Bonnyknox Solar Site

Acoustic Impact Assessment

Ref	05114-8989673

Revision History

Issue	Date	Name	Latest Changes	File Reference
01	04/03/2024	Lucy Connor	First Created	05114-8936885 05114-8429704

Contents

1 Introduction

This report contains an assessment of the acoustic impact of the proposed Bonnyknox Solar Site (the 'Proposed Development') in terms of potential operational impacts. One Member and one Associate of the Institute of Acoustics have been involved in its production. Details of their experience and qualifications can be found in **Appendix A**.

An assessment of the sound generated by the equipment to be installed has been undertaken in accordance with British Standard BS 4142:2014+A1:2019 'Methods for Rating and Assessing Industrial and Commercial Sound' [1] and British Standard BS 8233:2014 'Guidance on sound insulation and noise reduction for buildings' [2].

2 Planning Policy, Guidance & Standards

2.1 Planning Advice Note 1/2011: Planning and Noise

Within Scotland, the treatment of noise is defined in the planning context by 'Planning Advice Note (PAN) 1/2011: Planning and Noise' [3]. This document details the Government's planning policies and how these are expected to be applied. The PAN provides advice on the role of the planning system in helping to prevent and limit the adverse effects of noise, stating that planning policies and decisions should aim to avoid noise giving rise to significant adverse impacts, whilst at the same time mitigating and reducing other adverse impacts on health and quality of life to a minimum.

2.2 Technical Advice Note: Assessment of Noise

The online documentation 'Assessment of Noise: Technical Advice Note (TAN)' [4] provides guidance to assist in the technical evaluation of noise assessments and aims to assist in assessing the significance of impacts associated with various development. The guidance refers to a since superseded version of BS 4142 in terms of assessing the impact of new noise generating development on neighbouring residences (the latest and previous version of which are discussed herein) and provides various matrices as to the significance and sensitivity of residences resulting from the introduction of certain facilities. The document states, at Paragraph 3.20, that '… the Scottish Government consider impacts are normally not significant (in a quantitative sense only) [if] the difference between the rating and background noise levels is less than 5 dB(A), and that usually the threshold of minor significant impacts is when the difference between the rating and background noise levels is at least 5 dB(A); and commonly do not become sufficiently significant to warrant mitigation until the difference between the rating and background noise levels is more than 10 dB(A)'. The documentation also refers to publications released by the World Health Organisation (WHO) in terms of general internal and external absolute noise criteria for the protection of health, amenity, and sleep disturbance.

2.3 BS 4142 Methods for Rating and Assessing Industrial & Commercial Sound

BS 4142:2014+A1:2019 describes methods for rating and assessing sound of an industrial or commercial nature. Outdoor sound levels are used to assess the likely effects on people who might be inside or outside a residential property via the comparison of the pre-existing background sound levels with the predicted/modelled sound associated with the introduction of a particular development, known as the 'rating' level, which also accounts for any distinguishing characteristics of the emitted sound.

To determine a value for the background sound level at a specific assessment point, a series of measurements are made at a location at, or representative of, a dwelling or receptor of interest. The standard requires that the background sound measurements (dB $L_{A90,\,T}$ – the sound level exceeded for 90% of the time, or the lowest 10 % of sound, for the reference time period, T) should be measured during times when the sound source in question could or will be operating and that the individual measurement intervals should not normally be less than 15-minutes in length. The objective is then to determine a justifiable representative background sound level for time periods of interest via statistical analysis and/or observations of the data set collected. The standard states that the representative background sound level '… should not automatically be assumed to be either the minimum or modal value'.

The 'rating' level is defined as the 'specific' sound level (dB L_{Aeq} – the equivalent continuous sound level) plus any corrections for the presence tones (i.e., whines, whistles, or hums), impulsive character (i.e., banging, crashing, or tapping), intermittency, or other sound characteristics (distinctiveness against the residual acoustic environment) in the sound generated by the source in question. In instances where the sound is unlikely to have a specific character at the assessment location then the rating level can be assumed to equal to the 'specific' sound level. Where corrections are required, a number of decibels are added to the specific sound level to determine the rating level.

The defined representative background sound level(s) and rating level(s) are then compared to determine the possible impact but with consideration of the context in which the industrial or commercial sound source to be introduced presents itself in respect of other sound sources and the existing character of the area. **Table 1** provides a summary of expected impacts when comparing background sound levels and rating levels.

Table 1 – BS 4142 Assessment Criteria

Rating Level	BS 4142 Assessment Criteria
Equal to or below background sound level	'…an indication of the specific sound source having a low impact, depending on the context'.
Approximately +5 dB greater than the background sound level	'…an indication of an adverse impact, depending on the context'.
Approximately +10 dB or more greater than the background sound level	'…an indication of a significant adverse impact, depending on the context'.

Further to the above, it may not be appropriate or proportionate to undertake a full assessment in accordance with the BS 4142 standard, particularly when the rating level associated with the new source is particularly low at neighbouring receptors and/or the existing background sound levels are low. The previous version of BS 4142 [5] stated that this version of the standard is not appropriate for use in instances where background

and rating noise levels are very low and that '… background noise levels below about 30 dB and rating levels below about 35 dB are considered to be very low'.

2.4 BS 8233 Guidance on Sound Insulation and Noise Reduction for Buildings

British Standard BS 8233:2014 provides information on the design of buildings to ensure they have internal acoustic environments appropriate to their functions. The standard specifies guideline indoor ambient sound levels for buildings for different activities, locations and times of day and states that it is desirable that these guideline values are not exceeded. Therefore, in practice the guidelines specify absolute limits for sound levels in specific environments. The most conservative applicable values specified are those conducive to sleeping or daytime resting in a house bedroom where the internal sound level should not exceed 30 dB $L_{Aeq,\ 8\ hour}$ at night. If a 15 dB reduction is assumed for attenuation through an open window, then a maximum outdoor sound level of 45 dB $L_{Aeq,\ 8\ hour}$ is applicable.

BS 8233:2014 also includes a methodology for assessment to noise rating (NR) values. This is a method for assigning a single-number rating to a noise spectrum. It can be used to specify the maximum acceptable level in each octave band of a frequency spectrum.

2.5 Consultation with Angus Council

Angus Council have been consulted to ensure that this acoustic assessment meets their requirements. RES and Angus Council agreed the following:

- To undertake a noise impact assessment for the Proposed Development according to BS 4142:2014+A1:2019.
- The measured background sound pressure levels ($L_{Aeq,15\ min}$ dB and $L_{A90,15\ min}$ dB) over a minimum period of 7 days will be used to undertake an acoustic impact assessment in accordance with BS 4142:2014+A1:2019.
- Consideration will be given to Noise Rating Curve NR30 in the daytime and NR20 at night-time, according to the values defined in BS 8233:2014, calculated within the nearest noise sensitive property with windows open.
- Background sound level measurements were proposed in the vicinity of the nearest residential properties, on different sides of the Proposed Development. The four locations to use for unattended background sound measurements were agreed.
- Meteorological conditions will be recorded and a detailed description of the sound environment will be provided.

3 Methodology

3.1 Baseline Conditions

In order to complete a BS 4142 assessment of the proposed development, the background sound level at the times when the new sound source is intended to be operational should be measured. The background sound level is defined as the A-weighted sound pressure level that is exceeded for 90 % of the measurement time interval T, or $L_{A90,\,T}$.

Measurements should be made at a location that is representative of the assessment locations, the time interval should be sufficient to obtain a representative value, and the duration should be long enough to reflect the range of background sound levels over the period of interest.

Precautions should be taken to minimise the influence on the results from sources of interference. Weather conditions that may affect the measurements should be recorded and an effective wind shield used to minimise wind interference at the microphone.

A statistical analysis, following the example given by BS 4142, should be used to determine an appropriate background sound level for the analysis from the range of results obtained.

3.2 Propagation

A sound propagation model of the Proposed Development and the surroundings has been developed using CadnaA[1] noise modelling software. The ISO 9613-2 [6] propagation model is referenced by BS 4142:2014+A1:2019 as a validated methodology and shall be used to predict the specific sound levels due to the Proposed Development at nearby residential properties, incorporating various assumptions and factors which are considered appropriate for use here:

- The various sound-emitting equipment to be installed as part of the Proposed Development have been modelled as point sources. The sources are assumed to be operating at their maximum potential output for all time periods as the most conservative basis for the assessment.
- Soft ground conditions have been applied (i.e., a ground factor of 1) as representative of the farmland surrounding the Proposed Development.
- The receptors have been assigned a height of 4 m above ground level.
- Atmospheric attenuation corresponding to a temperature and relative humidity of 10 °C and 70 % respectively, as defined within ISO 9613-1 [7], which represents relatively low levels of sound absorption in the atmosphere.
- The topography of the site and surroundings has been included within the model.
- The photovoltaic panels to be introduced as part of the development have also been included within the prediction model. This provides some shielding of sound generated by the equipment to be installed at the Proposed Development where certain panels are located directly between residences and the respective plant.

[1] https://www.datakustik.com/

The effect of surface features such as buildings, trees or other objects is not included in the model. There is a level of conservatism built into the model as a result of the adoption of these settings.

ISO 9613-2 is a downwind propagation model. Where conditions less favourable to sound propagation occur, such as when the assessment locations are crosswind or upwind of the proposed development, the sound levels would be expected to be less, and the downwind predictions presented here would be regarded as conservative, i.e., greater than those likely to be experienced in practice.

The inverters (PCS units) at the Proposed Development are assumed not to be operational during night-time periods. However, these sites may start becoming operational in early hours of the morning during particularly bright summer months, although this will occur very rarely and this equipment will be operating under a much-reduced electrical load during these periods, substantially reducing the expected sound levels as compared with the daytime/evening scenarios.

3.3 Noise Rating

Annex B of BS 8233:2014 states Noise Rating (NR) is a method for assigning a single-number rating to a noise spectrum. BS 8233:2014 provides guidance on the methodology for determining noise rating values in each octave band from unweighted sound pressure levels.

The sound level outdoors is calculated according to the methodology detailed in **Section 3.2** as an A-weighted sound pressure level spectrum in each octave band. These values have been converted to un-weighted sound pressure levels in each octave band and attenuation values for sound propagation through an open window have been applied. The attenuation values used for sound propagation through an open window have been taken from Table 5-6 (opening size 200k mm^2) of a report produced by Napier University for the Department of Environment, Food and Rural Affairs [8].

The resulting internal un-weighted sound pressure level in each octave band is compared to the NR curve values to obtain an NR rating.

4 Background Sound Environment

4.1 Details of the Survey

Baseline sound levels were determined in a survey undertaken between 21st and 28th August 2024. Survey locations are shown on the map in **Figure 1** (**Appendix B.1**) and their co-ordinates are shown in **Table 1 (Appendix B.1)**.

The sound level meters are certified as meeting either BS 7580-1:1997 [9] or IEC 61672-1:2013 [10] Class 1 precision standards. The microphone was approximately 1.2 m above ground level and an outdoor wind shield supplied by the manufacturer was used.

The sound level meters were placed away from reflective surfaces as shown in the photos in **Appendix C**. The equipment was field calibrated at the start and end of the survey. Maximum detected drift was 0.3 dB, which is appropriate. All the sound level meters had been subject to laboratory calibration traceable to national standards within the previous 24 months and the sound calibrator had been subject to laboratory calibration traceable to national standards within the previous 12 months, with the calibration dates and references provided in **Table 2**.

Table 2 - Instrumentation Records for Unattended Measurements

	Meter 1	Meter 2	Meter 3	Meter 4
Type	Rion NL-52	Rion NL-52	Rion NL-31	Rion NL-52
Serial No.	00197726	00610207	00983380	00732144
Calibration Certificate No.	UCRT23/1469	UCRT24/1086	UCRT23/1071	UCRT24/1272
Date of Issue	03/04/2023	17/01/2024	16/01/2023	19/02/2024
Microphone Serial No.	14675	24815	315831	05336
Preamp Serial No.	87395	10201	28713	32172
Sound Calibrator Type	Rion NC-74	Rion NC-74	Rion NC-74	Rion NC-74
Calibrator Serial No.	34315132	34315132	34315132	34315132
Calibrator Cert. No.	UCRT23/2386	UCRT23/2386	UCRT23/2386	UCRT23/2386
Date of Issue	23/10/23	23/10/23	23/10/23	23/10/23

The background acoustic environment during installation and decommission was dominated mainly by wind blowing through trees at all locations with very distant agricultural machinery sounds.

Weather conditions during the survey were dry and overcast with temperatures ranging between 7°C and 20°C. There was some rain during the survey, therefore measurement data during those periods of rain has been excluded from the data analysis. Data has also been excluded for wind speeds over 5 m/s. Note that the weather station was set up at survey location 4, see **Figure 22 (Appendix C.1)**.

4.2 Survey Results

Time histories recorded during the survey at each location are shown in **Appendix B.2**. The average residual sound levels ($L_{Aeq, 15mins}$) measured during day and night-time at each location are shown in **Table 3**.

In accordance with BS 4142:2014+A1:2019 representative background sound levels need to be determined from statistical analysis of measured L_{A90} levels. Histograms of measured background sound levels are shown in **Appendix B.3**, and derived representative background sound levels are shown in **Table 3**.

Table 3 - Survey Results

Survey location	Residual Sound Level, $L_{Aeq, 15\ min}$, dB		Background Sound Level, $L_{A90, 15\ min}$, dB	
	Daytime (07:00-23:00)	Night-time (23:00-07:00)	Daytime (07:00-23:00)	Night-time (23:00-07:00)
1	43	38	49	41
2	37	29	42	33
3	35	30	43	33
4	37	24	41	34

It should be noted that upon analysis of the survey data from location 1, the results were deemed to be unrepresentative for the area due to unexpected high background sound levels. This was likely attributable to a grain drier which was not operational during the setup but was during decommission of the survey. Therefore the receivers within this area were re-assigned one of the more conservative background sound levels.

This report presents an assessment for the 20 closest residential properties to the site which may be affected.

The residential properties used for the assessment are shown in **Figures 14 & 15** (**Appendix B.4**). The house ID numbers, coordinates, as well as representative measured acoustic data for each house are presented in **Table 4**. The coordinate system used is the British National Grid (EPSG 27700).

Table 4 - Residential Properties and Baseline Levels

House ID	X/m	Y/m	Day Background Sound Level / L_{A90} dB	Night Background Sound Level / L_{A90} dB	Day Residual Sound Level / L_{Aeq} dB	Night Residual Sound Level / L_{Aeq} dB
H01	357305	739832	35	30	47	41
H02	357293	739796	35	30	47	41
H03	358231	739746	35	30	47	41
H04	356919	739714	35	30	47	41
H05	357028	739568	35	30	47	41
H06	357005	739607	35	30	47	41
H07	356986	739646	35	30	47	41
H08	357030	739649	35	30	47	41
H09	356393	740471	37	29	42	37
H10	358608	740570	37	29	42	37
H11	357031	740647	37	29	42	37
H12	357579	740914	37	29	42	37
H13	357261	740196	35	30	47	41
H14	357151	740441	37	29	42	37
H15	355332	741346	37	24	46	39
H16	356653	740334	37	29	42	37
H17	357233	741465	37	24	46	39
H18	355750	741568	37	24	46	39
H19	356387	741808	37	24	46	39
H20	356363	741524	37	24	46	39

5 Assessment

5.1 Sound Generating Equipment

The predominant sources of sound to be introduced as part of the Proposed Development are the 14 power conversion systems (PCS) inverter units, 14 PCS medium voltage (MV) transformers, and the 50MW capacity grid transformer.

The sound power level data for representative equipment to be installed as part of the Proposed Development are provided in **Table 5.** The source levels associated with the inverter/PCS, MV transformer and grid transformer at the Proposed Development are based on the expected maximum sound output for anticipatory units, as advised as appropriate by candidate manufacturers, and/or historical source information where appropriate. The propagation modelling therefore represents a conservative scenario and actual sound levels would be expected to be lower when the site is not operating at maximum capacity.

Table 5 - Overall Sound Power Levels, dB L_{WA}

Equipment & ID	Sound Power Level, dB L_{WA}
Power Conversion System (PCS)	80
MV Transformer (MV TRA)	76
Grid Transformer (GRID TRA)	90

The data is further supplemented by the sound power level in octave bands, as provided in **Table 6.**

Table 6 - Octave Band Sound Power Levels, dB L_{WA}

ID	Overall, dB L_{WA}	Octave Band Centre Frequency, Hz							
		63	125	250	500	1k	2k	4k	8k
PCS	80	55	65	75	73	73	72	67	63
MV TRA	76	41	62	70	74	64	57	51	49
GRID TRA	90	55	77	85	88	78	71	65	63

The results of the predictions at the various residences surrounding the Proposed Development are shown in **Section 5.3**.

5.2 Acoustic Feature Correction

In accordance with BS 4142:2014+A1:2019 penalties can be applied to the predicted specific sound level to achieve the rating level at each receptor. The penalties can be applied for “attention catching features” such as tonality, impulsivity, intermittency and other distinguishable characteristics.

The sound emitted by the various equipment to be introduced as part of the Proposed Development can have distinctive tonal character (i.e. a whine, whistle or hum). Under the subjective method described in BS 4142, a correction of 2 dB has been applied to account for this feature. However, the assessed specific and rating sound levels detailed in **Section 5.3** are particularly low and, in most instances, potential tonal component

in the sound emitted from the various plant may well be masked by existing sources of background/ambient sound in the area.

The sound generated by the proposed equipment is not expected to be intermittent or impulsive, due to the equipment operating consistently. Changes to sound pressure levels due to load changes will be gradual and will not result in attention catching characteristics. There are no other specific sound feature characteristics expected to be present which would be readily distinctive against the residual acoustic environment.

5.3 Acoustic Impact

The potential impact is described as 'negligible' if the rating level is more than 10 dB below the background noise level; 'low' if less than or equal to the background noise level; 'minor' if not more than 5 dB above; 'moderate' if not more than 10 dB above and 'major' if more than 10 dB above.

The assessment indicates that the predicted noise impact from the Proposed Development at the nearest neighbouring residences is negligible-to-low for daytime periods and negligible-to-minor for night-time periods, with the minor impact predicted to occur at the residency just south of the site. This level would be considered not significant in terms of the guidance provided within the Technical Advice Note (TAN) detailed at Section 2.2, as outlined by the Scottish Government.

Predicted rating levels at nearby properties are detailed in **Table 7** for day and night-time periods respectively.

The rating level is then compared to the background sound levels from **Table 4** to give an initial estimate of the potential impact at each location and results of this are also shown in **Table 7**. An illustrative sound footprint for the proposed development showing the predicted specific sound level during the day and night are provided in **Figures 14 & 15 respectively (Appendix B.4)**. The predicted maximum rating level ($L_{Ar,\,Tr}$) at any house is 33 dB.

Table 7 - BS 4142 Assessment Results

House ID	Rating Level, dB $L_{Ar,\,Tr}$		Rating vs Background, dB		Potential Impact	
	Daytime (07:00-23:00)	Night-time (23:00-07:00)	Daytime (07:00-23:00)	Night-time (23:00-07:00)	Daytime (07:00-23:00)	Night-time (23:00-07:00)
H01	17	16	-18	-14	Negligible	Negligible
H02	17	16	-18	-14	Negligible	Negligible
H03	11	9	-24	-21	Negligible	Negligible
H04	16	15	-19	-15	Negligible	Negligible
H05	15	14	-20	-16	Negligible	Negligible
H06	16	14	-19	-16	Negligible	Negligible
H07	16	15	-19	-15	Negligible	Negligible
H08	16	15	-19	-15	Negligible	Negligible
H09	21	19	-16	-10	Negligible	Negligible
H10	11	10	-26	-19	Negligible	Negligible

House ID	Rating Level, dB $L_{Ar, Tr}$		Rating vs Background, dB		Potential Impact	
	Daytime (07:00-23:00)	Night-time (23:00-07:00)	Daytime (07:00-23:00)	Night-time (23:00-07:00)	Daytime (07:00-23:00)	Night-time (23:00-07:00)
H11	33	33	-4	4	Low	Minor
H12	26	22	-11	-7	Negligible	Low
H13	20	19	-15	-11	Negligible	Negligible
H14	24	23	-13	-6	Negligible	Low
H15	13	10	-24	-14	Negligible	Negligible
H16	21	19	-16	-10	Negligible	Negligible
H17	24	21	-13	-3	Negligible	Low
H18	17	13	-20	-11	Negligible	Negligible
H19	18	15	-19	-9	Negligible	Low
H20	22	18	-15	-6	Negligible	Low

Overall, based on the modelling assumptions and assessment results presented, the sound emitted by the Proposed Development can be considered not significant in terms of technical advice provided by the Scottish Government.

BS 4142 recognises the importance of the context in which a sound occurs. It states that the impact depends upon both the margin by which the rating level of the specific sound source exceeds the background sound level and the context in which the sound occurs. For instance, the property with the highest predicted levels, H11, belongs to the landowner and was unoccupied at the time of the background sound survey. It should be noted that this property is completely shielded by a number of farm buildings which are located between the grid transformer and the property. Since the grid transformer is the most significant contributor to the predicted sound levels, it would be expected that in practice, these predicted levels would be significantly reduced as a result of the nearby buildings. The background levels at this location were the highest and most likely attributable to the farming activities and equipment, including a grain drier, located nearby.

BS 4142 states that absolute levels may be more relevant than the margin by which the rating level exceeds the background sound level in circumstances where the background sound levels and rating levels are low. The previous version of BS 4142 (1997 version) provides numerical values for this and states that "background noise levels below about 30 dB and rating levels below about 35 dB are considered to be very low". The representative background sound level at most houses is around 30 dB or below at night and the rating levels at all houses are below 35 dB. Therefore in accordance with BS 4142 an assessment against absolute limits is more relevant during night time.

An assessment against an outdoor sound level of 45 dB $L_{Aeq, 8\ hour}$ (as detailed in **Section 2.4**) shows that the Proposed Development does not exceed this absolute limit at any of the properties during the night-time. In addition the noise rating assessment in **Section 5.4** below is also against absolute limits.

The wording for a suggested planning condition that would restrict noise/sound associated with the introduction of the Proposed Development, should the site gain planning consent, is provided in **Appendix D**.

5.4 Noise Rating Assessment

Following the methodology as detailed in **Section 3.3**, the resulting internal un-weighted sound pressure levels in each octave band at H11 (the nearest property to the Proposed Development) are compared to NR curve values for NR20 during night-time (23:00 - 07:00) and NR30 during daytime (07:00-23:00) hours.

Table 8 - Noise Rating Levels at H11 (Day)

Octave band Centre Frequency, Hz	63	125	250	500	1000	2000	4000	8000
Outdoor Level Spectrum, dB(A)	3	20	22	31	22	15	5	-9
Outdoor Level Spectrum, dB(Z)	30	36	30	34	22	13	4	-8
Open Window Sound Attenuation, dB(Z)	20	14	14	16	14	17	19	19
Indoor Level Spectrum, dB(Z)	10	22	16	18	8	-4	-15	-27
NR30 Values, dB(Z)	59	48	40	34	30	27	25	23
Resulting Noise Rating Value (NR)	0	0	5	14	8	0	0	0

Table 9 - Noise Rating Levels at H11 (Night)

Octave band Centre Frequency, Hz	63	125	250	500	1000	2000	4000	8000
Outdoor Level Spectrum, dB(A)	1	20	21	31	22	14	4	-9
Outdoor Level Spectrum, dB(Z)	27	36	30	34	22	13	3	-8
Open Window Sound Attenuation, dB(Z)	20	14	14	16	14	17	19	19
Indoor Level Spectrum, dB(Z)	7	22	16	18	8	-4	-16	-27
NR20 Values, dB(Z)	51	39	31	24	20	17	14	13
Resulting Noise Rating Value (NR)	0	0	4	14	8	0	0	0

Table 8 and 9 show that the internal level spectrum is below the NR20 and NR30 values. The highest noise rating value is NR14 in both cases, therefore noise rating NR20 is met during the night-time and NR30 is met during the day. These results are displayed graphically in **Figure 16 and 17** (**Appendix B.5**).

As H11 is the nearest property to the Proposed Development, the NR20 and NR30 values will also be met at all other properties.

6 Conclusions

An acoustic impact assessment of the proposed Bonnyknox Solar Site has been undertaken. The results show that the impact resulting from the operation of the site will not be significant in the context of relevant assessment criteria (i.e., BS 4142 and BS 8233) and can be considered insignificant in terms of technical advice provided by the Scottish Government.

7 References

[1] British Standards Institution (2019) BS 4142:2014+A1:2019 Methods for Rating and Assessing Industrial and Commercial Sound

[2] British Standards Institution (2014) BS 8233:2014 Guidance on Sound Insulation and Noise Reduction for Buildings

[3] Scottish Government (March 2011) Planning Advice Notice 1/2011: Planning and Noise

[4] Scottish Government (March 2011) Assessment of Noise: Technical Advice Note

[5] British Standards Institution (1997) BS 4142:1997 Rating Industrial Noise Affecting Mixed Residential and Industrial Areas

[6] International Organisation for Standardisation (1996) ISO 9613-2:1996 Acoustics - Attenuation of Sound During Propagation Outdoors - Part 2: General Method of Calculation

[7] International Organisation for Standardisation (1993) ISO 9613-1:1993 Acoustics - Attenuation of sound during propagation outdoors - Part 1: Calculation of the Absorption of Sound by the Atmosphere

[8] The Building Performance Centre, Napier University (2007) NANR116: 'Open/closed window research' Sound Insulation Through Ventilated Domestic Windows

[9] British Standards Institution (1997) BS 7580-1:1997 Specification for the verification of sound level meters - Comprehensive procedure

[10] International Electrotechnical Commission (2013) IEC 61672-1:2013 Electroacoustics - Sound level meters - Part 1: Specifications

Appendix A – Experience & Qualifications

Table A.1 - Author

Name	Lucy Connor
Experience	Acoustic Specialist, Renewable Energy Systems, 2024-Present
Qualifications	AMIOA, Associate Member of the Institute of Acoustics MSc Acoustics and Music technology, University of Edinburgh BSc Mathematics and Statistics, University of Strathclyde

Table A.2 - Checker

Name	Stuart Hill
Experience	Senior Acoustic Specialist, Renewable Energy Systems (RES), 2024-Present Senior Acoustic Consultant, Mabbett, 2022-2024 Senior Environmentalist (Acoustics), Amey, 2021-2022 Associate Consultant – Acoustics, Noise & Vibration, SLR Consulting, 2017-2020 Technical Analyst/Senior Acoustic Analyst, RES, 2013-2017
Qualifications	MIOA, Member of the Institute of Acoustics MInstP, Member of the Institute of Physics MSc Principles and Applications of Radiation in Industry, the Environment and Medicine, University of St Andrews BEng Electronics Engineering, University of Aberdeen

Table A.3 - Approver

Name	Karen Anne Hutton
Experience	Technical Director, Renewable Energy Systems (RES), 2023–Present Head of Repowering & Life Extension, RES, 2019-2023 Head of Innovation & Optimisation, RES, 2018-2019 Transformation Manager, RES, 2016-2018 Initiatives Manager, RES, 2015-2016 Prospecting & Development Data Manager, RES, 2012-2015 Technical Manager, RES, 2009-2012 Senior Wind Analyst, RES, 2007-2009 Wind Analyst, RES, 2001-2007
Qualifications	MEng Civil Engineering, Heriot-Watt University

Appendix B – Figures

B.1 Background Sound Monitoring Locations

Figure 1 - Background Sound Monitoring Locations

Table 1 - Co-ordinates of Survey Locations (EPSG 27700)

Survey Location	Co-ordinates	
	X/m	Y/m
1	357029	740637
2	357617	741120
3	357355	739985
4	356385	741361

B.2 Measured Time Histories of Measurements

Figure 2 - Time History of Measurements Taken at Location 1

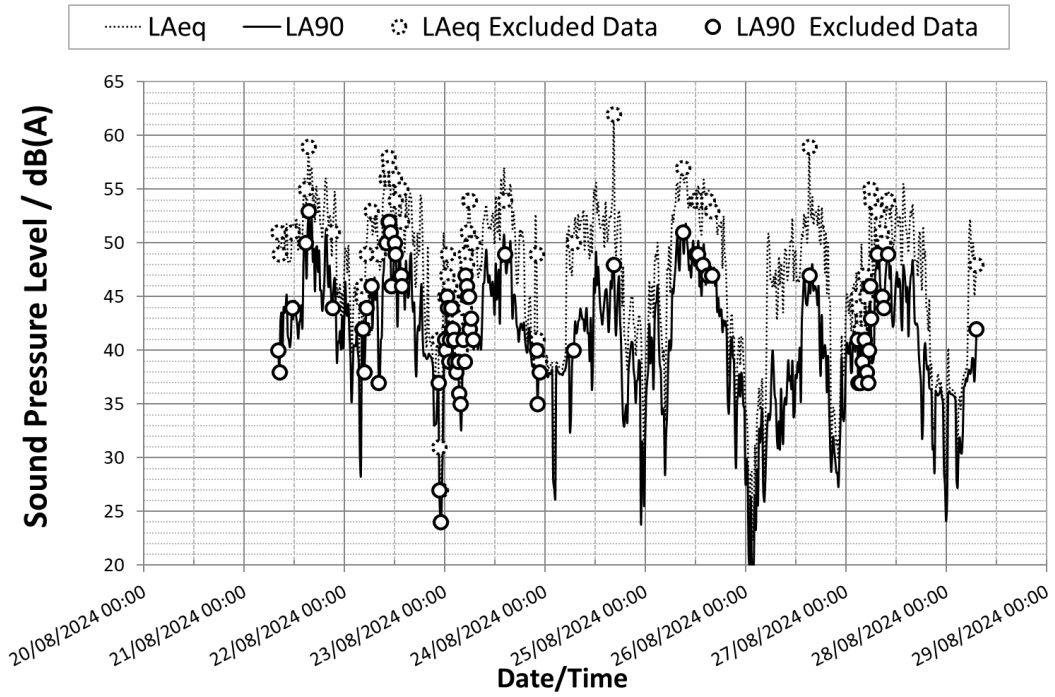


Figure 3 - Time History of Measurements Taken at Location 2

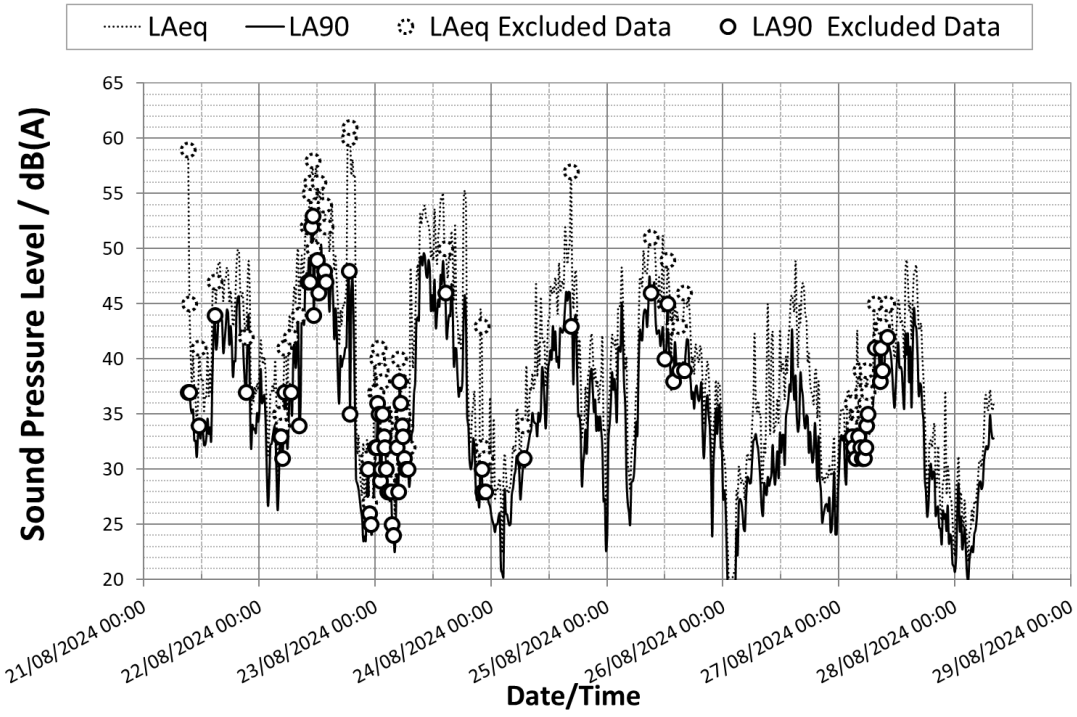


Figure 4 - Time History of Measurements Taken at Location 3

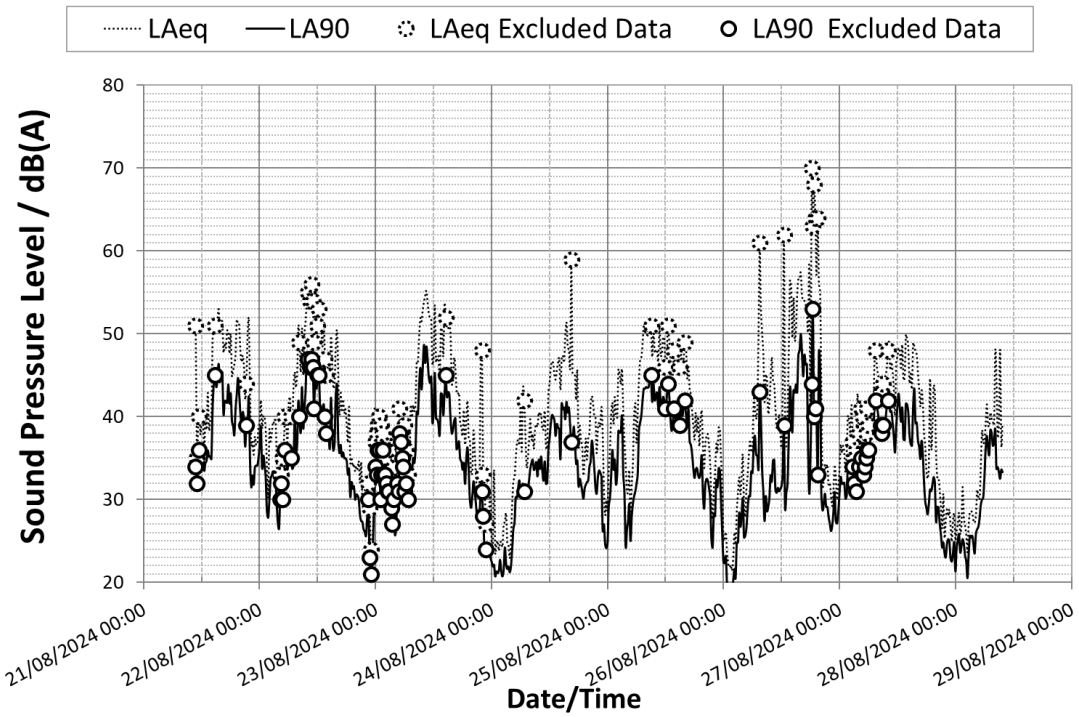
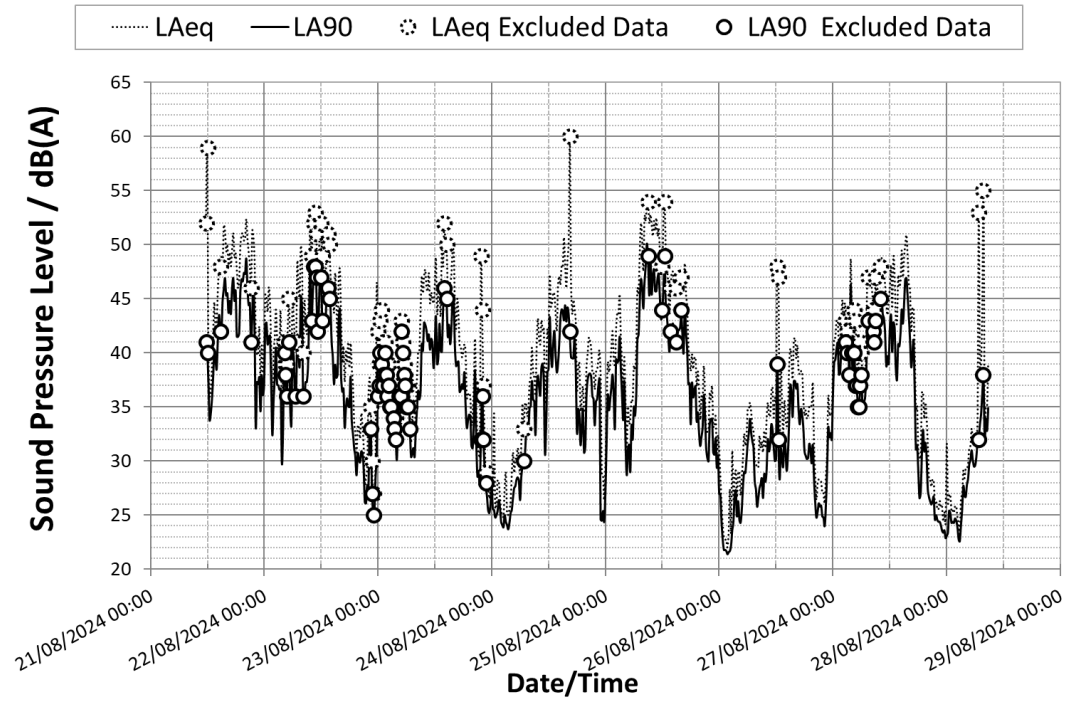


Figure 5 - Time History of Measurements Taken at Location 4



B.3 Histograms of Background Sound Levels from Measurements

B.3.1 Monitoring Position 1

Figure 6 - Histogram of Daytime $L_{A90,\ 15\ Min}$, dB, Measured at Measurement Position 1

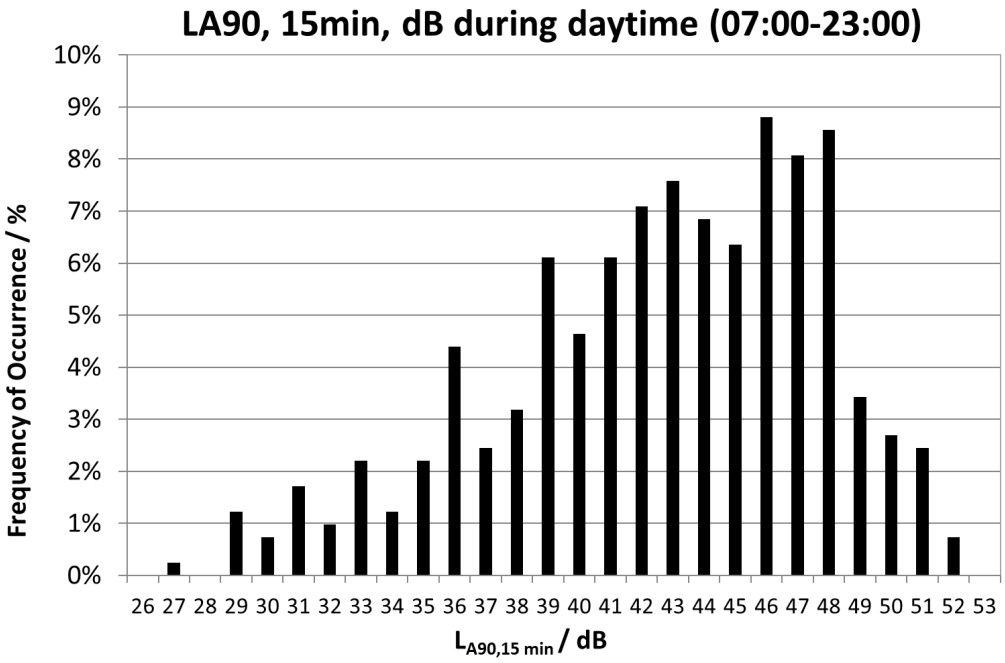
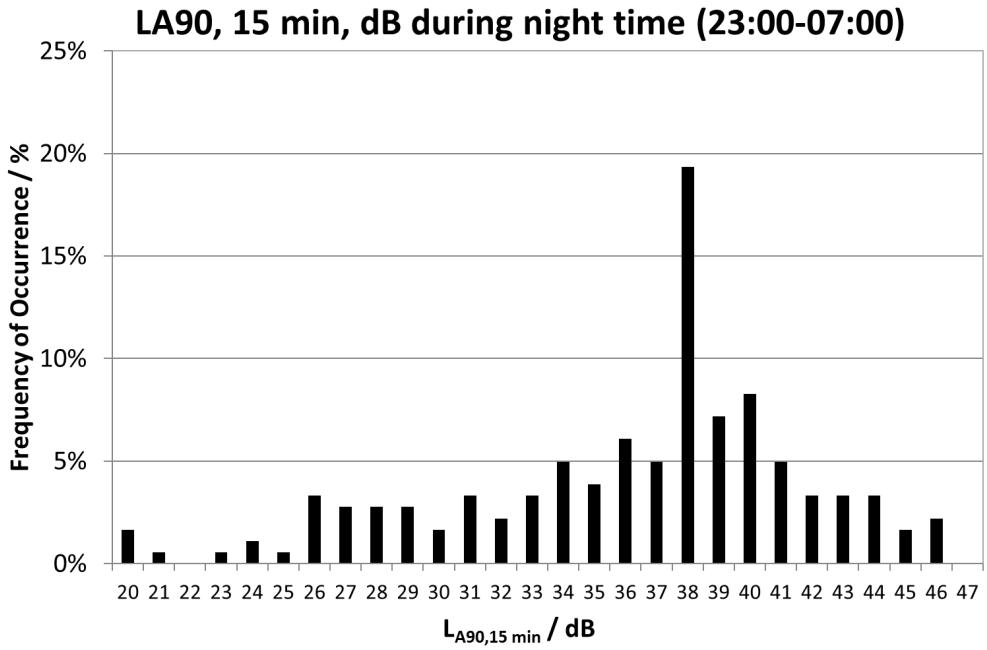


Figure 7 - Histogram of Night-time $L_{A90,\ 15\ Min}$, dB, Measured at Measurement Position 1



B.3.2 Monitoring Position 2

Figure 8 - Histogram of Daytime $L_{A90,\ 15\ Min}$, dB, Measured at Measurement Position 2

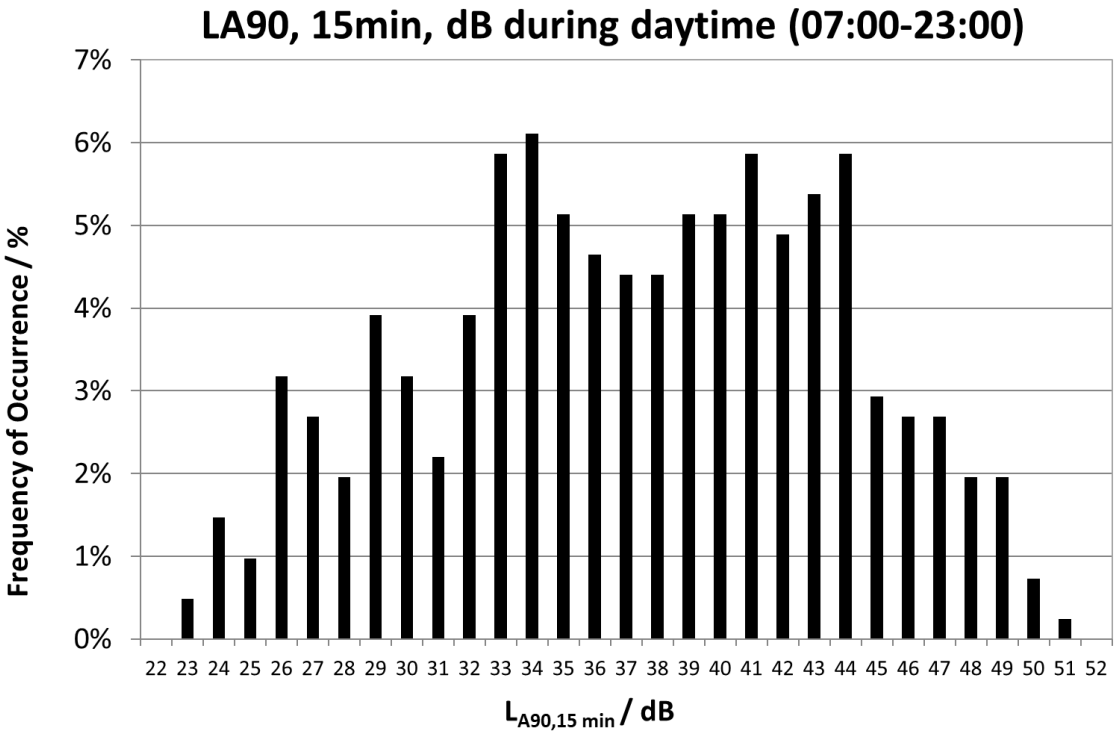
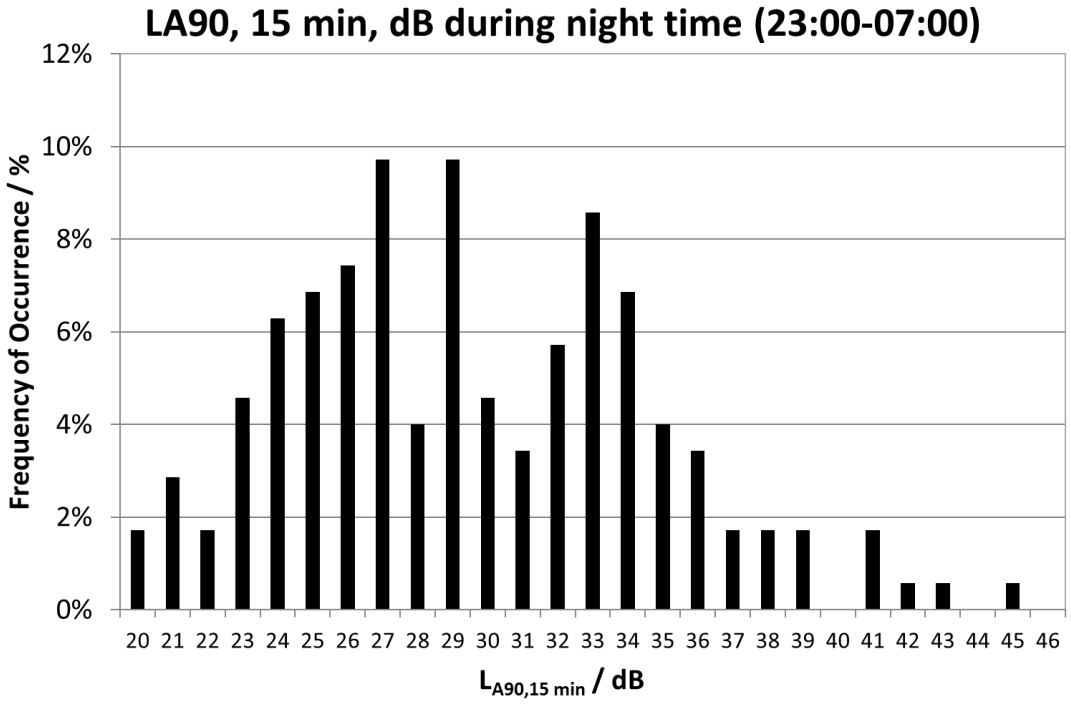


Figure 9 - Histogram of Night-time $L_{A90,\ 15\ Min}$, dB, Measured at Measurement Position 2



B.3.3 Monitoring Position 3

Figure 10 - Histogram of Daytime $L_{A90,\ 15\ Min}$, dB, Measured at Measurement Position 3

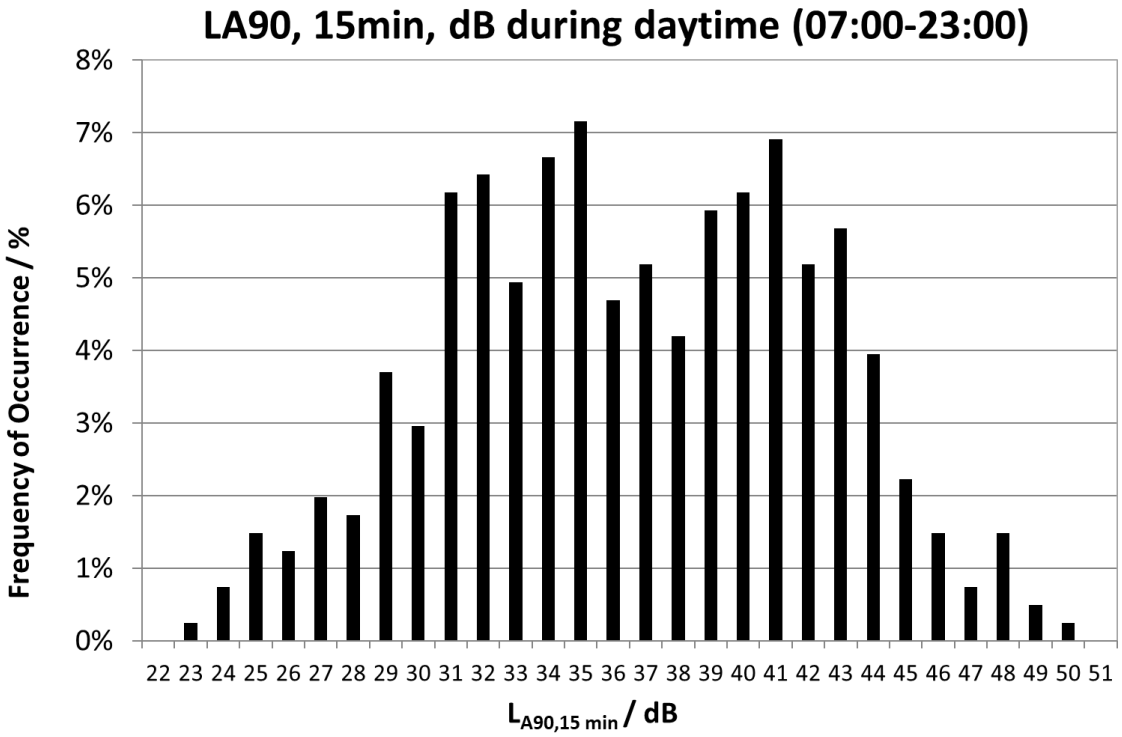
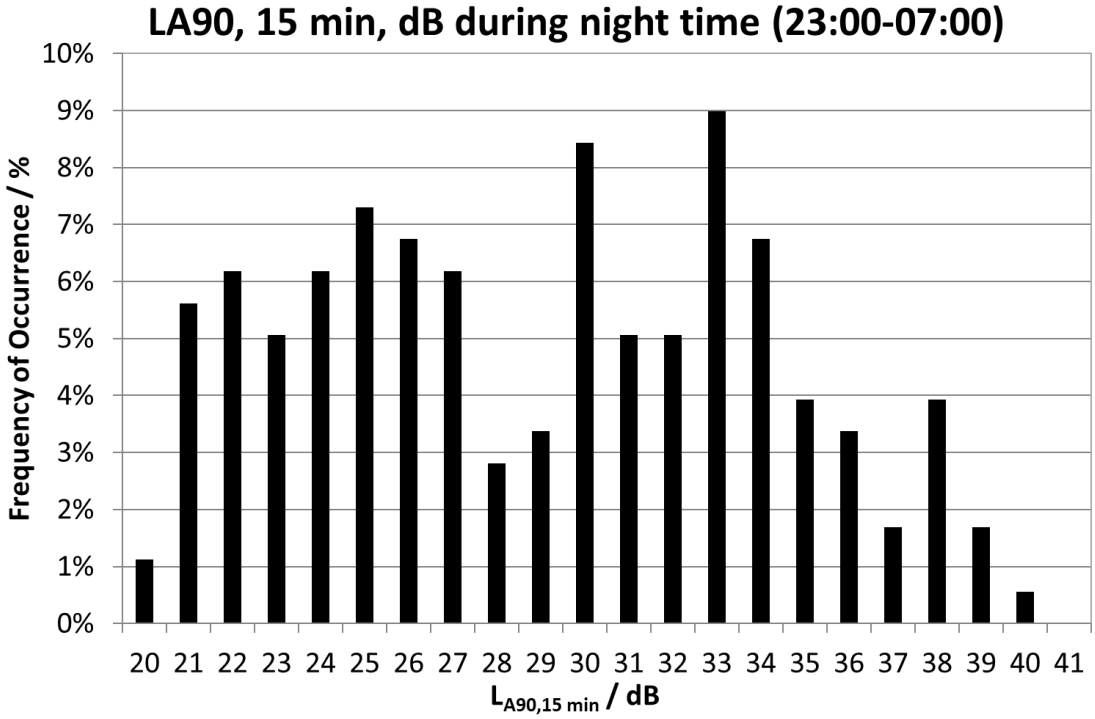


Figure 11 - Histogram of Night-time $L_{A90,\ 15\ Min}$, dB, Measured at Measurement Position 3



B.3.4 Monitoring Position 4

Figure 12 - Histogram of Daytime $L_{A90,\ 15\ Min}$, dB, Measured at Measurement Position 4

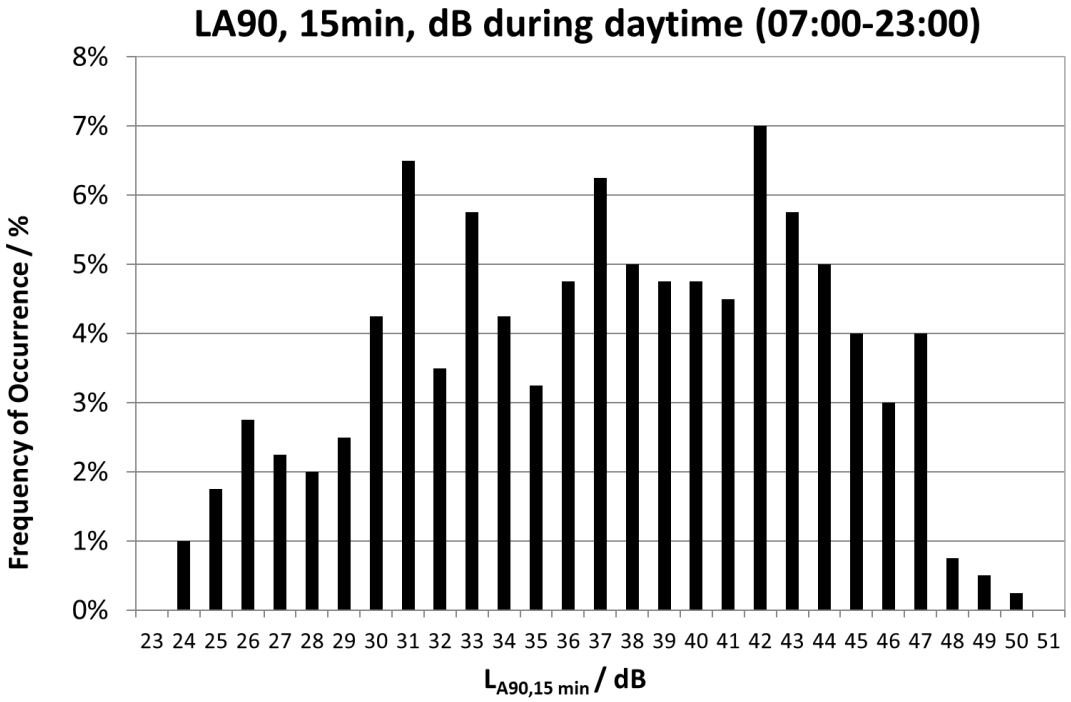
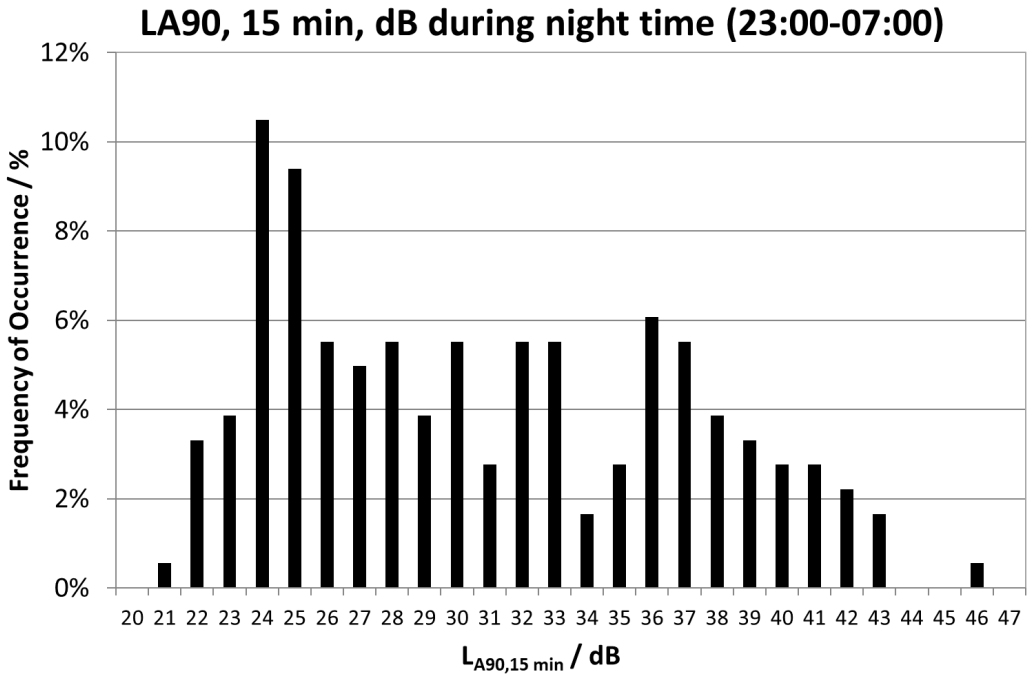


Figure 13 - Histogram of Night-time $L_{A90,\ 15\ Min}$, dB, Measured at Measurement Position 4



B.4 Predicted Acoustic Footprint

Figure 14 - Predicted operational acoustic footprint of the site during daytime (dB $L_{Aeq,Tr}$)

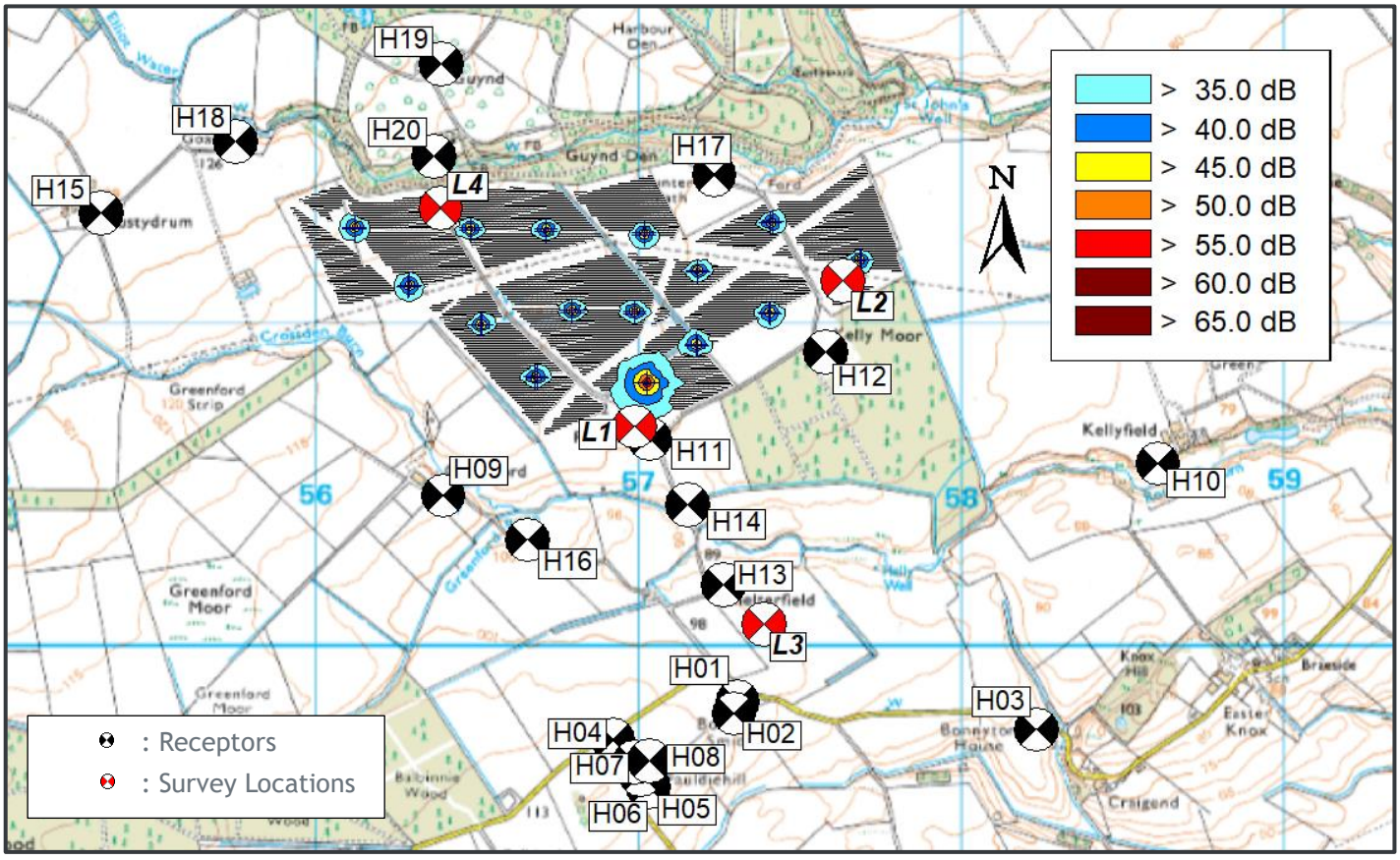
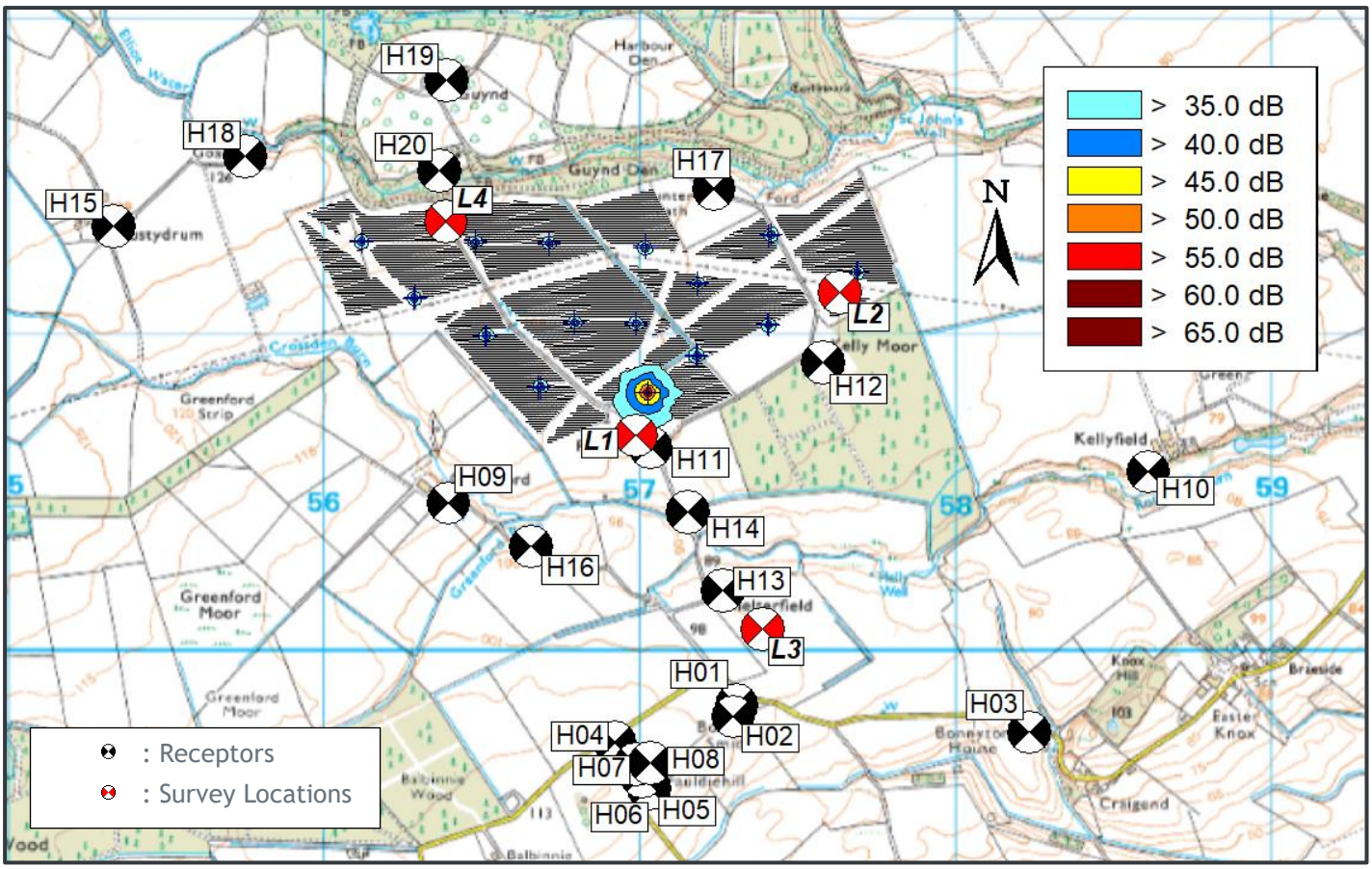


Figure 15 - Predicted operational acoustic footprint of the site during night time (dB $L_{Aeq,Tr}$)



B.5 Noise Rating Curves

Figure 16 – Noise Rating Curves Compared to H11 Level Spectrum Daytime, dB(Z)

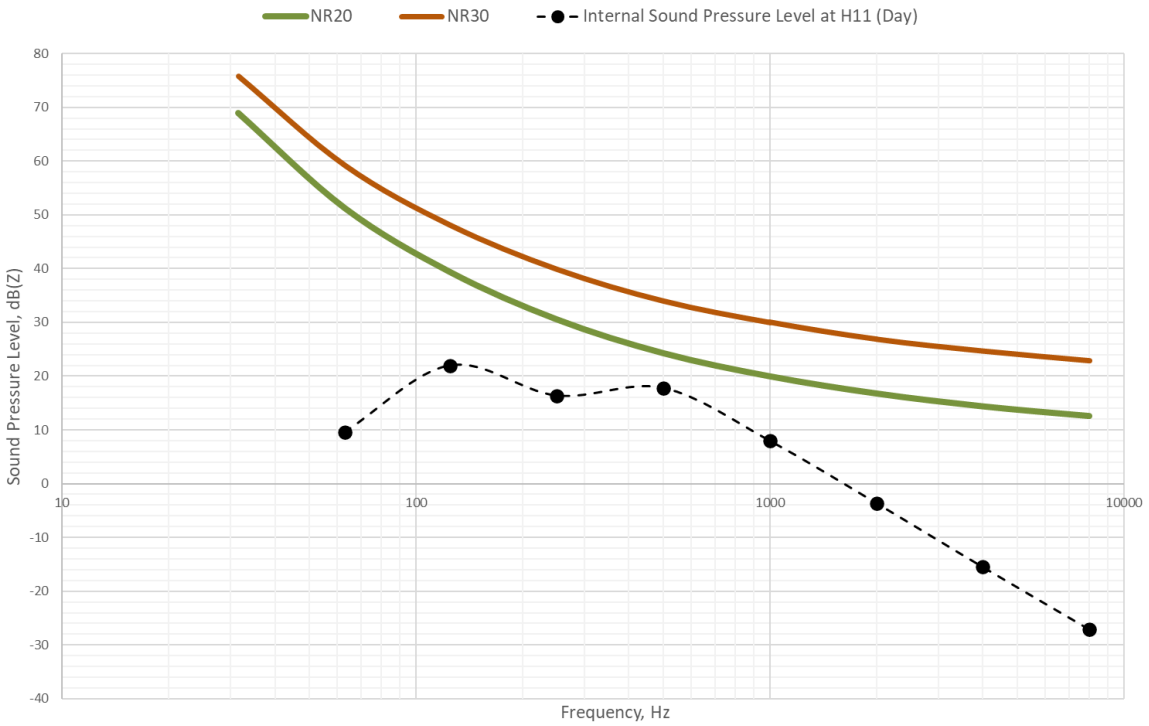
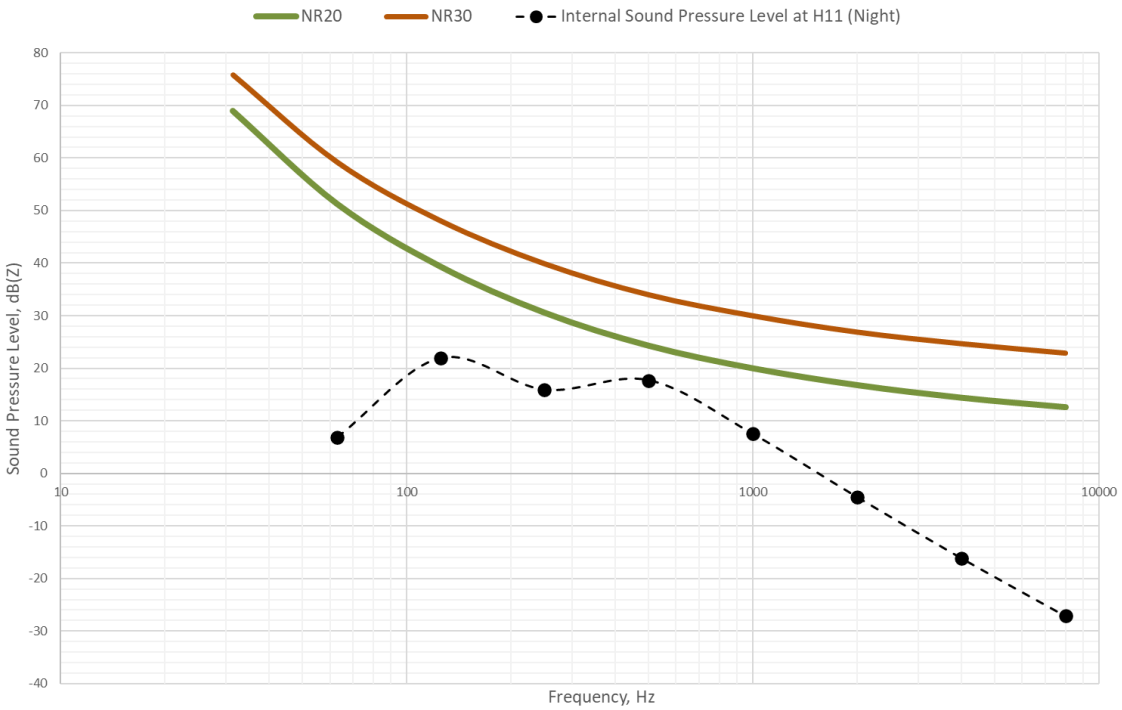


Figure 17 – Noise Rating Curves Compared to H11 Level Spectrum Night Time, dB(Z)



Appendix C – Photos

C.1 Background Sound Survey Positions

Figure 18 - Background Sound Monitor at Location 1

Figure 19 - Background Sound Monitor at Location 2

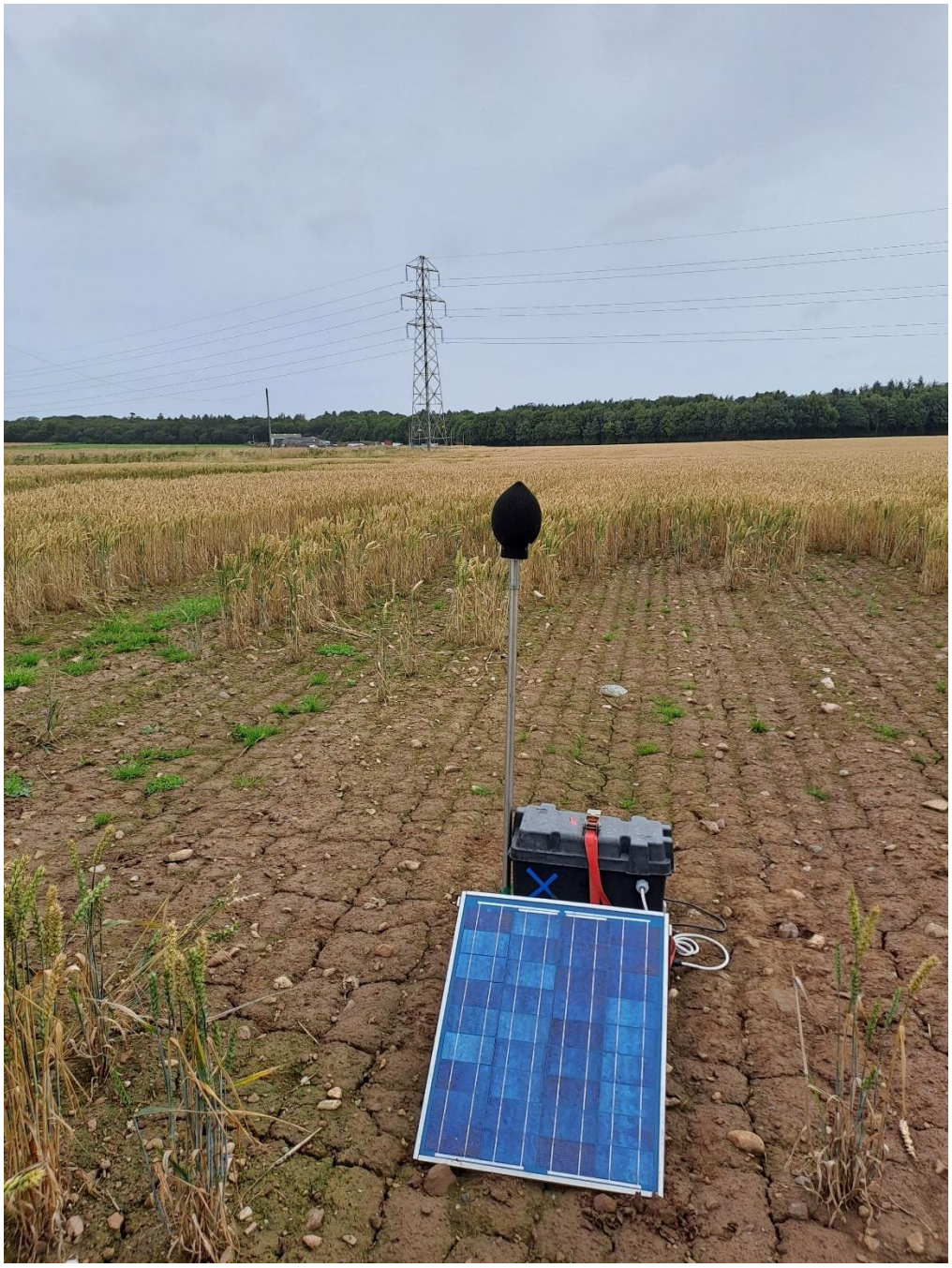


Figure 20 - Background Sound Monitor at Location 3

Figure 21 - Background Sound Monitor at Location 4

Figure 22 - Weather Station Setup at Location 4

Appendix D – Suggested Planning Condition Wording

Bonnyknox Solar Site shall be designed and operated to ensure that the rating sound level, determined using the BS 4142:2014 + A1:2019 methodology external to an existing residence, shall not exceed 40 dB L_{Ar} or the background sound level plus 5 dB, whichever is the greater, for both daytime and night-time periods.