MT FYANS
WIND FARM

APPENDIX K

BACKGROUND NOISE REPORT

MARSHALL DAY

JULY 2018

MARSHALL DAY Acoustics

MT FYANS WIND FARM
BACKGROUND NOISE REPORT

Rp 002 2012102ML | 20 July 2018

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Document Control

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1.0 INTRODUCTION

This report presents the results of background noise monitoring undertaken for the proposed Mt Fyans Wind Farm.

The background noise monitoring was commissioned by Hydro Tasmania as part of the noise studies associated with the Mt Fyans Wind Farm planning application. The purpose of the monitoring was to obtain a representation of typical baseline conditions at receiver locations in the vicinity of the wind farm and, where appropriate, derive background noise related limits.

Background noise monitoring was conducted at different times during the development of the Mt Fyans Wind Farm proposal. The body of this report primarily addresses the most recent monitoring undertaken in 2017. However, for completeness, the results of monitoring conducted during the earlier planning phases of the project in 2012 and 2013 are also provided in Appendix H to this report. Due to the time that has passed since these earlier surveys were undertaken, as well as improvements in contemporary measurement practices (i.e. the use of enhanced microphone wind shield systems), the data from these earlier surveys are provided for reference purpose only (i.e. background noise related limits are not derived from this data).

This report documents the survey methodology and the results of the background noise monitoring, along with the derived noise limits from the most recent monitoring which may be used to assess operational noise levels associated with the wind farm.

The basic quantities used within this document to describe noise adopt the conventions outlined in ISO 1996-1:2016 *Acoustics - Description measurement and assessment of environmental noise – Part 1: Basic quantities and assessment procedures.* Accordingly, all frequency weighted sound pressure levels are expressed as decibels (dB) in this report. For example, sound pressure levels measured using an "A" frequency weighting are expressed as dB L_A. Alternative ways of expressing A-weighted decibels such as dBA or dB(A) are therefore not used within this report.

Acoustic terminology used throughout this report is presented in Appendix A. Site layout and relevant coordinates are detailed in Appendix B.

Throughout this report, the term receiver is used to identify any dwelling existing on land in the vicinity of the proposed wind energy facility. Receiver locations where a noise agreement is in place between the land owners and Hydro Tasmania (at the time of preparing this report) are referred to as stakeholder receivers.

2.0 BACKGROUND NOISE SURVEY & ANALYSIS METHODOLOGY

The background noise survey and analysis has been conducted in accordance with the following:

- New Zealand Standard 6808:2010 *Acoustics – Wind farm noise* (NZS 6808:2010), as required by *Policy and Planning Guidelines for Development of Wind Energy Facilities in Victoria* published by the Victorian Department of Environment, Land, Water and Planning in November 2017 (the *Victorian Wind Energy Guidelines*)
- Supplementary guidance contained in UK Institute of Acoustics publication *A good practice guide to the application of ETSU-R-97 for the assessment and rating of wind turbine noise* dated May 2013 (UK IOA good practice guide).

This section of the report presents:

- An overview of the survey methodology
- Details of the selected noise monitoring locations
- A summary of the data analysis procedures.

2.1 Monitoring locations

Background noise monitoring was carried out at four (4) receiver locations listed in Table 1.

Table 1: Background noise monitoring locations

Receiver	Direction from wind farm	Distance from nearest turbine
u17	North, east and west	1,446 m
u31	North, east and west	1,702 m
u47	North, east and west	1,505 m
u51	South	1,201 m

The monitoring locations are illustrated in Appendix H, along with the locations of the 2012 and 2013 surveys.

The monitoring locations were selected on the basis of:

- A total of eighty-seven (87) turbines located at the coordinates detailed in Appendix B
- The noise monitoring procedures outlined in NZS 6808:2010
- Predicted operational wind farm noise levels prepared at the time of the survey planning.

The above information was used to identify the locations where background noise levels would inform the assessment of operational noise.

At each of the receiver locations where noise monitoring was carried out, the choice of location relative to the dwelling was made on account of the range of considerations specified in NZS 6808:2010. The following specific considerations were factored:

- The noise monitors were located on the proposed wind farm side of the dwelling
- The noise monitors were located at least 5 m away from the dwelling and any significant vertical reflecting structures
- The noise monitors were located as far as practical from taller vegetation at each dwelling and any obvious sources of extraneous noise.

Coordinates and photographs for the noise monitoring locations are provided in Appendix D to Appendix G.

2.2 Survey description

The background noise survey comprised unattended monitoring over a number of weeks to measure sound levels for a range of environmental conditions. Site wind speeds were simultaneously recorded throughout the survey to enable the relationship between background noise levels and site winds to be assessed. Local weather conditions and periodic audio samples were also recorded to assist the analysis of the survey results.

The key elements of the background noise survey are summarised in Table 2 below.

Table 2: Summary of key elements of background noise survey

Item	Description
Monitoring locations	Four (4) residential receiver locations as described in Section 2.1.
Monitoring Period	10/08/17 to 27/09/17 equating to approximately 7 weeks at each location. The duration was chosen to satisfy the guidance of NZS 6808:2010 which indicates the measurements should be made for a representative range of wind speeds and directions for the site, and that a minimum of 1,440 individual 10-minute measurements, equivalent to 10 days of monitoring is normally required to obtain a satisfactory range.
Sound level meters	Class 1 automated sound loggers (most accurate class rating for field usage). Microphones mounted at approximately 1.5 m above ground level and fitted with enhanced wind shielding systems based on the design recommendations detailed in the UK IOA good practice guide. See equipment specifications and calibration records in Appendix B.
Noise measurement data	A-weighted average and statistical sound pressure levels. One-third octave band frequency noise levels and a brief audio sample every ten (10) minutes to aid the identification of extraneous noise influences.
Local wind speed and rainfall data	A weather station was installed beside one of the noise monitoring locations to concurrently record rainfall and wind speeds at microphone height. This data was recorded to identify periods when local weather conditions may have resulted in excessive extraneous noise at the microphone (i.e. rainfall).
Site wind speed data	Hub height wind speeds for correlating background noise levels with site wind speeds. Site wind speed data was sourced from the met mast at the site with anemometers extending to a height of 79 m. Hub height wind speed data (125 m above ground level) was provided by Entura, based on their analysis to extrapolate the 79 m height wind speeds to 125 m, accounting for the increase in wind speed with increasing height. Entura advised that the analysis involved determining a best fit wind shear profile across the wind speeds measured at the 40, 79 and 79 m height anemometers for each 10-minute period (using the anemometers oriented at 270° to the meteorological mast). The shear profile was determined using a method referred to as the power law, which involves the calculation of a wind shear exponent. The calculated wind shear exponents were limited to a range of -0.05 to 1.00 to limit the effect any erroneous values which can occur as a result of wind turbulence.

2.3 Data analysis

The survey data has been analysed in accordance with NZS 6808:2010. The analysis involves:

- Collating the measured noise levels, site wind speeds and local weather data into a single dataset
- Filtering the data set to remove measurement results affected by extraneous or atypical noise
- Filtering the data for the range of site wind speeds in which the turbines are expected to operate
- Filtering the data where necessary to account for site wind directions
- Plotting a chart of noise levels versus wind speeds and determining the line of best fit to the data.

A summary of the key steps in the analysis is presented in Table 3.

Table 3: Background noise data analysis

Process	Description
Data collation	Time stamps for each source of measurement data are reviewed to clarify start or end times and measurement time zone. Measured noise levels, site wind speeds and local weather conditions are then collated for each ten-minute measurement interval.
Local weather data filtering	10-minute intervals are identified and filtered from the analysis if rainfall was identified for any ten-minute measurement interval
Extraneous noise filtering	The measured sound frequencies (one-third octave bands) in each 10-minute interval are used to identify periods that are significantly affected by bird or insect sounds. 10-minute intervals have been identified, and filtered from the analysis, when the following conditions[1] are satisfied: • the highest A-weighted one-third octave band noise level is within 5 dB of the broadband A-weighted background noise level for that interval; and • the identified one-third octave band A-weighted noise level is greater than a level of 20 dB L_{A90}.
Time periods	Neither NZS 6808:2010 nor the Victorian Wind Energy Guidelines define separate time periods for the analysis of background noise levels or assessment of wind farm noise. However, previous Victorian wind farm planning permits have often required separate analysis for the night period. Given that the background noise levels measured at the Mt Fyans Wind Farm showed significant variations between day and night noise levels at some locations, a separate analysis was conducted for the night period. Consistent with previous wind farm planning permits which refer to night period analysis, the data sets are considered for the following time periods: • All periods: no restriction on hours (i.e. data during day and night hours included) • Night period: 2200 to 0700 hours.

[1] Griffin, D., Delaire, C., & Pischedda, P. (2013). Methods of identifying extraneous noise during unattended noise measurements. *20th International Congress of Sound & Vibration*.

Process	Description
Regression analysis	Two datasets are plotted on a chart of noise levels versus wind speeds: • All data points that have been removed from the analysis using the above processes • The filtered dataset comprising all retained measurement data The chart of filtered noise levels versus wind speed is reviewed to determine if there are any distinctive trends or gaps in the data which could warrant separation of the measurement results into subgroups (e.g. subgroups for time of day or wind direction). A line of best fit is determined for the filtered data and, where applicable, any subgroups of the filtered data. The line of best fit is determined using a regression analysis of the range of noise levels and wind speeds or, where necessary, analysis of noise levels at individual wind speeds.
Noise limits	Noise limits are defined at each wind speed in accordance with NZS 6808:2010 by an L_{A90} value of 40 dB or the background plus 5 dB, whichever is higher. The value of the background noise level at each integer wind speed is defined by the line of best to the measurement results. As per the background noise analysis, the noise limits are separately defined for all-hours period (i.e. including all hours of the day and night) and the night time period.

3.0 SURVEY & ANALYSIS RESULTS

This section presents a summary of the 2017 background noise measurement results, analysed in accordance with the methodology described in Section 2.2.

The analysis results include the derived noise limits for assessing operational wind farm noise levels associated with the Mt Fyans Wind Farm.

The data in this section is provided for the key wind speeds relevant to the assessment of wind farm noise. The detailed results for all surveyed wind speeds are illustrated in the graphical data provided for each receiver location in Appendix D to Appendix G.

3.1 Background noise levels

The tabulated data presented in Table 4 and Table 5 summarises the derived background noise levels for the all-time and night-time periods respectively.

Table 4: All-time period – operational wind farm noise limits (dB L_{A90})

Location	Hub height wind speed (m/s) [1]												
	4	5	6	7	8	9	10	11	12	13	14	15	16
u17	28.8	29.8	31.0	32.2	33.7	35.2	36.9	38.7	40.6	42.6	44.7	46.9	49.2
u31	32.9	33.5	34.2	35.1	36.2	37.3	38.7	40.1	41.7	43.3	45.1	47.0	49.0
u47	28.7	29.3	30.1	31.0	32.1	33.4	34.8	36.4	38.1	40.0	42.0	44.1	46.4
u51	35.3	36.7	38.0	39.1	40.1	41.0	41.8	42.6	43.5	44.4	45.4	46.6	47.9

Note 1: 125 m above ground level at 663440 E, 5789538 N (MGA 94 Zone 54)

Table 5: Night-time period – operational wind farm noise limits (dB L_{A90})

Location	Hub height wind speed (m/s) [1]												
	4	5	6	7	8	9	10	11	12	13	14	15	16
u17	24.4	25.0	26.0	27.3	28.8	30.5	32.5	34.7	37.1	39.6	42.3	45.0	47.9
u31	28.0	28.3	28.9	29.9	31.1	32.6	34.3	36.3	38.4	40.7	43.1	45.5	48.1
u47	25.9	26.5	27.1	27.9	28.9	30.1	31.5	33.1	34.9	37.0	39.4	42.0	45.0
u51	27.8	29.3	30.8	32.4	34.0	35.6	37.2	38.8	40.4	42.0	43.5	44.9	46.3

Note 1: 125 m above ground level at 663440 E, 5789538 N (MGA 94 Zone 54)

The results presented in Table 4 and Table 5 are generally consistent with the range of background sound levels expected in a rural setting. However, the environment at u51 was affected by a range of domestic sources located around the property including pets, livestock, two small wind turbines and a diesel generator. Periods affected by diesel generator noise were identified and removed from the dataset using the low frequency noise characteristics associated with diesel generators. However, other sources of noise at the property are less distinct in terms of time periods or level of affect, and therefore remain in the data as part of the total sound around the dwelling. While the results are a true representation of the noise levels which occurred at the dwelling during the survey period, the elevated levels cannot be assumed to be an enduring long-term characteristic of the sound environment at the dwelling. The results for receiver u51 are therefore not considered suitable for setting noise limits and are only provided as a reference for current background noise conditions at the property.

3.2 Noise limits

The limits presented herein are based on background noise levels presented in Section 3.1 and the status of each receiver at the time of preparation of this report. In particular, the receivers are considered non-stakeholder locations and the minimum limit is therefore set at 40 dB L_{A90} in accordance with NZS 6808:2010.

Table 6: All-hours period operational wind farm noise limits (dB L_{A90})

Location	Hub height wind speed (m/s) [1]												
	4	5	6	7	8	9	10	11	12	13	14	15	16
u17	40.0	40.0	40.0	40.0	40.0	40.2	41.9	43.7	45.6	47.6	49.7	51.9	54.2
u31	40.0	40.0	40.0	40.1	41.2	42.3	43.7	45.1	46.7	48.3	50.1	52.0	54.0
u47	40.0	40.0	40.0	40.0	40.0	40.0	40.0	41.4	43.1	45.0	47.0	49.1	51.4

Note 1: 125 m above ground level at 663440 E, 5789538 N (MGA 94 Zone 54)

Table 7: Night period operational wind farm noise limits (dB L_{A90})

Location	Hub height wind speed (m/s) [1]												
	4	5	6	7	8	9	10	11	12	13	14	15	16
u17	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	42.1	44.6	47.3	50.0	52.9
u31	40.0	40.0	40.0	40.0	40.0	40.0	40.0	41.3	43.4	45.7	48.1	50.5	53.1
u47	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	42.0	44.4	47.0	50.0

Note 1: 125 m above ground level at 663440 E, 5789538 N (MGA 94 Zone 54)

4.0 SUMMARY

Background noise monitoring was conducted in 2017 at four (4) receiver locations around the proposed Mt Fyans Wind Farm.

The survey and analysis has been carried out on the basis of:

- New Zealand Standard 6808:2010 *Acoustics – The assessment and measurement of sound from wind turbine generators* (NZS 6808:2010), as required by *Policy and Planning Guidelines for Development of Wind Energy Facilities in Victoria* published by the Victorian Department of Environment, Land, Water and Planning in November 2017.
- Supplementary guidance contained in UK Institute of Acoustics publication *A good practice guide to the application of ETSU-R-97 for the assessment and rating of wind turbine noise* dated May 2013 (UK IOA good practice guide).

The results have been analysed to derive noise limits in accordance with NZS 6808:2010 for three (3) of the surrounding receiver locations. Specifically, noise limits have been derived at integer hub-height wind speeds as the greater of a minimum limit (40 dB L_{A90}) and the background level plus 5 dB. At the fourth location, the noise levels have not been used to derive noise limits as a result of domestic sources of noise around the property that cannot be assumed to be an enduring long-term characteristic of the sound environment at the dwelling.

In addition to the 2017 background noise monitoring data, the results of previous surveys conducted in 2012 and 2013 are reproduced in Appendix H for reference purposes.

APPENDIX A GLOSSARY

dB	Decibel. The unit of sound level.
A-weighting	The process by which noise levels are corrected to account for the non-linear frequency response of the human ear.
L_{Aeq}	The A-weighted equivalent continuous sound level and is measured in dB.
L_{A90}	The A-weighted noise level exceeded for 90% of the measurement period, measured in dB. This is commonly referred to as the background noise level.

APPENDIX B TURBINE COORDINATES

The following table sets out the coordinates of the eighty-seven (87) turbines of the Mt Fyans Wind Farm (data supplied by Hydro Tasmania on 27/04/18).

Table 8: Mt Fyans Wind Farm turbine coordinates – MGA 94 zone 54

Turbine	Easting	Northing	Turbine	Easting	Northing
1	668010	5799149	49	663175	5789275
2	670284	5796768	50	655923	5790627
3	656397	5795472	51	657354	5792501
4	659632	5792797	52	661877	5789367
5	667192	5795441	53	669731	5796626
7	666686	5792435	54	663705	5789380
9	661713	5788497	55	666288	5790894
10	668677	5799296	56	659595	5791846
11	659978	5792247	57	655207	5790907
12	657850	5793230	58	664655	5787642
13	664817	5789436	59	667353	5790927
14	668782	5795093	60	667081	5789708
15	662896	5788444	61	661826	5790575
16	667693	5789246	62	665296	5790313
17	666098	5795080	63	665830	5793760
18	662679	5787695	64	655879	5794930
19	665818	5790610	65	663166	5787306
20	666569	5793792	66	665497	5788332
21	658458	5793144	67	664980	5788114
22	669172	5796108	68	667649	5789905
23	669498	5797460	69	660477	5791459
24	667282	5794782	70	666336	5795566
25	667150	5793248	71	663397	5787946
26	667663	5792443	72	668786	5798385
27	663945	5788633	73	654999	5792071
29	654553	5791325	74	655964	5794091
30	654975	5794218	75	667200	5791992
31	654220	5792117	76	662582	5789614
32	666493	5791631	77	669449	5796956
33	666950	5790403	78	665929	5794501

Turbine	Easting	Northing	Turbine	Easting	Northing
34	661106	5791625	79	666642	5794385
35	669606	5798065	81	664015	5787576
37	662357	5788194	82	666037	5789323
38	661391	5791230	83	655430	5791555
39	668304	5794530	84	657025	5794171
40	654672	5792711	86	658830	5792616
41	667763	5793196	87	654722	5793338
42	655277	5794701	88	657799	5793896
43	666274	5793023	89	665389	5789213
44	655929	5792960	90	656877	5793409
45	670041	5797581	91	658313	5792228
46	666686	5789219	92	656721	5791922
47	667977	5793926	93	656408	5791021
48	662242	5790139	-	-	-

APPENDIX C SURVEY INSTRUMENTATION

Table 9: Sound level measurement instrumentation summary

Item	Description
Equipment type	Automated/unattended integrating sound levels
Make & model	01dB CUBE & DUO
Instrumentation class	Certified to Type1 / Class 1 (precision grade) standards in accordance with AS 1259.2-1990[2] and IEC 61672.1-2004[3]
Instrumentation noise floor	Less than 20 dB
Time synchronisation	Internal GPS clocks
Wind shielding	Enhanced wind shielding system based on the design recommendations detailed in the UK IOA good practice guide. The system comprises an inner solid primary wind shield and an outer secondary large diameter hollow wind shield

Table 10: Sound level meter installation records

Receiver	System	Unit serial number	Microphone serial number	Independent calibration date [1]	Calibration drift [2,3]
u17	01dB DUO	10196	136987	06/04/17	< 1 dB
u31	01dB DUO	10495	136880	14/06/16	< 1 dB
u47	01dB DUO	10193	288097	09/05/17	< 1 dB
u51	01dB CUBE	10515	161881	28/06/16	< 1 dB
-	01dB-Stell CAL21	34924044	-	17/05/17	-

Note 1: Independent (laboratory) calibration date to be within 2 years of measurement period as per AS 1055-1:1997[4]

Note 2: Difference between reference level checks during deployment and collection of instruments

Note 3: Calibration drift should not be greater than 1 dB as specified in AS 1055-1:1997

Table 11: Wind speed measurement instrumentation

Wind speeds	Description
Local wind speeds	Vaisala WXT 520 weather station (serial number H5020012) positioned at receiver u47
Site wind speeds	Third party owned and operated system comprising of one meteorological mast with anemometry at multiple heights Further information provided in Section 2.2

[2] AS 1259.2-1990: *Acoustics - Sound level meters - Integrating - Averaging*

[3] IEC 61672.1-2004: *Electroacoustics - Sound level meters - Specification*

[4] AS 1055-1:1997 *Acoustics – Description and measurement of environmental noise - Part 1: General Procedures*

APPENDIX D RECEIVER U17 DATA

D1 Receiver u17 location data

Table 12: Receiver u17 dwelling and noise monitor coordinates for each receiver – MGA 94 Zone 54

Location	Easting	Northing
Dwelling location	665042	5792261
Background noise monitoring location	665059	5792257

Figure 1: Receiver u17 aerial view - dwelling and noise monitor locations

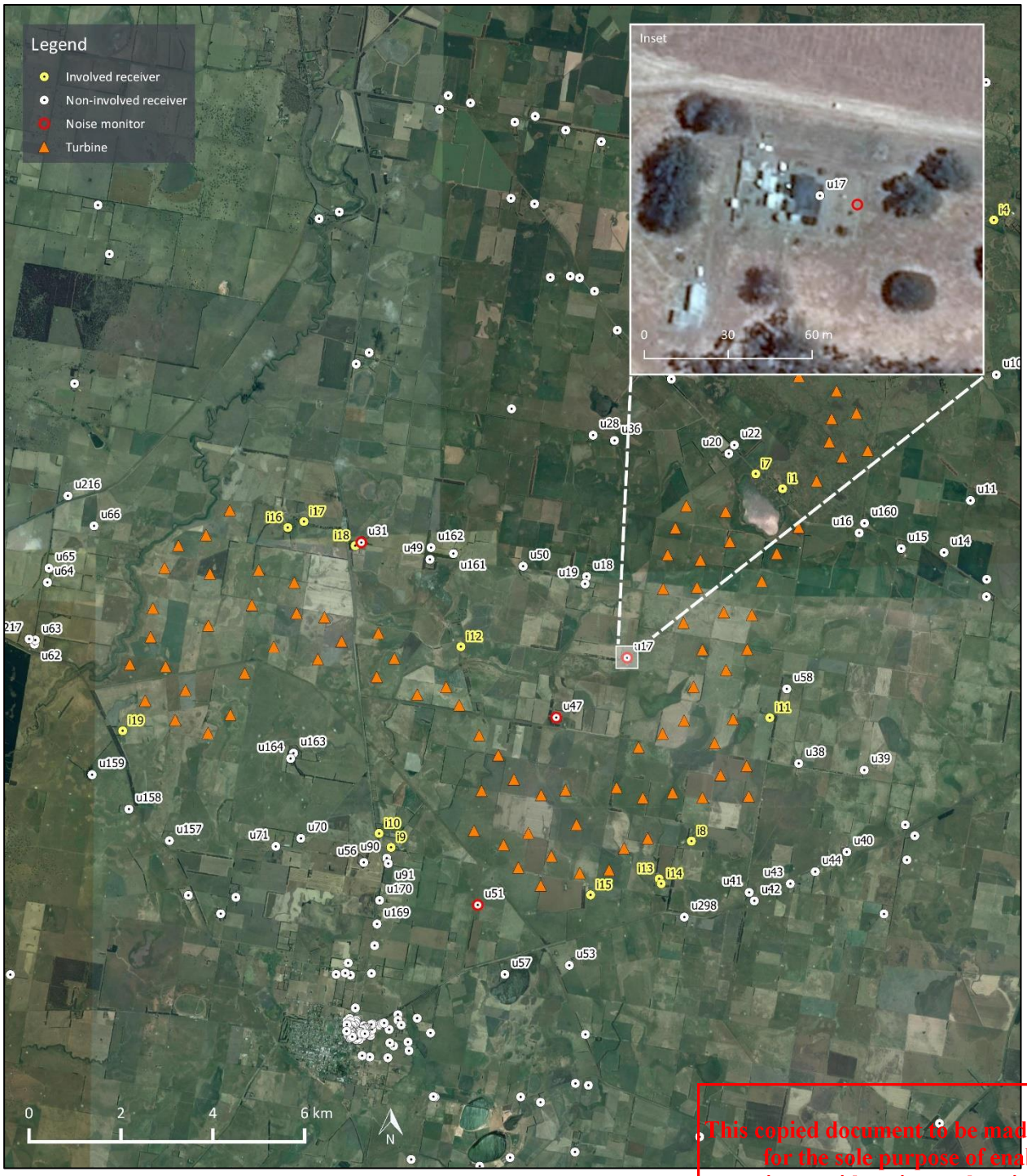


Table 13: Receiver u17 monitor installation photos

Looking North	Looking East
	
Looking South	**Looking West**
	

D2 Receiver U17 measurement data summary

Table 14: Receiver u17 background noise level analysis summary

Item	All-time (day & night combined)	Night-time (2200 – 0700 hrs)
Number of data points collected	6,721	2,504
Number of data points removed	1,593	630
Number of data points for analysis	5,128	1,874

Figure 2: Receiver u17 background noise level and wind speed time history

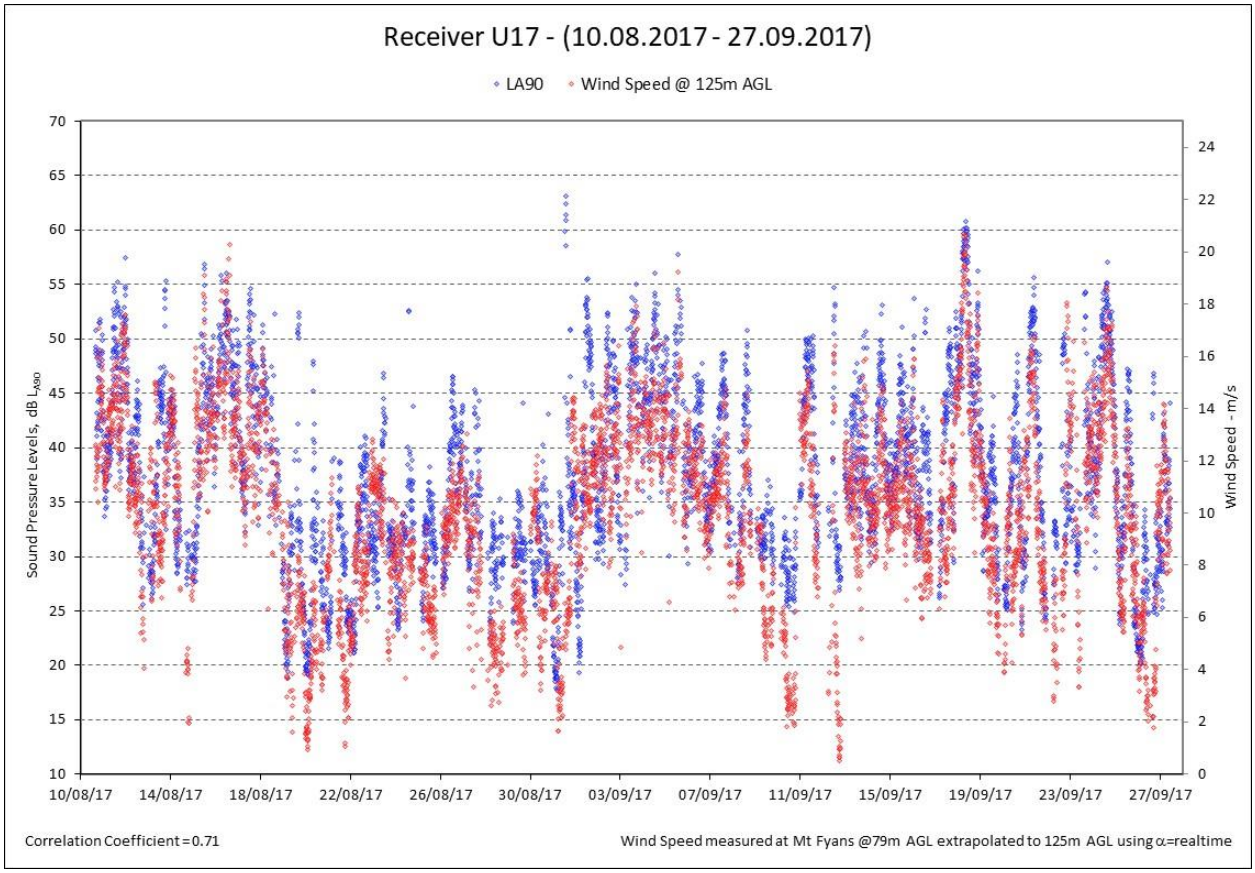


Figure 3: Receiver u17 all-time periods – derived background noise levels and noise limits

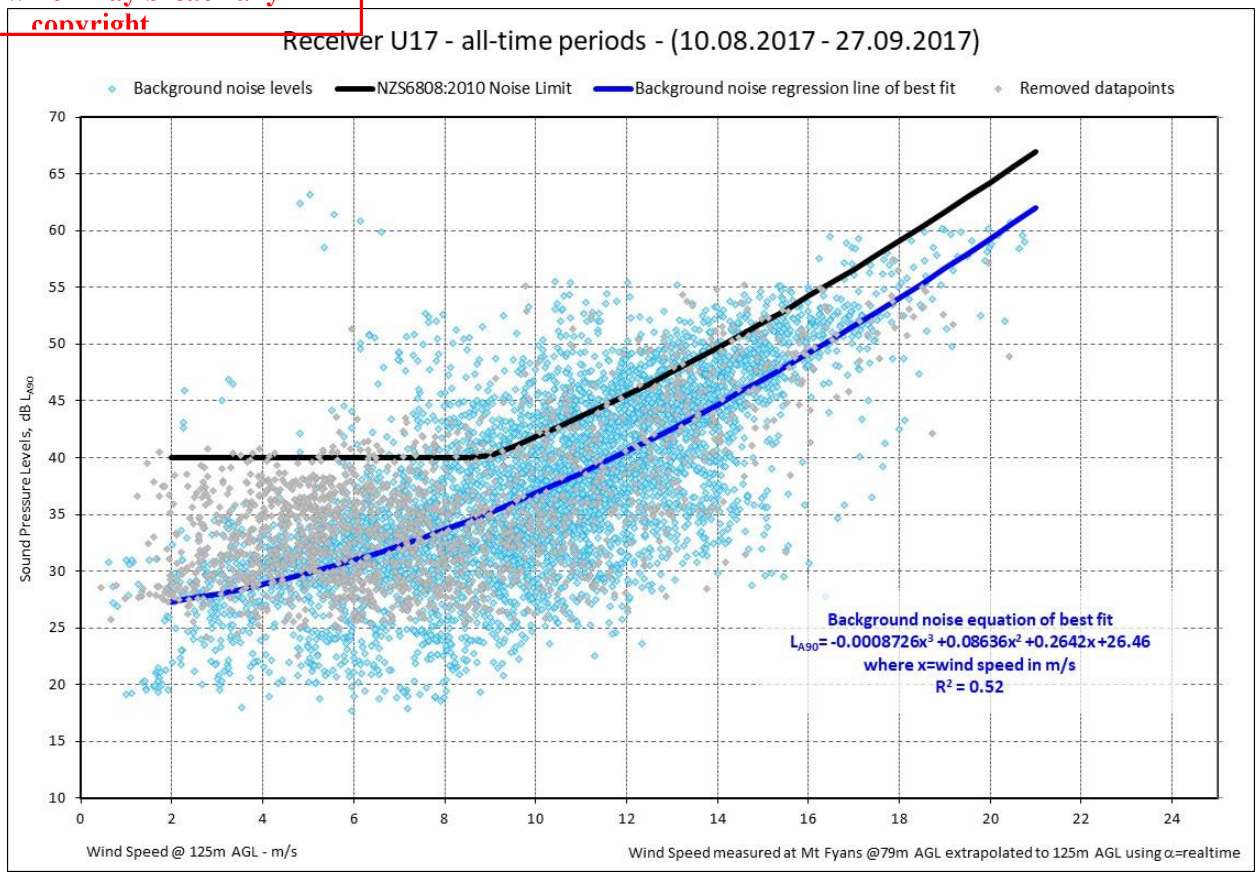
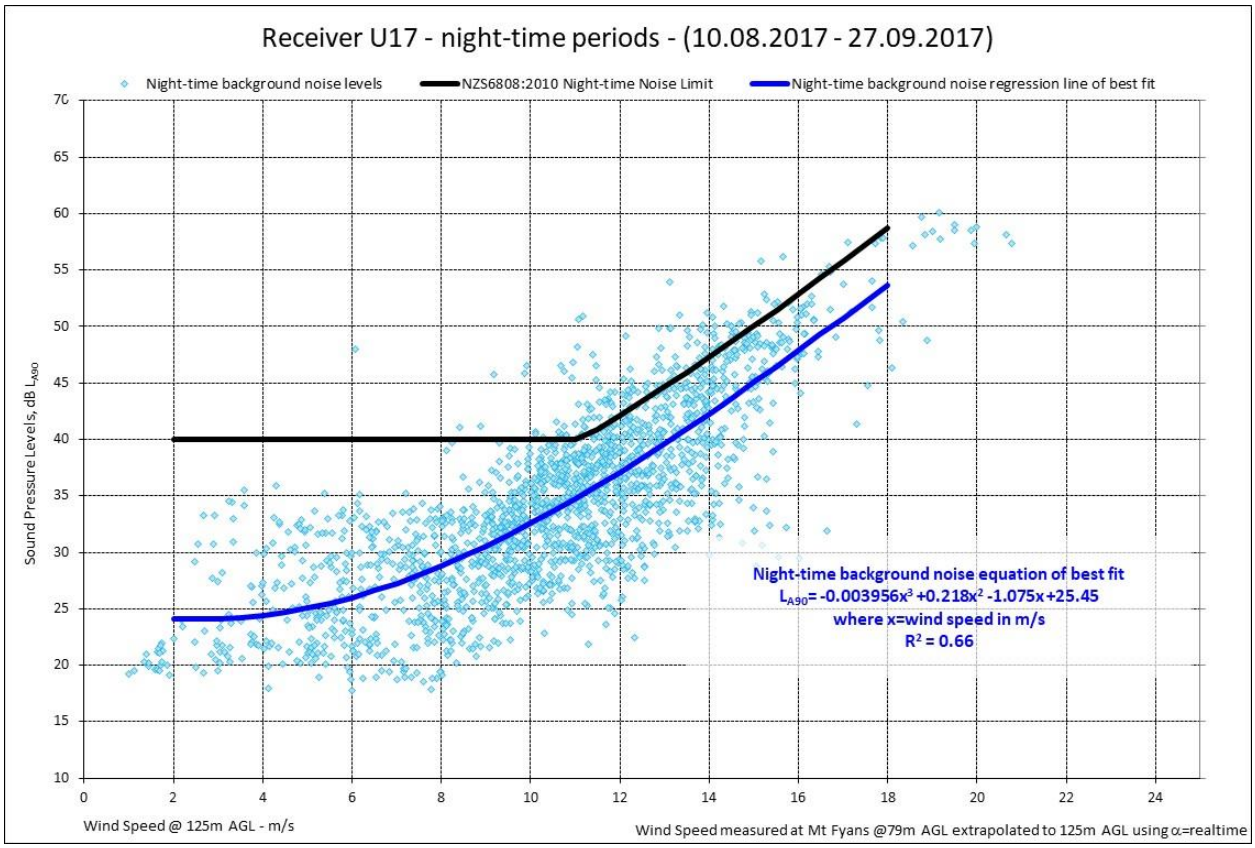


Figure 4: Receiver u17 night-time periods – derived background noise levels and noise limits



APPENDIX E RECEIVER U31 DATA

E1 Receiver u31 location data

Table 15: Receiver u31 dwelling and noise monitor coordinates for each receiver – MGA 94 Zone 54

Location	Easting	Northing
Dwelling location	659320	5794817
Background noise monitoring location	659275	5794749

Figure 5: Receiver u31 aerial view - dwelling and noise monitor locations

Table 16: Receiver u31 monitor installation photos

Looking North	Looking East
	
Looking South	**Looking West**
	

E2 Receiver U31 measurement data summary

Table 17: Receiver u31 background noise level analysis summary

Item	All-time (day & night combined)	Night-time (2200 – 0700 hrs)
Number of data points collected	6,732	2,510
Number of data points removed	1,462	734
Number of data points for analysis	5,270	1,776

Figure 6: Receiver u31 background noise level and wind speed time history

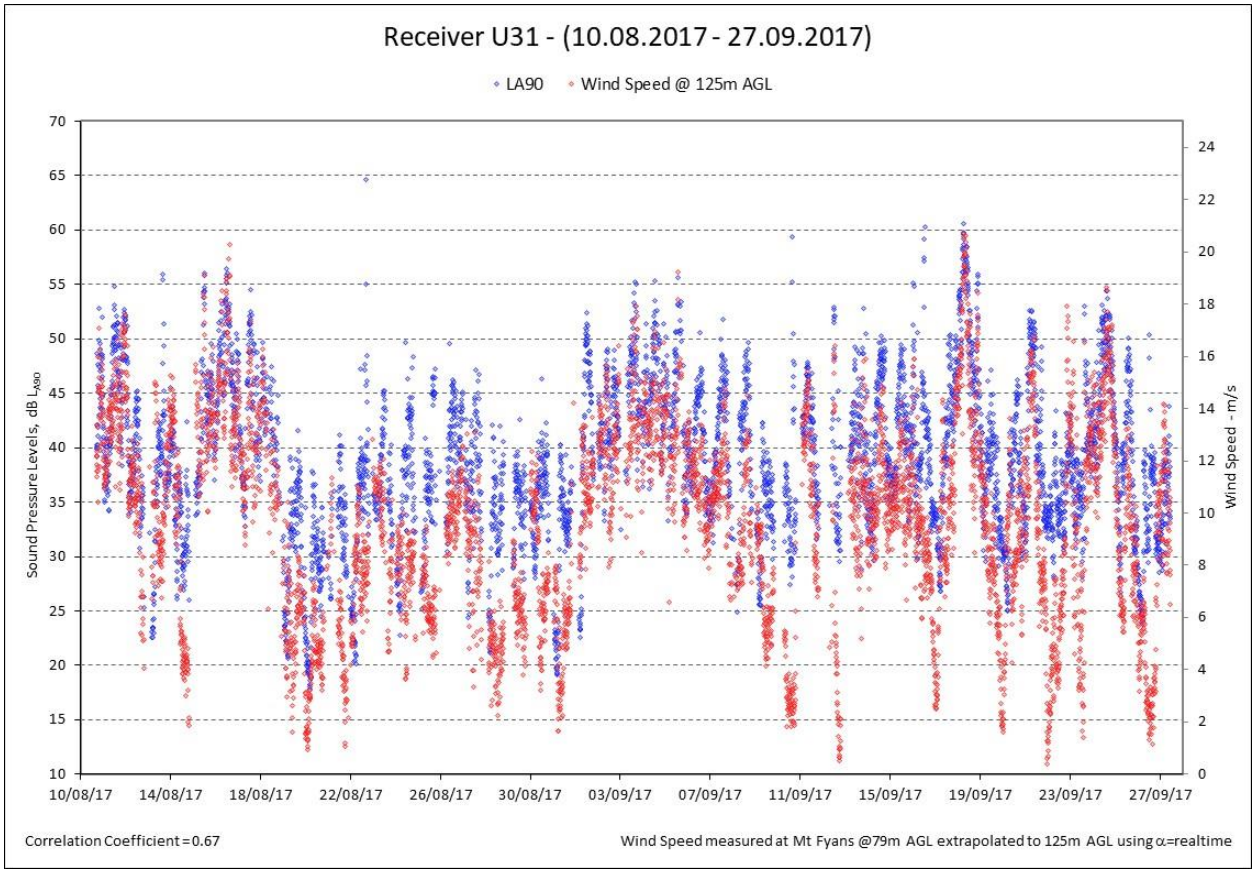


Figure 7: Receiver u31 all-time periods – derived background noise levels and noise limits

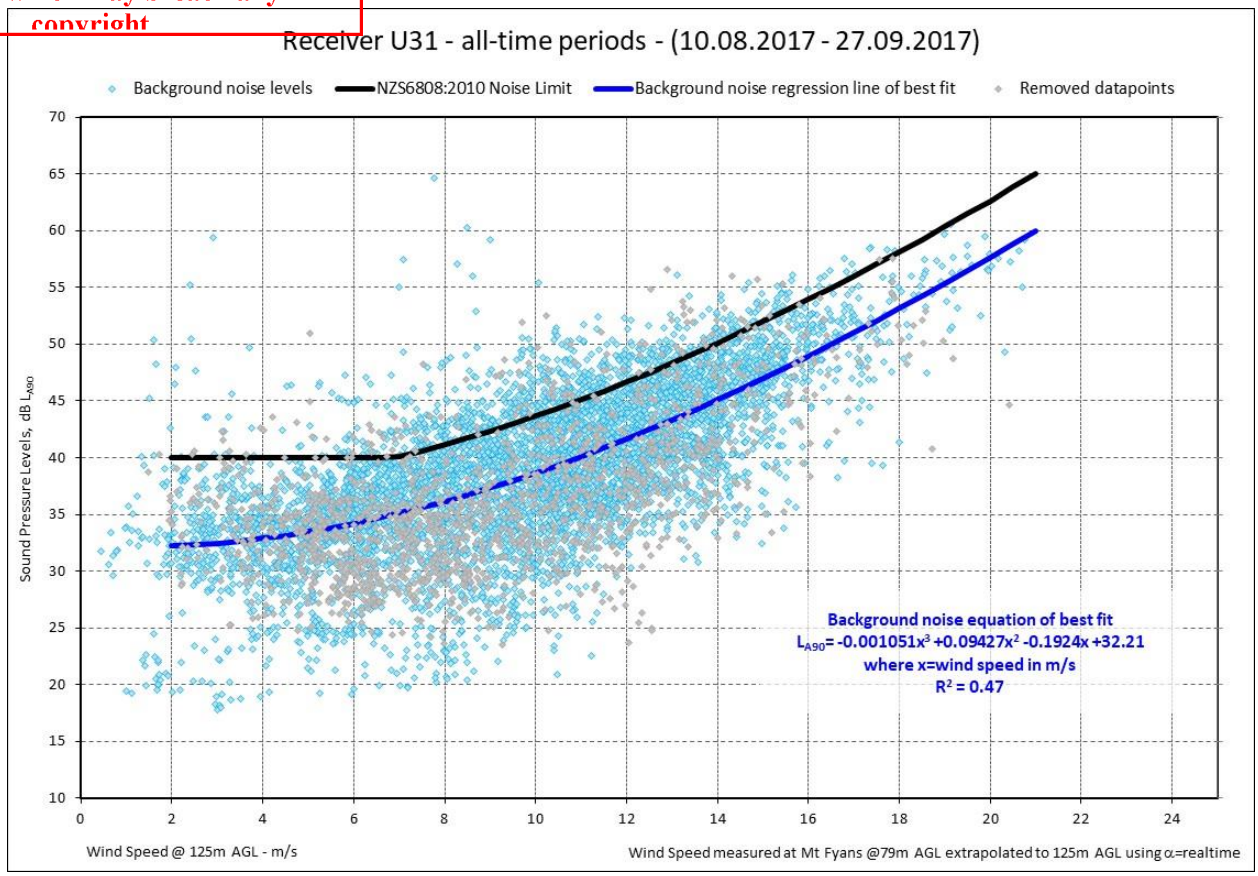
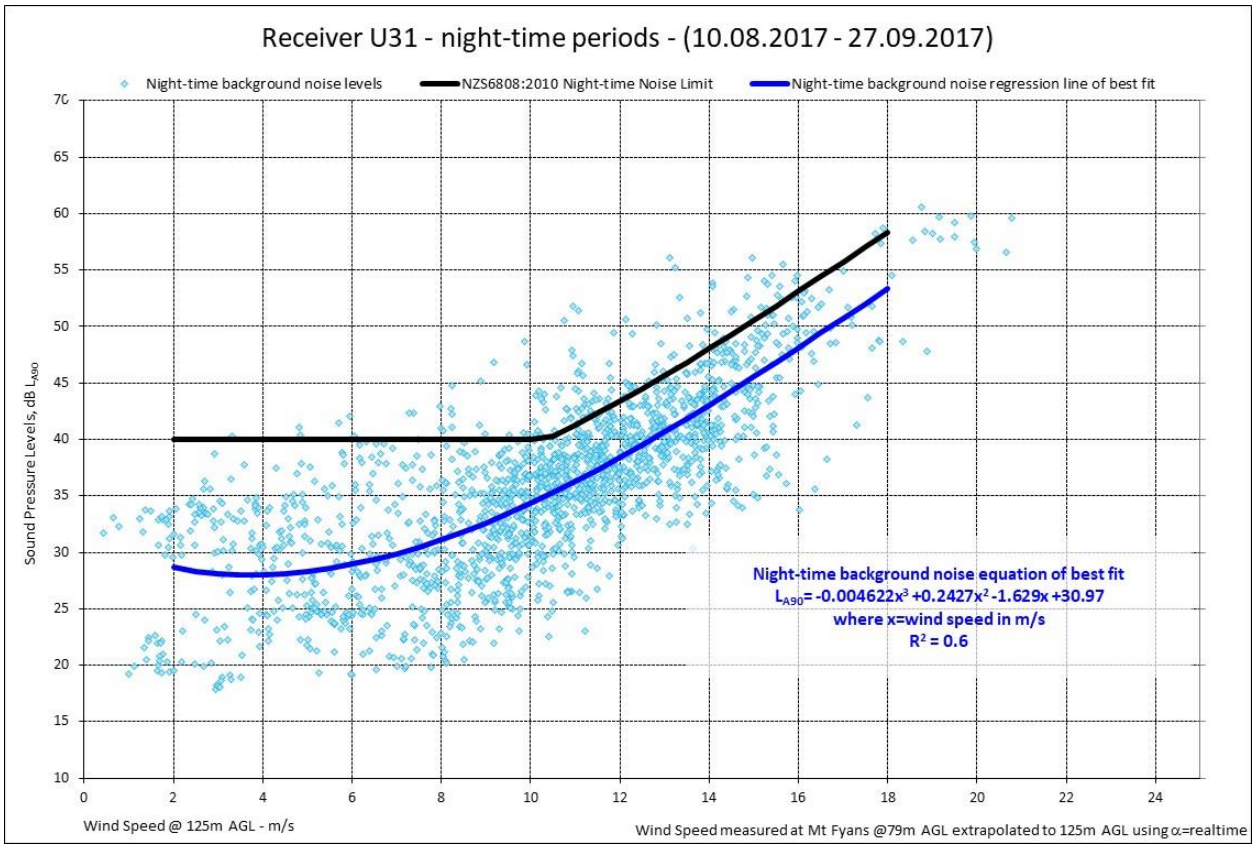


Figure 8: Receiver u31 night-time periods – derived background noise levels and noise limits



APPENDIX F RECEIVER U47 DATA

F1 Receiver u47 location data

Table 18: Receiver u47 dwelling and noise monitor coordinates for each receiver – MGA 94 Zone 54

Location	Easting	Northing
Dwelling location	663483	5790969
Background noise monitoring location	663500	5790944

Figure 9: Receiver u47 aerial view - dwelling and noise monitor locations

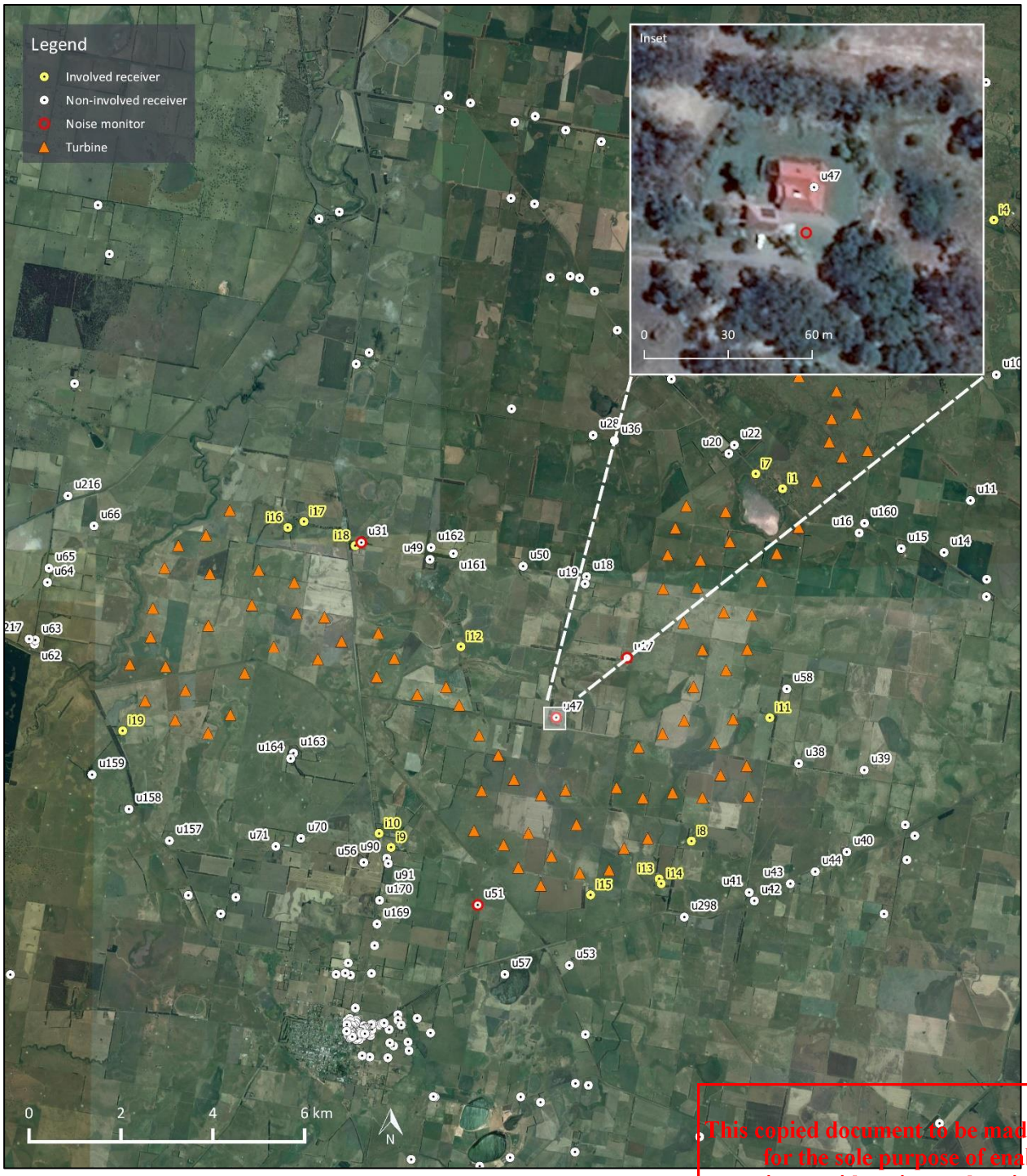


Table 19: Receiver u47 monitor installation photos

Looking North	Looking East
	
Looking South	**Looking West**
	

F2 Receiver U47 measurement data summary

Table 20: Receiver u47 background noise level analysis summary

Item	All-time (day & night combined)	Night-time (2200 – 0700 hrs)
Number of data points collected	4,718	1,741
Number of data points removed	1,350	590
Number of data points for analysis	3,368	1,151

Figure 10: Receiver u47 background noise level and wind speed time history

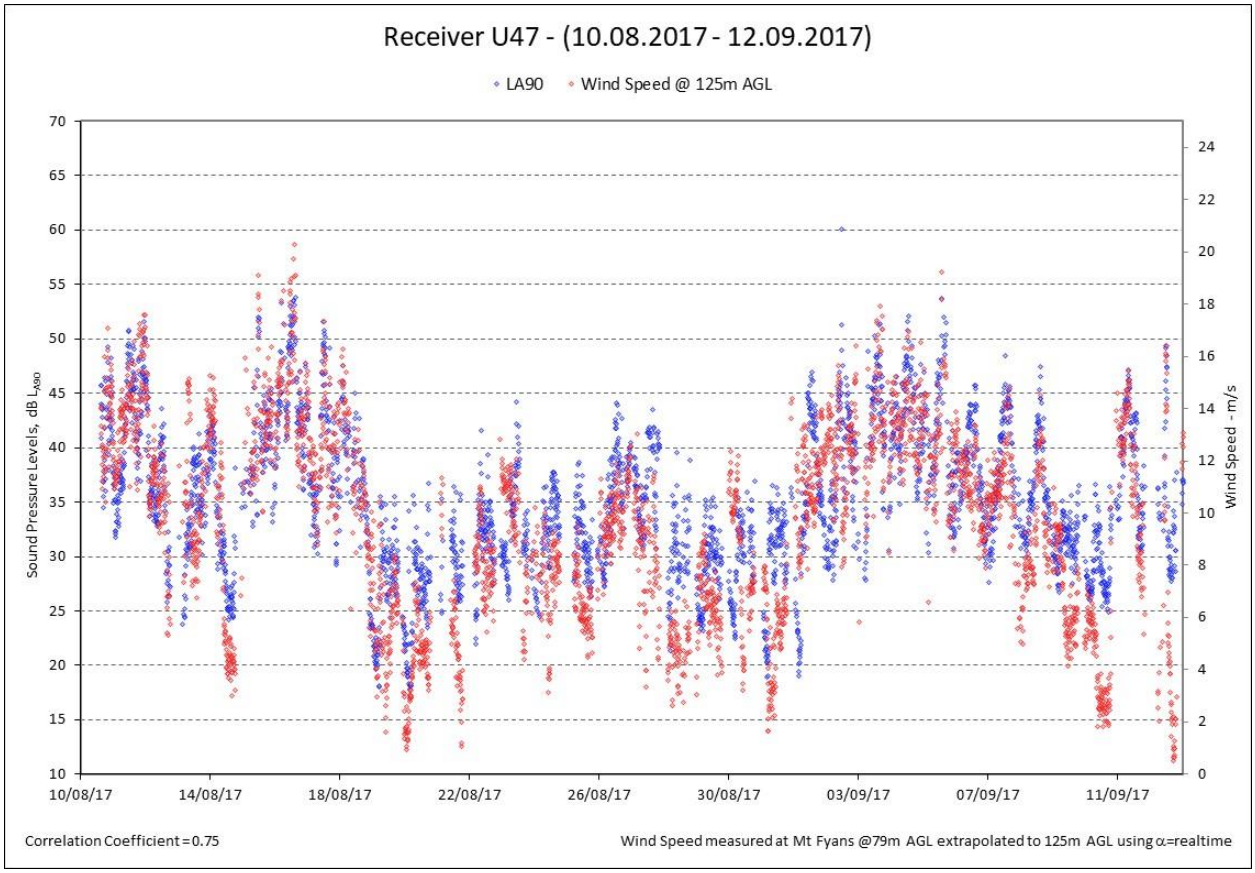


Figure 11: Receiver u47 all-time periods – derived background noise levels and noise limits

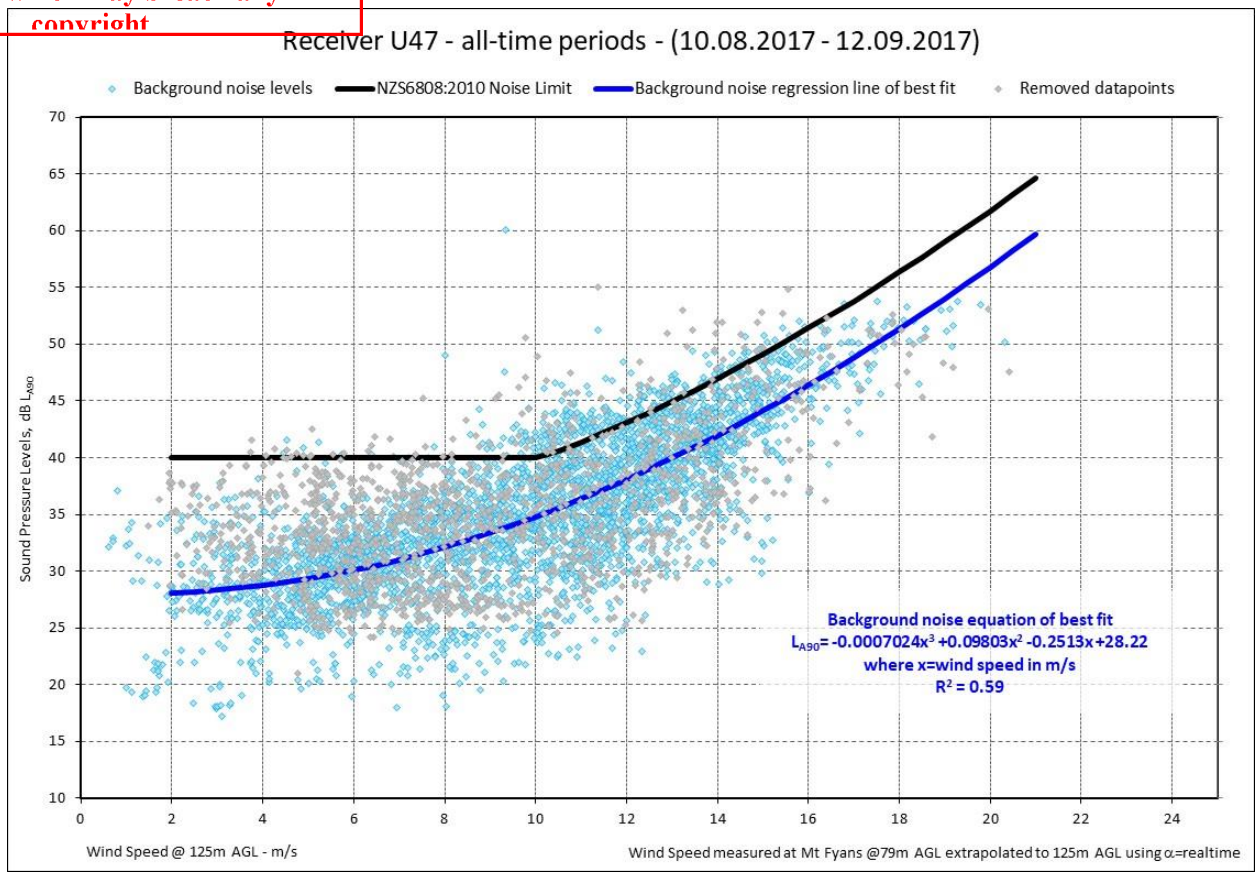
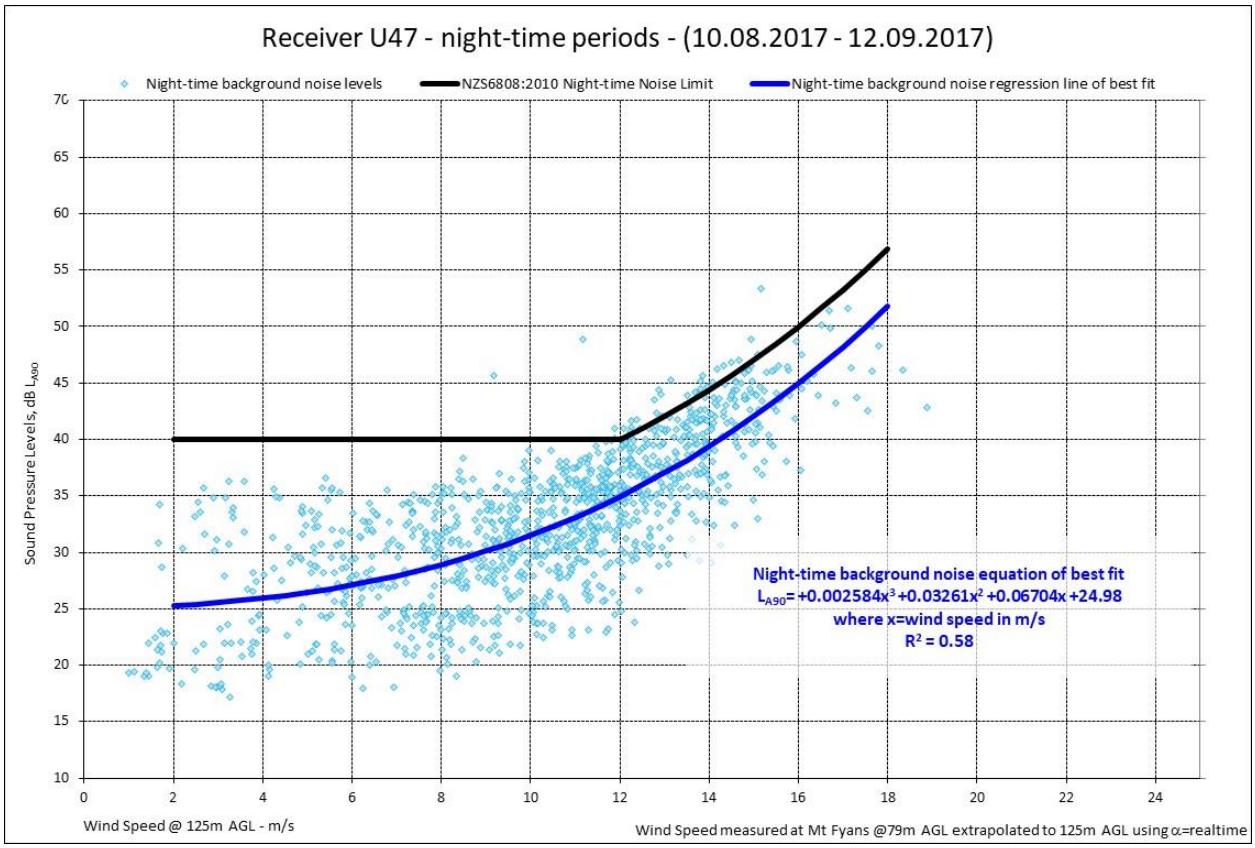


Figure 12: Receiver u47 night-time periods – derived background noise levels and noise limits



APPENDIX G RECEIVER U51 DATA

G1 Receiver u51 location data

Table 21: Receiver u51 dwelling and noise monitor coordinates for each receiver – MGA 94 Zone 54

Location	Easting	Northing
Dwelling location	661808	5786877
Background noise monitoring location	661811	5786898

Figure 13: Receiver u51 aerial view - dwelling and noise monitor locations

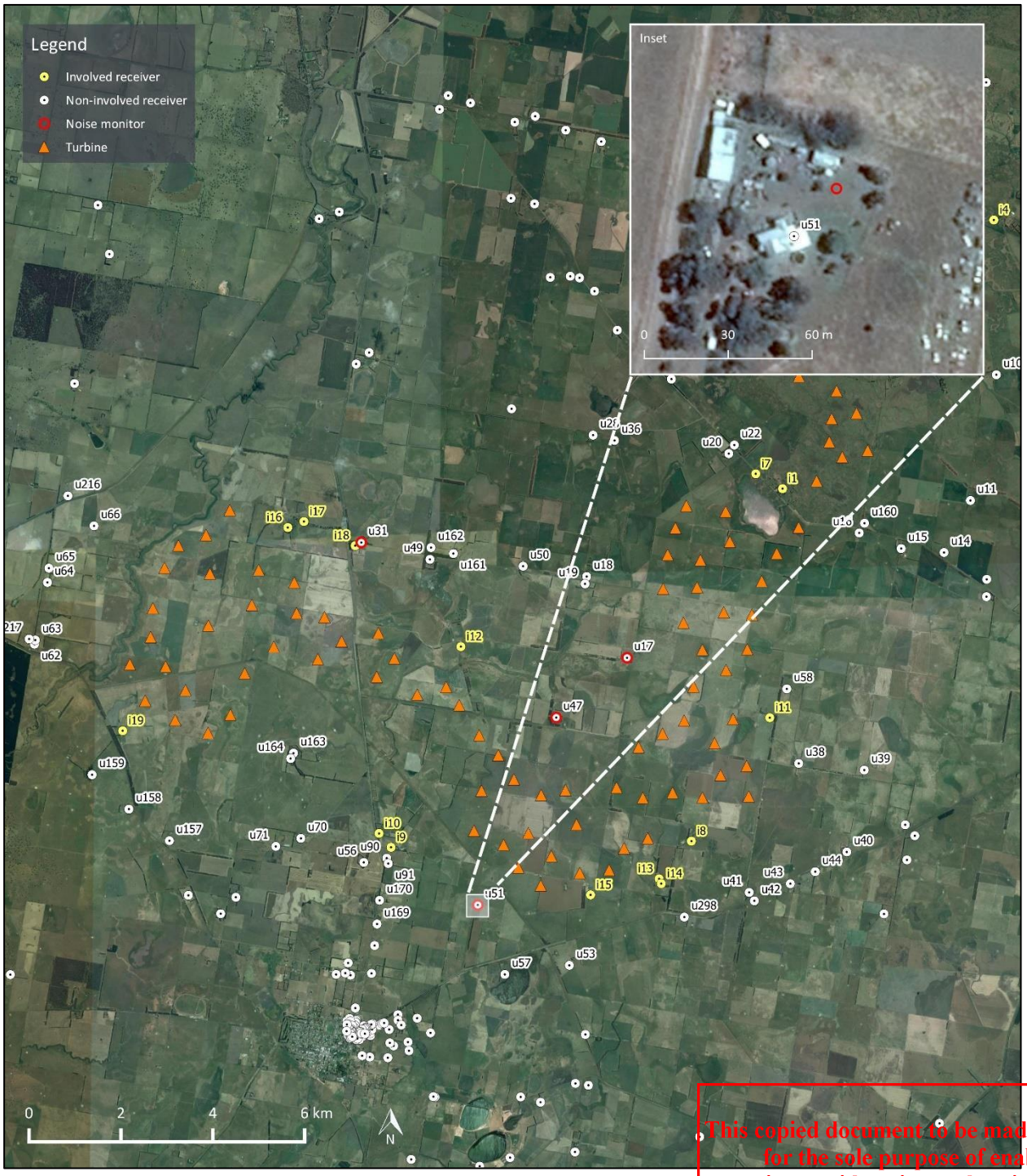


Table 22: Receiver u51 monitor installation photos

Looking North	Looking East
Photo not available	
Looking South	**Looking West**
	

G2 Receiver u51 measurement data summary

Table 23: Receiver u51 background noise level analysis summary

Item	All-time (day & night combined)	Night-time (2200 – 0700 hrs)
Number of data points collected	6,734	2,518
Number of data points removed	2,299	937
Number of data points for analysis	4,435	1,581

Figure 14: Receiver u51 background noise level and wind speed time history

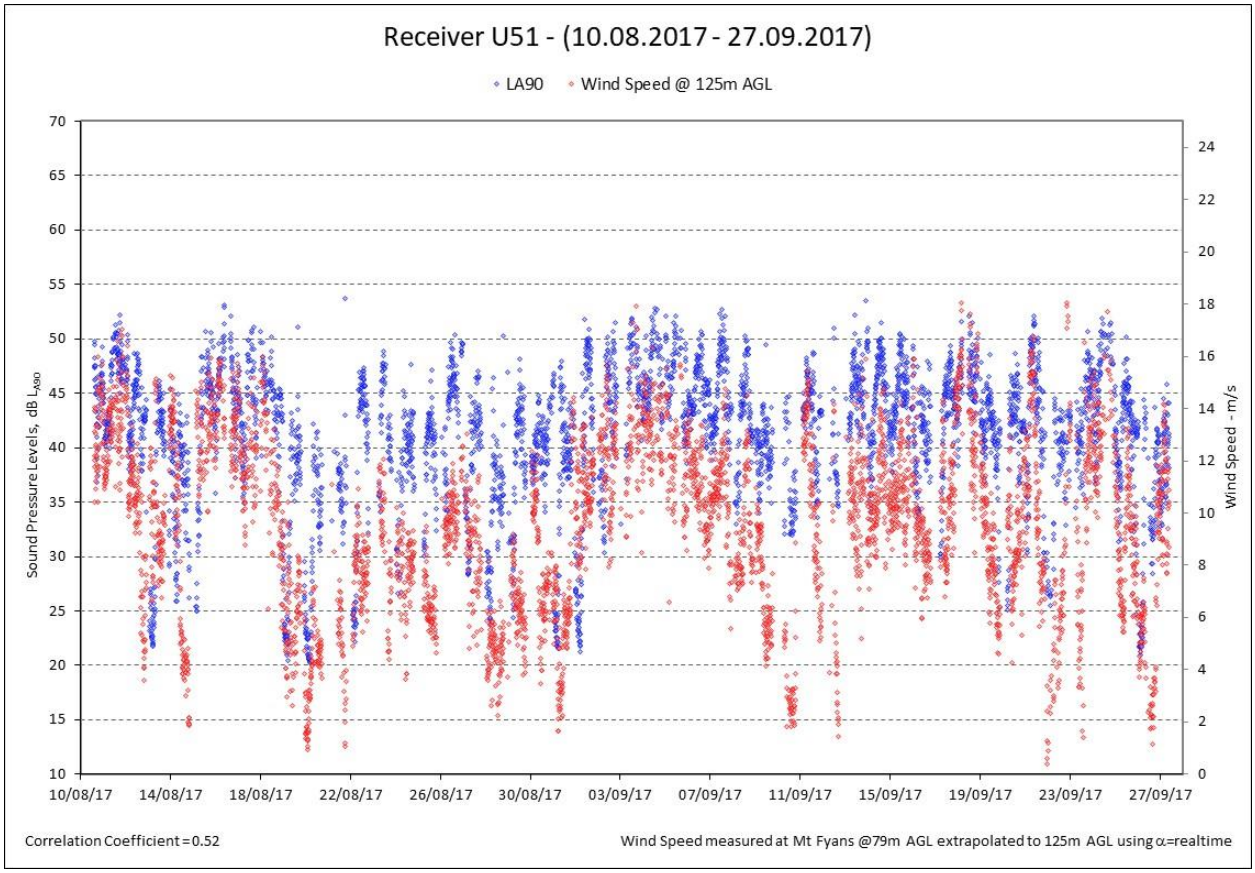


Figure 15: Receiver u51 all-time periods – derived background noise levels and noise limits

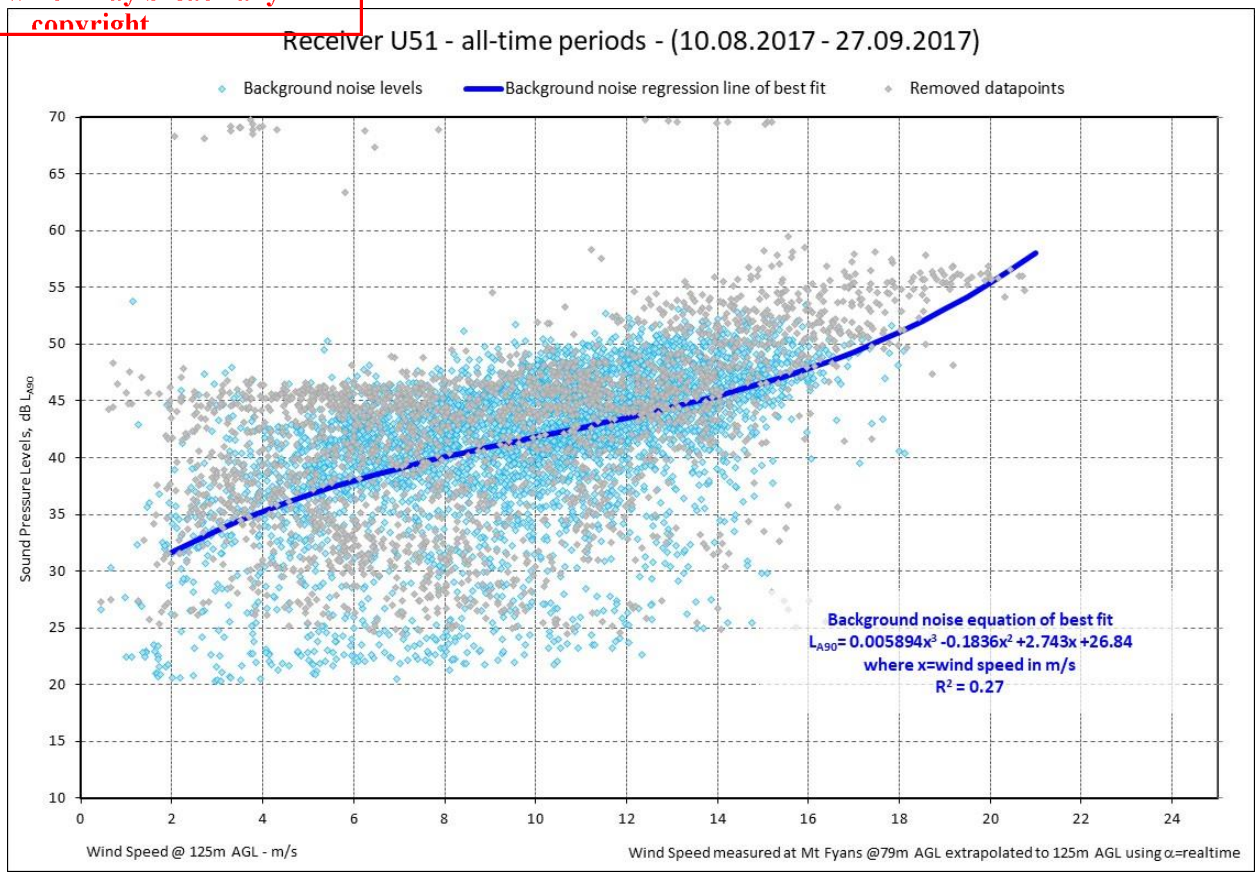
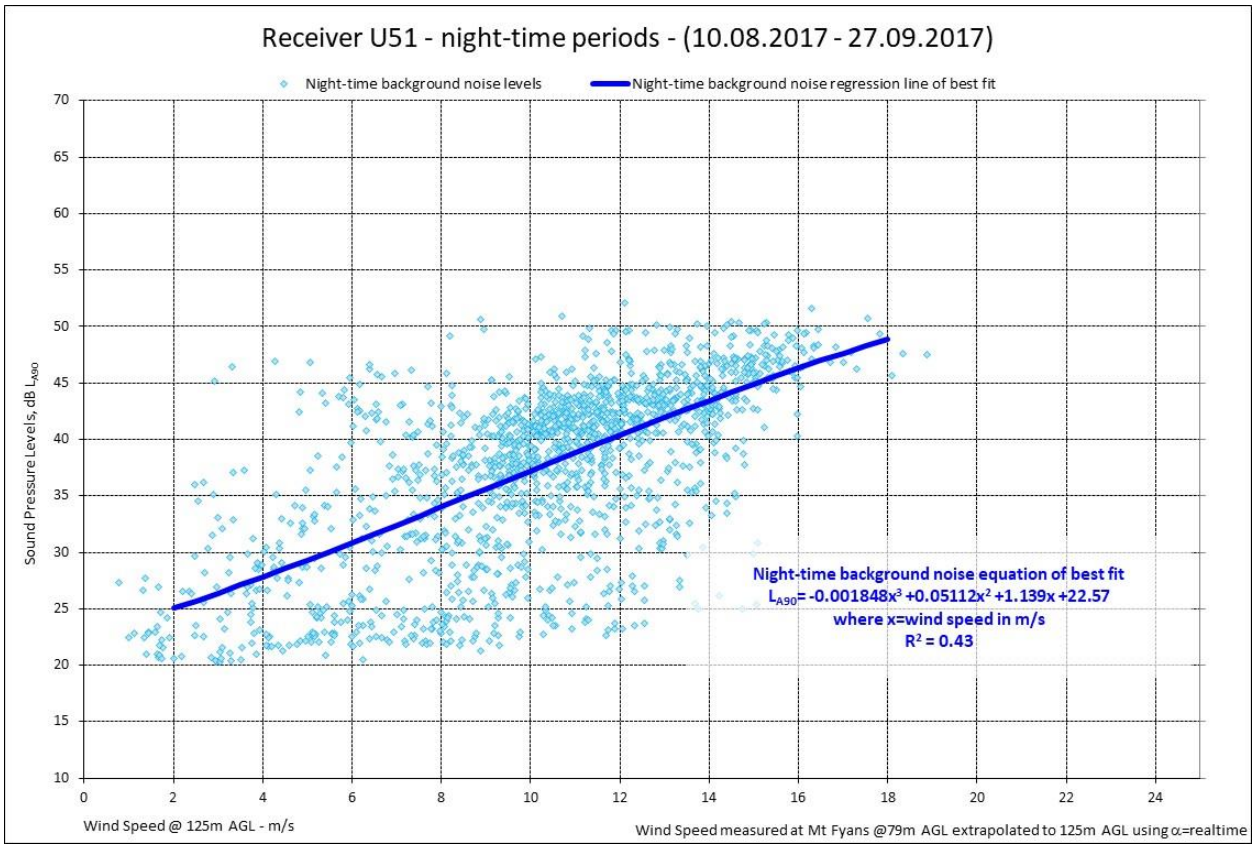


Figure 16: Receiver u51 night-time periods – derived background noise levels and noise limits



APPENDIX H HISTORIC BACKGROUND NOISE SURVEYS

The results of background noise monitoring conducted during the earlier planning phases of the project in 2012 and 2013 are provided in this appendix.

Due to the time that has passed since these earlier surveys were undertaken, as well as improvements in contemporary measurement practices (i.e. the use of enhanced microphone wind shield systems), the results from these earlier surveys are provided for reference purposes only (i.e. background noise related limits are not derived from this data).

Importantly, at the time when this monitoring data was obtained, the analysis of the 2012 and 2013 data was referenced to the proposed 79 m hub height which was being considered at the time. In contrast, the current proposal is based on a significantly taller hub height of 125 m. The data in this appendix therefore cannot be directly compared with the latest measurement results obtained in 2017 and is not suitable to reference in a quantitative assessment of operational noise associated with the proposed wind farm. Instead, the data provides an indication of underlying background conditions at low wind speeds, and the extent to which background noise levels are influenced by changes in wind speed.

The analysis has been conducted in the same manner described in Section 2.3 of this report, with the following exceptions:

- The 79 m reference wind speed height noted above
- In lieu of the enhanced secondary wind shields used in the 2017 survey, the local wind speed measured at one of the dwellings during each survey was used to filter the data. Specifically, any 10 minute period in which a local wind speed was greater than 5 m/s was recorded was removed from the analysis
- The analysis of the 2012 data involved a slightly different method of reviewing one-third octave band frequencies for the effect of insect or bird noise. The analysis determined that the portion of measurement results which were significantly affected by insect or bird noise was small and not sufficient to alter the derived background noise levels. The results for 2012 are therefore presented on the basis of the total measurement data set (i.e. without removal of periods where insect or bird noise was identified, on the basis that their inclusion did not change the regression curve)

H1 2012 Background noise levels

The tabulated data presented in Table 4 and Table 5 summarises the derived background noise levels for the all-time and night-time periods respectively for the background noise that was conducted from the 9 May to 31 May 2012.

The data in these tables is provided for the key wind speeds relevant to the assessment of wind farm noise.

Table 24: All-time period – background noise levels (dB L_{A90})

Location	Hub height wind speed (m/s) [1]												
	4	5	6	7	8	9	10	11	12	13	14	15	16
i1	22.4	23.0	24.1	25.6	27.4	29.5	31.9	34.4	37.0	39.6	42.2	44.8	47.2
i8	24.1	24.9	26.1	27.8	29.8	32.1	34.6	37.1	39.6	42.1	44.4	46.5	48.2
i9	24.2	24.6	25.5	26.8	28.4	30.3	32.4	34.6	37.0	39.5	42.0	44.5	46.9
i11	22.4	23.6	25.4	27.6	30.2	32.9	35.9	38.9	41.9	44.9	47.6	50.1	52.3
i12	24.5	25.3	26.5	28.1	30.0	32.1	34.4	36.8	39.2	41.7	44.0	46.2	48.2
i14	24.4	25.4	26.8	28.7	30.9	33.4	36.0	38.8	41.6	44.4	47.0	49.5	51.7
i15	23.9	25.1	26.7	28.7	31.0	33.6	36.3	39.1	41.9	44.7	47.3	49.6	51.7

Note 1: 79 m above ground level

Table 25: Night-time period – background noise levels (dB L_{A90})

Location	Hub height wind speed (m/s) [1]												
	4	5	6	7	8	9	10	11	12	13	14	15	16
i1	16.7	17.6	18.9	20.6	22.7	25.1	27.6	30.3	33.0	35.6	38.2	40.7	42.8
i8	18.9	19.5	20.8	22.7	25.0	27.7	30.4	33.2	35.7	37.8	39.5	40.4	40.6
i9	19.0	19.3	20.0	21.3	22.9	24.7	26.8	29.1	31.4	33.8	36.1	38.3	40.3
i11	18.9	20.1	22.0	24.3	26.9	29.8	32.8	35.7	38.6	41.1	43.4	45.1	46.2
i12	17.4	18.7	20.7	23.3	26.2	29.1	31.8	34.0	35.5	36.1	35.4	33.3	29.5
i14	17.5	18.4	20.2	22.6	25.4	28.5	31.7	34.9	37.8	40.4	42.4	43.7	44.2
i15	17.5	18.6	20.7	23.4	26.7	30.1	33.4	36.5	38.9	40.5	41.1	40.2	37.8

Note 1: 79 m above ground level

H2 2013 Background noise levels

The tabulated data presented in Table 4 and Table 5 summarises the derived background noise levels for the all-time and night-time periods respectively for the background noise survey that was conducted from 1 February to 1 March 2013.

The data in these tables is provided for the key wind speeds relevant to the assessment of wind farm noise. The results for all surveyed wind speeds are illustrated in the graphical data provided for each receiver location in Appendix D to Appendix G.

Table 26: All-time period – operational wind farm noise limits (dB L_{A90})

Location	Hub height wind speed (m/s) [1]												
	4	5	6	7	8	9	10	11	12	13	14	15	16
i16	32	33	34.6	36.5	38.7	40.9	42.9	44.6	45.9	46.5	-	-	-
i18	32.8	33.1	34.3	36.1	38.2	40.5	42.6	44.2	45.2	45.3	-	-	-
i19	27.1	28.5	30.5	32.9	35.5	38.2	40.7	43	44.8	-	-	-	-
u16	28.4	30.1	32.2	34.5	37	39.5	41.9	44.1	46	47.4	-	-	-
u47	26.8	27.7	29.3	31.6	34.3	37.2	40.2	43	45.4	-	-	-	-
u160	28.3	30.2	32.6	35.4	38.3	41.2	43.9	46.3	48.2	-	-	-	-
u163	32.1	33	34.4	36.1	38	40.1	42.2	44.2	46	47.5	-	-	-

Note 1: 79 m above ground level

Table 27: Night-time period – operational wind farm noise limits (dB L_{A90})

Location	Hub height wind speed (m/s) [1]												
	4	5	6	7	8	9	10	11	12	13	14	15	16
i16	21.1	21.9	23.2	24.9	26.8	28.9	31.1	33.2	35.0	-	-	-	-
i18	22.0	21.9	23.8	26.6	29.6	31.9	32.6	30.9	25.7	-	-	-	-
i19	20.9	20.7	21.2	22.3	23.7	25.4	27.2	28.9	30.4	-	-	-	-
u16	22.6	23.1	24.8	27.3	30.6	34.6	39.0	43.7	-	-	-	-	-
u47	24.2	24.5	26.2	28.9	32.0	34.9	37.4	38.8	-	-	-	-	-
u160	20.3	20.6	22.0	24.3	27.4	31.0	35.0	-	-	-	-	-	-
u163	21.9	23.0	24.3	25.8	27.6	29.5	31.7	34.2	-	-	-	-	-

Note 1: 79 m above ground level

APPENDIX I BACKGROUND MONITORING LOCATIONS