Residential Noise Assessment

Site Address: 56 Lincoln Street, Basford Vernon, Nottingham, NG6 0FX

Client Name: Mr. Ken Cuddeford

Project Reference No: NP-009950

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01	--

Disclaimer

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Delivering sustainable development by promoting good health and well-being through effective management of noise.

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1. Introduction

NOVA Acoustics Ltd has been commissioned to prepare a noise and vibration assessment for a new build residential development ('the Proposed Development') on a plot of land at 56 Lincoln Street, Basford Vernon, Nottingham, NG6 0FX ('the Site'). The site is subject to tram, train and road traffic noise from the surrounding transit network.

A noise & vibration survey has been undertaken to categorise the environment at the proposed development site. The findings have subsequently been used to assess the suitability of the site for residential use. Measures required to mitigate noise and vibration impacts for the proposed development have been assessed in accordance with the relevant performance standards, legislation, policy, and guidance.

This noise assessment is necessarily technical in nature; therefore, a glossary of terms is included in Appendix A to assist the reader.

1.1 Standards, Legislation, Policy & Guidance

The following performance standards, legislation, policy, and guidance have been considered to ensure good acoustic design in the assessment:

- National Planning Policy Framework (2023)
- Noise Policy Statement for England (2010)
- British Standard BS8233:2014 – 'Guidance on sound insulation and noise reduction for buildings'
- ProPG: 'Planning and Noise 2017' (including supplementary documents 1 & 2).
- Approved Document O: Overheating (2021)
- Acoustics Ventilation Overheating: Residential Design Guide 2020' (AVO Guide)

Further information on the legislation can be found in Appendix B.

1.2 Proposal Brief

The proposal is to clear an existing parcel of land for the construction of a new three-story dwelling. The figure below shows elevations and floorplans of the proposed development.

Drawing Ref No. C494.103 from 'Curve Chartered Architects'

Figure 1 – Proposed Development

2. Environmental Noise Survey

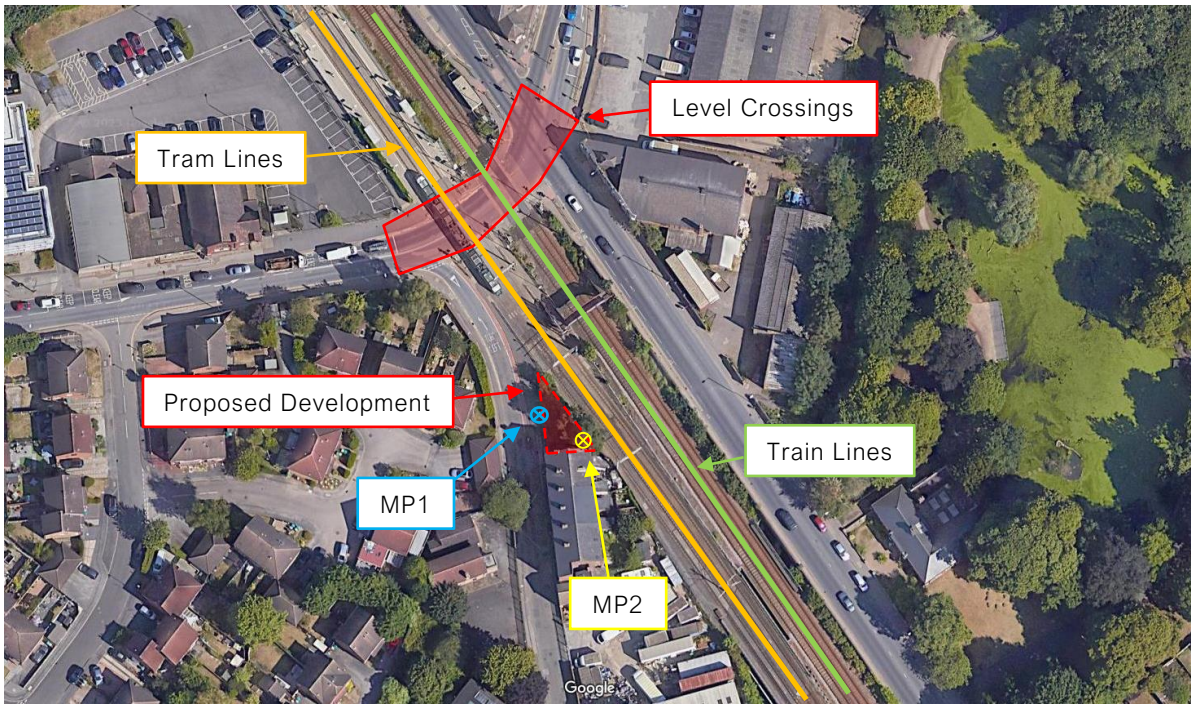
2.1 *Measurement Methodology*

The following table outlines the measurement dates and particulars.

Location	Survey Dates / Survey Type	Measurement Particulars
MP1	20/09/2023 (Long Term Noise Monitoring)	Equipment mounted on a lamppost 3.5m above the ground (free field).
MP2	20/09/2023 (Short Term Noise and Vibration Monitoring)	An accelerometer attached to a mounting plate 1m from the site boundary.
		Sound Level Meter tripod mounted 1.5m above the ground adjacent to the accelerometer (free field).

Table 1 – Measurement Methodology

The figure below outlines the site surroundings and measurement locations:



Imagery ©2023 Infoterra Ltd & Bluesky, Maxar Technologies, The GeoInformation Group, Map data ©2023

Figure 2 – Measurement Locations and Site Surroundings

2.2 *Context & Subjective Impression*

At both monitoring positions the acoustic environment was moderate to high with frequent tram pass-bys, infrequent train pass-bys and highly audible vehicular traffic from the level crossings. Secondary noise sources included non-anthropogenic sources such as birdsong and rustling of leaves.

2.3 Environmental Noise Survey Results

The following table shows a summary of the results of the long-term environmental survey. The typical $L_{AFmax,1min}$ is determined by that which is not normally exceeded more than 10 times during the night-time. The time history results can be found in Appendix D.

Location	Measurement Period ('T')	Octave Frequency Band (Hz, $L_{eq,T}$, dB)							$L_{Aeq,T}$ (dB)	'Typical' $L_{AFmax,1min}$ (dB)
		63	125	250	500	1k	2k	4k		
MP1	$L_{eq,16hr}$ (Day)	68	62	61	60	60	56	49	64	--
	$L_{eq,8hr}$ (Night)	61	56	55	54	54	50	43	58	77
	Highest $L_{eq,1hr}$ (Day)	69	63	62	62	62	59	52	66	--
	Highest $L_{eq,1hr}$ (Night)	68	62	60	60	59	55	47	63	77

Table 2 – Sound Level Results Summary – Long-term

The following table shows a summary of the results of the short-term environmental noise survey.

Location	Measurement Period ('T')	Octave Frequency Band (Hz, $L_{eq,T}$, dB)							$L_{Aeq,T}$ (dB)	$L_{AFmax,T}$ (dB)
		63	125	250	500	1k	2k	4k		
MP2	$L_{eq,T}$ (09:03 – 11:17)	68	63	63	61	60	57	51	64	89

Table 3 – Sound Level Results Summary – Short-term

3. Noise Break-in Assessment and Sound Insulation Scheme

3.1 Internal Noise Level Criteria

The following table outlines the internal and external acoustic design criteria used in the following assessment.

Activity	Location	Daytime (07:00 – 23:00)	Night-time (23:00 – 07:00)
Resting	Living Room	35 dB $L_{Aeq,16hr}$ / NR30	--
Dining	Dining Room/Area	40 dB $L_{Aeq,16hr}$ / NR35	--
Sleeping (Daytime resting)	Bedroom	35 dB $L_{Aeq,16hr}$ / NR30	30 dB $L_{Aeq,8hr}$/ NR25 45 dB L_{AFmax*}

**Note 1: The maximum criteria have been taken from the World Health Organisation (WHO) Guidelines for Community Noise.*

**Note 2: ProPG:2017 which is relevant to 'New Residential' states; "In most circumstances in noise sensitive rooms at night (e.g., bedrooms) good acoustic design can be used so that individual noise events do not normally exceed 45dB $L_{Amax,F}$ more than 10 times a night. However, where it is not reasonably practicable to achieve this guideline then the judgement of acceptability will depend not only on the maximum noise levels but also on factors such as the source, number, distribution, predictability, and regularity of noise events".*

Note 3: BS8233:2014 states: "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".

Note 4: BS8233:2014 states: "The levels shown in Table 4 (criteria shown above) are based on the existing guidelines issued by the WHO and assume normal diurnal fluctuations in external noise. In cases where local conditions do not follow a typical diurnal pattern, for example on a road serving a port with high levels of traffic at certain times of the night, an appropriate alternative period, e.g., 1 hour, may be used, but the level should be selected to ensure consistency with the levels recommended in Table 4.

Note 5: BS8233:2014 states: "If relying on closed windows to meet the guide values, there needs to be an appropriate alternative ventilation that does not compromise the façade insulation or the resulting noise level.

Table 4 – Acoustic Design Criteria

As can be seen in Appendix D, the measured noise levels are clearly diurnal in nature with typical daytime and night-time fluctuations generally associated with transport noise. However, as rail noise is impulsive, the façade sound reduction will be specified using the loudest 1-hour measurements as opposed to the average 16-hour (daytime) and 8-hour (night-time) measurements specified in BS8233. This is thought to present a robust assessment which is in line with the guidance provided in Note 4 of the table above.

3.2 Glazing and Background Ventilation Specification

The following section provides a glazing and background ventilation specification that achieves the relevant internal noise criteria. The calculations considering the following sound insulation scheme can be found in Appendix E.

Description	Octave Frequency Band (Hz, dB)							Overall (dB)	
	63	125	250	500	1k	2k	4k		
8mm Glass / 16mm Air Cavity / 6mm Glass	20	20	21	33	40	36	48	34 (R_W)	29 ($R_W + C_{tr}$)
Greenwoods 2500EA.AC1 (2 No. Trickle)	31	41	40	37	47	43	46	42 ($D_{n,e}$)	40 ($D_{n,e,W} + C_{tr}$)

Table 5 – Glazing and Ventilation Specification

4. Open Window Noise Break-In Assessment

4.1 Internal Noise Levels with Open Windows Criteria

The AVO Guide advises that if windows are open regularly to provide higher rates of ventilation to mitigate overheating, this will lead to elevated internal noise levels which could lead to undesirable living conditions. If windows are opened rarely the occupants may be able to tolerate elevated noise levels due to the inherent benefits of natural ventilation. This assessment will firstly assess whether the internal noise level criteria can be achieved with open windows. The AVO Guide provides criteria for both daytime and night-time periods which shown below.

Windows	Daytime (07:00 – 23:00)	Night-time (23:00 – 07:00)	AVO Guide Table 3-3 Example Outcomes	AVO Guide Table 3 – 2 Recommendation for Level 2 Assessment
Rarely Open	50 dB $L_{Aeq,16hour}$	42 dB $L_{Aeq,8hour}$ Normally Exceeds 65 dB L_{AFmax}	Noise causes a material change in behaviour e.g., having to keep windows closed most of the time	Recommended
Increasing Noise Level			Increasing likelihood of impact on reliable speech communication during the day or sleep disturbance at night	Optional
Often Open	40 dB $L_{Aeq,16hour}$	35 dB $L_{Aeq,8hour}$ Normally Exceeds 45 dB L_{AFmax}	Noise can be heard, but does not cause any change in behaviour	Not Required

Table 6 – AVO Guide Open Window Criteria

To advise if openable windows can be used as the ventilation strategy (whilst maintaining reasonable internal noise levels), an open window assessment will be provided. The suitability of the internal noise levels will be based upon the internal noise criteria above and an open window providing 13dB attenuation. If required, an alternative ventilation strategy compliant with Approved Document F will be proposed.

4.2 Open Window Assessment

This assessment will firstly consider whether the internal noise level criteria from Table 3 – 3 of the AVO Guide can be achieved with open windows.

External Noise Levels	AVO Guide Windows Open Often	Exceedance	AVO Guide Windows Rarely Open	Exceedance
66 $L_{Aeq,16hr}$ (Day)	53	+13	63	+3
63 $L_{Aeq,8hr}$ (Night)	48	+15	55	+8
77 L_{AFmax} (Night)	58	+19	78	-1

Table 7 – Open Window Assessment

The external noise levels exceed the AVO Guides 'Rarely Open' criteria which means that windows cannot be used for the primary means of ventilation and an alternate ventilation strategy is required that is capable of a higher rate of ventilation. A mechanical extract ventilation system should be installed to provide 'Whole Dwelling Ventilation' in accordance with Approved Document F. It is understood that continuous MEV extract fans installed in accordance with the specified trickle ventilators to allow the ingress of fresh air will be adequate. The ventilation system should be designed by an appropriately qualified person to ascertain compliance with the relevant Building Regulations. Special consideration should be given to 1.5 to 1.7 of Approved Document F to assist in the design of the ventilation system and to ensure the self-generated noise levels from the MEV extract fans to not exceed the specified criteria.

To provide further context, sound typically falls into two categories: the first being 'anonymous' sources, such as road, rail, and aircraft and the second being 'non-anonymous', which includes noise from pubs and clubs, industry, etc. Transport noise sources are generally termed 'environmental noise', which affects everybody in society to varying degrees, however, there is a recognised benefit of transportation sources for mobility and movement of goods. Humans tend to habituate to transportation noise over time as it does not threaten safety or trigger a flight or fight psychological stress response. It is a noise that is consistent within society, benign in terms of threat, acceptable as a societal norm and characterless to the point that it does not normally draw attention.

Considering the nature of the acoustic environment at the site, it is thought that installing windows that can be opened and closed at the occupants' discretion is unlikely to have a negative impact on residential amenity. It is not recommended that any windows are 'forced closed' or 'sealed' units, regardless of whether mechanical ventilation is required.

5. External Noise Level Assessment

The following section analyses the external amenity area noise levels across the proposed development.

It is proposed that there will be a 2m tall brick wall erected between the site and the adjacent rail lines. As such, the reduction in noise levels incident on the amenity areas will be calculated accordingly.

For the calculations, the brick wall is assumed to be 1.5m from the receiving point within the garden and 10m from the central point of the rail lines. The reduction from the barrier is calculated in accordance with Chart 6(b) of CRN. The corrected noise levels are shown in the table below.

Description	$L_{Aeq,T}$ (dB)
Measured Noise Level	64
Shielding Noise Reduction	-19
Façade Reflections	+3
Resultant Noise Level within Garden	48

Table 8 – Barrier Noise Attenuation Calculation

The external amenity area sound levels are compared with the specified criteria in the table below.

External Areas	$L_{Aeq,16hr}$ Noise Level (dB)	BS8233 Criteria (dB)	Exceedance above Upper Limit (dB)
Ground Floor Amenity Area	48	50 – 55 $L_{Aeq,16hr}$	-2

Table 9 – BS8233 External Amenity Area Noise Level Assessment

As can be seen in table, the noise levels with the 2m brick wall installed are predicted to be within the criteria.

6. Ground-Borne Vibration Screening Assessment

Due to the proximity of the tram and train lines, it is possible that the site may be affected by ground borne vibration. For this reason, vibration measurements were taken on site, and the results are analysed in the following section.

Ground-Borne Vibration Criteria

BS6472-1:2008 provides criteria for assessing ground-borne vibration in the form of the "likelihood of adverse comment" that might result from given Vibration Dose Values (VDV) within buildings. The following table outlines the criteria presented within BS6472-1:2008.

Description	VDV $m.s^{-1.75}$		
	Low Probability of Adverse Comment	Adverse Comment Possible	Adverse Comment Probable
Residential 16-hour Day	0.2 – 0.4	0.4 – 0.8	0.8 – 1.6
Residential 8-hour Night	0.1 – 0.2	0.2 – 0.4	0.4 – 0.8

Table 10 – BS6472-1:2008 Ground-Borne Vibration Criteria Inside Dwellings

The guidance above relates to vibration measured at a point of entry into the human body, which is usually taken to mean the ground surface or at a point mid-span of an upper-storey floor, rather than the point of entry into the building, a foundation element for example.

Where the vibration is measured at another location, BS6472-1:2008 states that a transfer function should be applied; however, no such guidance on suitable transfer functions is provided in BS6472-1:2008. It does however reference other publications that contain transfer functions. It is necessary to estimate the effect that any building will have on the magnitude of vibration at the point of entry to the human body.

Two key aspects in terms of building structure effect the measured vibration levels:

- Generally, a reduction occurs as the vibration passes into the foundations of a building.
- Typically, amplification occurs as the vibration propagates up the building to the upper storeys and across the potentially suspended floors.

The railway line is founded upon the same ground as the building's foundations and coupling loss is assumed to be negligible. Further guidance has been sort from the technical appendix of the 'HS2 London-West Midlands Environmental Statement, Volume 5: Appendix SV001-000: Annex D1'. The document relates to the ground-borne vibration emitted from trains and states that ground floor vibrations (VDV) should be multiplied by a net amplification factor of 2, and that first-floors (considered to be the most vulnerable) should be multiplied by a net amplification factor of 4.

Ground-Borne Vibration Measured Results

VDV measurements were taken using a Svantek SV958A Vibration Meter and Svantek SV84 accelerometer. The meter was set up at the boundary of site, closest to the trainline and measurements were taken across the relevant low-frequency range (1-80Hz) over a 1-hour period on 21/09/2023. The accelerometer was situated on the floor at the approximate location of the proposed residential dwelling.

The table below presents the maximum tri-axial vibration dose during tram and train pass-bys.

Description	Max VDV Event $m.s^{-1.75}$		
	X Axis (W_d)	Y Axis (W_d)	Z Axis (W_b)
21/09/2023, 09:10 – 10:05 Trams	0.01	0.04	0.14
21/09/2023, 09:10 – 10:05 Trains	0.01	0.03	0.15

Table 11 – Maximum Measured VDV Levels during Tram and Train Pass-bys

The table below shows the number of trams and trains for both the daytime and night-time periods, taken from the 'Realtime Trains' and 'NET Tram' databases.

Description	Day (07:00 – 23:00)	Night (23:00 – 07:00)
Trams	432	16
Trains	37	4

Table 12 – Number of Trams and Trains

The calculated day and night-time vibration dose values are detailed in the table below. The calculation method is taken from Example 1 in Appendix B of BS6472-1:2008

Description	Cumulative VDV ($m.s^{-1.75}$)		
	X Axis (W_d)	Y Axis (W_d)	Z Axis (W_b)
16-hour Day – Ground Floor	0.13	0.42	1.61
8-hour Night – Ground Floor	0.06	0.19	0.76
16-hour Day – First Floor	0.23	0.75	2.85
8-hour Night – First Floor	0.11	0.34	1.30

Table 13 – Summary of Calculated VDV Levels

Discussion

With reference to the human response criteria in BS6472-1:2008, the calculated VDVs for the daytime and night-time periods fall within the "Adverse Comment Probable" category. As such, it is recommended that a structural engineer is consulted regarding the construction of the foundation and intermediate floors. It is likely that it will be necessary for vibration mitigation to be installed, which could include various structural considerations such as dampening within the foundations.

7. Conclusion and Action Plan

The proposed development has been assessed against the acoustic design criteria and a sound insulation scheme has been provided to ensure the criteria has been achieved.

The following 'Action Plan' is outlined to ensure the design considerations and specifications from this report are duly implemented:

1. The proposed glazing and background ventilation system, or a suitable alternative, should be installed as shown in Section 5.
2. A mechanical extract ventilation system should be installed to provide 'Whole Dwelling Ventilation' in accordance with Approved Document F.
3. A structural engineer should be consulted regarding the construction of the foundation to establish which mitigation against vibration is required.

The findings of this report will require written approval from the Local Authority prior to work commencing.

Appendix A – Acoustic Terminology

A-weighted sound pressure level, L_{pA}	Quantity of A-weighted sound pressure given by the following formula in decibels (dBA). $L_{pA} = 10 \log_{10} (pA/p_0)^2$. Where: pA is the A-weighted sound pressure in pascals (Pa) and $p0$ is the reference sound pressure (20 µPa)
Background Sound	Underlying level of sound over a period, T, which might in part be an indication of relative quietness at a given location
Equivalent continuous A-weighted sound pressure level, $L_{Aeq,T}$	Value of the A-weighted sound pressure level in decibels (dB) of a continuous, steady sound that, within a specified time interval, T, has the same mean-squared sound pressure as the sound under consideration that varies with time
Facade level	Sound pressure level 1 m in front of the facade
Free-field level	Sound pressure level away from reflecting surfaces
Indoor ambient noise	Noise in a given situation at a given time, usually composed of noise from many sources, inside and outside the building, but excluding noise from activities of the occupants
Noise Criteria	Numerical indices used to define design goals in a given space
Noise Rating (NR)	Graphical method for rating a noise by comparing the noise spectrum with a family of noise rating curves
Octave Band	Band of frequencies in which the upper limit of the band is twice the frequency of the lower limit
Percentile Level, $L_{AN,T}$	A-weighted sound pressure level obtained using time-weighting “F”, which is exceeded for N% of a specified time interval
Rating Level, $L_{Ar,Tr}$	Equivalent continuous A-weighted sound pressure level of the noise, plus any adjustment for the characteristic features of the noise
Reverberation time, T	Time that would be required for the sound pressure level to decrease by 60 dB after the sound source has stopped
Sound Pressure, p	root-mean-square value of the variation in air pressure, measured in pascals (Pa) above and below atmospheric pressure, caused by the sound
Sound Pressure Level, L_p	Quantity of sound pressure, in decibels (dB), given by the formula: $L_p = 10\log_{10}(p/p_0)^{2.}$ Where: p is the root-mean-square sound pressure in pascals (Pa) and $p0$ is the reference sound pressure (20 µPa)
Weighted sound reduction index, R_w	Single-number quantity which characterizes the airborne sound insulating properties of a material or building element over a range of frequencies

Appendix B – Standards, Legislation, Policy, and Guidance

This report is to be primarily based on the following standards, legislation, policy, and guidance.

B.1 – National Planning Policy Framework (2023)

Government policy on noise is set out in the National Planning Policy Framework (NPPF), published in 2021. This replaced all earlier guidance on noise and places an emphasis on sustainability. In section 15, Conserving and enhancing the natural and local environment, paragraph 174e, it states:

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.

Paragraph 185 states:

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 the quality of life.*
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; and*
c) *Limit the impact of light pollution from artificial light on local amenity, intrinsically dark landscapes, and nature conservation.*

B.2 – Noise Policy Statement for England (2010)

Paragraph 185 of the NPPF also refers to advice on adverse effects of noise given in the Noise Policy Statement for England (NPSE). This document sets out a policy vision to:

Promote good health and a good quality of life through the effective management of noise within the context of Government policy on sustainable development.

To achieve this vision the Statement identifies the following three aims:

Through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development:

- Avoid significant adverse impacts on health and quality of life.
- Mitigate and minimise adverse impacts on health and quality of life.
- Where possible, contribute to the improvement of health and quality of life.

In achieving these aims the document introduces significance criteria as follows:

SOAEL – Significant Observed Adverse Effect Level

This is the level above which significant adverse effects on health and quality of life occur. It is stated that "significant adverse effects on health and quality of life should be avoided while also considering the guiding principles of sustainable development".

LOAEL – Lowest Observed Adverse Effect Level

This is the level above which adverse effects on health and quality of life can be detected. It is stated that the second aim above lies somewhere between LOAEL and SOAEL and requires that: "all reasonable steps should be taken to mitigate and minimise adverse effects on health and quality of life while also considering the guiding principles of sustainable development. This does not mean that such adverse effects cannot occur."

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 the noise. This can be related to the third aim above, which seeks: "where possible, positively to improve health and quality of life through the pro-active management of noise while also considering the guiding principles of sustainable development, recognising that there will be opportunities for such measures to be taken and that they will deliver potential benefits to society. The protection of quiet places and quiet times as well as the enhancement of the acoustic environment will assist with delivering this aim."

The NPSE recognises that it is not possible to have a single objective noise-based measure that is mandatory and applicable to all sources of noise in all situations and provides no guidance as to how these criteria should be interpreted. It is clear, however, that there is no requirement to achieve noise levels where there are no observable adverse impacts but that reasonable and practicable steps to reduce adverse noise impacts should be taken in the context of sustainable development and ensure a balance between noise sensitive and the need for noise generating developments.

Any scheme of noise mitigation outlined in this report will, therefore, aim to abide by the above principles of the NPPF and NPSE whilst recognizing the constraints of the site.

B.3 – BS8233:2014 'Guidance on Sound insulation and noise reduction for buildings'

BS8233 provides guidance on noise levels from sources without specific character in the built environment, based on the recommendations of the World Health Organization; specifically, 'WHO Guidelines on Community Noise, 1999'. The Guidelines on Community Noise (1999) document defines community noise to include noise from "industries" and "construction". The desirable criteria levels of steady state, "anonymous" noise in unoccupied spaces within dwellings, from sources such as road traffic, mechanical services and other continuously running plant, are tabulated below.

BS8233:2014 Internal Ambient Noise Level Criteria			
Activity	Location	Daytime (07:00 – 23:00)	Night-time (23:00 – 07:00)
Resting	Living Room	35 dB $L_{Aeq,16hour}$	--
Dining	Dining Room/Area	40 dB $L_{Aeq,16hour}$	--
Sleeping (Daytime resting)	Bedroom	35 dB $L_{Aeq,16hour}$	30 dB $L_{Aeq,8hour}$ 45 dB L_{AFmax}*

Table 14 – BS8233:2014 Internal Ambient Noise Level Criteria

**ProPG:2017 states that's good acoustic design can be used so that individual noise events do not normally exceed 45 dB L_{AFmax} more than 10 time a night within noise sensitive rooms such as bedrooms. However, where it is not reasonably practicable to achieve the guideline then the judgment of acceptability will depend not only on the maximum noise levels but also on factors such as the source, number distribution, predictability, and regularity of noise events.*

It is noted, however, that where development is considered necessary or desirable, despite external noise level above WHO guidelines, the above target levels may be relaxed by up to 5 dB.

General recommendations for mitigation to enable these targets to be achieved are provided, including the use of bunds and barriers to reduce external noise and space planning and sound insulation for the control of internal noise levels.

For this assessment, the above criteria are considered to be the 'LOAEL' as defined in the NPSE in Appendix B.

B.4 – ProPG: Planning and Noise (2017)

ProPG Planning and Noise published May 2017 by the Association of Noise Consultants (ANC) was produced to provide practitioners with guidance on a recommended approach to the management of noise within the planning system in England. ProPG aims to encourage better acoustic design of new residential developments promoting good health and wellbeing through the effective management of noise. It therefore outlines four key elements which should be considered in the assessment of noise:

- Element 1 – demonstrating a "Good Acoustic Design Process".
- Element 2 – observing internal "Noise Level Guidelines".
- Element 3 – undertaking an "External Amenity Area Noise Assessment"; and
- Element 4 – consideration of "Other Relevant Issues".

The ProPG supplementary document 2 provides the following 'Good Acoustic Design' hierarchy of noise management measures which LPAs should encourage. These are shown below, In descending order of preference:

Order of Preference	Noise Management Measure
1	Reduction of the noise generated at source by redesign, relocation, or containment. *
2	Maximising the spatial separation of noise source(s) and receptor(s).
3	Using existing topography and existing structures (that are likely to last the expected life of the noise-sensitive scheme) to screen the proposed development site from significant sources of noise.
4	Investigating the necessity and feasibility of reducing existing noise levels and relocating existing noise sources.
5	Incorporating noise barriers as part of the scheme to screen the proposed development site from significant sources of noise.
6	Using the layout of the scheme to reduce noise propagation across the site.
7	Using the orientation of buildings to reduce the noise exposure of noise sensitive rooms.
8	Using the building envelope to mitigate noise to acceptable levels.

Table 15 – Hierarchy of Noise Management Measures

**Not from ProPG*

B.5 – Approved Document 0: Overheating (2021)

Approved Document O states the following in relation to noise:

1. In locations where external noise may be an issue (for example, where the local planning authority considered external noise to be an issue at the planning stage), the overheating mitigation strategy should take account of the likelihood that windows will be closed during sleeping hours (11pm to 7am).
2. Windows are likely to be closed during sleeping hours if noise within bedrooms exceeds the following limits.
    a. 40dB $L_{Aeq,T}$, averaged over 8 hours (between 11pm and 7am).
    b. 55dB L_{AFmax}, more than 10 times a night (between 11pm and 7am).
3. Where in-situ noise measurements are used as evidence that these limits are not exceeded, measurements should be taken in accordance with the Association of Noise Consultants' Measurement of Sound Levels in Buildings with the overheating mitigation strategy in use.

    NOTE: Guidance on reducing the passage of external noise into buildings can be found in the National Model Design Code: Part 2 – Guidance Notes (MHCLG, 2021) and the Association of Noise Consultants' Acoustics, Ventilation and Overheating: Residential Design Guide (2020).B.6 - Acoustics Ventilation and Overheating – Residential Design Guide 2020

B.6 – Acoustics Ventilation and Overheating – Residential Design Guide 2020

It is suggested that the desirable internal noise criteria within BS8233:2014 should be achieved considering adequate ventilation as defined by Building Regulations 'Approved Document F' ('ADF') whole dwelling ventilation. However, for a whole dwelling ventilation system such as MVHR it is considered

reasonable to allow higher levels of internal ambient noise from transport sources when higher rates of ventilation are required in relation to the overheating condition.

The 'Institute of Acoustics' ('IOA') and the 'Association of Noise Consultant's ('ANC') have published 'The AVO Guide: 2020' document 2020. It provides guidance for those acousticians involved in the design of buildings to prevent noise ingress to and achieve reasonable internal levels. This provides valuable guidance on ventilation and overheating in support of the "Good Acoustic Design" principle advocated by ProPG. Along with guidance showing an acoustic assessment during the overheating condition, the AVO Guide (2020) provides a framework that has a two-level assessment procedure to estimate the potential impact on occupants:

Level 1 Risk Assessment

AVO 'Level 1' risk assessment criteria guide based on external free field ambient noise levels for dwellings relying on purge ventilation (e.g., opening windows) to prevent summertime overheating. AVO Guide Table 3-2 detailed in the figure below. To assess the possibility of overheating it is reasonable to relax the BS 8233:2014 internal ambient noise levels from opening a window by 5 decibels (5 dB). Also, it is assumed that a partially open window will provide a sound reduction of 13 dB. Therefore, to achieve internal noise levels in line with BS 8233:2014 the façade external noise levels should fall inside the levels shown in Table 3-2.

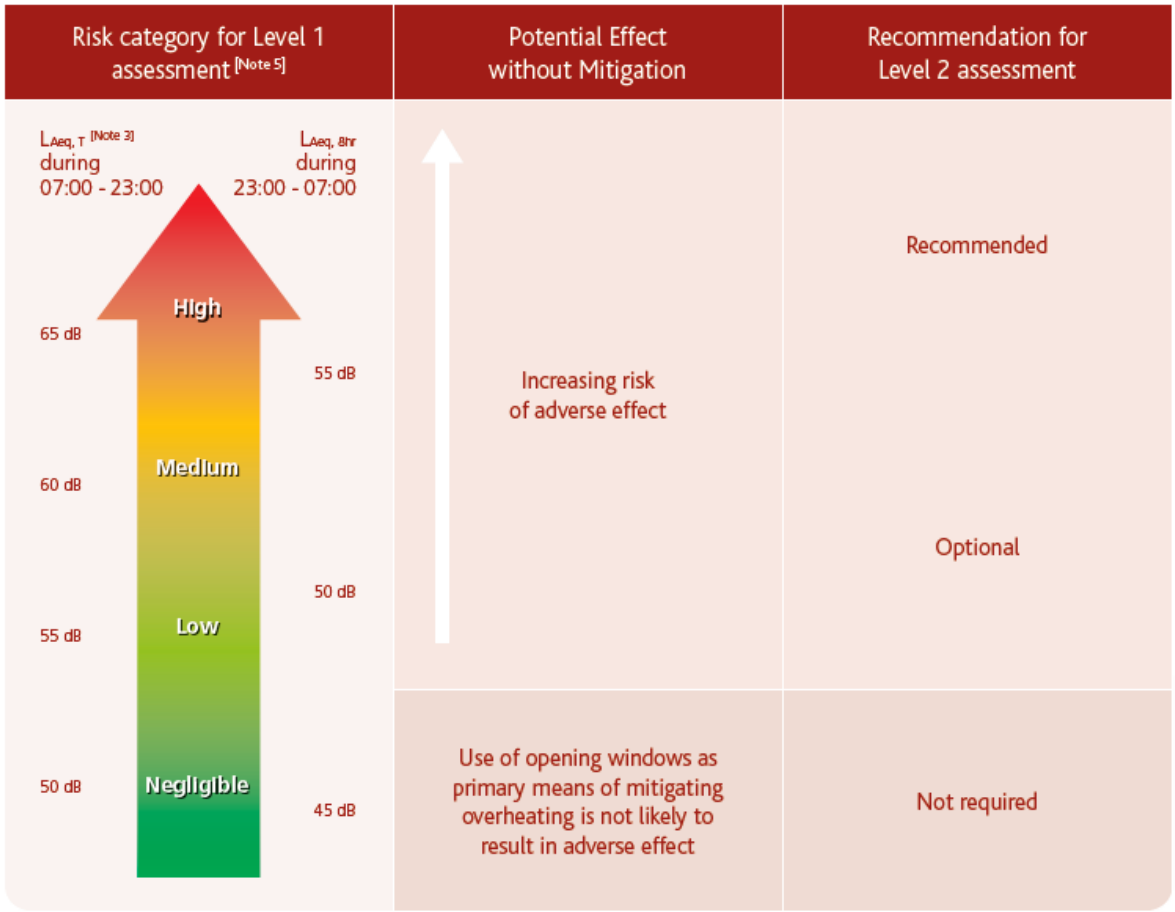


Table 3-2 of AVO Guide (2020)

Figure 3 – AVO Guide Level 1 Risk Category

The AVO Guide (2020) seeks to determine the level of risk associated with overheating in a new residential development based on the existing noise climate. The AVO risk categories are detailed in the table below with clearer categorisation.

AVO Guide (2020) Level 1 Risk Assessment			
Daytime (07:00 – 23:00)	Night-time (23:00 – 07:00)	Risk Category	Mitigation
≥63 dB $L_{Aeq,16hour}$	≥55 dB $L_{Aeq,8hour}$	High Risk	Level 2 assessment recommended. Windows which are unopenable on grounds of noise will inevitably create issues for the overheating strategy.
57 – 62 dB $L_{Aeq,16hour}$	52 – 54 dB $L_{Aeq,8hour}$	Medium Risk	Level 2 assessment optional to give more confidence regarding the suitability of internal noise conditions.
54 – 56 dB $L_{Aeq,16hour}$	49 – 51 dB $L_{Aeq,8hour}$	Low Risk	
≤53 dB $L_{Aeq,16hour}$	≤48 dB $L_{Aeq,8hour}$	Negligible Risk	None required – openable windows suitable for ventilation

Table 16 – AVO Guide (2020) Level 1 Risk Assessment

Level 2 Risk Assessment:

A 'Level 2' assessment of noise is recommended where a dwelling using purge ventilation (e.g., open windows) reaches Level 1 'High Risk' or 'Medium Risk'. The Level 2 assessment guidance comments that where internal ambient noise levels are >50 dB $L_{Aeq,16hr}$ (day) or >42 dB $L_{Aeq,8hr}$ (night) then the outcome might be that the noise causes a material change in behaviour, e.g., having to keep windows closed for the majority of the time, or there is the potential for sleep disturbance.

To conduct a Level 2 assessment, the following minimum information is required:

- Statement of the overheating criteria being applied.
- Description of the provisions for meeting the stated overheating criteria. This should include, where relevant, the area of façade opening.
- Details of the likely internal ambient noise levels whilst using provisions for mitigating overheating, and the method used to predict these.
- Estimation of how frequently and for what duration such provisions are required to mitigate overheating.
- Consideration of the effect of individual noise events.

- Assessment of the adverse effect on occupants.

The figure below outlines the AVO Guide (2020) guidance for a Level 2 assessment of noise from transport sources relating to the Overheating Condition.

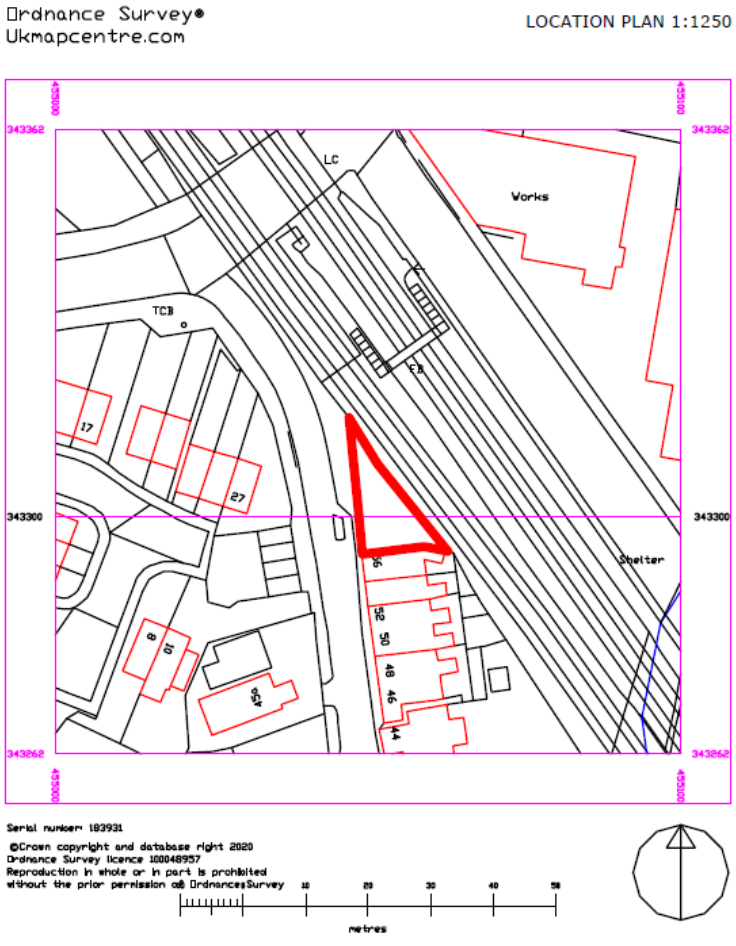
Internal ambient noise level [Note 2]			Examples of Outcomes [Note 5]	
$L_{Aeq,T}$ [Note 3] during 07:00 – 23:00 [Note 6]	$L_{Aeq,8h}$ during 23:00 – 07:00	Individual noise events during 23:00 – 07:00 [Note 4]		
> 50 dB	> 42 dB	Normally exceeds 65 dB $L_{AF,max}$	Noise causes a material change in behaviour e.g. having to keep windows closed most of the time	Avoiding certain activities during periods of intrusion. 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.
			Increasing likelihood of impact on reliable speech communication during the day or sleep disturbance at night	At higher noise levels, more significant behavioural change is expected and may only be considered suitable if occurring for limited periods. As noise levels increase, small behaviour changes are expected e.g. turning up the volume on the television; speaking a little more loudly; having to close windows for certain activities, for example ones which require a high level of concentration. Potential for some reported sleep disturbance. Affects the acoustic environment inside the dwelling such that there is a perceived change in quality of life. At lower noise levels, limited behavioural change is expected unless conditions are prevalent for most of the time. [Note 8]
≤ 35 dB	≤ 30 dB	Do not normally exceed $L_{AF,max}$ 45 dB more than 10 times a night	Noise can be heard, but does not cause any change in behaviour	Noise can be heard, but does not cause any change in behaviour, attitude, or other physiological response[Note 9]. Can slightly affect the acoustic character of the area but not such that there is a perceived change in the quality of life.

Note 1 The noise levels suggested in Tables 3-2 and 3-3 assume a steady road traffic noise source but may be adapted for other types of transport.

Table 3-3 of AVO Guide (2020)

Figure 4 – AVO Guide Level 2 Internal Ambient Noise Levels

Appendix C – Location and Site Plans



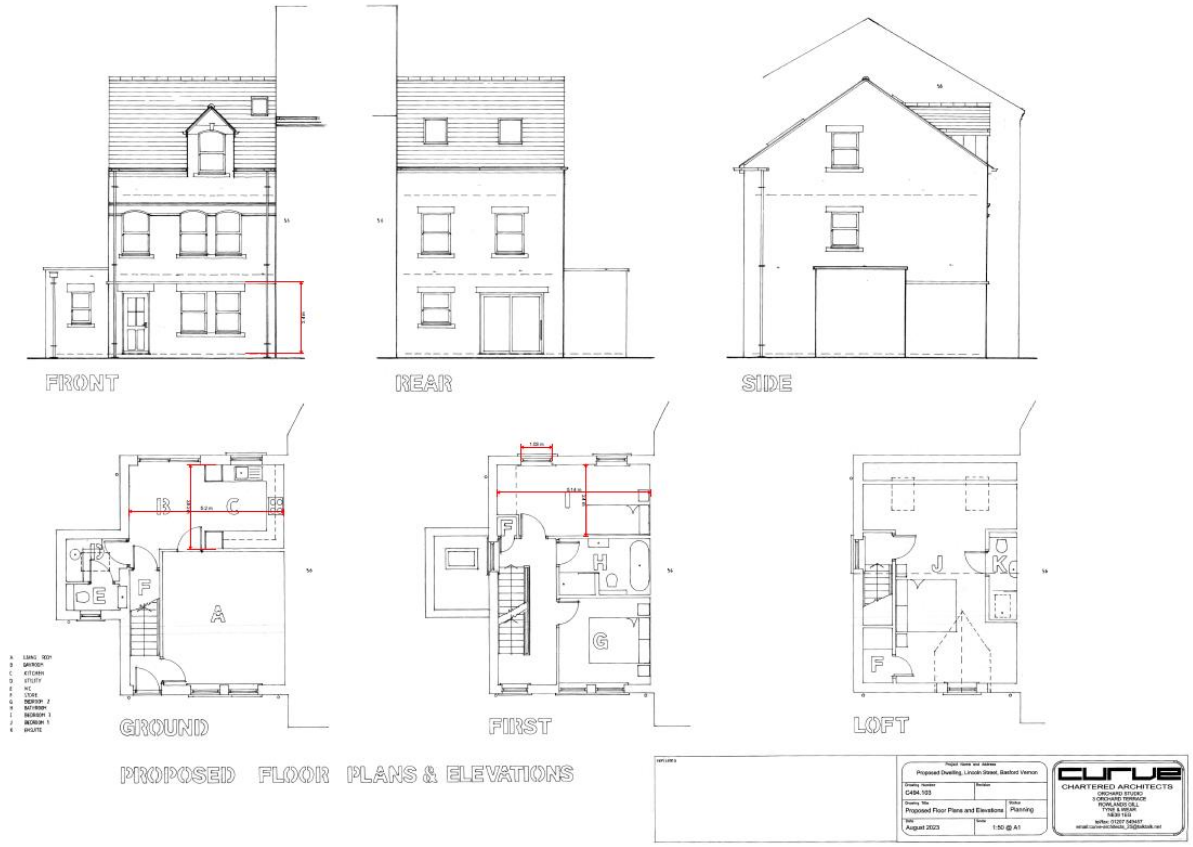


Figure 5 – Site and Location Plans

Appendix D – Environmental Survey

D.1 – Time History Noise Data

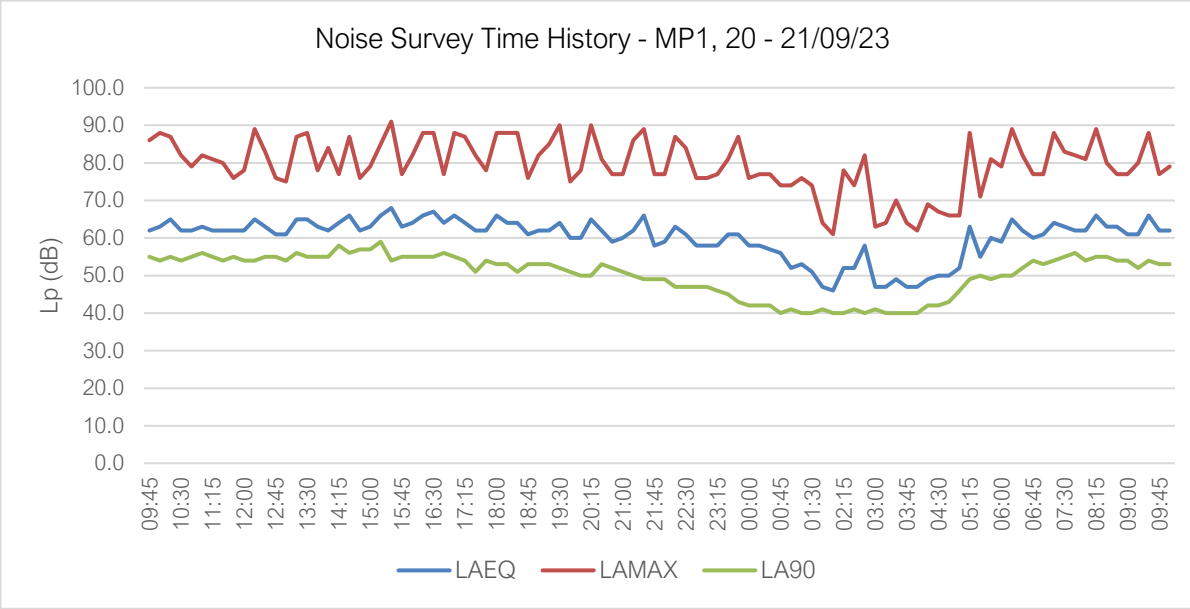


Figure 6 – MP1 Noise Survey Time History

D.2 – Surveying Equipment

Piece of Equipment	Serial No.	Calibration Deviation
Svantek 971 Class 1 Sound Level Meter	77796	≤0.1
Class 1 Calibrator	116639	
Svantek 977 Class 1 Sound Level Meter	34826	≤0.1
CESVA CB006 Class 1 Calibrator	116639	
Svantek SB84 Accelerometer	L8013	Refer to Cert No. 00000919-2a
Svantek SV36 Calibrator	106876	

Table 17 – Surveying Equipment

All equipment used during the survey was field calibrated at the start and end of the measurement period with a negligible deviation of ≤0.2 dB. All sound level meters are calibrated every 24 months and all calibrators are calibrated every 12 months, by a third-party calibration laboratory. All microphones were fitted with a protective windshield for the entire measurements period. Calibration certificates can be provided upon request.

D.3 – Meteorological Conditions

As the environmental noise survey was carried out over a long un-manned period no localised records of weather conditions were taken. However, all measurements have been compared with met office weather data of the area, specifically the closest weather station, and the data from the weather station is outlined in the table below. When reviewing the time history of the noise measurements, any scenarios that were considered potentially to be affected by the local weather conditions have been omitted. The analysis of the noise data includes statistical and percentile analysis and review of minimum and maximum values, which aids in the preclusion of any periods of undesirable weather conditions. The weather conditions were deemed suitable for the measurement of environmental noise in accordance with BS7445 Description and Measurement of Environmental Noise. The table below presents the average temperature, wind speed and rainfall range for each 24-hour period during the entire measurement.

Weather Conditions – Calverton (Approx. 8km Northeast of Site)				
Time Period	Air Temp (^{0}C)	Rainfall (mm/h)	Prevailing Wind Direction	Wind Speed (m/s)
20/09/2023 – 00:00 – 23:59	11.8 – 17.6	0.0 – 4.6	SSW	0.5 – 7.0
21/09/2023 – 00:00 – 23:59	8.9 – 18.6	0.0	S	0.0 – 3.5

Table 18 – Weather Conditions

Appendix E – Noise Break-in Calculations

E.1 – Façades with Background Ventilation

The façade sound reduction and predicted internal noise levels are calculated assuming the following:

- The calculation method for façade sound reduction is in accordance with BS8233:2014 and BS EN 12354-3.
- Based on previous experience and measurements of reverberation in furnished rooms, values of 0.3s and 0.5s are used in the calculations for bedrooms and living rooms respectively.
- The acoustic performance of the façade elements are taken from the relevant manufacturers technical information or the sound reduction has been predicted using INSUL 9.0.
- For background trickle ventilation a total Equivalent Area of 5000mm^2 per habitable room has been used in the calculations, which equates to 2 No. trickle vents (2500mm^2 each).
- Based on the technical drawings provided to NOVA Acoustics, the worst-case window areas and room volumes have been used.

Living Room Day Time Leq

Item / Description	dB(A)	63	125	250	500	1k	2k	4k
Measured Leq,T	66	69	63	62	62	62	59	52
Glazing Noise Ingress	30	44	38	36	24	17	18	-1
Ventilation Noise Ingress	27	41	25	25	28	18	19	9
Wall Noise Ingress	8	25	14	11	1	0	-3	-10
Roof Noise Ingress								
Room Absorption Correction		0	0	-1	-1	-1	-2	-3
Total Noise Ingress	**34**	**49**	**41**	**39**	**31**	**23**	**23**	**10**
NR30	35	59	48	39	33	30	26	24
Exceedance of Criteria	-1	-10	-7	0	-2	-7	-3	-14

Bedroom Day Time Leq

Item / Description	dB(A)	63	125	250	500	1k	2k	4k
Measured Leq,T	66	69	63	62	62	62	59	52
Glazing Noise Ingress	25	39	33	31	19	12	13	-6
Ventilation Noise Ingress	25	38	22	22	25	15	16	6
Wall Noise Ingress	9	27	16	13	3	2	-1	-8
Roof Noise Ingress								
Room Absorption Correction		2	1	1	1	1	0	-1
Total Noise Ingress	**32**	**47**	**38**	**36**	**30**	**21**	**21**	**9**
NR30	35	59	48	39	33	30	26	24
Exceedance of Criteria	-3	-12	-10	-3	-3	-9	-5	-15

Bedroom Night-Time Leq

Item / Description	dB(A)	63	125	250	500	1k	2k	4k
Measured Leq,T	63	68	62	60	60	59	55	47
Glazing Noise Ingress	23	38	32	29	17	9	9	-11
Ventilation Noise Ingress	22	37	21	20	23	12	12	1
Wall Noise Ingress	7	26	15	11	1	-1	-5	-13
Roof Noise Ingress								
Room Absorption Correction		2	1	1	1	1	0	-1
Total Noise Ingress	**30**	**46**	**37**	**34**	**28**	**18**	**17**	**4**
NR25	30	55	43	35	28	25	21	19
Exceedance of Criteria	0	-9	-6	-1	0	-7	-4	-15

Bedroom Night-Time Max

Item / Description	dB(A)	63	125	250	500	1k	2k	4k
Corrected Lmax Spectrum	77	82	76	74	74	73	69	61
Glazing Noise Ingress	38	52	46	43	31	23	23	3
Ventilation Noise Ingress	36	51	35	34	37	26	26	15
Wall Noise Ingress	21	40	29	25	15	13	9	1
Roof Noise Ingress								
Room Absorption Correction		2	1	1	1	1	0	-1
Total Noise Ingress	**44**	**60**	**51**	**48**	**42**	**32**	**31**	**18**
NR40	45	67	56	49	43	40	37	34
Exceedance of Criteria	-1	-7	-5	-1	-1	-8	-6	-16

Figure 7 – Noise Break-In Calculations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