	44	46	46	47	47	**YES**
AV	NO	342553.6	7048149.0	33	35	35	35	35	35	35	36	37	39	40	42	43	44	46	46	47	47	**YES**
AW	NO	342159.1	7052618.4	23	35	35	35	35	35	35	35	36	36	37	37	38	38	38	38	38	37	**YES**
AX	NO	338631.9	7052421.8	32	35	35	35	35	35	35	35	36	36	37	37	38	38	38	38	38	37	**YES**
AY	NO	340135.1	7052136.1	28	35	35	35	35	35	35	35	36	36	37	37	38	38	38	38	38	37	**YES**
AZ	NO	339907.2	7051919.0	27	35	35	35	35	35	35	35	36	36	37	37	38	38	38	38	38	37	**YES**
B	YES	336940.5	7045734.7	38	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	**YES**
BA	NO	340849.5	7051426.7	31	35	35	35	35	35	35	35	36	36	37	37	38	38	38	38	38	37	**YES**
BB	NO	340478.0	7050425.2	31	35	35	35	35	35	35	35	36	36	37	37	38	38	38	38	38	37	**YES**
BD	NO	340462.5	7049386.3	35	35	35	35	35	35	35	35	36	36	37	37	38	38	38	38	38	37	**YES**
BE	NO	340649.3	7049465.3	34	35	35	35	35	35	35	35	36	36	37	37	38	38	38	38	38	37	**YES**
BF	NO	335084.1	7050742.3	35	35	35	35	35	35	36	36	37	36	35	35	35	35	35	35	35	35	**YES**
BG	NO	332375.0	7045921.4	25	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	36	38	**YES**
BH	NO	330442.9	7046291.9	20	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	36	38	**YES**
BI	NO	331115.8	7045011.2	20	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	36	38	**YES**
BJ	NO	331254.8	7045013.4	21	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	36	38	**YES**
BK	NO	337093.1	7041604.1	25	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	36	38	**YES**

Receptor ID	Participating Landowner	Easting[1]	Northing	Predicted $L_{Aeq,10m}$ noise level, dB(A)	10pm-6am $L_{Aeq,10min}$ noise limit in dB(A) versus wind speed (m/s) at hub height of 117 m																Complies at all wind speeds?
					4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s	15 m/s	16 m/s	17 m/s	18 m/s	19 m/s	20 m/s	
BL	NO	338340.1	7039540.2	27	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	36	38	**YES**
BM	NO	337241.9	7038885.3	24	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	36	38	**YES**
BN	NO	337415.0	7038704.7	24	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	36	38	**YES**
BO	NO	337588.7	7037802.7	18	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	36	38	**YES**
BP	NO	337518.7	7037277.6	20	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	36	38	**YES**
BQ	NO	338111.0	7036755.8	20	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	36	38	**YES**
BR	NO	339132.3	7037598.6	24	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	**YES**
BS	NO	339984.9	7037397.7	26	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	**YES**
BT	NO	340047.0	7037449.3	27	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	**YES**
BU	NO	339999.6	7037566.9	27	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	**YES**
BV	NO	341701.8	7037728.3	27	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	**YES**
BW	NO	344024.3	7036226.3	26	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	**YES**
BX	NO	345776.4	7036220.8	27	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	**YES**
BY	NO	347491.7	7036362.8	27	37	38	38	39	39	39	39	39	38	37	36	35	35	35	35	35	35	**YES**
BZ	NO	348008.2	7036796.9	27	37	38	38	39	39	39	39	39	38	37	36	35	35	35	35	35	35	**YES**
C	YES	336840.4	7049667.4	43	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	**YES**
CA	NO	348654.2	7036210.0	24	38	39	39	40	39	39	39	38	37	37	36	36	35	35	35	35	35	**YES**
CB	NO	348791.8	7035972.5	24	38	39	39	40	39	39	39	38	37	37	36	36	35	35	35	35	35	**YES**
CC	NO	349614.7	7037357.7	25	38	39	39	40	39	39	39	38	37	37	36	36	35	35	35	35	35	**YES**
CD	NO	350349.7	7037619.1	23	38	39	39	40	39	39	39	38	37	37	36	36	35	35	35	35	35	**YES**
CE	NO	350211.4	7037982.8	24	38	39	39	40	39	39	39	38	37	37	36	36	35	35	35	35	35	**YES**

Receptor ID	Participating Landowner	Easting[1]	Northing	Predicted $L_{Aeq,10m}$ noise level, dB(A)	10pm-6am $L_{Aeq,10min}$ noise limit in dB(A) versus wind speed (m/s) at hub height of 117 m																	Complies at all wind speeds?
					4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s	15 m/s	16 m/s	17 m/s	18 m/s	19 m/s	20 m/s	
CF	NO	349763.0	7038200.9	30	38	39	39	40	39	39	39	38	37	37	36	36	35	35	35	35	35	**YES**
CG	NO	332797.7	7046721.7	28	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	36	38	**YES**
CH	NO	340905.8	7036659.6	24	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	**YES**
CHURCH 1	NO	341470.9	7039535.1	34	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	**YES**
CHURCH 2	NO	341636.5	7039151.3	34	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	**YES**
D	YES	336677.1	7050047.0	41	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	**YES**
E	YES	341658.5	7047167.5	40	45	45	45	45	45	45	45	45	45	45	45	45	45	46	47	49	50	**YES**
F	YES	341691.4	7047075.2	40	45	45	45	45	45	45	45	45	45	45	45	45	45	46	47	49	50	**YES**
G	YES	346234.3	7042890.4	45	45	45	45	45	45	45	45	45	45	46	48	50	52	54	56	57	58	**YES**
H	YES	346167.6	7042874.8	44	45	45	45	45	45	45	45	45	45	46	48	50	52	54	56	57	58	**YES**
I	NO	343404.3	7043808.6	34	35	35	35	35	36	38	40	42	44	46	48	50	52	54	56	57	58	**YES**
J	YES	341073.2	7045511.1	41	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	47	50	**YES**
K	NO	336432.3	7044775.9	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	36	38	**YES**
L	NO	338266.8	7044523.4	33	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	36	38	**YES**
M	NO	339498.1	7042915.9	34	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	36	38	**YES**
N	NO	339485.1	7042871.9	34	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	36	38	**YES**
O	NO	339739.2	7041619.4	34	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	36	38	**YES**
P	YES	340106.3	7040162.1	34	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	**YES**
Q	YES	340984.4	7039395.2	34	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	**YES**
R	YES	340958.4	7039353.9	34	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	**YES**
S	NO	341571.1	7038592.5	32	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	**YES**

Receptor ID	Participating Landowner	Easting[1]	Northing	Predicted $L_{Aeq,10m}$ noise level, dB(A)	10pm-6am $L_{Aeq,10min}$ noise limit in dB(A) versus wind speed (m/s) at hub height of 117 m																Complies at all wind speeds?
					4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s	15 m/s	16 m/s	17 m/s	18 m/s	19 m/s	20 m/s	
T	NO	341484.2	7038469.5	32	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	**YES**
U	NO	341675.2	7038266.3	32	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	**YES**
V	NO	341567.5	7038197.2	32	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	**YES**
W	YES	344403.2	7038524.5	40	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	**YES**
X	YES	344326.0	7038445.7	40	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	**YES**
Y	YES	345841.2	7038503.0	37	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	**YES**
Z	NO	346682.0	7038195.6	34	37	38	38	39	39	39	39	39	38	37	36	35	35	35	35	35	35	**YES**

Table 19: $L_{Ceq,10min}$ noise compliance assessment. The $L_{Ceq,10min}$ noise prediction during worst-case turbine noise emission is assessed against a 60 dB(C) night time noise limit.

ID	Participating Landowner	Easting[2]	Northing	Predicted $L_{Ceq,10min}$ noise level, dB(C)	Noise limit, dB(C)	Complies at all wind speeds
A	YES	340083.6	7046383.8	57	60	**YES**
AA	NO	346821.9	7038249.7	51	60	**YES**
AB	YES	348509.7	7038355.6	49	60	**YES**
AC	YES	348599.9	7038225.8	50	60	**YES**
AD	NO	350481.4	7038561.8	45	60	**YES**
AE	NO	350862.4	7040011.3	47	60	**YES**
AF	NO	350894.1	7040160.0	47	60	**YES**
AG	NO	351062.8	7040332.8	47	60	**YES**
AH	NO	350644.4	7041787.8	49	60	**YES**
AI	NO	351635.3	7041956.1	48	60	**YES**
AJ	NO	351992.9	7042313.9	51	60	**YES**
AK	NO	353390.6	7043055.3	48	60	**YES**
AL	NO	351111.7	7043812.2	51	60	**YES**
AM	NO	351892.9	7048035.2	50	60	**YES**
AN	NO	350015.2	7047959.0	50	60	**YES**
AO	NO	352602.5	7049683.8	38	60	**YES**
AP	NO	352560.0	7049534.0	47	60	**YES**
AQ	NO	346316.4	7053162.1	37	60	**YES**
AR	NO	346966.6	7049264.7	51	60	**YES**

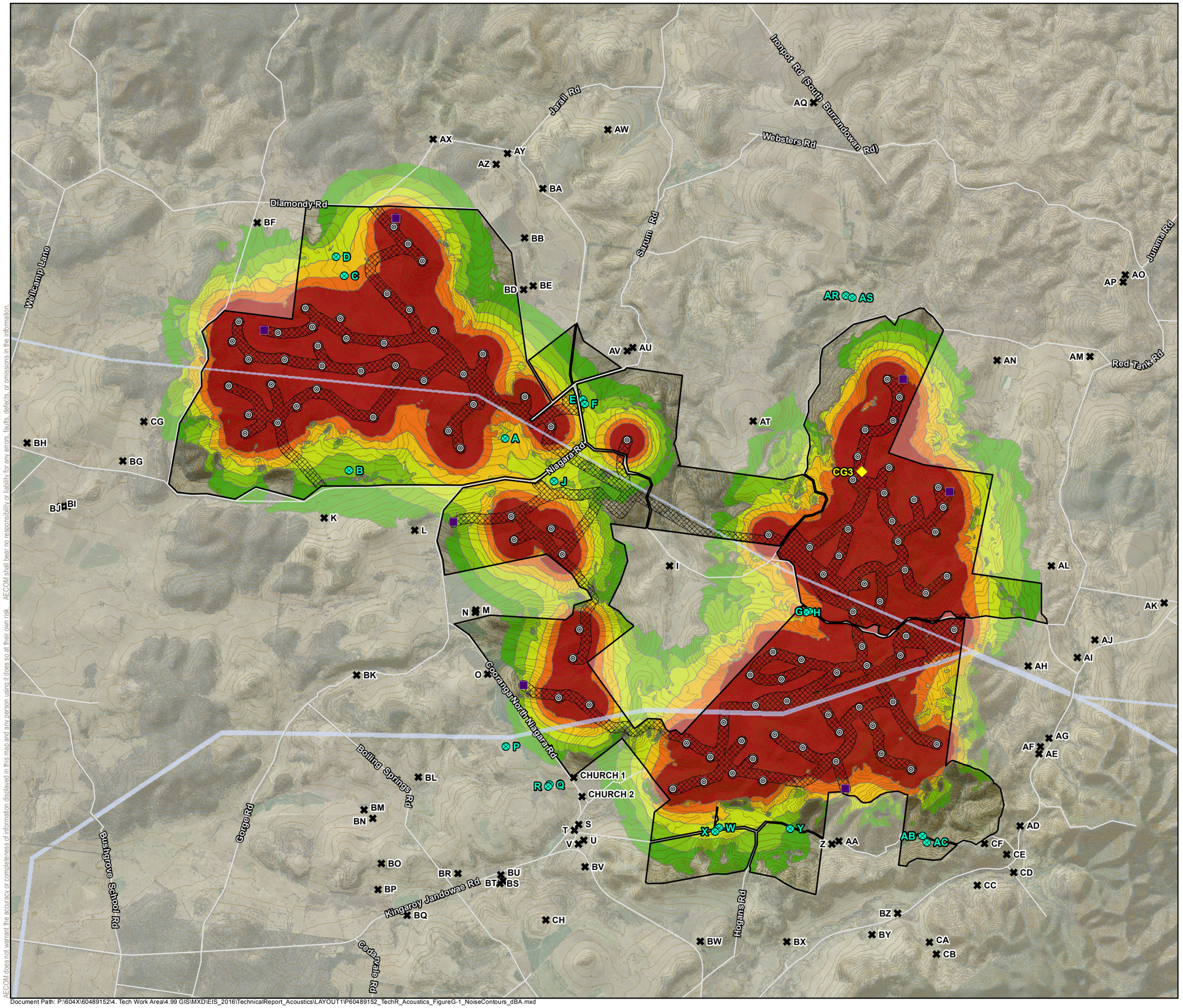
ID	Participating Landowner	Easting[2]	Northing	Predicted $L_{Ceq,10min}$ noise level, dB(C)	Noise limit, dB(C)	Complies at all wind speeds
AS	NO	347091.8	7049224.1	51	60	**YES**
AT	NO	345095.3	7046725.8	55	60	**YES**
AU	NO	342660.6	7048215.9	50	60	**YES**
AV	NO	342553.6	7048149.0	51	60	**YES**
AW	NO	342159.1	7052618.4	42	60	**YES**
AX	NO	338631.9	7052421.8	51	60	**YES**
AY	NO	340135.1	7052136.1	47	60	**YES**
AZ	NO	339907.2	7051919.0	46	60	**YES**
B	YES	336940.5	7045734.7	55	60	**YES**
BA	NO	340849.5	7051426.7	50	60	**YES**
BB	NO	340478.0	7050425.2	48	60	**YES**
BD	NO	340462.5	7049386.3	52	60	**YES**
BE	NO	340649.3	7049465.3	52	60	**YES**
BF	NO	335084.1	7050742.3	52	60	**YES**
BG	NO	332375.0	7045921.4	45	60	**YES**
BH	NO	330442.9	7046291.9	41	60	**YES**
BI	NO	331115.8	7045011.2	41	60	**YES**
BJ	NO	331254.8	7045013.4	41	60	**YES**
BK	NO	337093.1	7041604.1	45	60	**YES**
BL	NO	338340.1	7039540.2	47	60	**YES**
BM	NO	337241.9	7038885.3	44	60	**YES**
BN	NO	337415.0	7038704.7	44	60	**YES**
BO	NO	337588.7	7037802.7	38	60	**YES**

ID	Participating Landowner	Easting[2]	Northing	Predicted $L_{Ceq,10min}$ noise level, dB(C)	Noise limit, dB(C)	Complies at all wind speeds
BP	NO	337518.7	7037277.6	41	60	**YES**
BQ	NO	338111.0	7036755.8	38	60	**YES**
BR	NO	339132.3	7037598.6	44	60	**YES**
BS	NO	339984.9	7037397.7	45	60	**YES**
BT	NO	340047.0	7037449.3	47	60	**YES**
BU	NO	339999.6	7037566.9	47	60	**YES**
BV	NO	341701.8	7037728.3	47	60	**YES**
BW	NO	344024.3	7036226.3	45	60	**YES**
BX	NO	345776.4	7036220.8	46	60	**YES**
BY	NO	347491.7	7036362.8	46	60	**YES**
BZ	NO	348008.2	7036796.9	47	60	**YES**
C	YES	336840.4	7049667.4	59	60	**YES**
CA	NO	348654.2	7036210.0	44	60	**YES**
CB	NO	348791.8	7035972.5	44	60	**YES**
CC	NO	349614.7	7037357.7	45	60	**YES**
CD	NO	350349.7	7037619.1	44	60	**YES**
CE	NO	350211.4	7037982.8	45	60	**YES**
CF	NO	349763.0	7038200.9	48	60	**YES**
CG	NO	332797.7	7046721.7	47	60	**YES**
CH	NO	340905.8	7036659.6	44	60	**YES**
CHURCH 1	NO	341470.9	7039535.1	52	60	**YES**
CHURCH 2	NO	341636.5	7039151.3	52	60	**YES**
D	YES	336677.1	7050047.0	58	60	**YES**

ID	Participating Landowner	Easting[2]	Northing	Predicted $L_{Ceq,10min}$ noise level, dB(C)	Noise limit, dB(C)	Complies at all wind speeds
E	YES	341658.5	7047167.5	56	60	**YES**
F	YES	341691.4	7047075.2	56	60	**YES**
G	YES	346234.3	7042890.4	61	60	**NO**
H	YES	346167.6	7042874.8	60	60	**YES**
I	NO	343404.3	7043808.6	53	60	**YES**
J	YES	341073.2	7045511.1	57	60	**YES**
K	NO	336432.3	7044775.9	54	60	**YES**
L	NO	338266.8	7044523.4	51	60	**YES**
M	NO	339498.1	7042915.9	52	60	**YES**
N	NO	339485.1	7042871.9	52	60	**YES**
O	NO	339739.2	7041619.4	52	60	**YES**
P	YES	340106.3	7040162.1	52	60	**YES**
Q	YES	340984.4	7039395.2	53	60	**YES**
R	YES	340958.4	7039353.9	52	60	**YES**
S	NO	341571.1	7038592.5	51	60	**YES**
T	NO	341484.2	7038469.5	51	60	**YES**
U	NO	341675.2	7038266.3	51	60	**YES**
V	NO	341567.5	7038197.2	51	60	**YES**
W	YES	344403.2	7038524.5	57	60	**YES**
X	YES	344326.0	7038445.7	56	60	**YES**
Y	YES	345841.2	7038503.0	54	60	**YES**
Z	NO	346682.0	7038195.6	52	60	**YES**

Appendix G

Noise Contour Maps



AGL Energy in action.

AECOM

DATUM GDA 1994, PROJECTION MGA ZONE 56

0 1.5 3
Kilometres

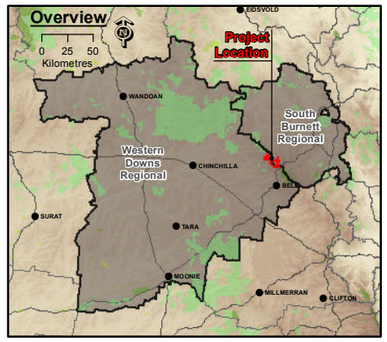
1:72,500 (when printed at A3)

Legend

- Project Site
- Study Area
- Met Masts
- Existing Met Mast used during noise monitoring
- Turbines
- Participating Landowners
- Non-Participating Landowners
- Contours 10m
- Road

$L_{Aeq,10min}$ *noise levels at 4 m above the ground (reference wind speed: 10 m/s at hub height)*

- ≤ 37 dB(A)
- ≤ 39 dB(A)
- ≤ 41 dB(A)
- ≤ 43 dB(A)
- ≤ 45 dB(A)
- >45 dB(A)



Data Sources:
1. Project Site, Turbine Layout © 2016 AECOM Australia Pty Ltd.
2. Surat Basin 40 cm Imagery © SISP, 2013
3. Service Road, Transmission Lines © AGL 2014
4. Locality, Roads © StreetPro 2011
5. Cadastral Data (DCDB) © State of Queensland (Department of Natural Resources and Mines) 2016
6. Contours 10m © Department of Natural Resources and Mines, 2013.
7. Hillshade, based on the 25m DEM covering the SEQ, DNRM 2005
8. Local Government Area (LGA) boundaries © Australia Bureau of Statistic (ABS), 2011.
9. Vegetation Management Watercourse and Drainage feature map (1:100 000 and 1:250 000) - version 1.4 dataset © State of Queensland (Department of Natural Resources and Mines) 2016
10. Noise Contours @ AECOM, 2016

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COOPERS GAP WIND FARM
NOISE AND VIBRATION IMPACT ASSESSMENT

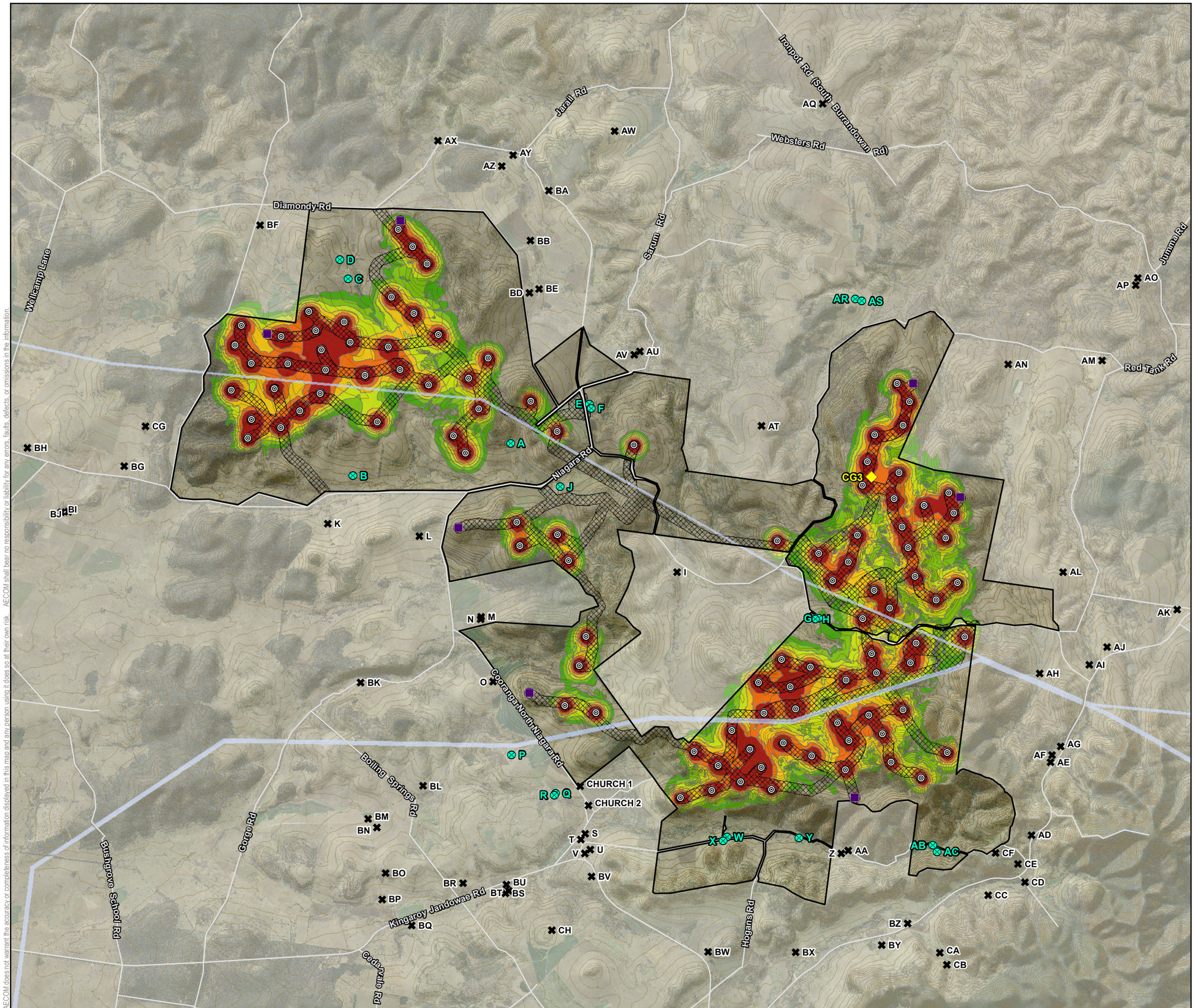
$L_{Aeq,10MIN}$ NOISE CONTOUR MAP

PROJECT #:	60489152
CREATED BY:	BM
LAST MODIFIED:	BM: 25/11/2016
VERSION:	1

Figure G-1

A3 size

Document Path: P:\604X\604891521\4. Tech Work Area\4.99 GIS\MXD\EIS_2016\TechnicalReport_Acoustics\LAYOUT1\P60489152_TechR_Acoustics_FigureG-1_NoiseContours_dBA.mxd



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AGL Energy in action.

AECOM

DATUM GDA 1994, PROJECTION MGA ZONE 56

0 1.5 3
Kilometres

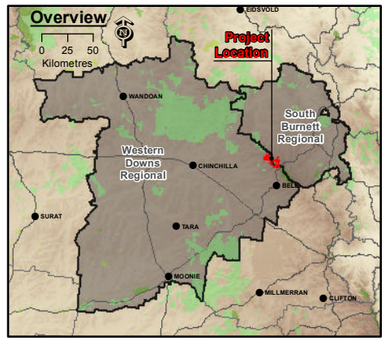
1:72,500 (when printed at A3)

Legend

- Project Site
- Study Area
- Met Masts
- Existing Met Mast used during noise monitoring
- Turbines
- Participating Landowners
- Non-Participating Landowners
- Contours 10m
- Road

$L_{Ceq,10min}$ *noise levels at 4 m above the ground (reference wind speed: 10 m/s at hub height)*

- ≤ 61 dB(C)
- ≤ 62 dB(C)
- ≤ 63 dB(C)
- ≤ 64 dB(C)
- ≤ 65 dB(C)
- > 65 dB(C)



Data Sources:
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2. Surat Basin 40 cm Imagery © SISP, 2013
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10. Noise Contours @ AECOM, 2016

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COOPERS GAP WIND FARM
NOISE AND VIBRATION IMPACT ASSESSMENT

$L_{Ceq,10MIN}$ NOISE CONTOUR MAP

PROJECT #:	60489152
CREATED BY:	BM
LAST MODIFIED:	BM: 25/11/2016
VERSION:	1

Figure G-2

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A3 size

Appendix H

Preliminary Compliance Management Plan

Appendix H Preliminary Compliance Management Plan

Introduction

AGL Energy Limited (AGL) is seeking approval to construct the Coopers Gap Wind Farm located at Cooranga North, approximately 60 km northeast the town of Dalby, in Queensland. The wind farm will be built along the western side of the Bunya Highway.

This Compliance Management Plan (CMP) was developed to define the methodology for undertaking post-construction noise monitoring, which is required to demonstrate whether the wind farm achieves compliance with the noise limits determined in the Noise and Vibration Impact Assessment (NVIA).

The applicable noise criterion for the operation of wind farms in Queensland is defined in the Queensland Department of Infrastructure, Local Government and Planning (DILGP) *Wind Farm State Code* (referred to in this report as the QLD Code), contained within the Queensland State Development Assessment Provisions (SDAP) Version 1.9 effective 22 July 2016. The noise limits for the Coopers Gap Wind Farm were determined from noise measurements of background noise as part of the NVIA by following guidance from the DILGP *Wind Farm State Code Planning Guideline* (referred to in this report as the QLD Code Planning Guideline), dated July 2016.

The QLD Code Planning Guideline does not prescribe a methodology to assess compliance during construction and/or operation of wind farms. The QLD Code Planning Guideline only provides guidance on the measurement of background noise before construction for the purpose of establishing operational noise limits. As such, in developing this CMP, the principles from the QLD Code Planning Guideline for conducting background measurements were used as the basis for conducting compliance noise measurements with reference to the following documents for aspects specific to compliance testing:

- AS4959-2010 Acoustics – *Measurement, prediction and assessment of noise from wind turbine generators* (AS4959).
- South Australia Environmental Protection Authority – Wind Farms – *Environmental Noise Guidelines* (SA2009).
- New Zealand Standard NZS6808:2010 *Acoustics – Wind farm noise* (NZS6808).
- NSW Department of Planning & Infrastructure *Draft NSW Planning Guidelines – Wind Farms*, December 2011 (NSW2011). This guideline follows methodologies and practices presented in the SA2009 and AS4959-2010.
- Victoria Department of Planning and Community Development *Policy and Planning Guidelines for development of wind energy facilities in Victoria, July 2012 (VIC2012)*, which refers to NZS6808:2010 for the assessment of wind farm noise impacts

Where a specification has been derived from any of the above documents, a reference has been made to the relevant document in this report.

Specifically, this CMP defines:

- A procedure to audit compliance with the limits during operation of the wind farm
- Proposed post-construction noise monitoring locations
- Appropriate noise monitoring and analysis procedures
- A general methodology for the assessment of ‘special audible characteristics’.

A Noise Compliance Report should be prepared and submitted within 12 months of the commencement of the operation of the wind farm (NSW2011).

Noise Criteria

The performance outcomes from the QLD Code, contained in the State Development Assessment Provisions (SDAP), were used as a basis to establish the applicable noise limits at sensitive receptors.

The As detailed in the QLD Code, the following noise limits apply to this project:

- The outdoor (free-field) day-time (6am to 10pm) A-weighted equivalent acoustic level (L_{Aeq}), assessed at all noise affected existing or approved sensitive land uses, does not exceed 37dB(A), or the background noise (L_{A90}) by more than 5dB(A), whichever is greater.
- The outdoor (free-field) night-time (10pm to 6am) A-weighted equivalent acoustic level (L_{Aeq}), assessed at all noise affected existing or approved sensitive land uses, does not exceed 45dB(A), or the background noise (L_{A90}) by more than 5dB(A), whichever is the greater.
- The outdoor (free-field) night-time (10pm to 6am) A-weighted equivalent acoustic level (L_{Aeq}), assessed at all noise affected existing or approved sensitive land uses, does not exceed 35dB(A), or the background noise (L_{A90}) by more than 5dB(A), whichever is the greater.

For sensitive receptors to the Project that are located on either host lots, or non-host lots who have an agreed Deed of Release with AGL, as per the QLD Code, are referred to in this report as “Financial Landowners”. A free-field night-time A-weighted equivalent acoustic level (L_{Aeq}) of 45 dB(A) should not be exceeded at these receptors, as per the QLD Code. For all other sensitive receptors on non-host lots where landowners have not entered a commercial agreement with AGL, (referred to in this report as “Non-Financial Landowners”) a conservative baseline 35 dB(A) L_{Aeq} noise limit is applied.

The QLD Code outlines performance outcomes for construction management, The QLD Code Planning Guideline specifies that a construction management plan is to be prepared by a suitably qualified person, identifying all potential construction impacts and the proposed measures to be undertaken to avoid, manage and mitigate the identified impacts. Wind farm construction noise limits are not defined in the QLD Code, nor does any legislation in Queensland specifically set construction noise limits. In lieu of no specific noise limits for construction of the wind farm and the requirement to development of a Construction Environment Management (CEMP) that will be required to mitigate potential construction noise impacts and demonstrate compliance, construction noise compliance is not addressed further within this document.

General Noise Compliance Assessment Procedure

Once operational, compliance noise measurements will be undertaken at a number of sensitive receptors adjacent to the wind farm in order to demonstrate that compliance with the relevant criteria has been achieved.

The following procedure will be followed to select noise monitoring locations:

1. Post-construction noise monitoring equipment will be located as near as practically possible to the same location as the pre-construction background measurement locations (AS4659 & VIC2012), and/or.
2. Noise monitoring will be conducted where free-field noise levels predicted in the NVIA are close to the 35 dB(A) noise limit for non-participating land owners, or 45 dB(A) for participating land owners. It is noted that the NVIA determined that noise levels at all receptors would comply with these noise limits.

Based on criteria 1 and 2 above, proposed compliance noise monitoring locations are provided in Table 20 to assess the general compliance of the Coopers Gap Wind Farm against the applicable noise limits. These locations are representative of worst-case noise monitoring locations, due to their closeness to the Coopers Gap Wind Farm.

Noise levels will be measured at outdoor locations with the microphone at a height of 1.2 m - 1.5 m above ground level, ideally within 20 m of the receptor dwelling and at least 5 m from any significant vertical reflecting surfaces. The monitoring locations will be on the wind farm side of a dwelling and as far away as possible from potential sources of domestic noise (e.g. air conditioners, water pumps, dog kennels, etc.) and vegetation noise from trees and shrubs (QLD2016). The microphone will be facing upwards.

All monitoring locations will be located using GPS and photographic images will be taken of the location of the noise monitor and the surroundings in multiple directions (QLD2016).

Sensitive receptors and locations where background noise was monitored during the NVIA process are provided in Appendix C.

Dominant winds on site are north-easterly and south-westerly. As such, collecting a large data sample for downwind directions at sites located east and west of the wind farm may not be possible.

Table 20 Recommended noise monitoring locations

Background noise monitoring locations	Recommended monitoring locations for noise compliance assessment	Approximate worst-case wind directions
AA	AA, AB, AC	Northerly
AD	AL, AB, AC	Westerly
AU, AV	AU, AV	South-easterly
BB	BD, BE	South-westerly
BF	BF	South-easterly
C	C	South-easterly to Easterly
CF	CF, AB, AC	North-westerly
F	F	Southerly and South-westerly
G	G	All but Westerly
J	J	All
L	L, K, M, N	North-easterly
Y	Y	Northerly

Noise monitoring equipment

The following monitoring equipment will be used:

1. Wind farm noise will be measured using Class 1 or Class 2 sound level meters in accordance with AS IEC−61672.1-2004 *Electroacoustics – Sound level meters*. All noise monitoring equipment must have an inherent noise floor no greater than 20 dB(A) (QLD2016).
2. The $L_{Aeq,10min}$ and $L_{A90,10min}$ will be measured to assess noise compliance, at 10 minute intervals, as a minimum. The $L_{A50,10min}$, $L_{A10,10min}$ and $L_{A1,10min}$ will also be measured to describe the ambient noise environment surrounding the wind farm (QLD2016).
3. The sound level meters will be suitably calibrated before and after measurements and if the difference is greater than 1 dB, the data will be discarded (QLD2016).
4. Where possible, the microphones will be protected with windshields which reduce wind induced noise on the microphone to 10 dB(A) or more below the monitored background noise levels.
5. All noise measurements will be synchronised with the data collected from either the closest meteorological mast (corrected to hub height) to the measurement location, or the wind speeds logged at the closest Wind Turbine Generator (WTG). The WTG power generation, nacelle angle, and rotational speed (RPM) will also be logged.
6. The wind shear factor used for extrapolation to hub height will be measured directly by a hub height ultrasonic anemometer or estimated from the measured wind speeds at two heights on a meteorological mast (QLD2016).
7. Meteorological monitoring at ground level shall be conducted simultaneously with the noise monitoring at selected locations near the noise monitoring locations to register rainfall during the

noise monitoring period so that rain affected noise samples are discarded from the noise data set (QLD2016). This will be done by analysing data from a portable weather station installed near a representative noise monitoring location, or by analysing data downloaded from the closest Bureau of Meteorology weather station. The former method is preferred.

8. Noise and weather data will be obtained at 10-minute averages logged continuously over 24 hour periods.

Measurement duration

Noise measurements shall be conducted for a duration that allows to:

1. Conduct noise measurements for the operational range of the wind turbines, from the WTG cut-in speed to the maximum 'rated' power wind speed (NZS6808).
2. Measure for a duration of approximately six weeks. Any shorter duration should be justified (QLD2016).

Wind speed reference

1. All wind data related to the wind environment at the site and the operating performance of the wind turbines will be expressed in terms of the hub height of the turbines (QLD2016). Formulae are specified in QLD2016 to extrapolate wind data measured at heights other than hub height.

Microphone wind induced noise

2. Where wind induced noise on the microphone is 10 dB(A) to 4 dB(A) below the monitored background noise levels, the potentially wind affected noise data will be retained with the wind induced noise logarithmically subtracted from the measured background noise levels. Where wind-induced noise on the microphone is within 4 dB(A) of the measured noise levels, the potentially wind affected noise data shall be discarded from the analysis.

   Wind induced noise on the microphone can be estimated following the procedure from Cooper *et al* [1].

Extraneous noise

3. Data that is affected by extraneous noise will be excluded from the final data set. Screening tools which develop a relationship between L_{Aeq} and L_{A90} noise descriptors, such as a difference greater than 5 dB(A) can be useful in identifying potentially contaminated data. If available, audio recordings can be used to subjectively analyse the presence of extraneous noise (NSW2011).

Corrections for special audible characteristics

4. If a tone is suspected at a monitoring location, an assessment using either a simplified or reference method will be performed.

   The simplified method applies a 5 dB(A) correction when the level of one-third octave band measured in the equivalent noise level $L_{eq,10min}$ exceeds the arithmetic mean level of the adjacent bands by:

   - 5 dB or more if the centre frequency of the band containing the tone is above 400Hz
   - 8 dB or more if the centre frequency of the band containing the tone is 160Hz to 400Hz inclusive
   - 15 dB or more if the centre frequency of the band containing the tone is below 160Hz (NSW2011 and NZS6808).

   If tonality is found to be a repeated characteristic of the wind turbine noise, 5 dB(A) should be added to the measured noise level from the wind farm (NSW2011).

   The reference method using narrow-band analysis may also be conducted to confirm the presence of tones, in accordance with Annex C of ISO 1996-2:2007 – Acoustics – *Description,*

[1] J. Cooper, D. Leclercq, and M. Stead. *'Wind induced aerodynamic noise on microphones from atmospheric measurements'*. International Congress on Acoustics 2010, Sydney, August 23-27 2010.

measurement and assessment of environmental noise – Part 2: Determination of environmental noise levels.

5. Amplitude Modulation (AM) is an expected characteristic of wind turbine noise (commonly described as a 'swish'), and this character has been included when determining appropriate noise limits. Under normal circumstances, no assessment of AM is required. If there is concern that AM is excessive at receptors, further analysis will be conducted. AM will only be considered to be a special audible characteristic if the measured A-weighted Peak to through levels exceed 5 dB on a regularly varying basis, or if the measured third-octave band peaks to through levels exceed 6 dB on a regular basis in respect to the blade pass frequency. AM occurs when there is a greater than normal degree of fluctuation as a function of the blade passing frequency (typically about one per second) (NZS6808).

   If excessive AM is found to be a repeated characteristic of the wind turbine noise, 5 dB(A) correction should be added to the measured noise level from the wind farm (NSW2011).

6. Impulsiveness is not commonly experienced in wind farms and is not addressed by Australian guidelines and standards. No assessment or penalty will be applied to the measured data.

7. Wind turbine noise levels with special audible characteristics (i.e. tonality and AM) will be adjusted by arithmetically adding up to +6 dB to the measured noise level. Cumulative adjustments for multiple special audible characteristics will not exceed +6 dB regardless of how many special audible characteristics exist (NZS6808).

8. Where special audible characteristics are confirmed, the value of the adjustment will apply to that specific sample (NZS6808) and will apply only if these are audible at the relevant receptor (NSW2011).

It is noted that *criteria do not usually include consideration of special audible characteristics that are not a normal characteristic of a correctly functioning WTG* (AS4959). As such, prior to conducting the noise measurements, it is recommended that the WTGs are audited to confirm that they are operating normally so that penalties for special audible characteristics are avoided.

Regression curves

9. Scatter plots will be drawn of the post-installation sound levels against measured wind speeds and a best fit regression analysis will be carried out separately on the day and night background noise-hub height wind speed data. Polynomials (from linear up to third order) will be used to present the fitted regression line to calculate the wind farm noise level. A 'bin analysis' such as that outlined in IEC 61400-11 - Wind Turbines - Part 11: *Acoustic noise measurement techniques* may be used for this purpose (NZS6808).

Noise compliance

10. To identify the contribution of the wind farm to the total noise level (i.e. the wind farm's equivalent noise level (L_{Aeq})), the background L_{A90} noise level will be logarithmically subtracted from the total measured noise L_{Aeq}. While a simple energy subtraction of background and post-installation noise levels is not mathematically correct for the L_{A90} noise descriptor, the difference may be taken as the L_{A90} wind farm noise levels (NZS6808). This is based on the assumption that wind farm noise is constant noise and therefore the L_{A90} and L_{Aeq} noise levels produced by the wind farm are equivalent (i.e. $L_{Aeq} = L_{A90}$).

    The total noise levels and the background noise levels will be determined from the best fit regression curves for the relevant integer wind speeds.

11. The wind farm noise level per integer wind speed will be assessed against the noise criteria specified in the NVIA to determine compliance.

Background noise levels

Where noise measurements are conducted at receptors where background noise levels have not been determined, the background noise levels at integer wind speeds can be defined by either:

1. Using the best fit curve determined for the closest receptor where background noise is specified in the NVIA (specified in the 'closest measured receptor' column of Table 7 and Table 8). This method assumes that the background noise measured previously at the closest receptor is 'representative' of the background noise at the alternative complainants location; or
2. By measuring background noise levels specific to the site. This may be achieved with the wind turbines parked/offline or with the wind turbine rotor revolutions below 2 RPM (NSW2011). Relevant WTGs to be parked/offline can be confirmed via acoustic modelling.

When possible, it is desirable that background noise measurements and compliance noise measurements be conducted during the same time of the year, particular when monitoring is adjacent deciduous vegetation. In addition, there may be significant changes in dominant wind directions.

Noise compliance report

An acoustic report will be provided to detail the following information:

1. Description of the noise monitoring equipment used, including any ancillary equipment
2. Description of the wind monitoring equipment and met mast sensor heights
3. Frequency and time-weightings used during measurements
4. Noise monitoring locations and surrounding area description
5. Make and model of the wind turbines
6. Operational wind turbines at the time of measurement
7. Time and duration of monitoring period
8. Averaging period for both sound and wind speed measurements
9. Atmospheric conditions: the wind speed and direction at the wind farm position and rainfall recorded
10. Number of data sample pairs measured (wind speed and noise data pairs)
11. Description of the regression analysis
12. Plots showing the data scatter and regression lines
13. Plots showing regression lines for total noise, wind farm noise, background noise, and noise limits
14. Assessment of special audible characteristics
15. A statement that the wind farm complies with relevant limits, or exceeds them, as determined from the best fit regression analysis.

Noise Monitoring for Noise Complaints

Where noise monitoring is required in response to complaints, a combination of attended and unattended monitoring can be used.

1. Attended monitoring

Attended noise monitoring can be used to verify a complaint before committing to extensive noise monitoring. Wind forecast should be obtained from the wind farm meteorological mast control system to assist in determining the most suitable monitoring days, based on the worst case wind direction for the complainant site and at maximum sound power level. Monitoring will generally be required to be performed at night where background sound levels are lowest.

2. Unattended monitoring

Should complaints arise from the operation of the Coopers Gap Wind Farm, noise monitoring at the noise complainant receptors should be conducted following the process described above. Background noise levels at integer wind speeds can be obtained by the method explained above.