

LAND OFF HALLSTEADS, DOVEHOLES – APPROVED RESIDENTIAL DEVELOPMENT
NOISE MITIGATION SCHEME

On behalf of:
HJK Construction

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NOISE MITIGATION SCHEME**

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1.0 INTRODUCTION

1.1 Hepworth Acoustics Ltd was commissioned by HJK Construction to recommend an appropriate scheme of noise mitigation scheme for the approved residential development on land off Hallsteads Close in Doveholes. The development consists of 83 dwellings in a mix of houses, bungalows, and flats.

1.2 Full planning permission has been granted for the development subject to conditions. Planning Conditions 27 and 34 are relevant to acoustics. These state:

“27. Development shall not commence until a site specific scheme for protecting the proposed residential units from external noise, has been submitted to, and approved in writing by the Local Planning Authority. The submitted scheme shall have due regard for the British Standard BS8233:2014 Guidance on Sound Insulation for Buildings and be designed to achieve noise levels of:

a) An internal noise level for habitable rooms during the day (0700-2300hrs) of 35dB(A)LAeq,16hrs

b) An internal noise level for bedrooms during the night (2300-0700hrs) of 30dB(A)LAeq,8hrs and 45dB(A)LAmx

c) Noise levels within external living areas such as balconies, terraces and gardens during the day (0700-2300hrs) of 50dB(A)LAeq,16hrs

A report shall be produced containing all raw data and showing how calculations have been made. A copy of such report shall be submitted to the Local Planning Authority and approved in writing

34. Prior to the commencement of development details shall be submitted to and approved in writing to by the Local Planning Authority to demonstrate the required measures to mitigate noise and vibration from the existing operational railway. Thereafter the approved measures shall be implemented in full prior to the first occupation of the development hereby approved. “

1.3 The site is located on the northern edge of Doveholes in a broadly rural location, the land is currently used for livestock grazing. To the west, the site is bounded by the Manchester to Buxton Railway line; the line runs in a deep cutting and the trains pass the site very slowly as trains stop at the nearby Doveholes Station. To the east, the site is bounded by Hallsteads (A6) a busy road that is trafficked by a large number of HGVs.

1.4 The assessment has been based on the layout shown on drawing 21.03-SL-01-RevA, as provided by HJK Construction dated July 2021. The layout drawing shows that the row of dwellings fronting onto

Hallsteads will be set back from the A6 by the intervening estate road and front gardens, such that the dwellings will be approximately 20 metres from Hallsteads.

1.5 The noise assessment has included:

- An inspection of the site and surrounding area;
- Measurement and assessment of road traffic noise levels from the A6 during a representative period of the daytime and night time; and
- Measurement and assessment railway noise and vibration levels during a representative period of the daytime and night time; and
- Recommendation of appropriate traffic noise mitigation measures as required by Planning Conditions 27 and 34.

1.6 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 GUIDANCE AND ACOUSTIC DESIGN CRITERIA

NPPF:2021

- 2.1 Paragraph 185 of the National Planning Policy Framework (NPPF) 2021 states that planning policies and decisions should *“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

- 2.2 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.

British Standard 8233:2014

- 2.3 No specific guidance is given in the NPPF on acoustic design criteria, therefore, the guidance discussed below has been used for acoustic design purposes.
- 2.4 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). BS 8233 recommends that it is desirable that noise from external sources does not exceed the guidelines values that are shown in Table 1 inside habitable rooms for daytime (07:00–23:00) and night-time (23:00–07:00) periods.

Table 1: BS 8233:2014 recommended acoustic design criteria (dB $L_{Aeq,T}$)

Activity	Location	Daytime 07:00–23:00	Night-time 23:00–07:00
Resting	Living room	35	-
Dining	Dining room/area	40	-
Sleeping (daytime resting)	Bedroom	35	30

- 2.5 BS 8233 also recognises that regular individual noise events at night can cause sleep disturbance. Peaks of noise from individual events are usually described in terms of L_{AFmax} values and these can be highly variable and unpredictable.

Acoustic Design Criteria

- 2.6 For this development in line with the requirements of Condition 27 of the planning approval, the following noise criteria has been adopted with windows closed and trickle ventilation provided:
- Daytime noise below 35 dB $L_{Aeq,16hr}$ inside living rooms and bedrooms, 40 dB $L_{Aeq,16hr}$ inside dining rooms; and
 - Night-time noise levels not exceeding 30 dB $L_{Aeq,8hr}$ and generally not exceeding 45 dB L_{AFmax} in bedrooms (i.e. no more than 10 times per night).
- 2.7 Our noise mitigation recommendations are described in Section 4.0.

3.0 ROAD TRAFFIC NOISE SURVEY

- 3.1 Road traffic noise measurements were taken at a location representative of the nearest proposed dwellings to the A6. The measurement position was approximately 20 metres from the nearside carriageway of the A6.
- 3.2 The noise survey was carried out in terms of a series of consecutive 15-minute measurements from approximately 10:30 on Tuesday 20th September until 09:30 on Wednesday 21st September 2022 using automated noise monitoring instrumentation.
- 3.3 The noise survey was carried out using a NTi Audio XL2 'Class 1' integrating sound level meter (s/n: A2A-20361-E0), complying with BS EN 60804:2001) and independently calibrated within the preceding 24 months. Acoustic calibration of the sound level meter was carried out before and after the noise measurements using an acoustic calibrator that had been independently calibrated within the preceding 12 months. No significant variation in the calibrated noise level was noted.
- 3.4 The noise measurements have been carried out in general compliance with BS 7445: 2003. The noise measurements were taken in 'free-field' conditions and at a microphone height of approximately 1.5m above the ground. Octave band frequency analysis was also carried out to assist with the design of sound insulation measures.
- 3.5 Weather conditions during the daytime survey were warm (13-18°C), dry, mostly cloudy and with a light westerly breeze (<5 m/s). During night-time survey the weather conditions were mild (13°C), dry, mostly cloudy with a westerly breeze (<4 m/s).
- 3.6 The measured daytime (07:00-23:00) and night-time (23:00-07:00) L_{Aeq} values have been logarithmically averaged to obtain the actual $L_{Aeq,16hr}$ and $L_{Aeq,8hr}$ values respectively.

Table 2: Summary of Noise Levels Measured (dB)

Location	Daytime $L_{Aeq,16hr}$	Night-time $L_{Aeq,8hr}$	10 th Highest Night-time L_{Amax}
1. 20 metres from A6	62	59	78

- 3.7 Peaks of noise at night were in the range 71 – 91 dB L_{Amax} due to passing vehicles, with the 10th highest measured night-time L_{Amax} value being 78 dB.

4.0 RAILWAY NOISE & VIBRATION SURVEY

Railway Noise Survey

- 4.1 Noise measurements were carried out at a location on the site representative of the nearest proposed dwellings to the railway line and is indicated in Figure 1.
- 4.2 Noise measurements were taken in consecutive 15-minute periods between approximately 12:00 on Wednesday 21st September and 12:30 on Thursday 22nd September 2022 (i.e. over a period of 24 hours) when the trains were running normally. The noise measurements were taken in ‘free-field’ conditions and at a microphone height of approximately 1.5m above the ground.
- 4.3 The noise monitoring was carried out using a Rion NA-27 ‘Type 1’ sound level meter (s/n: 011706). Calibration checks were carried out before and after the noise survey with no variance in levels observed.
- 4.4 Weather conditions during the daytime survey were warm (15-19°C), dry, mostly cloudy and with a light breeze (<4 m/s). During night-time survey the weather conditions were mild (13°C), dry, cloudy with a breeze (<3 m/s).
- 4.5 The full results of the noise survey are shown in Appendix II and the railway noise exposure values are shown in Table 3.

Table 3: Railway Noise Exposure Values

Measurement Location	Period	L_{Aeq}
2. Western Boundary with Railway line	Day 07:00-23:00	53 dB $L_{Aeq,16hr}$
	Night 23:00-07:00	49 dB $L_{Aeq,8hr}$

- 4.6 Short-term peaks of noise at night at the measurement location were found to be in the range 77 - 57 dB $L_{Amax, 5mins}$. The 10th highest L_{Amax} value measured was 63 dB L_{Amax} .
- 4.7 The implications of the railway noise exposure values are set out in Section 5.0.

Railway Vibration Survey

- 4.8 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. Vibration dose values (in

$\text{ms}^{-1.75}$) in residential buildings at which various degrees of adverse comment may be expected are quoted in BS 6472 and are reproduced in Table 4:

Table 4: Extract from BS6472 in VDV $\text{ms}^{-1.75}$

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

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

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

where:

$\text{VDV}_{\text{b/d, day/night}}$ 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

4.10 A ground vibration monitoring survey of passing trains was carried out on site close to the noise monitoring location as shown in Figure 1. The survey was carried out between approximately 12:00 on Wednesday 21st September and 12:30 on Thursday 22nd September 2022 (i.e. over a period of 24 hours) when the trains were running normally. A Vibrock V901 tri-axial vibration recorder, with a VDV transducer, was used to measure the railway vibration with the transducer located on a concrete slab seated firmly into the ground to ensure a good coupling.

4.11 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 5.

Table 5: Railway Vibration Levels

Period	VDV		
	X	Y	Z
Day time (07:00-23:00)	0.031	0.023	0.032
Night time (23:00-07:00)	0.024	0.020	0.023

4.12 The daytime and night-time VDV values shown in Table 5 are very low and are well within the threshold values set out in BS 6472.

- 4.13 Therefore, even allowing for some magnification of vibration within the proposed buildings, the results of the survey demonstrate that there will not be any significant impact from vibration due to trains. Moreover, no special vibration isolation measures will be necessary for this development and thus vibration is not considered further in this report.

5.0 NOISE MITIGATION SCHEME

- 5.1 The proposed site layout shown in Figure 2 indicates that the majority of dwellings will be located away from the A6 with access roads being located along the eastern boundary, in addition gardens on the western boundary will face towards the railway line. Therefore, it will be necessary to implement some noise mitigation measures for these dwellings.

Gardens

- 5.2 The majority of rear gardens on the proposed development are located away from the A6 and will be screened adequately by the houses themselves. Nevertheless, the daytime traffic noise exposure levels at the east side of the site were found to be 62 dB $L_{Aeq,16hr}$ and for the dwellings close to the railway line the measured daytime noise level was 53 dB $L_{Aeq,16hr}$. Therefore, in order to achieve acceptable noise levels in the gardens marked in green on Figure 2 it will be necessary to install an acoustic fence at or near the site boundary.
- 5.3 We recommend proprietary acoustic fencing of minimum 2 metres in height to the lateral extents shown in Figure 2. The acoustic fencing must be imperforate (i.e. have no holes or gaps), have a surface mass no less than 10 kg/m² and be at least 20 mm thick. Gates in the fencing, if/where required, are acceptable as long as they are built to the same specification as the fence. Network Rail should be consulted to check on any specific operational requirements for fencing near to the railway.
- 5.4 Suppliers of proprietary acoustic fences include GRAMM Barrier Systems Ltd (grammbarriers.com) Jacksons Fencing (jacksons-fencing.co.uk), Guardian Fencing (guardianfencing.com), and Ransfords (ransfords.co.uk).

Glazing

- 5.5 Windows of standard well-sealed thermal double glazing (4mm glass – nominal air cavity – 4mm glass) have a typical sound reduction performance of 25 dB $R_w + C_{tr}$. Therefore, where external noise levels exceed values of 60 dB $L_{Aeq,16hr}$ during the daytime and/or 55 dB $L_{Aeq,8hr}$ and/or 70 dB $L_{Amax,f}$ at night, higher specification glazing will be necessary.
- 5.6 Therefore, as daytime noise levels exceed 60 dB $L_{Aeq,16hr}$ during the daytime, and exceed 55 dB $L_{Aeq,8hr}$ and 70 dB $L_{Amax,f}$ at night, noise levels within habitable rooms that face towards the A6 will require a scheme of noise mitigation to ensure compliance with Condition 27 of the planning approval.

5.7 We therefore recommend that **living rooms** of the dwellings indicated in blue on Figure 2 are fitted with the following specification of glazing is fitted (minimum 29 dB $R_w + C_{tr}$):

- 6mm glass - nominal (8-20mm) cavity - 4mm glass.

5.8 All living rooms closest to the A6, as indicated in Figure 2, will require an acoustically treated means of ventilation, instead of standard window frame slot vents, to achieve the internal noise criteria. We would recommend either:

- Aereco EHA2 Acoustic Trickle Ventilator with acoustic canopy and sleeve (44 dB $D_{n,e,w}$); or
- Rytons AAC125HP Super Acoustic Controllable LookRyt AirCore Ventilator (43 dB $D_{n,e,w}$); or
- Another ventilation system with a good acoustic performance (i.e. above 40 dB $D_{n,e,w}$).

5.9 Due to the large number of HGVs that pass on the A6 at we recommend for **bedrooms** facing towards the A6 as indicated in blue on Figure 2 are fitted with the following specification of glazing is fitted (minimum 37 dB $R_w + C_{tr}$):

- 10mm glass – 12mm cavity – 8.4mm Stadip Silence Acoustic Laminated Glass.

5.10 For bedrooms where sound insulated windows have been recommended, specialist mechanically powered acoustically treated through wall ventilation capable of purge ventilation and summertime cooling will be necessary and window frame slot vents should not be fitted.

5.11 We recommend specialist powered acoustic ventilators are necessary for the relevant habitable rooms such as Titon Sonair F+ or a similar product with a sound reduction of at least 50 dB $D_{n,e,w}$.

5.12 For all other bedrooms, and all living rooms, on the development, we recommend standard double glazing of 4mm glass - nominal (10-16mm) cavity - 4mm glass (25 dB $R_w + C_{tr}$).

5.13 Due care and attention must be taken to ensure that all glazing is well-fitted and well-sealed.

Rooms in Roof Spaces

5.14 We recommend that any bedrooms in roof spaces on outward facing elevations closest to the A6, as indicated in Figure 2 have ceilings of 2 layers of 15 mm dense plasterboard (e.g. Gyproc 'SoundBloc' or Gyproc 'Fireline', or equivalent).

6.0 SUMMARY

- 6.1 The impact of noise and vibration on a proposed residential development on land off Hallsteads Close in Doveholes has been assessed.
- 6.2 This has involved inspecting the development land and carrying out noise and vibration measurements at a number of locations.
- 6.3 The railway to the west of the site is fairly low-trafficked, although a scheme of acoustic fencing to ensure daytime external criteria is achieved has been recommended.
- 6.4 The A6 is well trafficked during the daytime and at night, therefore sound insulation measures are recommended for the nearest houses to the road. This would ensure that the development would be fully compliant with the criteria of Condition 27 of the planning approval.

Figure 1 – Site Location & Noise Measurement Positions

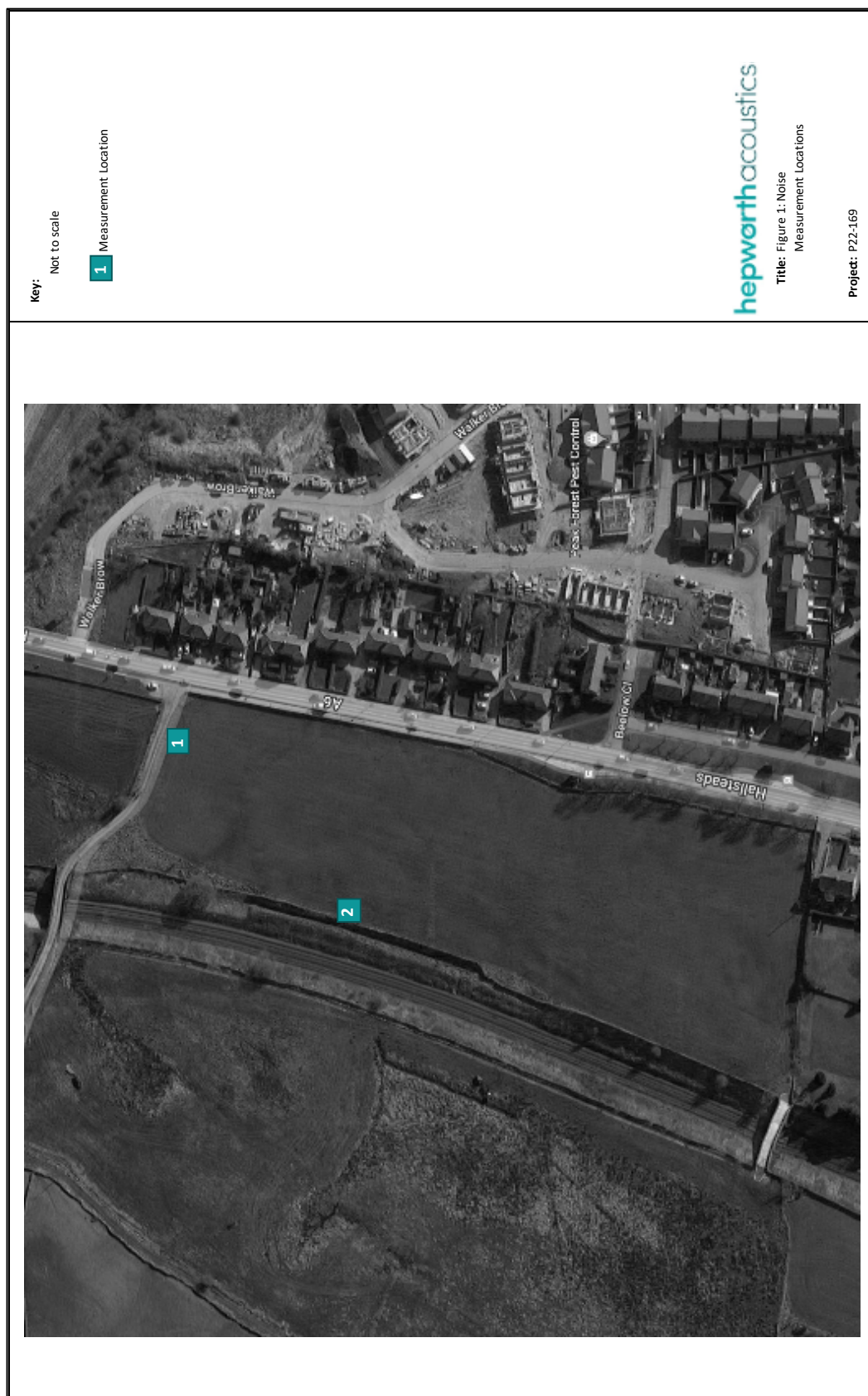
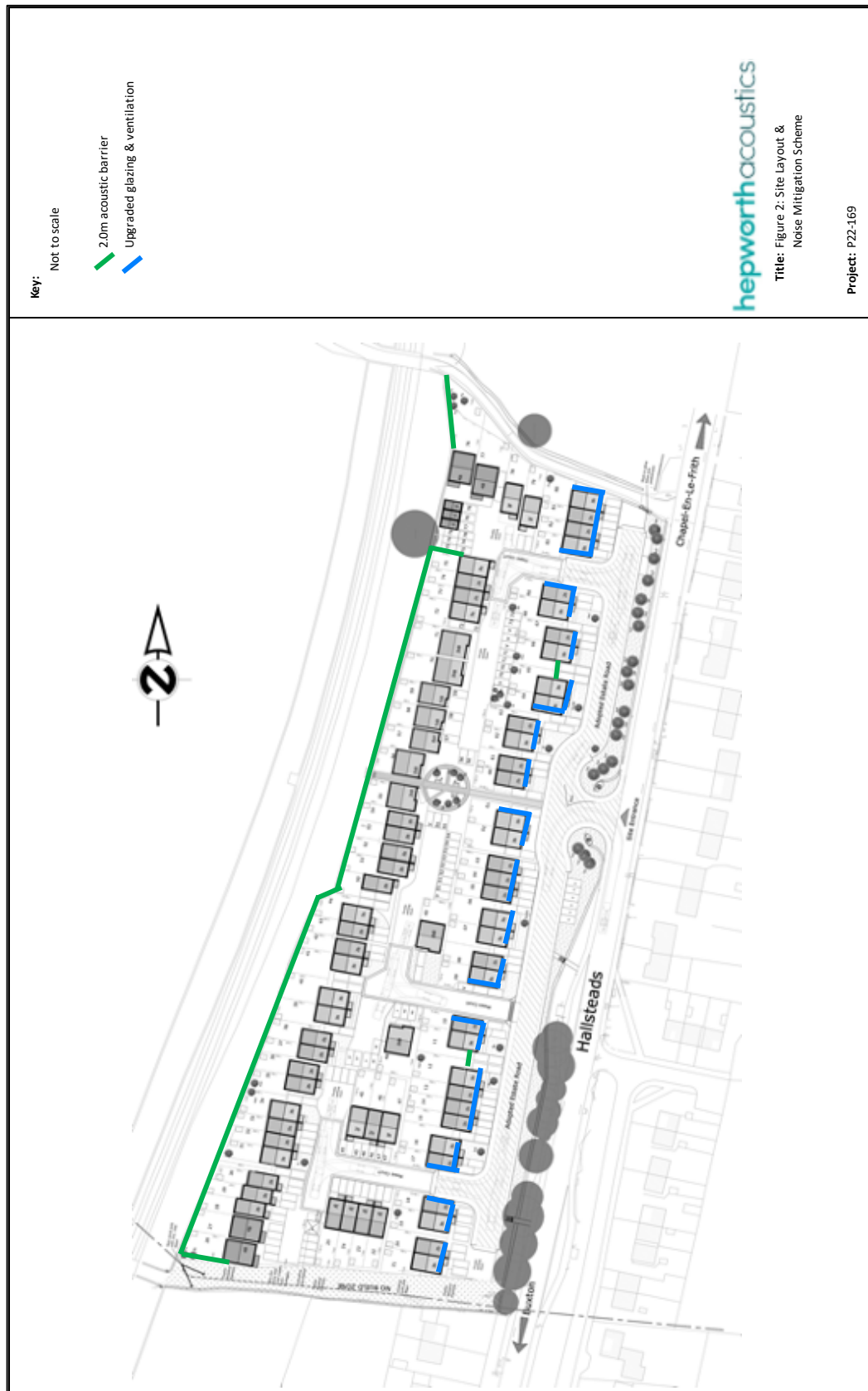


Figure 2: Site Layout & Noise Mitigation Scheme



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.

C_{tr} This is an A-weighted urban traffic noise spectrum, which can be added to $D_{nT,w}$ or R_w in some standards to take into account different source spectra such as low frequency sound.

$L_{Aeq,T}$ 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.

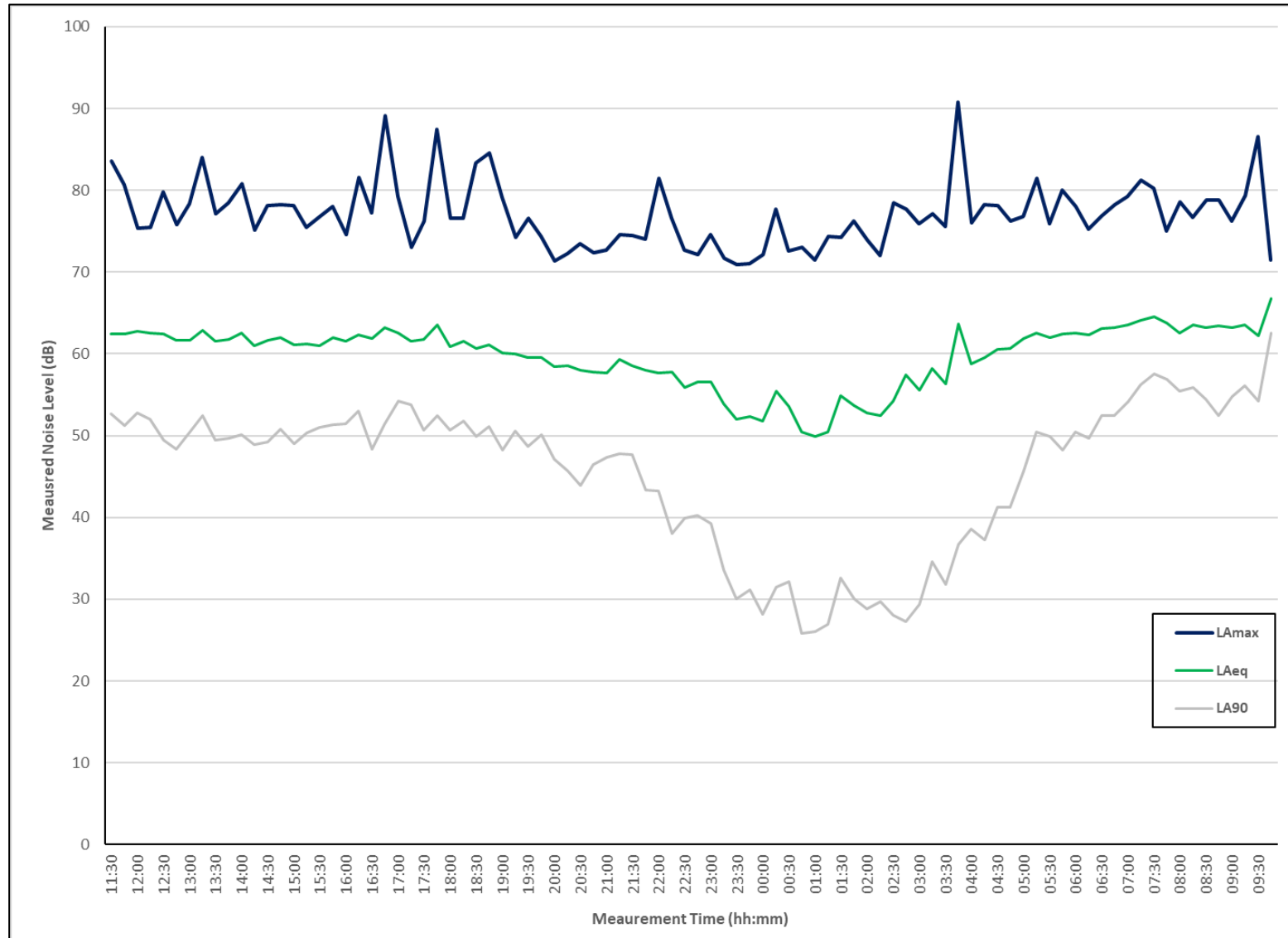
$L_{A10,T}$ This is the A-weighted noise level exceeded for 10% of the time period. $L_{A10,T}$ is usually used as a measure of traffic noise.

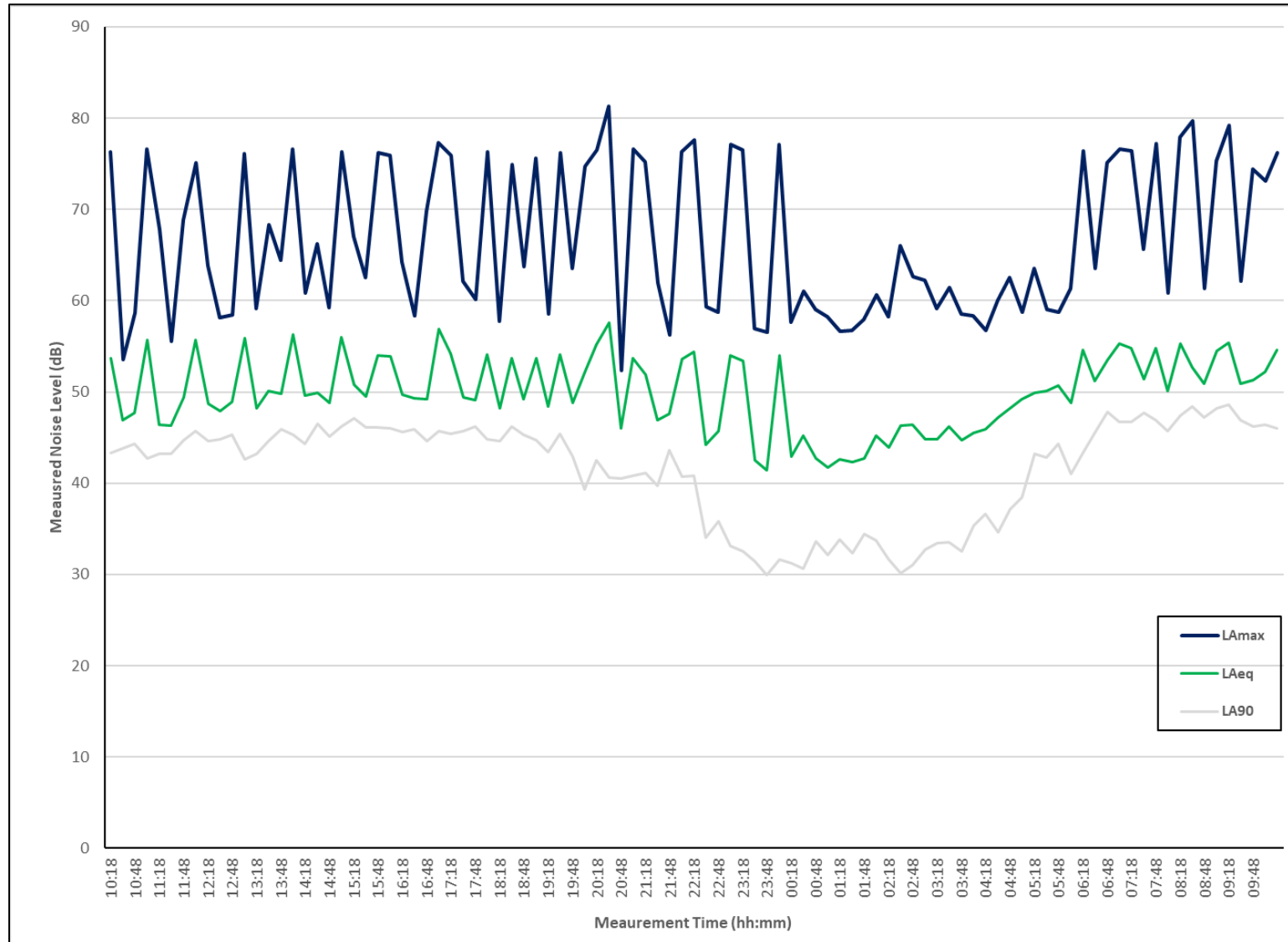
$L_{A90,T}$ This is the A-weighted noise level exceeded for 90% of the time period. $L_{A90,T}$ is used as a measure of background noise.

Appendix II: Noise Survey Results

Date(s)	Road Traffic Survey: Tuesday 20 th – Wednesday 21 st September 2022 Railway Noise & Vibration Survey: Wednesday 21 st – Thursday 22 nd September 2022
Equipment	NTi XL2 'Class 1' sound level meters (s/n: A2A-20361-E0) with associated calibrator and environmental outdoor monitoring kit Rion NA-27 'Class 1' sound level meters (s/n: 590966) with associated calibrator and environmental outdoor monitoring kit
Weather	Daytime: warm (15-19°C), dry, mostly cloudy, and with a light breeze (<4 m/s). Night-time: mild (13°C), dry, cloudy with a breeze (<3 m/s).

All levels in dB(A)

Location 1:

Location 2:

Appendix III: Calculation Sheets

BS8233 Calculation of Noise Break-in

The expected precision of this calculation is ±2 dB

Site: **Hallsteads**Period: **Day**Room: **Location 1 (A6)**

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Term	Term Description	Value
S	Façade area (incl. window) (m ²)	3.0
S _{wi}	Area of the windows (m ²)	1.5
S _{ew}	Area of the external wall (m ²)	1.5
x	Room Dimension x (m)	3.0
y	Room Dimension y (m)	3.0
z	Room Dimension z (m)	2.3

RT	Receiving Room RT
----	-------------------

A	L _{eq}	Outside Room
	D _{n,e}	Insulation of the Acoustic Vents Aereco EHA with acoustic canopy and sleeve (EAR206 + AEAS51)
	R _{wi}	SRI of the window 6:12:4 mm
	R _{ew}	SRI of the external wall BS8233 Example - Brick and block external wall

F	=10 log (b + c + d)
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G	=10 x log (S*RT/0.161*V)
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L _{eq}	Inside Room (A + F + G + 3dB façade correction)
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A-weighting

L _{Aeq}	Inside Room
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Octave Band Centre Frequency				
125	250	500	1000	2000
0.5	0.4	0.4	0.4	0.4

62	61	59	59	52
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41	42	38	45	47
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23	22	27	38	40
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40	44	45	51	56
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-25	-25	-28	-37	-39
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-3	-4	-5	-5	-5
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36	35	29	20	11
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-16	-9	-3	0	1
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20	26	26	20	12
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$$B = \frac{A_0}{S} 10^{-\frac{D_{n,e}}{10}}$$

$$C = \frac{S_{ew}}{S} 10^{-\frac{R_{e,w}}{10}}$$

$$D = \frac{S_{ew}}{S} 10^{-\frac{R_{e,w}}{10}}$$

BS 8233 RESULT

L _{Aeq}	33
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BS8233 Calculation of Noise BreakinThe expected precision of this calculation is ± 2 dB

Site: **Hallsteads**
 Period: **Night**
 Room: **Location 1 (A6)**



Term	Term Description	Value
S	Façade area (incl. window) (m ²)	2.0
S _{wi}	Area of the windows (m ²)	1.0
S _{ew}	Area of the external wall (m ²)	1.0
x	Room Dimension x (m)	4.0
y	Room Dimension y (m)	4.0
z	Room Dimension z (m)	2.3

RT	Receiving Room RT
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A	L _{max}	Outside Room
A	L _{eq}	Outside Room

D _{0,e}	Insulation of the Acoustic Vents	Fiton Sonair F+ (G2 Filter)
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R _{wi}	SRI of the window	10:12:8.4 mm Stadip Silence
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R _{ew}	SRI of the external wall	BS8233 Example - Brick and block external wall
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F	$\approx 10 \log(b + c + d)$
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G	$\approx 10 \times \log(S \cdot RT / 0.161 \cdot V)$
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L _{max}	Inside Room (A + F + 3dB façade correction)
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L _{eq}	Inside Room (A + F + G + 3dB façade correction)
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	A-weighting
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L _{Amax}	Inside Room
-------------------	-------------

L _{Aeq}	Inside Room
------------------	-------------

Octave Band Centre Frequency				
125	250	500	1000	2000
0.5	0.4	0.4	0.4	0.4

78	76	75	74	67
55	53	56	56	49

40	45	54	54	62
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28	30	39	44	49
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40	44	45	51	56
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-29	-32	-40	-43	-50
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-8	-9	-9	-9	-9
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52	47	38	34	20
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21	15	9	7	-7
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-16	-9	-3	0	1
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36	38	35	34	21
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5	6	6	7	-6
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$$B = \frac{A_0}{S} 10^{\frac{-D_{0,e}}{10}}$$

$$C = \frac{S_{ew}}{S} 10^{\frac{-Re_w}{10}}$$

$$D = \frac{S_{ew}}{S} 10^{\frac{-Re_w}{10}}$$

BS 8233 RESULT

L _{Amax}	42
L _{Aeq}	15