MARSHALL DAY Acoustics

ST PATRICKS PLAINS WIND FARM BACKGROUND NOISE ASSESSMENT

Rp 002 20190433 | 20 October 2021

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Project: **ST PATRICKS PLAINS WIND FARM**
Background Noise Assessment

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1.0 INTRODUCTION

This report presents the results of background noise monitoring undertaken for the proposed St Patricks Plains Wind Farm located in the Central Highlands, Tasmania.

The assessment is based on the proposed wind farm layout comprising forty-seven (47) multi-megawatt turbines.

In accordance with the Project Specific Guidelines[1], the noise assessment for the St Patricks Plains Wind Farm should consider the Tasmanian EPA publication *Noise Measurement Procedures Manual*, dated July 2008 and the New Zealand Standard 6808:2010 *Acoustics – Wind farm noise*.

This report documents the survey methodology and the results of the background noise monitoring, along with the derived noise limits which would be used to assess the wind farm's compliance with operational noise conditions.

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 approved wind energy facility.

This report has been prepared as a standalone account of the background noise levels and derived noise limits which can be referenced in other noise assessment documentation, including the pre-construction noise assessment report and subsequent post-construction noise assessment reports.

[1] *Project Specific Guidelines for Preparing an Environmental Impact Statement for Epuron Projects Pty Ltd St Patricks Plains Wind Farm* dated October 2019

2.0 BACKGROUND NOISE SURVEY & ANALYSIS METHODOLOGY

The background noise survey and analysis were carried out in accordance with the following:

- New Zealand Standard 6808:2010 *Acoustics – Wind farm noise* (NZS 6808), as referenced in the Tasmanian EPA publication *Noise Measurement Procedures Manual* (Tasmanian Manual)
- 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:

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

2.1 Monitoring locations

In accordance with NZS 6808, background noise monitoring was only strictly warranted at one survey location. However, it was elected to undertake additional surveys at a broader range of locations to inform the assessment of the wind farm. Accordingly, a total of seven (7) receivers were identified as preferred locations for conducting post-construction noise compliance monitoring, subject to permission being granted by the landowners.

Permission was not able to be obtained at one (1) of the seven (7) preferred locations (receiver K17-1). After review of potential substitute locations, an alternative nearby receiver location positioned approximately 1 km northwest of receiver K17-1 was selected for monitoring. Background noise data obtained at the substitute location is used solely as a reference for the potential contribution of background noise to any future post-construction noise measurements undertaken at K17-1 (i.e. not for the purpose of setting noise limits).

Background noise monitoring was subsequently carried out at a total of seven (7) locations listed in Table 1.

Table 1: Background noise monitoring locations – distance and direction relative to wind farm

Receiver	Direction from nearest turbine	Distance from nearest turbine (m)
D10-13	WNW	3,087
F16-6	SSW	4,261
K17-1 (sub)	NW	2,473
L19-1	W	836
M5-1	NNW	1,276
O7-2	ENE	1,695
Q13-1	E	1,161

The location of each of these receivers is illustrated in Figure 1.

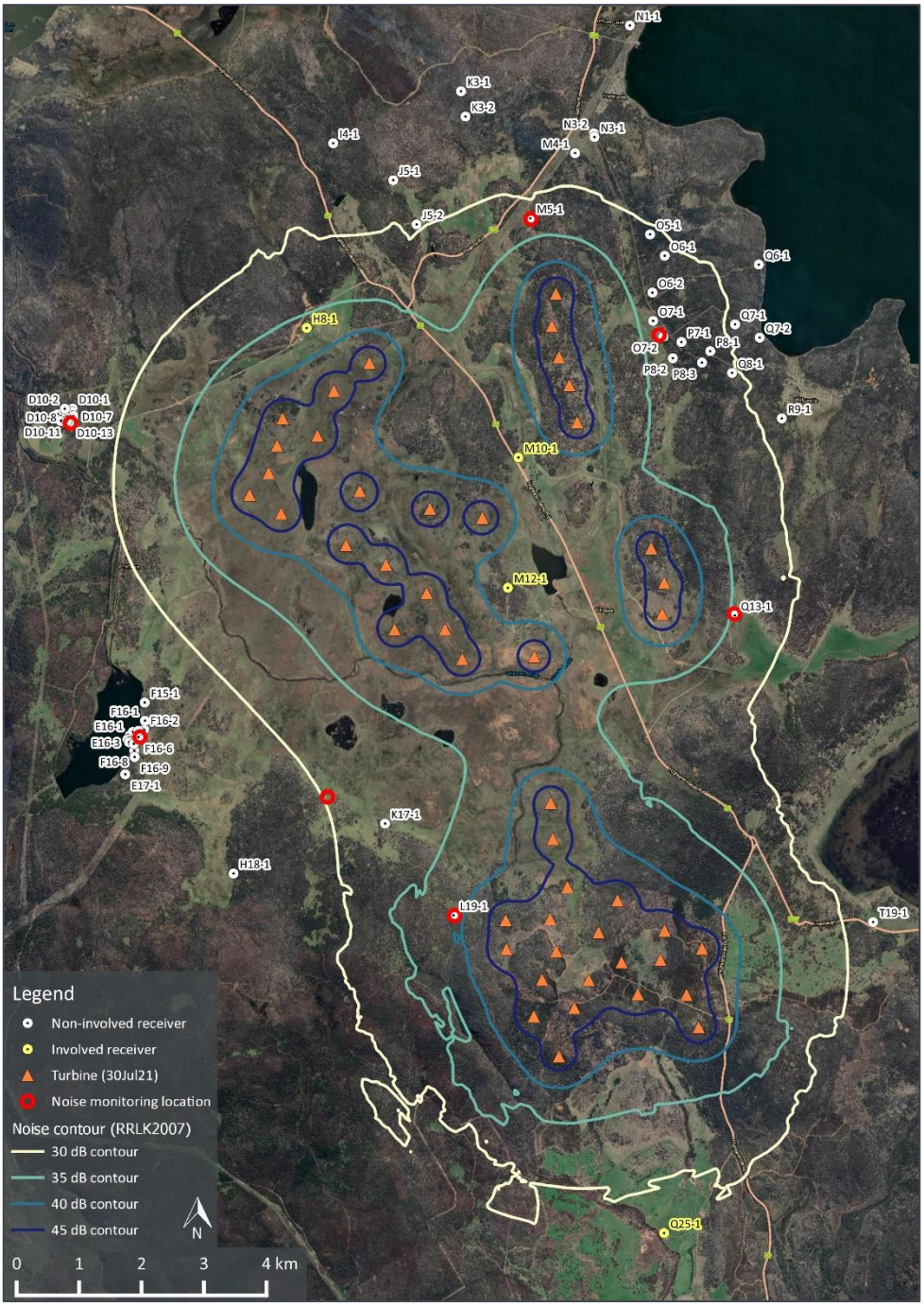
Due to travel restrictions surrounding the Australian response to COVID-19, MDA staff members could not travel to Tasmania for the deployment or retrieval of the noise monitoring equipment. The equipment was therefore deployed and retrieved by pitt&sherry with remote guidance from MDA.

At each of the receivers 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. The following specific considerations were factored:

- The noise monitors were located on the approved wind farm side of the dwelling;
- The noise monitors were located at least 3.5 m away from the dwelling and any significant vertical reflecting structures;
- The noise monitors were generally located as far as practical from taller vegetation and any obvious sources of extraneous noise (where practical).

Coordinates and photographs for the noise monitoring locations are provided in Appendix F to Appendix L.

Figure 1: Monitoring locations relative to the St Patricks Plains Wind Farm



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 and local weather conditions were simultaneously recorded throughout the survey, along with periodic audio samples, to enable the relationship between background noise levels and site winds to be assessed.

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	Seven (7) receiver locations as described in Section 2.1.
Monitoring Period	12 August 2020 to 10 November 2020 equating to approximately six (6) to nine (9) weeks at each location. The duration was chosen to satisfy the guidance of NZS 6808 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 C.
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 mast reference SPP1, extending to a height of 120 m above ground level. Hub height wind speed data (150 m above ground level) was provided by Epuron's wind data analysts, based on their analysis to extrapolate the 60 m, 80 m, 100 m and 120 m height anemometer wind speed data to 150 m using site-specific wind shear calculations. A summary of the wind data and the analysis process is reproduced in Appendix D.

2.3 Data analysis

The analysis of the survey data has been conducted in accordance with the NZS 6808 as referenced in the Project Specific Guidelines.

This analysis broadly 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 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 of the data 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 10-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[2] 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}. Additional data filtering procedures were investigated for receivers D10-13, K17-1 (sub), L19-1, M5-1, O7-2 and Q13-1 to address the potential influence from snow coverage, wind noise on microphone and extraneous noise from a nearby stream. Further details specific to these locations are provided in Section 2.4.
Time periods	In accordance with the NZS 6808, the data sets are considered as follows: • All periods: no restriction on hours (i.e. data during day and night hours included)

[2] 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 by a 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 fit to the measurement results.

2.4 Additional potential extraneous noise investigations

2.4.1 Snow coverage

As evident in the deployment photos, snow coverage was reported by pitt&sherry during the monitoring periods at K17-1 (sub), L19-1, O7-2, and Q13-1. Based on advice from pitt&sherry, we understand that from 24 August 2020, snow had melted at these four (4) monitoring locations.

As the ground around the units appeared to have been covered with snow for the first weeks of the monitoring, the survey was extended in recognition of potential variation attributable to snow coverage at the start.

At D10-13 and F16-6, snow was reported the day after deployment (5 October 2020), however pitt&sherry could not advise when the snow had melted. Therefore, the influence of snow could not be investigated at these locations.

Although snow is common at this site, it is not a common seasonal factor to address in Australia. Therefore, this seasonal influence was considered in accordance with clause C7.2.1 of NZS 6808, which states:

> […] *It may be necessary to take further measurements if the results show* […] *Significant variation due to seasonal factors* […]

During snowy conditions, noise levels could be lower due to reduced activity in the broader area. Conversely, there can be specific and infrequent circumstances when snow can result in higher noise levels as a result of noise from distant sources travelling further (an effect related to a phenomenon known as surface waves). The presence of snow is therefore quite a particular seasonal factor that has been investigated as it could lead to variation in background noise levels, compared to conditions without snow.

Data points corresponding to periods when snow is understood to have been present were separately plotted on the noise versus wind speeds charts for each of the locations and compared to the trend of variation in noise levels across the entire monitoring period. These charts are illustrated in Appendix H, Appendix I, Appendix K and Appendix L.

During this survey, the range of variation during periods when snow was present was consistent with other periods when snow was not present. This indicates that the background noise levels were primarily attributable to sources of noise which exhibit little change as a result of the presence of snow (e.g. sources of noise that are local to the monitoring locations, particularly background noise associated with wind disturbed vegetation). The analysis therefore demonstrated that snow did not result in an effect which could be identified or isolated amid the broader inherent variation in background noise levels. As a result, snow periods have not been removed from the analysis.

2.4.2 Potential influence of local wind noise

The noise monitoring period at M5-1 was extended to collect sufficient data after a wind shield installation defect had been rectified on 21 September 2020. All data measured prior to the rectification was excluded from the analysis.

2.4.3 Potential influence from local stream

The background noise level correlation and time history at receiver D10-13 (see Figure 3 of Appendix F) exhibit slightly elevated noise levels at low wind speeds relative to other locations. This is evident as an increased minimum measured noise level, and recurring periods of relatively constant noise levels above 30 dB L_{A90} at low wind speeds. Audio records for this location contained sounds consistent with the influence of a water stream.

Considering the snow coverage identified at some of the monitoring locations during the survey period, it is believed that this this elevated noise at low wind speeds was due to increased water flow in the nearby Shannon River, located approximately 150 m south of receiver D10-13.

As it is not possible to accurately identify each of the 10-minute datapoints that may have been affected by this presumed seasonal source of extraneous noise, the derived background noise level and noise limit at each hub height wind speed is provided for information only.

3.0 SURVEY & ANALYSIS RESULTS

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

The analysis results include the noise limits which would be used during compliance monitoring to assess the operational noise of the St Patricks Plains Wind Farm.

3.1 Background noise levels

The tabulated data presented in Table 4 summarises the derived background noise levels.

The data in the table 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 F to Appendix L.

All data presented in these tables has been analysed and filtered according to the procedures described in Section 2.3 and Section 2.4.

Table 4: Background noise levels, dB L_{A90}

Location	Hub height wind speed (m/s) [1]												
	3	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
D10-13 [2]	*29.4*	*30.0*	*30.7*	*31.4*	*32.2*	*33.0*	*33.9*	*34.8*	*35.7*	*36.6*	*37.6*	*38.5*	*39.5*
F16-1	25.4	26.4	27.5	28.7	30.1	31.5	33.0	34.6	36.3	38.0	39.7	41.4	43.2
K17-1 (sub) [2]	*24.2*	*24.9*	*25.8*	*26.9*	*28.2*	*29.6*	*31.1*	*32.6*	*34.3*	*36.0*	*37.7*	*39.5*	*41.3*
L19-1	25.7	26.4	27.2	28.2	29.2	30.4	31.6	32.9	34.3	35.7	37.2	38.8	40.4
M5-1	23.1	24.1	25.4	27.0	28.8	30.7	32.7	34.8	37.0	39.1	41.1	43.0	44.8
O7-2	24.0	25.2	26.5	27.9	29.5	31.1	32.7	34.4	36.1	37.8	39.5	41.1	42.7
Q13-1	25.5	26.0	26.6	27.4	28.3	29.3	30.5	31.7	33.1	34.5	35.9	37.3	38.7

Notes:

1 150 m above ground level at 488767 m E, 5336591 N (GDA 94 zone 55)

2 Values provided for information only

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 uninvolved locations and the minimum limit[3] is therefore set at 40 dB L_{A90} in accordance with NZS 6808.

As per the background noise data, the tabulated data is provided for the key wind speeds relevant to the assessment of wind farm noise. The derived noise limits for all surveyed wind speeds at applicable locations are illustrated in the graphical data provided for each receiver location in Appendix F to Appendix L.

Table 5: Operational wind farm noise limits, dB L_{A90}

Location	Hub height wind speed (m/s) [1]												
	3	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
D10-13 [2]	*40.0*	*40.0*	*40.0*	*40.0*	*40.0*	*40.0*	*40.0*	*40.0*	*40.7*	*41.6*	*42.6*	*43.5*	*44.5*
F16-1	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	41.3	43.0	44.7	46.4	48.2
K17-1 (sub) [2]	*40.0*	*40.0*	*40.0*	*40.0*	*40.0*	*40.0*	*40.0*	*40.0*	*40.0*	*41.0*	*42.7*	*44.5*	*46.3*
L19-1	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.7	42.2	43.8	45.4
M5-1	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	42.0	44.1	46.1	48.0	49.8
O7-2	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	41.1	42.8	44.5	46.1	47.7
Q13-1	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.9	42.3	43.7

Notes:

[1] 150 m above ground level at 488767 m E, 5336591 N (GDA 94 zone 55)

[2] Values provided for information only

[3] The lower high amenity base noise limit of 35 dB L_{A90} was not deemed applicable for this project as detailed in Section 7.1.1 of MDA report Rp 001 2019433 *St Patricks Plains Wind Farm - Environmental Noise Assessment*, dated 20 October 2021

4.0 SUMMARY

Background noise monitoring was carried out at seven (7) receiver locations around the proposed St Patricks Plains Wind Farm.

The survey and analysis were carried out in accordance with NZS 6808, as specified in the Project Specific Guidelines.

The results have been analysed to derive noise limits in accordance with NZS 6808. 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 (L_{A90}) plus 5 dB.

The background noise measurement results are to be referenced during the compliance monitoring phase of the project as an indication of potential background noise levels contributing to the compliance measurements.

APPENDIX A GLOSSARY

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 L_A dB. Alternative ways of expressing A-weighted decibels such as dBA or dB(A) are therefore not used within this report.

Term	Definition	Abbreviation
A-weighting	A method of adjusting sound levels to reflect the human ear's varied sensitivity to different frequencies of sound.	See discussion above this table.
A-weighted 90th centile	The A-weighted pressure level that is exceeded for 90 % of a defined measurement period. It is used to describe the underlying background sound level in the absence of a source of sound that is being investigated, as well as the sound level of steady, or semi steady, sound sources.	L_{A90}
Decibel	The unit of sound level.	dB
Hertz	The unit for describing the frequency of a sound in terms of the number of cycles per second.	Hz
Octave Band	A range of frequencies. Octave bands are referred to by their logarithmic centre frequencies, these being 31.5 Hz, 63 Hz, 125 Hz, 250 Hz, 500 Hz, 1 kHz, 2 kHz, 4 kHz, 8 kHz, and 16 kHz for the audible range of sound.	-
Sound pressure level	A measure of the level of sound expressed in decibels.	L_p

APPENDIX B SITE LAYOUT

B1 Turbine coordinates

The following table sets out the coordinates of the proposed turbine layout.

(Data received from the proponent on 31 July 2021).

Table 6: Turbine coordinates – MGA 94 zone 55

Turbine	Easting, m	Northing, m	Terrain elevation, m
1	487,523	5,346,922	970
2	487,672	5,346,435	930
3	487,870	5,345,996	950
4	488,037	5,345,412	901
6	489,361	5,343,479	940
7	489,608	5,342,943	902
8	489,610	5,342,440	885
9	484,652	5,346,126	910
11	485,781	5,343,864	900
12	486,630	5,343,776	891
13	484,115	5,345,642	906
14	483,902	5,344,904	900
15	484,640	5,344,067	900
16	484,483	5,343,184	890
17	485,143	5,342,917	900
18	485,825	5,342,506	890
19	486,160	5,341,947	890
20	486,468	5,341,492	880
25	485,353	5,341,891	885
29	483,327	5,345,140	910
30	483,267	5,344,700	906
31	482,885	5,343,881	900
32	483,166	5,344,253	900
33	483,410	5,343,620	898
39	487,617	5,341,614	870
42	488,042	5,339,289	860
43	488,118	5,338,718	860
44	488,406	5,337,966	880

Turbine	Easting, m	Northing, m	Terrain elevation, m
45	487,456	5,337,363	890
46	487,500	5,336,900	877
47	488,014	5,335,860	880
48	488,164	5,337,433	908
49	488,300	5,336,925	920
50	489,220	5,337,807	920
51	488,954	5,337,271	925
52	488,850	5,336,501	915
53	488,651	5,336,038	891
54	488,460	5,335,246	850
55	490,006	5,337,378	880
56	489,649	5,336,327	857
57	489,973	5,336,904	885
58	490,428	5,336,375	840
59	490,660	5,335,867	840
68	487,553	5,347,444	955
69	488,105	5,336,453	930
70	489,354	5,336,821	885
71	490,624	5,337,131	845

B2 Dwelling coordinates

The following table sets out the twenty-five (25) assessed receivers located within 3 km of the proposed turbines considered in the environmental noise assessment together with their respective distance to the nearest turbine. This includes three (3) involved receivers.

(Data received from the proponent on 22 January 2021)

Table 7: Receivers within 3 km of the proposed turbines – MGA 94 zone 55

Receiver ID	Easting, m	Northing, m	Terrain elevation, m	Distance to the nearest turbine, m	Nearest turbine
H8-1 (I)	483,610	5,346,615	914	1,106	13
J5-1	484,827	5,349,077	939	2,960	9
J5-2	485,250	5,348,395	927	2,351	9
K17-1	485,420	5,338,772	893	2,480	45
L19-1	486,619	5,337,381	875	851	45
M10-1 (I)	487,138	5,344,780	884	1,109	4
M12-1 (I)	487,116	5,342,683	890	1,190	39
M4-1	487,701	5,349,714	980	2,279	68
M5-1	487,060	5,348,620	978	1,283	68
N3-1	487,992	5,349,993	981	2,591	68
N3-2	487,977	5,350,051	980	2,646	68
O5-1	488,990	5,348,498	974	1,788	68
O6-1	489,248	5,348,171	986	1,851	68
O6-2	489,094	5,347,569	939	1,553	68
O7-1	489,136	5,347,117	925	1,622	2
O7-2	489,320	5,346,879	929	1,704	3
P7-1	489,612	5,346,811	950	1,929	3
P8-1	490,082	5,346,697	993	2,325	3
P8-2	489,493	5,346,541	932	1,718	3
P8-3	489,964	5,346,505	966	2,160	3
Q13-1	490,773	5,342,494	884	1,173	8
Q7-1	490,450	5,347,154	1,012	2,832	3
Q8-1	490,456	5,346,374	1,025	2,607	4
R9-1	491,302	5,345,702	1,010	2,955	6
T19-1	493,327	5,337,746	770	2,776	71

(I) Involved receiver

APPENDIX C SURVEY INSTRUMENTATION

Table 8: Sound level measurement instrumentation summary

Item	Description
Equipment type	Automated/unattended integrating sound levels
Make & model	01dB CUBE & DUO
Instrumentation class	Class 1 (precision grade) in accordance with AS/IEC 61672.1:2019[4]
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 9: Sound level meter installation records

Receiver	System	Unit serial number	Microphone serial number	Independent calibration date [1]	Calibration drift [2,3]
D10-13	01dB CUBE	10517	161870	23/05/2019	+0.22
F16-6	01dB CUBE	10520	224328	20/02/2020	+0.20
K17-1 (sub)	01dB CUBE	10517	161870	23/05/2019	-0.10
L19-1	01dB CUBE	11276	292433	30/03/2020	-0.10
M5-1	01dB DUO	10778	162059	16/09/2019	+0.52
O7-2	01dB DUO	10409	224184	30/05/2019	+0.44
Q13-1	01dB CUBE	10520	224328	20/02/2020	+0.30
D10-13	01dB CUBE	10517	161870	23/05/2019	+0.22

Note 1: Independent laboratory calibration date to be within 2 years of measurement period as per AS 1055:2018

Note 2: Difference between reference level checks during deployment and collection of instruments by pitt&sherry

Note 3: Calibration drift should not be greater than 1 dB as specified in AS 1055:2018

Table 10: Wind speed measurement instrumentation

Wind speeds	Description
Local wind speeds	Vaisala WXT520 weather station (serial number K1850003) positioned at receiver K17-1 (sub) and subsequently at D10-13.
Site wind speeds	Third party owned and operated system comprising a meteorological mast with anemometry at multiple heights. Further information provided in Appendix D.

[4] AS/IEC 61672.1-2019 *Electroacoustics - Sound level meters - Specifications*, which is identical to IEC 61672.1:2.0 *Electroacoustics - Sound Level Meters - Part 1: Specifications* published 2013

APPENDIX D SITE WIND SPEED DATA DERIVATION

This appendix summarises the wind speed data and analysis undertaken by Epuron to produce a continuous data set of wind speeds at the proposed hub height of the turbines.

Hub height wind speed data can be sourced either directly from measurements at the proposed hub height or, as is more commonly the case, by calculations to extrapolate wind speed measurements made at lower heights to the required hub-height. In this case, the hub-height data was determined by calculation from lower measurement heights.

A summary of the data sources and analysis methodology is provided in Table 11.

Table 11: Wind data source and analysis methodology

Item	Description
Wind speed measurement data source	Meteorological mast reference: SPP1 Coordinates: 488767 m E, 5336591 N (GDA 94 zone 55)
Wind speed measurement heights	60 m, 80 m, 100 m and 120 m
Data extrapolation methodology	A brief overview was provided by Epuron by email on 17 February 2021 as follows: For each 10-minute timestamp, the power law shear exponent α is calculated. These values are then divided into bins based on: • Hour of day • Month of year • Wind direction The average value of α is calculated for each bin. Then for each timestamp the average α value is obtained from the corresponding bin and the 150m wind speed calculated using this shear exponent.
Extrapolated wind speed data file	Spreadsheet *11Aug20 - 10Nov20 HH Time Series.xlsx* received via email from Epuron on 9 December 2020.
Time series	The format of the timeseries was confirmed by Epuron by email on 9 December 2020 as follows: • Data time zone: UTC +10 (Australian Eastern Standard Time) • Time stamp format: all timestamps designate the end of a 10-minute measurement period.

APPENDIX E SUMMARY OF BACKGROUND NOISE LEVELS

Table 12: Regression equation coefficients

	Regression equation coefficients for background noise equation of best fit $L_{A90} = ax^3+bx^2+cx+d$, where x = windspeed in m/s					
Location	**a**	**b**	**c**	**d**	**R^2**	**Valid wind speed range (m/s)**
D10-13*	*-0.00098*	*0.0434*	*0.3307*	*28.09*	*0.4474*	*3-18*
F16-1	-0.00222	0.0944	0.3978	23.43	0.5816	3-18
K17-1 (sub)*	*-0.00324*	*0.1340*	*-0.0842*	*23.32*	*0.6173*	*3-18*
L19-1	-0.00119	0.0730	0.2455	24.34	0.7245	3-18
M5-1	-0.00762	0.2385	-0.3612	22.22	0.6731	3-18
O7-2	-0.00284	0.0950	0.6445	21.28	0.5607	3-18
Q13-1	-0.00300	0.1269	-0.3479	25.53	0.5675	3-18

* Values provided for information only

APPENDIX F RECEIVER D10-13 DATA

F1 Receiver D10-13 location data

Table 13: Receiver D10-13 dwelling and noise monitor coordinates for each receiver – MGA 94 zone 55

Location	Easting	Northing
Dwelling location	479,948	5,344,850
Background noise monitoring location	479,943	5,344,829

Figure 2: Receiver D10-13 aerial view - dwelling and noise monitor locations

Table 14: Receiver D10-13 monitor installation photos

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

F2 Receiver D10-13 measurement data summary

Table 15: Receiver D10-13 background noise level analysis summary

Item	Number of data points
Data points collected	5,578
Data points removed	530
Data points for analysis	5,048

Figure 3: Receiver D10-13 background noise level and wind speed time history

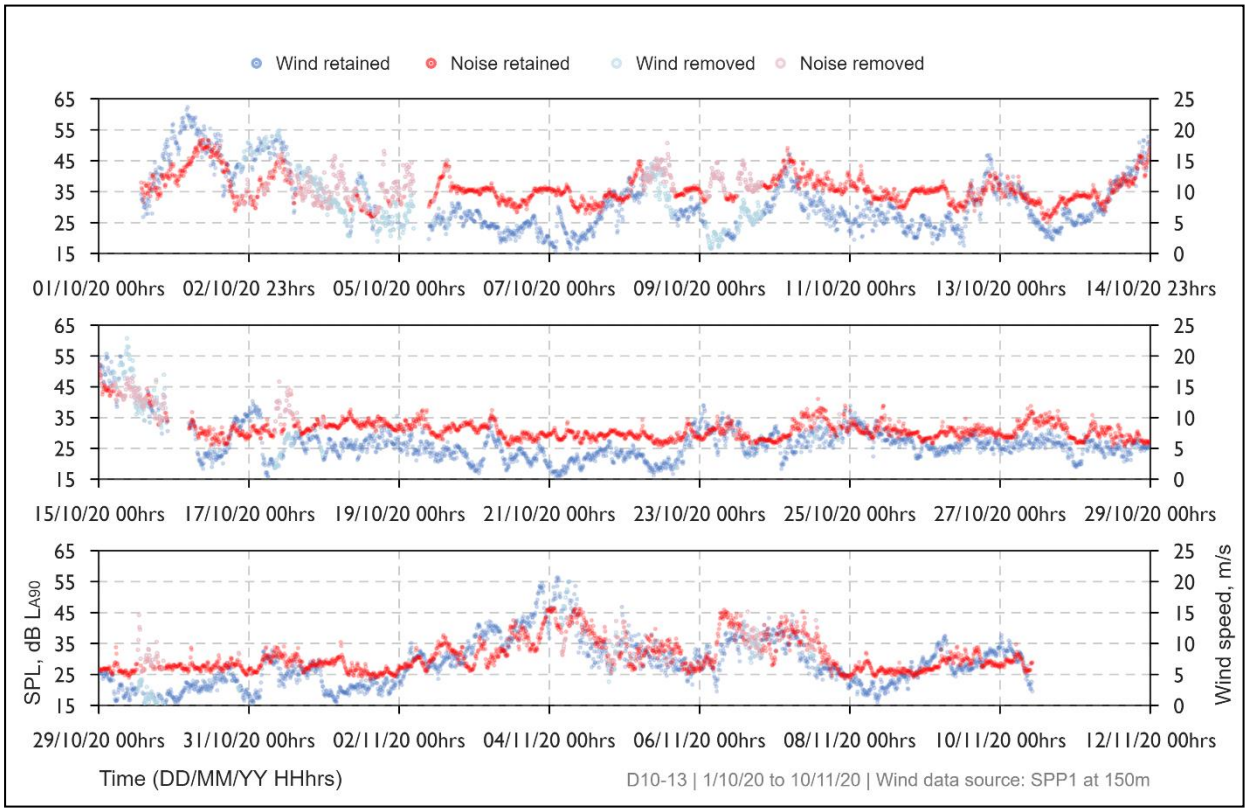
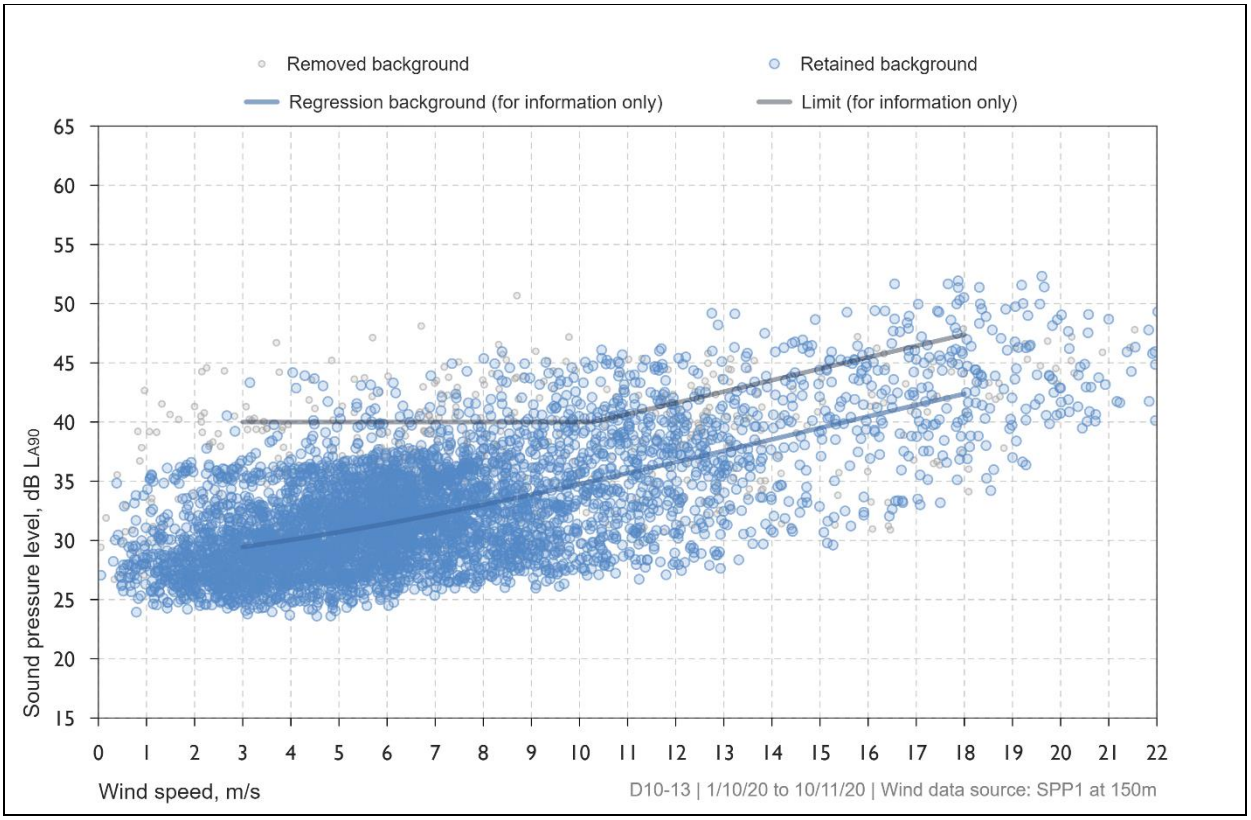


Figure 4: Receiver D10-13 – derived background noise levels and indicative noise limits (for information only)



APPENDIX G RECEIVER F16-6 DATA

G1 Receiver F16-6 location data

Table 16: Receiver F16-6 dwelling and noise monitor coordinates for each receiver – MGA 94 zone 55

Location	Easting	Northing
Dwelling location	481,382	5,339,876
Background noise monitoring location	481,408	5,339,882

Figure 5: Receiver F16-6 aerial view - dwelling and noise monitor locations

Table 17: Receiver F16-6 monitor installation photos

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

G2 Receiver F16-6 measurement data summary

Table 18: Receiver F16-6 background noise level analysis summary

Item	Number of data points
Data points collected	5,538
Data points removed	699
Data points for analysis	4,839

Figure 6: Receiver F16-6 background noise level and wind speed time history

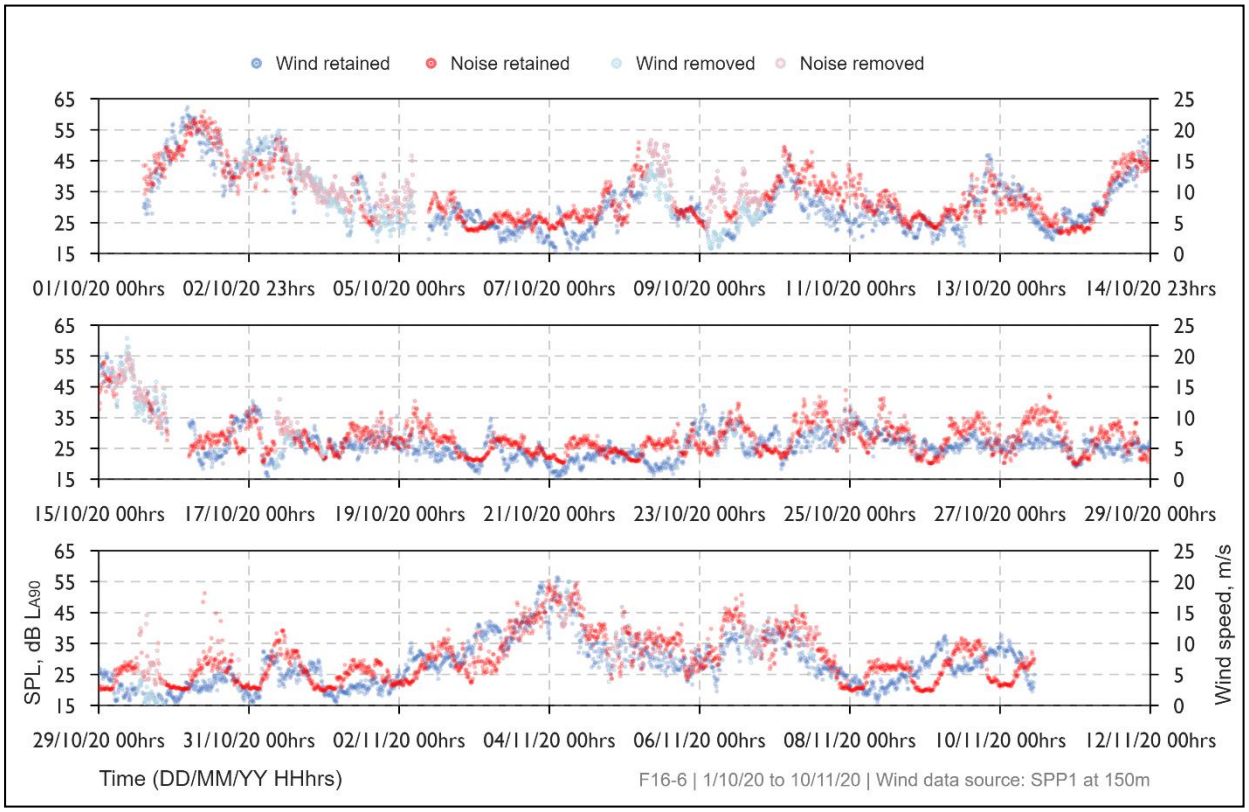
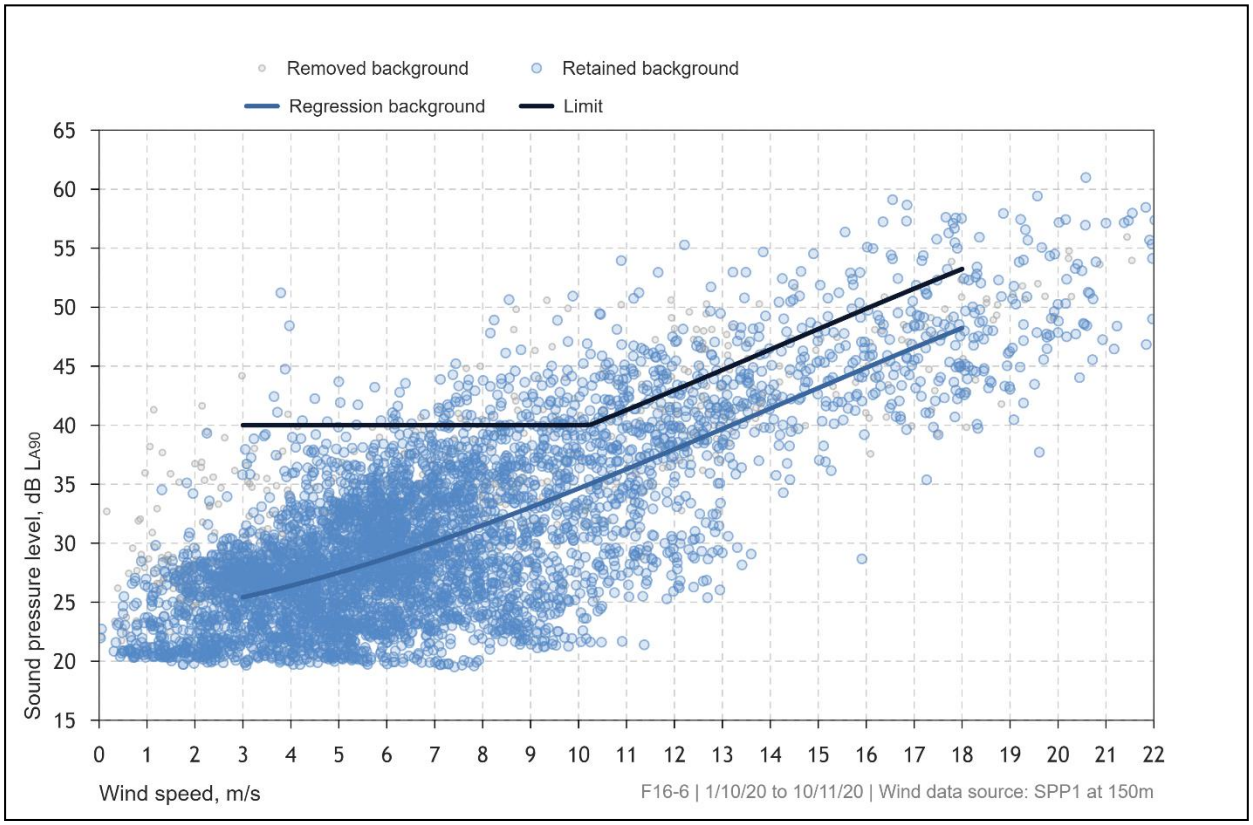


Figure 7: Receiver F16-6 – derived background noise levels and noise limits



APPENDIX H RECEIVER K17-1 DATA

H1 Receiver K17-1 (sub) location data

Table 19: Receiver K17-1 dwelling and noise monitor coordinates for each receiver – MGA 94 zone 55

Location	Easting	Northing
Dwelling location	485,420	5,338,772
Background noise monitoring location	484,471	5,339,134

Figure 8: Receiver K17-1 (sub) aerial view - dwelling and noise monitor locations

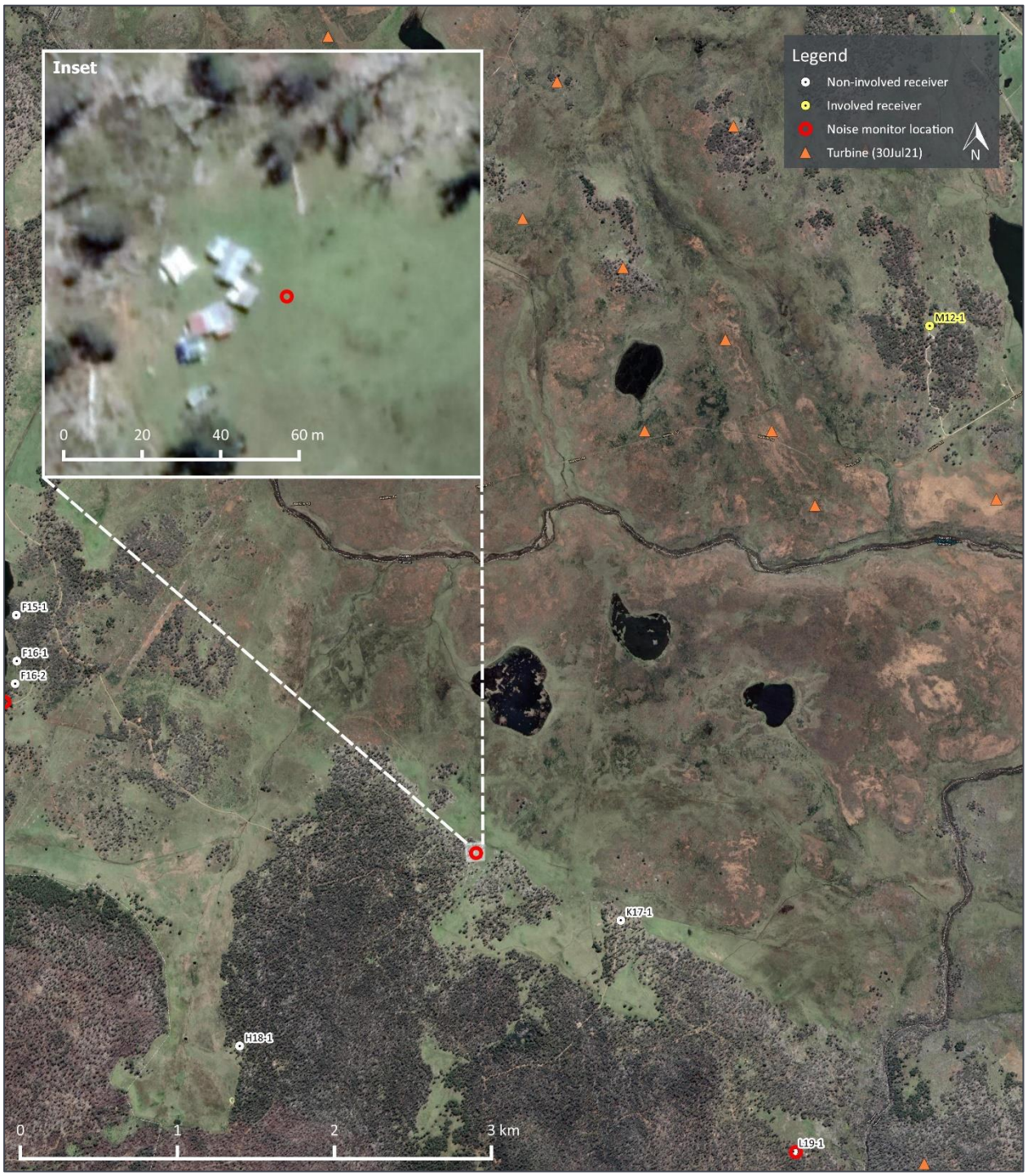


Table 20: Receiver K17-1 (sub) monitor installation photos

Looking North	Looking East
	
Looking South[1]	Looking West
	

Note 1: Photo showing completed setup not available in this cardinal direction

H2 Receiver K17-1 (sub) measurement data summary

Table 21: Receiver K17-1 background noise level analysis summary

Item	Number of data points
Data points collected	6,085
Data points removed	741
Data points for analysis	5,344

Figure 9: Receiver K17-1 (sub) background noise level and wind speed time history

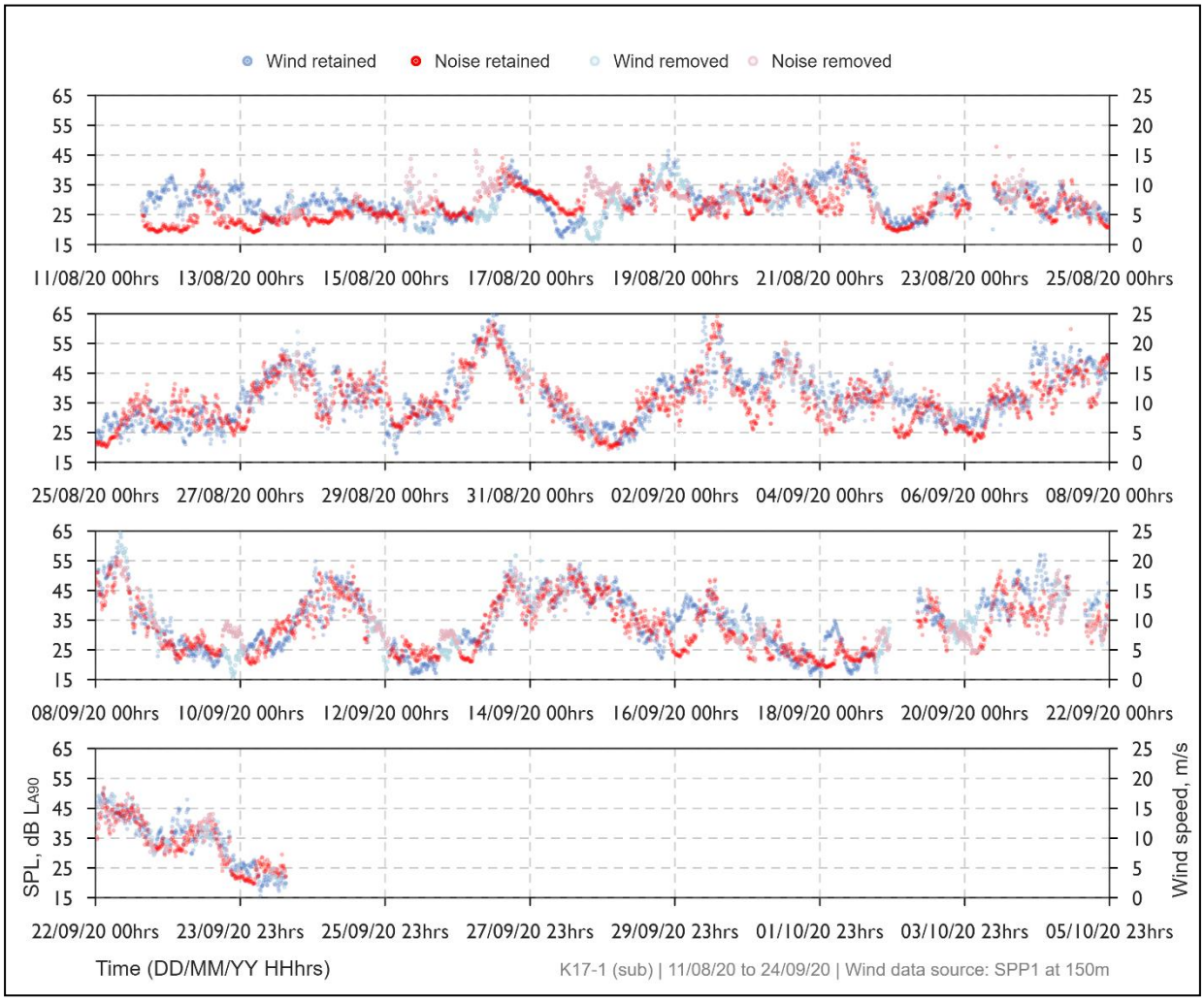


Figure 10: Receiver K17-1 (sub) – background noise levels with highlighted snow periods

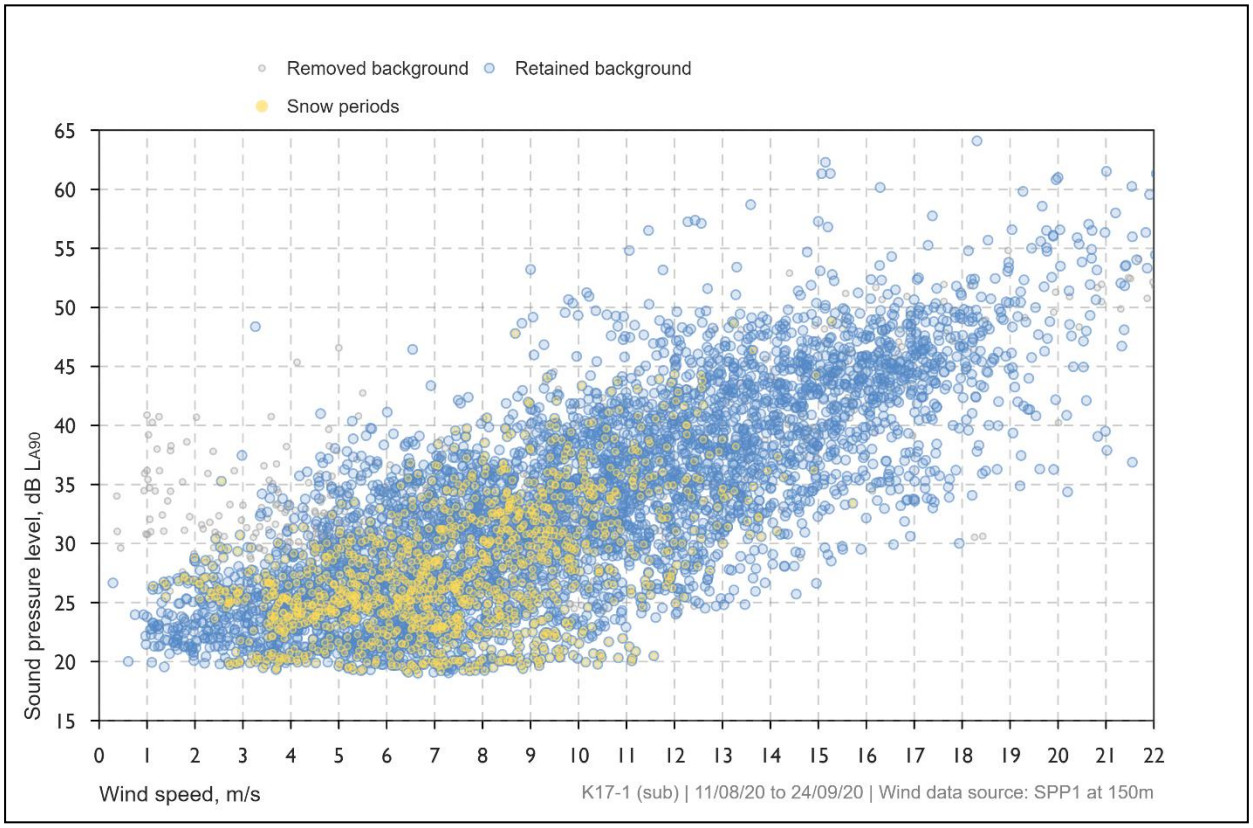
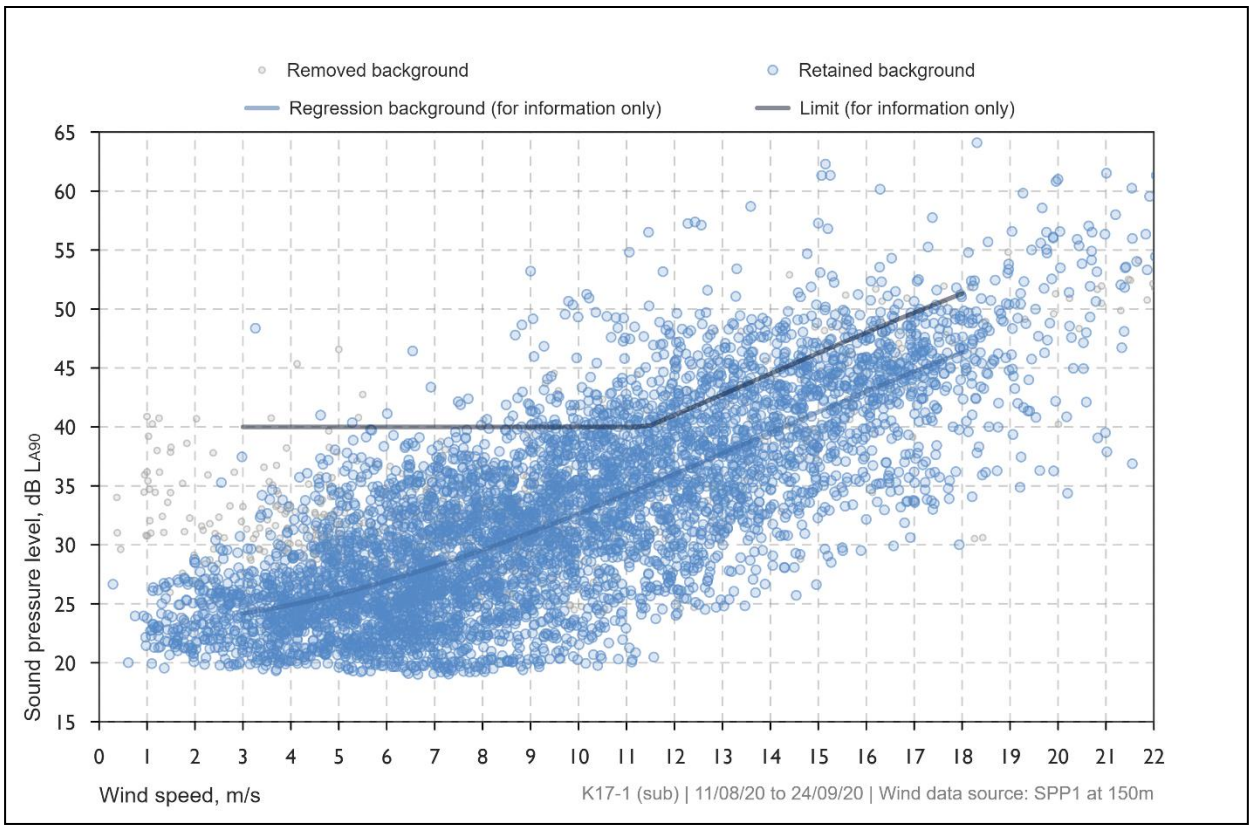


Figure 11: Receiver K17-1 (sub) – derived background noise levels and indicative noise limits (for information only)



APPENDIX I RECEIVER L19-1 DATA

I1 Receiver L19-1 location data

Table 22: Receiver L19-1 dwelling and noise monitor coordinates for each receiver – MGA 94 zone 55

Location	Easting	Northing
Dwelling location	486,619	5,337,381
Background noise monitoring location	486,636	5,337,379

Figure 12: Receiver L19-1 aerial view - dwelling and noise monitor locations

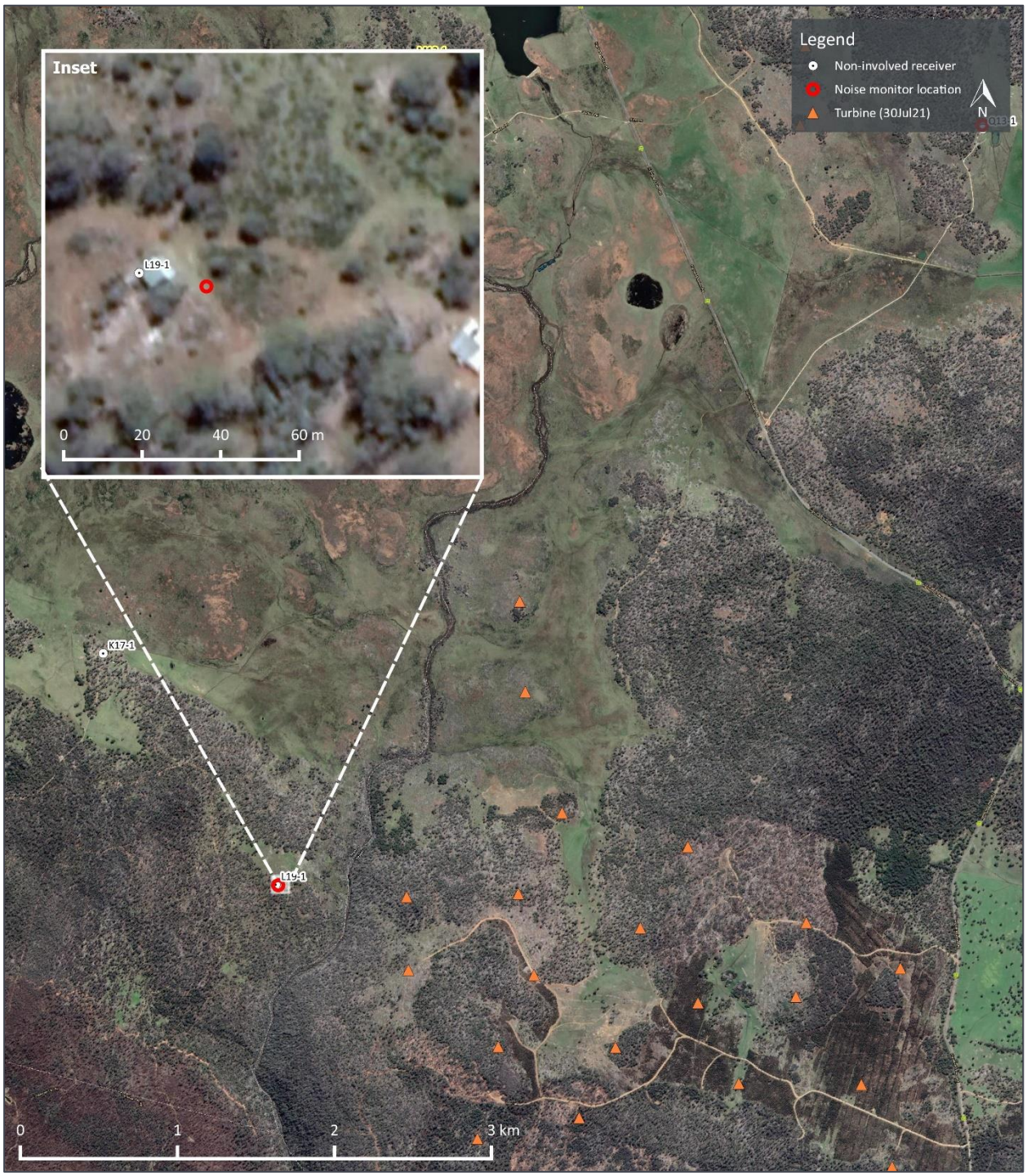


Table 23: Receiver L19-1 monitor installation photos

Looking North	Looking East
	
Looking South	Looking West
	

I2 Receiver L19-1 measurement data summary

Table 24: Receiver L19-1 background noise level analysis summary

Item	Number of data points
Data points collected	5,931
Data points removed	440
Data points for analysis	5,491

Figure 13: Receiver L19-1 background noise level and wind speed time history

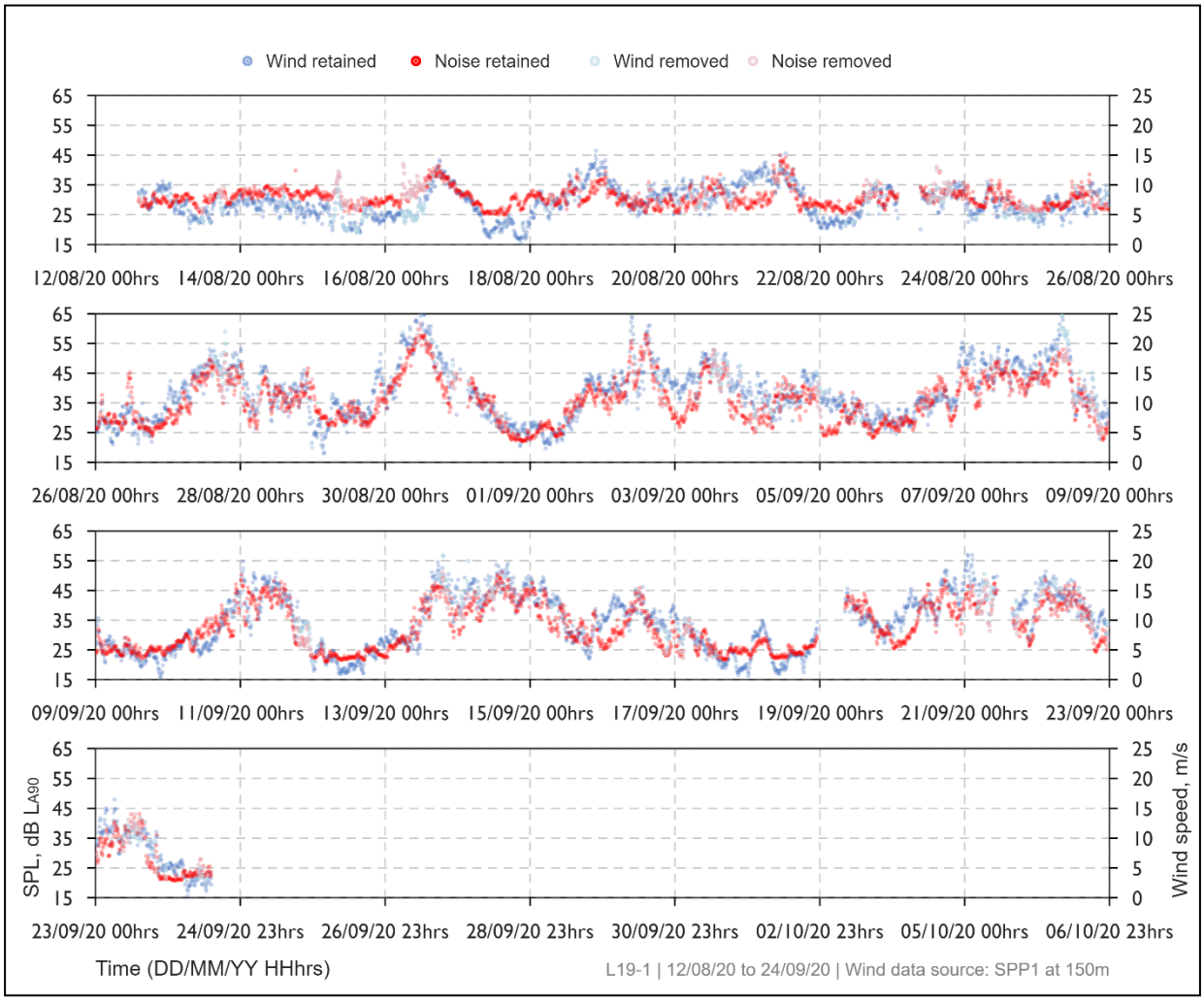


Figure 14: Receiver L19-1 – background noise levels with highlighted snow periods

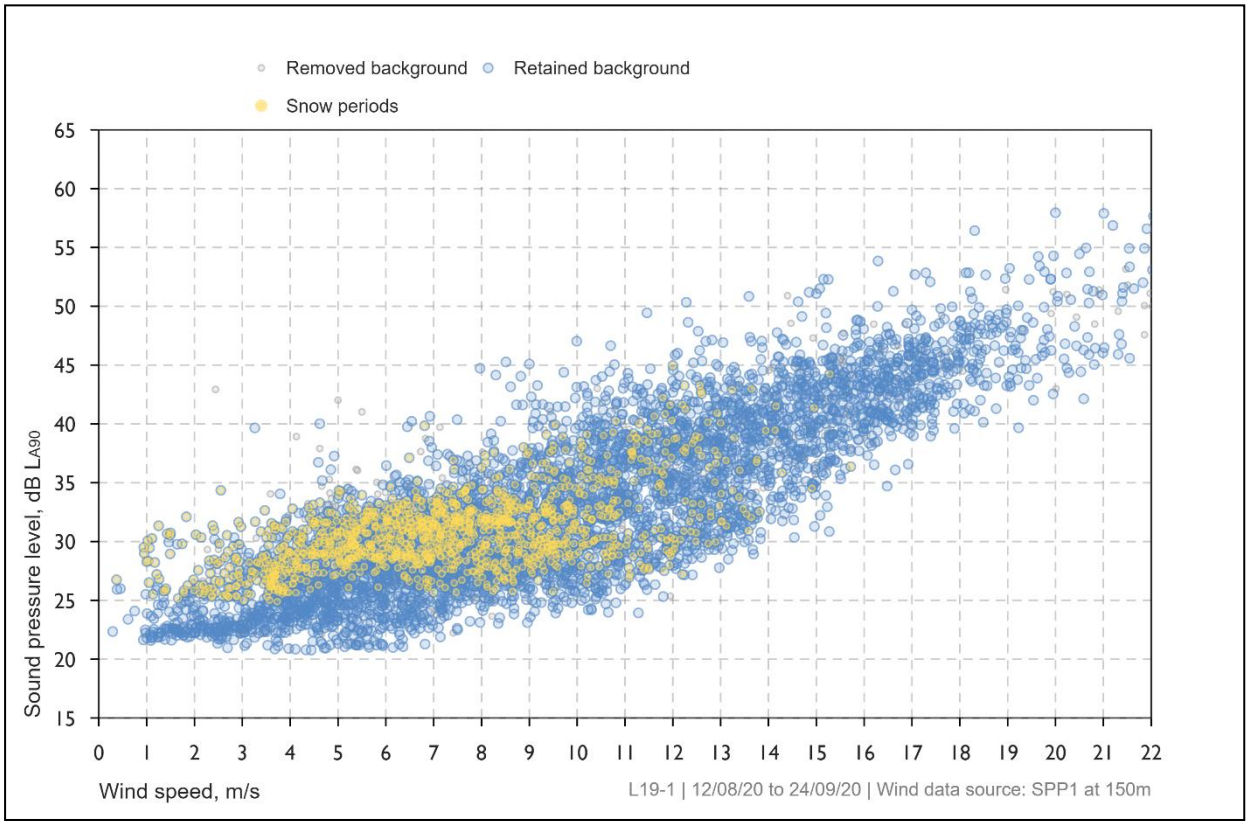
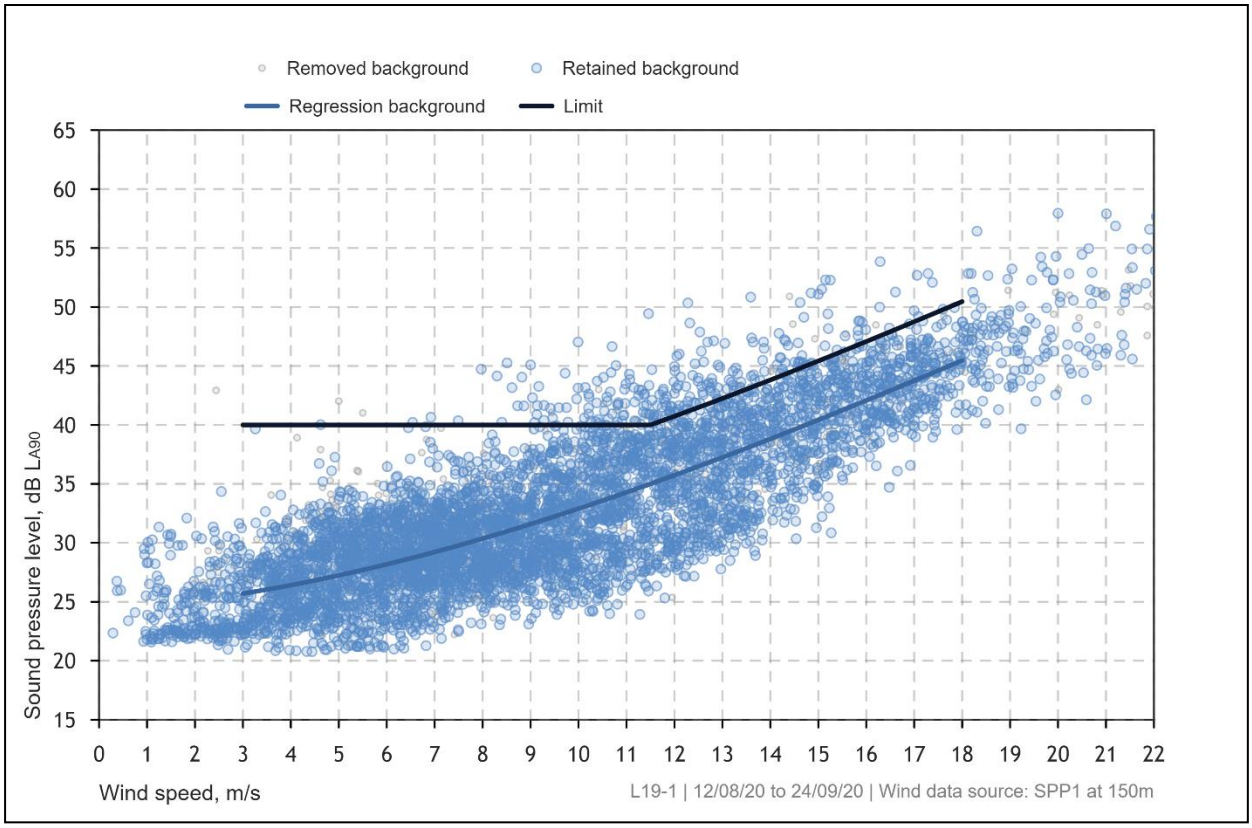


Figure 15: Receiver L19-1 – background noise levels and derived noise limits



APPENDIX J RECEIVER M5-1 DATA

J1 Receiver M5-1 location data

Table 25: Receiver M5-1 dwelling and noise monitor coordinates for each receiver – MGA 94 zone 55

Location	Easting	Northing
Dwelling location	487,060	5,348,620
Background noise monitoring location	487,073	5,348,610

Figure 16: Receiver M5-1 aerial view - dwelling and noise monitor locations

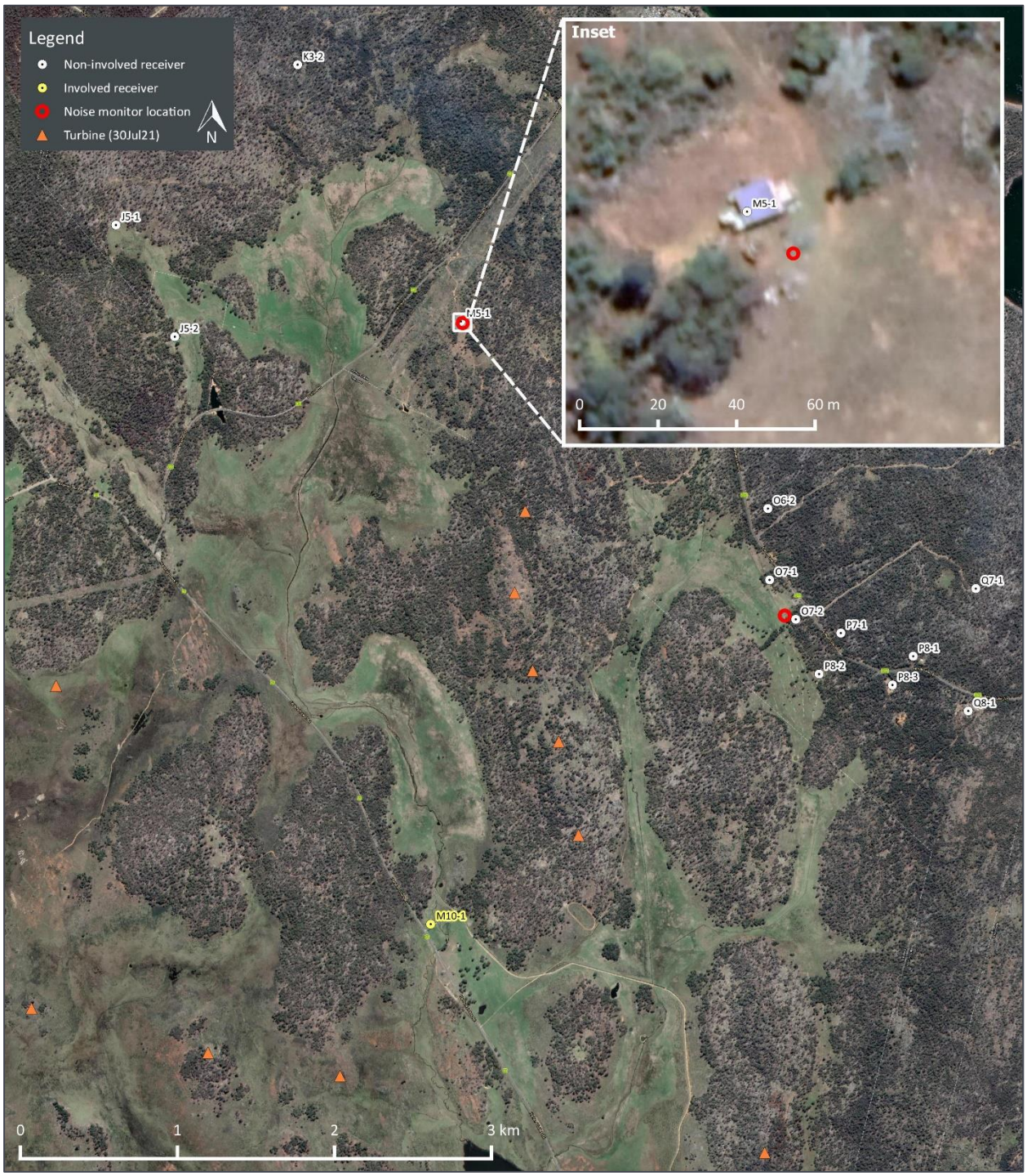


Table 26: Receiver M5-1 monitor installation photos

Looking North	Looking East [1]
	
Looking South [1]	**Looking West [1]**
	

[1] Photo showing completed setup not available in this cardinal direction

J2 Receiver M5-1 measurement data summary

Table 27: Receiver M5-1 background noise level analysis summary

Item	Number of data point
Data points collected	9,237
Data points removed	6,956
Data points for analysis	2,281

Figure 17: Receiver M5-1 background noise level and wind speed time history

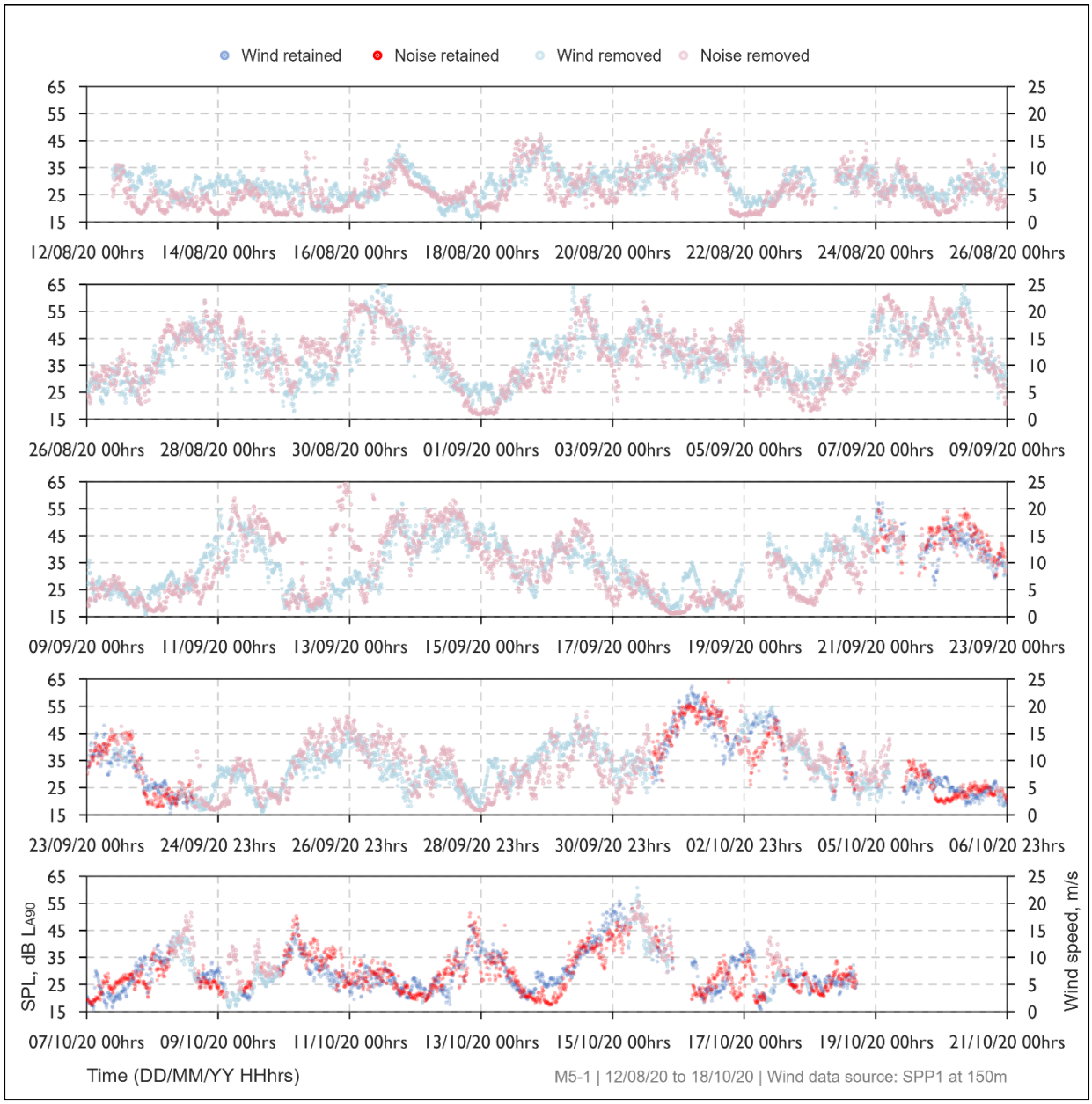
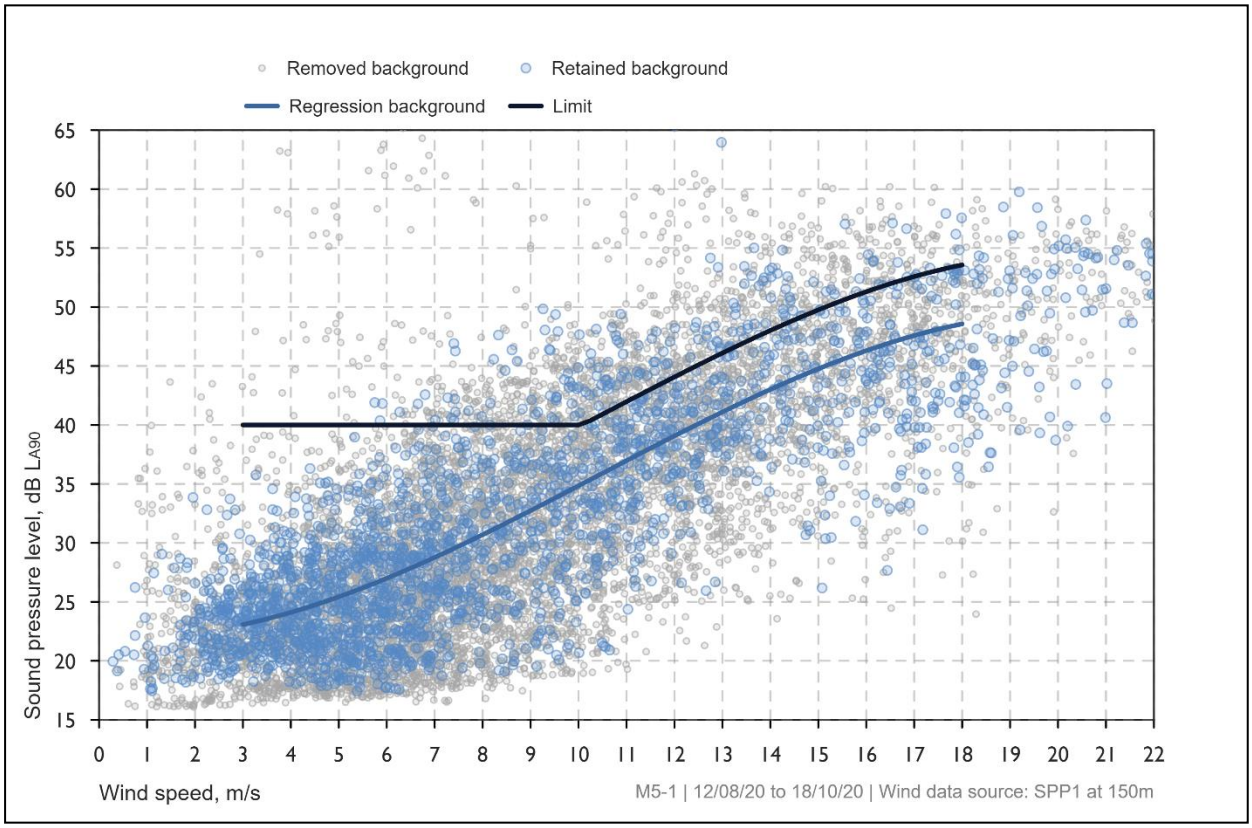


Figure 18: Receiver M5-1 – background noise levels and derived noise limits



APPENDIX K RECEIVER O7-2 DATA

K1 Receiver O7-2 location data

Table 28: Receiver O7-2 dwelling and noise monitor coordinates for each receiver – MGA 94 zone 55

Location	Easting	Northing
Dwelling location	489,320	5,346,879
Background noise monitoring location	489,248	5,346,897

Figure 19: Receiver O7-2 aerial view - dwelling and noise monitor locations

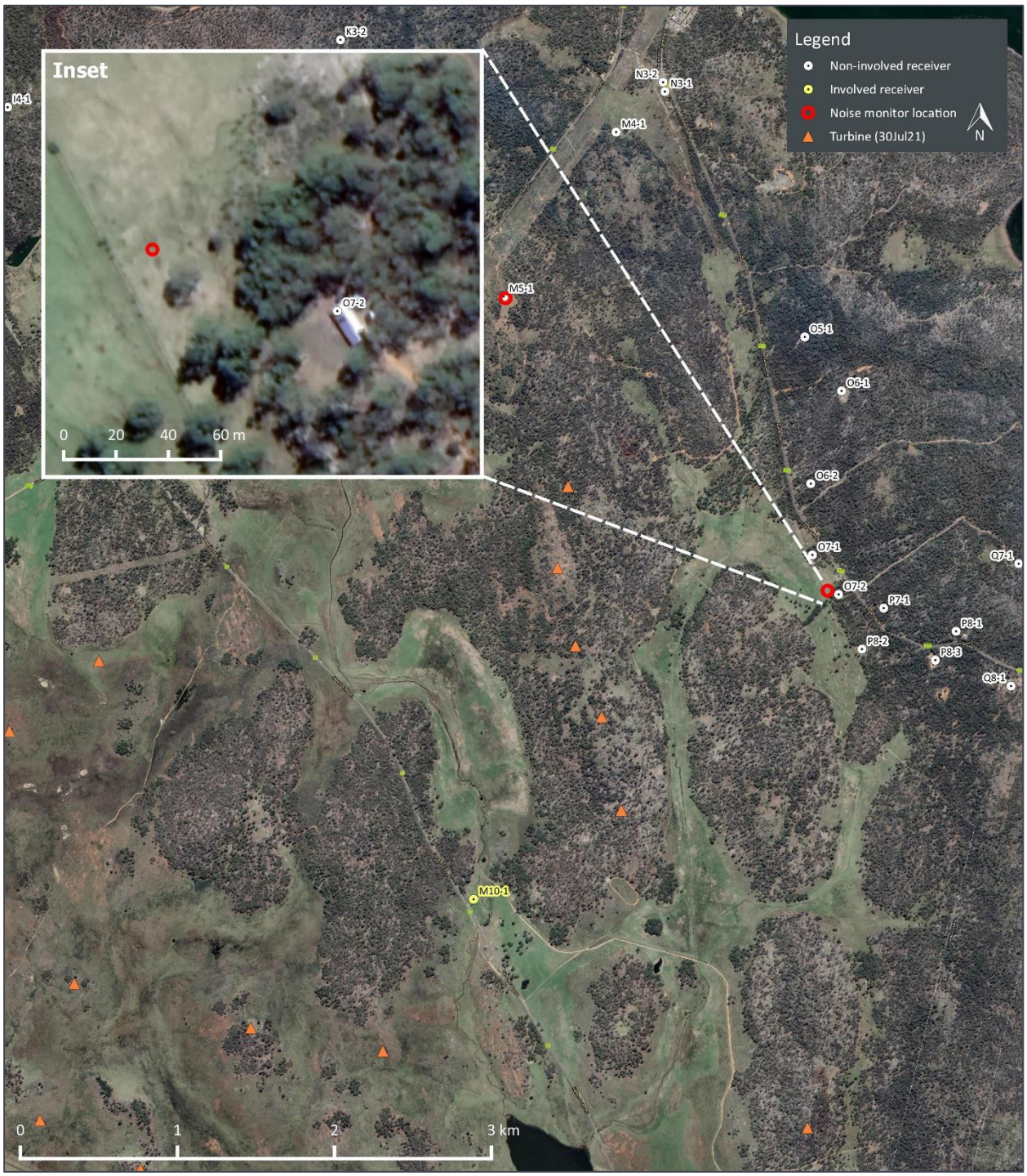


Table 29: Receiver O7-2 monitor installation photos

Looking North [1]	Looking East
	
Looking South	**Looking West**
	

[1] Photo showing completed setup not available in this cardinal direction

K2 Receiver O7-2 measurement data summary

Table 30: Receiver O7-2 background noise level analysis summary

Item	Number of data points
Data points collected	5,908
Data points removed	1,105
Data points for analysis	4,803

Figure 20: Receiver O7-2 background noise level and wind speed time history

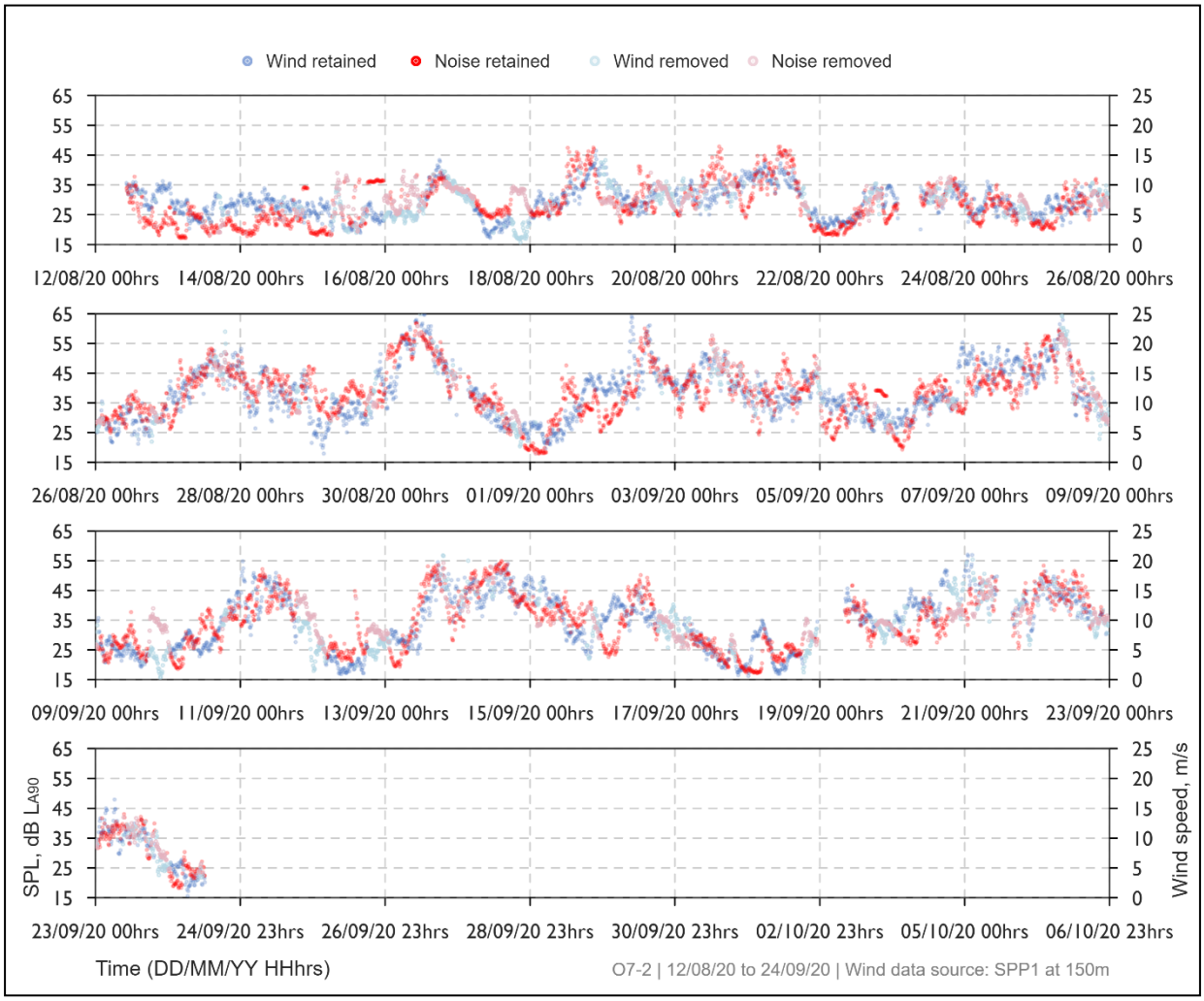


Figure 21: Receiver O7-2 – background noise levels with highlighted snow periods

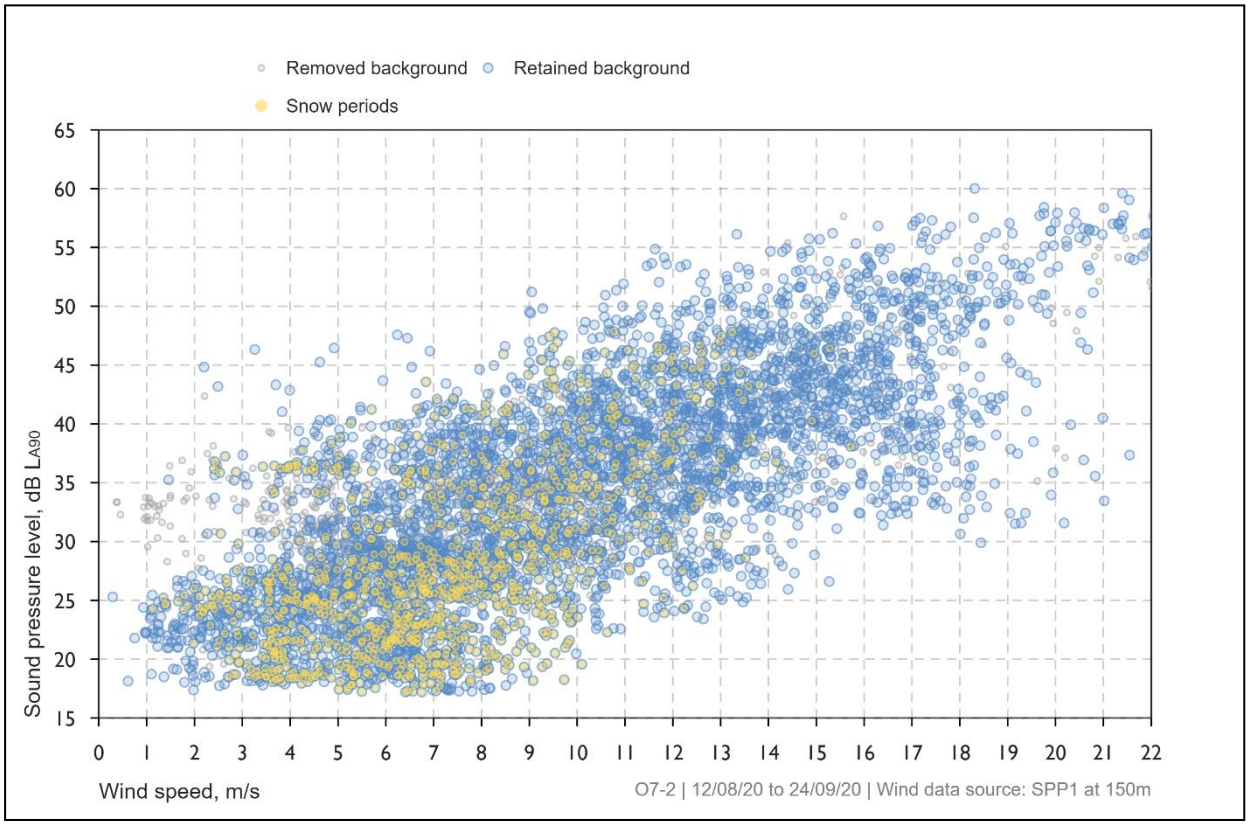
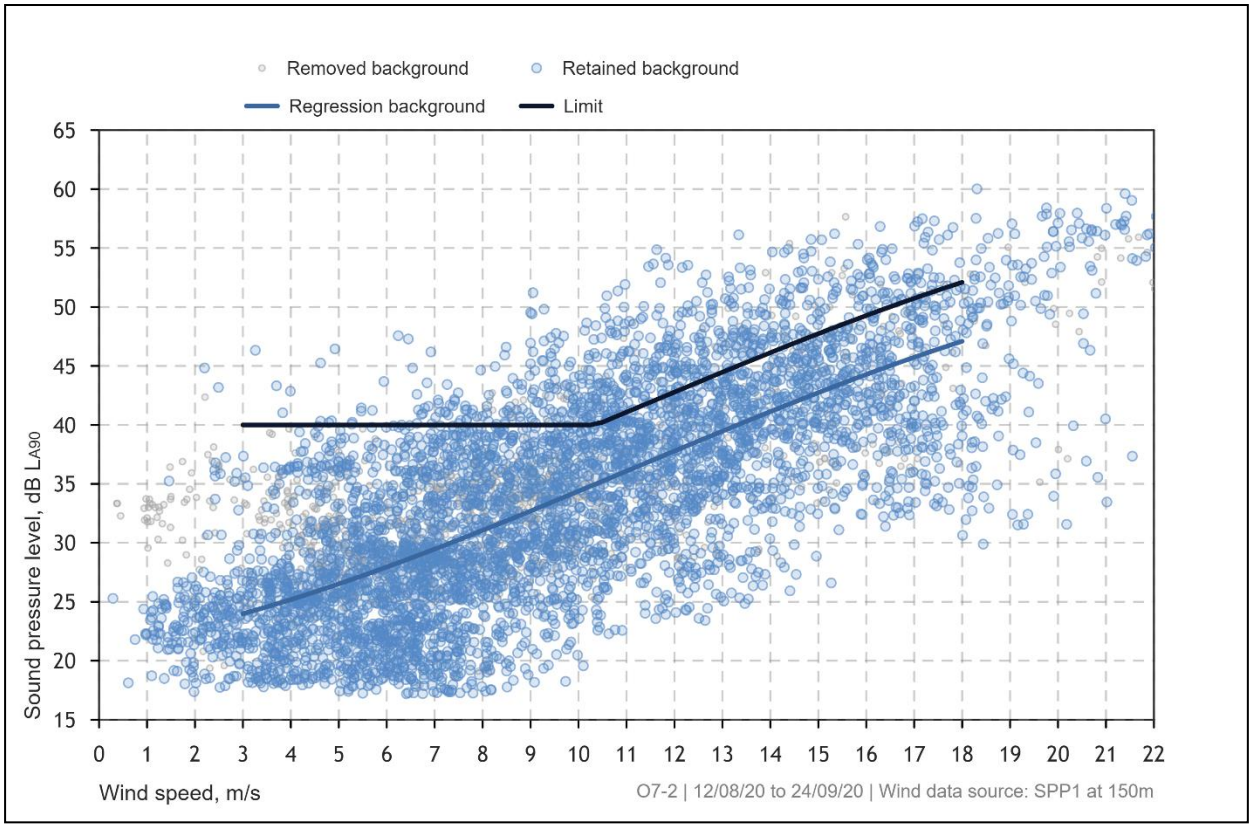


Figure 22: Receiver O7-2 – background noise levels and derived noise limits



APPENDIX L RECEIVER Q13-1 DATA

L1 Receiver Q13-1 location data

Table 31: Receiver Q13-1 dwelling and noise monitor coordinates for each receiver – MGA 94 zone 55

Location	Easting	Northing
Dwelling location	490,773	5,342,494
Background noise monitoring location	490,767	5,342,520

Figure 23: Receiver Q13-1 aerial view - dwelling and noise monitor locations

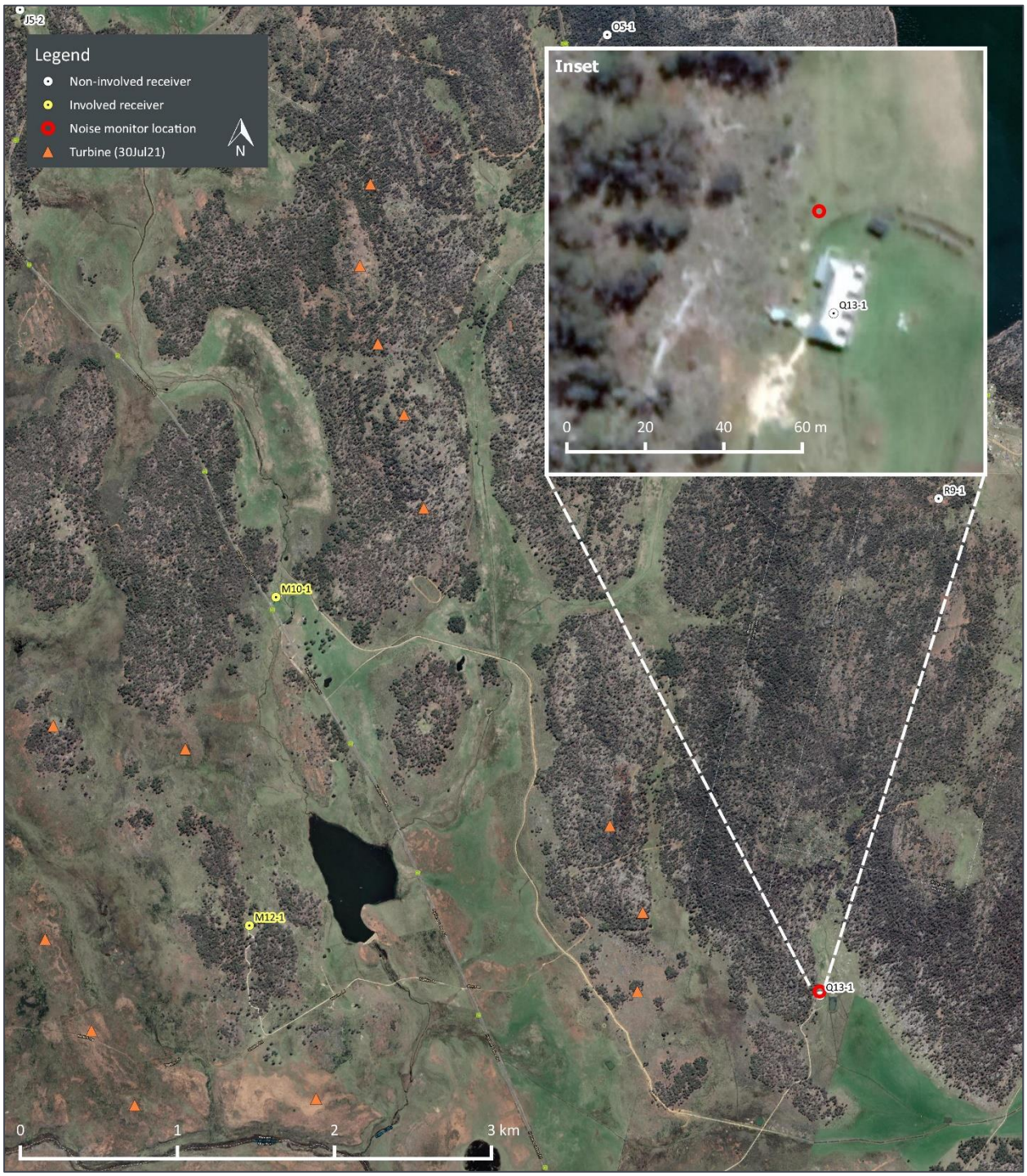


Table 32: Receiver Q13-1 monitor installation photos

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

L2 Receiver Q13-1 measurement data summary

Table 33: Receiver Q13-1 background noise level analysis summary

Item	Number of data points
Data points collected	6,037
Data points removed	1,302
Data points for analysis	4,735

Figure 24: Receiver Q13-1 background noise level and wind speed time history

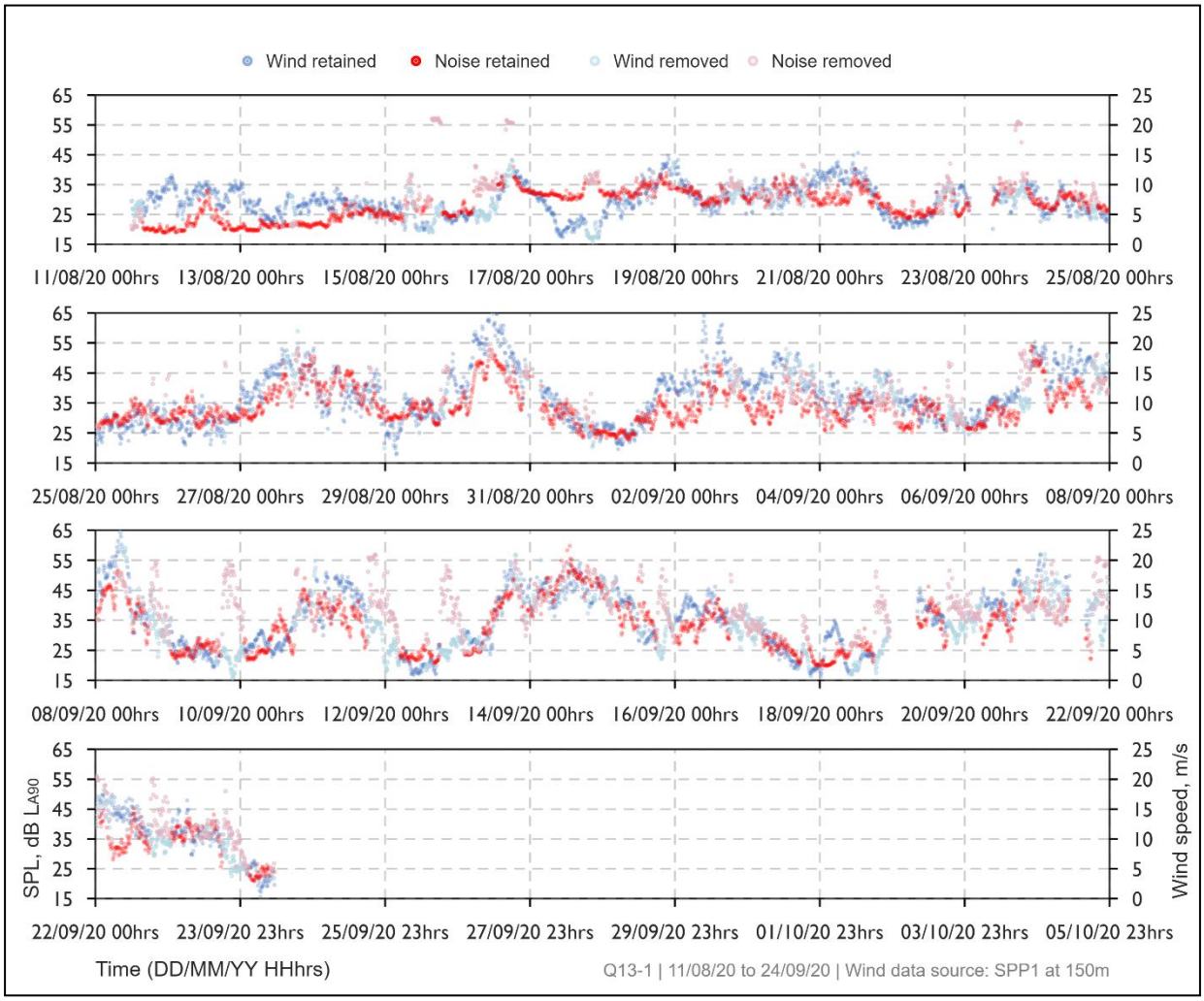


Figure 25: Receiver Q13-1 – background noise levels with highlighted snow periods

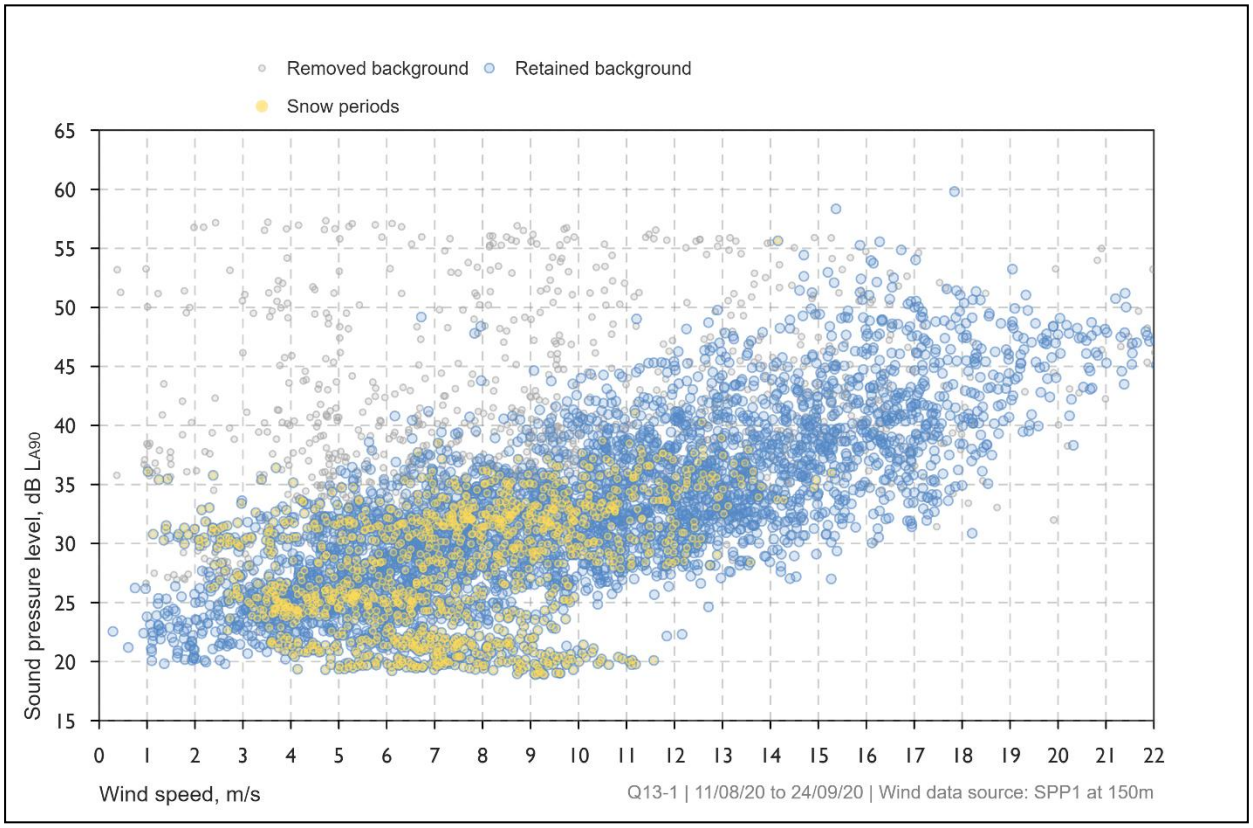


Figure 26: Receiver Q13-1 – background noise levels and derived noise limits