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LINDISFARNE NATURE RESERVE – PROPOSED RESEARCH AND ACCOMODATION FACILITY
NOISE & VIBRATION ASSESSMENT

On behalf of:

Rider Levett Bucknall

Report No: P22-329-R02v3
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NATIONAL NATURE RESERVES - PROPOSED RESEARCH AND ACCOMODATION FACILITY
NOISE & VIBRATION ASSESSMENT

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1.0 INTRODUCTION

1.1 Hepworth Acoustics Ltd was commissioned by Rider Levett Bucknall to carry out environmental noise and vibration assessment in connection with a proposed new research and accommodation building at Lindisfarne Nature Reserve.

1.2 The proposed site the site forms part of land currently in use as part of the existing Natural England reserve base. There are agricultural fields to the north, south and west. The site is bounded to the east by the East Coast Mainline with fields beyond and slightly further to the north some 40m away is Beal Level Crossing.

1.3 Access to the site is via an unnamed road to the north which also provides access to Lindisfarne Island at low tides and is thus fairly well trafficked at various parts of the day. The nearest residential building is located to the north on the unnamed road approximately 25m from the site. The site location is shown on Figure 1.

1.4 We understand a single storey building is proposed that includes a laboratory area, kitchen and two bedrooms, the bedrooms are located on the shielded side of the building away from the railway. In addition, there is a small plant area to the south of the building, there is no outdoor amenity space proposed.

1.5 The layout of the proposed building is shown in Figure 2.

1.6 The assessment was requested following feedback from Northumberland Country Council.

1.7 The noise and vibration assessment has included:

i. An inspection of the site and surrounding area;

ii. Measurement of noise and vibration from trains passing on the adjacent railway line for a period of 24 hours;

iii. Assessment of the potential noise and impact on the development; and

iv. Recommendation of appropriate mitigation measures where necessary

1.8 The various noise units and indices referred to in this report are described in Appendix I. All noise levels mentioned in the text have been rounded to the nearest decibel, as fractions of decibels are imperceptible.

2.0 RAILWAY NOISE & VIBRATION SURVEY

Railway Noise Survey

2.1 Noise monitoring was undertaken in sequential 15-minutes periods over the period 14:00 on Tuesday 6th September until 11:00 on Wednesday 7th September 2022. The purpose of the surveys was to establish existing noise levels on the site from the railway line.

2.2 The noise surveys were carried out in calm and dry weather conditions using a NTi Audio 'Class 1' sound level meter (serial no. A2A-20361-E0). Calibration checks were carried out both before and after each survey using an acoustic calibrator. No significant variance in the calibrated noise levels was noted.

2.3 The measurement microphone was fitted with a windshield and mounted externally in free-field conditions at about 1.5m above local ground in a location representative of the location of the building. It was agreed with staff at the reserve at the time of deployment of the equipment that this was the most appropriate monitoring location.

2.4 For each 15-minute measurement period, full third-octave band analysis was included, as was full and continuous audio recording.

2.5 The results of the noise survey, equipment used, and prevailing weather conditions are detailed in Appendix II. The results are analysed and discussed below.

2.6 Most trains operate in the daytime with relatively few trains at night. The line is also used by some freight trains the number of which are variable. The majority of trains are intercity trains that pass the site at high speed.

2.7 The railway track is of a 'continuously welded track' construction, i.e. there are no gaps between the rails, and therefore the passing trains run relatively smoothly.

2.8 The typical timetabled daily numbers of passing trains on a weekday are shown in Table 1. This data has been obtained from the current passenger train timetables and information from realtimetrains.co.uk.

Table 1: Typical Daily Train Flows

Train type	Period	
	Daytime (07:00 – 23:00)	Night-time (23:00 – 07:00)
Passenger trains	86	4
Freight trains	30	7

2.9 The full results of the noise survey are shown in Appendix II and the measured daytime and night time railway noise exposure values are shown in Table 2.

Table 2: Railway Noise Exposure Values

Period	L_{Aeq}
Day	56 dB $L_{Aeq,16hr}$
Night	48 dB $L_{Aeq,8hr}$

2.10 Short-term peaks of noise at night at the measurement location were found to be in the range 48 – 79 dB $L_{Amax,\ 15mins}$ with peaks of noise due to passing trains being between 72 – 79 dB $L_{Amax,\ 15mins}$.

2.11 We have analysed the results of the background noise monitoring to determine the representative background sound level. Based on this analysis, we have identified **25** dB $L_{A90,T}$ as the lowest during the daytime (07:00-23:00). The mode (most common) of the measured background noise levels during the daytime was **26** dB $L_{A90,T}$.

2.12 During the night time (23:00-07:00) **20** dB $L_{A90,T}$ has been identified as the lowest measured background. The mode (most common) of the measured background noise levels during the night was **22** dB $L_{A90,T}$.

Railway Vibration Survey

2.13 BS 6472: 2008 sets out national guidance on measuring and assessing the potential annoyance resulting from vibration in buildings. The standard includes a section on intermittent vibrations which requires the vibration exposure to be determined in terms of a 'vibration dose value', VDV. This takes into account the magnitude of the vibration and the duration of exposure.

2.14 Vibration dose values (in $ms^{-1.75}$) in residential buildings at which various degrees of adverse comment may be expected are quoted in BS 6472 and are reproduced in Table 3.

Table 3: Extract from BS6472 in VDV $ms^{-1.75}$

Period	Low probability of adverse comment	Adverse comment possible	Adverse comment probable
Daytime (07:00 – 23:00)	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Night-time (23:00 – 07:00)	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8

2.15 The vibration dose value for the day or night-time period can be calculated using the formula:

$$VDV_{b/d,\ day/night} = \left(\int_0^T a^4 t(dt) \right)$$

where: $VDV_{b/d,\ day/night}$ is the vibration dose value

a(t) is the frequency weighted acceleration in ms^{-2}

T is the total period of day or night (in seconds) during which vibration can occur

2.16 A ground vibration monitoring survey of passing trains was carried out at the site at Location 2 at a location representative of the position of the proposed building.

2.17 A dual channel Vibrock V901 tri-axial vibration recorder, with a VDV transducer, was used to measure the railway vibration with the transducers located on a 300x200x25mm concrete slab seated firmly into the ground to ensure a good coupling. Vibration measurements were taken between approximately 14:00 on Tuesday 6th September until 14:00 on Wednesday 7th September 20221.

2.18 The corresponding daytime and night-time VDV values have been extrapolated from one-hour measurements and the highest in each of the X (parallel to the track), Y (perpendicular to the track) and Z (vertical) axes used. The highest extrapolated VDV values are shown Table 4.

Table 4: Railway Vibration Levels

Period	VDV		
	X	Y	Z
Day time (07:00-23:00)	0.02	0.02	0.04
Night time (23:00-07:00)	0.02	0.02	0.03

2.19 The extrapolated daytime and night-time VDV values are well below the threshold values set out in BS 6472.

2.20 Therefore, no special vibration isolation measures will be necessary at this site.

3.0 PLANT NOISE ASSESSMENT

3.1 It is necessary to ensure that external noise emissions from any building services plant do not exceed acceptable limits determined in accordance with British Standard 4142: 2014, '*Methods for rating and assessing industrial and commercial sound*'.

3.2 BS 4142 provides methods for rating and assessing sound of an industrial nature from industrial or commercial premises. An initial estimate of the impact of the operation is determined by subtracting the background level from the 'rating' level. BS 4142 states that where the 'rating' level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context. The 'rating' level is derived based on the 'specific' L_{Aeq} sound level attributable to the operation with an 'acoustic feature' penalty added for any sound sources which give rise to tonal, impulsive, intermittent, or other characteristics readily distinctive against the residual acoustic environment.

3.3 BS 4142 requires that "*values are reliable and suitably represent the particular circumstances and periods of interest… the objective is not simply to ascertain a lowest measured background sound level, but rather to quantify what is typical during particular time periods*".

Based on the noise survey results, it is therefore recommended that the cumulative 'rating' noise level of all plant should not exceed levels set out in Table 5 at the nearest bedroom window.

Table 5: Recommended Plant Noise Limits at Nearby Residences

Daytime Noise Rating Limit, dB L_{Ar}	Night Noise Rating Limit, dB L_{Ar}
25	20

3.4 The following plant is proposed to be located on the rear elevation of the existing building:

- 2 x Mitsubishi Ecodan PUZ-WM112VAA Air Source Heat Pumps (Sound Pressure Level 45 dBA at 1m)

3.5 Calculations have been undertaken assuming the following:

- Minimum plant distances of 17m to nearest habitable room
- Robust assumption of each condenser unit being located adjacent to two hard surfaces
- Acoustic screening correction of -10 dB provided by the existing building

3.1 The units will generate a steady and broadband noise, although they may operate on demand therefore a +3 dB correction has been included for intermittency.

3.2 The results of the initial BS 4142:2014 assessment is shown in Table 6.

Table 6: Initial BS 4142 Assessment at Nearest Dwellings (dB)

Description	Daytime	Night time
Specific source level at assessment location ($L_{Aeq,T}$)	13	13
Character correction	+3	+3
Rating level ($L_{Ar,T}$)	16	16
Background level ($L_{A90,T}$)	25	20
Excess of rating level over background level	-9	-4
Likelihood of impact	Initial assessment indicates a likelihood of low adverse impact	

3.3 The predicted values are between 4 and 9 dB below the lowest measured background noise level therefore the assessment indicates a low adverse impact outside the windows of the proposed bedrooms of the new facility. Notwithstanding, the recommended limits may be enforced by way of a suitably worded planning condition, for example to account for any necessary alterations to the plant selections.

4.0 ACOUSTIC DESIGN CRITERIA

NPPF

4.1 The National Planning Policy Framework (NPPF) 2021 states at paragraph 174 that "*Planning policies and decisions should contribute to and enhance the natural and local environment by: … e) preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of … noise pollution …*".

4.2 Further, paragraph 185 states that *"Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so they should: a) mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life …"*.

NPSE:2010

4.3 The Noise Policy Statement for England (NPSE) 2010, which is referred to the in NPPF, includes three aims:

i. Avoid significant adverse impacts on health and quality of life from environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development.

ii. Mitigate and minimise adverse impacts on health and quality of life from environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development.

iii. Where possible, contribute to the improvement of health and quality of life through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development.

4.4 Therefore, it is necessary to refer to established national guidance such as the acoustic design goals for residential development that are set out in British Standard 8233: 2014, *Guidance on sound insulation and noise reduction for buildings*, which carries the full weight of an adopted British Standard.

BS 8233: 2014 '*Guidance on sound insulation and noise reduction for buildings*'

4.5 Guidance on acceptable noise levels in habitable rooms and private gardens is set out in British Standard 8233:2014 '*Guidance on sound insulation and noise reduction for buildings*' (referred to hereafter as BS 8233). The design criteria recommended in BS 8233 for daytime periods (07:00–23:00) and night-time periods (23:00–07:00) are summarised in Table 7.

Table 7: BS 8233:2014 Recommended Acoustic Design Criteria

Activity	Location	Daytime (07:00-23:00)	Night-time (23:00-07:00)
Resting	Living room	35 dB $L_{Aeq,16hr}$	-
Dining	Dining room/area	40 dB $L_{Aeq,16hr}$	-
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq,16hr}$	30 dB $L_{Aeq,8hr}$

4.6 BS 8233 also recognises that regular individual noise events at night can cause sleep disturbance but does not provide specific design criteria. Peaks of noise from individual events such as these are usually described in terms of dB L_{Amax} values. ProPG: Planning & Noise 'Professional Practice Guidance on Planning & Noise' 2017 states that "*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 45dB $L_{Amax,F}$ more than 10 times a night*.". The 10th highest L_{Amax} value measured at this site was 60 dB.

4.7 The living areas in the development will not be used in a traditional manner. The overnight accommodation offered by the development will only occasionally be occupied by researchers when necessary and also not for prolonged periods of time.

4.8 Nevertheless, for this development we recommend that the following noise criteria be adopted:

- Daytime noise levels within 35 dB $L_{Aeq,16hr}$ inside bedrooms, and within 40 dB $L_{Aeq,16hr}$ in dining rooms.

- Night-time noise levels in bedrooms within 30 dB $L_{Aeq,8h}$, and generally not exceeding 45 dB L_{Amax} (i.e. typically no more than 10 times per night).

5.0 NOISE ASSESSMENT

Internal Noise: Sound Insulation of Living Accommodation

5.1 Windows of standard well-sealed thermal double glazing (4mm glass – 4mm glass) have a typical sound reduction performance of 25 dB $R_w + C_{tr}$.

5.2 Therefore, where noise levels exceed 60 dB $L_{Aeq,16hr}$ during the daytime and/or 55 dB $L_{Aeq,8hr}$ and/or 70 dB L_{Amax} at night, higher specification glazing will be necessary in order to meet the acoustic design criteria adopted from BS 8233.

5.3 The combined fact that the proposed bedrooms are on the shielded side of the building and that railway noise exposure level at this development site were found to be low and well within these values, both during the daytime and night.

5.4 Therefore, no special mitigation measures are necessary for the living spaces and standard well-fitting double glazing and trickle ventilation will be suitable.

Key:

Not to scale

1 Measurement Location

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Title: Figure 1: Noise Measurement Location

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Key:
Not to scale

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Title: Figure 2: Proposed Site Layout

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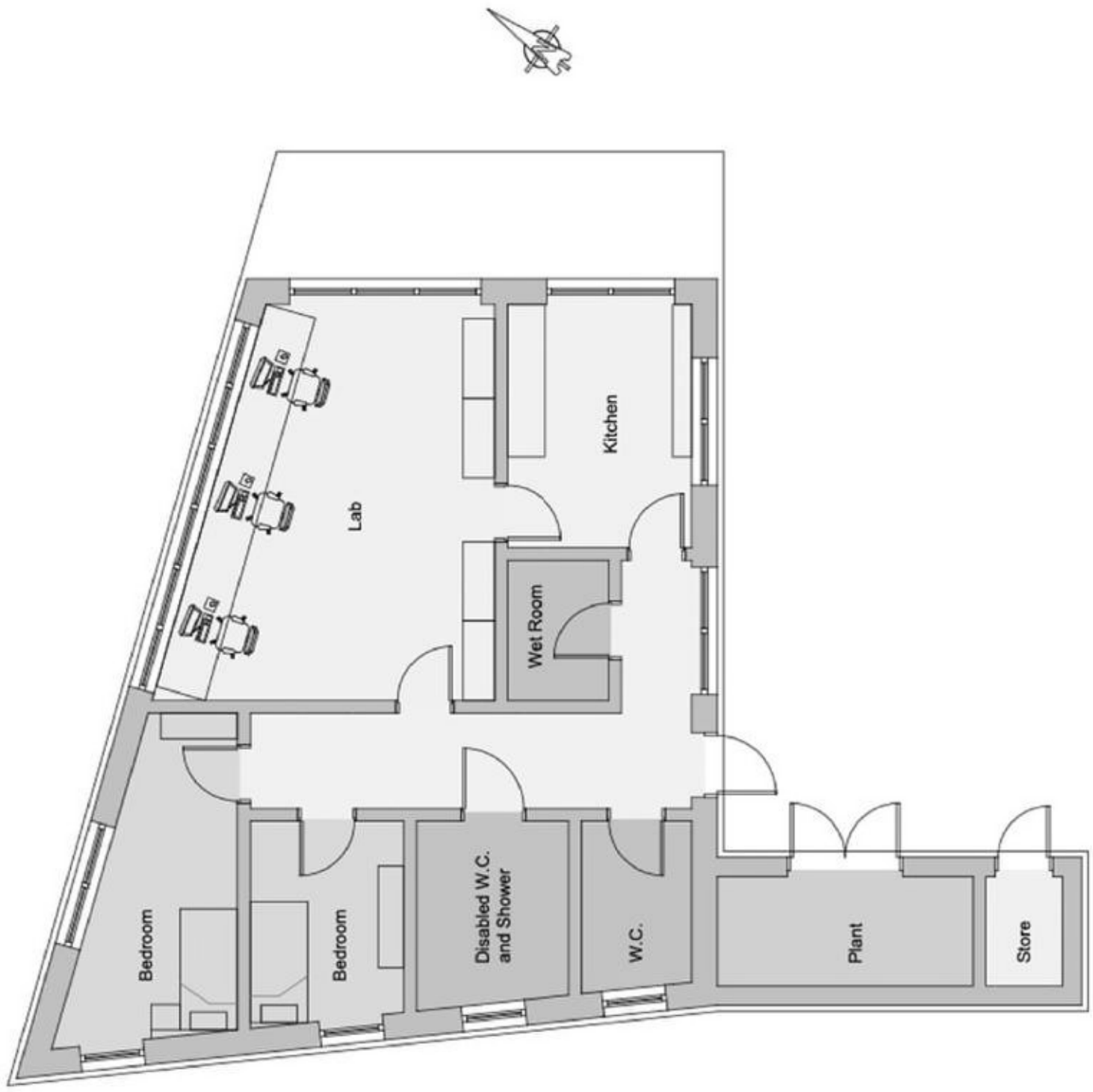

Appendix I: Noise Units & Indices

Sound and the decibel

A sound wave is a small fluctuation of atmospheric pressure. The human ear responds to these variations in pressure, producing the sensation of hearing. The ear can detect a very wide range of pressure variations. In order to cope with this wide range of pressure variations, a logarithmic scale is used to convert the values into manageable numbers. Although it might seem unusual to use a logarithmic scale to measure a physical phenomenon, it has been found that human hearing also responds to sound in an approximately logarithmic fashion. The dB (decibel) is the logarithmic unit used to describe sound (or noise) levels. The usual range of sound pressure levels is from 0 dB (threshold of hearing) to 120dB (threshold of pain).

Due to the logarithmic nature of decibels, when two noises of the same level are combined together, the total noise level is (under normal circumstances) 3 dB(A) higher than each of the individual noise levels e.g. 60 dB(A) plus 60 dB(A) = 63 dB(A). In terms of perceived 'loudness', a 3 dB(A) variation in noise level is a relatively small (but nevertheless just noticeable) change. An increase in noise level of 10 dB(A) generally corresponds to a doubling of perceived loudness. Likewise, a reduction in noise level of 10 dB(A) generally corresponds to a halving of perceived loudness.

The ear is not equally sensitive to sound at all frequencies. It is less sensitive to sound at low and very high frequencies, compared with the frequencies in between. Therefore, when measuring a sound made up of different frequencies, it is often useful to 'weight' each frequency appropriately, so that the measurement correlates better with what a person would actually hear. This is usually achieved by using an electronic filter called the 'A' weighting, which is built into sound level meters. Noise levels measured using the 'A' weighting are denoted dB(A) or dBA.

Frequency and Hertz (Hz)

As well as the loudness of a sound, the frequency content of a sound is also very important. Frequency is a measure of the rate of fluctuation of a sound wave. The unit used is cycles per second, or hertz (Hz). Sometimes large frequency values are written as kiloHertz (kHz), where 1 kHz = 1000 Hz.

Young people with normal hearing can hear frequencies in the range 20 Hz to 20 kHz. However, the upper frequency limit gradually reduces as a person gets older.

Glossary of Terms

When a noise level is constant and does not fluctuate, it can be described adequately by measuring the dB(A) level. However, when the noise level varies with time, the measured dB(A) level will vary as well. In this case it is therefore not possible to represent the noise climate with a simple dB(A) value. In order to describe noise where the level is continuously varying, a number of other indices can be used. The indices used in this report are described below.

$L_{Aeq,T}$ This is the A–weighted 'equivalent continuous noise level' which is an average of the total sound energy measured over a specified time period. In other words, $L_{Aeq,T}$ is the level of a continuous noise which has the same total (A–weighted) energy as the real fluctuating noise, measured over the same time period. It is increasingly being used as the preferred parameter for all forms of environmental noise.

L_{AFmax} This is the maximum A–weighted noise level that was recorded during the measurement period in terms of 'Fast' time weighting.

$L_{A90,T}$ This is the A–weighted noise level exceeded for 90% of the time period. $L_{A90,T}$ is used as a measure of background noise.

Appendix II: Noise Survey Results

Date(s):	Tuesday 6th September - Wednesday 7th September 2022
Equipment	NTi XL2 'Class 1' sound level meters (s/n: A2A-20361-E0) with associated calibrator and environmental outdoor monitoring kit. Vibrock 901 vibration monitor (S/N: 901) with VDV Transducers.
Weather	Dry, ~13-19°C, clear/partly cloudy skies and calm <3 m/s, with a period of light rain between 15:00-17:00

All levels in dB(A)

Location 1: Measured Noise Levels