



## **APPENDIX E      NOISE IMPACT ASSESSMENT**



## **E.2 BACKGROUND NOISE MONITORING**

# Hills of Gold Wind Farm

Background Noise Monitoring

S6400C10

October 2020

sonus.

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## INTRODUCTION

Sonus has been engaged by Wind Energy Partners to conduct background noise monitoring in the vicinity of the proposed Hills of Gold Wind Farm. Noise monitoring locations were selected to provide noise data indicative of the noise levels at sensitive receivers within the vicinity of the proposed wind farm.

Five background noise locations were originally selected by Sonus based on a review of the layout and nearby dwellings, as well as previous experience with similar projects. This number was then increased to seven by Wind Energy Partners to aid in additional community consultation.

Noise monitoring was conducted with respect to the requirements of the New South Wales Planning and Environment *Wind Energy: Noise Assessment Bulletin (the Bulletin)*. Reference has also been made to the South Australian Environment Protection Authority *Wind Farms – Environmental Noise Guidelines (SA 2009)* as the Bulletin adopts SA 2009 as the basis of the assessment methodology in NSW.

The noise data measured at each monitoring location have been correlated with wind speed referenced to an indicative hub height of 150m. This corresponds to approximately the hub height of the tallest turbine being considered (151m). This represents a conservative approach as less onerous criteria would apply if a lower hub height were to be used. From the measured background noise levels, criteria are assigned for each dwelling. It is noted that if the hub height were to change, the criteria would therefore need to be updated.

Background noise measurements were taken during a period that corresponded to COVID-19 restrictions. Although traffic volumes may have been reduced during this period, the background noise levels are unlikely to be affected. Although unlikely, any impact of the reduced traffic volumes would result in lower (more onerous) criteria than might have been determined during times of regular activity.

This report provides the methodology and results of the background noise monitoring regime.

## NOISE MONITORING

Background noise monitoring was conducted at seven locations over the time periods described in Table 1.

**Table 1: Noise Monitoring Periods.**

Location	Monitoring Period(s)
AD 2	06/05/2020 to 15/06/2020
NAD 5	05/05/2020 to 15/06/2020
NAD 11*	05/05/2020 to 16/06/2020
NAD 12	05/05/2020 to 15/06/2020
NAD 33	05/05/2020 to 16/06/2020
NAD 74	05/05/2020 to 16/06/2020
Nundle Township	05/05/2020 to 16/06/2020

\* When collecting the noise logger at NAD11, it was apparent that it had been moved. Review of the noise data indicated that this occurred on 24 May. Data collected from this time have therefore not been used in the assessment.

## Location

A noise logger was positioned on the wind farm side of each dwelling, at an equivalent distance to major trees as the dwellings. Noise monitoring locations are provided in Table 2 and circled in Figure 1 below. A photograph of the noise monitoring equipment at each location, as well as an aerial photograph of the location, is provided in Appendix A. A full list of the dwelling locations are shown in Appendix C.

**Table 2: Noise Monitoring Locations Coordinates.**

Measurement Location	Coordinates (UTM WGS84 56 J)	
	Easting	Northing
AD 2	328741	6505957
NAD 5	324010	6508244
NAD 11	327750	6510937
NAD 12	328026	6511246
NAD 33	320268	6509243
NAD 74	315164	6507289
Nundle Township	321826	6516741

It is noted that the logger at AD 2 was positioned to be a proxy for NAD 67, as access to this property was not available. The logger at Nundle Township was located at the nearest point within the town to the wind farm site.



**Hills of Gold Wind Farm**

70 Turbine Layout

**August 2020**

**Legend**

- Dwelling
- ✈ Wind Turbine
- + DA Dwelling
- + Associated Dwelling
- NAD Non-Associated Dwelling
- AD Associated Dwelling

**Preliminary Prediction Contour (dB(A))**

30 = 30

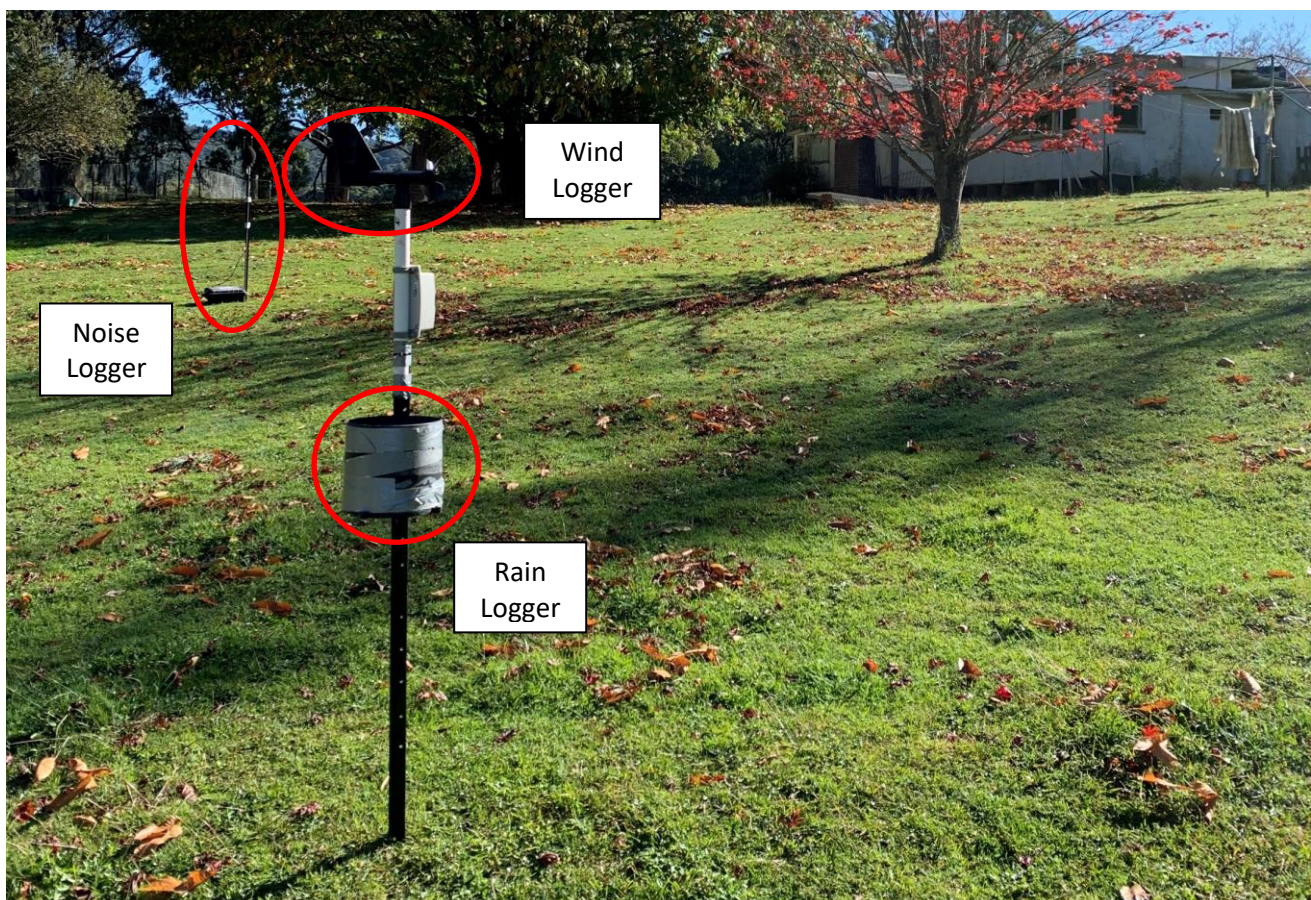
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## Equipment

The background noise was measured in 10 minute intervals with a combination of Rion Class 1 sound level meters with a noise floor of less than 20 dB(A), calibrated at the beginning and end of the measurement period with a Rion Calibrator. The microphones were positioned approximately 1.5 m above ground level, as per the requirements of SA 2009, and fitted with a wind shield with a diameter of at least 150mm. An example of a typical on-site setup is shown in Figure 2 below.

*Figure 2: Typical Monitoring Location Setup*



## Hub Height Wind Speed

During the background noise monitoring, the wind speeds were measured in 10 minute intervals at four locations. Table 3 provides the measurement locations and the noise monitoring locations near each mast where applicable.



**Table 3:** Wind measurement locations and closest monitoring locations.

Measurement Location	Coordinates (UTM WGS84 56 J)		Noise monitoring location
	Easting	Northing	
Met Mast 2	323260	6499312	-
Met Mast 3	326974	6501361	-
Met Mast 4	317573	6501422	NAD 74
Lidar 4	325751	6506439	AD 2, NAD 5, NAD 11, NAD 12, NAD 33, Nundle Township

The background noise data were correlated with wind speeds measured closest to the noise monitoring location. The wind data were sheared to a height of 150m before being provided to Sonus. It should be noted that data from Lidar 4 was not available for all time periods. Times where data is missing have been excluded from the analysis.

#### Data Analysis

During the background noise monitoring period, wind speed at the microphone location (approximately 1.5m above ground level) was measured using “Rainwise” wind speed loggers. At AD 2 and NAD 74, rainfall was also recorded. The rainfall and wind speed data were used to determine the periods when weather may have affected the background noise measurements. Data within these periods were discarded as the data could artificially increase the background noise. This includes periods where rainfall was measured and/or where the measured wind speed exceeded 5 m/s at the microphone for more than 90% of the measurement period. The rainfall loggers at AD 2 and NAD 74 were taken to be indicative of rainfall at the other monitoring locations for the eastern and western portions of the site, respectively. Any data for wind speeds below the cut in wind speed and above the rated power of the turbine were also removed. In this case, this was any data for a wind speed less than 3 m/s or greater than 12 m/s. Some additional data were removed at NAD 74 where there were clear outliers present. Intermittent noise sources, such as the noise from dogs barking or passing cars, are excluded as the  $L_{A90,10min}$  measured considers only the level of noise that is exceeded for 90% of the 10 minute time period.

Following the data removal procedure, the following number of points remained for each of the monitoring locations. As per the Bulletin, a minimum of 2000 data points are required for a valid assessment. Additionally, 500 downwind data points are required, or if this is impractical to collect, the monitoring must continue for up to six weeks.

**Table 4:** Data Points Remaining at each Monitoring Location

Location	Data Points	Downwind Data Points
AD 2	4070	1295
NAD 5	4153	1856
NAD 11	1803	74
NAD 12	4151	515
NAD 33	4134	1772
NAD 74	4514	1473
Nundle Township	4145	635

As noted above, the reduced number of data points at NAD 11 is the result of the exclusion of data after the movement of the logger. Given the reduced number of data points, a conservative approach has been taken by assigning the background noise levels from NAD 12 to NAD 11, where the level is lower.

#### Background Noise Correlation

The background noise data collected at each monitoring location were correlated with the sheared wind speed at the nearest wind measurement location for an indicative hub height of 150m for each 10 minute period.

A least squares regression analysis of the data was undertaken to determine the line of best fit for the correlations. The data and the regression curves are shown in Appendix B. The low correlation at some locations indicates that the background noise is not significantly influenced by wind speed.

Based on the line of best fit in Appendix B, the background noise level ( $L_{A90,10min}$ ) can be determined for each integer hub height wind speed.

Table 5 summarises the background noise level for each integer wind speed at an indicative hub height of 150m, between 3 and 12 m/s:

**Table 5: Background Noise Levels ( $L_{A90,10min}$ ) at Monitoring Locations (dB(A)).**

Measurement Location	Wind Speed (m/s) at 150m									
	3	4	5	6	7	8	9	10	11	12
AD 2	21	22	22	23	23	24	24	25	25	26
NAD 5	22	22	23	24	25	26	27	28	30	31
NAD 11	22	23	24	25	26	28	30	32	35	38
NAD 11 (assigned from NAD 12)	20	21	22	23	25	27	29	31	33	35
NAD 12	20	21	22	23	25	27	29	31	33	35
NAD 33	24	25	25	25	25	25	26	26	26	26
NAD 74	24	25	26	26	26	25	25	25	25	25
Nundle Township	26	26	26	27	27	26	26	26	26	25



## WIND TURBINE CRITERIA

In order to determine the criteria for a wind turbine installation, reference is made to the Secretary's Environmental Assessment Requirements (**SEARs**).

The SEARs reference the New South Wales Planning and Environment *Wind Energy: Noise Assessment Bulletin* (**the Bulletin**) for the assessment of operational noise from the wind turbine generators.

The Bulletin adopts the South Australian Environment Protection Authority *Wind Farms – Environmental Noise Guidelines* (**SA 2009**) as the basis of the regulatory noise standard and assessment methodology in NSW.

The Bulletin states that the *"NSW Government recognises that rural land use zones in NSW are often more densely settled than those of South Australia and that there is a relatively high density of rural residential living in parts of regional NSW with reliable wind resources.*

*Therefore, only the lower base noise criteria in SA 2009 will be applied in NSW, this Criteria is defined as:*

*The predicted equivalent noise level ( $L_{Aeq,10 \text{ minute}}$ ), adjusted for tonality and low frequency noise in accordance with these guidelines, should not exceed 35 dB(A) or the background noise ( $L_{A90,10 \text{ minute}}$ ) by more than 5 dB(A), whichever is the greater, at all relevant receivers for wind speed from cut-in to rated power of the wind turbine generator and each integer wind speed in between."*

### Operational Noise Criteria

The noise criteria that relate to the wind farm are separated into two categories, these being non-associated dwellings and associated dwellings. The criteria for each category are set in different ways.

#### Non-associated Dwellings

Based on the Bulletin, noise from the wind farm at non-associated dwellings should not exceed an outdoor noise level of 35 dB(A) or the background noise ( $L_{A90, 10 \text{ minute}}$ ) by more than 5 dB(A), whichever is the greater.

### Associated Dwellings

Where a landowner has formed a commercial agreement with the developer, the Bulletin enables less onerous noise criteria to be used where the affected persons are appropriately informed of the expected noise levels.

Utilising SA 2009, a suitable criterion is based on the World Health Organisation (**WHO**) *Guidelines for Community Noise (WHO Guidelines)* which provide recommendations to protect against:

- sleep disturbance within habitable rooms of residences, and;
- annoyance during the daytime for outdoor areas.

The recommendations of the WHO Guidelines are repeated below:

*“For a good night's sleep, the equivalent sound level should not exceed 30 dB(A) (inside the bedroom) for continuous background noise”*

and

*“To protect the majority of people from being..... moderately annoyed during the daytime, the outdoor sound pressure level should not exceed 50 dB  $L_{Aeq}$ .”*

An outdoor level of 45 dB(A) at the *associated dwellings* will satisfy the WHO Guidelines, including inside a bedroom with the windows to the dwelling open.

Based on the above, the criteria for each of the measurement locations are shown in Table 6 below. These measurement locations have also been used as representative of the background noise at other locations, where background noise has not been measured. These are also shown in Table 6.

When considering the locations where background noise monitoring was not conducted, the following factors were considered to determine the representative location:

- The nearest background noise monitoring location;
- The relative elevations;
- The foliage in the vicinity of the dwellings; and
- The location of the dwelling in relation to the nearest wind turbines.

Based on the above factors, each dwelling was then assigned to a background noise monitoring location that is expected to be most similar to the conditions at the dwelling.

**Table 6: Criteria (dB(A)).**

Measurement Location	Associated/ Non-Associated	Representative Locations	Wind Speed (m/s) at 150m									
			3	4	5	6	7	8	9	10	11	12
AD 2	Y	AD 2, AD 11	45	45	45	45	45	45	45	45	45	45
	N	NAD 3, NAD 4a, NAD 4b, NAD 4c, NAD 48, NAD 67	35	35	35	35	35	35	35	35	35	35
NAD 5	Y	AD 3, AD 6, AD 8, AD 13	45	45	45	45	45	45	45	45	45	45
	N	NAD 5, NAD 10, NAD 10a, NAD 17, NAD 66	35	35	35	35	35	35	35	35	35	36
NAD 11, NAD 12	N	NAD 7, NAD 8, NAD 11	35	35	35	35	35	35	35	36	38	40
NAD 12	Y	AD 5	45	45	45	45	45	45	45	45	45	45
	N	NAD 12, NAD 13, NAD 14, NAD 15, NAD 16, NAD 18, NAD 19, NAD 20, NAD 23, NAD 24, NAD 25, NAD 26, NAD 30, NAD 32, NAD 38, NAD 39, NAD 40, NAD 44, NAD 35, NAD 36, NAD 37, NAD 57, NAD 58, NAD 59, NAD 60, NAD 61, NAD 62, NAD 63, NAD 64, NAD 65	35	35	35	35	35	35	35	36	38	40
NAD 33	N	NAD 33, NAD 45, NAD 47, NAD 68, DAD 10	35	35	35	35	35	35	35	35	35	35
NAD 74	Y	AD 7, AD 10	45	45	45	45	45	45	45	45	45	45
	N	NAD 1, NAD 21, NAD 22, NAD 34, NAD 41, NAD 49, NAD 50, NAD 51, NAD 52, NAD 53, NAD 54, NAD 55, NAD 56, NAD 69, NAD 70, NAD 71, NAD 72, NAD 73, NAD 74	35	35	35	35	35	35	35	35	35	35
Nundle Township	N	NAD 75, NAD 76, NAD 77, Nundle Township	35	35	35	35	35	35	35	35	35	35



**Appendix A: Photograph of logger at monitoring locations**

*Figure 3: AD 2 monitoring location.*



*Figure 4: AD 2 aerial photograph.*





*Figure 5: NAD 5 monitoring location.*



*Figure 6: NAD 5 aerial photograph.*

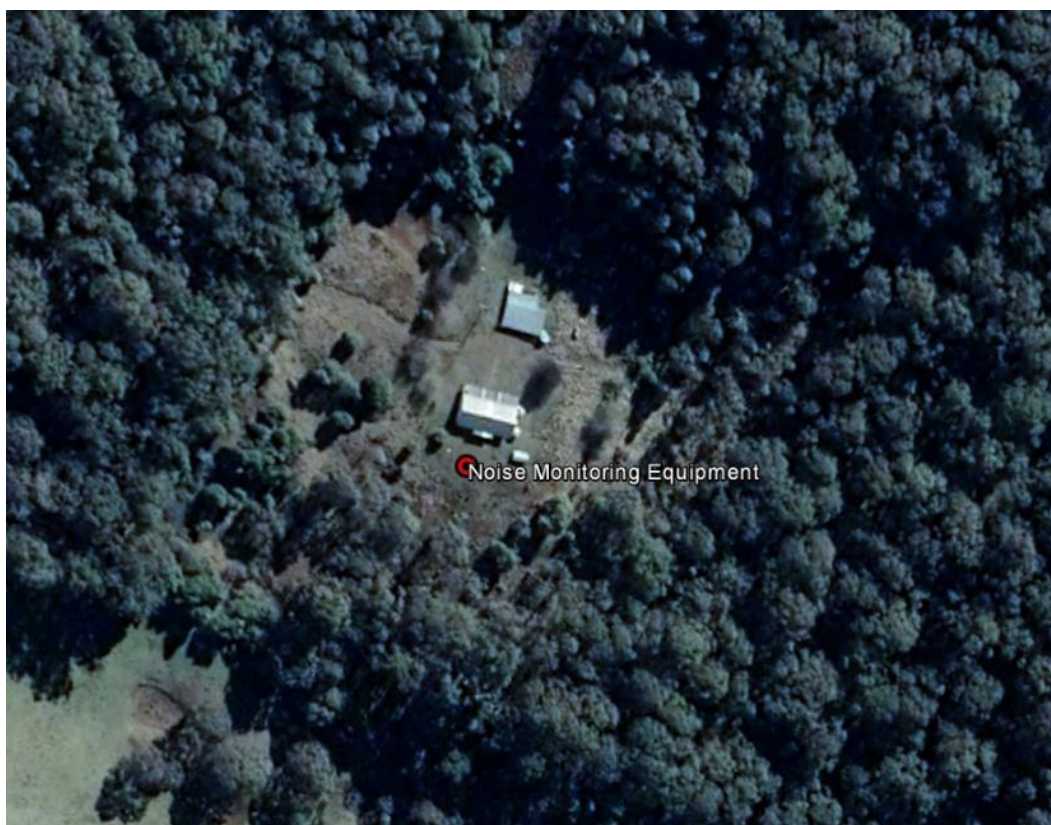




*Figure 7: NAD 11 monitoring location.*



*Figure 8: NAD 11 aerial photograph.*

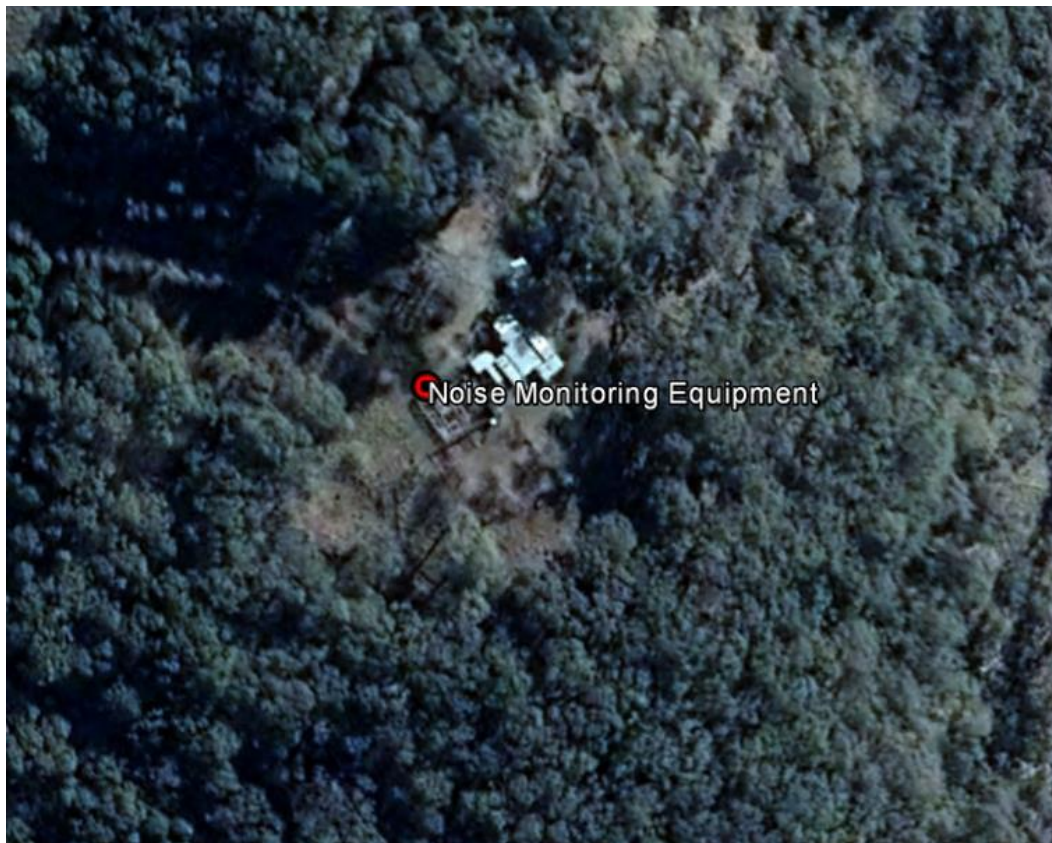




*Figure 9: NAD 12 monitoring location.*



*Figure 10: NAD 12 aerial photograph.*

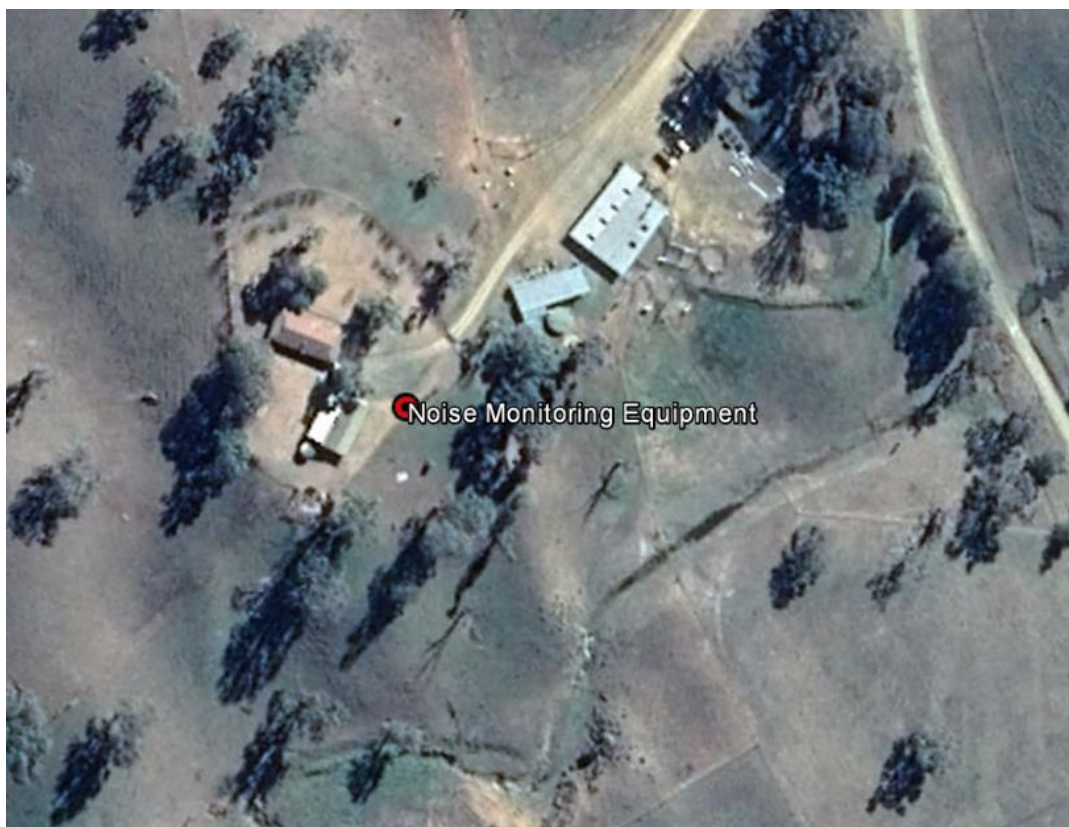




*Figure 11: NAD 33 monitoring location.*



*Figure 12: NAD 33 aerial photograph.*





**Figure 13:** NAD 74 monitoring location.



**Figure 14:** NAD 74 aerial photograph.





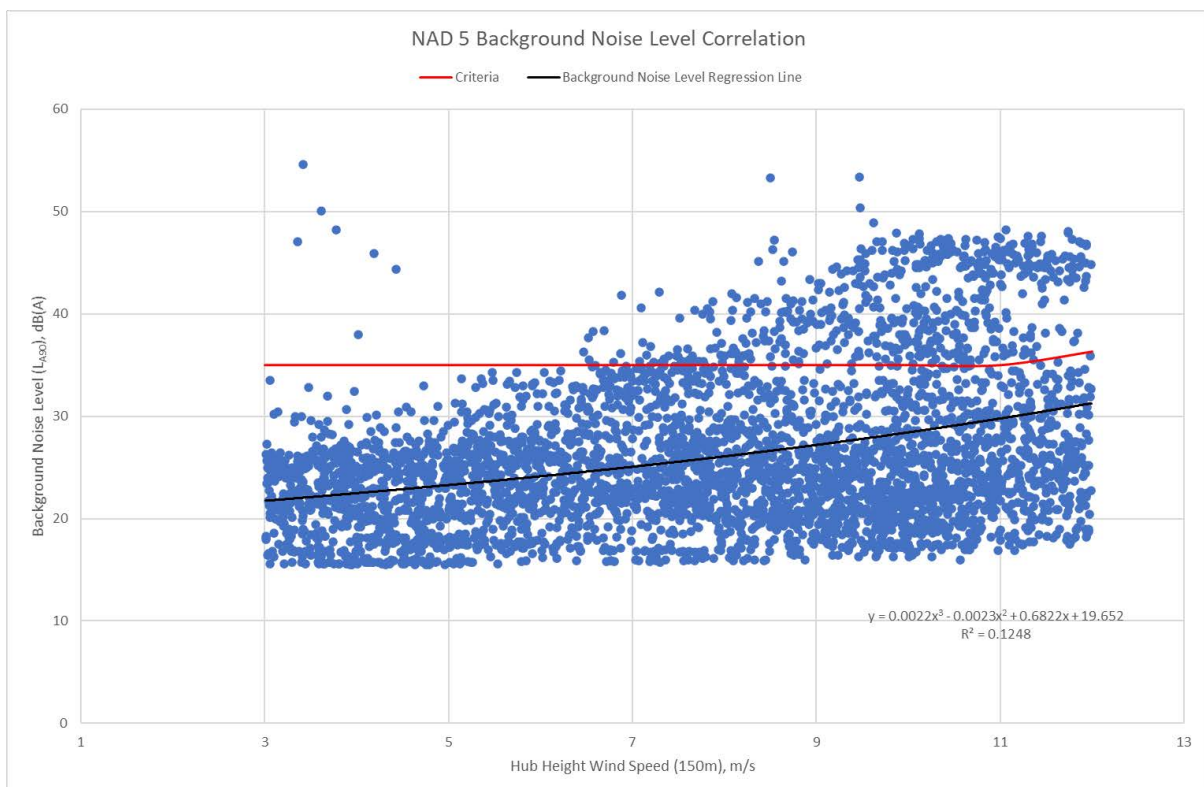
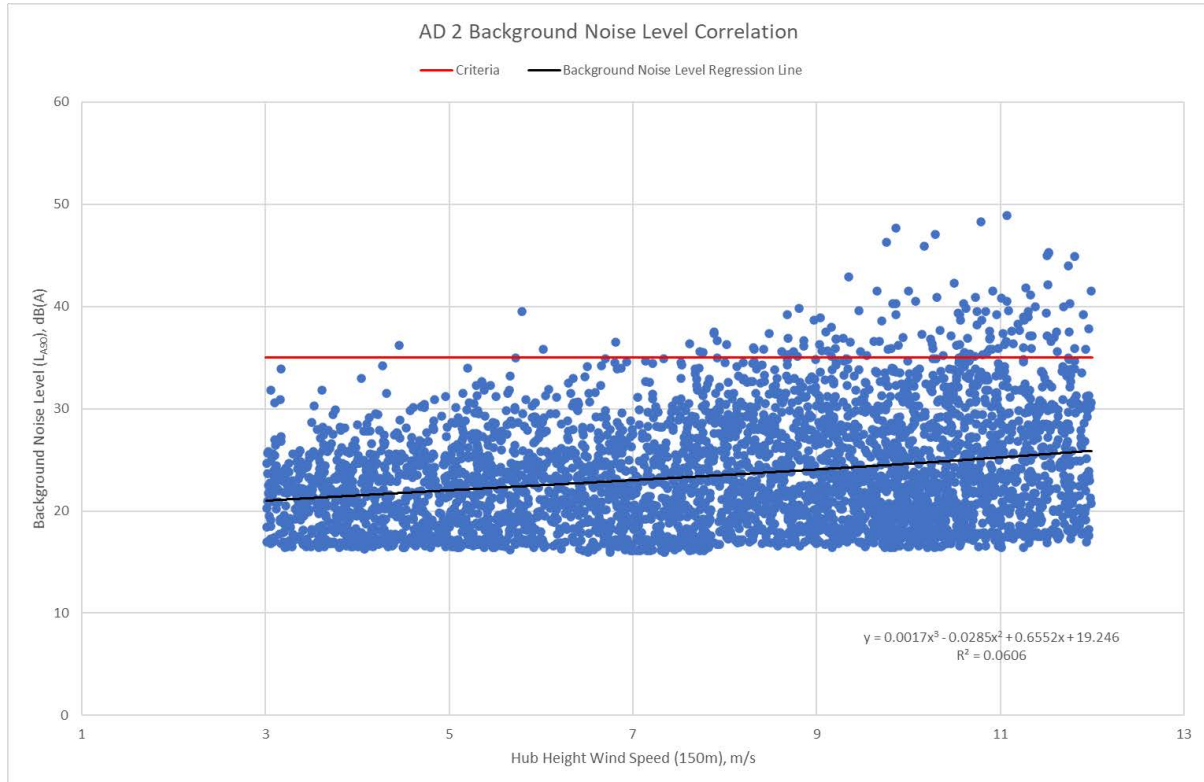
**Figure 15:** *Nundle Township monitoring location.*

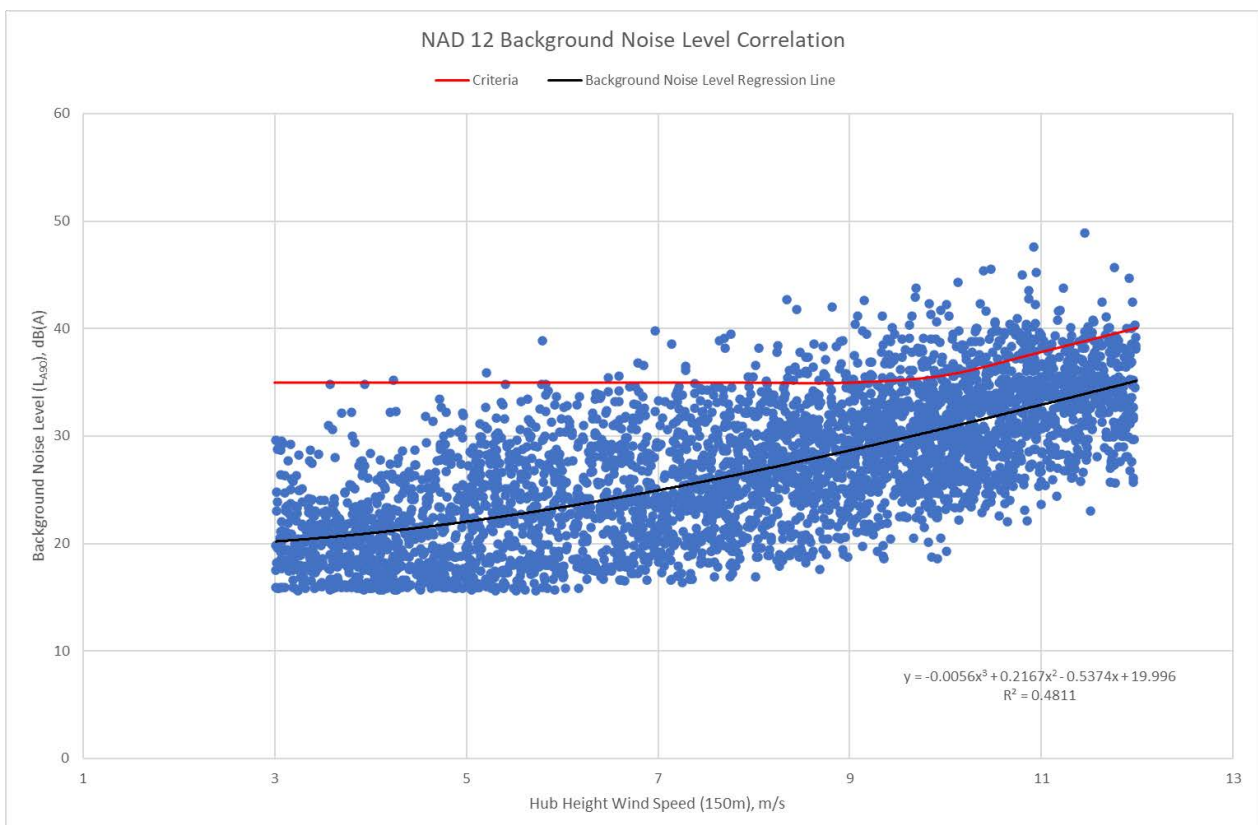
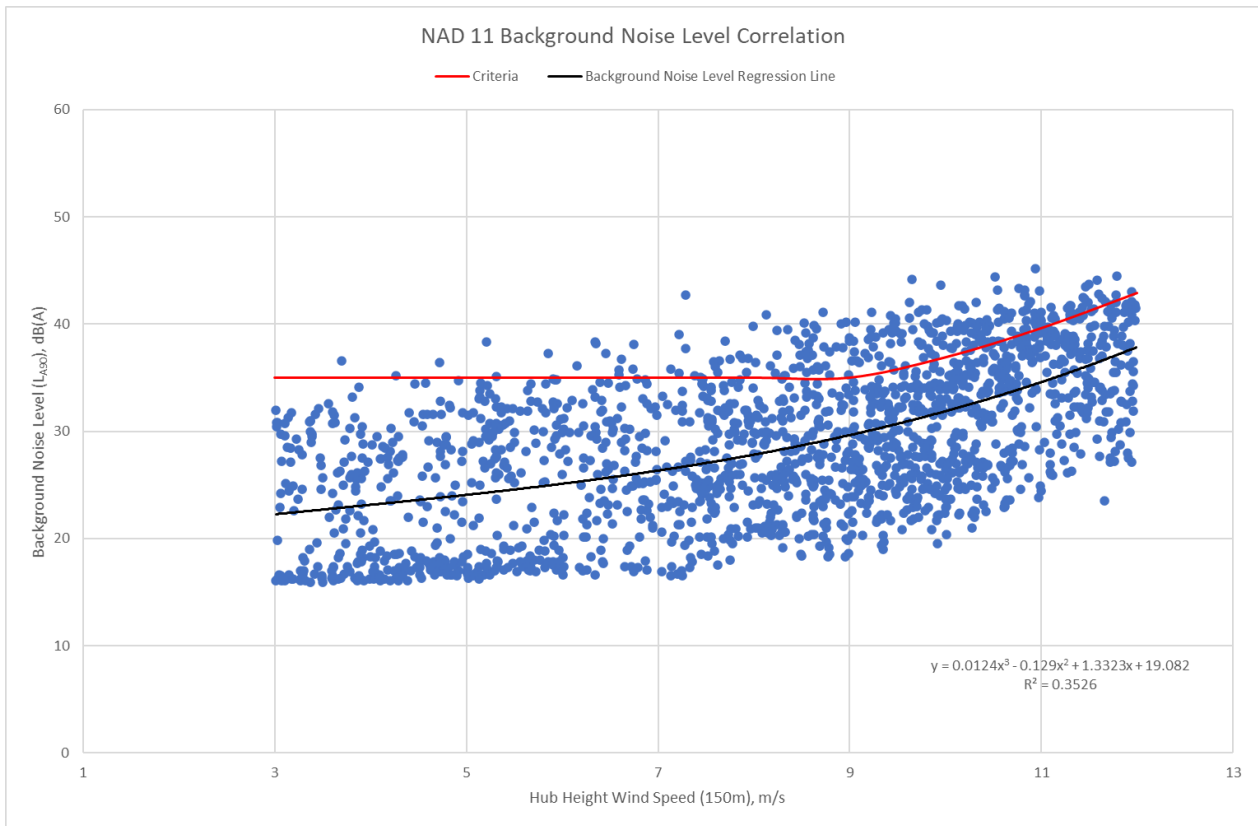


**Figure 16:** *Nundle Township aerial photograph.*

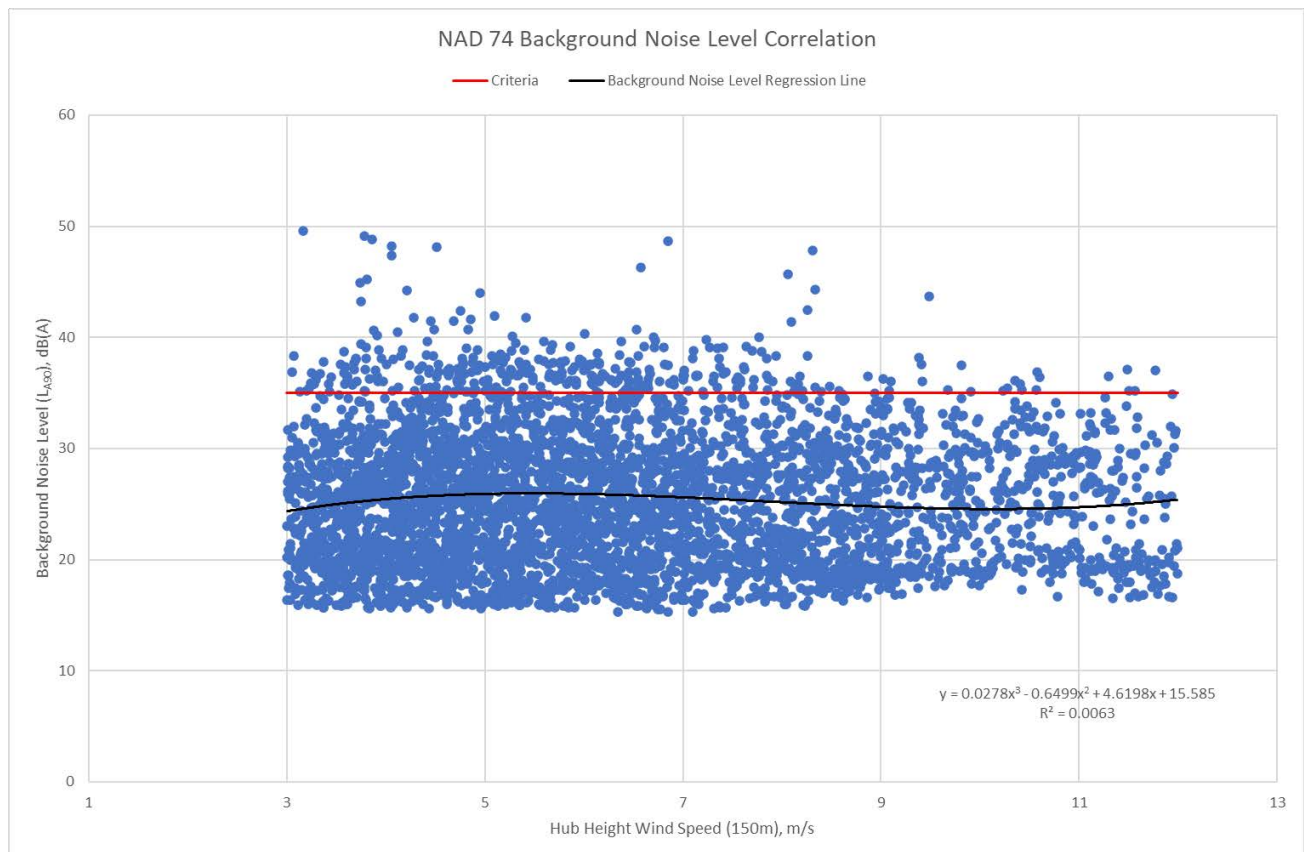
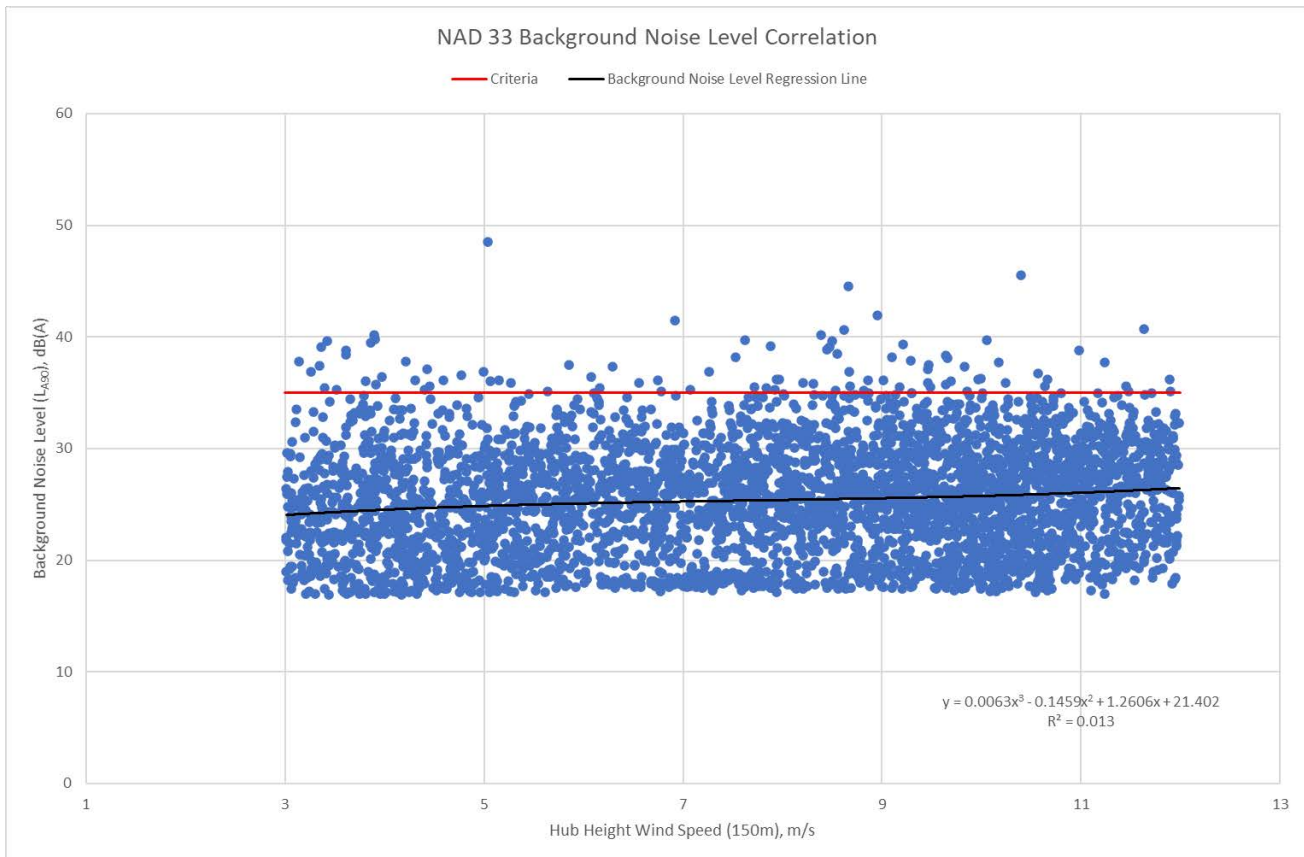


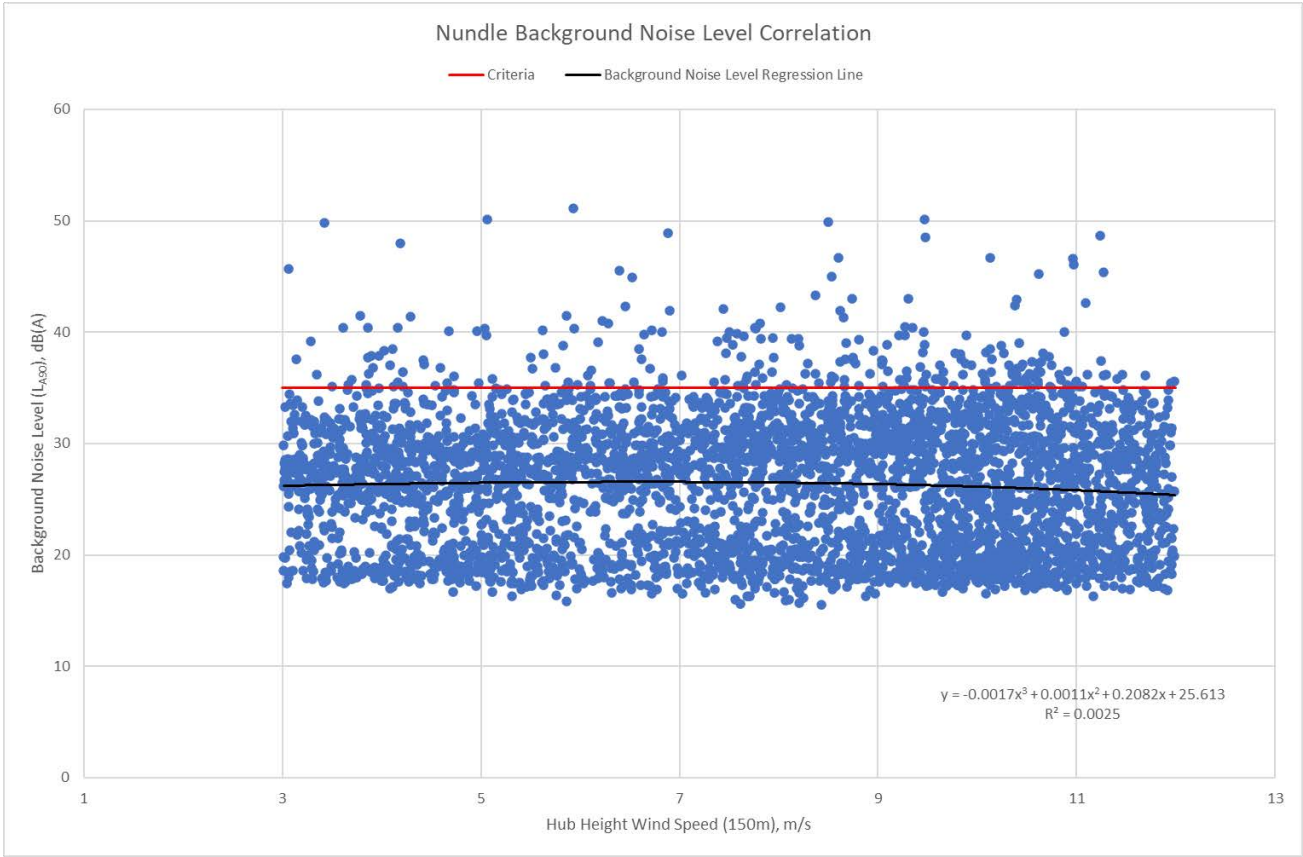
## Appendix B: Background noise and wind speed correlation for monitoring locations













## Appendix C: Dwelling Coordinates

Dwelling ID	Coordinates (UTM WGS84 56 J)	
	Easting	Northing
<b>Non-Associated Dwellings</b>		
NAD_1	320992	6496158
NAD_3	329854	6506558
NAD_4a	329397	6507209
NAD_4b	329534	6507212
NAD_4c	329350	6507326
NAD_5	324003	6508235
NAD_7	329663	6509501
NAD_8	328903	6509784
NAD_10	323436	6510321
NAD_10a	324750	6510549
NAD_11	327761	6510966
NAD_12	328054	6511244
NAD_13	328155	6511648
NAD_14	328483	6511690
NAD_15	328490	6511836
NAD_16	328430	6512004
NAD_17	325779	6512114
NAD_18	329077	6512215
NAD_19	329299	6512385
NAD_20	329450	6512433
NAD_21	314719	6505531
NAD_22	315473	6507424
NAD_23	328943	6512128
NAD_24	327870	6511947
NAD_25	328919	6513366
NAD_26	328442	6513705
NAD_30	330239	6512943
NAD_32	330182	6512615
NAD_33	320291	6509321
NAD_34	316860	6509584
NAD_35	328329	6513939
NAD_36	328474	6513861
NAD_37	328334	6514024
NAD_38	329106	6513475
NAD_39	330544	6512768
NAD_40	328495	6513789
NAD_41	316108	6496893
NAD_44	331096	6512617
NAD_45	320278	6514434
NAD_47	321049	6514768
NAD_48	331392	6505905
NAD_49	316386	6509799
NAD_50	320353	6495383
NAD_51	307480	6511211
NAD_52	307953	6511904

Dwelling ID	Coordinates (UTM WGS84 56 J)	
	Easting	Northing
NAD_53	307917	6512259
NAD_54	312970	6508604
NAD_55	314743	6509871
NAD_56	316134	6510901
NAD_57	328393	6514480
NAD_58	328559	6514581
NAD_59	328502	6514660
NAD_60	328503	6514683
NAD_61	328334	6514826
NAD_62	328300	6514859
NAD_63	328292	6515063
NAD_64	328657	6515117
NAD_65	328296	6515187
NAD_66	323698	6511863
NAD_67	327486	6506061
NAD_68	322643	6515070
NAD_69	320456	6495895
NAD_70	318539	6494620
NAD_71	308435	6513767
NAD_72	314889	6499214
NAD_73	315882	6498385
NAD_74	315171	6507263
NAD_75	321384	6515431
NAD_76	320925	6515433
NAD_77	321125	6515811
Nundle Township	321826	6516740
<b>Development Approved Dwelling<sup>1</sup></b>		
DAD_10	323119	6513312
<b>Associated Dwellings</b>		
AD_2	328733	6505963
AD_3	323978	6502750
AD_5	326945	6507944
AD_6	324410	6508941
AD_7	315761	6499069
AD_8	324949	6501859
AD_10	317746	6496505
AD_11	328384	6508125
AD_13	324403	6509959

<sup>1</sup> A dwelling location understood to not yet be constructed, but approved and therefore considered to be a noise sensitive location.