APPENDIX 11.1

BASELINE NOISE MEASUREMENTS

Baseline Noise Measurements

Baseline noise monitoring was undertaken at six receptor locations, to establish the existing background noise levels at noise sensitive locations in the vicinity of the proposed wind farm site. These six locations represent the nearest residential locations to the north, south, east and west of the proposed wind farm.

Baseline noise measurements are used to define the construction noise limits. These are summarised at the end of this Appendix.

In addition, the baseline noise measured are summarised for the substation noise assessment at the end of this chapter.

Selection of Monitoring Locations

Section 2.2.5 of the Institute of Acoustics', *A Good Practice Guide to the Application of ETUS-R-97 for the Assessment at Rating of Wind Turbine Noise* (2013) regarding use of proxy locations states "*When choosing a location that will serve as a proxy for others, the basis for selection is that it can reasonably be claimed, from inspection and observation, to be representative of the non-surveyed locations, in line with the criteria of Section 2.5. Measurement locations outside a property's curtilage (such as an adjacent field) may be used when access to a representative property cannot be obtained, provided that such a location can be justified as being representative. No general guidance can therefore be given on the number of measurement locations as this will be site-specific*." Section 2.5 of the GPG is summarised in Table A11.1.1 with the applicability of the proxy locations selected for Littleton Wind Farm.

Table A11.1.1: IOA GPG Section 2.5 Criteria and Applicability to Littleton Wind Farm Monitoring Locations

Requirements of Section 2.5	Littleton Wind Farm Monitoring Locations
2.5.1 *Where possible, measurements should be made in the vicinity of a dwelling in an area frequently used for rest and recreation.*	Location N3 was located at edge of property near farm buildings at the property.
2.5.2 *Equipment should be placed at outdoor positions where noise levels are representative of typical 'low' levels likely to be experienced in the vicinity of a dwelling (or group of dwellings if the measurements are intended to be applied to more than one dwelling). The overriding consideration is that it can reasonably be claimed, from inspection and observation, that there are no other suitable noise-sensitive locations, in the vicinity of any selected location and close to a dwelling, where background noise levels would be expected to be consistently lower than the levels at the selected position.*	All locations met this requirement.
2.5.3 *Ideally the position should be one which would be exposed to noise from the wind turbines whilst being best-screened from other noise sources such as nearby roads or vegetation.*	All locations met this requirement.
2.5.4 *The background surveys provide the basis for setting both daytime and night-time noise limits: the measurement position must therefore reasonably represent external areas (for daytime noise) and also building façades containing windows (for night-time noise).*	All locations met this requirement.
2.5.5 *In most locations, background noise levels will be determined by wind in trees and vegetation and noise sources external to the property such as traffic noise. The presence of local noise sources such as boiler flues, garden fountains, domestic drains, watercourses and farm equipment should be identified.*	All locations met this requirement. If measurements were made next to vegetation (e.g. N5) this was representative of the noise environment at this property.
2.5.6 *Where it is not possible to exclude the influence of variable local noise sources by selection of monitoring position, it is generally possible to identify such data from inspection of noise level time histories and therefore to exclude it from the data set used to derive noise limits*	No other noise sources were noted during the survey. Noise sources noted during equipment deployment and setup are described below and atypical data has been removed from the graphs.

Requirements of Section 2.5	Littleton Wind Farm Monitoring Locations
2.5.7 *In all cases, microphones should be supported at a height of 1.2 – 1.5 metres above the ground and no closer than 3.5 metres to any significant reflecting surface (such as a building or fence), except the ground. The position should be within 20 metres of the dwelling unless there are particular reasons for measuring at a more distant position (such as the presence of vegetation or denial of access); if so, the reasons should be explained.*	In terms of the distance from the microphone to the nearest noise sensitive property, Location N3 was placed away from the property to avoid screening from the proposed windfarm location and the farm buildings at the property. All other locations met this requirement of distance from property. All locations met the requirement for height above ground and distance to reflecting surfaces.
2.5.8 *A resident at a selected property may request that measurements are made at a position which is considered inappropriate; perhaps because the preferred location(s) are inconvenient (it might obstruct lawn mowing, for example). In this situation the consultant should explain clearly the reasons why the measurements could be compromised; if no agreement can be reached, an alternative property or location should be sought. The assistance of the EHO may help to resolve these situations.*	This was not an issue at any location.

Monitoring Locations

Noise monitoring was conducted at six locations, selected for obtaining a detailed representation of the background noise levels at receptors surrounding the proposed development. Details of the six noise monitoring locations are provided in Table A.11.1.2. The position of the monitoring locations is shown in Figure 11.2, Volume 4 of this EIAR.

Table A11.1.2: Details on the Noise Monitoring Locations

Location ID	Easting	Northing	Description	Photograph
N1a	624078	659047	North of the proposed windfarm, In the front garden in direction of property windfarm, 5m from the property facade. Screened from traffic noise to the north	Plate A11.1-1
N2	625689	657056	At northern side of property, approximately 5m from the corner of the propertyat end of cul de sac, near to forested area.	Plate A11.1-2
N3	624825	655721	Behind farm buildings at a property, approximately 100m from property façade.	Plate A11.1-3

Location ID	Easting	Northing	Description	Photograph
N4	621749	652771	In rear garden of property, with view of proposed windfarm to north. Approximately 18m from the rear façade and 3.5m from garden fence.	Plate A11.1-4
N5	622066	650342	Near a track to the front (west of the house), some distance from local road, 17m from façade.	Plate A11.1-5
N6	622373	658422	In rear garden of property, approximately 13m from the property.	Plate A11.1-6

Location N1, This location was to the north of the proposed windfarm. The noise meter was located in the front garden in the direction of the proposed windfarm, approximately 5m from the property facade. As there was noise from the M8 motorway to the north, the meter was located in the front garden overlooking the adjacent local road, at the quietest point in the front garden.

Plate A11.1-1: Monitoring Location N1

Location N2, This location was located in a cul de sac and near to a wooded area, east of the proposed windfarm. The noise meter was located in the front garden north of the property in the direction of the proposed windfarm, approximately 5m from the property.

Plate A11.1-2: Monitoring Location N2

Location N3, This was located north west of a cottage, behind farm buildings in the direction of the proposed windfarm. The location is approximately 100m from the property. There is a wooded area, at the edge of the field approximately 200m from the measurement location.

This represents a group of properties to the north east of the measurement location. There was noise from livestock at an adjacent barn observed when equipment was deployed. The meter was set up at 3.5m from the base of the hay bales.

Plate A11.1-3: Monitoring Location N3

Location N4, This location is in the rear garden of the property, behind a shed in the rear garden. The measurement location is approximately 18m from the rear façade of the property. There is a slight embankment along the rear boundary of the property and some hawthorn in the next field.

Plate A11.1-4: Monitoring Location N4

Location N5, This location is near to a track close to the front (west) of the house. The house is on a farm, located approximately 680m from the local road. The measurement location overlooks the windfarm and is away from trees to the north of the property. The measurement location is approximately 17m from the property.

Plate A11.1-5: Monitoring Location N5

Location N6, This location is on a local road off the R639 and approximately 800m from the M8 motorway. The noise monitor was located in the rear garden, approximately 13m from the property in the direction of the proposed windfarm at the quietest point in the property. The monitoring location is next to a field of sheep and also the location of the rain gauge. The main noise source at this location was from the M8 motorway.

Plate A11.1-6: Monitoring Location N6

Measurement Periods

The IOA GPG states "*The duration of a background noise survey is determined only by the need to acquire sufficient valid data over the range of wind speeds. It is unlikely that this requirement can be met in less than 2 weeks.*" If insufficient wind data is collected after two weeks, the monitoring period will be extended subject to acquiring sufficient valid data over the range of wind speeds. Sufficient data was captured at all monitoring locations with a minimum of two and a half weeks' worth of data captured at all monitoring locations.

Definition of Time Periods

The 2006 DoEHLG Wind Energy Development Guidelines do not provide the specific periods which are represented by daytime and night-time hours. The noise data has been analysed based on the Amenity and night time hours defined in ETSU-R-97:

Amenity/Quiet Daytime hours	18:00 – 23:00 Monday to Friday 13:00 – 18:00 Saturday 07:00 – 18:00 Sunday
Night-time hours	23:00 – 07:00

Monitoring Equipment

Baseline noise monitoring was carried out using Svantek 307, Svantek 977 and Larson Davis SoundExpert Lxt Class 1 sound level meters. Details of the noise monitoring equipment are presented in Table A11.1.3. The sound level meters were fitted with 1/2" microphones. The microphones connected to the Svantek sound level meters were fitted with a wind shield made from open-pored polyurethane foam with a diameter of 130mm. Both the Svantek 977 and the Larson Davis sound level meters were fitted with a 90mm diameter windshield with a secondary windshield. The setup used is in keeping with ESTU W/13/00386/REP, Noise Measurements in Windy Conditions and IOA Good Practice Guidelines, 2013. Calibration certificates for each sound level meter and the calibrator are provided in Appendix 11.2.

Table A11.1.3: Details of Noise Monitoring Equipment

Monitoring Location	Meter Type	Serial Number
N1	Larson Davis SoundExpert	LXT0006870
N2	Svantek 977	34173
N3	Svantek 307	104985
N4	Larson Davis SoundExpert	LXT0006603
N5	Larson Davis SoundExpert	LXT0006850
N6	Svantek 307	104990

A Campbell Scientific ARG100 Tipping Bucket Raingauge and CR800 series datalogger was used to record rainfall and this was located at monitoring location N6. This meteorological data was acquired every 10 minutes synchronised to the hour, simultaneously with noise data.

Monitoring Protocol

Baseline noise measurements were undertaken at six locations near the proposed wind farm. Equipment was installed by FT between 18th November 2021 and the 9th December 2021.

The following monitoring protocol was carried out at each of the monitoring locations:

1. The sound level meters were calibrated on-site and set to log L_{A90} statistics on a fast time weighted response every ten minutes.
2. Each sound level meter microphone was mounted at 1.5 m above ground level and fitted with an enhanced windshield. Each microphone was placed at least 3.5 m from reflecting surfaces to obtain 'free field' conditions.
3. Wind speed and wind direction measurements were taken from a permanent mast installed on site. Wind speed was measured at a range of heights and data from anemometers at 80m and 100m and were used to extrapolate the wind speed data up to a hub height of 119m.
4. The standardised 10 m wind speed was obtained from the turbine hub height wind speed by correcting it to 10 m height using a ground roughness factor of 0.05 m. Roughness length (or logarithmic) shear profile:

$$U_1 = U_2 \frac{ln\left(H_1/z\right)}{ln\left(H_2/z\right)}$$

   where U_1 is the wind speed to be calculated, U_2 is the measured wind speed, H_1 is the height of the measured wind speed to be calculated (10m), H_2 is the height of the measured wind speed and z is the ground roughness length (m). A roughness length of 0.05m is used to standardise hub height wind speeds to 10m height in the IEC 61400-11:2012 standard.
5. The L_{A90} statistic measurements were synchronised with the 10 m standardised wind speeds derived from the on-site meteorological mast data.

6. A logging rain gauge was also installed (at Monitoring Location N6) and similarly logged rainfall events over successive 10-minute intervals, also synchronised to the noise level and wind speed measurements.
7. After the monitoring was completed, the noise meters were re-tested using the calibration noise source to ensure that the meters had not drifted.

Analysis of the Baseline Data

Following collection of the site data, the following protocol was used to analyse the baseline data:

1. The raw baseline L_{A90} noise data was reviewed to determine whether there are any periods of non-consistent noise level due to equipment malfunction.
2. The raw noise level data was then correlated with the time synchronised wind speed and rainfall data. Preliminary data analysis was used to remove datasets (L_{A90}, wind speed and occurrence of rainfall event) which contain a rainfall event as these data sets are required to be removed from further analysis in line with best practice as outlined in the IOA Good Practice Guide and Supplementary Guidance Note 2 on Data Processing.
3. The prevailing background noise during for daytime periods uses the amenity/quiet daytime hours. The prevailing background noise during night-time periods excludes early morning periods to remove the dawn chorus which is not prevalent through that whole year, with data recorded between 04:00 and 07:00 removed from further analysis in accordance with the guidance outlined in the IOA GPG.
4. Once the rainfall events have been accounted for, the remaining data was graphed using a wind speed based plot to establish whether there are any remaining data outliers, representing atypical noise sources or events. Location N6 data was affected by M8 Motorway noise. Atypical noise was removed from location N4. The source of this noise was not apparent from observations made on site.
5. Once the remaining data sets were found to be representative of the noise environment, they were analysed to ensure that sufficient data remained to provide sufficient data coverage over the necessary wind speeds. The IOA Good Practice Guide (May 2013) requires, as a minimum, no fewer than five valid data sets across each 1 m/s wind speed from turbine cut-in to rated power. Where integer wind speeds have less than five valid data sets, the prevailing background noise trend will not be extended beyond the range covered by adequate data sets. See Section 'Data Available for Determination of Prevailing Background Noise Levels' for details.
6. A 'best fit' trend (not higher than a fourth order polynomial) was then derived to present the assumed prevailing background noise level at each monitoring location. See Section 'Results' for details.

Data Available for Determination of Prevailing Background Noise Levels

The requirement for the survey duration is dictated by the range of wind speeds to be collected. The IOA Good Practice Guide to the Application of ETSU-R-97[1] for the Assessment and Rating of Wind Turbine Noise, (May 2013) states that "*As a guideline, no fewer than 200 data points should be recorded in each of the amenity hours and night-time periods with no fewer than 5 data points in any 1 m/s wind speed bin.*"

The Wind Energy Development Guidelines (Department of Environment, Heritage and Local Government, 2006) do not provide the specific periods which are represented by daytime and night-time hours. The definitions from ETSU-R-97 are taken as 23:00 to 07:00 hrs for night-time, and the Amenity/Quiet Daytime

[1] Department of Trade and Industry (1996), The Assessment and Rating of Noise from Wind Farms Report ETSU-R-97

hours (18:-23:00 Monday to Saturday, 13:00-18:00 Saturday and 07:00-18:00 Sunday. Prevailing background noise levels were derived for daytime and night-time periods. The number of valid datasets are shown in Tables A11.1.4 and A11.1.5 with wind speed ranges greyed out which did not satisfy the criteria of at least 5 data points in any 1 m/s wind speed bin. The daytime range of windspeeds was between 2 and 10m/s. The night time range of windspeeds was between 2 and 12m /s. Therefore an adequate range of windspeeds was achieved in accordance with the IOAGPG. This guidance recommends an upper limit of 10 m/s, noting that in some cases the top turbine sound power is achieved at lower windspeeds.

Table A11.1.4: Number of Valid Datasets: Noise Monitoring Locations -Daytime

Wind Speed (at standardised 10 m height), m/s	Valid Datasets					
	N1	N2	N3	N4	N5	N6
0	1	1	1	1	1	1
1	3	3	3	3	3	3
2	56	59	57	46	57	57
3	87	88	88	54	88	89
4	80	88	85	77	88	88
5	150	150	150	130	151	151
6	184	184	182	131	185	185
7	113	117	115	85	115	115
8	73	76	71	48	74	74
9	32	33	30	25	32	32
10	11	11	10	10	11	11
11	2	2	2	2	2	2
12	4	5	4	0	4	4
13	9	10	9	0	9	9
14	6	7	6	0	6	6
Total Number of Data Points	811	834	813	612	826	827
	Did not satisfy the criteria of at least 5 data points in any 1 m/s wind speed bin					

Table A11.1.5: Number of Valid Datasets: Noise Monitoring Locations– Night-time

Wind Speed (at standardised 10 m height), m/s	Valid Datasets					
	N1	N2	N3	N4	N5	N6
0	2	2	2	2	2	2
1	16	16	16	14	16	16
2	41	41	41	40	41	41
3	15	15	15	14	15	15
4	75	75	75	58	75	75
5	135	135	135	106	135	135
6	81	82	81	53	81	81
7	55	56	55	37	54	55
8	57	61	57	45	56	57
9	29	29	29	29	29	29
10	21	22	21	21	21	21
11	11	12	11	11	11	11
12	7	7	7	7	7	7
13	1	1	1	1	1	1
Total Number of Data Points	546	554	546	438	544	546
	Did not satisfy the criteria of at least 5 data points in any 1 m/s wind speed bin					

Results

In this section, the prevailing background noise level in dB L_{A90} relative to standardised 10 m height wind speeds are provided for each monitoring location as per the requirements of the survey. The prevailing background noise level is plotted as a solid line for each daytime and night-time periods at each monitoring location. In all cases, the highest order of polynomial used is a third order polynomials provided lines of best fit to the scatter data.

Figure A11.1: Prevailing Amenity/Daytime Background (L_{A90}) Noise Levels at N1

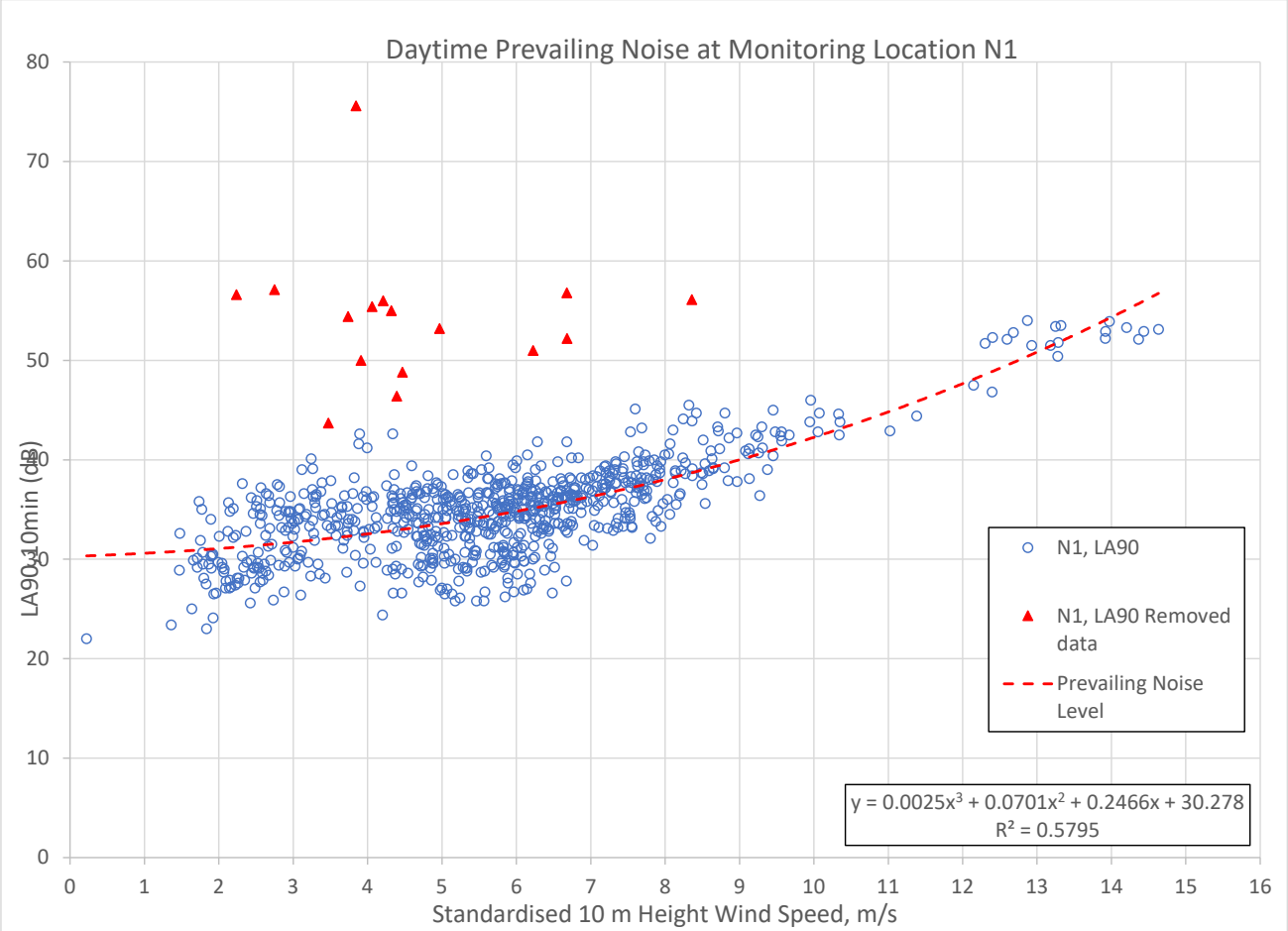

Figure A11.2: Prevailing Amenity/Daytime Background (L_{A90}) Noise Levels at N2

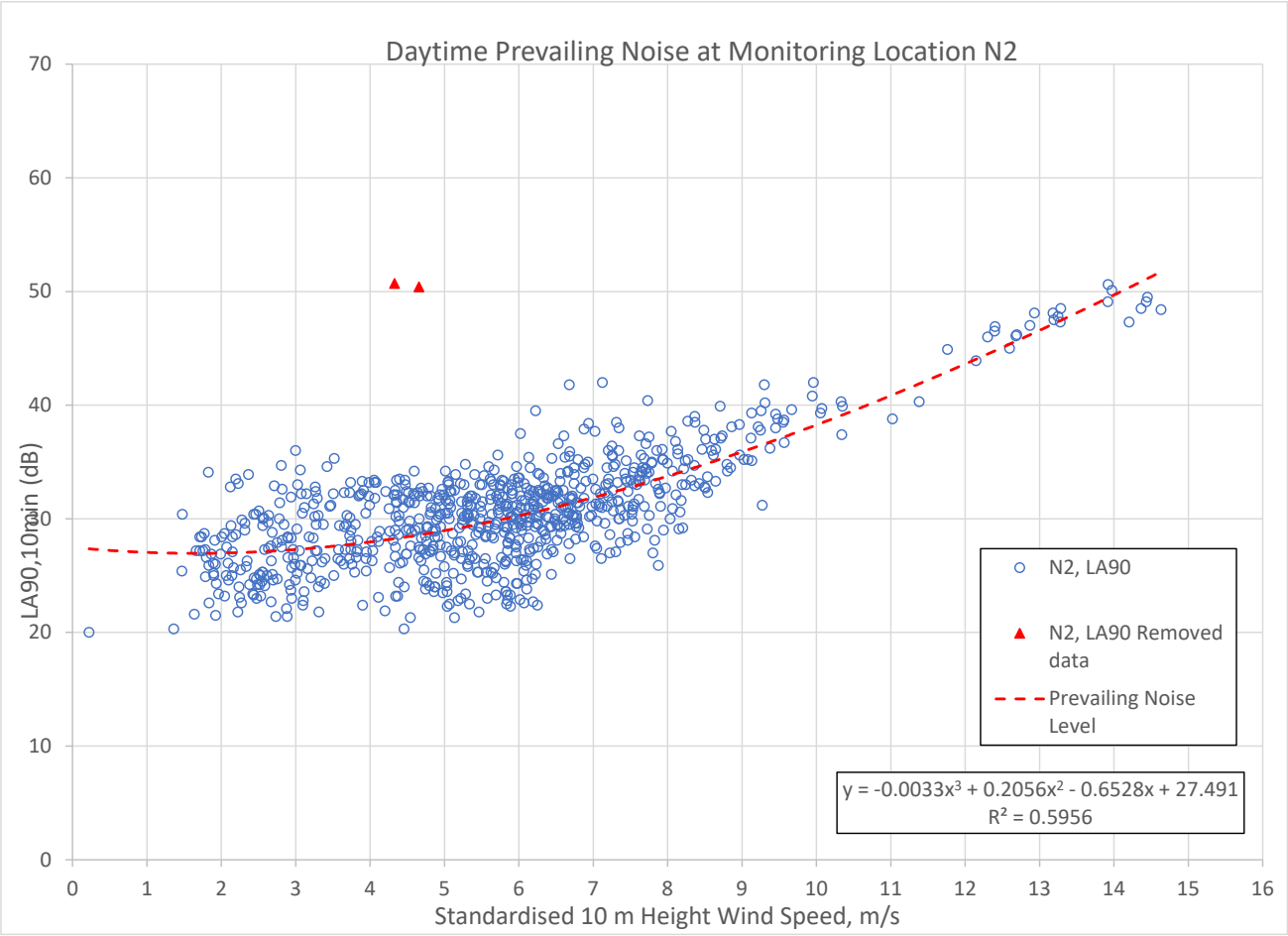

Figure A11.3: Prevailing Amenity/Daytime Background (L_{A90}) Noise Levels at N3

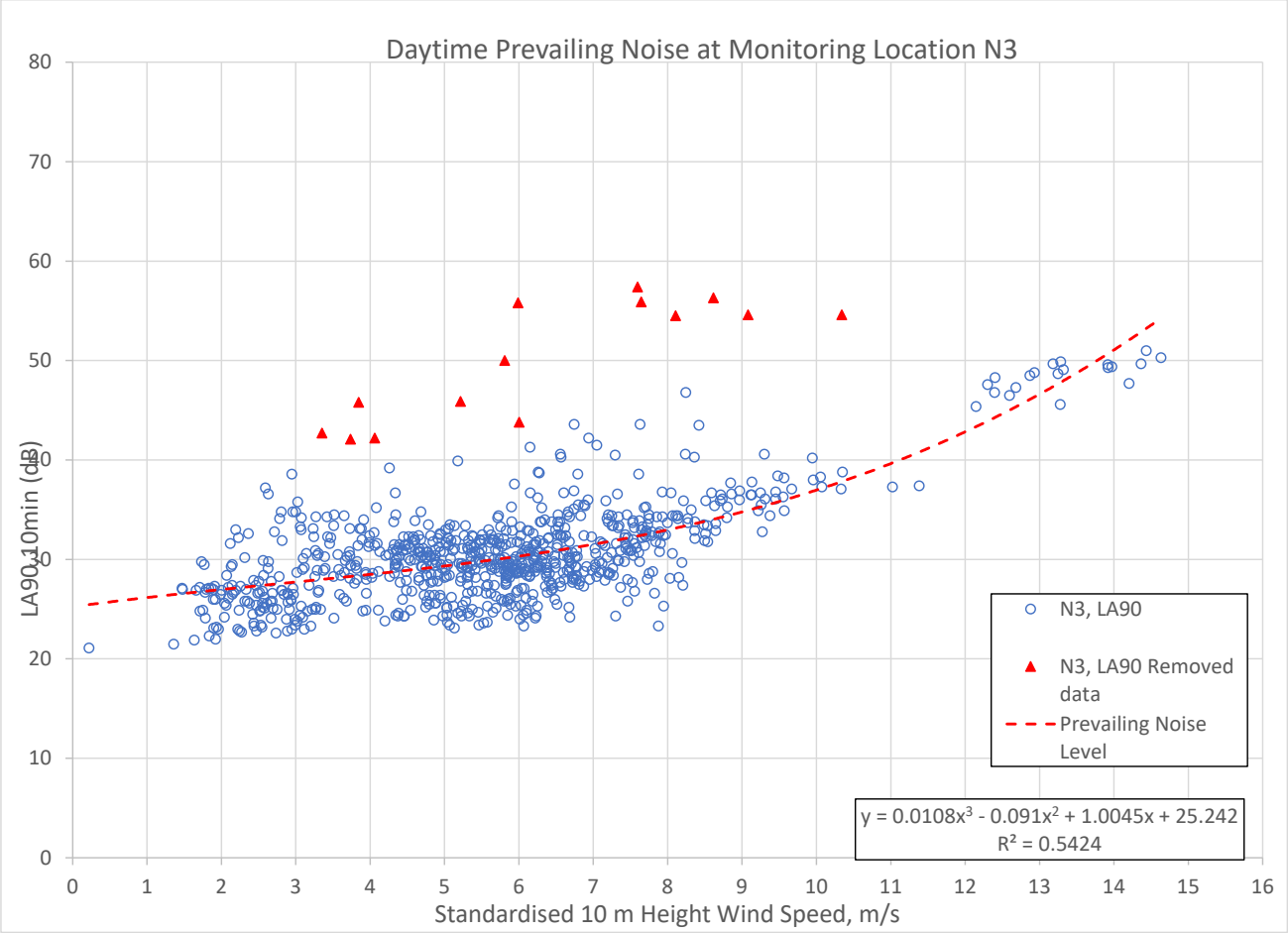

Figure A11.4: Prevailing Amenity/Daytime Background (L_{A90}) Noise Levels at N4

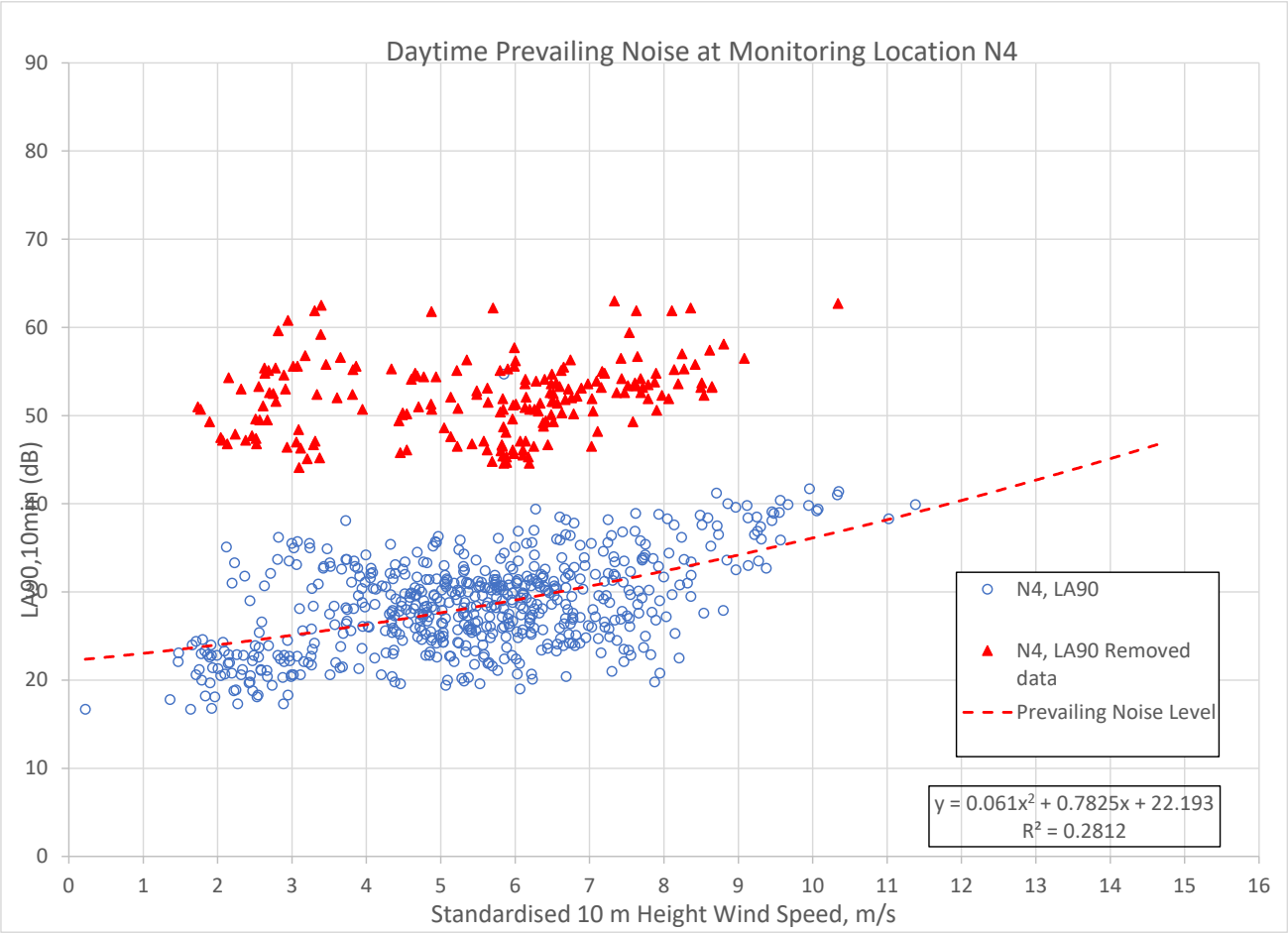

Figure A11.5: Prevailing Amenity/Daytime Background (L_{A90}) Noise Levels at N5

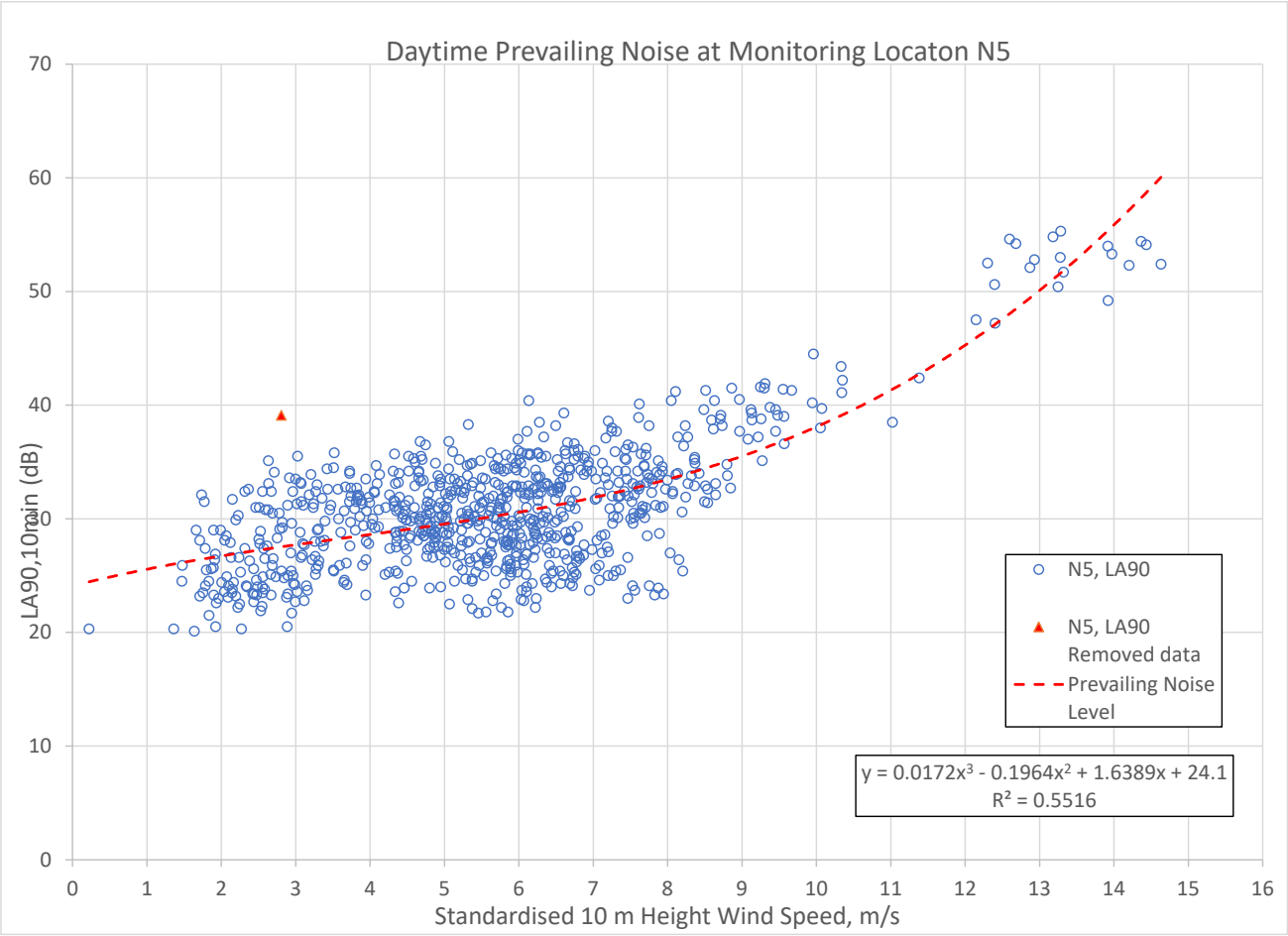

Figure A11.6: Prevailing Amenity/Daytime Background (L_{A90}) Noise Levels at N6

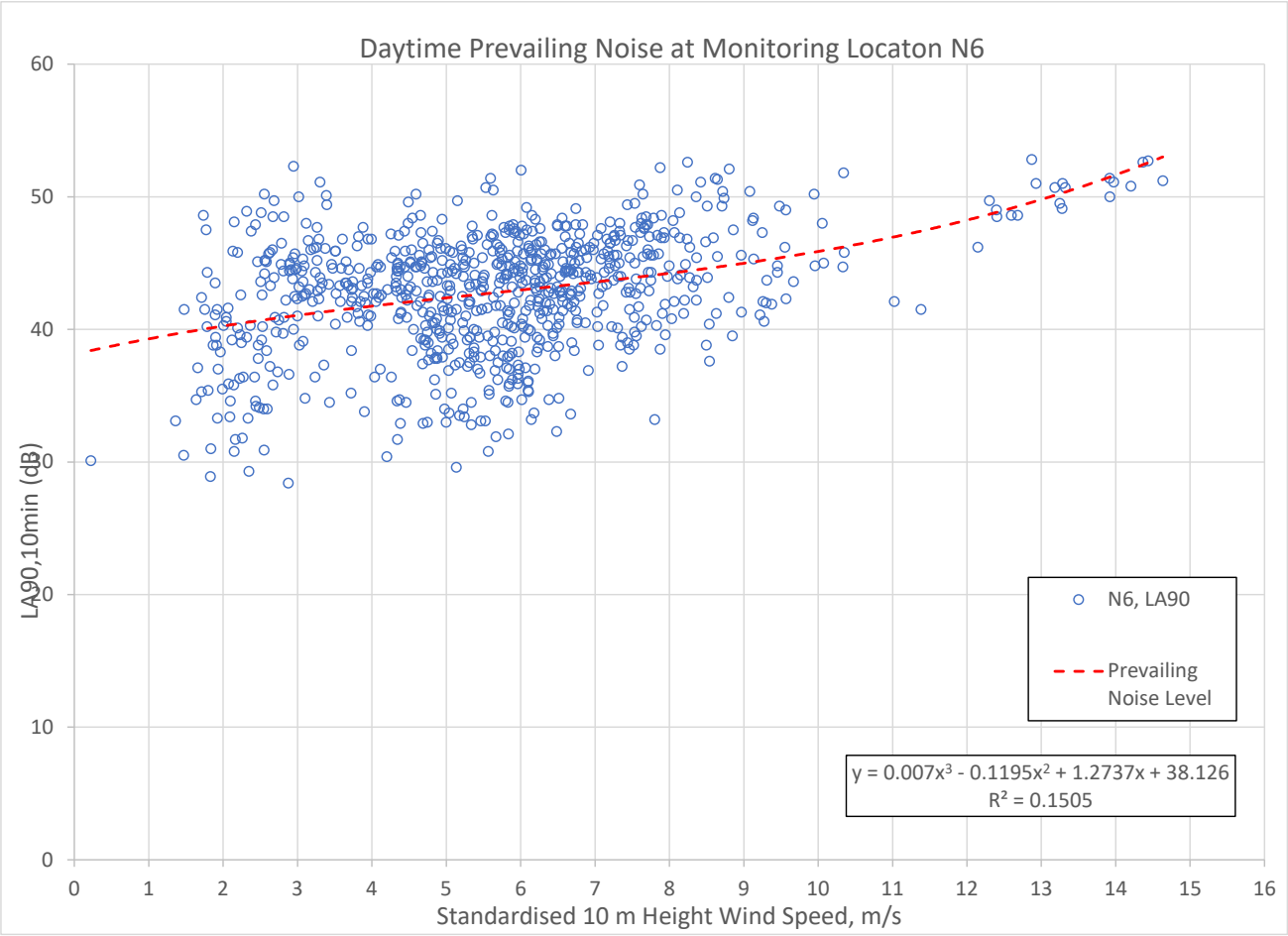

Figure A11.7: Prevailing Night-time Background (L_{A90}) Noise Levels at N1

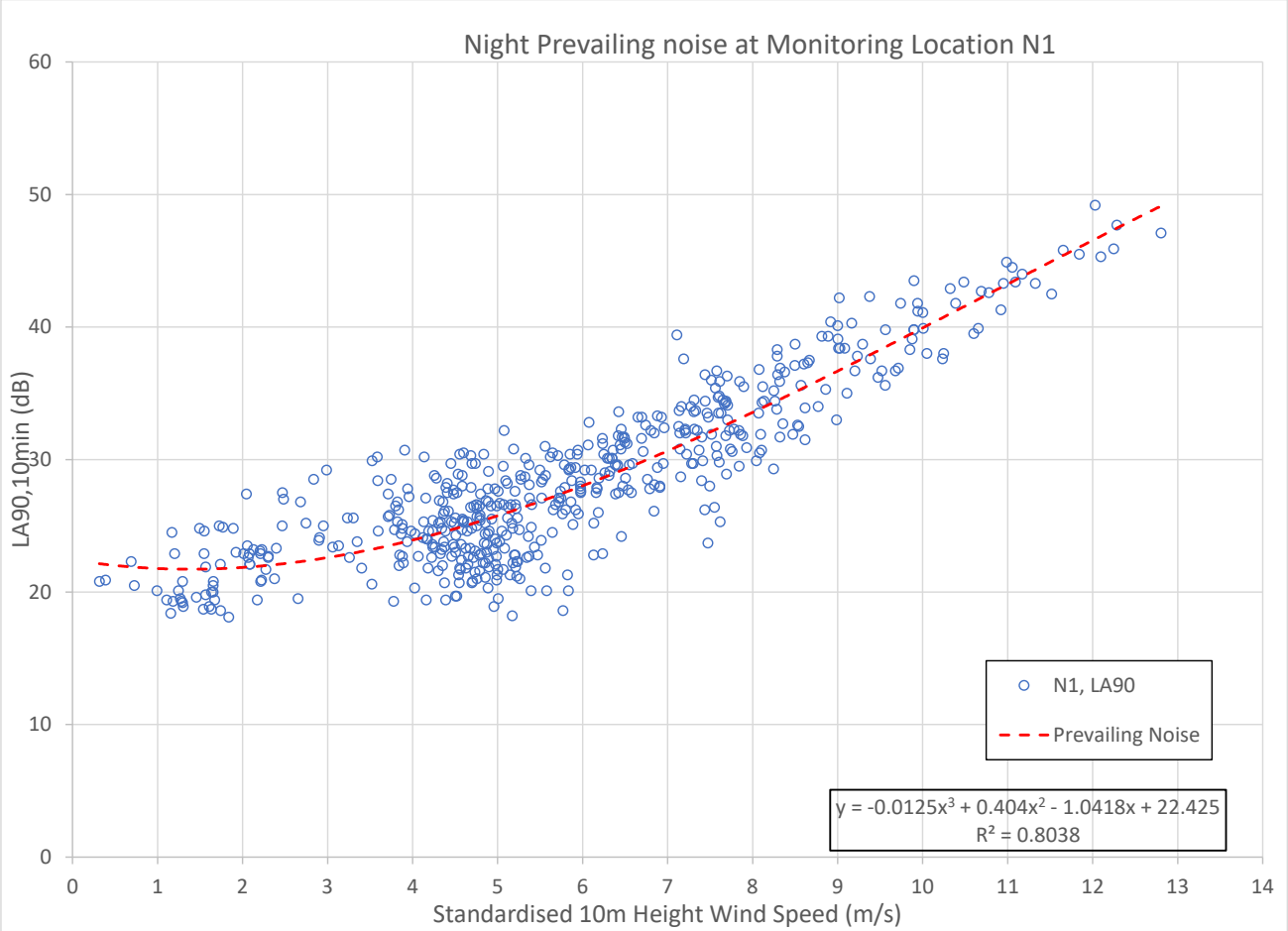

Figure A11.8: Prevailing Night-time Background (L_{A90}) Noise Levels at N2

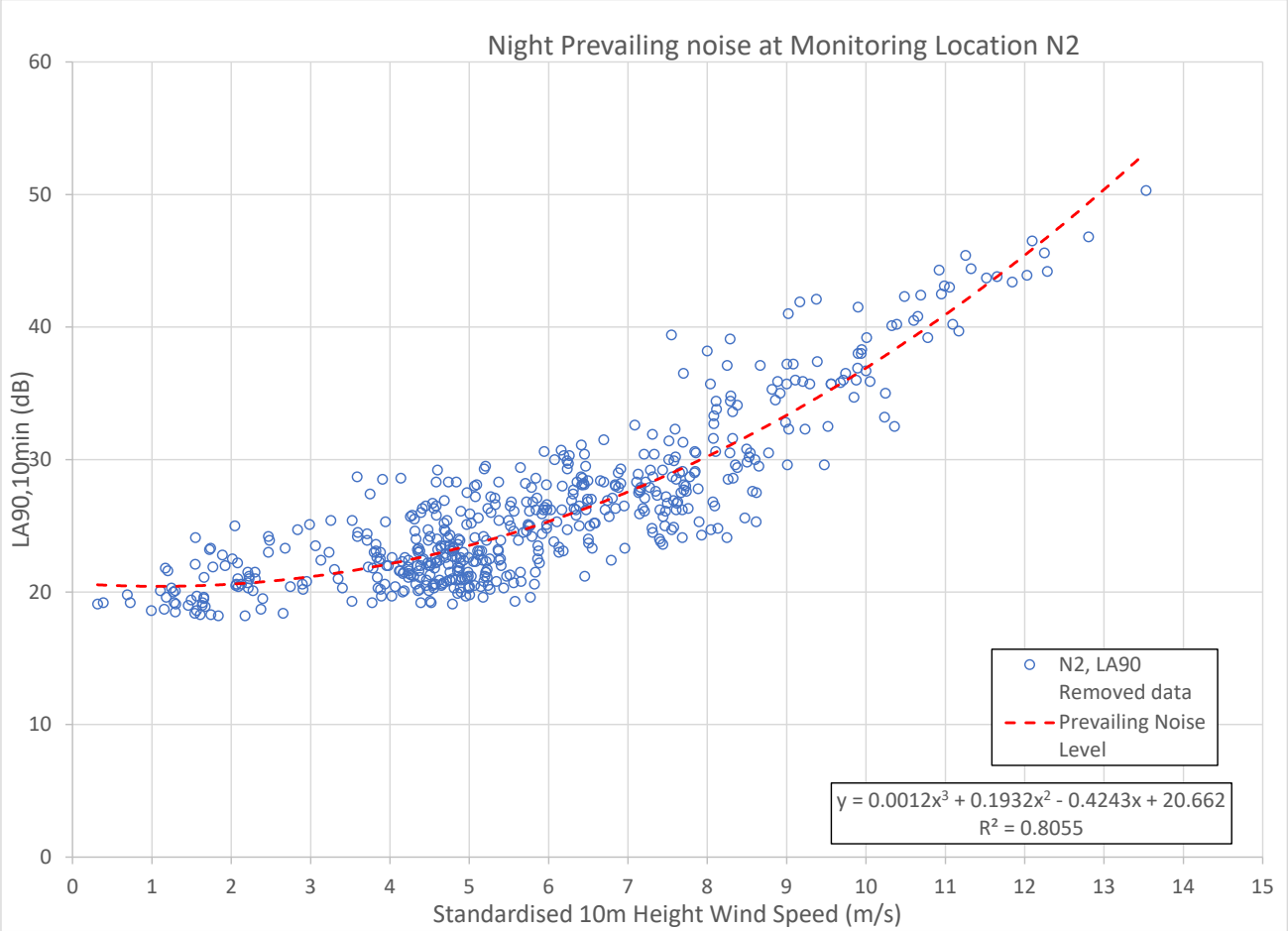

Figure A11.9: Prevailing Night-time Background (L_{A90}) Noise Levels at N3

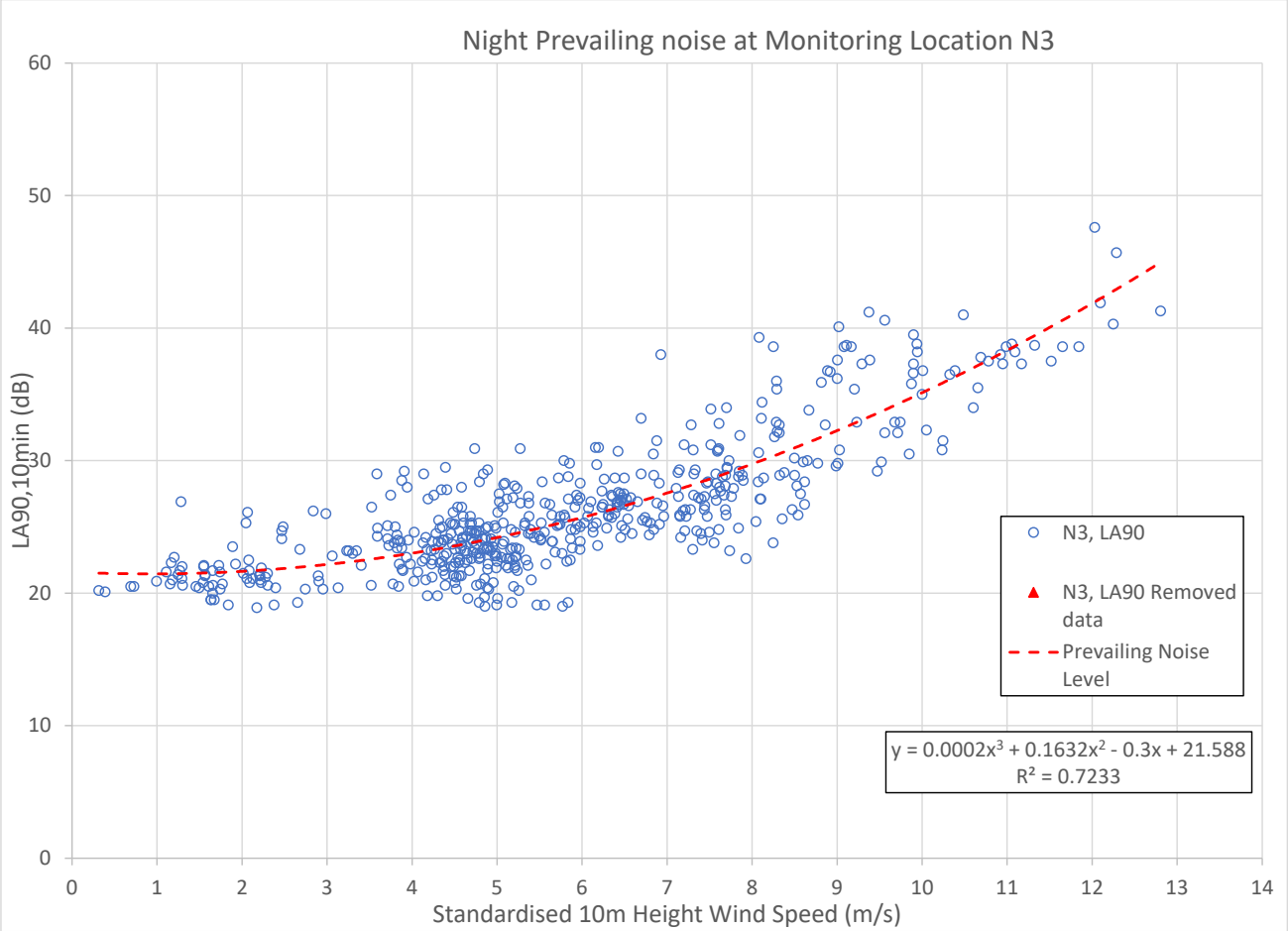

Figure A11.10: Prevailing Night-time Background (L_{A90}) Noise Levels at N4

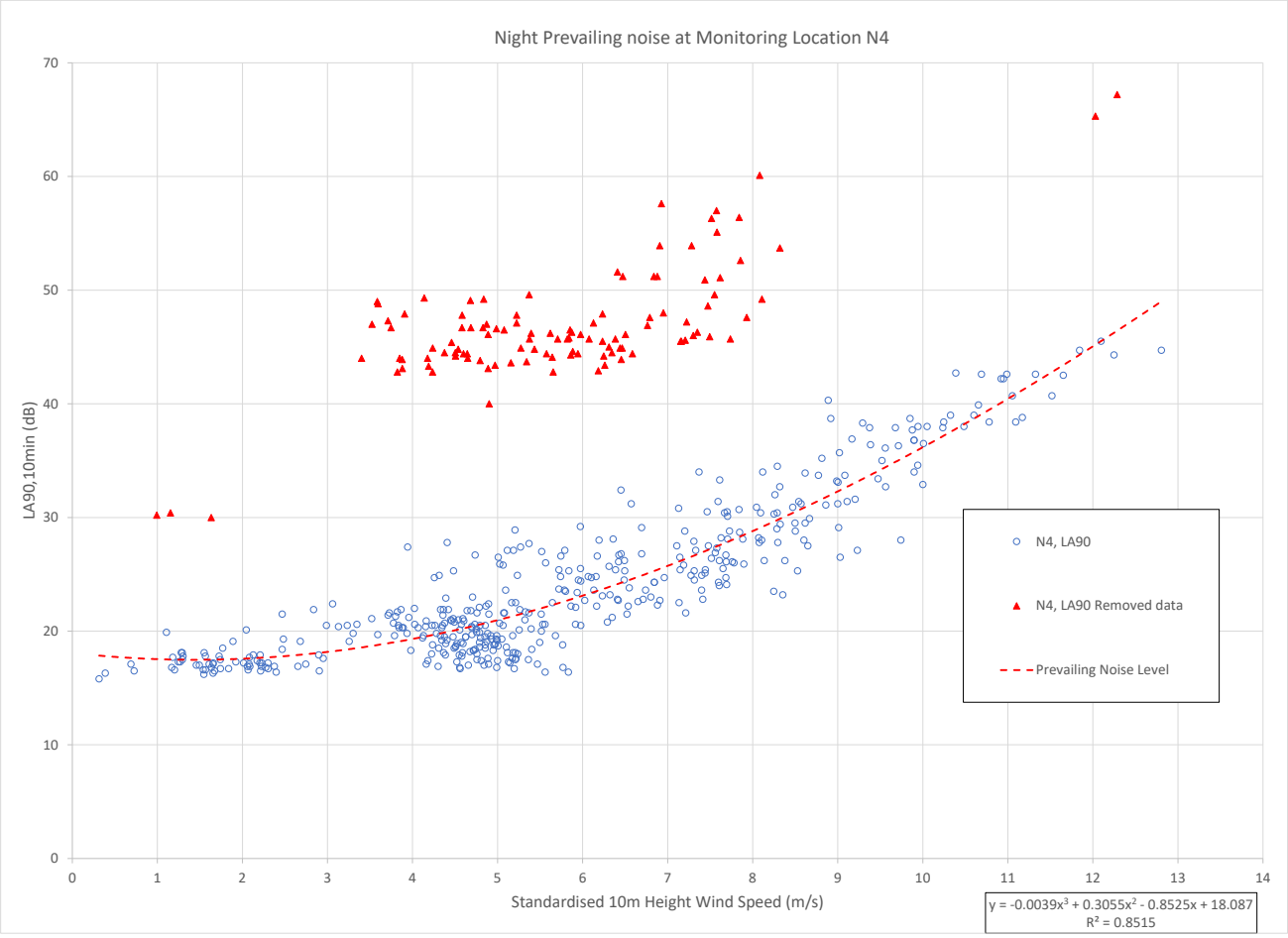

Figure A11.11: Prevailing Night-time Background (L_{A90}) Noise Levels at N5

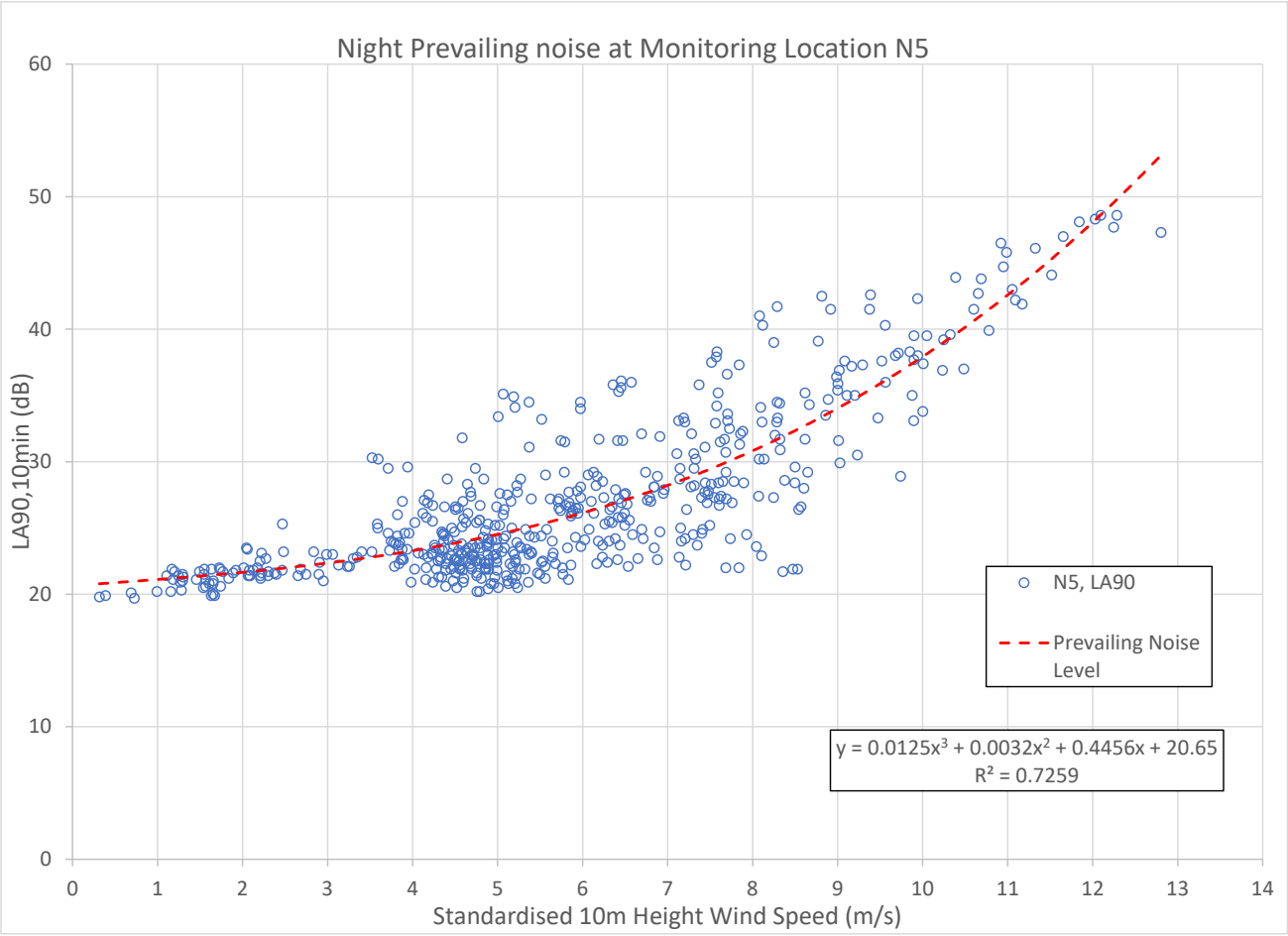

Figure A11.12: Prevailing Night-time Background (L_{A90}) Noise Levels at N6

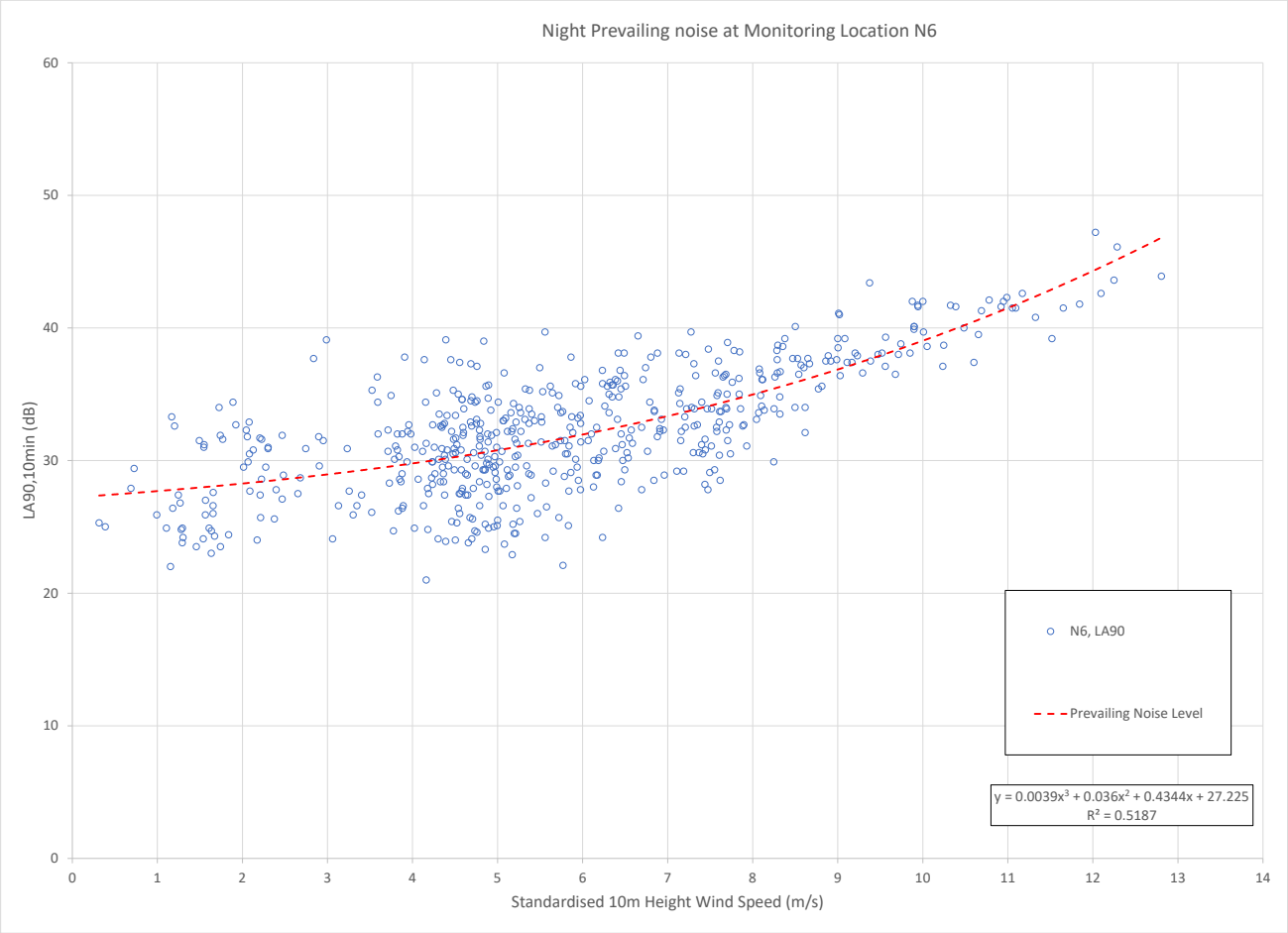

Table A11.1.6: Prevailing Background Noise – Daytime Periods

Location	Prevailing Background Noise $L_{A90,10min}$ (dB) at Standardised 10 m Height Wind Speed (m/s)													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
N1	30.6	31.1	31.7	32.5	33.6	34.8	36.3	38.0	40.0	42.3	44.8	47.7	50.8	54.3
N2	27.0	27.0	27.3	28.0	29.0	30.3	31.9	33.7	35.9	38.2	40.8	43.6	46.5	49.6
N3	26.2	27.0	27.7	28.5	29.3	30.3	31.5	33.0	34.8	37.0	39.7	42.9	46.6	51.1
N4	23.0	24.0	25.1	26.3	27.6	29.1	30.7	32.4	34.2	36.1	38.2	40.4	42.7	45.1
N5	25.6	26.7	27.7	28.6	29.5	30.6	31.8	33.4	35.5	38.0	41.3	45.2	50.0	55.7
N6	39.3	40.3	41.1	41.8	42.4	43.0	43.6	44.3	45.0	45.9	47.0	48.3	49.9	51.7

§ - noise level restricted to the highest derived point
* - noise level restricted to lowest derived point
Shaded areas indicate windspeeds which did not satisfy the criteria of at least 5 data points in any 1m/s wind speed bin.

Table A11.1.7: Prevailing Background Noise – Nighttime Periods

Location	Prevailing Background Noise $L_{A90,10min}$ (dB) at Standardised 10 m Height Wind Speed (m/s)											
	1	2	3	4	5	6	7	8	9	10	11	12
N1	21.8	21.9	22.6	23.9	25.8	28.0	30.6	33.5	36.7	39.9	43.2	46.5
N2	20.4	20.6	21.2	22.1	23.5	25.3	27.6	30.2	33.4	36.9	41.0	45.5
N3	21.5	21.6	22.2	23.0	24.2	25.7	27.6	29.7	32.3	35.1	38.3	41.8
N4	17.5	17.6	18.2	19.3	21.0	23.1	25.8	28.8	32.3	36.2	40.5	45.1
N5	21.1	21.7	22.4	23.3	24.5	26.1	28.2	30.8	34.0	37.9	42.6	48.1
N6	27.7	28.3	29.0	29.8	30.8	32.0	33.4	35.0	36.9	39.1	41.6	44.4

§ - noise level restricted to the highest derived point
* - noise level restricted to lowest derived point

Construction Noise Baseline Measurements

Based on noise monitoring conducted at the windfarm as detailed above, baseline noise measurements at the six locations described above have been summarised for the purpose of setting construction noise limits. Noise was averaged across the construction noise daytime period (0700-1900) and compared with the BS5228 ABC category, as discussed in Table 11.1 and Section of Chapter 11 Noise and Vibration. Periods with rain were removed and the data only includes information where windspeeds were less than or equal to 5m/s

Table A11.1.8: Background Noise Summary – Construction Noise – Daytime Periods

Location	LAeq, 10mins*	BS5228 Category
N1	43	A:65 dB
N2	40	A:65 dB
N3	41	A:65 dB
N4	46	A:65 dB
N5	40	A:65 dB
N6	49	A:65 dB

* Arithmetic average of measured noise between 18th November and 6th December

Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are less than these values.

Baseline Noise Measurements for BS4142 Assessment

Baseline noise measurements at the six locations described above have been summarised for the location closest to the proposed substation for the purpose of defining background and ambient noise levels.

The daytime and nighttime background (and residual) noise measurements ($L_{AF90, 10min}$ and $L_{Aeq, 10min}$) have been rounded to the nearest dB, filtered to exclude data for windspeeds above 5 m/s and any data where a rainfall event occurred. Data was categorised into daytime (0700-2300) and nighttime (2300-0700) periods. A summary of the main statistical results are presented in Table A11.1.9. A histogram of the noise data was used to determine the L_{Aeq} and L_{A90} during the measurement periods (See graphs). The mode (the most frequently occurring data) has been used to represent the data for the daytime and night time periods, as summarised in the table below.

Table A11.1.9: Background Noise Summary Substation Noise Assessment

	Daytime		Night time	
Location	**LAeq, 10mins***	**LA90, 10mins***	**LAeq, 10mins***	**LA90, 10mins***
N1	41	36	30	23

Figure A11.13: Night time (L_{Aeq}) Noise Levels at N1

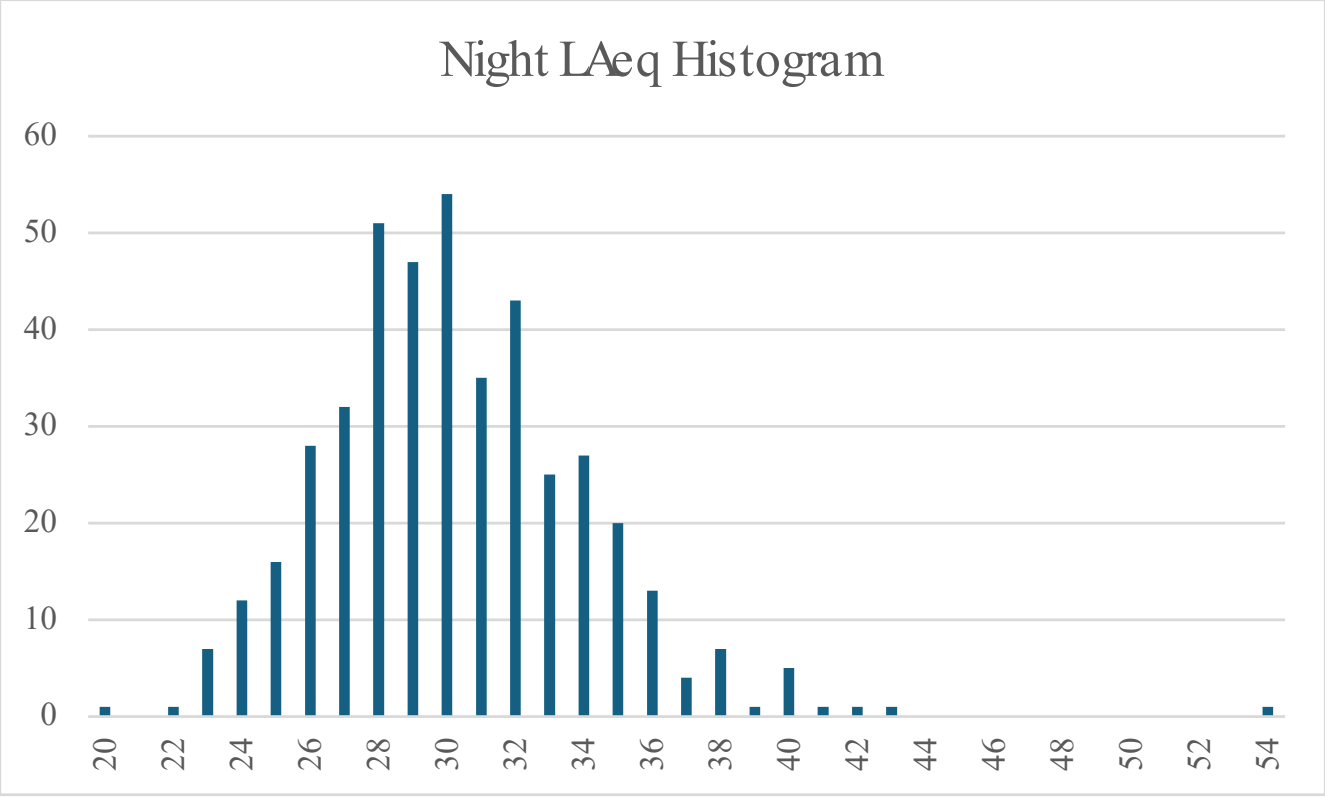

Figure A11.14: Night time background(L_{A90}) Noise Levels at N1

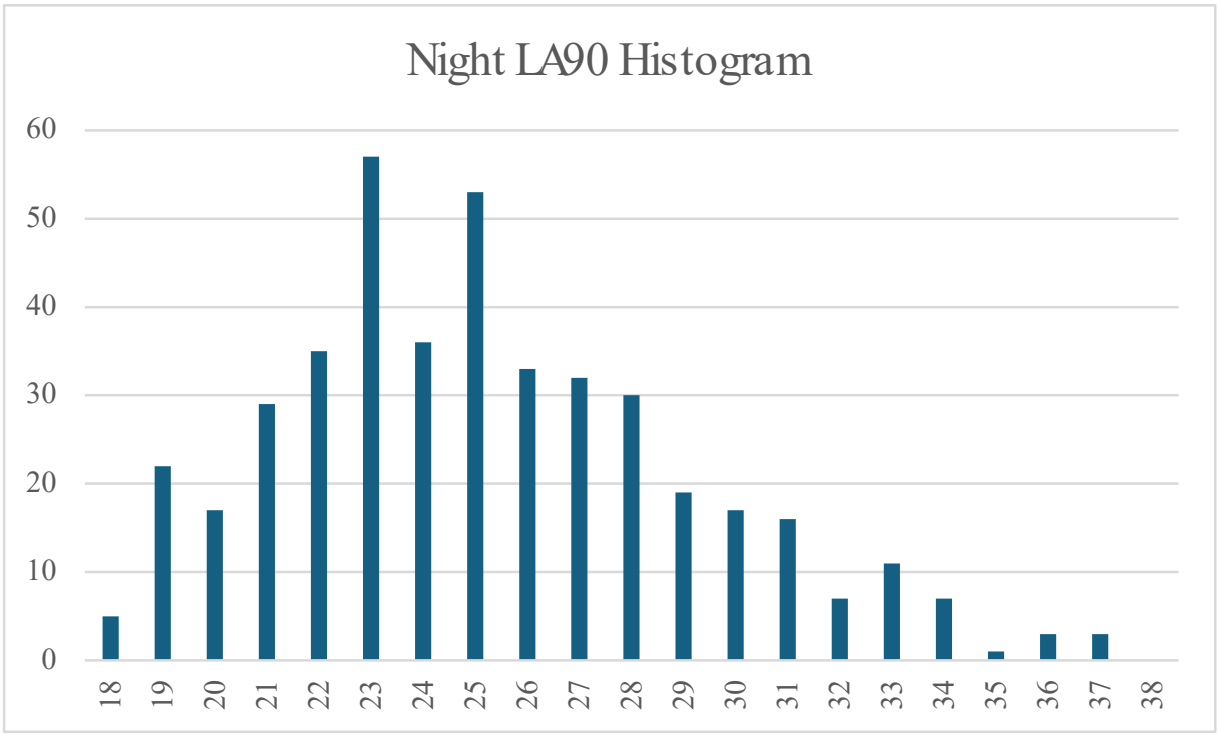

Figure A11.15: Day time (L_{Aeq}) Noise Levels at N1

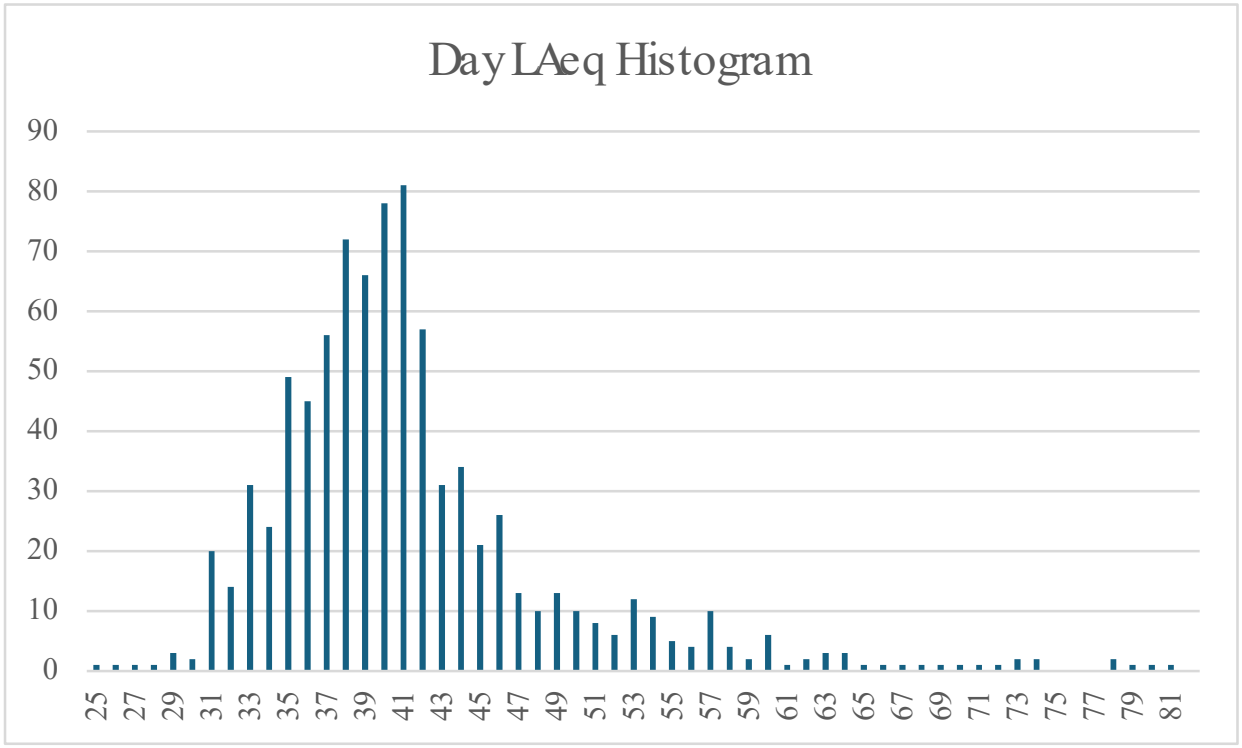

Figure A11.16: Day time background (L_{A90}) Noise Levels at N1