Contullich Energy Storage Project

Acoustic Impact Assessment

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Contents

1 Introduction

This report provides an acoustic assessment of the proposed Contullich Energy Storage Project, referred to as 'the Proposed Development' herein, in terms of operational and potential construction impacts. Two Members of the Institute of Acoustics (MIOA) have been involved in its production and details of their experience and qualifications can be found in **Appendix A**.

An assessment of the noise generated by the equipment to be installed has been undertaken in accordance with BS 4142:2014 + A1:2019 'BS 4142 Methods for Rating and Assessing Industrial & Commercial Sound' and guidance within BS 8233 and that provided by the World Health Organisation (WHO).

A discussion of the potential impacts resulting from the construction of the Proposed Development has been provided with reference to BS 5228-1:2009 'Code of Practice for Noise and Vibration Control on Construction and Open Sites - Parts 1 & 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' [1]. 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 'Technical Advice Note (TAN): Assessment of Noise' [2] 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 The guidance refers to a since superseded version of BS 4142 in terms of assessing the impact of new noise generating development on neighbouring residences (the latest and previous version of which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 (see **Section 2.4**).

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

BS 4142 [3] 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 noise levels with the predicted/modelled noise 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 noise 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 that the background noise measurements (dB $L_{A90,\,T}$ – the noise level exceeded for 90% of the time, or the lowest 10 % of noise, for the reference time period, T) should be measured during times when the noise source in question could or will be operating and that the individual measurement intervals should not normally be less than 15-minuites in length. The objective is then to determine a justifiable representative background noise level for time periods of interest via statistical analysis and/or observations of the data set collected. The standard states that the representative background noise 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 average sound level) plus any corrections for the presence tones (i.e. whines, whistles or hums) or other impulsive character (i.e. banging, crashing or tapping) in the sound generated by the source in question. In instances where the source 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 tones are present a correction of 2 to 6 dB can be added to the 'specific' sound level to determine the 'rating' level and a further addition of up to 9 dB maybe added where the source is highly impulsive.

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 noise sources and the existing character of the area. **Table 1** provides a summary of expected impacts when comparing background and rating levels.

Table 1 – BS 4142 Assessment Criteria

Rating Level	BS 4142 Assessment Criteria
Equal to or below background	'…an indication of the specific sound source having a low impact, depending on the context'.
Approximately +5 dB greater than the background noise level	'…an indication of an adverse impact, depending on the context'.
Approximately +10 dB or more greater than the background noise 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 sound level associated with the new source is particularly low at neighbouring receptors and/or is expected to be much lower than the existing background sound levels. The previous version of BS 4142 [4] 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 World Health Organisation (WHO)

The WHO document Guidelines for Community Noise [5] provides guideline values on overall desirable internal and external noise levels for a variety of situations which are intended to minimise health impacts for certain environments. The guidance informs much of the standards and guidance relating to the protection of external and internal amenity in relation to the impacts of sound on residences such as BS 8233 (as discussed at **Section 2.5**).

The guidelines state that overall internal night-time sound levels should not be above 30 dB L_{Aeq} within bedrooms such that people may sleep with minimal disturbance while the windows are open and it is stated that this corresponds to an external night-time noise level of 45 dB L_{Aeq}, when assuming a 15 dB attenuation in noise levels externally to internally. Furthermore, the guidance recommends that daytime external noise levels should not exceed 50 dB L_{Aeq} to protect the majority of people from being moderately annoyed.

The Night Noise Guidelines for Europe [6] are described as complementary to the Guidelines for Community Noise and recommend a limit of 40 dB L_{night}, outside. This is a yearly average night-time sound level which could potentially be exceeded on some nights of the year such that it is not necessarily inconsistent with the Guidelines for Community Noise if the sound levels do not exceed 45 dB L_{Aeq} on those nights.

The WHO Environmental Noise Guidelines for the European Region [7] was published in 2018 and provides '… recommendations for protecting human health from exposure to environmental noise originating from various sources: transportation (road traffic, railway and aircraft) noise, wind turbine noise and leisure noise' and make a series of strong or conditional noise exposure recommendations for each based on the weight of evidence available at the time the report was being drafted. The document does not consider noise from industrial sources as the specific features of these sources are usually very localised and vary between different kinds of development.

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

BS 8233 [8] provides guidance on the control of noise for new buildings or those undergoing refurbishment rather than providing guidance on assessing the effect of changes in external noise levels on occupants of existing buildings. The document provides a range of desirable internal average noise levels for dwellings which may be achieved via appropriate design where necessary. The levels are provided at **Table 2** for

reference and include additional detail as provided within the ProPG: Professional Practice Guidance on Planning & Noise document discussed below.

2.6 ProPG: Professional Practice Guidance on Planning & Noise

The ProPG: Professional Practice Guidance on Planning & Noise document [9], similarly to BS 8233, is intended to provide guidance in terms of assessment and design of new or newly refurbished housing development in terms of pre-existing airborne noise sources impacting on them (typically from transportation noise) and the requirements to achieve a suitable internal noise environment for potential inhabitants.

Table 2 shows the desirable noise levels referenced within BS 8233 for reference and with the additional detail and notes the ProPG provides.

The guideline internal noise values specified are based on values specified within the Guidelines for Community Noise, published by the World Health Organisation (WHO) [5].

Table 2 - Internal Noise Criteria

Activity	Location	Daytime	Night-time
		07:00 - 23:00 hrs	23:00 - 07:00 hrs
Resting	Living room	35 dB $L_{Aeq,\ 16\ hr}$	-
Dining	Dining room/area	40 dB $L_{Aeq,\ 16\ hr}$	-
Sleeping	Bedroom	35 dB $L_{Aeq,\ 16\ hr}$	30 dB $L_{Aeq,\ 8\ hr}$ 45 dB $L_{Amax,F}$ (Note 4)

NOTE 4: Regular individual noise events (for example, scheduled aircraft or passing trains) can cause sleep disturbance. A guideline value may be set in terms of SEL or $L_{Amax,F}$, depending on the character and number of events per night. Sporadic noise events could require separate values. In most circumstances in noise sensitive rooms at night (e.g. bedrooms) good acoustic design can be used so that individual noise events do not normally exceed 45 dB $L_{Amax,F}$ more than 10 times a night. However, where it is not reasonably practicable to achieve this guideline then the judgement of acceptability will depend not only on the maximum noise levels but also on factors such as the source, number, distribution, predictability and regularity of noise events (see Appendix A).

2.7 NANR45 Procedure for the Assessment of Low Frequency Noise Complaints

NANR45 - Procedure for the Assessment of Low Frequency Noise Complaints [10] provides a generalised procedure and aid as to the investigation and assessment of low frequency noise (LFN) for instances where complaints occur. The procedure contains generic internal noise criteria, over a range of 1/3 octave bands, which can be referenced when determining whether a LFN issue exists. The values are intended as a guide and are not intended to be used as any fixed criteria for planning purposes or otherwise. However, they have been referenced here to provide context as to the potential noise levels resulting from the introduction of Proposed Development in the low frequency range. The values are provided at **Table 3** for reference and the corresponding A-weighted levels are also shown.

Table 3 - NANR45 Internal Low Frequency Noise Criteria

ID	Centre of 1/3 Octave Band (A-Weighted), Hz												
	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160
Linear, dB L_{eq}	92	87	83	74	64	56	49	43	42	40	38	36	34
A-Weighted, dB L_{Aeq}	22	23	27	24	19	17	15	13	16	18	19	20	21

2.8 BS 5228 Code of Practice for Noise and Vibration Control on Construction and Open Sites

BS 5228-1:2009 'Code of practice for noise and vibration control on construction and open sites - Part 1: Noise' [11], this has been identified as being the appropriate source of guidance on appropriate methods for minimising noise from construction activities and is adopted herein. The document provides guidance on construction noise limits, noise modelling techniques and best practicable measures for the reduction of noise generated during construction activities.

Annex E of BS 5228-1:2009 provides guidance on setting environmental noise targets for construction noise. Several methods of assessing the significance of noise levels are presented with the most applicable being the ABC method. This method sets threshold noise levels for construction noise for specific periods based on the pre-existing ambient noise levels, subject to average lower Category A limiting values of 65, 55 and 45 dB L_{Aeq} for daytime (07:00 - 19:00 weekdays and Saturdays 07:00 – 13:00), evenings and weekends (19:00 – 23:00 weekdays, 13:00 – 23:00 Saturdays and 07:00 – 23:00 Sundays) and night-time (23:00 – 07:00) periods respectively in instances where existing ambient noise levels are low in relation to these values, which is the case here.

BS 5228-2:2009 'Code of practice for noise and vibration control on construction and open sites - Part 2: Vibration' [12], provides a method for predicting levels of vibration. The document provides guidance on construction vibration limits, vibration modelling techniques and best practicable measures for the reduction of vibration generated during construction activities.

The generally accepted maximum satisfactory magnitude of vibration due to construction activities, at residential premises during daytime periods (08:00 – 18:00 Monday to Friday and 08:00 – 13:00 on Saturdays), is a peak particle velocity (ppv) of 6 to 10 $mm.s^{-1}$. In practice, the lower satisfactory magnitude is typically used with the higher magnitude being justified on a case-by-case basis.

2.9 Local Guidance & Consultation

The Environmental Health Officer (EHO) representing the Highland Council (HC) has made a series of recommendations as to the assessment of noise generated by the operation and construction of the Proposed Development, with the main recommendations being that the overall operational noise level should not exceed the background noise level when assessed according to BS 4142 and that the 100 Hz 1/3 octave band level should not be higher than 30 dB(Z).

Since the Proposed Development is to be in a particularly rural location, the criteria set by the EHO could be considered particularly challenging due to the low levels of existing background noise expected at residential locations, which is very typical of developments of this nature. As a result, the low-level fixed noise limits that accord with the broad requirements of BS8233 and WHO, at least in principle, can be considered an appropriate alternative/additional means of assessment given this context.

The 30 dB(Z) level referenced by the EHO is equivalent to approximately 11 dB(A) in the 100 Hz 1/3 octave band, which is close to the average threshold of perception for human hearing in this frequency range. Designing to achieve a such a low level, particularly in the context of the NANR45 internal noise criteria shown at **Section 2.7**, externally to a residence, can be particularly difficult and is an atypical

requirement in planning terms for a development of this kind. Furthermore, existing ambient/background noise levels in this frequency band will often exceed this threshold as a result of pre-existing sources including that from wind induced noise. However, the current existing ambient/background levels and potential noise generated by the Proposed Development, over a range of one third octave bands, including the 100 Hz band, have been considered herein to provide further context as to this aspect.

The EHO also refers to a similar development neighbouring the site known as Balnacraig Energy Storage (Planning Ref. 22/05167/FUL), indicating that, if this neighbouring site is granted planning consent, then the cumulative/combined noise levels generated by the Balnacraig and Contullich developments would need to be considered as part of this assessment. The site was granted planning consent on the 11th December 2023 subject to various conditions including one that restricts operational noise levels to 29 dB L_{Ar} at the nearest neighbouring property. This information has been used to inform an assessment of the Proposed Development operating at the same time as the Balnacraig site.

3 Baseline Environment

3.1 Sensitive Receptors

A list of the residential assessment locations considered representative of those most sensitive to noise from the Proposed Development is provided in **Table 3**, as also shown in **Figure 1, Section 5**.

Table 3 - Sensitive Receptors / Assessment Locations

ID	Co-ordinates	
	Easting	Northing
H3	264089	871269
H4	263693	870487
H7	264314	871155
H9	264543	871323
H52	263708	870712
H53	263612	870808
H59	263839	870284
H62	264107	870173
H65	263723	870696
H66	264310	871154

3.2 Existing Sources of Sound

The current noise environment at properties surrounding the site is considered typical of a rural environment, sources of which include farm stock, dogs barking, water noise emanating from streams and burns, localised human and animal activities, birdsong, occasional aircraft passing overhead and traffic along local roads.

3.3 Existing Sound Levels

A survey of the existing background and ambient noise levels was undertaken at three locations considered representative of the noise environment at properties neighbouring the Proposed Development (L1, L2 & L3), as agreed with the EHO dealing with the Proposed Development. The monitoring locations are marked in **Figure 1 - Section 5**.

Sound level meters (SLMs) were installed at the properties between the 12th and 20th September 2023 with the equipment setup to collect average ambient (dB L_{Aeq}) and background (dB L_{A90}) noise levels in 15-minute intervals, including the associated 1/3 octave band levels for each and various other statistical parameters throughout the week-long survey period. The equipment was housed with appropriate outdoor protections and uprated microphone wind shields. The microphones were placed at a height approximately 1.3 m above the ground, in free-field conditions and the equipment was field calibrated at the start of the survey and checked at the end, with the drift in calibration level being well within normal tolerances.

The measurement setup at each survey locations are shown in **Appendix B** of this report.

A meteorological station was located beside Location 3 (L3) which obtained wind speed and precipitation information throughout the survey period for the same time intervals such that the noise information collected at both locations may be readily filtered to remove any data considered to be affected by adverse weather conditions and/or noise associated with the pattering of rain on the measurement equipment and its surroundings.

The sound level meters used for the measurement campaign, corresponding serial numbers and calibration records are shown in **Table 4**.

Table 4 - Instrumentation Records

Location	L1	L2	L3
Type	Rion NL-52	Rion NL-52	Rion NL-52
Serial No.	00620870	00732101	00620807
Calibration Certificate No.	UCRT23/1437	UCRT23/1688	UCRT23/1480
Date of Issue	28-Mar-2023	22-May-23	5-April-23
Microphone Serial No.	03712	05286	03633
Preamp Serial No.	31969	32129	20867
Calibrator Type	34315132	34315132	34315132
Calibrator Serial No.	UCRT22/2312	UCRT22/2312	UCRT22/2312
Calibrator Cert. No.	07-Nov-2020	07-Nov-2022	07-Nov-2022

The data sets were filtered to remove periods where measured wind speeds were above 5 $m.s^{-1}$ and where any precipitation was detected during any 15-minute measurement period.

The adopted background (dB L_{A90}) and ambient (dB L_{Aeq}) noise levels have been determined from statistical analysis and observations of the remaining filtered data sets collected during daytime (07:00 – 23:00) and night-time (23:00 – 07:00) periods respectively for all measurement locations. The background and ambient levels have been determined from the median values of the filtered data sets as a reasonable basis of assessment.

Figures showing the collected data sets and background and ambient/residual noise analysis are provided within **Appendix C** of this report. The results are summarised in **Table 5**. Indicative 1/3 octave band noise levels corresponding to the background and ambient noise levels shown are provided at **Tables 6 & 7** respectively.

Table 5 - Existing Background & Ambient Noise Levels

ID	Co-ordinates		Background Noise Level, dB L_{A90}		Ambient Noise Level, dB L_{Aeq}	
	Easting	Northing	Daytime	Night-time	Daytime	Night-time
L1	264089	870247	30	26	38	32
L2	263764	870663	34	28	47	35
L3	264228	871013	32	29	42	35

Table 6 - Indicative 1/3 Octave Band Background Levels, dB L_{A90}

Period	ID	Centre of 1/3 Octave Band (A-Weighted), Hz											
		50	63	80	100	125	160	200	250	315	400	500	630
Daytime	L1	2	6	7	**8**	9	10	11	12	14	16	18	20
	L2	7	7	10	**13**	11	11	12	14	17	20	22	25
	L3	3	5	7	**8**	9	10	10	10	14	18	21	23
	ID	**800**	**1k**	**1.25k**	**1.6k**	**2k**	**2.5k**	**3.15k**	**4k**	**5k**	**6.3k**	**8k**	**10k**
	L1	21	21	19	17	15	14	14	14	13	12	10	8
	L2	27	26	22	19	17	14	12	11	11	10	8	7
	L3	24	24	22	19	17	16	15	14	13	12	11	10
Period	**ID**	**50**	**63**	**80**	**100**	**125**	**160**	**200**	**250**	**315**	**400**	**500**	**630**
Night-time	L1	-1	-1	2	**3**	2	3	5	10	13	15	16	17
	L2	1	1	5	**4**	3	2	3	9	13	16	16	17
	L3	-2	-1	0	**2**	2	2	4	6	10	14	18	20
	ID	**800**	**1k**	**1.25k**	**1.6k**	**2k**	**2.5k**	**3.15k**	**4k**	**5k**	**6.3k**	**8k**	**10k**
	L1	18	17	15	12	9	8	8	9	9	9	8	7
	L2	17	16	15	14	13	12	11	10	9	9	8	7
	L3	21	20	19	17	13	10	9	8	9	9	9	8

Table 7 - Indicative 1/3 Octave Band Ambient Levels, dB L_{Aeq}

Period	ID	Centre of 1/3 Octave Band (A-Weighted), Hz											
		50	63	80	100	125	160	200	250	315	400	500	630
Daytime	L1	15	22	21	**23**	24	22	21	21	23	24	26	27
	L2	20	24	20	**26**	28	27	27	26	26	29	32	35
	L3	13	16	16	**18**	18	18	17	16	18	22	27	32
	ID	**800**	**1k**	**1.25k**	**1.6k**	**2k**	**2.5k**	**3.15k**	**4k**	**5k**	**6.3k**	**8k**	**10k**
	L1	29	29	27	27	24	22	21	21	21	20	22	15
	L2	39	40	39	37	34	31	30	28	30	26	24	12
	L3	36	38	34	30	27	24	22	21	21	19	18	16
Period	**ID**	**50**	**63**	**80**	**100**	**125**	**160**	**200**	**250**	**315**	**400**	**500**	**630**
Night-time	L1	6	5	6	**8**	6	6	8	15	16	19	19	21
	L2	4	8	11	**9**	10	9	8	12	19	19	20	23
	L3	5	7	9	**10**	12	12	13	10	13	17	21	24
	ID	**800**	**1k**	**1.25k**	**1.6k**	**2k**	**2.5k**	**3.15k**	**4k**	**5k**	**6.3k**	**8k**	**10k**
	L1	24	27	24	22	17	12	11	11	12	11	10	8
	L2	27	30	28	25	20	14	12	11	10	9	8	7
	L3	27	28	29	27	22	17	15	12	10	10	9	8

Table 7 shows that existing noise levels in the 100 Hz band are close to the criteria set by the EHO during night-time periods and above the criteria during daytime periods (see **Section 2.9**).

4 Predictions

4.1 Operation

A noise model of the battery storage facilities and the surroundings has been developed using CadnaA[1] noise modelling software. The ISO 9613-2 [13] noise propagation/prediction methodology has been employed to predict the noise levels resulting from the development at nearby residential properties, incorporating various assumptions and factors which are considered appropriate for use here:

- The various plant to be installed as part of the development has been modelled as point sources with a height of 2 m and these sources are assumed to be operating at their near maximum potential output for all time periods as a conservative basis of assessment;
- Soft ground conditions have been assumed (i.e. G=1) as representative of the farmland surrounding the Proposed Development. The ISO 9613-2 standard allows for a range of ground conditions to be applied, from porous ground conditions (G=1), which includes surfaces suitable for the growth of vegetation (i.e. farmland), to hard ground (G=0), such as paving, water and concrete;
- The receptors have been assigned a height of 1.5 m;

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

- Atmospheric attenuation corresponding to a temperature and relative humidity of 10 °C and 70 % respectively, as defined within ISO 9613-1 [14], which represents relatively low levels of sound absorption in the atmosphere;
- A 4 m high barrier of suitable mass and density located directly between the PCS/inverter systems and battery units; and,
- The inclusion of the topography of the site and surroundings.

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

The predominant sources of sound to be introduced as part of the Proposed Development are the 16 attenuated inverters (PCS units) and 64 battery storage containers.

The site has been designed on an iterative basis with a view to minimising, as far as practicably possible, the projected operational noise levels with due regard to the relative sensitivity of neighbouring premises and all other site constraints.

The assumed sound power data for the equipment to be installed as part of the Proposed Development are provided at **Table 8**. The overall levels correspond to the near maximum expected sound output for each of the respective plant, as advised by a candidate manufacturer. The propagation modelling therefore represents a relatively conservative scenario and actual sound levels would be expected to be less when the site is not operating at this capacity.

Table 8 - Overall Sound Power Levels, dB L_{WA}

Equipment & ID	Sound Power Level, dB L_{WA}
Battery Energy Storage System (BESS)	68
Attenuated Power Conversion System (PCS)	87

The source noise data is further supplemented by the level of noise in 1/3 octave and octave bands, as provided at **Tables 9 & 10**. This information is based on a combination of manufacturers data and RES experience of similar plant.

Table 9 - Octave Band Sound Power Levels, dB L_{WA}

ID	Overall, dB L_{WA}	Centre of Octave Band (A-Weighted), Hz							
		63	125	250	500	1k	2k	4k	8k
BESS	68	56	60	61	61	63	58	48	41
PCS	87	62	72	82	80	80	79	76	70

Table 10 - 1/3 Octave Band Sound Power Levels, dB L_{WA}

ID	Overall, dB L_{WA}	Centre of 1/3 Octave Band (A-Weighted), Hz											
BESS	68	50	63	80	100	125	160	200	250	315	400	500	630
		47	53	53	53	56	56	54	56	57	55	57	57
		800	1k	1.25k	1.6k	2k	2.5k	3.15k	4k	5k	6.3k	8k	10k
		59	59	57	56	52	49	46	43	40	37	37	31
PCS	87	50	63	80	100	125	160	200	250	315	400	500	630
		54	56	59	62	66	69	76	79	76	73	76	75
		800	1k	1.25k	1.6k	2k	2.5k	3.15k	4k	5k	6.3k	8k	10k
		75	76	75	75	74	73	72	71	70	68	64	61

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 noise levels detailed in **Section 5** are particularly low and potential tonal noise in the sound emitted from the various plant may well be masked by existing sources of sound in the area.

The combination of assumptions detailed above are considered to provide a conservative prediction/modelling basis overall. The results of the predictions at the various residences surrounding the Proposed Development are shown at **Section 5**.

4.2 Construction

BS 5228 Parts 1 & 2 provides various means of predicting construction noise and vibration levels from a wide selection of plant and supplies a range of generic plant source noise levels for this purpose. However, a detailed construction plan for the Proposed Development is not yet available and specific construction noise predictions have not been undertaken as a result.

A discursive assessment as to the generic construction impacts associated with developments of this kind in respect of noise and vibration is provided at **Section 5.2**.

5 Assessment

5.1 Operation

The predicted specific sound and corresponding rating levels (i.e. including for a 2 dB penalty for tonal noise) at the most sensitive properties located nearest to the Proposed Development are shown in **Table 10** for daytime and night-time periods respectively. The corresponding rating level is compared to the background sound levels detailed in **Section 3.3** to provide the associated impact at each location.

The results of the survey analysis recorded at the three measurement locations are applied to the various residences surrounding the Proposed Development depending on the proximity of each to the nearby dwellings, see **Table 5** and **Figure 1**.

The resultant 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.

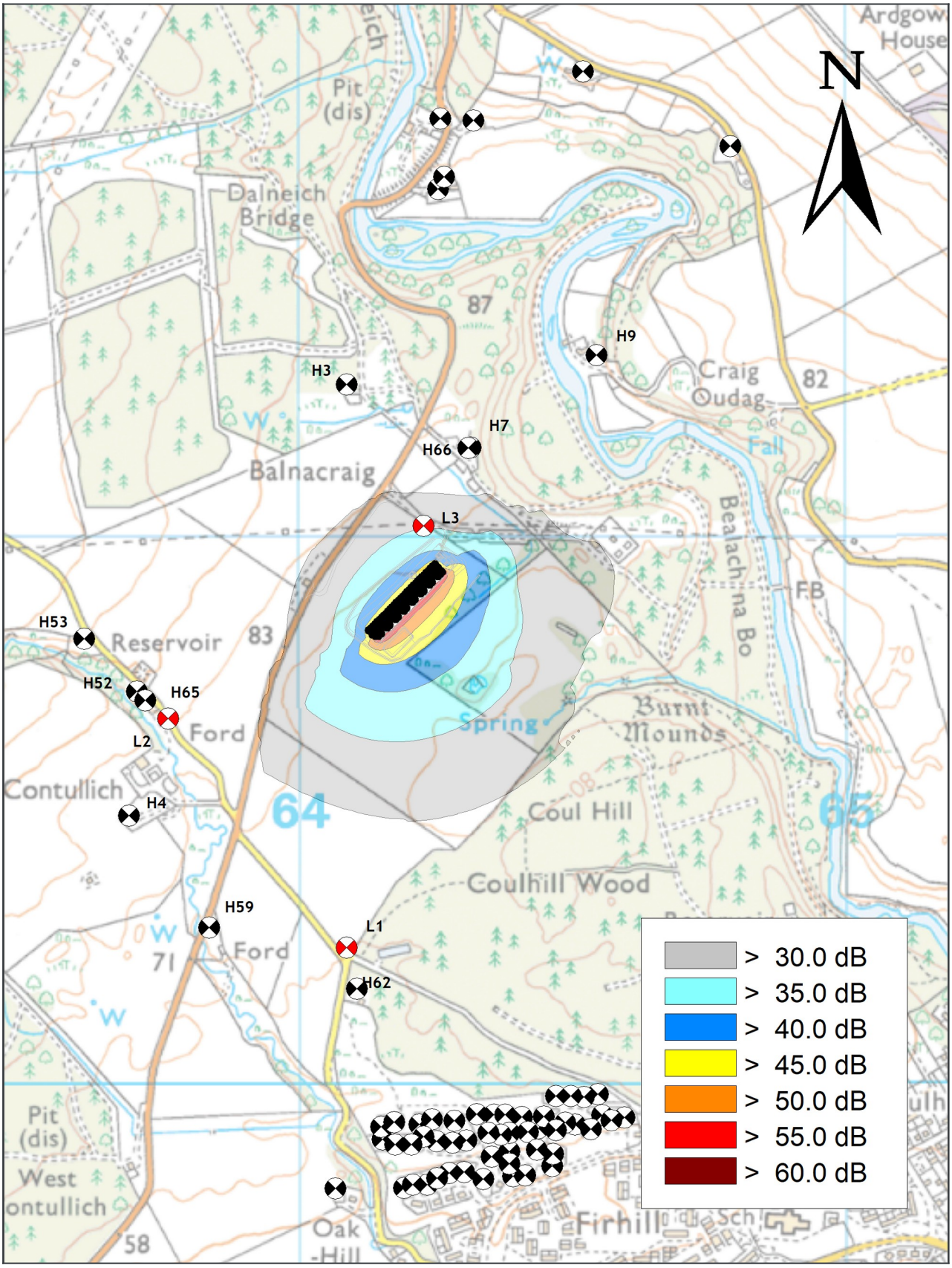
Table 11 - BS4142 Assessment

House ID	Specific Level, dB L_{Aeq}	Rating Level, dB L_{Ar}	Background Level, dB L_{A90}	L_{Ar} - L_{A90}, dB	Potential Impact
			Daytime		
H3	20	22	32	-10	Low
H4	22	24	32	-8	Low
H7	25	27	32	-5	Low
H9	18	20	32	-12	Negligible
H52	19	21	34	-13	Negligible
H53	20	22	34	-12	Negligible
H59	21	23	34	-11	Negligible
H62	20	22	30	-8	Low
H65	20	22	34	-12	Negligible
H66	25	27	32	-5	Low
			Night-time		
H3	20	22	29	-7	Low
H4	22	24	29	-5	Low
H7	25	27	29	-2	Low
H9	18	20	29	-9	Low
H52	19	21	28	-7	Low
H53	20	22	28	-6	Low
H59	21	23	28	-5	Low
H62	20	22	26	-4	Low
H65	20	22	28	-6	Low
H66	25	27	29	-2	Low

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 low for night-time periods. These levels 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.

An illustrative sound footprint for the proposed development showing the predicted rated sound level (dB L_{Ar}) is provided in **Figure 1**.

Figure 1 - Noise Contour Plot, dB L_{Aeq}



In all instances the predicted specific, rating and background noise levels are low, to the point at which the 1997 version of BS 4142 considered the standard was not appropriate for use (see **Section 2.3**). As a

result, a further assessment has been undertaken by comparing the overall expected overall external and internal ambient noise levels with guidance provided by the WHO (see **Section 2.4**) and criteria supplied within BS 8233 (see **Section 2.5**) to provide further context and basis of assessment.

The predicted specific sound levels due to the Proposed Development shown in **Table 11** are added to the adopted ambient/residual sound levels for daytime and night-time periods to determine the total external ambient sound level during daytime periods at each residence. The projected internal noise levels for daytime and night-time periods are determined by assuming a 15 dB reduction externally to internally, as assumed within the guidance provided by the World Health Organisation.

The resultant levels, as shown in **Table 12**, show that overall daytime and night-time noise levels do not exceed the WHO/BS8233 external and internal noise criteria (i.e. 50 & 45 dB L_{Aeq} externally and 35 & 30 dB L_{Aeq} internally for daytime and night-time periods respectively). Additionally, in all instances the increase in ambient noise levels due to the introduction of the Proposed Development is less than 1 dB.

Overall, in this context and based on the noise modelling assumptions and assessment results presented, the sound emitted by the Proposed Development can be considered not significant.

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 B**.

Table 12 – WHO & BS8233 Assessment

House ID	Specific Level, dB L_{Aeq}	Existing Ambient Noise Level, dB L_{Aeq}	Total External Ambient Noise Level, dB L_{Aeq}	Total Overall Internal Noise Level, dB L_{Aeq}
Daytime				
H3	20	42	42	27
H4	22	42	42	27
H7	25	42	42	27
H9	18	42	42	27
H52	19	47	47	32
H53	20	47	47	32
H59	21	47	47	32
H62	20	38	38	23
H65	20	47	47	32
H66	25	42	42	27
Night-time				
H3	20	35	35	20
H4	22	35	35	20
H7	25	35	35	20
H9	18	35	35	20
H52	19	35	35	20
H53	20	35	35	20

House ID	Specific Level, dB L_{Aeq}	Existing Ambient Noise Level, dB L_{Aeq}	Total External Ambient Noise Level, dB L_{Aeq}	Total Overall Internal Noise Level, dB L_{Aeq}
H59	21	35	35	20
H62	20	32	32	17
H65	20	35	35	20
H66	25	35	35	20

Further to the above, the neighbouring Balnacraig development has been consented with a planning condition applied relating to operational noise levels attached (i.e. a maximum rating level of 29 dB L_{Ar}, see **Section 2.9**). The introduction of the Proposed Development would serve to increase potential operational noise levels by around 2 dB at the most sensitive dwellings as compared to the scenario where only the Balnacraig site is operating. This would not change the overall assessment substantively, albeit with some minor cumulative impacts being expected during night-time operation. The overall assessed levels will remain below typical technical advice criteria provided by the Scottish Government.

Table 13 shows the predicted one third octave band noise levels at the most sensitive location neighbouring the proposed development (H7). The predicted external noise level in the 100 Hz band is approximately 9 dB(A) which slightly below the criteria suggested by the EHO dealing with the proposed development (see **Section 2.9**). Internal noise levels, assuming that windows are open for ventilation purposes, will be substantially (>10 dB) less, well below the DEFRA LFN criteria (see **Section 2.7**) in this octave band and similar can be said of the potential combined impact of the Proposed Development and the Balnacraig site in this frequency range.

Table 13 - One Third Octave Band Predicted Levels, dB L_{Aeq}

Location	Centre of 1/3 Octave Band (A-Weighted), Hz											
	50	63	80	100	125	160	200	250	315	400	500	630
H7	3	7	8	9	12	14	14	16	14	13	15	14
	800	1k	1.25k	1.6k	2k	2.5k	3.15k	4k	5k	6.3k	8k	10k
	14	15	13	11	7	4	-1	-6	-12	-22	-35	-54

5.2 Construction

Construction noise is discussed with reference to the 'ABC Method' daytime, evening/weekend and night-time limits of 65, 55 and 45 dB L_{Aeq} respectively, for instances where existing ambient noise levels are relatively low, which is the case here, and vibration is discussed in terms of the typical peak particle velocity (ppv) limits of 6 to 10 $mm.s^{-1}$ (see **Section 2.8**).

The construction of battery storage facilities is typically undertaken in phases starting with the formation of access tracks such that the main site construction activities can begin, following with the installation of security fencing; the introduction of a concrete base and the subsequent construction of the battery storage and ancillary equipment; installation of transmission connection and installation of any necessary ecological and landscape mitigation measures.

The main activities which have the potential to generate noise and vibration are the formation of the access tracks, concrete works and landscaping when occurring relatively close to neighbouring residences. The other activities either occur at distances which are very unlikely to result in noise levels that would breach typical construction noise limits or involve relatively light construction methods/techniques that would equally result in comparably low temporary levels of noise and vibration.

Additional traffic movements generated during the construction process, along existing local roads and access tracks, also have the potential to have sporadic noise and vibration impacts at residences adjacent to these. However, this essentially only tends to result in a minor increase in the average noise levels from existing roads, with the most noticeable noise and perceptible vibration effects resulting from the sporadic and increased number of HGV pass-bys at residences along the access routes and with resulting levels for individual events being similar to that created by existing HGV movements. In the case of the use of the introduced access tracks, overall levels are highly unlikely to breach typical overall construction noise limits.

Where relatively intense construction activities are to be undertaken near neighbouring residences, particularly during the construction of the site access routes, piling and trenching, specific attention to potential for enhanced mitigation measures to reduce the level of noise and vibration from these activities will be considered.

For all activities, measures will be taken to reduce noise levels with due regard to practicality and cost as per the concept of 'best practicable means' as defined for example in Section 72 of the Control of Pollution Act 1974 [15], which BS 5228-1 makes refence to. BS 5228-1 states that community relations are important in minimising the likelihood of complaints and therefore liaison with the local authority and members of the public will take place to ensure that residents are informed of the intended activities. Non-acoustic factors which influence the overall level of complaints, such as mud on roads and dust generation, shall also be controlled.

Activities that have the potential to generate significant noise and vibration will occur during normal working hours (07:00 - 19:00 weekdays and Saturdays 07:00 – 13:00) with less intensive activities potentially occurring outside these hours depending on the location and sensitivity of the works.

The following construction noise and vibration mitigation measures could be implemented where appropriate and proportionate:

- Consideration shall be given to noise and vibration emissions when selecting or modifying the plant and equipment to be used on site, with quieter variants given preference;
- All plant and equipment should be used in accordance with manufacturers' instructions, maintained in good working order and fitted with the appropriate silencers, mufflers or acoustic covers where applicable;
- Where noise generated from a specific activity is expected to be directional steps should be taken to orientate the equipment such that sound is directed away from any noise sensitive areas;

- Stationary noise sources shall be sited as far away as reasonably possible from residential properties and consideration given as to whether it is necessary to install acoustic barriers to provide screening;
- The movement of vehicles to and from the site shall be controlled and employees instructed to ensure compliance with the noise control measures adopted;
- Reducing the number of construction activities occurring simultaneously;
- Restricting activities being performed within a certain distance of noise sensitive locations; and,
- Reducing construction traffic.

Any strategy that would reasonably be expected to reduce the level of construction noise and vibration by the desired amount will be considered.

6 Conclusions

An acoustic impact assessment of the proposed Contullich Energy Storage Project has been undertaken. The results show that noise levels resulting from the operation of the site will generally be low in the context of relevant assessment criteria (i.e. BS 4142, BS 8233 and that provided by the World Health Organisation) and can be considered insignificant in terms of technical advice provided by the Scottish Government for both isolative and potential cumulative operational noise impacts.

Noise and vibration resulting from the construction of the site are unlikely to breach typical limits at neighbouring dwellings. However, appropriate noise reduction measures via the use of 'best practicable means' will be implemented as mitigation in any case.

7 References

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

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

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

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

[5] World Health Organisation (2000) Guidelines for Community Noise

[6] World Health Organisation (2009) Night Noise Guidelines for Europe

[7] World Health Organisation (2018) Environmental Noise Guidelines for the European Region

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

[9] Association of Noise Consultants, Institute of Acoustics & Chartered Institute of Environmental Health (2017) ProPG: Planning & Noise: Professional Practice Guidance on Planning & Noise: New Residential Development

[10] University of Salford (February 2005) NANR45 - Procedure for the Assessment of Low Frequency Noise Complaints

[11] British Standards Institution (February 2014) BS 5228-1:2009 + A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites - Part 1: Noise

[12] British Standards Institution (June 2014) BS 5228-2:2009 + A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites - Part 2: Vibration

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

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

[15] Her Majesty's Stationery Office (July 1974) The Control of Pollution Act (CoPA)

Appendix A – Experience & Qualifications

Table A.1 - Author

Name	Mike Craven
Experience	Senior Acoustic Analyst, Renewable Energy Systems, 2023-Present Principal Acoustic Consultant, Hayes McKenzie Partnership Limited (HMPL), 2019-2022 Senior Acoustic Consultant, HMPL, 2013-2019 Acoustic Consultant, HMPL, 2011-2013 Acoustic Consultant, URS/Scott Wilson, 2008-2011 Acoustic Consultant, HMPL, 2004-2008
Qualifications	MIOA, Member of the Institute of Acoustics BSc Audio Technology, University of Salford

Table A.2 - Checker & Approver

Name	Dr Jeremy Bass
Experience	Head of Specialist Services/Senior Technical Manager, Renewable Energy Systems, 2000-Present Technical Analyst/Senior Technical Analyst, Renewable Energy Systems, 1990-2000 Foreign Exchange Researcher, Mechanical Engineering Laboratory, Tsukuba, Japan, 1989-1990 Research Associate, Energy Research Unit, Rutherford Appleton Laboratory, 1986-1989
Qualifications	MIOA, Member of the Institute of Acoustics MInstP, Member of the Institute of Physics PhD, The Potential of Combined Heat & Power, Wind Power & Load Management for Cost Reduction in Small Electricity Supply Systems, Department of Applied Physics, University of Strathclyde BSc Physics, University of Durham

Appendix B – Measurement Locations

Figure B.1 - Measurement Location 1


Figure B.2 - Measurement Location 2


Figure B.3 - Measurement Location 3


Appendix C – Survey Data & Analysis

Figure C.1 – Location 1 - Time Series

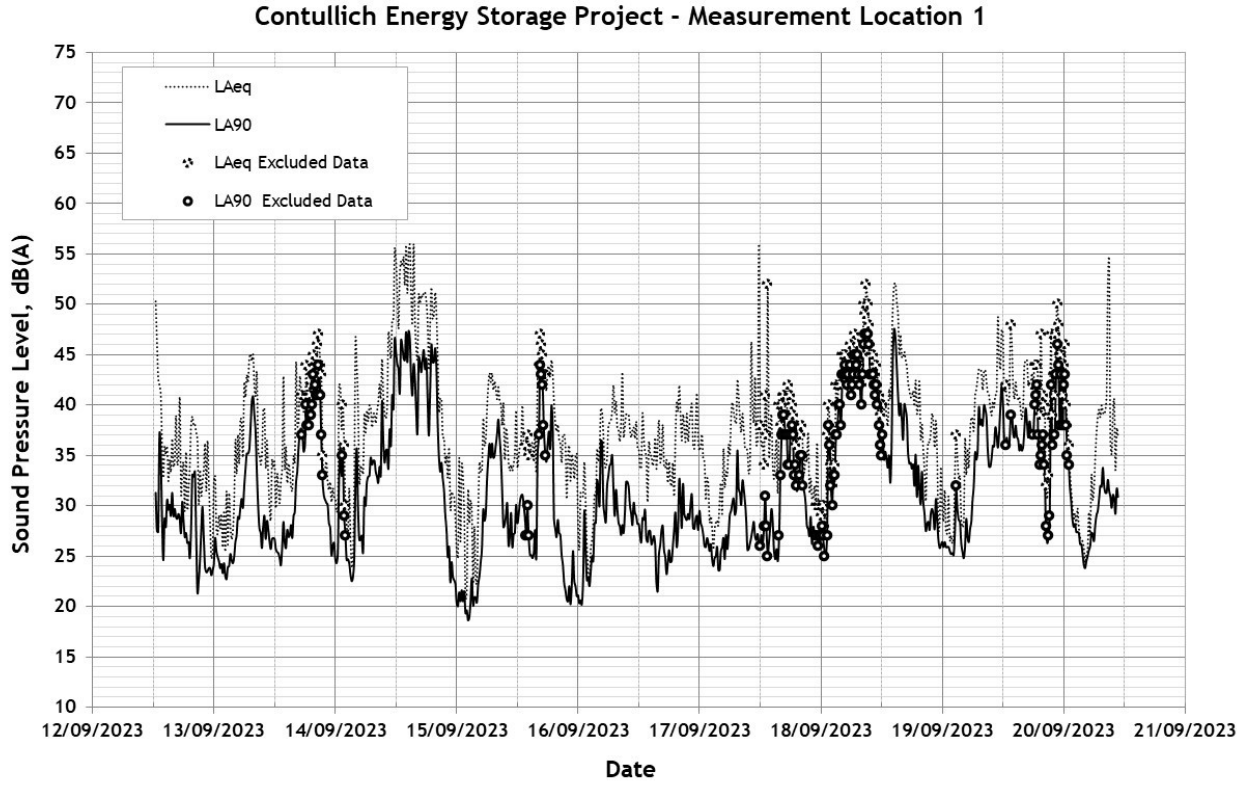


Figure C.2 – Location 1 Data Analysis – All Data

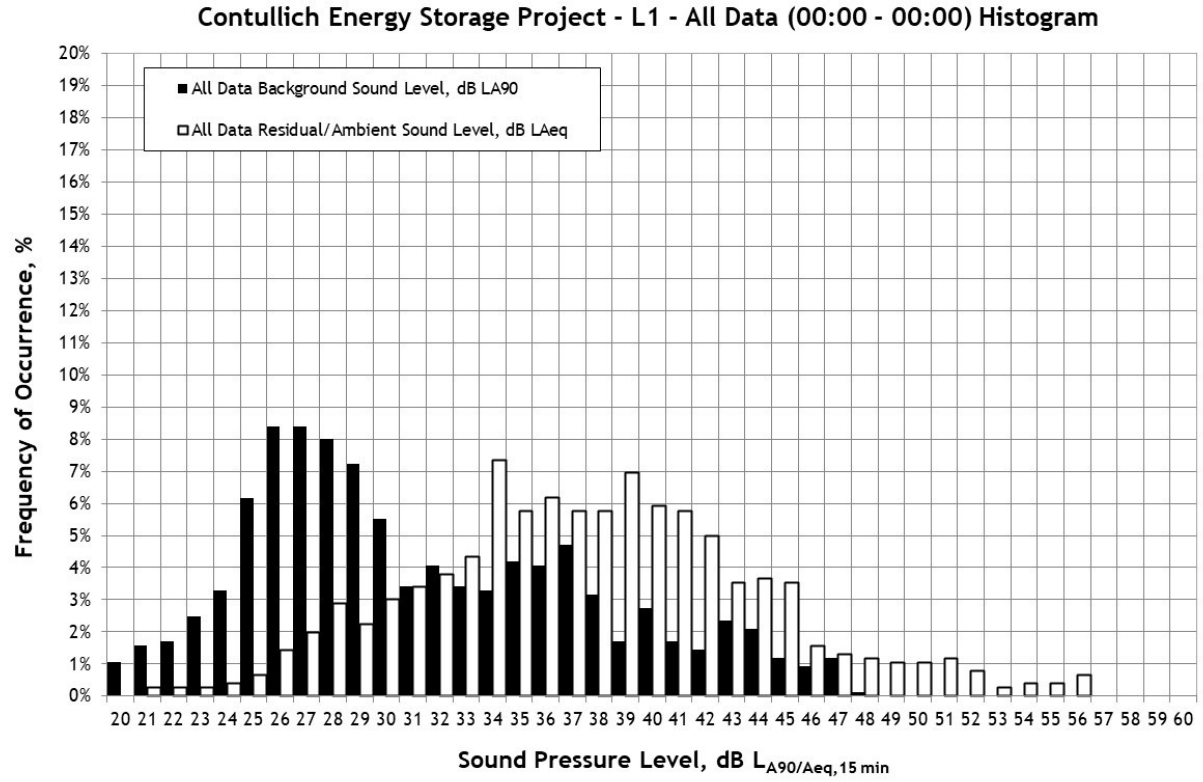


Figure C.3 – Location 1 Data Analysis - Daytime

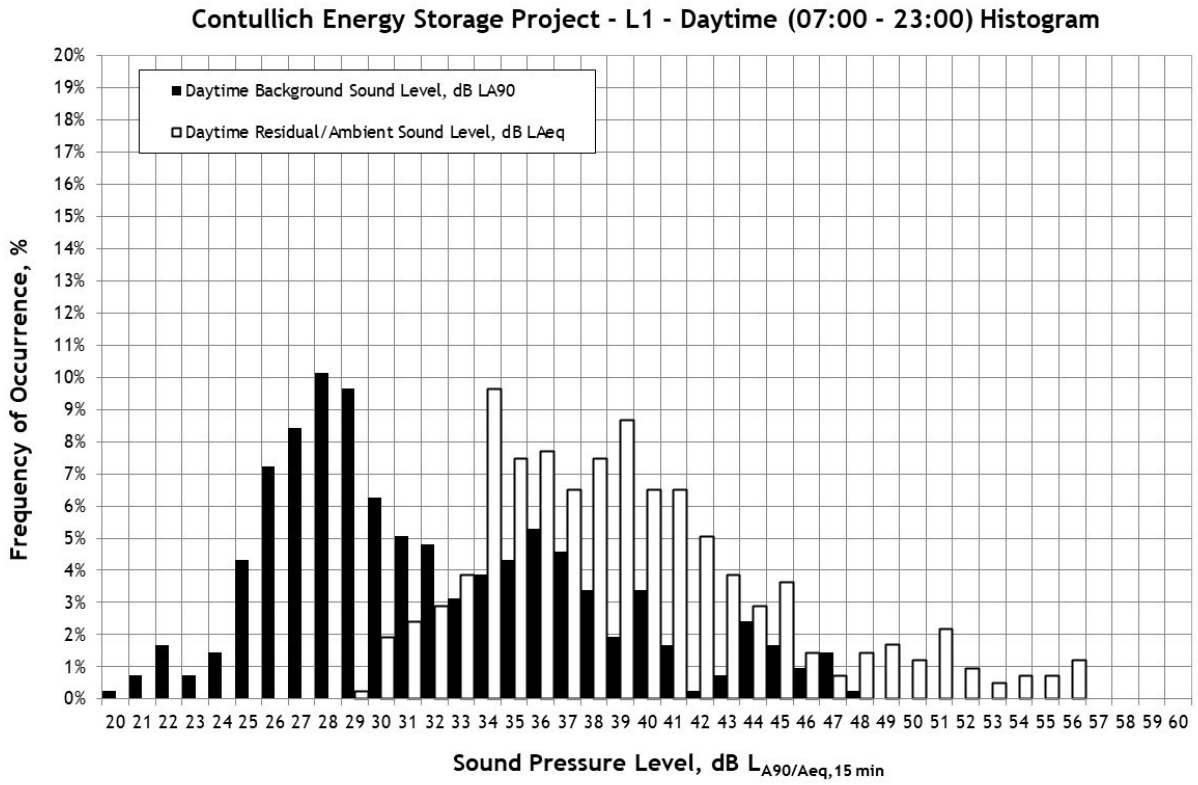


Figure C.4 – Location 1 Data Analysis – Night-time

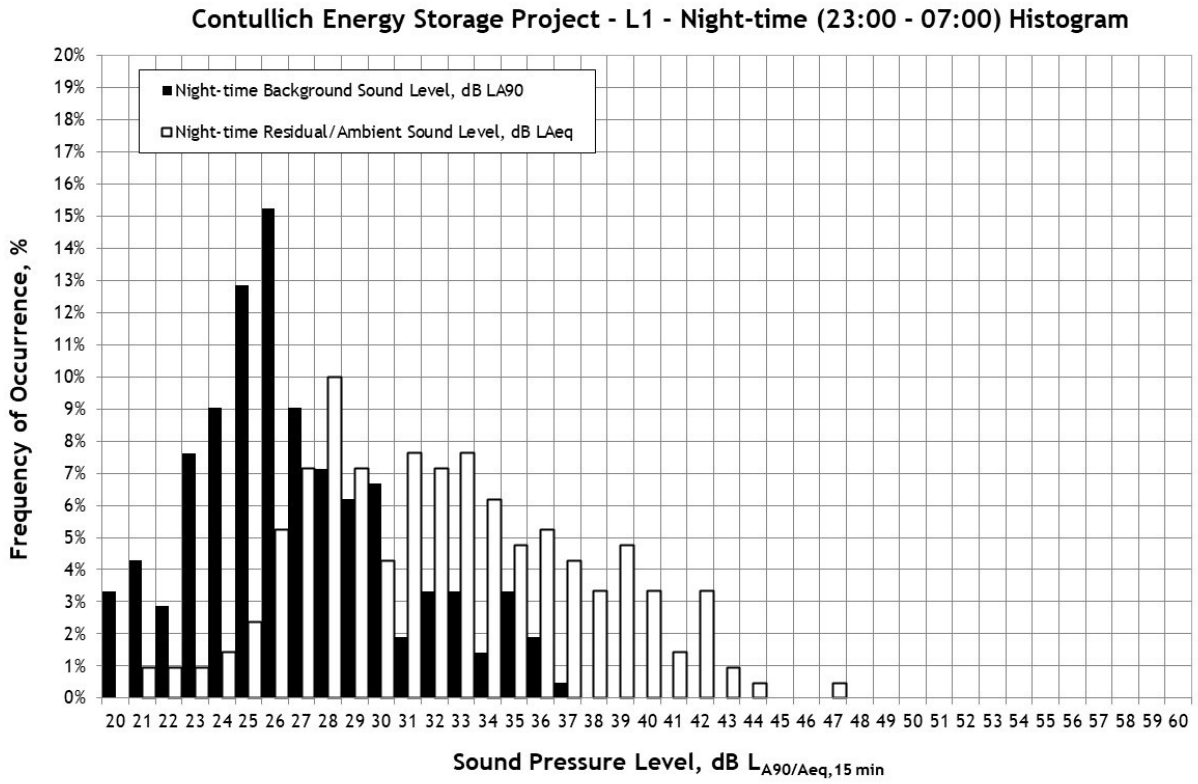


Figure C.5 – Location 2 - Time Series

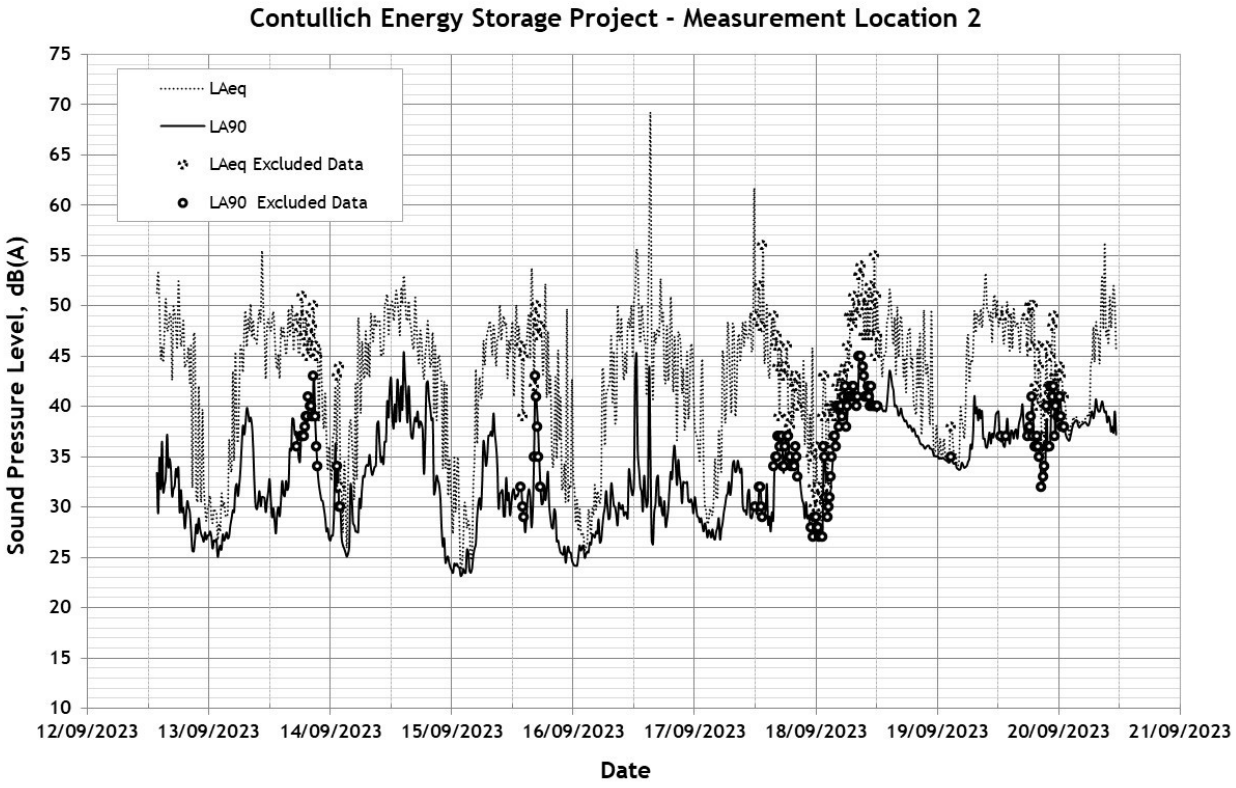


Figure C.6 – Location 2 Data Analysis – All Data

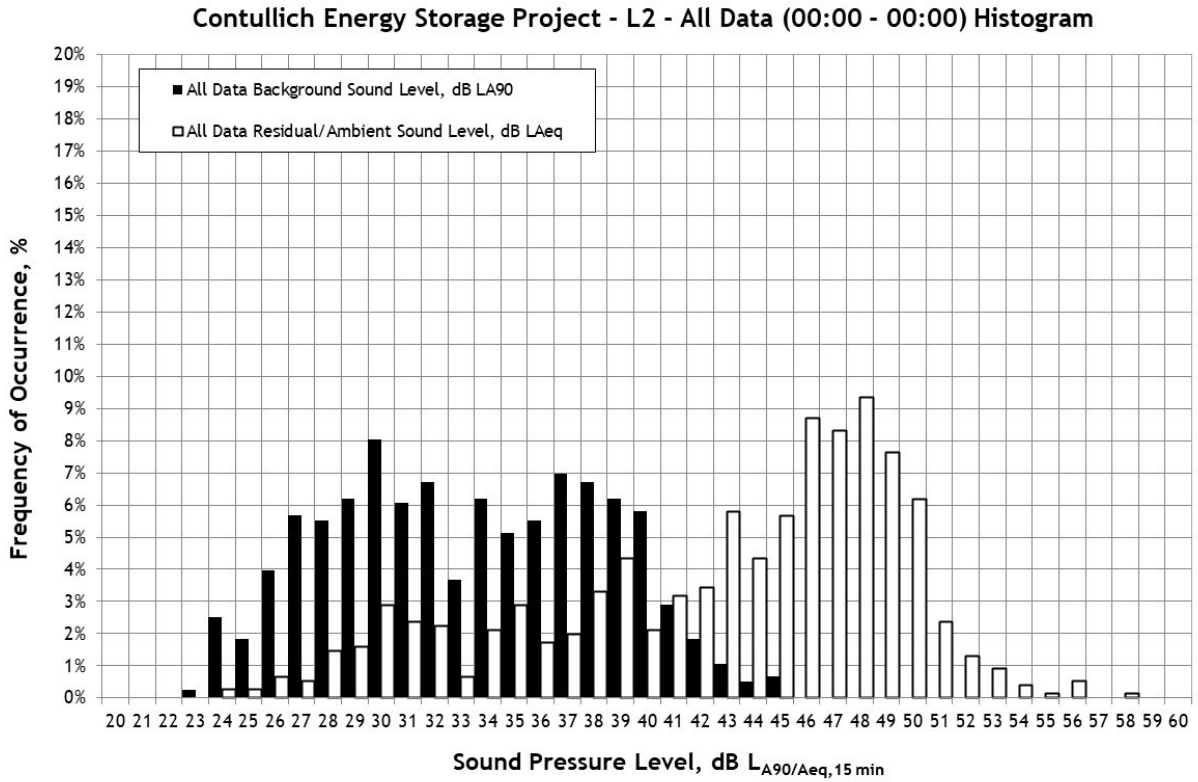


Figure C.7 – Location 2 Data Analysis - Daytime

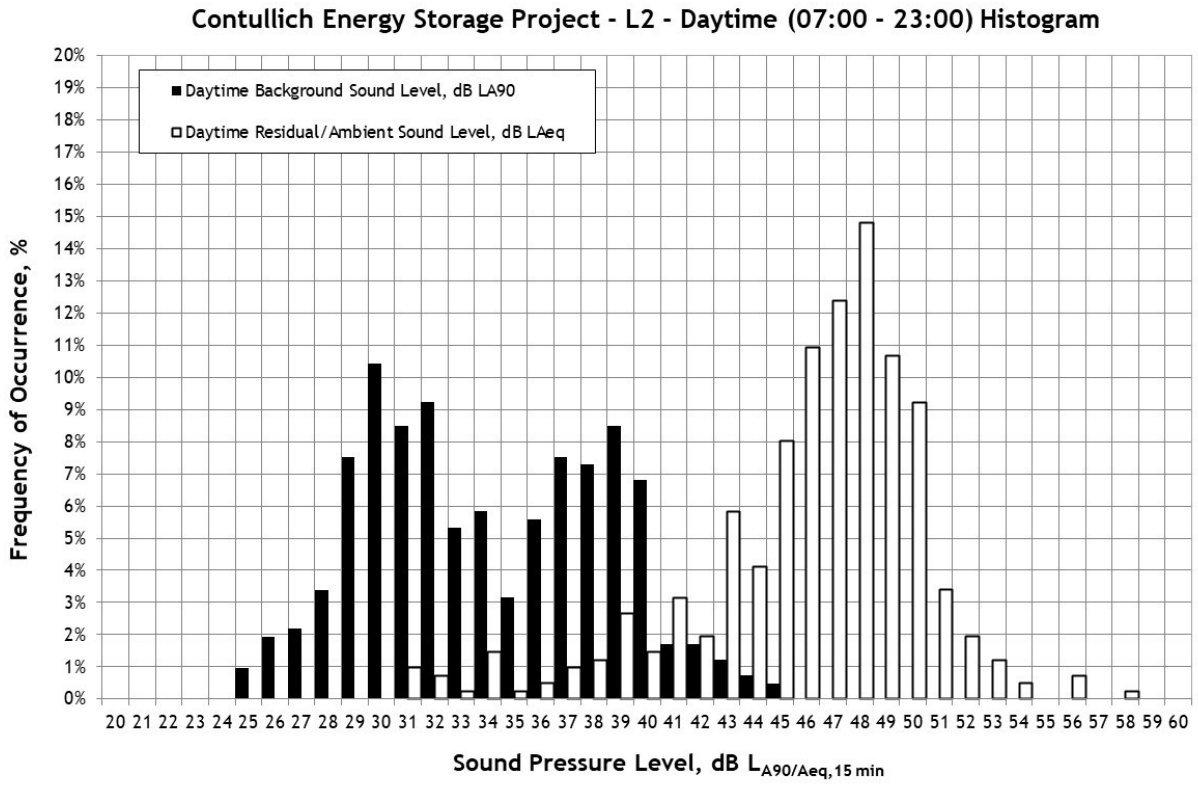


Figure C.8 – Location 2 Data Analysis – Night-time

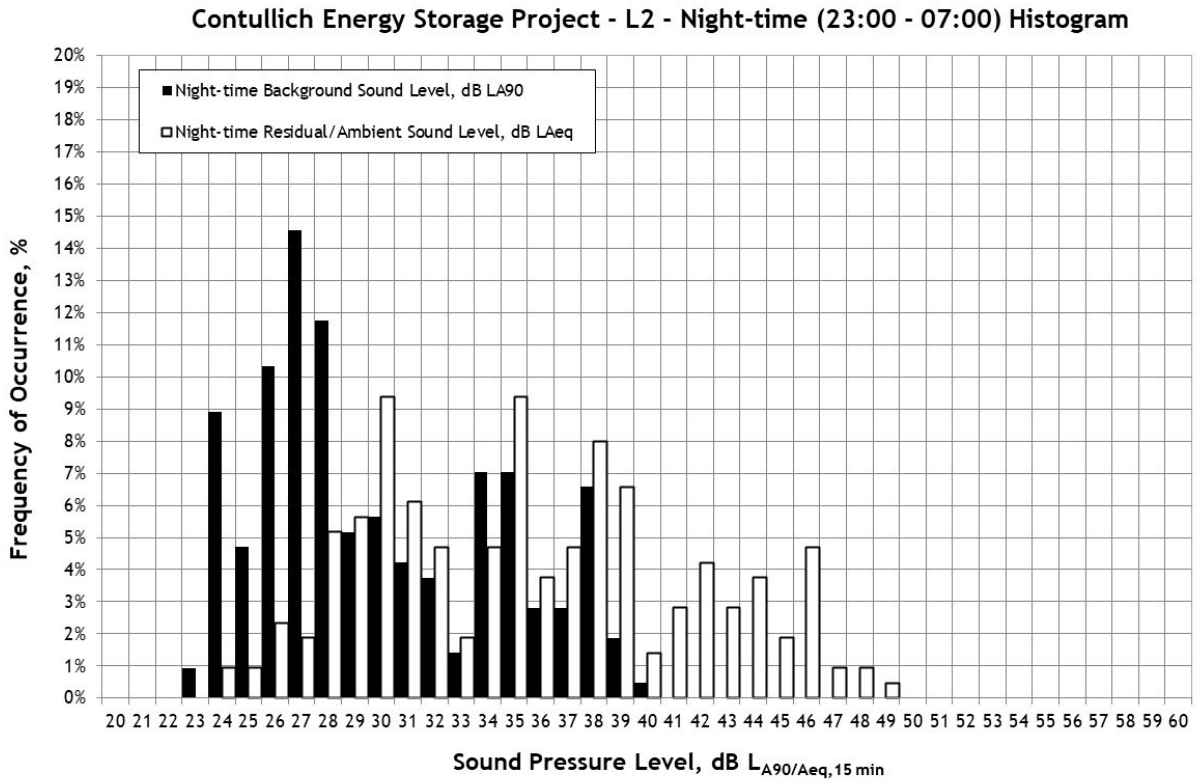


Figure C.9 – Location 3 - Time Series

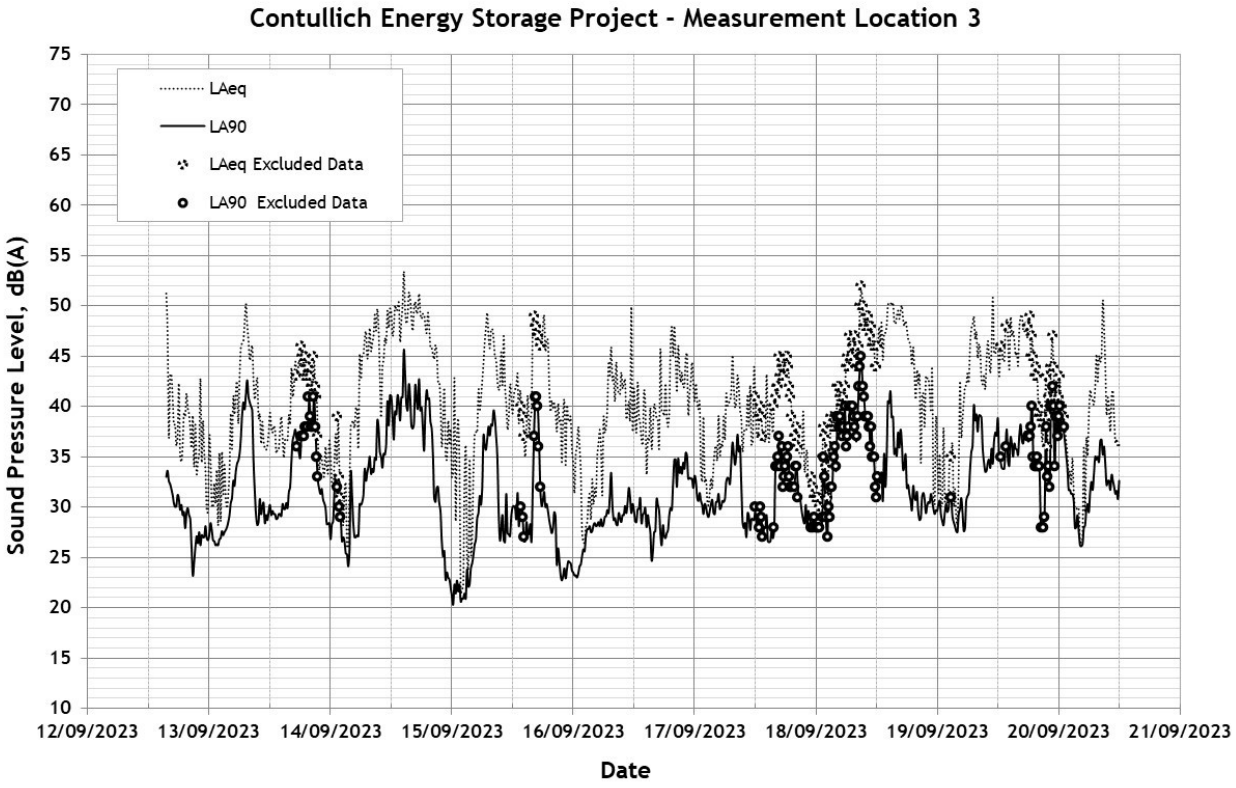


Figure C.10 – Location 3 Data Analysis – All Data

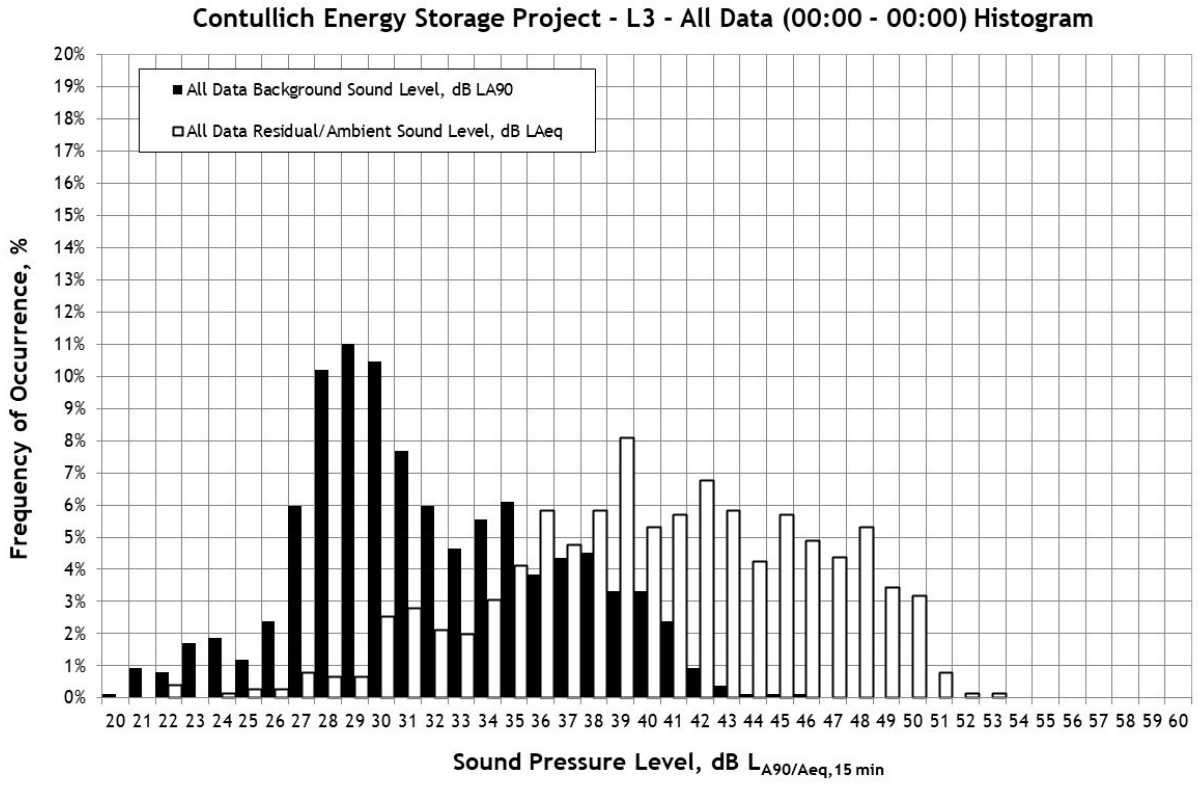


Figure C.11 – Location 3 Data Analysis - Daytime

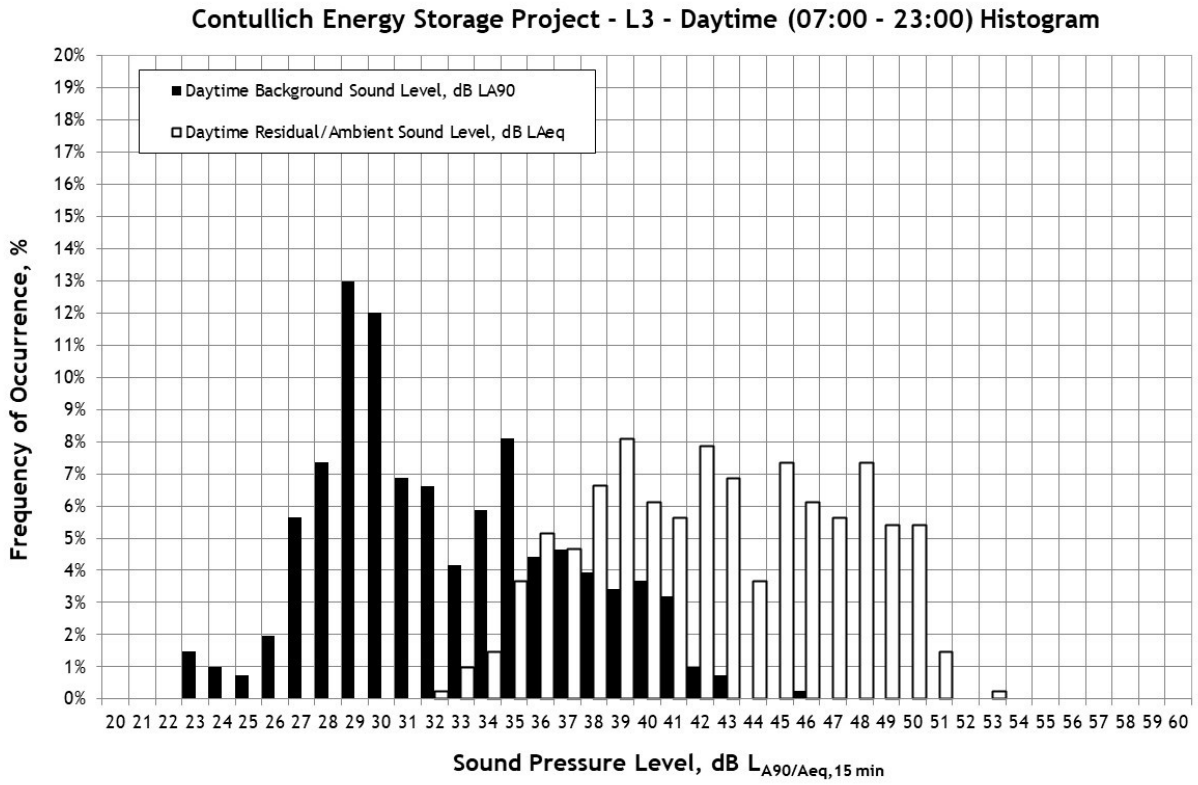
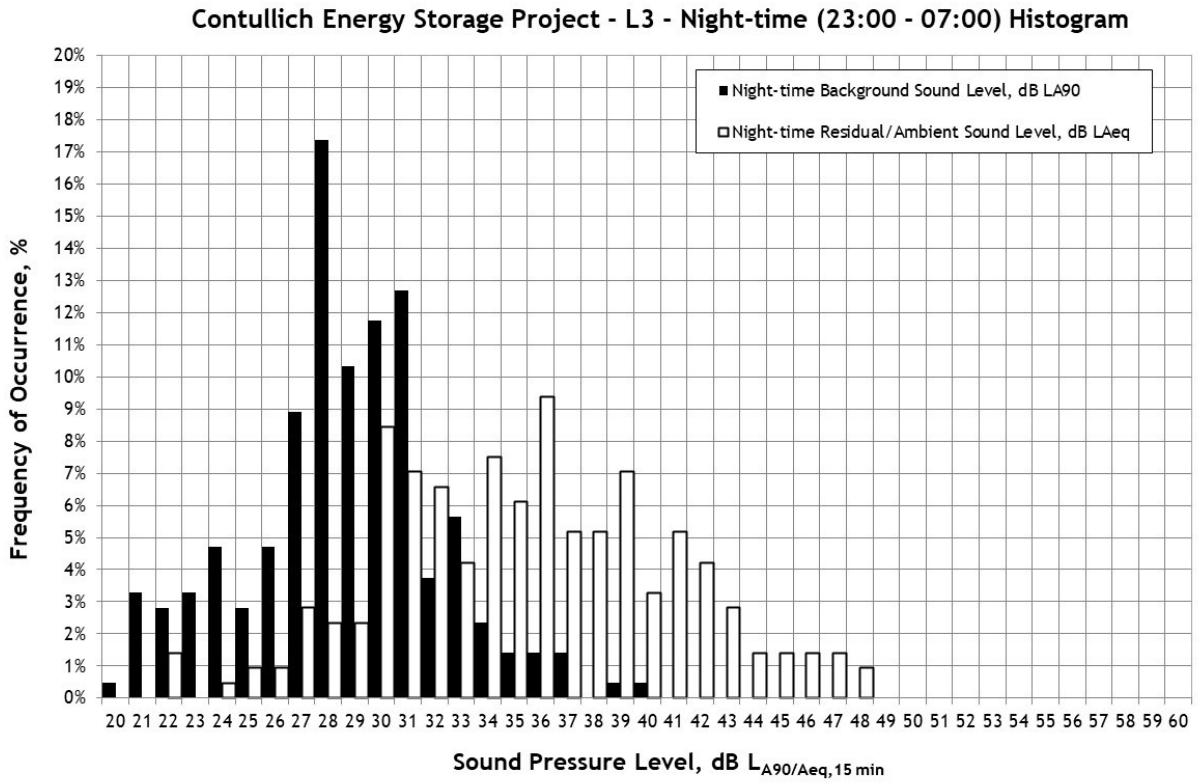


Figure C.12 – Location 3 Data Analysis – Night-time



Appendix D – Suggested Planning Condition Wording

The energy storage project shall be designed and operated to ensure that the rating sound level, determined using the BS 4142:2014 methodology external to any neighbouring property, shall not exceed 30 dB L_{Ar} or the background sound level plus 5 dB for daytime and night-time periods, whichever is the greater.