



BISHOP & CAMMELL PROPERTIES LTD

**2 CROFT COTTAGES, PIER ROAD
LITTLEHAMPTON, WEST SUSSEX**

NOISE IMPACT ASSESSMENT

TECHNICAL REPORT: RFE-0360-21-02

DATE: JULY 2021



PROJECT TITLE: 2 CROFT COTTAGES, PIER ROAD, LITTLEHAMPTON, WEST SUSSEX

REPORT REF: RFE-0360-21-02

DATE: JULY 2021

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DOCUMENT HISTORY		
Status	Description	Date
01	Draft report for client comment	30/06/2021
02	Final Issue	05/07/2021

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CONTENTS

1	INTRODUCTION	1
2	SITE DESCRIPTION AND PROPOSED DEVELOPMENT	2
2.1	Site Description	2
2.2	Proposed Redevelopment.....	2
3	ASSESSMENT CRITERIA	3
3.1	Noise Policy Statement for England (NPSE).....	3
3.2	National Planning Policy Framework.....	4
3.3	Planning Policy Guidance	5
3.4	British Standard BS8233:2014.....	6
3.5	World Health Organisation	7
3.6	Local Authority Requirements.....	8
4	ENVIRONMENTAL NOISE SURVEY	9
4.1	Unattended Baseline Noise Survey	9
4.2	Weather Conditions	10
4.3	Continuous Noise Survey Results	10
4.4	Representative Daytime and Night-time Ambient Noise Levels.....	10
5	NOISE CALCULATIONS.....	12
5.1	Noise Calculations	12
5.2	Construction Assumptions	12
5.3	Ventilation System	13
6	NOISE ASSESSMENT	14
6.1	Assessment of Internal Noise Levels	14
6.2	Assessment of External Noise Levels.....	14
6.3	World Health Organisation $L_{Amax,F}$ Noise Levels	15
6.4	Noise Mitigation.....	16
7	CONCLUSIONS.....	17



1 INTRODUCTION

RF Environmental Ltd (RFE) was commissioned in May 2021 by Bishop & Cammell Properties Ltd to undertake a noise assessment of a proposed residential development, located at no. 2 Croft Cottages, Pier Road, Littlehampton, West Sussex, BN17 5LS.

The noise assessment has been prepared to assist with the discharge of the noise related planning condition attached to planning decision notice LU/159/19/PL. Planning Condition 12 requires a detailed proposal to ensure that:

'Prior to the commencement of the development hereby approved, a scheme to demonstrate that the internal noise levels within the residential units will conform to the "Indoor ambient noise levels for dwellings" guideline values specified within Table 4 under section 7.7.2 of BS 8233:2014.

Details complied by a competent acoustician on sound insulation and noise reduction for buildings shall be submitted to and approved in writing by the Local Planning Authority. The scheme should take into account the correct number of air changes required for noise affected rooms. The works specified in the approved scheme shall then be carried out in accordance with the approved details prior to occupation of the premises and be retained thereafter.'

The principle sources of noise affecting the proposed development site is road traffic on Pier Road directly to the west / front of the property, and commercial activity associated with a Travis Perkins Building material supplier directly to the east and south / rear of the property.

The existing site and proposed redevelopment are described in the following section of this report, whilst the legislation and criteria used for the assessment are included within Section 3 of this report. The noise survey is presented in Section 4. The noise calculations are described in Section 5 whilst the noise assessment is presented in Section 6. The conclusions of this study are summarised in Section 7. Figures and Tables are presented in Appendix A and B respectively. A description of useful acoustic terms can be found in Appendix C.

The report has been produced by Jamie Pearson (MIOA) and reviewed by Richard Fenton (MIOA MCIEH) of RF Environmental Ltd. Jamie and Richard are both qualified and experienced in the production of noise impact assessments and have produced and reviewed a significant number of noise assessments in consultancy and local authority roles.



2 SITE DESCRIPTION AND PROPOSED DEVELOPMENT

2.1 Site Description

The redevelopment site at no. 2 Croft Cottages is located on Pier Road, within the administrative boundary of Arun District Council. Pier Road is located in an area with mixed residential and commercial premises.

No. 2 Croft Cottages is an existing three-bedroom semi-detached dwelling.

The principle source of noise affecting the site is road traffic on Pier Road directly to the west / front of the property, and commercial activity associated with a Travis Perkins Building material supplier directly to the east and south / rear of the property.

A plan of the site and immediate area is presented in Figure A1 of Appendix A.

Existing site elevations and floor plans are presented in Figures A2 and A3 of Appendix A respectively.

2.2 Proposed Redevelopment

The proposed redevelopment of no. 2 Croft Cottages consists of the construction of a 2-bed maisonette over parking area, extend crossover and alterations to rear fenestration.

Proposed elevations and floor plans are presented in Figures A4 and A5 of Appendix A respectively.



3 ASSESSMENT CRITERIA

3.1 Noise Policy Statement for England (NPSE)

The Noise Policy Statement for England (March 2010)¹, sets out the long-term vision of Government noise policy.

The vision of the NPSE is to 'Promote good health and a good quality of life through the effective management and control of noise within the context of Government policy on sustainable development.' This vision is supported by three key aims:

- avoid significant adverse impacts on health and quality of life.
- mitigate and reduce to a minimum other adverse impact on health and quality of life; and
- where possible, contribute to the improvement of health and quality of life.

The NPSE should apply to all forms of noise including environmental noise, neighbour noise and neighbourhood noise but does not apply to noise in the workplace (occupational noise).

The NPSE had adopted the following concepts, to help consider whether noise is likely to have 'significant adverse' or 'adverse' effects on health and quality of life:

NOEL – No Observed Effect Level

This is the level below which no effect can be detected. In simple terms, below this level, there is no detectable effect on health and quality of life due to noise.

LOAEL – Lowest Observed Adverse Effect Level

This is the level above which adverse effects on health and quality of life can be detected.

SOAEL – Significant Observed Adverse Effect Level

This is the level above which significant adverse effects on health and quality of life occur.

However, the NPSE goes on to state that:

'it is not possible to have a single objective noise-based measure that defines SOAEL that is applicable to all sources of noise in all situations. Consequently, the SOAEL is likely to be different for different noise sources, for different receptors and at different times. It is acknowledged that further research is required to increase our understanding of what may constitute a significant adverse impact on health and quality of life from noise. However, not having specific SOAEL values in the NPSE provides the necessary policy flexibility until further evidence and suitable guidance is available.'

¹ Department for Environment, Food and Rural Affairs (DEFRA). Noise Policy Statement for England (NPSE), 2010.

3.2 National Planning Policy Framework

The NPPF 2019², which refers to the “Explanatory Note in the in the NPSE, does not include specific noise criteria to be applied in planning decisions. It contains the following relevant guidance relating to noise and development:

“170. 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 soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air and water quality, taking into account relevant information such as river basin management plans...

180. 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 impact resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and quality of life; and

(b) identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason...

182. Planning policies and decisions should ensure that new development can be integrated effectively with existing businesses and community facilities (such as places of worship, pubs, music venues and sports clubs). Existing businesses and facilities should not have unreasonable restrictions placed on them as a result of development permitted after they were established. Where the operation of an existing business or community facility could have a significant adverse effect on new development (including changes of use) in its vicinity, the applicant (or ‘agent of change’) should be required to provide suitable mitigation before the development has been completed.

183. The focus of planning policies and decisions should be on whether proposed development is an acceptable use of land, rather than the control of processes or emissions (where these are subject to separate pollution control regimes). Planning decisions should assume that these regimes will operate effectively. Equally, where a planning decision has been made on a particular development, the planning issues should not be revisited through the permitting regimes operated by pollution control authorities.”

² Department of Communities and Local Government. National Planning Policy Framework, 2019



3.3 Planning Policy Guidance

Planning Practice Guidance (PPG) on noise was issued in March 2014 and updated in July 2019³. This web-based guidance advises local planning authorities that *“Noise needs to be considered when new developments may create additional noise (including any anticipated changes to that environment from activities that are permitted but not yet commenced)...”* It states that...

“noise can override other concerns, where justified, although it is important to look at noise in the context of the wider characteristics of a development proposal, its likely users and its surroundings, as these can have an important effect on whether noise is likely to pose a concern”

“...but neither the Noise Policy Statement for England nor the National Planning Policy Framework (which reflects the NPSE) expects noise to be considered in isolation, separately from the economic social and other environmental dimensions of proposed development.” (paragraph 002)

As regards planning decisions, the PPG advises that the decision taker ‘should take into account the acoustic environment, and in doing so consider the following:

- *whether or not a significant adverse effect is occurring or likely to occur;*
- *whether or not an adverse effect is occurring or likely to occur; and*
- *whether or not a good standard of amenity can be achieved.*

“In line with the explanatory note of the noise policy statement for England, this would include identifying whether the overall effect of the noise exposure (including the impact during the construction phase wherever applicable) is, or would be, above or below the significant observed adverse effect level and the lowest observed adverse effect level for the given situation.” (paragraph 003)

The PPG paragraph 004 refers to the NPSE ‘observed effect level’, while paragraph 005 sets out the noise exposure hierarchy which is based on the ‘likely average response,’ and gives example outcomes. The hierarchy table is presented in Table 3.1 below.

The hierarchy table provides guidance regarding how the concept of SOAELs and LOAELs, introduced through the NPSE, can be applied; and allows for informed subjective perceptions to be made in respect of the noticeability of noise in the context of potential effect levels. The PPG states that *“Although the word ‘level’ is used here, this does not mean that the effects can only be defined in terms of a single value of noise exposure. In some circumstances adverse effects are defined in terms of a combination of more than one factor such as noise exposure, the number of occurrences of the noise in a given time period, the duration of the noise and the time of the day the noise occurs”*.

³ Department for Communities and Local Government: Planning Practice Guidance – Noise paragraph 001 Ref. ID: 30-001-20140306. Revision date July 2019.

Response	Examples of Outcomes	Increasing Effect Level	Action
No Observed Effect Level			
Not Present	No Effect	No Observed Adverse Effect	No specific measures required
No Observed Adverse Effect Level			
Present and not intrusive	Noise can be heard, but does not cause any change in behaviour, attitude or other physiological response. Can slightly affect the acoustic character of the area but not such that there is a change in quality of life.	No Observed Adverse Effect	No specific measures required
Lowest Observed Adverse Effect Level			
Present and intrusive	Noise can be heard and causes small changes in behaviour, attitude or other physiological response, e.g. turning up volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a small actual or perceived change in the quality of life.	Observed Adverse Effect	Mitigate and reduce to a minimum
Significant Observed Adverse Effect Level			
Present of disruptive	The noise causes a material change in behaviour, attitude or other physiological response, e.g. avoiding certain activities during periods of intrusion; where there is no alternative ventilation, having to keep windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in acoustic character of the area.	Significant Observed Adverse Effect	Avoid
Present and very disruptive	Extensive and regular changes in behaviour, attitude or other physiological response and/or an inability to mitigate effect of noise leading to psychological stress, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g. auditory and non-auditory	Unacceptable Adverse Effect	Prevent

TABLE 3.1: PPG NOISE EXPOSURE HEIRARCHY

(Source – Planning Practice Guidance)

3.4 British Standard BS8233:2014

BS 8233:2014 Guidance on sound insulation and noise reduction for buildings⁴ gives recommendations for the control of noise in and around buildings. The Standard suggests appropriate criteria and limits for different situations to guide the design of new or refurbished buildings undergoing a change of use.

Desirable upper noise levels inside residential habitable rooms are specified in the Standard and are reproduced overleaf in Table 3.2.

Activity	Room	Ambient Indoor Noise Level 07:00 to 23:00 hrs, dB LAeq,35hr	Ambient Indoor Noise Level 23:00 to 07:00 hrs, dB LAeq,35hr
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⁴ British Standard BS 8233: 2014. Guidance on sound insulation and noise reduction in buildings.

Resting	Living Room	35	-
Dining	Dining room/ area	40	-
Sleeping (daytime resting)	Bedroom	35	30

TABLE 3.2: BS8233 DESIRABLE INDOOR AMBIENT NOISE LEVELS FOR DWELLINGS

Where development is considered necessary or desirable, despite external noise levels above WHO guidelines, the internal target levels may be relaxed by up to 5 dB and reasonable internal conditions still achieved.

In external amenity spaces, such as private gardens and patios, BS 8233 indicates that it is desirable that the external noise level in these areas does not exceed 50 dB $L_{Aeq,T}$ with an upper guideline value of 55 dB $L_{Aeq,T}$ in noisier environments.

3.5 World Health Organisation

The most recent WHO guidelines '*Environmental Noise Guidelines for the European Region*'⁵ acknowledge that 'single event noise indicators such as the maximum sound pressure level are warranted in specific situations such as night time railway or aircraft noise events that can clearly elicit awakenings', however, the guidance indicates that 'the relationship between different types of single-event noise indicators and long-term health outcomes at the population level remains tentative' and therefore does not make any recommendations for single event noise indicators.

However, guideline values for community noise in specific environments are presented in the WHO's '*Guidelines for Community Noise*'⁶ document. The guideline values pertinent to this noise assessment are presented below in Table 3.3.

Specific Environment	Critical Health Effect(s)	dB $L_{Aeq,T}$	Time Base, Hours	dB $L_{Amax,F}$
Outdoor living area	Serious annoyance, daytime and evening	55	16	-
	Moderate annoyance, daytime and evening	50	16	-
Dwelling indoors	Speech intelligibility and moderate annoyance, daytime and evening	35	16	-
Inside bedrooms	Sleep disturbance, night-time	30	8	45

TABLE 3.3: WHO GUIDELINE NOISE VALUES

⁵ World Health Organisation. 2018. Environmental Noise Guidelines for the European Region.

⁶ World Health Organisation. 1999. Guidelines for Community Noise.



3.6 Local Authority Requirements

Local Authorities in Sussex, including Arun District Council, have produced a planning guidance document 'Planning Noise Advice Document – Sussex'⁷ which sets out the required approach for undertaking a noise assessment, for certain types of development.

For new residential dwellings, the guidance presents information which states:

'Where the noise assessment has shown that habitable rooms will be exposed to noise levels likely to give rise to any adverse impact, noise mitigation will be required.'

Design control measures should aim to meet the recommended standards set out in table 4 of BS 8233:2014 and the night time L_{Amax} level recommended in the WHO's Night Noise Guidelines for Europe (2009), unless there are particular reasons why this is not considered appropriate. In such cases, a clear explanation of the reasons should be provided.

While it is acknowledged that noise mitigation measures can be used in a lot of cases to achieve suitable internal levels, it is important that preference is given to criteria based on windows being partially open.

If it is not possible to achieve suitable internal levels with the windows opened then details of alternative ventilation must be supplied. Where the noise assessment has shown that habitable rooms will be exposed to noise levels likely to give rise to any adverse impact, noise mitigation will be required'

⁷ The Planning Noise Advice Document: Sussex. 2021.

4 ENVIRONMENTAL NOISE SURVEY

4.1 Unattended Baseline Noise Survey

Unattended continuous monitoring of existing noise levels was undertaken at the monitoring location shown as LT1 on Figure A6 of Appendix A. The equipment used during the survey is presented in Table 4.1 below.

Manufacturer	Model No.	Description	Serial No.	Calibration Due Date
Larson Davis	LxT	Sound Level Meter	0004968	April 2022
Larson Davis	CAL200	Calibrator	12981	April 2022

TABLE 4.1: SOUND MONITORING EQUIPMENT

The sound level meter was powered by dry cell batteries and stored inside a weatherproof security box.

Measurements were obtained using the 'F' time weighting and A-weighting frequency network. The equipment was calibrated before and after the survey to generate a calibration level of 114.0 dB at 1 kHz.

15-minute measurements of $L_{Amax,F}$, $L_{Aeq,15min}$, and $L_{A90,15min}$ noise levels were obtained at this monitoring location between 14:30 hrs on Tuesday 25th May 2021 and 13:56 hrs on Thursday 27th May 2021, with the microphone position set at a height of approximately 2.5 m above local ground level in free-field conditions. A photograph of the monitoring equipment is shown in Figure 4.1 below.

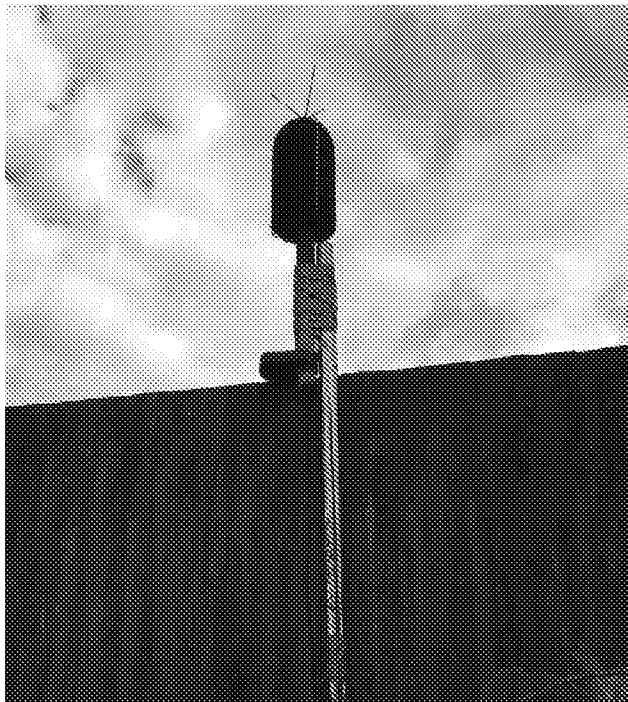


FIGURE 4.1: PHOTOGRAPH SHOWING UNATTENDED NOISE MONITORING EQUIPMENT

4.2 Weather Conditions

Weather conditions during the site visits are presented below in Table 4.2.

Site Visit	Date and Time	Noted Weather
Setup	25/05/21 14:30	Dry with average windspeeds below 3m/s. air temperatures around 13.5 ° and relative humidity 60%.
Collection	27/05/21 13:56	Dry and calm, air temperatures around 15 ° and relative humidity 68%.

TABLE 4.2: WEATHER CONDITIONS DURING SITE VISITS

A history of the weather conditions during the continuous survey period has been obtained from an internet source (ILITTLE21 www.wunderground.com). Analysis of the data shows a period of dry, calm weather. The weather conditions obtained for the survey period are summarised in Figure A7 of Appendix A.

4.3 Continuous Noise Survey Results

The results of the unattended noise measurement survey are presented graphically in Figure A8 of Appendix A, tabulated in Table B1 of Appendix B and summarised in Table 4.3 below.

Date	Measured Noise Levels, dB					
	Daytime (07:00 - 23:00)			Night-time (23:00 - 07:00)		
	L _{max,1}	L _{Aeq,16hr}	L _{90,16hr}	L _{max,1}	L _{Aeq,8hr}	L _{90,8hr}
Tue 25/05/21	74(63-87)	60	41	62(41-82)	48	33
Wed 26/05/21	76(62-89)	60	44	62(42-85)	48	32
Thu 27/05/21	78(68-86)	59	47	-	-	-
Average	76(74-78)	60	44	62(62-62)	48	33

TABLE 4.3: SUMMARY OF UNATTENDED NOISE MEASUREMENTS, LT1

The results of the unattended noise measurement show that ambient day time L_{Aeq,16hr} sound levels produced an arithmetic average of 60 dB L_{Aeq,16hr}. The ambient night-time L_{Aeq,8hr} sound levels produced an arithmetic average of 48 dB L_{Aeq,8hr}.

4.4 Representative Daytime and Night-time Ambient Noise Levels

Based on the noise levels obtained during the unattended monitoring between the 25th and 27th May 2021, the following noise levels for day and night-time periods have been calculated to be representative of the mean daytime L_{Aeq,16hr} and night-time L_{Aeq,8hr} external free-field noise levels at the future façade position of the proposed development. These are presented overleaf in Table 4.4.



Period	Time Base (hr)	L _{avg,T} dB (A)	1/1-Octave Band External Free-Field Noise Level, dB L _{eq,T}					
			125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
Daytime	16	60	65.8	62.0	56.3	54.1	51.4	46.4
Night-time	8	48	46.5	43.7	42.5	43.2	41.2	40.0

TABLE 4.4: SUMMARY OF REPRESENTATIVE EXTERNAL DAYTIME AND NIGHT-TIME NOISE LEVELS



5 NOISE CALCULATIONS

5.1 Noise Calculations

The calculation method described in Annex G of BS 8233:2014 has been used to predict noise levels inside habitable rooms within the proposed development dwelling.

The calculation method enables composite façade sound reductions to be calculated taking into consideration the sound reduction afforded by the external walls, roof and window elements plus any ventilation apertures in the façade.

The acoustic algorithm used to calculate the façade sound reduction and the internal noise levels is reproduced below.

$$L_{eq,2} = L_{eq,ff} + 10 \log_{10} \left(\frac{A_0}{S} 10^{\frac{-D_{n,e}}{10}} + \frac{S_{wi}}{S} 10^{\frac{-R_{wi}}{10}} + \frac{S_{ew}}{S} 10^{\frac{-R_{ew}}{10}} + \frac{S_{rr}}{S} 10^{\frac{-R_{rr}}{10}} \right) + 10 \log_{10} \left(\frac{S}{A} \right) + 3$$

Where:

- $L_{eq,ff}$ is the equivalent, free-field, continuous sound pressure level outside the room elements under consideration;
- A_0 is a reference absorption area of 10 m² and is independent of frequency;
- $D_{n,e}$ is the insulation of the trickle ventilator measured according to BS EN ISO 10140;
- S_{wi} is the area in square metres (m²) of the windows of the room;
- R_{wi} is the sound reduction index (octave band value) of the window;
- S_{ew} is the area in square metres (m²) of the external wall of the room;
- R_{ew} is the sound reduction index (octave band value) of the external wall;
- S_{rr} is the area in square metres (m²) of the ceiling of the room;
- R_{rr} is the sound reduction index (octave band values) of the roof/ceiling;
- S_f is the total façade area in square metres (m²) of the room in question;
- S is the total area in square metres (m²) of elements through which sound enters the room, i.e. $S_f + S_{rr}$;
- A is the equivalent absorption area of the receiving room being considered; and
- +3 is a correction factor

5.2 Construction Assumptions

Architectural plans, received from Bishop & Cammell Properties Ltd, have been used to derive details of the specific construction of the building envelope.

The sound reduction of the roof element has been calculated using Insul version 9. This commercial software package implements complex calculations to predict the Transmission



Loss (TL) of building elements. A screenshot of the Insul calculation for the roof construction is presented in Figure A9 of Appendix A.

The sound reduction for a typical masonry wall construction has been extracted from the Woods Practical Guide to Noise Control⁸.

It has been necessary to calculate the total transmission loss of the wall and roof elements in this way due to there being no manufacturer's acoustical specification data for each material due to be used in the building construction.

The assumed SRI of the wall and roof constructions are presented below in Table 5.1.

As the glazing units are yet to be selected, the sound reduction for a double-glazing system is also presented in Table 5.1.

Building Element	Source	R _w	1/1 Octave Band Frequency, Sound Reduction Index, dB					
			125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
Wall	Woods	-	34	34	40	56	73	76
Roof	Insul	57	36	48	55	60	62	62
Glazing ^[1]	Velfac	35	23	23	33	39	39	38

TABLE 5.1: BUILDING ELEMENT SOUND REDUCTION INDEX (SRI)

Note: [1] Glazing specified as 4-16-4 configuration. Velfac option used for purpose of calculation.

5.3 Ventilation System

As the ventilation system is yet to be selected, the sound reduction performance presented in Table 5.2 has been identified for the proposed trickle ventilator system.

Building Element	Source	R _w	1/1 Octave Band Frequency, Sound Reduction Index, dB					
			125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
Trickle Vent - Standard with Direct Air Path	Titon Vents	35	38	36	32	37	39	48

TABLE 5.2: VENTILATION SYSTEM SOUND REDUCTION INDEX (SRI)

⁸ Woods practical guide to noise control. Ian Sharland. 1990

6 NOISE ASSESSMENT

6.1 Assessment of Internal Noise Levels

BS 8233:2014 contains recommended daytime guideline levels of 35 dB $L_{Aeq,T}$ for resting inside bedrooms and living rooms during the daytime, 40 dB $L_{Aeq,T}$ for dining areas and 30 dB $L_{Aeq,T}$ for sleeping inside bedrooms at night.

Based on the calculated composite faced sound reductions, predicted ambient noise levels inside the living areas and bedrooms of the dwelling are presented in Tables B2 to B9 of Appendix B and summarised below in Table 6.1.

Period	Room	Floor	Free-Field External Noise Level, dB $L_{Aeq,T}$	Calculated Internal Noise Level, dB $L_{Aeq,T}$	Room Activity	BS 8233 Guideline Level, dB $L_{Aeq,T}$	BS 8233 Guideline Level Achieved
Daytime (07:00 to 23:00 hrs)	Snug/Study	First	60	33	Living	35	✓
	Kitchen/Dining	First	60	30	Dining	40	✓
	Bedroom 1	Second	60	34	Resting	35	✓
	Bedroom 2	Second	60	31	Resting	35	✓
Night-time (23:00 to 07:00 hrs)	Bedroom 1	Second	48	18	Sleeping	30	✓
	Bedroom 2	Second	48	17	Sleeping	30	✓

TABLE 6.1: CALCULATED DAYTIME & NIGHT-TIME INTERNAL NOISE LEVELS & NOISE ASSESSMENT

Based on the calculated façade sound reductions, the noise predictions show that internal noise levels fall below the daytime and night-time criterion of 35 and 30 dB $L_{Aeq,T}$, respectively, with closed windows.

It should be noted that the daytime and night-time criteria of 35 dB $L_{Aeq,16hr}$ and 30 dB $L_{Aeq,8hr}$ set out in BS 8233 respectively are unlikely to be achieved with windows partially open for natural air ventilation purposes.

6.2 Assessment of External Noise Levels

BS 8233 indicates that it is desirable that the external noise level in these areas does not exceed 50 dB $L_{Aeq,T}$ with an upper guideline value of 55 dB $L_{Aeq,T}$ in noisier environments.

2.5m high close boarded fencing is proposed to be positioned around the boundary of the site.

BS 5228-1:2009+A1:2014⁹ indicates that as a working approximation, the degree of protection from a barrier is limited to 5-10dB(A).

⁹ British Standard BS 5228-1: 2009+A1:2014. Code of Practice for Noise and Vibration Control on Construction and Open Sites

Taking the unscreened mean ambient day time $L_{Aeq,16hr}$ sound level of 60 dB $L_{Aeq,16hr}$ and applying a minimum 5 dB reduction due to the screening provided by the proposed 2.5m high close boarded fencing acting as a noise barrier, the noise level estimated within the external amenity area is 55 dB $L_{Aeq,16hr}$. With the minimum working approximation of noise reduction due to a barrier applied to the measured external noise level, the estimated noise level is equal to the upper guideline level of 55dB $L_{Aeq, 16hrs}$ set out in BS8233:2014.

6.3 World Health Organisation $L_{Amax,F}$ Noise Levels

Maximum $L_{Amax,F}$ noise levels generated at night have also been considered at the proposed development site.

WHO guideline noise criteria sets an internal sleep disturbance noise limit of 42 dB $L_{Amax,F}$ for the onset of critical health effects, which is a level which should not be exceeded on a regular basis. Based on an interpretation that for a noise to be regular, it needs to occur several (i.e. more than two) times per hour, the $L_{Amax,F}$ noise needs to be based upon an average of at least 10-15 events that are typical in nature.

Based on an interpretation that for a noise to be regular, it needs to occur several (i.e. more than two) times per hour, the $L_{Amax,F}$ noise needs to be based upon an average of at least 10-15 events that are typical in nature. The arithmetic average of the highest 10% of night-time maximum events across the survey period measured at LT1 has been used to determine the external $L_{Amax, F}$ value for calculating internal $L_{Amax, F}$ values inside habitable rooms. A summary of the representative external night-time $L_{Amax, F}$ noise levels are presented below in Table 6.2.

Period	Time Base (hr)	$L_{Amax,F}$ dB (A)	1/1-Octave Band External Free-Field Noise Level, dB $L_{Amax,F}$					
			125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
Night-time $L_{Amax,F}$	8	73	70.4	65.6	66.2	65.4	67.1	67.0

TABLE 6.2: SUMMARY OF REPRESENTATIVE EXTERNAL NIGHT-TIME L_{MAX} NOISE LEVELS

WHO guideline noise criteria indicate an internal noise criterion of 42 dB $L_{Amax,F}$ for assessing the onset of sleep disturbance effects.

An assessment of the calculated night-time $L_{Amax,F}$ noise levels inside the second-floor bedrooms of the proposed dwelling, assuming closed windows, has been undertaken and is presented in Table 6.3 below.

Period	Room	Floor	Free-Field External Noise Level, dB $L_{Amax,F}$	Calculated Internal Noise Level, dB $L_{Amax,F}$	Room Activity	WHO Guideline Level, dB $L_{Amax,F}$	WHO Guideline Level Achieved
Night-time (23:00 to 07:00 hrs)	Bedroom 1	Second	73	42	Sleeping	42	Y
	Bedroom 2	Second	73	40	Sleeping	42	Y

TABLE 6.3: CALCULATED INTERNAL $L_{MAX,F}$ NOISE LEVELS & NOISE ASSESSMENT



Table 6.3 indicates that based on the assumed composite façade sound reductions, a typical night-time mean $L_{Amax,F}$ noise level of 73dB should be attenuated sufficiently to fall below WHO's internal sleep disturbance noise criterion of 42 dB $L_{Amax,F}$ with closed windows

6.4 Noise Mitigation

Glazing

As the glazing units are yet to be selected, the sound reduction for a potential glazing system is presented in Table 5.1. These are the minimum values that should guide the selection of the glazing product.

Ventilation

BS 8233 notes that, if relying on closed windows to meet the guide values, there needs to be an appropriate alternative ventilation system that does not compromise the façade insulation or the resulting noise level.

To maximise the sound insulation performance of the proposed external walls and roof constructions it is recommended that where possible the following should be considered:

- trickle vents installed in the window units;
- acoustics air bricks installed in the façade; and/or
- passive or mechanical silenced ventilation (whole house or individual).

It is understood that trickle vents are proposed for the new dwelling. The minimum sound reduction performance for a potential trickle ventilation system and adopted for this assessment is presented in Table 5.2. These are the minimum values that should guide the selection of the ventilation product.



7 CONCLUSIONS

RF Environmental Ltd was appointed to undertake a noise impact assessment for the development site at 2 Croft Cottages, Pier Road, Littlehampton, West Sussex.

The existing noise environment has been established, which is considered representative of the development site, through unattended noise monitoring.

Detailed noise calculations have been undertaken to consider the suitability of the specified façade construction elements, including glazing and passive ventilators, for the protection against the ingress of external noise into habitable rooms.

The predicted internal noise levels have been assessed to assist with the discharge of the noise related condition attached to the development's planning approval.

The internal ambient $L_{Aeq,T}$ noise levels calculated during 16-hour day and 8-hour night-time periods are predicted to meet BS 8233:2014's desirable guideline noise levels with windows closed within the habitable rooms of the dwelling.

The development is proposed to be equipped with passive ventilation and UPVC double glazed windows to ensure internal noise levels meet the desirable guideline noise levels with windows closed. Acoustic performance characteristics of the glazing and ventilation system have been provided. These are minimum values that should guide the selection of the glazing and ventilation products.

External $L_{Aeq,T}$ noise levels are estimated to meet the upper guideline criteria set out in BS8233 of 55dB $L_{Aeq, 16hr}$.

Typical night-time $L_{Amax,F}$ noise levels (23:00 to 07:00 hrs) have been calculated to achieve the WHO's night-time sleep disturbance guideline noise level of 42 dB $L_{Amax,F}$.

APPENDIX A: FIGURES

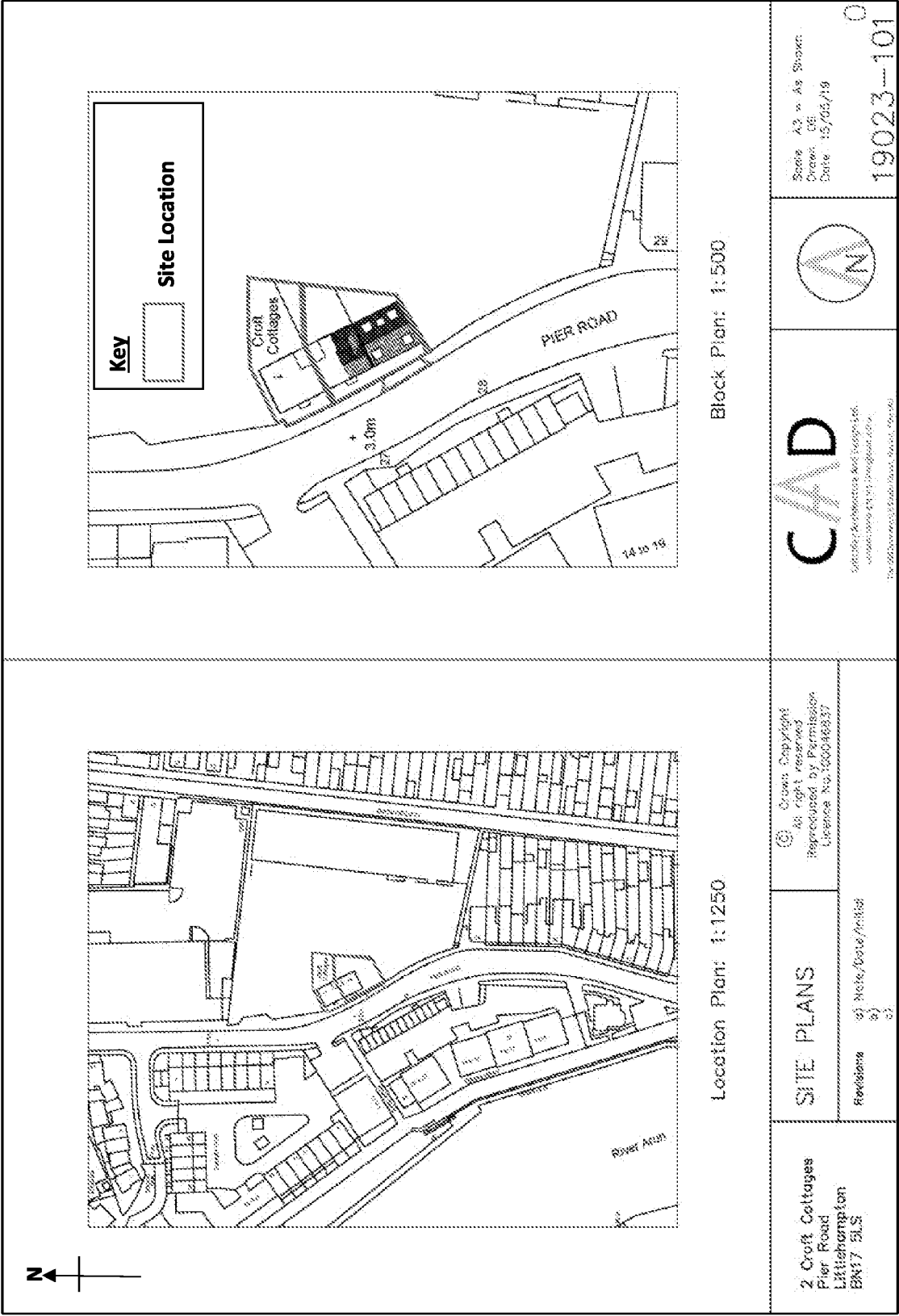


FIGURE A1: LOCATION OF PROPOSED DEVELOPMENT SITE

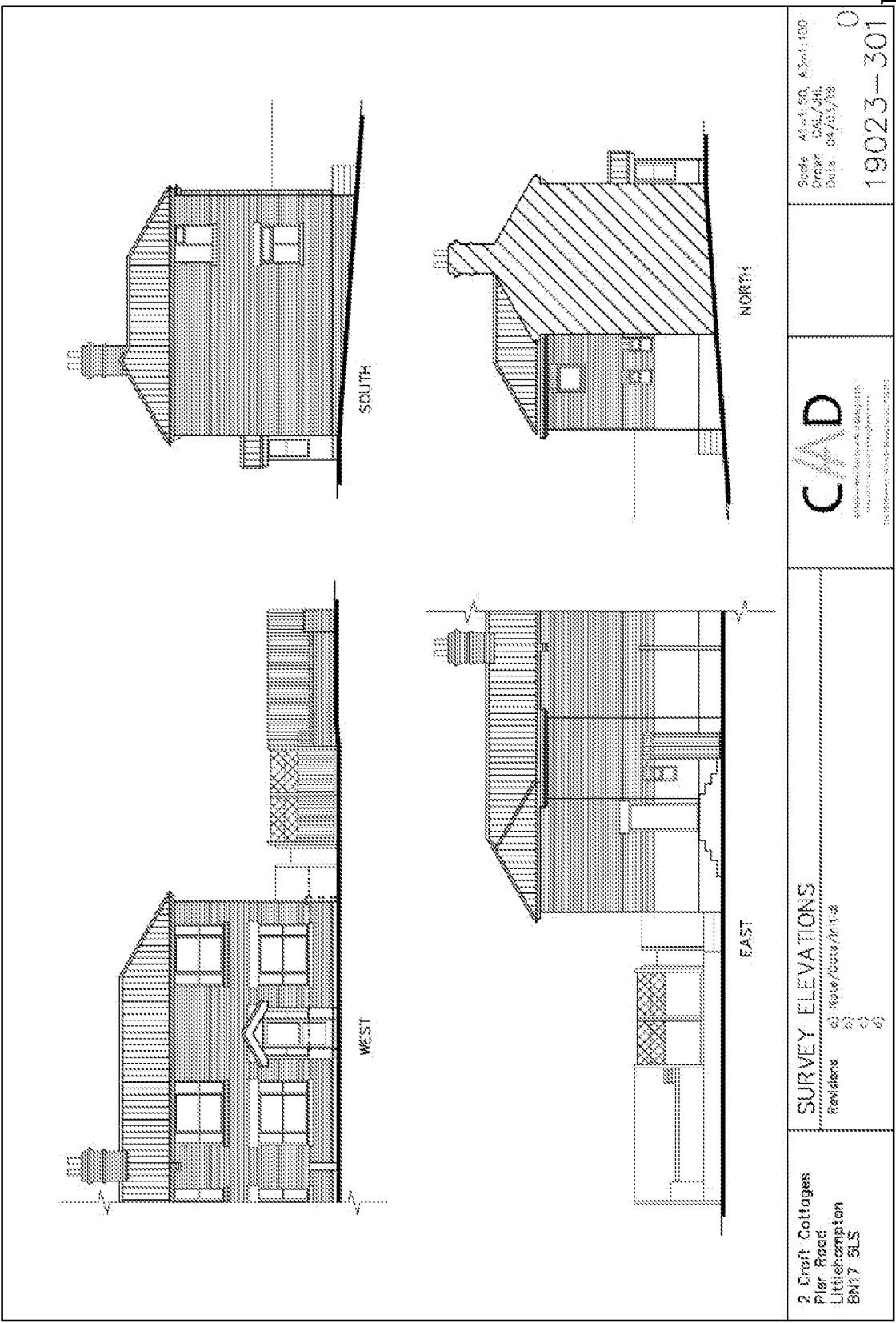
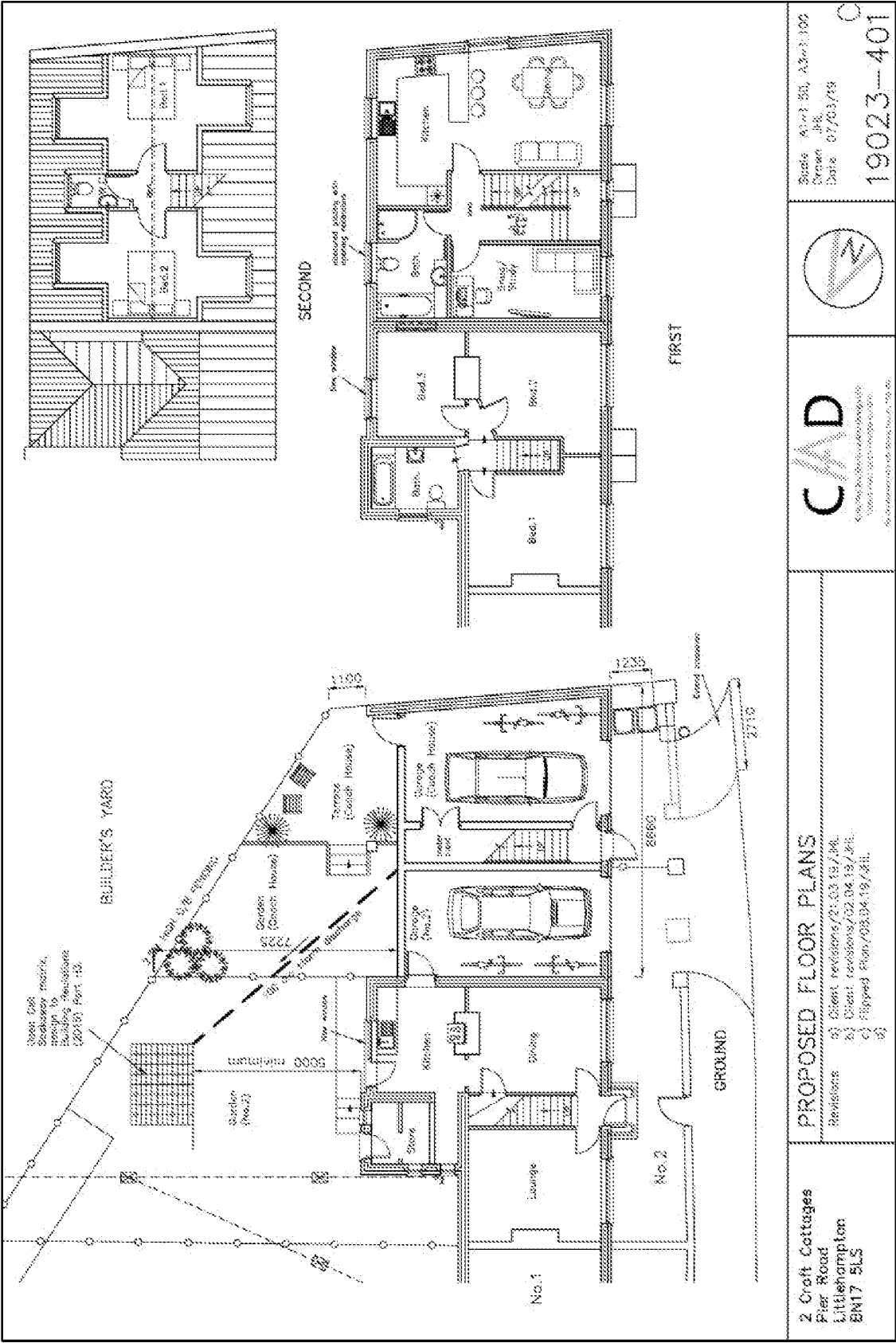


FIGURE A2: EXISTING SITE ELEVATIONS





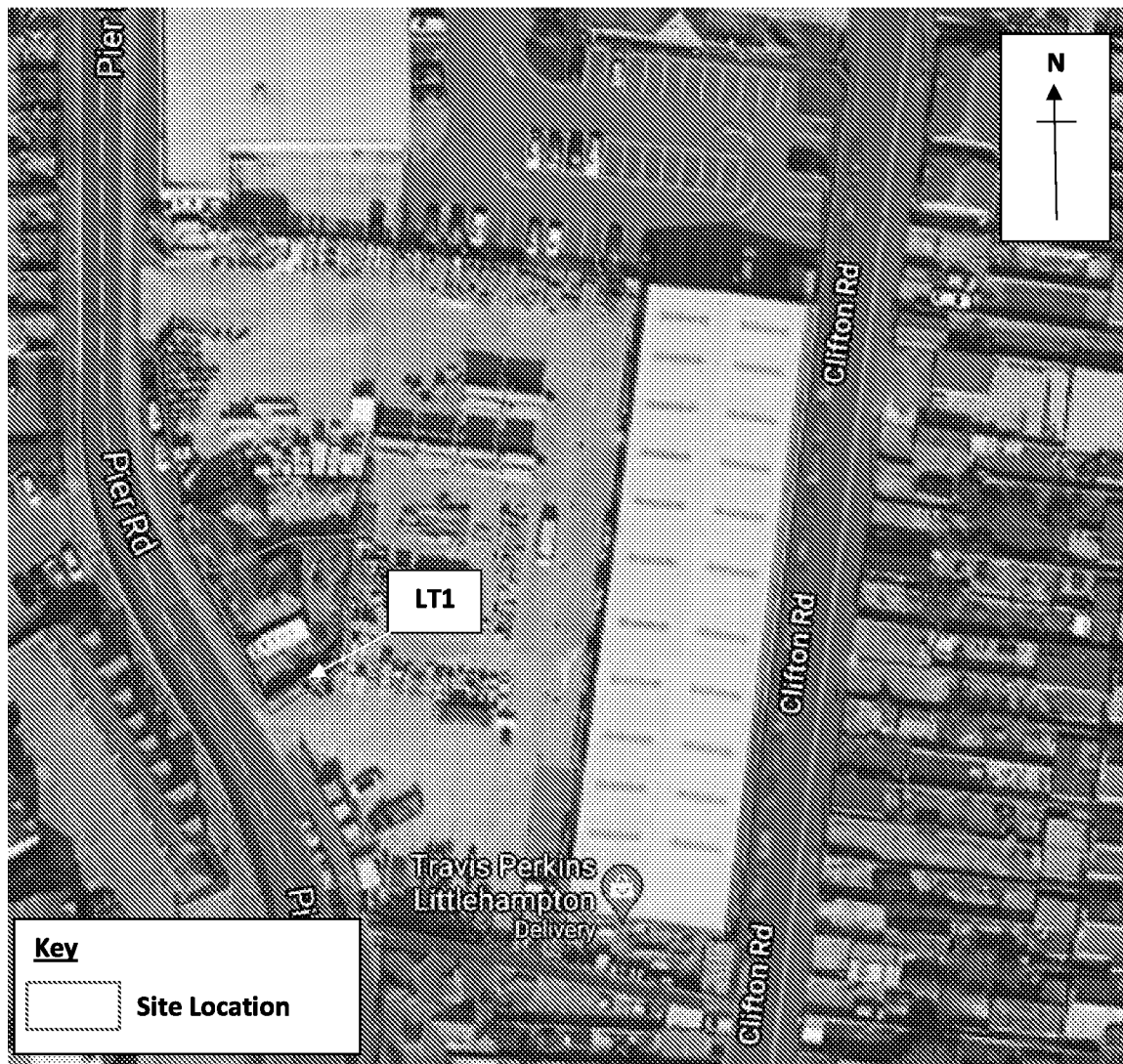


FIGURE A6: LOCATION OF SITE AND UNATTENDED NOISE MONITORING LOCATION

Aerial mapping obtained from google maps

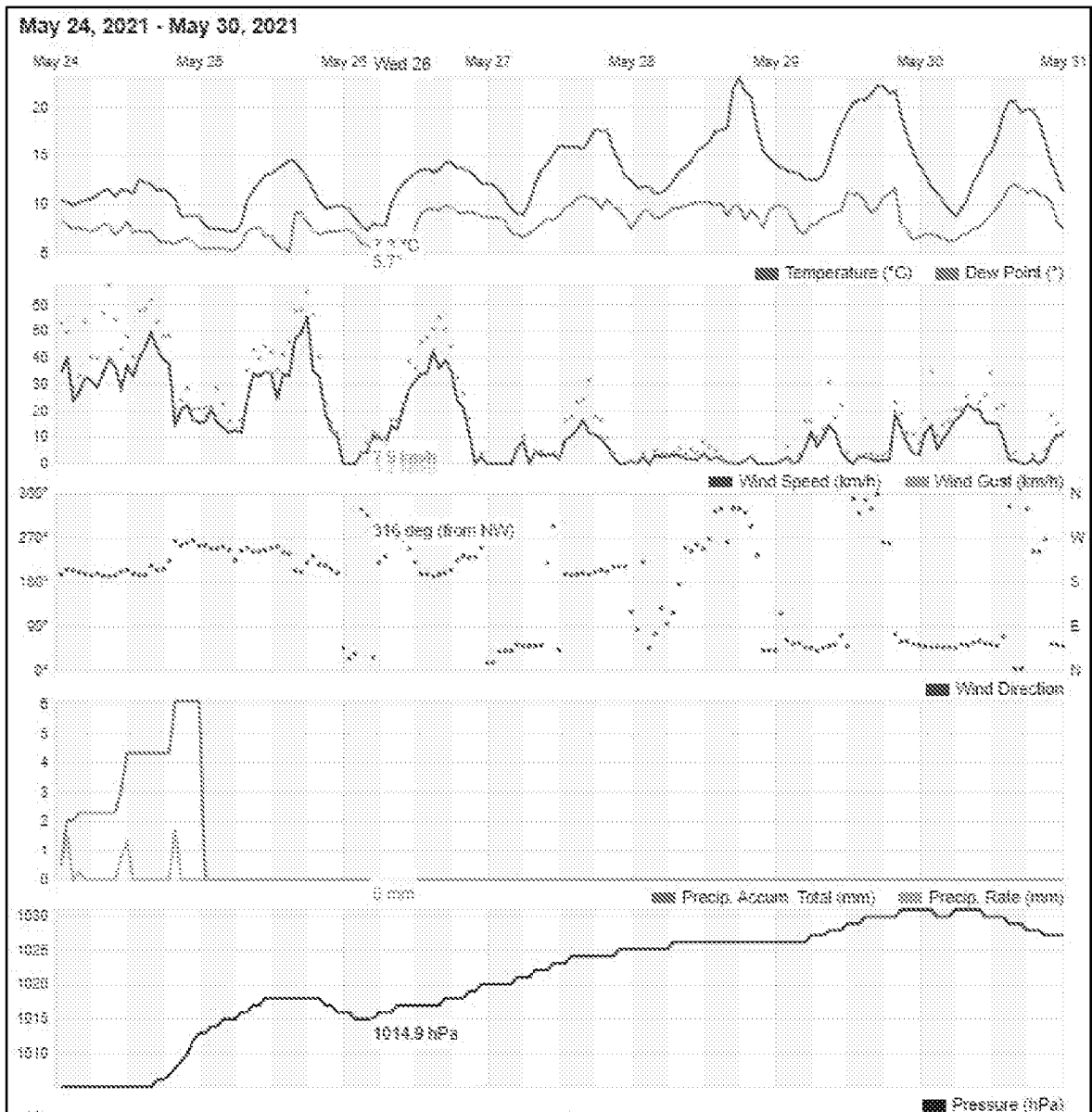


FIGURE A7: WEATHER DATA DURING MONITORING PERIOD

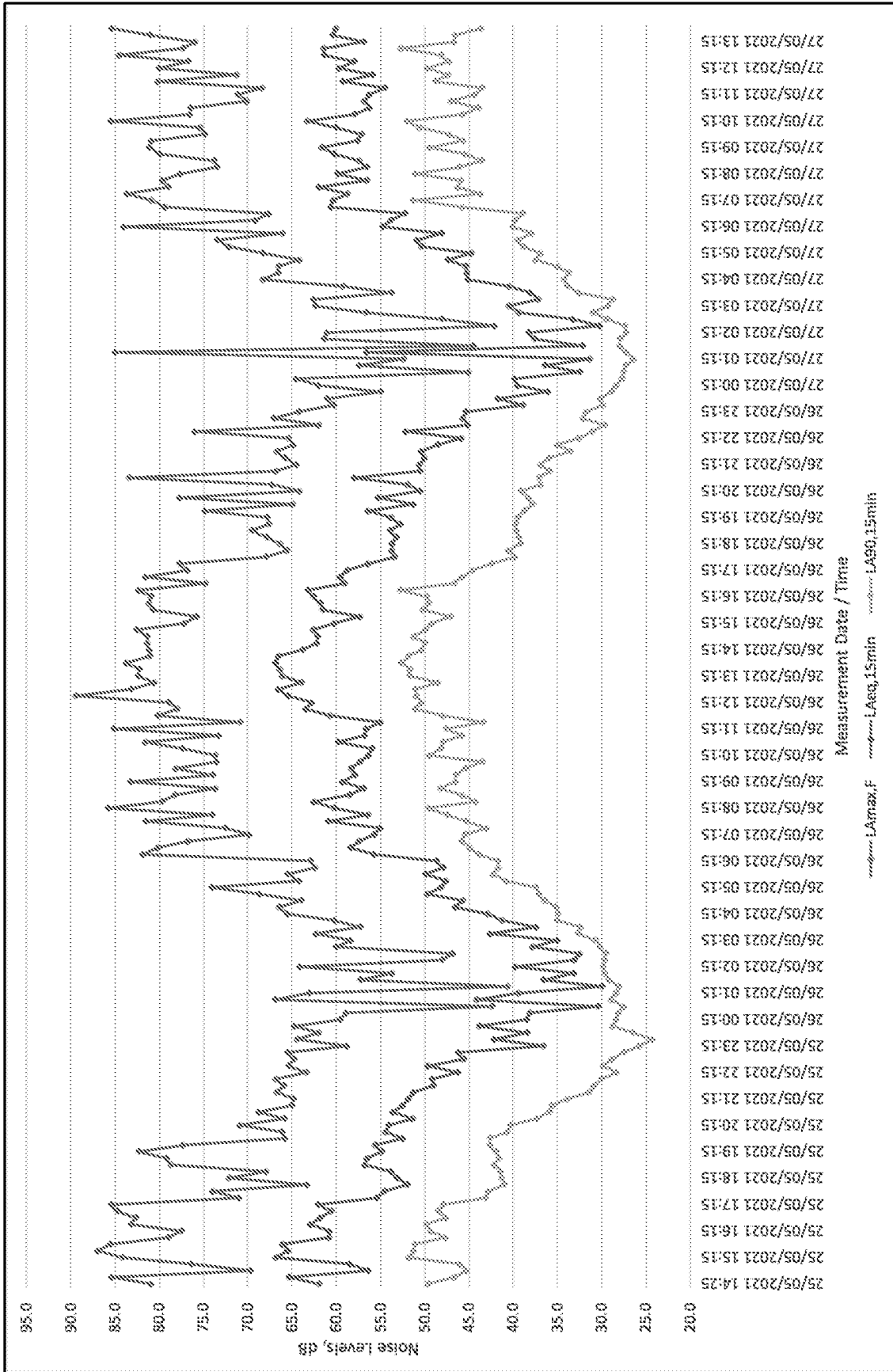


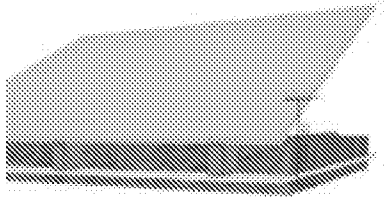
FIGURE A8: TIME HISTORY OF CONTINUOUS NOISE MONITORING DATA, LT1

Sound Insulation Prediction (v9.0.5)

Program copyright Marshall Day Acoustics 2017

Key No: 0001
Job Name:
Job No:
Date: 26/05/2018
File Name:

Insulation



Notes:

Rw 57 dB
C -2 dB
Ctr -7 dB

Mass-air-mass resonance frequency = 145 Hz

Panel Size = 2.7 m x 3.0 m

Random surface mass = 40 kg/m²

System description

Floor 1 : 1 x 14.0 mm floating floor

Floor: Pitched roof : Gully 1000 mm dia. (flat section) 100 mm x 100 mm (70kg/m²) : Trusses: 150 mm x 100 mm (40 kg/m²) : Rafters : 1 x 1 x 10.0 mm (Gully 1000 mm dia.)

freq (Hz)	TL (dB)	TL (dB)
50	15	
63	20	18
80	27	
100	33	
125	38	36
160	42	
200	45	
250	48	48
315	51	
400	53	
500	55	55
630	57	
800	59	
1000	60	60
1250	61	
1600	62	
2000	63	62
2500	65	
3150	61	
4000	61	62
5000	65	

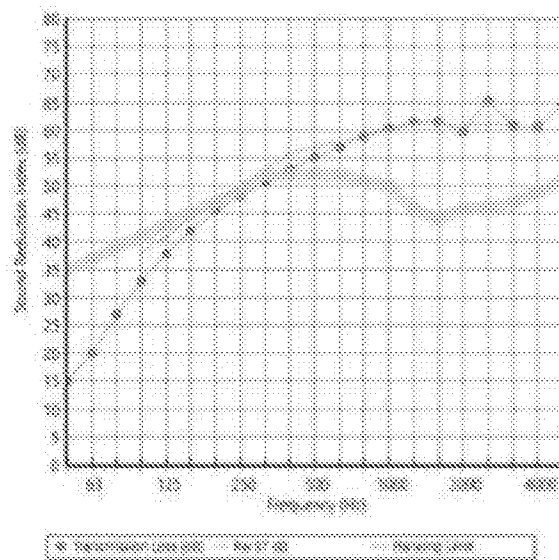


FIGURE A9: INSUL CALCULATION FOR ROOF CONSTRUCTION

APPENDIX B: TABLES

Date of Measurement	Start Time	Measured Noise Levels, dB			
		L _{max} , d	L _{eq, 1}	L _{eq, 10min}	L _{eq, 15min}
Tuesday 25 th May 2021	14:30:00	85.4	66.4	65.4	46.7
	14:45:00	69.7	60.5	56.4	45.3
	15:00:00	76.4	62.0	58.5	46.1
	15:15:00	84.2	70.8	66.8	51.8
	15:30:00	86.9	69.2	65.5	51.2
	15:45:00	85.6	69.4	66.1	51.2
	16:00:00	79.0	63.6	60.8	47.7
	16:15:00	77.5	64.1	60.8	49.3
	16:30:00	83.2	65.9	62.9	49.9
	16:45:00	82.7	63.0	61.9	47.6
	17:00:00	84.8	63.0	60.6	48.5
	17:15:00	85.5	64.3	62.1	47.9
	17:30:00	71.0	59.8	55.5	43.2
	17:45:00	74.0	58.7	54.6	42.8
	18:00:00	63.3	57.3	52.0	41.0
	18:15:00	72.1	57.9	53.2	41.4
	18:30:00	67.9	58.5	53.8	41.4
	18:45:00	78.7	60.4	56.8	42.2
	19:00:00	79.2	58.9	56.5	41.6
	19:15:00	82.4	58.4	54.9	42.0
	19:30:00	77.3	58.5	55.6	42.7
	19:45:00	65.8	57.0	52.5	42.6
	20:00:00	66.1	59.8	54.4	40.7
	20:15:00	70.9	58.7	54.1	40.3
	20:30:00	65.9	55.8	51.4	37.4
	20:45:00	68.8	58.5	53.6	35.9
	21:00:00	65.0	56.8	52.5	35.6
	21:15:00	64.8	56.9	51.8	33.9
	21:30:00	66.7	55.3	51.3	31.4
	21:45:00	66.0	51.1	49.0	30.9
	22:00:00	66.9	50.6	49.1	30.0
	22:15:00	63.4	46.4	46.3	28.3
	22:30:00	65.4	52.6	49.6	29.8
	22:45:00	64.8	46.4	45.6	28.9
	23:00:00	65.5	44.7	46.2	27.5
	23:15:00	58.8	35.4	36.6	25.7
	23:30:00	64.4	38.4	42.2	24.3
	23:45:00	62.0	36.1	38.4	26.5
Wednesday 26 th May 2021	00:00:00	64.7	39.9	43.9	28.8
	00:15:00	59.6	35.2	38.5	28.4
	00:30:00	58.9	35.1	38.1	28.1
	00:45:00	42.4	32.2	30.4	27.5
	01:00:00	66.9	36.6	44.2	29.0

01:15:00	63.1	34.3	39.4	28.4
01:30:00	40.6	31.5	30.0	28.1
01:45:00	57.3	34.7	36.6	29.2
02:00:00	53.7	34.9	33.1	29.7
02:15:00	64.1	34.4	39.7	29.9
02:30:00	48.1	34.7	33.1	29.7
02:45:00	46.9	34.4	32.5	29.5
03:00:00	60.0	36.4	37.8	30.2
03:15:00	58.3	35.6	35.0	30.7
03:30:00	62.3	39.6	42.6	32.7
03:45:00	57.3	39.4	37.4	32.4
04:00:00	60.2	43.6	41.2	35.0
04:15:00	65.5	44.0	42.9	35.0
04:30:00	66.5	45.6	46.6	35.2
04:45:00	64.0	46.3	45.7	36.5
05:00:00	68.7	49.5	49.7	37.1
05:15:00	74.1	48.1	48.2	37.5
05:30:00	64.2	49.2	47.6	40.8
05:45:00	65.5	52.7	49.9	42.3
06:00:00	62.4	49.9	48.0	41.7
06:15:00	62.9	51.0	48.7	41.8
06:30:00	81.9	56.2	55.7	43.9
06:45:00	80.2	59.6	58.4	44.9
07:00:00	76.8	59.4	57.5	45.9
07:15:00	69.8	59.7	55.7	45.4
07:30:00	72.6	59.7	55.1	43.0
07:45:00	81.6	61.1	60.9	45.3
08:00:00	74.1	60.3	56.4	47.5
08:15:00	85.8	61.6	60.3	49.6
08:30:00	79.7	64.3	62.5	44.3
08:45:00	78.3	60.5	58.5	45.8
09:00:00	73.7	60.1	56.9	48.3
09:15:00	83.3	61.8	59.3	46.6
09:30:00	74.0	60.6	57.9	46.5
09:45:00	78.2	61.0	58.4	45.4
10:00:00	73.5	60.3	57.3	43.5
10:15:00	73.7	59.8	56.4	49.5
10:30:00	77.4	59.2	56.0	48.2
10:45:00	81.6	61.3	59.8	48.0
11:00:00	73.3	60.0	56.8	45.8
11:15:00	85.2	59.3	56.6	47.6
11:30:00	70.9	59.0	55.0	43.4
11:45:00	80.2	64.0	60.7	47.9
12:00:00	78.0	66.6	63.4	51.1
12:15:00	79.0	66.5	62.8	50.4
12:30:00	89.5	66.3	65.4	51.0

	12:45:00	83.2	70.8	66.6	51.1
	13:00:00	80.6	67.9	63.9	48.5
	13:15:00	82.4	70.2	66.1	51.7
	13:30:00	82.3	70.4	66.4	51.7
	13:45:00	83.7	71.0	66.9	52.7
	14:00:00	81.1	70.8	66.5	51.8
	14:15:00	81.1	67.5	63.8	50.4
	14:30:00	81.4	65.9	62.2	50.0
	14:45:00	81.4	65.3	62.1	51.3
	15:00:00	82.6	66.0	62.6	49.9
	15:15:00	77.2	63.2	60.3	49.2
	15:30:00	75.8	60.5	57.3	47.1
	15:45:00	80.7	64.9	61.6	50.2
	16:00:00	81.2	64.7	61.8	49.5
	16:15:00	81.0	66.3	62.6	49.8
	16:30:00	82.3	66.4	63.2	52.8
	16:45:00	74.8	62.4	59.1	46.7
	17:00:00	81.6	61.9	59.6	45.8
	17:15:00	76.9	61.5	58.8	44.6
	17:30:00	77.8	60.1	56.4	42.5
	17:45:00	68.0	58.5	53.4	39.8
	18:00:00	65.6	58.4	53.7	40.6
	18:15:00	66.4	58.4	53.7	39.2
	18:30:00	67.9	57.8	53.2	39.3
	18:45:00	69.6	58.5	54.0	39.7
	19:00:00	67.6	57.4	52.8	39.7
	19:15:00	67.9	58.2	53.8	39.5
	19:30:00	74.9	58.9	56.4	38.8
	19:45:00	64.9	56.0	51.2	37.8
	20:00:00	77.7	57.8	55.3	38.3
	20:15:00	64.2	55.5	50.5	39.1
	20:30:00	67.2	56.8	52.0	36.9
	20:45:00	83.4	59.5	58.0	37.1
	21:00:00	66.8	55.1	50.5	35.9
	21:15:00	64.5	55.4	50.6	36.9
	21:30:00	65.9	55.0	50.0	35.9
	21:45:00	66.7	54.5	50.4	33.6
	22:00:00	64.8	52.1	48.5	35.0
	22:15:00	65.4	47.6	45.9	32.6
	22:30:00	76.0	52.4	52.1	31.0
	22:45:00	62.0	48.2	45.2	29.7
	23:00:00	67.1	45.8	45.7	32.1
	23:15:00	64.3	44.6	45.4	31.8
	23:30:00	60.3	37.2	38.9	29.8
	23:45:00	61.0	37.4	41.7	30.1
Thursday 27 th	00:00:00	55.0	36.8	36.1	28.9

May 2021	00:15:00	62.0	34.9	39.5	28.4
	00:30:00	64.5	34.7	39.8	27.7
	00:45:00	45.1	35.4	32.5	27.5
	01:00:00	57.4	35.3	36.4	27.3
	01:15:00	52.4	33.8	31.3	26.4
	01:30:00	85.0	35.3	56.6	27.3
	01:45:00	44.6	35.1	32.2	28.0
	02:00:00	61.4	34.7	37.6	27.9
	02:15:00	61.0	35.0	38.3	27.2
	02:30:00	42.1	32.2	30.3	27.3
	02:45:00	48.1	35.6	33.2	29.4
	03:00:00	56.6	40.5	39.3	31.0
	03:15:00	62.4	36.1	40.5	29.3
	03:30:00	62.6	37.5	37.2	28.8
	03:45:00	53.8	41.1	38.1	32.6
	04:00:00	59.3	40.2	40.5	33.9
	04:15:00	68.3	41.1	45.2	34.3
	04:30:00	66.6	43.0	45.2	33.7
	04:45:00	66.5	45.8	45.4	35.0
	05:00:00	64.2	49.7	47.4	37.5
	05:15:00	68.3	45.7	44.7	36.9
	05:30:00	72.1	49.2	50.4	38.9
	05:45:00	73.5	51.8	50.9	39.5
	06:00:00	66.1	50.6	48.1	37.9
	06:15:00	84.0	55.1	54.8	40.0
	06:30:00	69.2	58.2	53.8	39.8
	06:45:00	67.6	56.9	52.3	38.9
	07:00:00	79.4	65.2	60.6	45.8
	07:15:00	80.9	62.7	60.4	51.3
	07:30:00	83.7	60.8	58.7	43.7
	07:45:00	79.0	63.2	62.0	46.3
	08:00:00	79.7	60.1	56.6	46.0
	08:15:00	77.7	62.6	59.9	51.1
	08:30:00	73.5	60.5	56.6	46.1
	08:45:00	73.9	60.4	57.4	43.6
	09:00:00	79.9	62.7	60.3	45.4
	09:15:00	81.2	64.9	61.6	49.4
	09:30:00	80.9	60.7	57.6	45.7
	09:45:00	74.9	60.6	57.2	47.2
	10:00:00	75.4	63.2	60.1	50.6
	10:15:00	85.5	63.8	63.3	52.0
	10:30:00	76.6	61.0	57.9	45.7
	10:45:00	76.5	58.7	56.3	43.9
	11:00:00	70.1	60.8	56.8	47.1
	11:15:00	71.2	59.8	56.3	44.4
	11:30:00	68.4	58.5	54.5	43.5

11:45:00	80.2	62.4	59.3	48.8
12:00:00	71.3	59.3	55.9	47.4
12:15:00	80.1	62.4	59.7	49.7
12:30:00	76.8	61.2	58.0	47.3
12:45:00	84.5	63.0	61.4	48.2
13:00:00	77.4	64.3	61.4	52.7
13:15:00	76.0	60.0	56.9	46.7
13:30:00	81.1	63.4	60.4	46.6
13:45:00	85.3	59.8	60.0	43.6

TABLE B1: CONTINUOUS NOISE MONITORING DATA, 15TH OCTOBER TO 19TH OCTOBER 2020

House Type	No. 2 Croft Cottages	Floor:	Room: Snug/Study	Day Time Measurements						
Term	Description	First	single-figure rating	Octave band frequency					dB (Lin)	
				125	250	500	1000	2000	4000	
$L_{eq,ff}$	Free-field level		-	65.8	62.0	56.3	54.1	51.4	46.4	68.0
$D_{n,e}$	Ventilation insulation		-	37.7	36.1	32.1	37.1	38.9	47.8	
R_{wl}	SRI of the window	Standard trickle Vent 4mm - 16mm - 4mm Double Glazing	-	23.0	23.0	32.8	38.5	38.5	37.9	
R_{aw}	SRI of the external wall	Masonry Wall Construction	-	34.0	34.0	40.0	56.0	73.0	76.0	
R_{rr}	SRI of the roof/ceiling	Roof Construction	-							
A	Room Volume m ³		22.7							
S_l	Exposed Façade area m ² (including window)		-	7.2	7.2	7.2	7.2	7.2	7.2	0.5
S_r	Roof area m ² (exposed side)		17.4	-	-	-	-	-	-	
S_{wl}	window area m ²		0.0	-	-	-	-	-	-	
S_{aw}	$S_l + S_{wl}$		1.1	-	-	-	-	-	-	
S_{rr}	area of ceiling m ²		16.3	-	-	-	-	-	-	
S	$S_l + S_{rr}$		17.4	-	-	-	-	-	-	
A_0	Reference absorption area given in BS EN ISO 10140-2		10.0	-	-	-	-	-	-	

Term	Reference Letter	Octave Band Centre Frequency, Hz						
		125	250	500	1000	2000	4000	
$L_{eq,ff}$	A	65.8	62.0	56.3	54.1	51.4	46.4	
$D_{n,e}$		37.7	36.1	32.1	37.1	38.9	47.8	
	B	0.00009747	0.00014088	0.00035388	0.00011191	0.00007394	0.00000952	
R_{wl}		22.0	32.0	33.0	38.0	40.0	39.0	
R_{aw}	C	0.00031641	0.00031641	0.00003313	0.00000892	0.00000892	0.00001024	
		34.0	34.0	40.0	56.0	73.0	76.0	
R_{rr}	D ₁	0.00037297	0.00037297	0.00009369	0.00000235	0.00000005	0.00000002	
		0.0	0.0	0.0	0.0	0.0	0.0	
$10\log_{10}(B+C+D+E)$	E	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	
A (Furnished)	F	-31.0	-30.8	-33.2	-39.1	-40.8	-47.0	
		7.24838400	7.24838400	7.24838400	7.24838400	7.24838400	7.24838400	
$L_{eq,2}$	G	3.8	3.8	3.8	3.8	3.8	3.8	
A-weighting dB	A+F+G+3	41.6	38.0	29.9	21.9	17.4	6.2	
$L_{eq,2} + A$ -weighting dB		-16.0	-9.0	-3.0	0.0	1.0	1.0	
		25.6	29.0	26.9	21.9	18.4	7.2	
								32.8

TABLE B2: DETAILED CALCULATIONS FOR THE EQUIVALENT SOUND PRESSURE LEVEL IN A ROOM – DAYTIME – SNUG/STUDY

House Type	No. 2 Croft Cottages	Floor:	Room: Kitchen/Diner	Day Time Measurements						
Term	Description	First	single-figure rating	Octave band frequency						
				125	250	500	1000	2000	4000	dB (Lin)
$L_{eq,ff}$	Free-field level		-	65.8 ✓ 38444419.7	62.0 ✓ 1596565.9	56.3 ✓ 427069.1	54.1 ✓ 259910.8	51.4 ✓ 137550.2	46.4 ✓ 43941.5	68.0
$D_{n,e}$	Ventilation insulation SRI of the window	Standard trickle Vent 4mm - 16mm - 4mm Double Glazing	-	37.7	36.1	32.1	37.1	38.9	47.8	
$R_{w,el}$	SRI of the external wall	Masonry Wall Construction	-	23.0	23.0	32.8	38.5	38.5	37.9	
$R_{w,w}$	SRI of the roof/ceiling	Roof Construction	-	34.0	34.0	40.0	56.0	73.0	76.0	
R_{tr}	Room Volume m ³		62.7							
A			-	20.1	20.1	20.1	20.1	20.1	20.1	0.5
S_r	Exposed Façade area m ² (including window)		37.2	-	-	-	-	-	-	
S_f	Roof area m ² (exposed side)		0.0	-	-	-	-	-	-	
$S_{w,el}$	window area m ²		3.3	-	-	-	-	-	-	
$S_{w,w}$	$S_f \cdot S_{w,el}$		33.9	-	-	-	-	-	-	
S_{tr}	area of ceiling m ²			-	-	-	-	-	-	
S	$S_f + S_{tr}$		37.2	-	-	-	-	-	-	
A_0	Reference absorption area given in BS EN ISO 10140-2		10.0	-	-	-	-	-	-	

Term	Reference Letter	Octave Band Centre Frequency, Hz						
		125	250	500	1000	2000	4000	
$L_{eq,ff}$	A	65.8	62.0	56.3	54.1	51.4	46.4	
$D_{n,e}$		37.7	36.1	32.1	37.1	38.9	47.8	
	B	0.00004562	0.00006594	0.00016564	0.00005238	0.00003461	0.00000446	
$R_{w,el}$		22.0	32.0	33.0	38.0	40.0	39.0	
		0.1	0.1	0.1	0.1	0.1	0.1	
		0.0	0.0	0.0	0.0	0.0	0.0	
	C	0.00044431	0.00044431	0.0004653	0.0001252	0.0001252	0.0001438	
$R_{w,w}$		34.0	34.0	40.0	56.0	73.0	76.0	
		0.9	0.9	0.9	0.9	0.9	0.9	
		0.0	0.0	0.0	0.0	0.0	0.0	
	D_1	0.00036281	0.00036281	0.00009113	0.00000229	0.00000005	0.00000002	
R_{tr}		0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	
		1.0	1.0	1.0	1.0	1.0	1.0	
	E	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	
$10 \log_{10} [B+C+D+E]$	F	-30.7	-30.6	-35.2	-41.7	-43.3	-47.2	
A (Furnished)		20.05850880	20.05850880	20.05850880	20.05850880	20.05850880	20.05850880	
		1.9	1.9	1.9	1.9	1.9	1.9	
	G	2.7	2.7	2.7	2.7	2.7	2.7	
$L_{w,2}$	A+F+G+3	40.8	37.1	26.8	18.1	13.8	4.9	
A-weighting dB		-16.0	-9.0	-3.0	0.0	1.0	1.0	
$L_{w,2} + A$ -weighting dB		24.8	28.1	23.8	18.1	14.8	5.9	
								30.0

TABLE B3: DETAILED CALCULATIONS FOR THE EQUIVALENT SOUND PRESSURE LEVEL IN A ROOM – DAYTIME – KITCHEN/DINING

House Type	No. 2 Croft Cottages	Floor:	Room: Bed1	Day Time Measurements						dB (Lin)
Term	Description	Second	single-figure rating	Octave band frequency						
				125	250	500	1000	2000	4000	
$L_{eq,ff}$	Free-field level		-	65.8	62.0	56.3	54.1	51.4	46.4	68.0
$D_{n,e}$	Ventilation insulation	Standard trickle Vent	-	37.7	36.1	32.1	37.1	38.9	47.8	
$R_{w,i}$	SRI of the window	4mm - 16mm - 4mm Double Glazing	-	23.0	23.0	32.8	38.5	38.5	37.9	
$R_{ew,w}$	SRI of the external wall	Masonry Wall Construction	-	34.0	34.0	40.0	56.0	73.0	76.0	
$R_{r,r}$	SRI of the roof/ceiling	Roof Construction	-	36.0	48.0	55.0	60.0	62.0	62.0	
A	Room Volume m ³		31.4							0.5
			-	10.1	10.1	10.1	10.1	10.1	10.1	
S_f	Exposed Façade area m ² (including window)		41.2	-	-	-	-	-	-	
S_r	Roof area m ² (exposed side)		0.0	-	-	-	-	-	-	
$S_{w,i}$	window area m ²		2.2	-	-	-	-	-	-	
$S_{ew,w}$	$S_f - S_{w,i}$		39.0	-	-	-	-	-	-	
$S_{r,r}$	area of ceiling m ²		43.3	-	-	-	-	-	-	
S	$S_f + S_{r,r}$		84.5	-	-	-	-	-	-	
A_0	Reference absorption area given in BS EN ISO 10140-2		10.0	-	-	-	-	-	-	

Octave Band Centre Frequency, Hz							
Term	Reference Letter	125	250	500	1000	2000	4000
$L_{eq,ff}$	A	65.8	62.0	56.3	54.1	51.4	46.4
$D_{n,e}$		37.7	36.1	32.1	37.1	38.9	47.8
$R_{w,i}$	B	0.00002010	0.00002905	0.00007298	0.00002308	0.00001525	0.00000196
		22.0	32.0	33.0	38.0	40.0	39.0
$R_{ew,w}$	C	0.00013051	0.00013051	0.00001367	0.00000368	0.00000368	0.00000422
		34.0	34.0	40.0	56.0	73.0	76.0
$R_{r,r}$	D ₁	0.00018380	0.00018380	0.00004617	0.00000116	0.00000002	0.00000001
		36.0	48.0	55.0	60.0	62.0	62.0
	E	0.00012868	0.00000812	0.00000162	0.00000051	0.00000032	0.00000032
$10\log_{10}(B+C+D+E)$	F	-33.3	-34.5	-38.7	-45.5	-47.2	-51.9
A (Furnished)		10.05480960	10.05480960	10.05480960	10.05480960	10.05480960	10.05480960
	G	9.2	9.2	9.2	9.2	9.2	9.2
$L_{eq,2}$	A+F+G+3	44.7	39.7	29.8	20.9	16.5	6.8
		-16.0	-9.0	-3.0	0.0	1.0	1.0
A-weighting dB							
$L_{w,2} + A$ -weighting dB		28.7	30.7	26.8	20.9	17.5	7.8
							34.2

House Type	No. 2 Croft Cottages	Floor:	Room: Bed2	Day Time Measurements						dB (Lin)
Term	Description	Second	single-figure rating	Octave band frequency						
				125	250	500	1000	2000	4000	
$L_{eq,ff}$	Free-field level		-	65.8	62.0	56.3	54.1	51.4	46.4	68.0
$D_{n,e}$	Ventilation insulation	Standard trickle Vent	-	3844419.7	1596565.9	427069.1	259910.8	137550.2	43941.5	
R_{wi}	SRI of the window	4mm - 16mm - 4mm Double Glazing	-	37.7	36.1	32.1	37.1	38.9	47.8	
R_{ew}	SRI of the external wall	Masonry Wall Construction	-	23.0	23.0	32.8	38.5	38.5	37.9	
R_{rr}	SRI of the roof/ceiling	Roof Construction	-	34.0	34.0	40.0	56.0	73.0	76.0	
A	Room Volume m ³		30.6	36.0	48.0	55.0	60.0	62.0	62.0	
A_0			-	9.8	9.8	9.8	9.8	9.8	9.8	0.5
S_f	Exposed Façade area m ² (including window)		15.3	-	-	-	-	-	-	
S_r	Roof area m ² (exposed side)		0.0	-	-	-	-	-	-	
S_{wi}	window area m ²		2.2	-	-	-	-	-	-	
S_{aw}	$S_r \cdot S_{wi}$		13.1	-	-	-	-	-	-	
S_{rr}	area of ceiling m ²		42.2	-	-	-	-	-	-	
S	$S_r + S_{rr}$		57.5	-	-	-	-	-	-	
A_0	Reference absorption area given in BS EN ISO 10140-2		10.0	-	-	-	-	-	-	
Term	Reference Letter	Octave Band Centre Frequency, Hz								
		125	250	500	1000	2000	4000			
$L_{eq,ff}$	A	65.8	62.0	56.3	54.1	51.4	46.4			
$D_{n,e}$	B	37.7	36.1	32.1	37.1	38.9	47.8			
R_{wi}		0.0002953	0.0004268	0.0010721	0.0003390	0.0002240	0.0000289			
		22.0	32.0	33.0	38.0	40.0	39.0			
		0.0	0.0	0.0	0.0	0.0	0.0			
		0.0	0.0	0.0	0.0	0.0	0.0			
	C	0.00019172	0.00019172	0.0002008	0.0000540	0.0000540	0.0000620			
R_{ew}		34.0	34.0	40.0	56.0	73.0	76.0			
		0.2	0.2	0.2	0.2	0.2	0.2			
		0.0	0.0	0.0	0.0	0.0	0.0			
	D_1	0.0009076	0.0009076	0.0002280	0.0000057	0.0000001	0.0000001			
R_{rr}		36.0	48.0	55.0	60.0	62.0	62.0			
		0.7	0.7	0.7	0.7	0.7	0.7			
		0.0	0.0	0.0	0.0	0.0	0.0			
	E	0.00018431	0.0001163	0.0000232	0.0000073	0.0000046	0.0000046			
$10\log_{10}(B+C+D+E)$	F	-33.0	-34.7	-38.2	-43.9	-45.5	-50.2			
A (Furnished)		9.80390400	9.80390400	9.80390400	9.80390400	9.80390400	9.80390400			
		5.9	5.9	5.9	5.9	5.9	5.9			
	G	7.7	7.7	7.7	7.7	7.7	7.7			
$L_{eq,2}$	A+F+G+3	43.5	38.0	28.8	20.9	16.6	6.9			
A-weighting dB		-16.0	-9.0	-3.0	0.0	1.0	1.0			
$L_{eq,2} + A\text{-weighting dB}$		27.5	29.0	25.8	20.9	17.6	7.9			31.3

TABLE B5: DETAILED CALCULATIONS FOR THE EQUIVALENT SOUND PRESSURE LEVEL IN A ROOM – DAYTIME – BEDROOM 2

House Type	No. 2 Croft Cottages	Floor:	Room: Bed1	Night-time Measurements					dB (Lin)
Term	Description	Second	single-figure rating	Octave band frequency					
				125	250	500	1000	2000	4000
$L_{eq,ff}$	Free-field level		-	46.5	43.7	42.5	43.2	41.2	40.0
$D_{n,e}$	Ventilation insulation		-	37.7	36.1	32.1	37.1	38.9	47.8
R_{wi}	SRI of the window	Standard trickle Vent	-	23.0	23.0	32.8	38.5	38.5	37.9
R_{ew}	SRI of the external wall	4mm - 16mm - 4mm Double Glazing	-	34.0	34.0	40.0	56.0	73.0	76.0
R_{tr}	SRI of the roof/ceiling	Masonry Wall Construction	-	36.0	48.0	55.0	60.0	62.0	62.0
A	Room Volume m ³	Roof Construction	31.4						
			-	10.1	10.1	10.1	10.1	10.1	10.1
S_f	Exposed Façade area m ² (including window)		41.2	-	-	-	-	-	-
S_r	Roof area m ² (exposed side)		0.0	-	-	-	-	-	-
S_{wi}	window area m ²		2.2	-	-	-	-	-	-
S_{ew}	$S_f - S_{wi}$		39.0	-	-	-	-	-	-
S_{tr}	area of ceiling m ²		43.3	-	-	-	-	-	-
S	$S_f + S_{tr}$		84.5	-	-	-	-	-	-
A_0	Reference absorption area given in BS EN ISO 10140-2		10.0	-	-	-	-	-	-

Term	Reference Letter	Octave Band Centre Frequency, Hz					
		125	250	500	1000	2000	4000
$L_{eq,ff}$	A	46.5	43.7	42.5	43.2	41.2	40.0
$D_{n,e}$		37.7	36.1	32.1	37.1	38.9	47.8
R_{wi}	B	0.00002010	0.00002905	0.00007298	0.00002308	0.00001525	0.00000196
		22.0	32.0	33.0	38.0	40.0	39.0
	C	0.00013051	0.00013051	0.00001367	0.00000368	0.00000368	0.00000422
		34.0	34.0	40.0	56.0	73.0	76.0
R_{ew}		0.00018380	0.00018380	0.00004617	0.00000116	0.00000002	0.00000001
R_{tr}	D ₁	36.0	48.0	55.0	60.0	62.0	62.0
	E	0.00012868	0.00000812	0.00000162	0.00000051	0.00000032	0.00000032
	F	-33.3	-34.5	-38.7	-45.5	-47.2	-51.9
$10\log_{10}(B+C+D+E)$		10.05480960	10.05480960	10.05480960	10.05480960	10.05480960	10.05480960
A (Furnished)		9.2	9.2	9.2	9.2	9.2	9.2
	G						
$L_{eq,2}$	A+F+G+3	25.4	21.4	16.0	10.0	6.3	0.4
		-16.0	-9.0	-3.0	0.0	1.0	1.0
A-weighting dB							
$L_{Aeq,t} + A_{weighting,dB}$		9.4	12.4	13.0	10.0	7.3	1.4

House Type	No. 2 Croft Cottages	Floor:	Room: Bed2	Night-time Measurements						
Term	Description	Second	single-figure rating	125	250	500	1000	2000	4000	dB (Ln)
$L_{eq,ff}$	Free-field level		-	46.5	43.7	42.5	43.2	41.2	40.0	51.1
$D_{n,e}$	Ventilation insulation	Standard trickle Vent	-	44179.7	23623.0	17850.8	20799.3	13232.5	10014.4	
R_{wi}	SRI of the window	4mm - 16mm - 4mm Double Glazing	-	37.7	36.1	32.1	37.1	38.9	47.8	
R_{sw}	SRI of the external wall	Masonry Wall Construction	-	23.0	23.0	32.8	38.5	38.5	37.9	
R_r	SRI of the roof/ceiling	Roof Construction	-	34.0	34.0	40.0	56.0	73.0	76.0	
	Room Volume m ³		30.6	36.0	48.0	55.0	60.0	62.0	62.0	
A			-	9.8	9.8	9.8	9.8	9.8	9.8	0.5
S_f	posed Façade area m ² (including window)		15.3	-	-	-	-	-	-	
S_r	Roof area m ² (exposed side)		0.0	-	-	-	-	-	-	
S_{wi}	window area m ²		2.2	-	-	-	-	-	-	
S_{sw}	$S_f \cdot S_{wi}$		13.1	-	-	-	-	-	-	
S_{rr}	area of ceiling m ²		42.2	-	-	-	-	-	-	
S	$S_f + S_{rr}$		57.5	-	-	-	-	-	-	
A_0	Reference absorption area given in BS EN ISO 10140-2		10.0	-	-	-	-	-	-	

Term	Reference Letter	Octave Band Centre Frequency, Hz						
		125	250	500	1000	2000	4000	
$L_{eq,ff}$	A	46.5	43.7	42.5	43.2	41.2	40.0	
$D_{n,e}$	B	37.7	36.1	32.1	37.1	38.9	47.8	
R_{wi}		0.0002953	0.0004268	0.0010721	0.0003390	0.0002240	0.0000289	
		22.0	32.0	33.0	38.0	40.0	39.0	
		0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	
R_{sw}	C	0.0019172	0.0019172	0.0002008	0.0000540	0.0000540	0.0000620	
		34.0	34.0	40.0	56.0	73.0	76.0	
		0.2	0.2	0.2	0.2	0.2	0.2	
		0.0	0.0	0.0	0.0	0.0	0.0	
R_{rr}	D ₁	0.00009076	0.00009076	0.00002280	0.0000057	0.0000001	0.0000001	
		36.0	48.0	55.0	60.0	62.0	62.0	
		0.7	0.7	0.7	0.7	0.7	0.7	
		0.0	0.0	0.0	0.0	0.0	0.0	
		0.0018431	0.0001163	0.0000232	0.0000073	0.0000046	0.0000046	
$10\log_{10}(B+C+D+E)$	F	-33.0	-34.7	-38.2	-43.9	-45.5	-50.2	
A (Furnished)		9.80390400	9.80390400	9.80390400	9.80390400	9.80390400	9.80390400	
		5.9	5.9	5.9	5.9	5.9	5.9	
		7.7	7.7	7.7	7.7	7.7	7.7	
$L_{sq,2}$	A+F+G+3	24.1	19.7	15.0	10.0	6.4	0.5	
A-weighting dB		-16.0	-9.0	-3.0	0.0	1.0	1.0	
$L_{sq,2} + A$ -weighting dB		8.1	10.7	12.0	10.0	7.4	1.5	16.5

TABLE B7: DETAILED CALCULATIONS FOR THE EQUIVALENT SOUND PRESSURE LEVEL IN A ROOM – NIGHT-TIME – BEDROOM 2

House Type	No. 2 Croft Cottages	Floor:	Room: Bed1	Night-time L _{Amax, F} Measurements						dB (Lin)
Term	Description	Second	single-figure rating	Octave band frequency						
				125	250	500	1000	2000	4000	
L _{eq,ff}	Free-field level		-	70.4	65.6	66.2	65.4	67.1	67.0	
D _{h,e}	Ventilation insulation	Standard trickle Vent	-	37.7	36.1	32.1	37.1	38.9	47.8	
R _{wl}	SRI of the window	4mm - 16mm - 4mm Double Glazing	-	23.0	23.0	32.8	38.5	38.5	37.9	
R _{ew}	SRI of the external wall	Masonry Wall Construction	-	34.0	34.0	40.0	56.0	73.0	76.0	
R _{tr}	SRI of the roof/ceiling	Roof Construction	-	36.0	48.0	55.0	60.0	62.0	62.0	
A	Room Volume m ³		31.4							
			-	10.1	10.1	10.1	10.1	10.1	10.1	
S _f	Exposed Façade area m ² (including window)		41.2	-	-	-	-	-	-	
S _r	Roof area m ² (exposed side)		0.0	-	-	-	-	-	-	
S _{wl}	window area m ²		2.2	-	-	-	-	-	-	
S _{ew}	S _f -S _{wl}		39.0	-	-	-	-	-	-	
S _{tr}	area of ceiling m ²		43.3	-	-	-	-	-	-	
S	S _f +S _r		84.5	-	-	-	-	-	-	
A ₀	Reference absorption area given in BS EN ISO 10140-2		10.0	-	-	-	-	-	-	
Term		Reference Letter	Octave Band Centre Frequency, Hz							
			125	250	500	1000	2000	4000		
	L _{eq,ff}	A	70.4	65.6	66.2	65.4	67.1	67.0		
	D _{h,e}		37.7	36.1	32.1	37.1	38.9	47.8		
	R _{wl}	B	0.00002010	0.00002905	0.00007298	0.00002308	0.00001525	0.00000196		
			22.0	32.0	33.0	38.0	40.0	39.0		
	R _{ew}	C	0.00013051	0.00013051	0.00001367	0.00000368	0.00000368	0.00000422		
			34.0	34.0	40.0	56.0	73.0	76.0		
	R _{tr}	D ₁	0.00018380	0.00018380	0.00004617	0.00000116	0.00000002	0.00000001		
			36.0	48.0	55.0	60.0	62.0	62.0		
	R _{rr}	E	0.00012868	0.00000812	0.00000162	0.00000051	0.00000032	0.00000032		
	10log10(B+C+D+E)	F	-33.3	-34.5	-38.7	-45.5	-47.2	-51.9		
	A (Furnished)		10.05480960	10.05480960	10.05480960	10.05480960	10.05480960	10.05480960		
		G	9.2	9.2	9.2	9.2	9.2	9.2		
	L _{wa,2}	A+F+G+3	49.3	43.3	39.7	32.2	32.2	27.4		
	A-weighting dB		-16.0	-9.0	-3.0	0.0	1.0	1.0		
	L _{wa,2} + A-weighting dB		33.3	34.3	36.7	32.2	33.2	28.4	41.5	

House Type	No. 2 Croft Cottages	Floor:	Room: Bed2	Night-time $L_{Amax, F}$ Measurements							dB (Lin)
Term	Description	Second	single-figure rating	Octave band frequency							
				125	250	500	1000	2000	4000		
$L_{eq,ff}$	Free-field level		-	70.4	65.6	66.2	65.4	67.1	67.0	75.1	
$D_{n,e}$	Ventilation Insultion	Standard trickle Vent 35dB 36dB Rw	-	11009158.3	3644170.0	4160368.1	3502228.6	5098839.6	5018023.7		
R_{wl}	SRI of the window		-	37.7	36.1	32.1	37.1	38.9	47.8		
R_{ew}	SRI of the external wall		-	23.0	23.0	32.8	38.5	38.5	37.9		
R_r	SRI of the roof/ceiling		-	34.0	34.0	40.0	56.0	73.0	76.0		
	Room Volume m ³		-	36.0	48.0	55.0	60.0	62.0	62.0		
A			30.6	9.8	9.8	9.8	9.8	9.8	9.8	0.5	
S_f	Exposed Façade area m ² (including window)		15.3	-	-	-	-	-	-		
S_r	Roof area m ² (exposed side)		0.0	-	-	-	-	-	-		
S_{wl}	window area m ²		2.2	-	-	-	-	-	-		
S_{ew}	S_f-S_{wl}		13.1	-	-	-	-	-	-		
S_{rr}	area of ceiling m ²		42.2	-	-	-	-	-	-		
S	S_f+S_r		57.5	-	-	-	-	-	-		
A_0	Reference absorption area given in BS EN ISO 10140-2		10.0	-	-	-	-	-	-		

Term		Reference Letter	Octave Band Centre Frequency, Hz						
			125	250	500	1000	2000	4000	
	$L_{eq,ff}$	A	70.4	65.6	66.2	65.4	67.1	67.0	
	$D_{n,e}$		37.7	36.1	32.1	37.1	38.9	47.8	
			0.2						
			0.0	0.0	0.0	0.0	0.0	0.0	
	R_{wl}	B	0.00002953	0.00004268	0.00010721	0.00003390	0.00002240	0.00000289	
			22.0	32.0	33.0	38.0	40.0	39.0	
			0.0	0.0	0.0	0.0	0.0	0.0	
			0.0	0.0	0.0	0.0	0.0	0.0	
	R_{ew}	C	0.00019172	0.00019172	0.00002008	0.00000540	0.00000540	0.00000620	
			34.0	34.0	40.0	56.0	73.0	76.0	
			0.2	0.2	0.2	0.2	0.2	0.2	
			0.0	0.0	0.0	0.0	0.0	0.0	
	R_r	D_1	0.00009076	0.00009076	0.00002280	0.00000057	0.00000001	0.00000001	
			36.0	48.0	55.0	60.0	62.0	62.0	
			0.7	0.7	0.7	0.7	0.7	0.7	
			0.0	0.0	0.0	0.0	0.0	0.0	
		E	0.00018431	0.00001163	0.00000232	0.00000073	0.00000046	0.00000046	
	$10\log_{10}(B+C+D+E)$	F	-33.0	-34.7	-38.2	-43.9	-45.5	-50.2	
	A (furnished)		9.80390400	9.80390400	9.80390400	9.80390400	9.80390400	9.80390400	
			5.9	5.9	5.9	5.9	5.9	5.9	
		G	7.7	7.7	7.7	7.7	7.7	7.7	
	$L_{eq,2}$	A+F+G+3	48.1	41.6	38.7	32.2	32.3	27.5	
	A-weighting dB		-16.0	-9.0	-3.0	0.0	1.0	1.0	
	$L_{eq,2} + A$ -weighting dB		32.1	32.6	35.7	32.2	33.3	28.5	40.0

TABLE B9: DETAILED CALCULATIONS FOR THE EQUIVALENT SOUND PRESSURE LEVEL IN A ROOM – NIGHT-TIME – BEDROOM 2

APPENDIX C: GLOSSARY OF ACOUSTIC TERMS

Noise

Noise is defined as unwanted sound. The range of audible sound is from 0 to 140 dB. The frequency response of the ear is usually taken to be around 18 Hz (number of oscillations per second) to 18000 Hz. The ear does not respond equally to different frequencies at the same level. It is more sensitive in the mid-frequency range than the lower and higher frequencies and because of this, the low and high frequency components of a sound are reduced in importance by applying a weighting (filtering) circuit to the noise measuring instrument. The weighting which is most widely used, and which correlates best with subjective response to noise is the dBA weighting. This is an internationally accepted standard for noise measurements.

For variable sources, such as traffic, a difference of 3 dBA is just distinguishable. In addition, a doubling of traffic flow will increase the overall noise by 3 dBA. The 'loudness' of a noise is a purely subjective parameter, but it is generally accepted that an increase/ decrease of 10 dBA corresponds to a doubling/ halving in perceived loudness. Noise is measured on a logarithmic scale in decibels (dB) because of the ears' sensitivity to a wide range of pressure changes. The sound pressure level (SPL) of a signal is denoted by the symbol L_p and defined by the equation $L_p = 10 \log (p/p_0)^2$ where p is the root mean square pressure of the signal and p_0 is the reference sound pressure (2×10^{-5} Pa).

An indication of the range of sound pressure levels commonly found in the environment is given below:

Location	$L_{pAdB(A)}$
Normal threshold of hearing	-10 to 20
Music halls and theatres	20 to 30
Living rooms and offices	30 to 50
Inside motor vehicles	50 to 70
Industrial premises	70 to 100
Burglar alarms at 1 m	100 to 110
Jet aircraft on take-off	110 to 130
Threshold of pain	130 to 140

External noise levels are rarely steady but rise and fall according to activities within an area. In attempt to produce a figure that relates this variable noise level to subjective response, a number of noise indices have been developed. These include:

i) The L_{Amax} noise level

This is the maximum noise level recorded over the measurement period.

ii) The L_{Aeq} noise level

This is “equivalent continuous A-weighted sound pressure level, in decibels” and is defined in British Standard BS 7445 as the “value of the A-weighted sound pressure level of a continuous, steady sound that, within a specified time interval, T, has the same mean square sound pressure as a sound under consideration whose level varies with time”.

It is a unit commonly used to describe construction noise and noise from industrial premises and is the most suitable unit for the description of other forms of environmental noise. In more straightforward terms, it is a measure of energy within the varying noise.

iii) The L_{A10} noise level

This is the noise level that is exceeded for 10% of the measurement period and gives an indication of the noisier levels. It is a unit that has been used over many years for the measurement and assessment of road traffic noise.

iv) The L_{A90} noise level

This is the noise level that is exceeded for 90% of the measurement period and gives an indication of the noise level during the quieter periods. It is often referred to as the background noise level and is used in the assessment of disturbance from industrial noise.

Community response to environmental noise sources is dependent on both acoustic and non-acoustic factors. The acoustic factors include absolute noise level, changes or exceedances of background and ambient levels as well as the characteristics, time, duration and frequency of noise.