MARSHALL DAY Acoustics

KENTBRUCK GREEN POWER HUB
BACKGROUND NOISE MONITORING

Rp 002 R03 20200682 | 16 July 2024

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Document Control

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Complete	R03	Minor amendments to address auditor comments	16 Jul 2024	C. Delaire	J. Adcock

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1.0 INTRODUCTION

This report presents the results of background noise monitoring undertaken for the proposed Kentbruck Green Power Hub (the Project).

The background noise monitoring was commissioned by Neoen Australia Pty Ltd (the proponent) as part of the noise studies associated with the Project's Environment Effects Statement. The background noise monitoring was undertaken to obtain a representation of typical baseline conditions at receivers in the vicinity of the project.

This report documents the survey method and the results of the background noise monitoring, along with the derived noise limits which would be used to assess the project'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 noise sensitive location (e.g. residential dwelling, camping ground, etc.) existing on land in the vicinity of the project.

2.0 BACKGROUND NOISE SURVEY & ANALYSIS METHOD

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), as required by the Victorian Department of Transport and Planning publication *Planning Guidelines for Development of Wind Energy Facilities* dated September 2023 (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 (the UK Institute of Acoustics guidance).

This section of the report presents:

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

2.1 Monitoring locations

Background noise monitoring was carried out at five (5) receivers listed in Table 1.

The monitoring locations included two (2) substitutes for receivers 10 and 673 where background noise monitoring was not able to be carried out for the following reasons:

- Receiver 10: consent to undertake background noise monitoring was not granted at this receiver.

  An alternative monitoring location was selected to the north of Receiver 10 within an empty paddock with limited vegetation, at a similar distance to the nearest proposed turbines. This monitoring location is referred to herein as *Receiver 10 proxy*.

  With the current wind farm layout, wind turbine noise levels at Receiver 10 are predicted to be below 35 dB L_{A90} and, as such, background noise monitoring would no longer be required in accordance with NZS 6808.

  However, since the background noise monitoring was undertaken, an additional receiver (Receiver 674) was identified closer to the wind turbines, where wind turbine noise levels are predicted above 35 dB L_{A90}. Receiver 674 is located approximately 1.5 km north of Receiver 10 and approximately 530 m to the northeast of Receiver 10 proxy.

  A range of factors contribute to the background noise levels in the area, including coastal noise, wind disturbed vegetation, fauna and road traffic noise at some locations. Given the distance between these locations, background noise levels are likely to be materially different at Receiver 674 and Receiver 10 Proxy. However, given the proximity of Receiver 674 to Portland Nelson Road, on balance the background noise at Receiver 674 is likely to be comparable to, or higher than, the levels measured at Receiver 10 proxy. The measured background noise levels at Receiver 10 proxy therefore provide a conservative representation of the background noise for Receiver 674.

- Receiver 673: a secure location for the noise monitoring equipment was not available within the camping ground.

  An alternative monitoring location was selected to the north of the camping ground on the edge of the pine plantation, between Receiver 673 and the proposed wind turbines near to the 40 dB L_{A90} noise contour. This monitoring location is referred herein as *Receiver 673 Int*.

  A range of factors can vary background noise levels between locations around this area such as increased distance from coastal noise but closer distance to trees. However, this was identified as the most suitable and secure location available for obtaining a representation of a similar environment.

The monitoring locations also included two (2) other receivers where background noise monitoring would no longer be required in accordance with NZS 6808:

- Receiver 21: now identified as a stakeholder where a noise agreement is proposed between the landowner and the proponent; and
- Receiver 81: now located approximately 7.1 km from a proposed wind turbine, outside the 5 km study area.

Table 1: Background noise monitoring locations

Receiver	Direction from wind farm	Distance from nearest turbine
10 proxy	West	Approximately 1,500 m
21	South of eastern section	Approximately 1,100 m
31	East and south of eastern section	Approximately 2,000 m
81	East	Approximately 7,100 m
673 Int	South of mid-section	Approximately 1,400 m

The monitoring locations were selected on the basis of:

- The noise monitoring procedures outlined in NZS 6808; and
- Upper predicted operational wind farm noise levels prepared at the time of the survey planning, based on a wind turbine layout dated 16 February 2021 and comprising one hundred and fifty-seven (157) turbines.

While the selection of the monitoring locations was based on predicted noise levels associated with a previous layout, the mapping presented in this report includes predicted noise contours associated with the wind turbine layout presented in the environmental noise and vibration assessment[1], dated 6 November 2023. Specifically, predicted noise levels presented herein are based on a layout comprising one hundred and five (105) wind turbines located at the coordinates detailed in Appendix B.

The background noise monitoring locations are presented in Figure 1 with the current wind farm layout and the earlier wind farm layout, used to inform the survey, together with the respective 35 dB L_{A90} noise contours.

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:

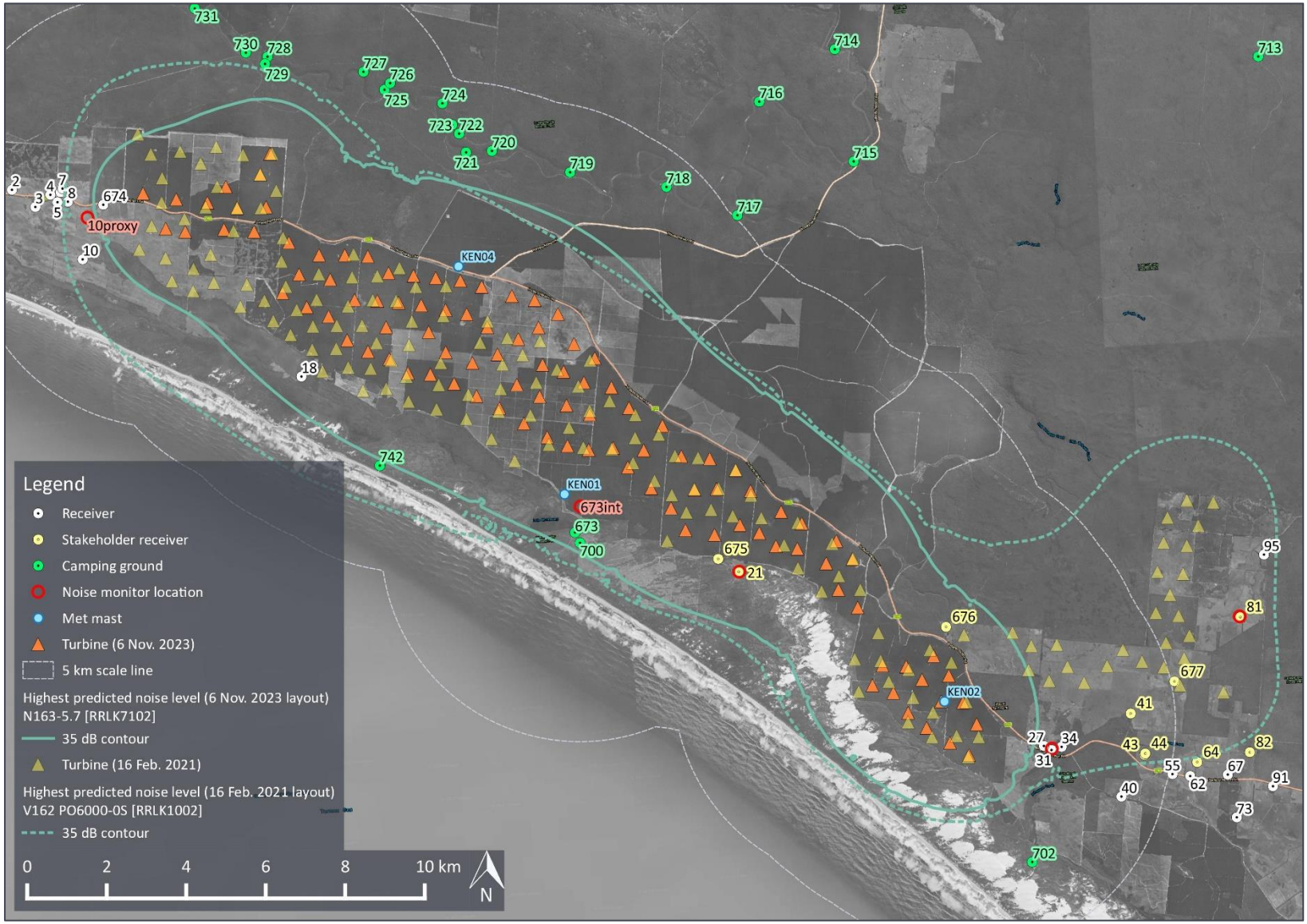
- The noise monitors were located on the proposed wind farm side of the dwelling, where relevant;
- The noise monitors were located at least 3.5 m away from the dwelling, where relevant, and any significant vertical reflecting structures; and
- The noise monitors were located as far as practical from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

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

Background noise levels at Receiver 673 Int have been used as an indication of the background environment in the vicinity of the camping ground referenced as Receiver 673. These measurements were not undertaken directly at the camping ground location and have not been used to derive a noise limit.

[1] MDA report Rp 001 R04 20200682 *Kentbruck Green Power Hub – Environmental noise & vibration assessment*, dated 16 July 2024

Figure 1: Background noise monitoring locations relative to the Project



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	Five (5) receivers as described in Section 2.1.
Monitoring Period	19 May 2021 to 13 July 2021 equating to approximately 7 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 Institute of Acoustics guidance. 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 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 three (3) masts at the site: • Mast reference KEN01 extending to a height of 109 m • Mast reference KEN02 extending to a height of 80 m • Mast reference KEN04 extending to a height of 80 m The reference masts were chosen on the basis of the position of the masts within the site, and the anticipated availability of comparable data in the future. Hub height wind speed data (166 m above ground level) was provided by Neoen, based on analysis conducted by Aurecon Group to extrapolate the 80 m and 109 m height anemometer wind speed data to 165 m using site-specific wind shear calculations. See additional information in Appendix D, including: • Coordinates of the three (3) reference masts; • Documentation summarising the analysis process; and • Wind roses for the all-time and night periods during the survey.

2.3 Data analysis

The analysis of the survey data has been conducted in accordance with NZS 6808. 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 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; and
- 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}.
Time periods	Neither NZS 6808 nor the Victorian Wind Energy Guidelines define separate time periods for the analysis of background noise levels or assessment of wind farm noise. However, in accordance with the requirements commonly defined in Victorian wind farm planning permits, the data sets are considered for separate periods as follows: • All periods: no restriction on hours (i.e. data during day and night hours included) • Night period: 2200 to 0700 hours

[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 (L_{A90}) 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. The *Environment Protection Regulations 2021* specify a noise limit for stakeholder receivers of 45 dB L_{A90} or background noise (L_{A90}) plus 5 dB, whichever is higher, where a noise agreement between the owner or operator of a wind energy facility and a landowner is made on or after 1 November 2021. In accordance with the requirements commonly defined in Victorian wind farm planning permits, the noise limits are separately defined for all-time 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 background noise measurement results, analysed in accordance with the method 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 Project.

3.1 Background noise levels

The tabulated data presented in Table 4 summarises the derived background noise levels for the all-time period and night period, respectively for all monitored receivers except from Receiver 673 Int (discussed separately below).

The data in Table 4 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 in Appendix F to Appendix J. The graphical background noise measurement data presented in Appendix F to Appendix J indicates a wide variation in the individual 10 minute background noise levels, ranging from less than 20 dB L_{A90} to more than 50 dB L_{A90} at the higher wind speeds. The general range is consistent with typical background noise levels observed in rural environments.

Note that, for certain receivers, the regression lines indicate an increase of background noise levels as hub height wind speed decreases. As this feature is deemed to be an artifact of the regression analysis process due to the large scatter of points at low hub height wind speeds, the regression lines have been truncated at their lowest values.

Table 4: Background noise levels at all receivers except for Receiver 673 Int, dB L_{A90}

Receiver	Hub height wind speed, m/s												
	3	4	5	6	7	8	9	10	11	12	13	14	15
All-time period													
10 proxy [1]	26.4	27.5	28.4	29.1	29.5	29.8	30.0	30.1	30.1	30.3	30.4	30.7	31.2
21 (S) [2]	26.8	27.9	28.8	29.5	30.1	30.5	30.9	31.2	31.6	32.0	32.5	33.2	34.0
31 [3]	30.5	30.5	30.7	31.1	31.7	32.4	33.3	34.2	35.1	36.0	36.9	37.6	38.3
81 (S) [3, 4]	*26.5*	*27.3*	*28.1*	*29.0*	*29.8*	*30.6*	*31.4*	*32.1*	*32.8*	*33.5*	*34.1*	*34.7*	*35.1*
Night period													
10 proxy [1]	- [5]	- [5]	- [5]	- [5]	- [5]	- [5]	- [5]	- [5]	28.1	28.3	28.7	29.1	29.7
21 (S) [2]	- [5]	- [5]	- [5]	- [5]	- [5]	31.4	31.4	31.4	31.6	32.0	32.4	33.1	33.8
31 [3]	- [5]	- [5]	- [5]	30.2	30.2	30.5	31.1	31.9	33.0	34.1	35.3	36.4	37.4
81 (S) [3, 4]	*24.7*	*25.3*	*26.0*	*26.7*	*27.4*	*28.2*	*28.9*	*29.7*	*30.5*	*31.2*	*31.9*	*32.6*	*33.2*

(S) Stakeholder receiver

1 KEN04 met mast – 165 m above ground level at 513762 E, 5786178 N (MGA 94 Zone 54)

2 KEN01 met mast – 165 m above ground level at 516053 E, 5780289 N (MGA 94 Zone 54)

3 KEN02 met mast – 165 m above ground level at 525250 E, 5774470 N (MGA 94 Zone 54)

4 Background noise levels at Receiver 81 are only provided for information as this receiver is no longer located within 5 km of a proposed wind turbine

5 Outside valid range of regression analysis

In relation to Receiver 673 Int, the analysis for this location presented in Appendix J2 identified unique trends according to time of day and wind direction. As a result, the data for this location was separately assessed for the periods 0700-1700 hrs and 1700-0700 hrs, excluding wind directions ranging from westerlies through to northeasterlies (between 270 and 45°) when noise levels were found to be elevated (noting these directions correspond to downwind conditions from the proposed wind turbine locations, but may relate to factors associated with a pine plantation). Even with these subgroups, the retained data for the night period at Receiver 673 Int still indicates elevated noise levels at low wind speeds. Listening studies for a sample of these elevated data points indicated clearly audible coastal noise which is likely to be a regular feature of the ambient noise environment. However, in recognition of these variations, the background noise levels for Receiver 673 Int are provided for indicative purposes only.

Table 5: Indicative background noise levels at Receiver 673 Int, dB L_{A90} - excluding wind directions between 270 and 45°

Time period	Hub height wind speed, m/s [1]												
	3	4	5	6	7	8	9	10	11	12	13	14	15
0700-1700 hrs	30.3	31.5	32.8	34.0	35.2	36.4	37.6	38.9	40.1	41.3	42.5	43.7	45.0
1700-0700 hrs	- [2]	- [2]	- [2]	- [2]	- [2]	37.0	37.4	38.0	38.9	40.0	41.2	42.6	44.1

1 KEN01 met mast – 165 m above ground level at 516053 E, 5780289 N (MGA 94 Zone 54)

2 Outside valid range of regression analysis

3.2 Noise limits

The limits presented in Table 6 are based on background noise levels presented in Section 3.1 and the status of each receiver as detailed in the environmental noise and vibration assessment. As discussed in Section 2.1 and Section 3.1, the background noise data obtained at Receiver 673 Int has been presented for indicative purposes only, and background noise related limits have therefore not been derived for this location.

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 are illustrated in the graphical data provided for each receiver in Appendix F to Appendix J.

Table 6: Operational wind farm noise limits at all relevant receivers except for Receiver 673 Int, dB L_{A90}

Receiver	Hub height wind speed, m/s												
	3	4	5	6	7	8	9	10	11	12	13	14	15
All-time period													
10 proxy [1]	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
21 (S) [2]	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
31 [3]	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.1	41.0	41.9	42.6	43.3
Night period													
10 proxy [1]	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
21 (S) [2]	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
31 [3]	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.3	41.4	42.4

(S) Stakeholder receiver

1 KEN04 met mast – 165 m above ground level at 513762 E, 5786178 N (MGA 94 Zone 54)

2 KEN01 met mast – 165 m above ground level at 516053 E, 5780289 N (MGA 94 Zone 54)

3 KEN02 met mast – 165 m above ground level at 525250 E, 5774470 N (MGA 94 Zone 54)

4.0 SUMMARY

Background noise monitoring has been conducted at five (5) receivers around the proposed Kentbruck Green Power Hub.

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

- New Zealand Standard 6808:2010 *Acoustics – Wind farm noise* (NZS 6808), as required by the Victorian Department of Transport and Planning publication *Planning Guidelines for Development of Wind Energy Facilities* dated September 2023 (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 Institute of Acoustics guidance).

The results have been analysed to derive noise limits in accordance with NZS 6808 for surrounding receivers. Specifically, noise limits have been derived at integer hub-height wind speeds as the greater of a minimum limit (40 or 45 dB, depending on the receiver status) and the background level plus 5 dB.

The results of the measurements 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 OF TERMINOLOGY

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 below 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
Sound pressure level	A measure of the level of sound expressed in decibels.	L_p

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 – 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.

APPENDIX B TURBINE COORDINATES

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

(Coordinates dated 6 November 2023 and supplied by the proponent on 5 December 2023).

Table 7: Turbine coordinates – MGA 94 zone 54

Turbine	Easting, m	Northing, m	Terrain elevation, m	Turbine	Easting, m	Northing, m	Terrain elevation, m
1	508,690	5,787,385	40	61	516,206	5,781,499	20
2	513,955	5,783,738	30	62	519,029	5,779,194	35
3	515,713	5,783,577	40	63	521,959	5,779,172	70
4	514,311	5,785,631	40	64	522,798	5,778,676	40
5	515,053	5,785,349	40	66	511,875	5,783,969	34
6	513,368	5,785,108	40	67	512,322	5,783,588	22
7	513,172	5,785,926	37	68	506,962	5,787,496	30
9	513,787	5,785,818	40	69	511,670	5,785,447	30
10	523,753	5,775,480	31	70	511,504	5,786,578	40
11	523,171	5,778,194	40	71	510,928	5,786,647	40
12	525,052	5,775,636	133	72	522,506	5,778,131	44
13	525,321	5,773,427	25	73	517,349	5,781,375	25
14	524,320	5,774,246	20	77	515,148	5,782,134	20
15	515,619	5,785,209	40	78	509,749	5,786,238	40
16	516,535	5,784,048	40	79	517,403	5,782,894	48
17	519,322	5,780,198	34	80	517,811	5,782,353	43
18	518,621	5,781,852	30	81	517,686	5,780,864	25
19	507,939	5,787,487	40	82	519,045	5,781,052	32
20	507,567	5,788,188	58	83	523,982	5,774,773	20
22	516,180	5,784,826	40	84	523,468	5,774,998	23
23	512,881	5,783,513	20	85	512,204	5,785,367	30
24	505,966	5,788,524	21	86	520,387	5,780,618	50
25	513,463	5,783,246	20	87	519,754	5,780,948	46
26	511,847	5,784,771	40	88	521,458	5,779,498	70
27	520,877	5,779,000	50	91	516,247	5,782,517	27
28	514,005	5,782,898	20	92	521,806	5,778,546	70
29	511,997	5,786,129	30	93	506,790	5,788,321	40
30	512,908	5,784,580	34	96	519,878	5,780,173	46
31	509,545	5,787,056	31	97	522,771	5,777,451	50
32	514,558	5,782,557	20	98	516,817	5,782,249	29
33	524,722	5,775,056	70	99	508,054	5,788,555	40
34	525,400	5,775,115	140	100	509,305	5,785,802	30

Turbine	Easting, m	Northing, m	Terrain elevation, m
35	525,715	5,774,415	118
37	525,779	5,773,089	27
39	521,273	5,778,644	56
40	510,522	5,786,060	40
41	510,282	5,786,688	45
42	526,022	5,773,849	114
43	511,101	5,785,508	30
44	509,030	5,787,978	40
45	508,938	5,788,808	55
48	513,301	5,784,047	40
49	515,710	5,781,752	22
50	525,165	5,774,480	76
51	515,034	5,783,116	30
52	516,229	5,783,367	40
53	515,673	5,784,516	40
54	515,145	5,784,259	33
55	519,751	5,779,032	41
56	515,588	5,782,780	21
58	510,218	5,784,929	20
59	510,735	5,784,444	31
60	518,235	5,780,302	29

Turbine	Easting, m	Northing, m	Terrain elevation, m
102	509,890	5,785,402	20
103	509,218	5,789,311	46
104	516,721	5,783,062	41
108	517,033	5,783,656	50
109	511,353	5,784,189	30
110	513,891	5,784,970	47
111	518,111	5,781,265	30
112	523,225	5,776,971	50
113	508,305	5,788,005	50
114	512,764	5,785,267	33
115	516,732	5,781,365	20
117	512,618	5,786,019	30
118	506,478	5,787,604	20
119	520,405	5,779,235	58
120	518,701	5,779,770	30
123	524,345	5,775,412	54
124	520,726	5,780,069	49
126	524,758	5,773,839	20
127	514,387	5,784,609	35
128	514,599	5,783,909	30

APPENDIX C SURVEY INSTRUMENTATION

Table 8: Sound level measurement instrumentation summary

Item	Description
Equipment type	Automated/unattended integrating sound levels
Make & model	01dB CUBE and 01dB DUO
Instrumentation class	Class 1 (precision grade) in accordance with AS/IEC 61672.1-2019[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 Institute of Acoustics guidance. 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]
10 proxy	01dB DUO	10769	162057	17/09/2019	0.0
21 (S)	01dB DUO	10394	144928	28/1/2020	0.0
31	01 dB CUBE	11276	292433	30/03/2020	+0.03
81 (S)	01dB CUBE	10514	161824	13/07/2020	+0.12
673 Int	01 dB CUBE	11916	330614	02/09/2021	-0.14
-	01dB CAL21	34924044	-	19/08/2020	-

1 Independent (laboratory) calibration date to be within 2 years of measurement period as per AS 1055-1:2018[4]

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

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

[3] AS/IEC 61672.1-2019 *Electroacoustics - Sound level meters Specifications*

[4] AS 1055-1:2018 *Acoustics – Description and measurement of environmental noise*

Table 10: Wind speed measurement instrumentation

Wind speeds	Description
Local wind speeds	Vaisala VTX 250 weather station (serial number K185003 & K2920005) positioned at Receivers 10 proxy and 31, respectively
Site wind speeds	Third party owned and operated system comprising of 4 monitoring locations with the use of Campbell Scientific Data Loggers (Location reference KEN01 – KEN04). It is noted that only KEN01, KEN02 and KEN04 have been used for this assessment. Further information provided in Appendix D.

APPENDIX D WIND DATA INFORMATION

D1 REFERENCE MAST COORDINATES

Table 11: Reference mast coordinates – MGA 94 zone 54

Mast	Easting, m	Northing, m
KEN01	516,053	5,780,289
KEN02	525,251	5,774,470
KEN04	513,763	5,786,178

D2 SITE WIND SPEED DATA DERIVATION

This appendix reproduces correspondence provided by Aurecon Group via email on 24 September 2021 documenting the process used to derive the 165 m AGL wind speeds required to analyse the measured background noise data.

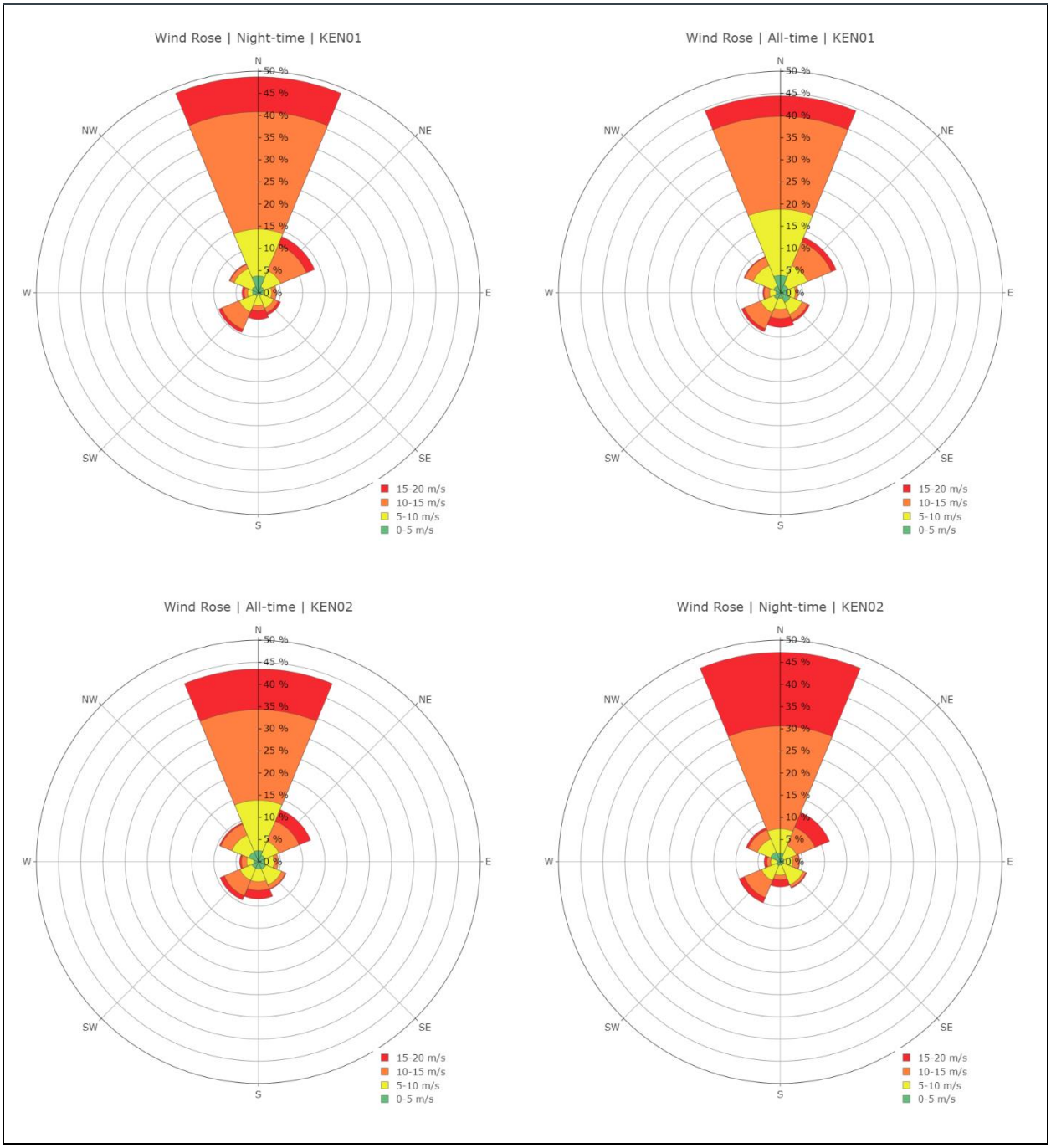
> *Aurecon provided wind data from masts Ken01, Ken02, and Ken04, covering the period 19/05/2021 – 14/07/2021 inclusive, as 10min statistics: wind speed average, wind speed std deviation, wind direction, temperature. The mast data was processed to remove invalid or inaccurate data (such as affected by sheltering from the mast), data from pairs of anemometers at the same level were combined, and then the wind speed data was extrapolated to 165m above ground level using the fitted shear profile for each time step. This method was chosen as it provides the most accurate diurnal profile at the higher level. Given the flatness of the site, we did not need to scale the wind data to take into account differences in average wind speed between the mast location and the nearest turbine to each noise monitoring location. The data files state that time stamps indicate the beginning of the time step. The time zone is AEST (UTC+10).*

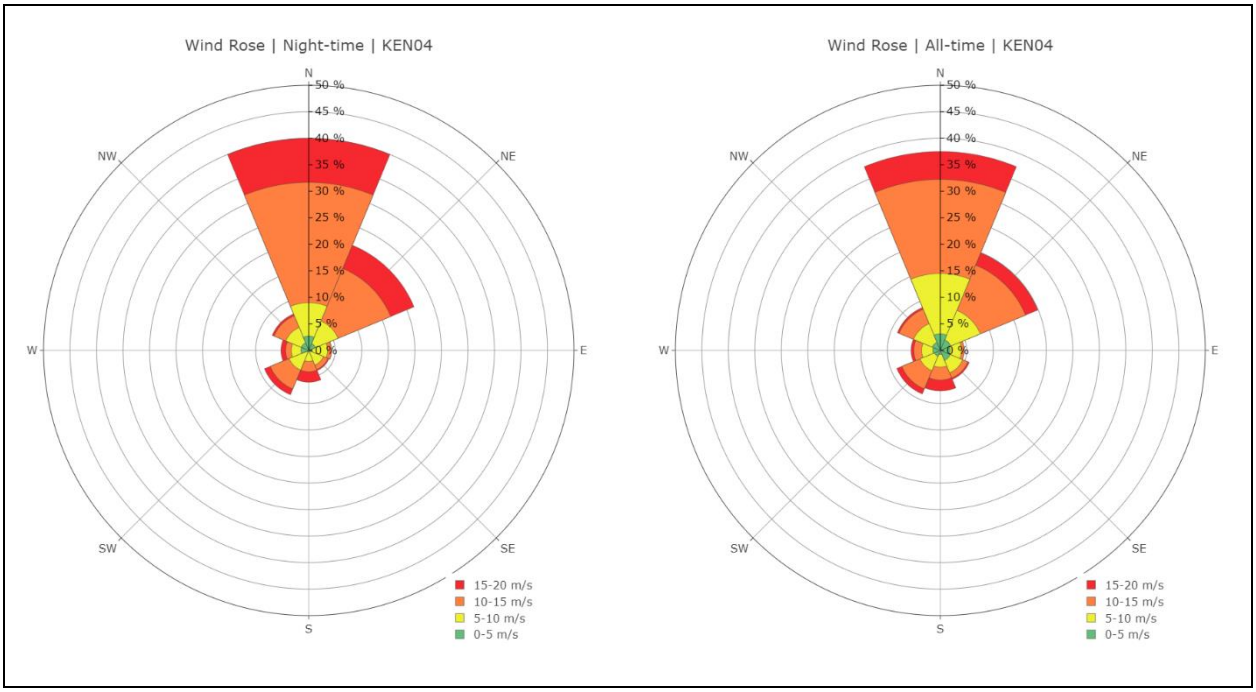
D3 WIND ROSES

Northerly wind conditions were clearly prominent during the survey period. A review of the annual wind directions trends from site from WillyWeather indicates these conditions occur regularly at the site.

As part of the analysis the relationship between measured background noise levels and wind directions was carried out and generally indicated that lower noise levels tended to occur during northerly conditions. The source of this variation has not been confirmed as part of this analysis but may be related to a reduced influence of coastal noise under northerly conditions.

Figure 2: Wind roses corresponding to the survey period at each reference mast




Wind Rose | Night-time | KEN04
N
NE
E
SE
S
SW
W
NW
50 %
45 %
40 %
35 %
30 %
25 %
20 %
15 %
10 %
5 %
0 %
15-20 m/s
10-15 m/s
5-10 m/s
0-5 m/s
Wind Rose | All-time | KEN04
N
NE
E
SE
S
SW
W
NW
50 %
45 %
40 %
35 %
30 %
25 %
20 %
15 %
10 %
5 %
0 %
15-20 m/s
10-15 m/s
5-10 m/s
0-5 m/s

APPENDIX E SUMMARY OF BACKGROUND NOISE LEVELS

Table 12: Regression equation coefficients - All-time period

	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**
10 proxy [1]	0.00761	-0.2384	2.571	20.58	0.11	3-20
21 (S) [2]	0.00671	-0.1948	2.237	21.65	0.20	3-20
31 [3]	-0.0066	0.2098	-1.291	32.69	0.28	3-17
81 (S) [3]	-0.0012	0.01512	0.7717	24.05	0.16	3-20

1 KEN04 met mast – 165 m above ground level at 513762 E, 5786178 N (MGA 94 Zone 54)

2 KEN01 met mast – 165 m above ground level at 516053 E, 5780289 N (MGA 94 Zone 54)

3 KEN02 met mast – 165 m above ground level at 525250 E, 5774470 N (MGA 94 Zone 54)

Table 13: Regression equation coefficients - Night period

	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**
10 proxy [1]	-	0.0649	-1.289	34.45	0.09	11-20
21 (S) [2]	-	0.07101	-1.29	37.22	0.12	8-20
31 [3]	-0.012	0.4463	-4.362	42.95	0.30	6-18
81 (S) [3]	-0.0019	0.05264	0.2932	23.43	0.10	3-20

1 KEN04 met mast – 165 m above ground level at 513762 E, 5786178 N (MGA 94 Zone 54)

2 KEN01 met mast – 165 m above ground level at 516053 E, 5780289 N (MGA 94 Zone 54)

3 KEN02 met mast – 165 m above ground level at 525250 E, 5774470 N (MGA 94 Zone 54)

Table 14: Regression equation coefficients at Receiver 673 Int

	Regression equation coefficients for background noise equation of best fit $L_{A90} = ax^3+bx^2+cx+d$, where x = windspeed in m/s [1]					
Time period	**a**	**b**	**c**	**d**	**R^2**	**Valid wind speed range, m/s**
0700-1700 hrs	-	-0.0001	1.222	26.64	0.71	3-20
1700-0700 hrs	-0.0061	0.3040	-3.490	48.59	0.44	8-20

1 KEN01 met mast – 165 m above ground level at 516053 E, 5780289 N (MGA 94 Zone 54)

APPENDIX F RECEIVER 10 DATA

F1 Receiver 10 proxy location data

Table 15: Receiver 10 proxy noise monitor coordinates – MGA 94 Zone 54

Location	Easting	Northing
Dwelling location (Receiver 10)	504345	5786967
Background noise monitoring location (Receiver 10 proxy)	504533	5788006

Figure 3: Receiver 10 proxy aerial view – dwelling and noise monitor locations

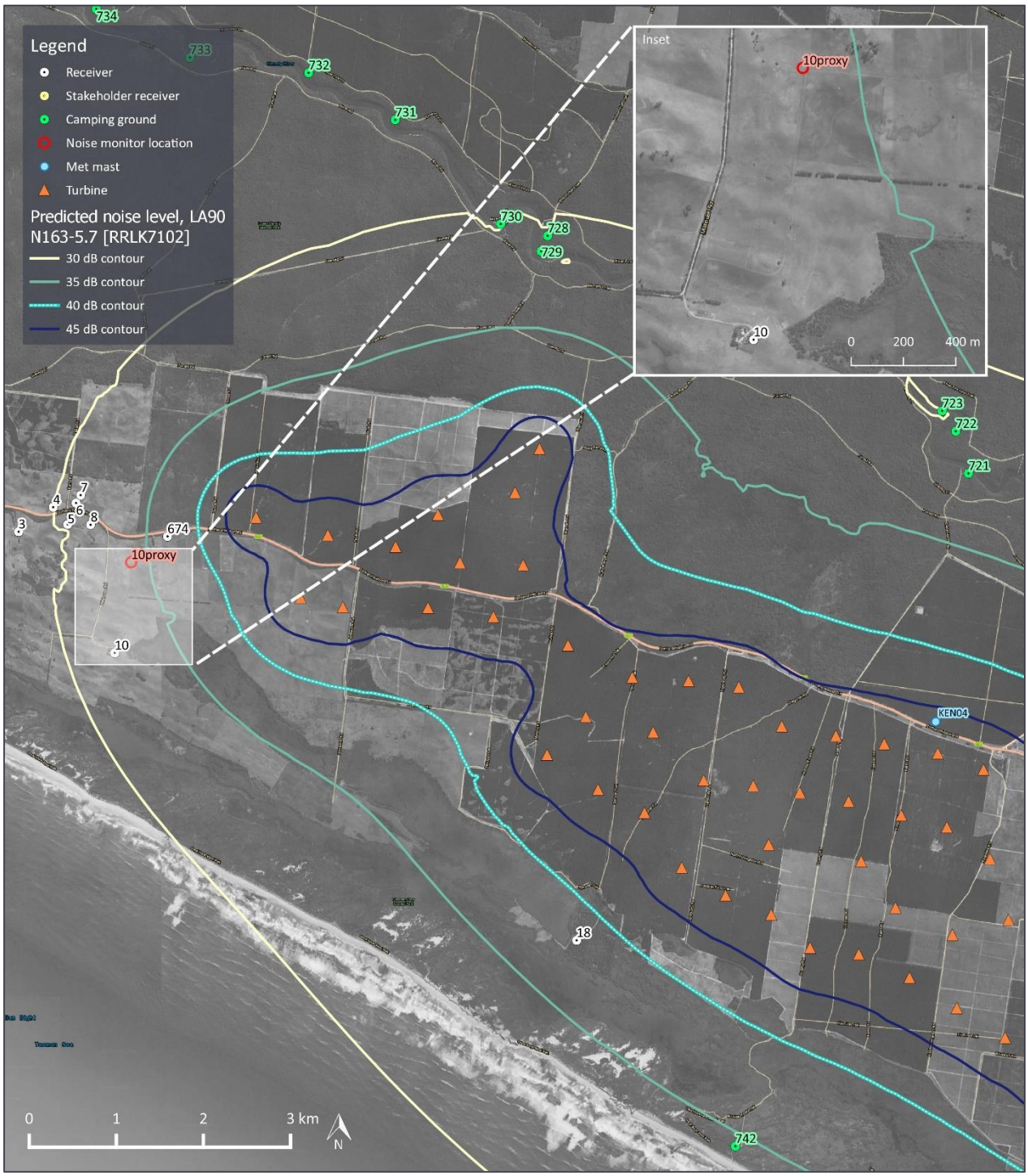


Table 16: Receiver 10 proxy monitor installation photos

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

F2 Receiver 10 proxy measurement data summary

Table 17: Receiver 10 proxy background noise level analysis summary

Item	All-time period	Night period
Number of data points collected	7625	2827
Number of data points removed	1440	458
Number of data points for analysis	6185	2369

Figure 4: Receiver 10 proxy noise level and wind speed time history

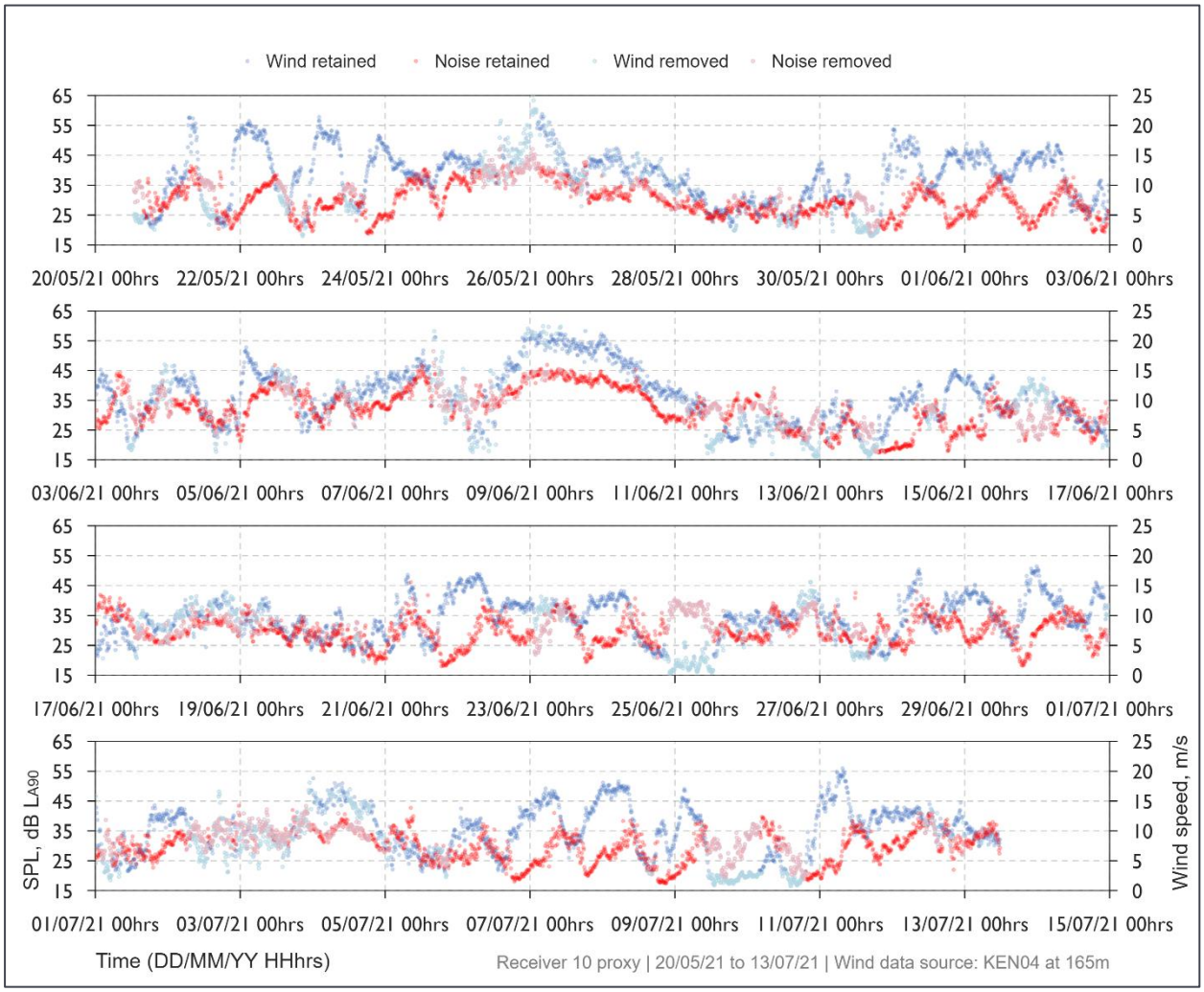


Figure 5: Receiver 10 proxy background noise levels and noise limits – All-time period

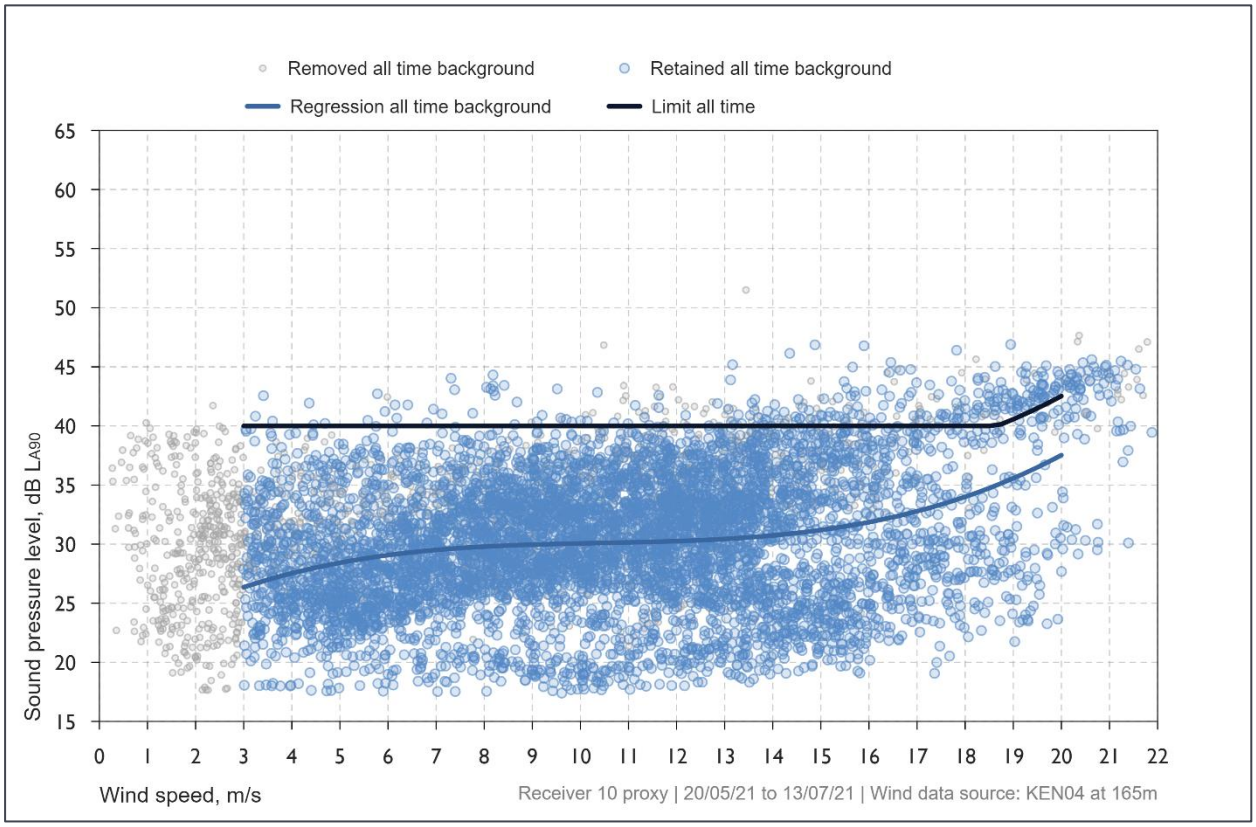
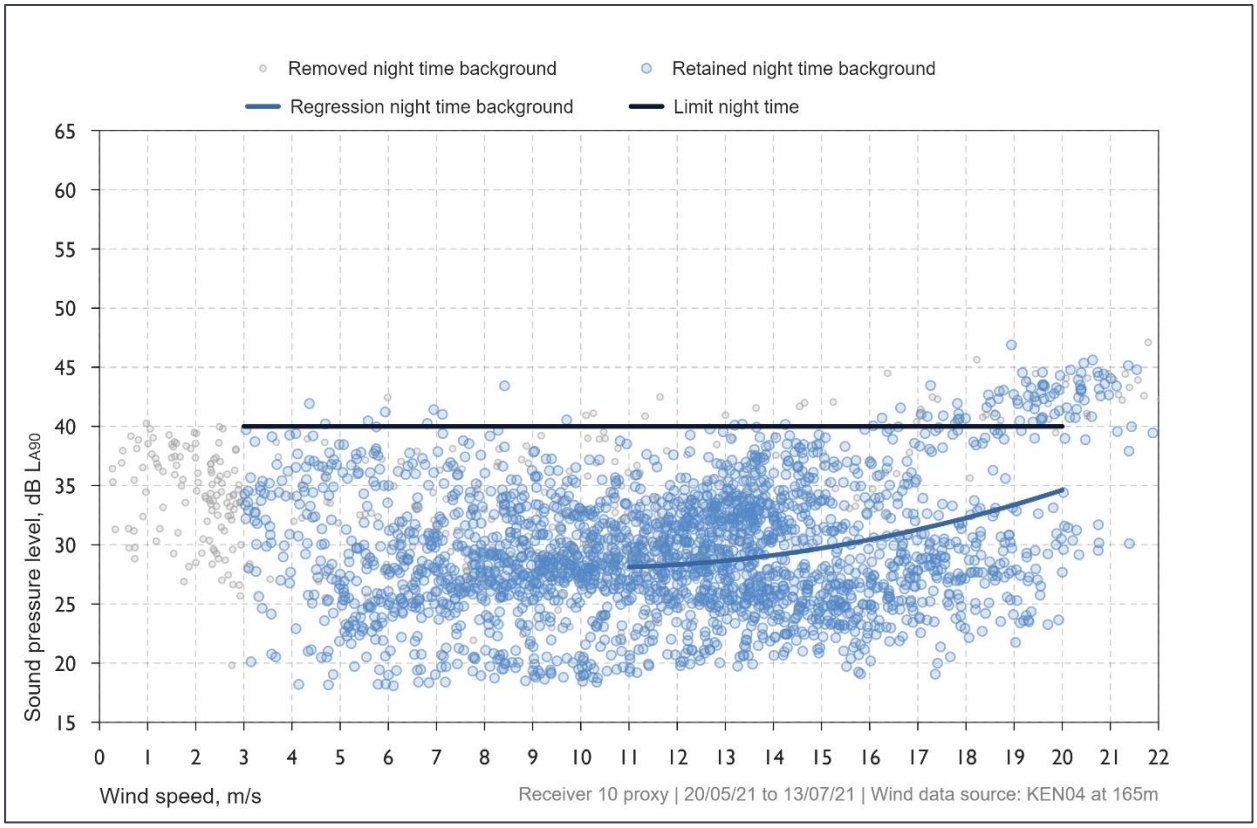


Figure 6: Receiver 10 proxy background noise levels and noise limits – Night period



APPENDIX G RECEIVER 21 (S) DATA

G1 Receiver 21 (S) location data

Table 18: Receiver 21 (S)dwelling and noise monitor coordinates – MGA 94 Zone 54

Location	Easting	Northing
Dwelling location	520295	5778058
Background noise monitoring location	520310	5778062

Figure 7: Receiver 21 (S) aerial view – dwelling and noise monitor locations

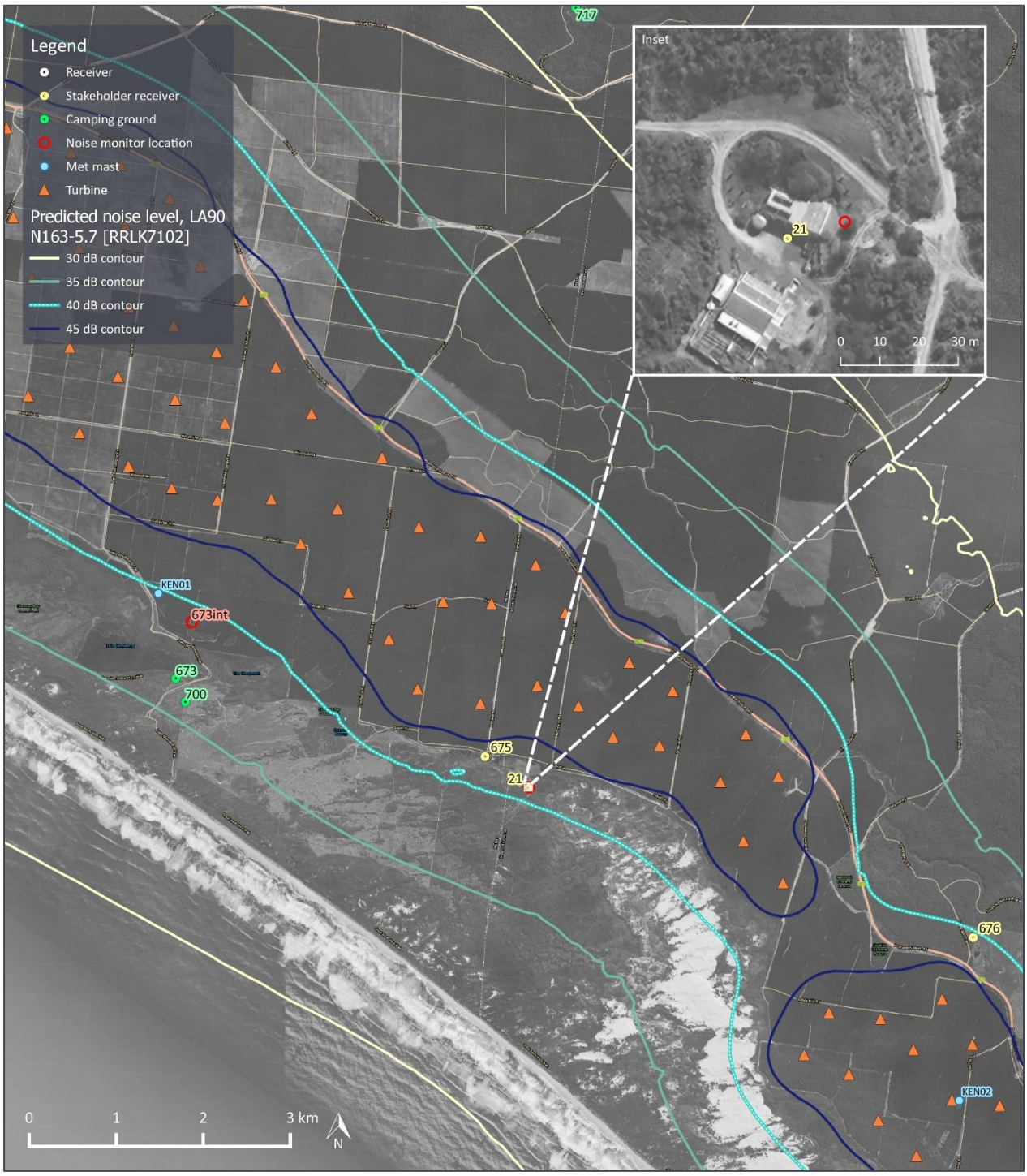


Table 19: Receiver 21 (S) monitor installation photos

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

G2 Receiver 21 (S) measurement data summary

Table 20: Receiver 21 (S) background noise level analysis summary

Item	All-time period	Night period
Number of data points collected	7618	2829
Number of data points removed	1456	555
Number of data points for analysis	6162	2274

Figure 8: Receiver 21 (S) noise level and wind speed time history

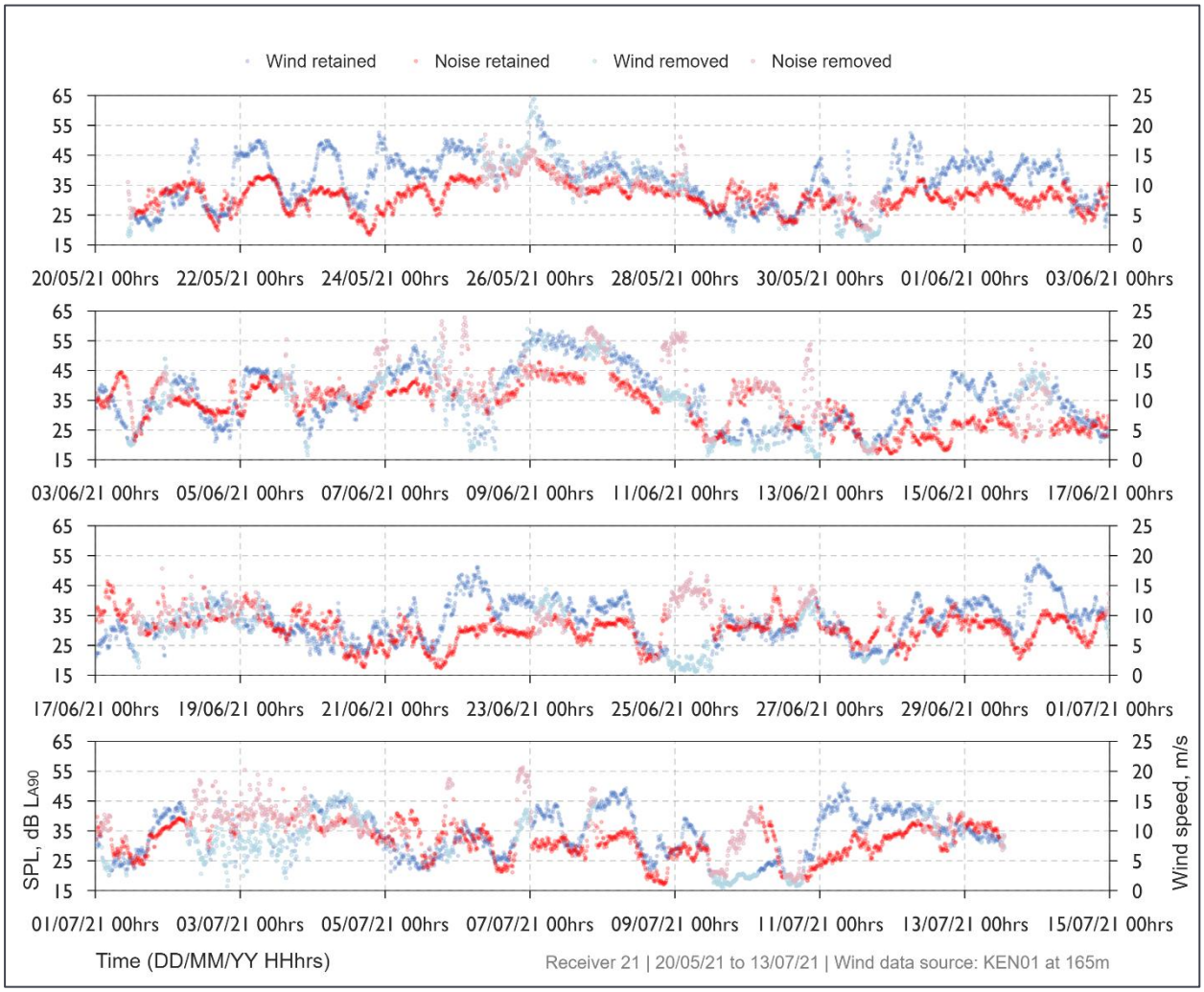


Figure 9: Receiver 21 (S) background noise levels and noise limits– All-time period

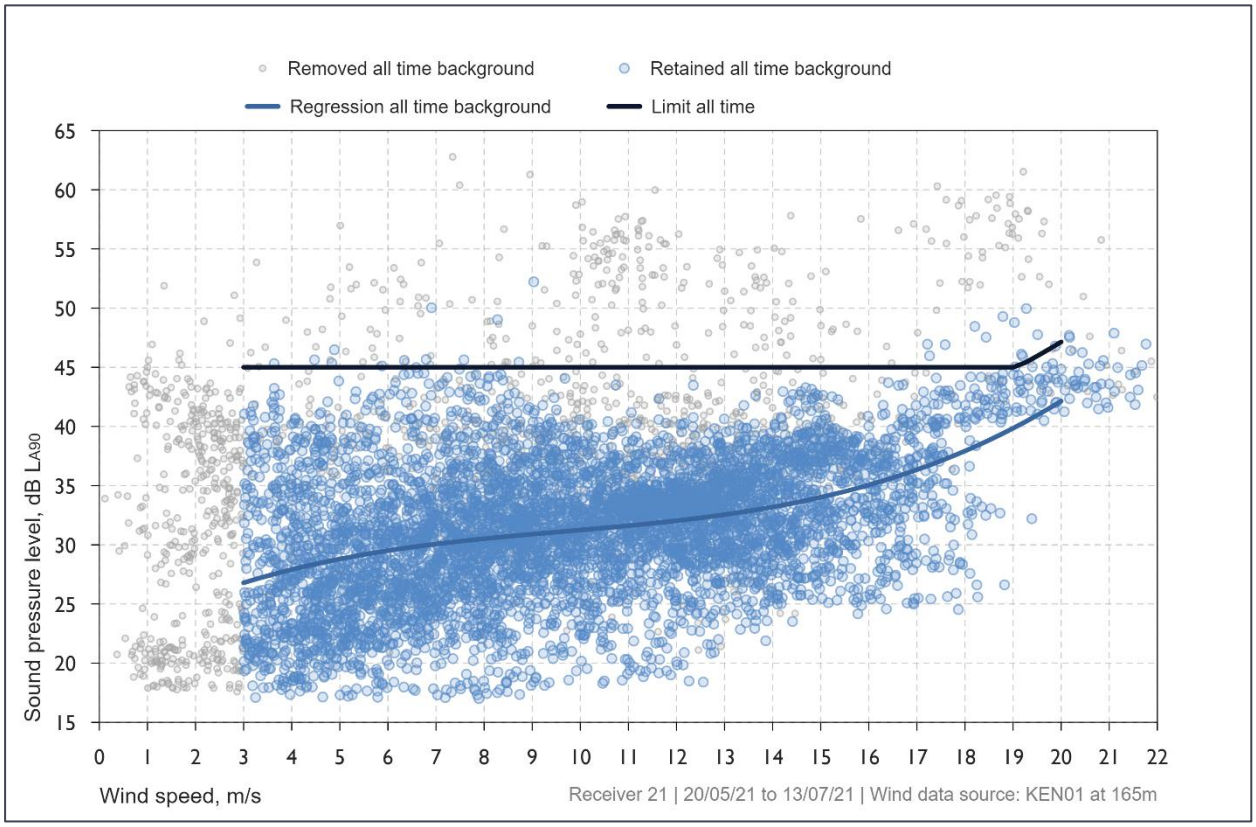
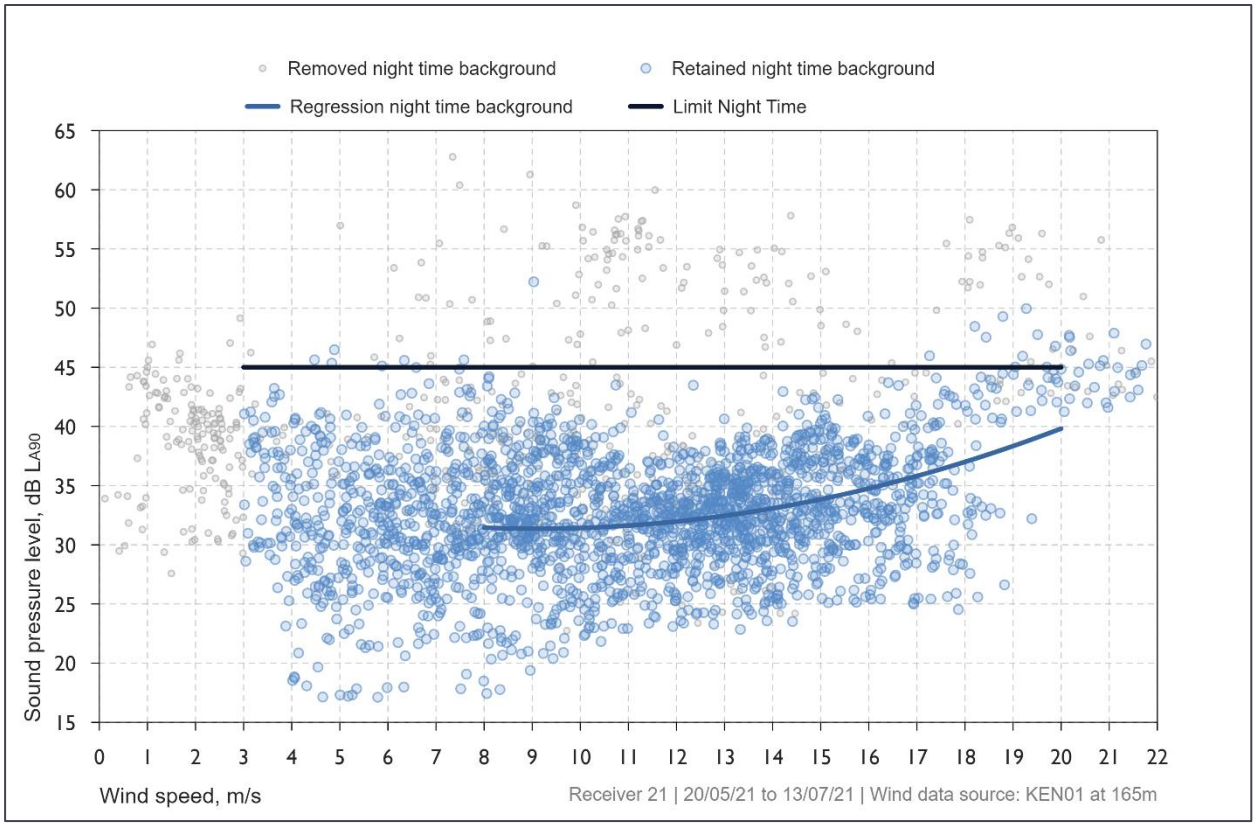


Figure 10: Receiver 21 (S) background noise levels and noise limits – Night period



APPENDIX H RECEIVER 31 DATA

H1 Receiver 31 location data

Table 21: Receiver 31 dwelling and noise monitor coordinates – MGA 94 Zone 54

Location	Easting	Northing
Dwelling location	527856	5773079
Background noise monitoring location	527868	5773114

Figure 11: Receiver 31 aerial view – dwelling and noise monitor locations

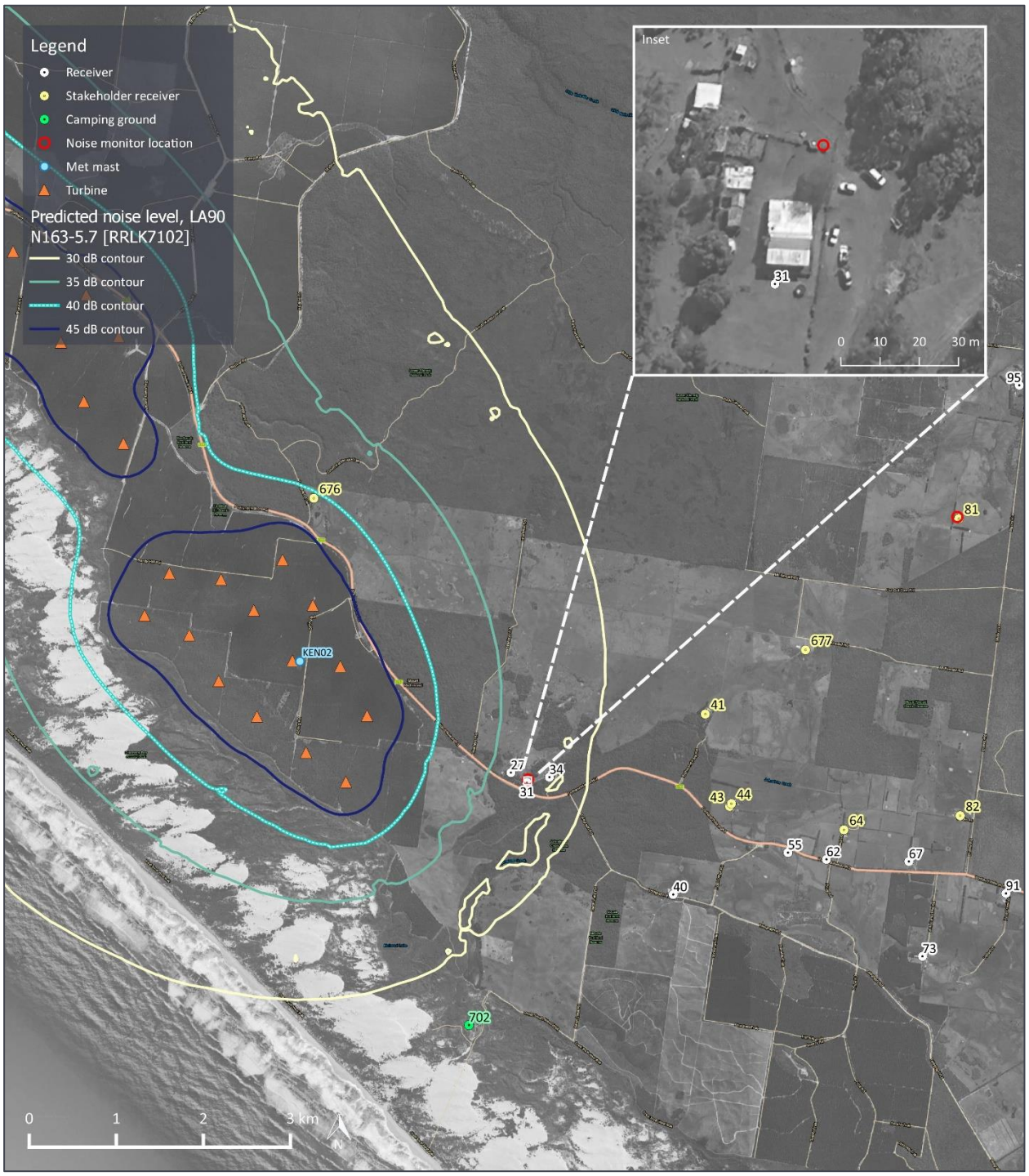


Table 22: Receiver 31 monitor installation photos

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

H2 Receiver 31 measurement data summary

Table 23: Receiver 31 background noise level analysis summary

Item	All-time period	Night period
Number of data points collected	7616	2818
Number of data points removed	1256	455
Number of data points for analysis	6360	2363

Figure 12: Receiver 31 noise level and wind speed time history

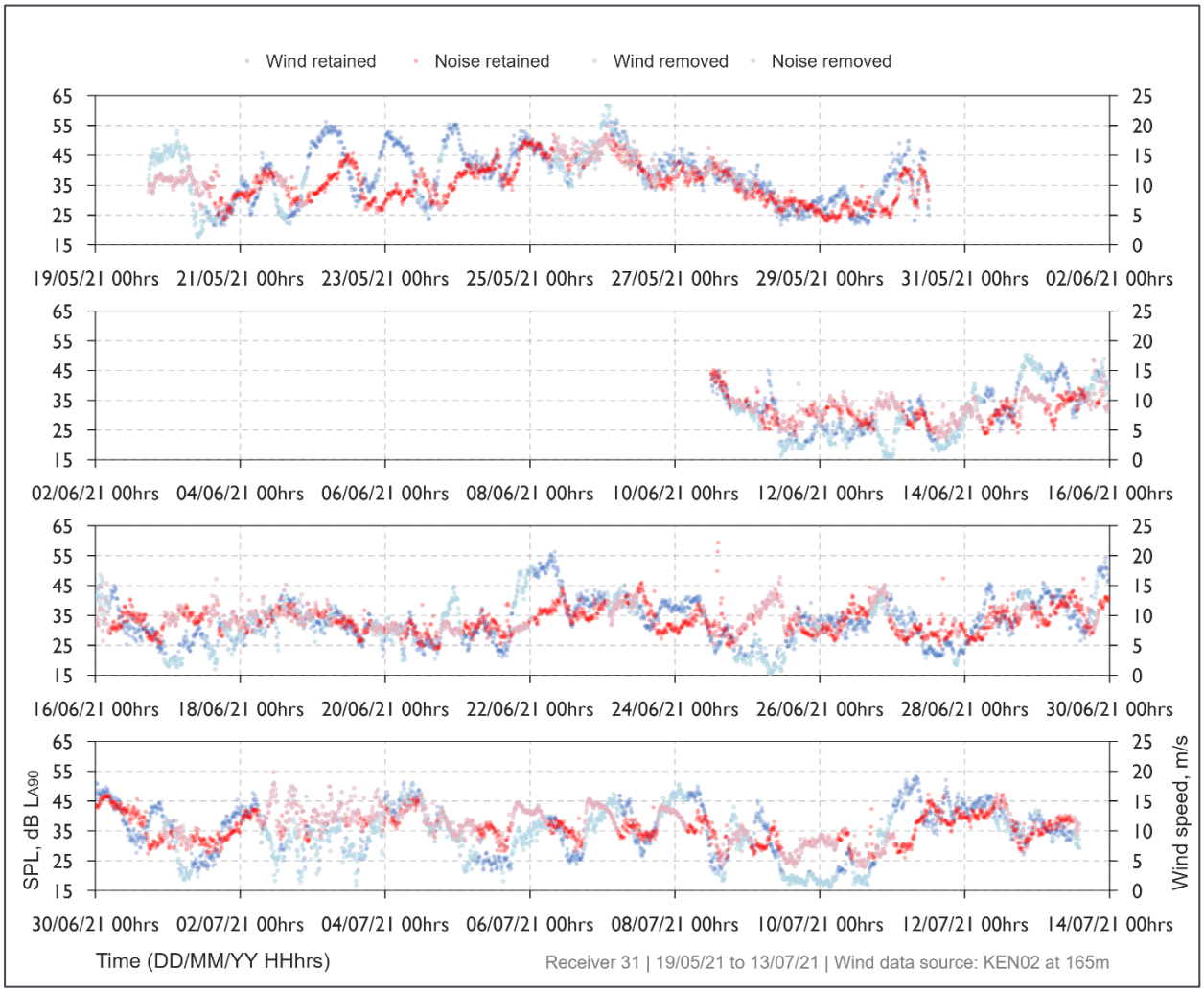


Figure 13: Receiver 31 background noise levels and noise limits – All-time period

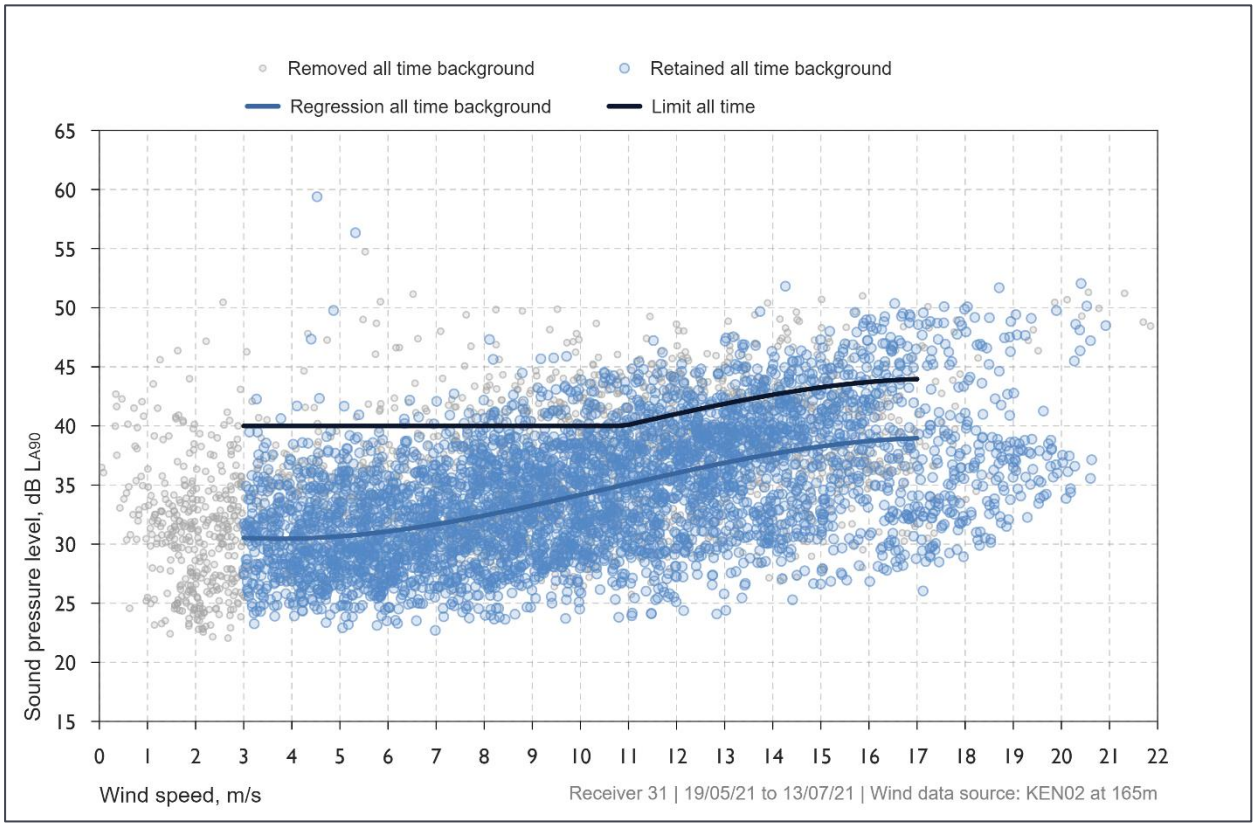
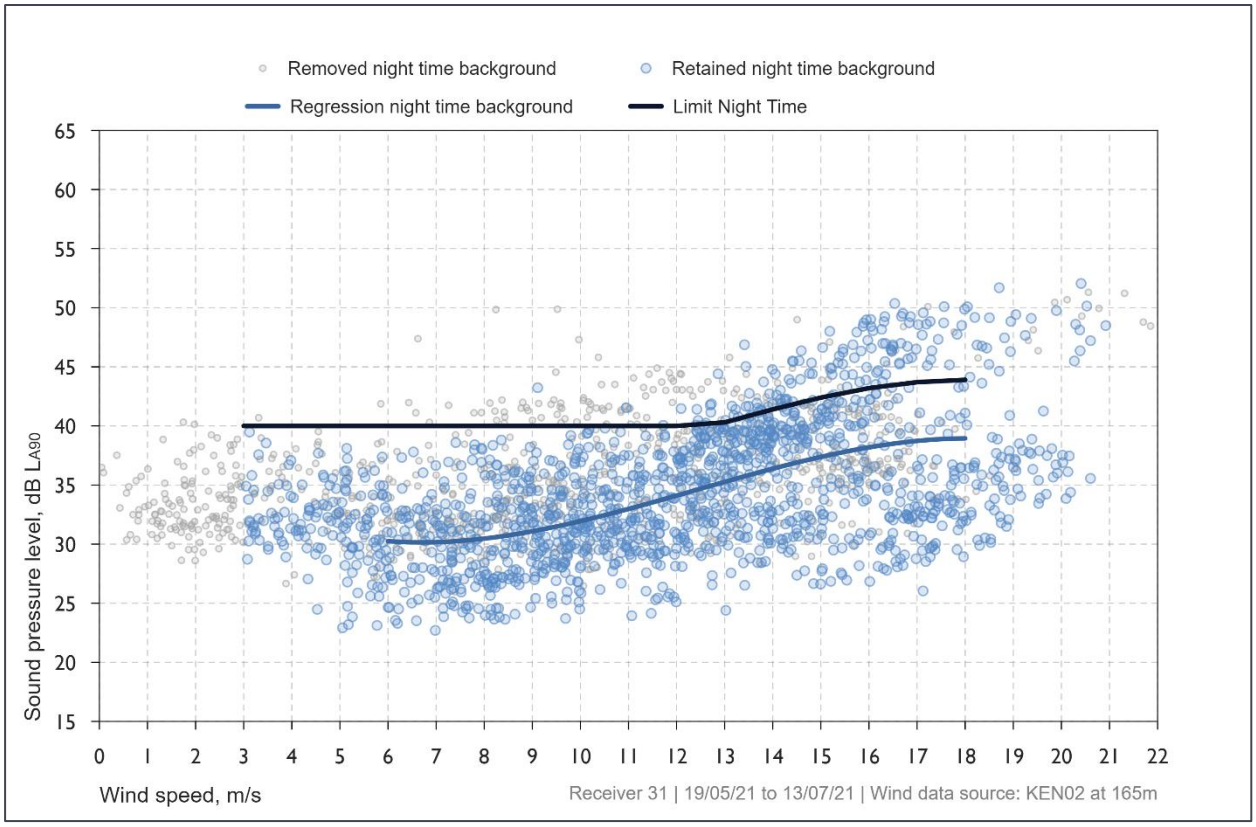


Figure 14: Receiver 31 background noise levels and noise limits – Night period



APPENDIX I RECEIVER 81 (S) DATA

I1 Receiver 81 (S) location data

Table 24: Receiver 81 dwelling and noise monitor coordinates – MGA 94 Zone 54

Location	Easting	Northing
Dwelling location	532815	5776106
Background noise monitoring location	532797	5776126

Figure 15: Receiver 81 (S) aerial view – dwelling and noise monitor locations

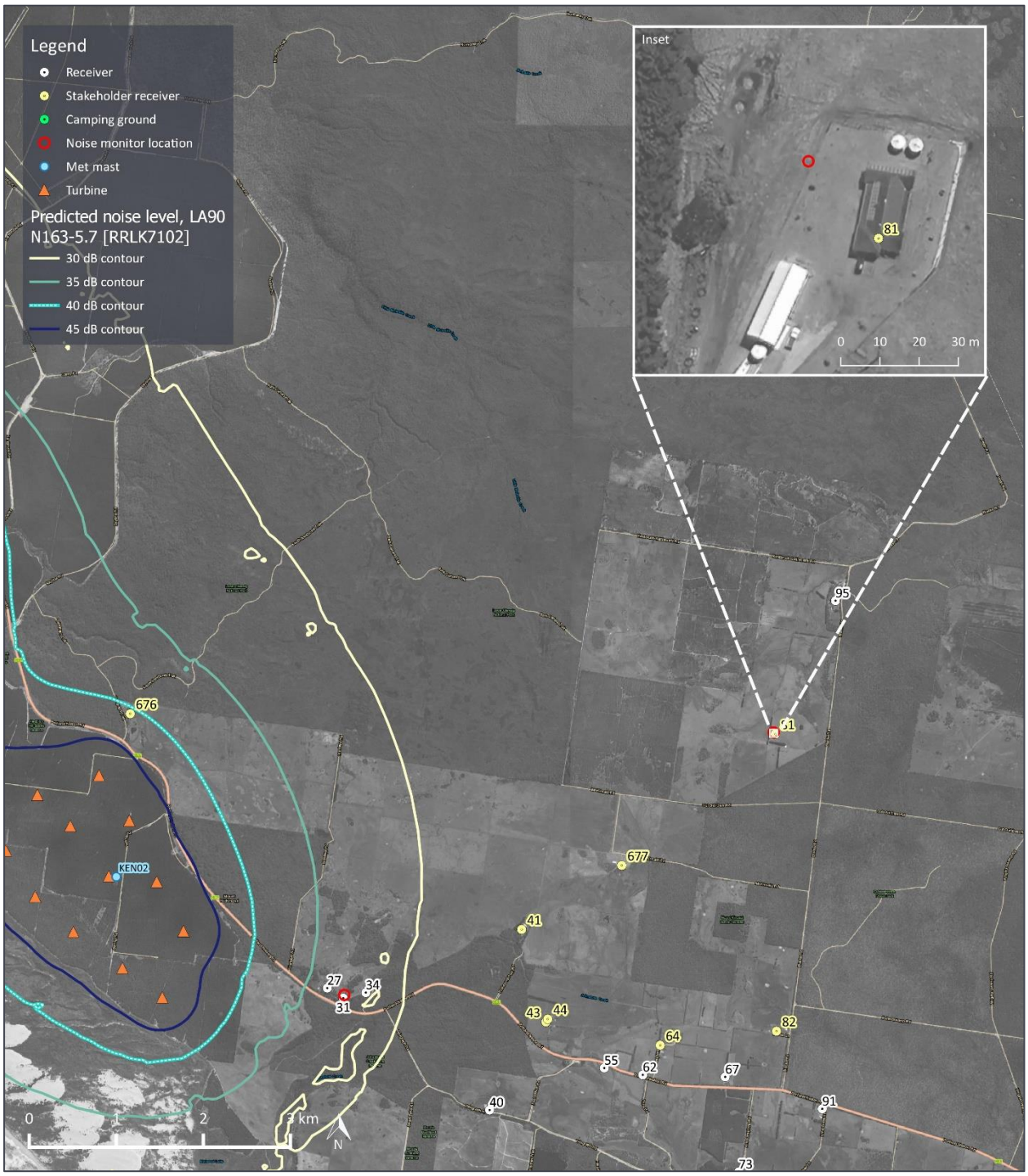


Table 25: Receiver 81 (S) monitor installation photos

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

I2 Receiver 81 (S) measurement data summary

Table 26: Receiver 81 (S) background noise level analysis summary

Item	All-time period	Night period
Number of data points collected	7639	2818
Number of data points removed	2619	1218
Number of data points for analysis	5020	1600

Figure 16: Receiver 81 (S) noise level and wind speed time history

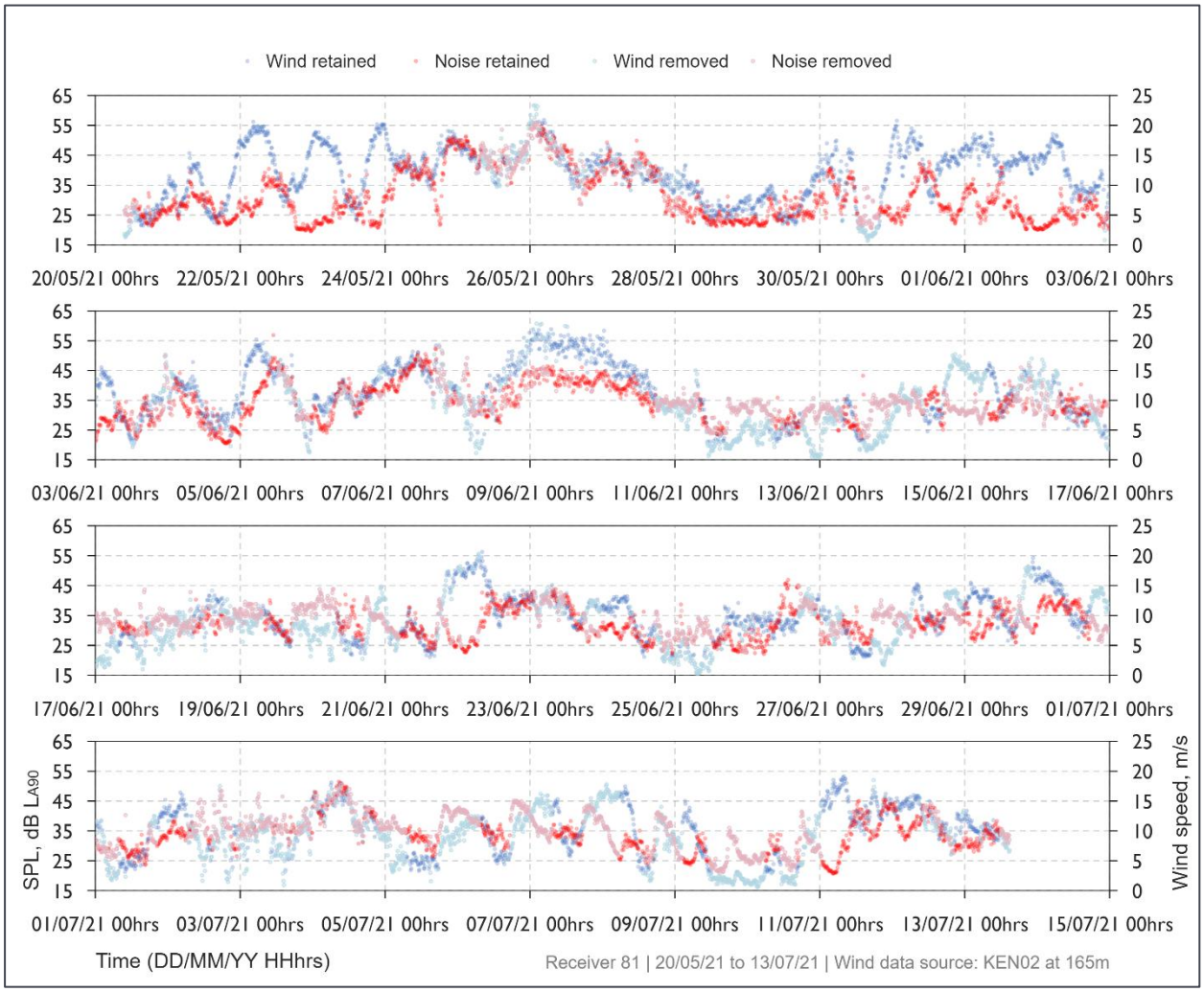


Figure 17: Receiver 81 (S) background noise levels and noise limits

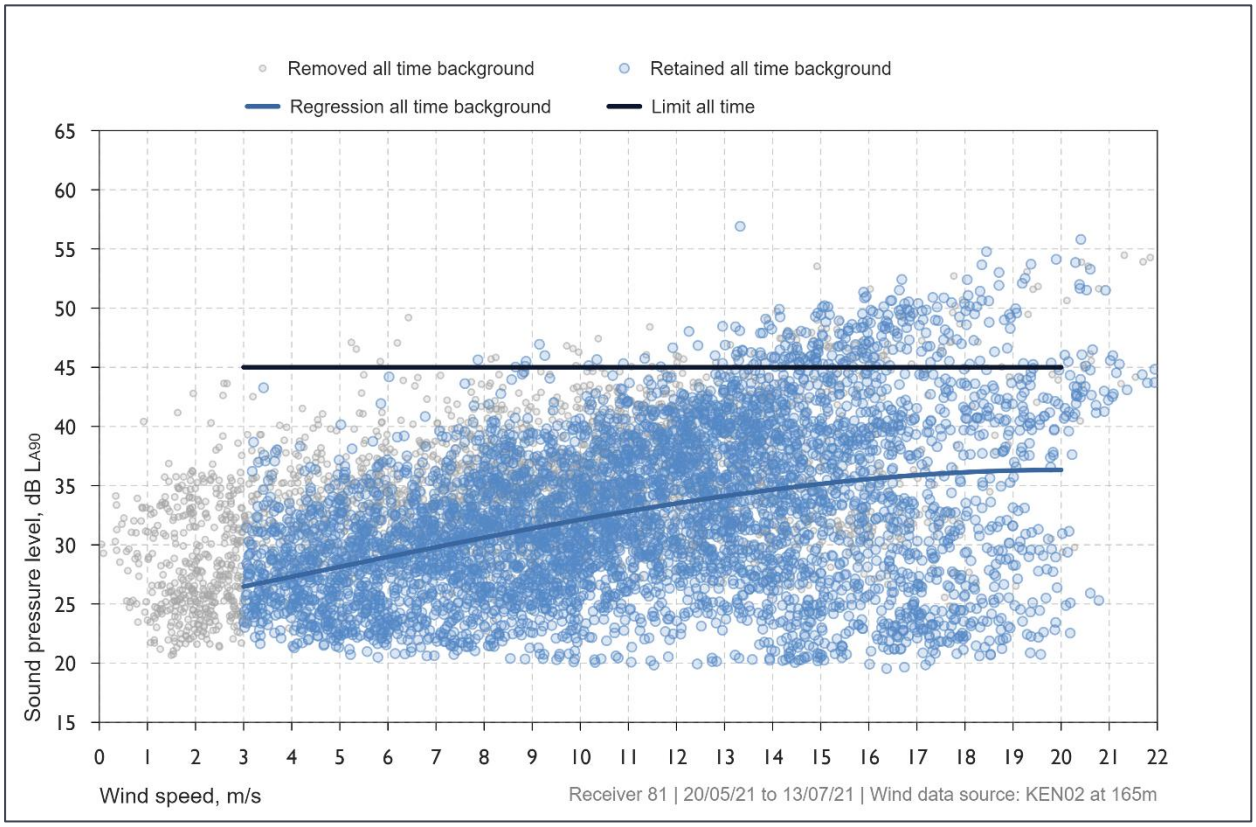
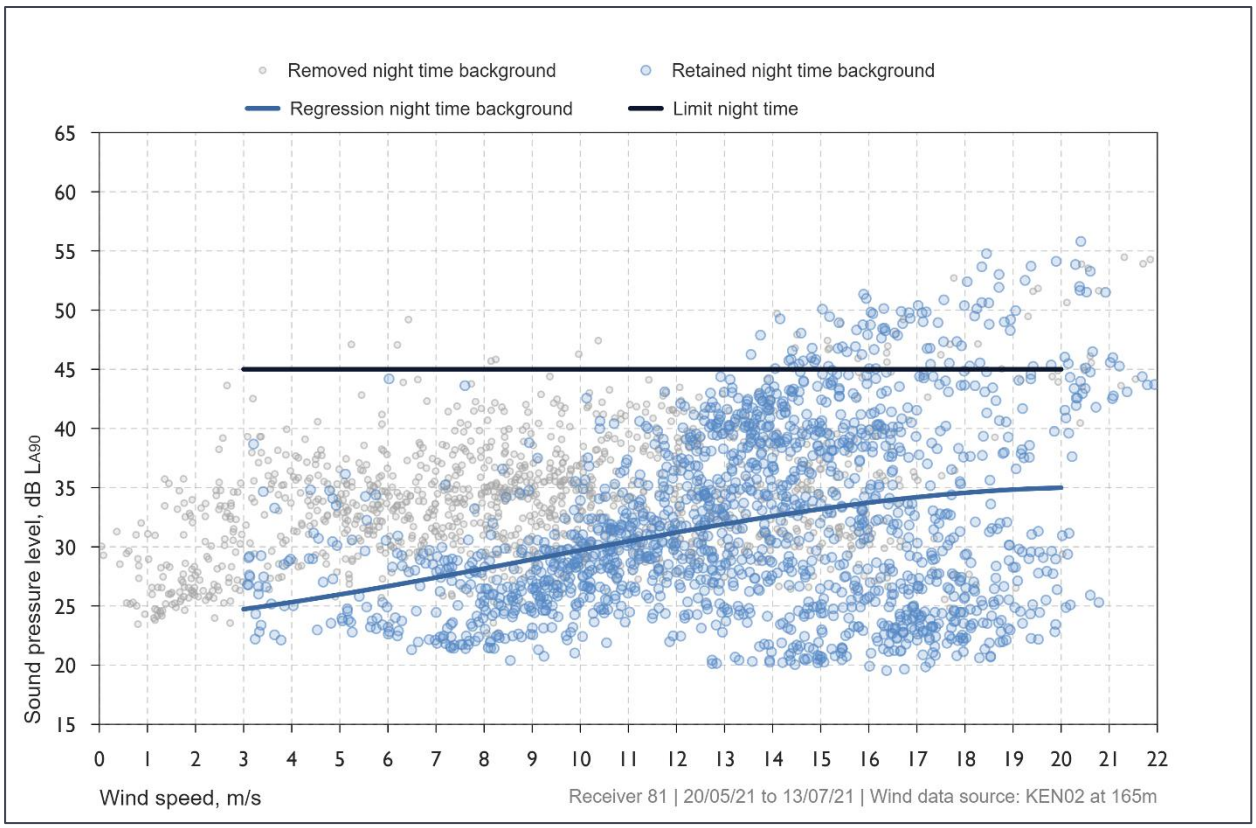


Figure 18: Receiver 81 (S) background noise levels and noise limits – Night period



APPENDIX J RECEIVER 673 INT DATA

J1 Receiver 673 Int location data

Table 27: Camping ground and Receiver 673 Int noise monitor coordinates – MGA 94 Zone 54

Location	Easting	Northing
Camping ground location	516253	5779314
Background noise monitoring location (Receiver 673 int)	516435	5779958

Figure 19: Receiver 673 Int aerial view – camping ground and noise monitor locations

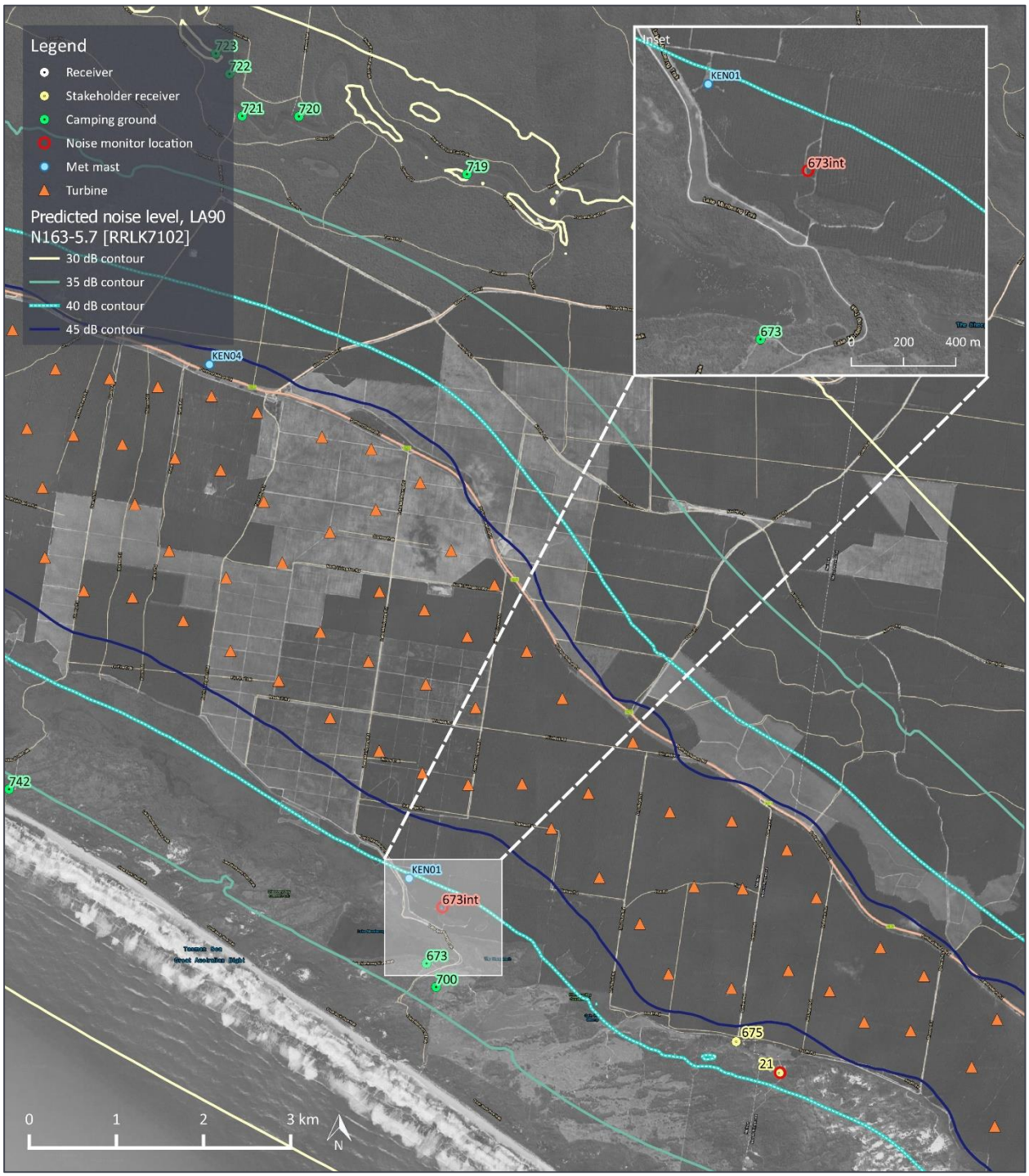


Table 28: Receiver 673 Int monitor installation photos

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

J2 Receiver 673 Int measurement data summary

At Receiver 673 Int a large number of periods of high noise levels (up to 55 dB L_{A90}) were identified at low wind speed (1–4 m/s) between 1700 hrs and 0700 hrs. Subsets of the data were reviewed to investigate any potential relationship between measured noise levels and wind directions. The review indicated that higher noise levels were generally associated with winds ranging from westerly (270°) to northeasterly (45°) directions between 1700 hrs and 0700 hrs.

The identified trends from Receiver 673 Int has been included for the period 0700-1700 hrs and 1700-0700 hrs in Figure 21 and Figure 22 respectively. The charts indicate that wind directions between 270 and 45°, through the pine plantation, between 1700-0700 hrs, tend to result in elevated noise levels at lower wind speeds.

Even with these subgroups, the retained data for the night period at Receiver 673 Int still indicates elevated noise levels at low wind speeds. Listening studies for a sample of these elevated data points indicated clearly audible coastal noise which is likely to be a regular feature of the ambient noise environment. However, in recognition of these variations, the background noise levels for Receiver 673 int are provided for indicative purposes only.

Table 29: Receiver 673 Int background noise level analysis summary

Item	0700-1700 hrs	1700-0700 hrs
Number of data points collected	3201	4415
Number of data points removed	2354	3090
Number of data points for analysis	847	1325

Figure 20: Receiver 673 Int noise level and wind speed time history

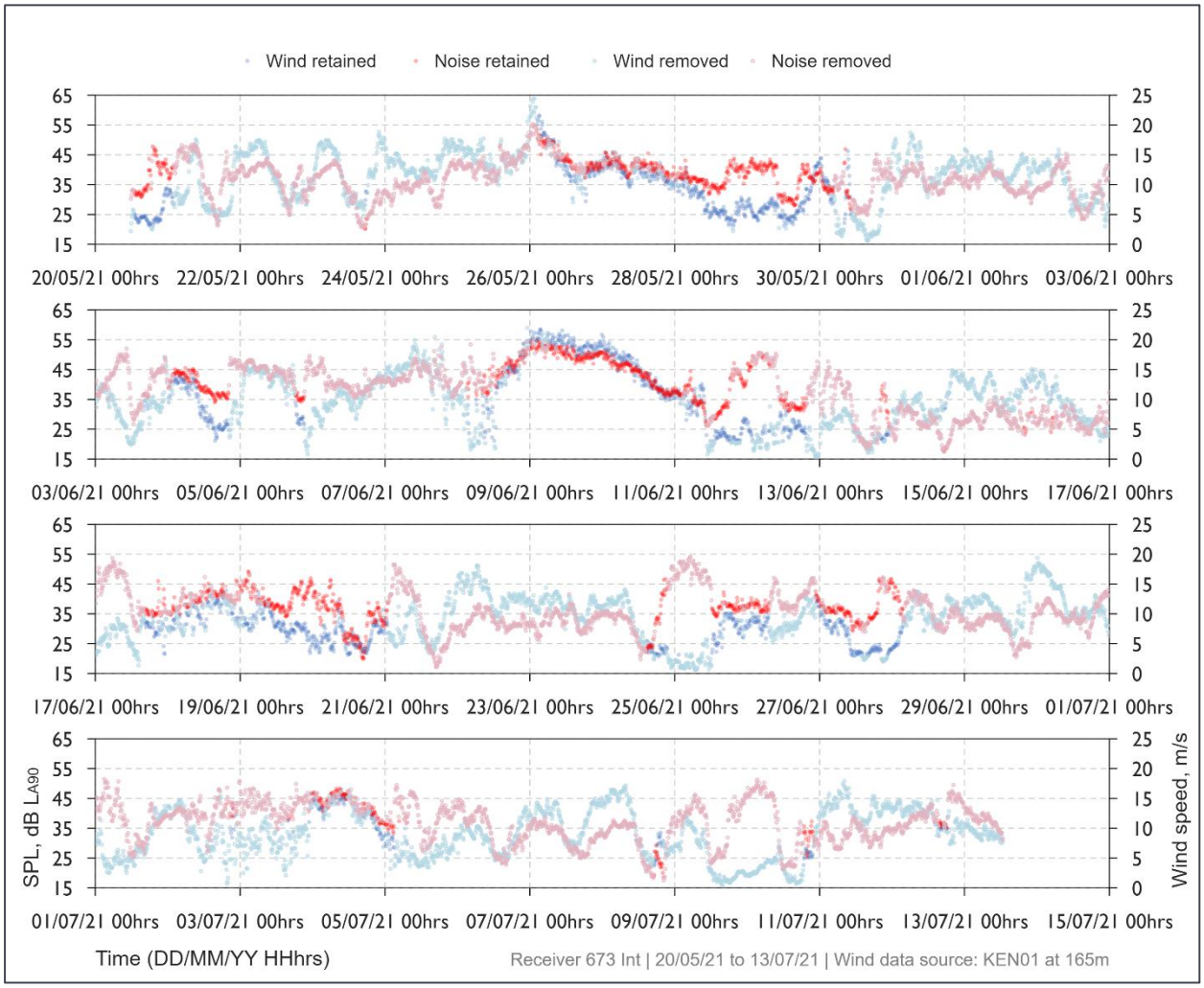


Figure 21: Receiver 673 Int background noise levels – 0700-1700 hrs – excluding 270 to 45° wind directions

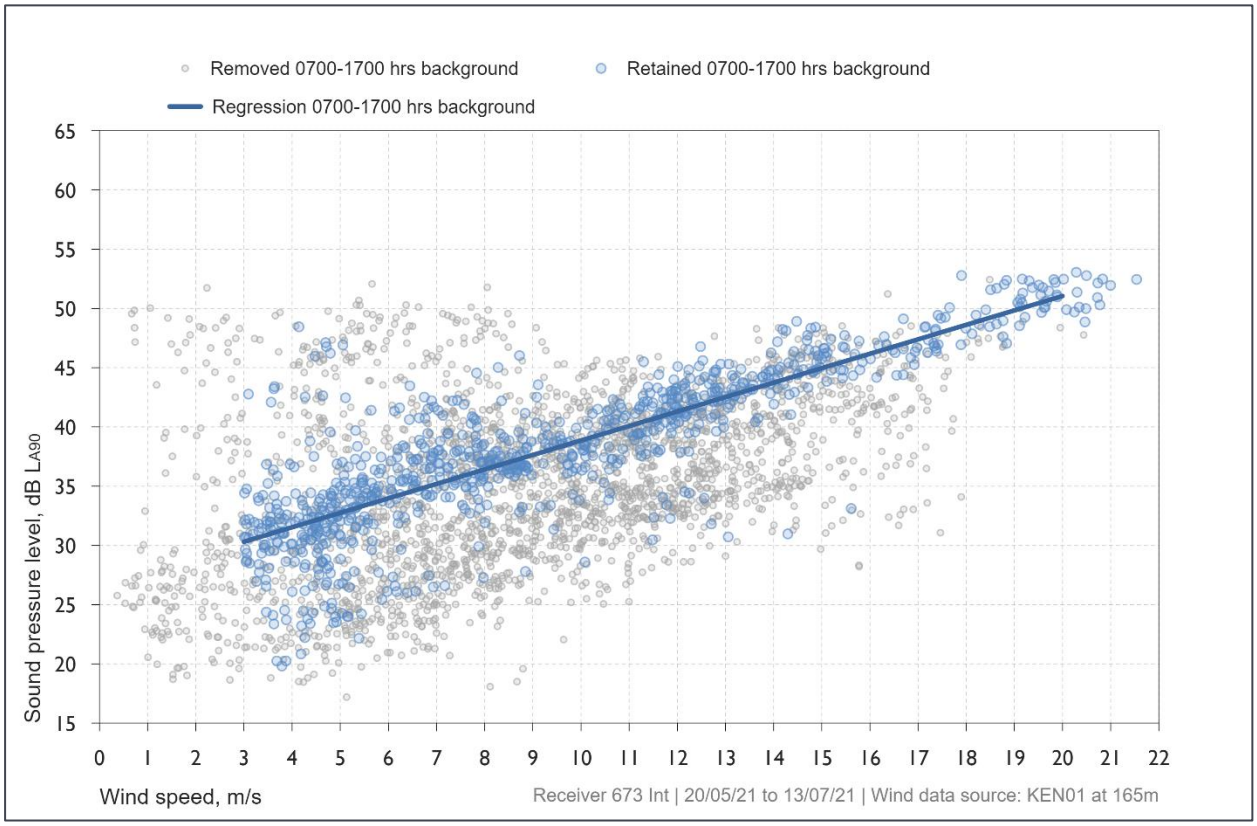


Figure 22: Receiver 673 Int background noise levels – 1700-0700 hrs – excluding 270 to 45° wind directions