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Noise and Vibration Impact Assessment

Pinner Road, Northwood

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Noise and Vibration Impact Assessment

Project: PINNER ROAD, NORTHWOOD

Report reference: RP01-22224-R0

Client:

POLARIS PROPERTY DEVELOPMENTS LIMITED
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0	28 April 2022	Laura Broadley, MSc AMIOA, Acoustics Consultant	Tim Ives, PhD BEng CEng FIOA, Technical Director	Initial issue

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1. INTRODUCTION

1.1 Cass Allen has been instructed by Polaris Property Developments Limited to assess the suitability of a proposed new development at Pinner Road in Northwood with respect to noise and vibration.

1.2 The assessment has been carried out in accordance with relevant local and national planning guidance.

1.3 The aims of the assessment were:

- To establish the suitability of existing noise and vibration levels at the site for the proposed development;
- Where required, identify appropriate measures to optimise the acoustic design of the development and achieve acceptable noise and vibration levels in habitable areas.

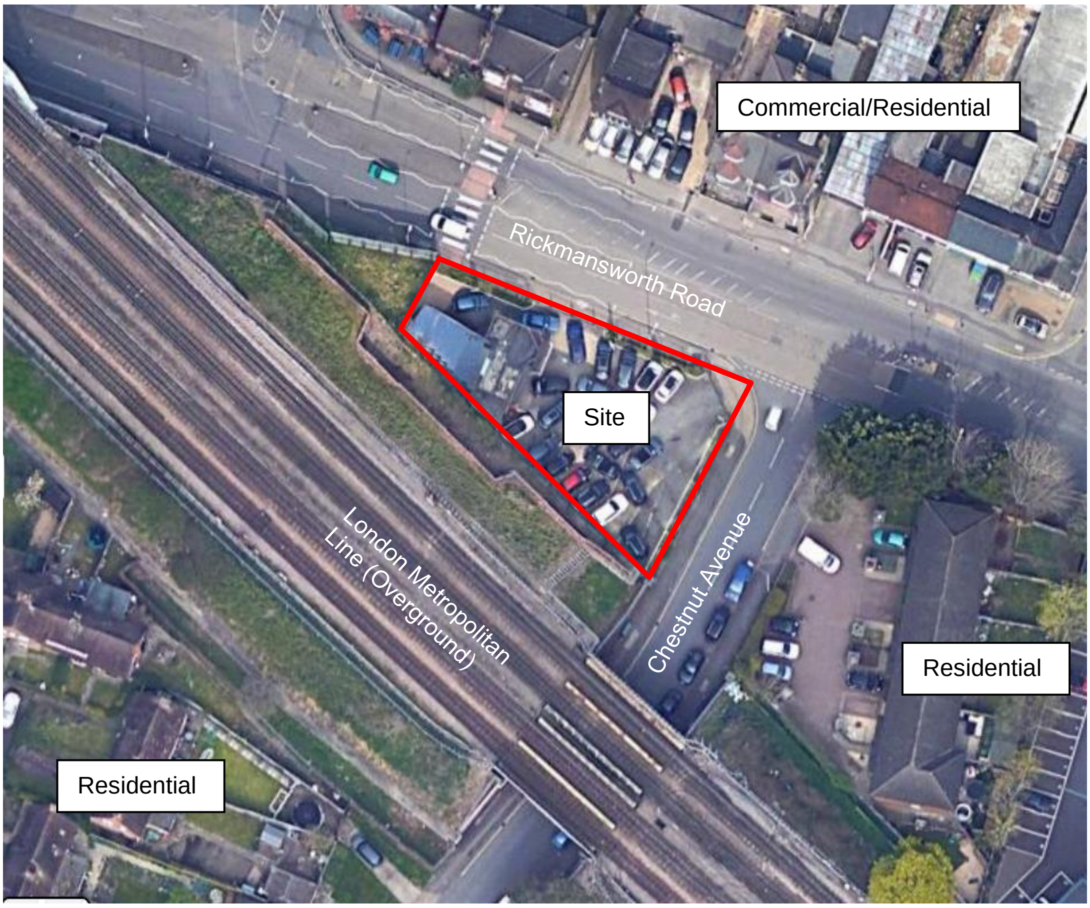
1.4 This report contains technical terminology; a glossary of terms can be found at www.cassallen.co.uk/glossary.

2. PROJECT DESCRIPTION

2.1 The site currently contains a disused retail unit and is located in a mixed-use area. The site is bounded to the north by Rickmansworth Road and to the east by Chestnut Avenue. To the south and west of the site is the London Underground Metropolitan Line (Overground). To the north of the site are commercial and residential units. To the south and east of the site is residential area.

2.2 The site location is shown in Figure 1 below.

Figure 1 Site Location and Surrounding Area



2.3 The proposal is to develop the site into residential properties.

3. PLANNING POLICY

National Policy

3.1 Outline guidance for the assessment of noise affecting new developments is given in the National Planning Policy Framework (NPPF). Relevant sections in this case are highlighted below:

> *174. Planning policies and decisions should contribute to and enhance the natural and local environment by … preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of …noise pollution.*
>
> *185. Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so they should:*
>
> *a) mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life;*
>
> *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.*

Local Policy

3.2 London Borough of Hillingdon's Local Plan: Part 1 - Strategic Policies (November 2012) provides outline guidance on the assessment of noise and vibration affecting new development in the borough. Strategic Objective 10 (SO10) is to *'Improve and protect air and water quality, reduce adverse impacts from noise including the safeguarding of quiet areas and reduce the impacts of contaminated land.'* SO10 refers to policy EM8: Land, Water, Air and Noise which states:

> *The Council will investigate Hillingdon's target areas identified in the Defra Noise Action Plans, promote the maximum possible reduction in noise levels and will minimise the number of people potentially affected.*
>
> *The Council will seek to identify and protect Quiet Areas in accordance with Government Policy on sustainable development and other Local Plan policies.*
>
> *The Council will seek to ensure that noise sensitive development and noise generating development are only permitted if noise impacts can be adequately controlled and mitigated.*

3.3 The London Plan (March 2021) states:

Policy D14 Noise

A *In order to reduce, manage and mitigate noise to improve health and quality of life, residential and other non-aviation development proposals should manage noise by:*

1) avoiding significant adverse noise impacts on health and quality of life

2) reflecting the Agent of Change principle as set out in Policy D13 Agent of Change

3) mitigating and minimising the existing and potential adverse impacts of noise on, from, within, as a result of, or in the vicinity of new development without placing unreasonable restrictions on existing noise-generating uses

4) improving and enhancing the acoustic environment and promoting appropriate soundscapes (including Quiet Areas and spaces of relative tranquillity)

5) separating new noise-sensitive development from major noise sources (such as road, rail, air transport and some types of industrial use) through the use of distance, screening, layout, orientation, uses and materials – in preference to sole reliance on sound insulation

6) where it is not possible to achieve separation of noise-sensitive development and noise sources without undue impact on other sustainable development objectives, then any potential adverse effects should be controlled and mitigated through applying good acoustic design principles

7) promoting new technologies and improved practices to reduce noise at source, and on the transmission path from source to receiver.

B *Boroughs, and others with relevant responsibilities, should identify and nominate new Quiet Areas and protect existing Quiet Areas in line with the procedure in Defra's Noise Action Plan for Agglomerations.*

3.4 To address the requirements of the national and local policies, the following key acoustic matters have been assessed:

- Noise affecting the habitable areas of the proposed development;
- Ground-borne vibration affecting the habitable areas of the proposed development.

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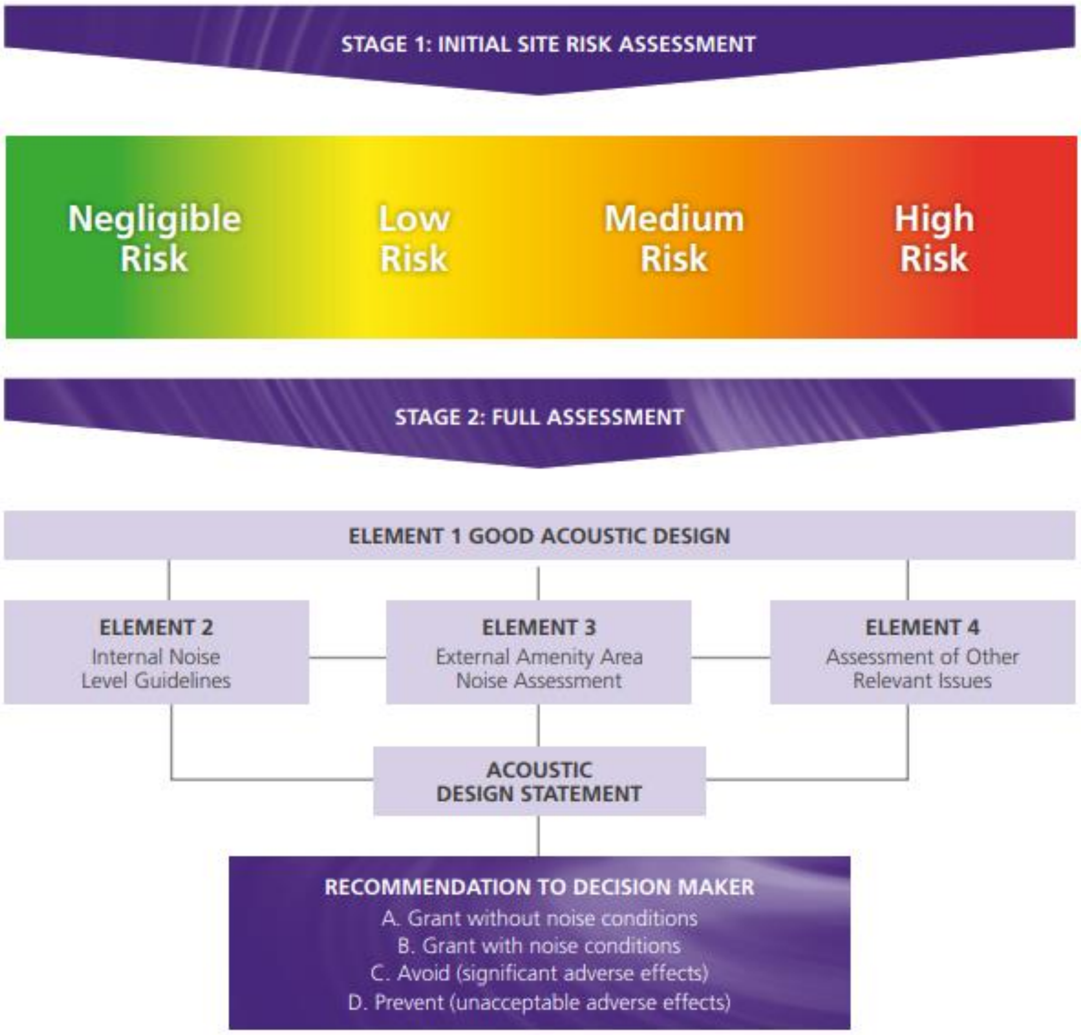
4. NOISE AFFECTING THE DEVELOPMENT

4.1 Specific guidance on the assessment of noise affecting new residential development is given in ProPG: Planning and Noise for New Residential Development, May 2017 (ProPG). The process within the ProPG guidance for the appraisal of noise levels affecting new residential development is considered to be current 'best practice' and therefore has been followed for the assessment. The assessment process can be summarised as follows:

- Stage 1 – measure noise levels at the site and carry out an initial noise risk assessment of the proposed development site based on the measured levels.
- Stage 2 – where a higher noise risk is identified, carry out a detailed assessment including the following four considerations:
    - Element 1 – the overall acoustic design and layout of the site
    - Element 2 – internal noise levels in habitable areas
    - Element 3 – noise levels in external amenity areas
    - Element 4 – consideration of other relevant issues
- Based on the results of the Stage assessment, provide a recommendation to the decision maker on whether planning permission can and should be granted.

4.2 The process is shown visually in Figure 2 below

Figure 2 ProPG Assessment Process



4.3 It should be noted that the guidance in ProPG relates primarily to noise from transportation sources, i.e. road traffic, aircraft, rail etc. Any significant noise from other sources (e.g. industrial, commercial or entertainment sources) is outside the scope of the ProPG guidance and therefore requires separate consideration.

Stage 1 – Noise survey and initial assessment

4.4 A noise survey was carried out at the site from 7th April to 13th April 2022 to assess existing noise levels in the area. The full methodology and results of the noise survey are provided in Appendix 1.

4.5 Average (LAeq,T) and maximum (LAmax) noise levels across the site were dictated by road traffic on Rickmansworth Road and train passes on the adjacent railway line.

4.6 Noise from nearby commercial businesses was insignificant in comparison to noise from Rickmansworth Road and the London Underground Metropolitan Line.

4.7 Background noise levels (LA90) across the site were dictated by constant road traffic noise from the surrounding roads.

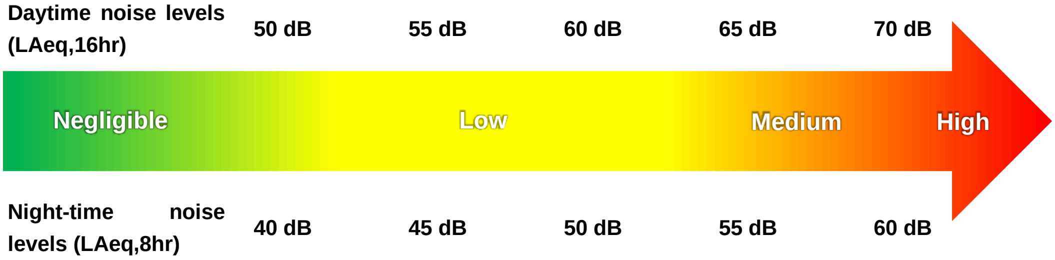
4.8 Areas of the development at the northern edge of the site will be subject to the highest noise levels. The noise survey results show that noise levels at this position are as follows:

- Average noise levels during the daytime - 67 dB LAeq,0700-2300hrs;
- Average noise levels during the night-time - 62 dB LAeq,2300-0700hrs;
- Typical maximum noise levels during the night-time - 80 dB LAmax.

4.9 The above noise levels include a distance correction to take into account the distance between the nearest the site boundary and Rickmansworth Road.

4.10 The measured noise levels can be compared with Figure 3 below to assess the ‘noise risk’ of the site. Where the noise risk is high, significant acoustic design measures may be required to achieve acceptable noise levels in the development. Where the noise risk is low, acceptable noise levels may be achievable with no specific acoustic design measures.

Figure 3 Noise Risk Assessment (Adaption of Figure 1 from ProPG)



4.11 It can be seen from a comparison of the measured noise levels in paragraph 4.8 above with Figure 3 that the site is ‘Medium’ risk in relation to daytime noise levels and ‘High’ risk in relation to night-time noise levels. ProPG therefore requires that a more detailed ‘Stage 2’ assessment is carried out.

Stage 2 – Element 1 – Overall acoustic design of the site

4.1 The overall design of the development has been reviewed in relation to the measured noise levels at the site. In this case acoustically attenuating facades overlooking the roads and railway may offer potential improvements to the acoustic design of the development.

4.2 The treatment of the facades is an acceptable approach. It is in line with current planning guidance, where the efficient use of land and the need for housing is a priority. The detailed design of the facades is discussed further below.

Stage 2 – Element 2 - Internal noise levels

4.3 Appropriate design criteria for acceptable noise levels in acoustically sensitive areas of new developments are given in BS8233:2014 '*Guidance on sound insulation and noise reduction for buildings*'.

4.4 Relevant BS8233 design criteria are summarised in Table 1 below.

Table 1 BS8233:2014 Internal Noise Criteria

Activity	Location	07:00 to 23:00	23:00 to 07:00
Resting	Living room	35 dB LAeq,16hour	-
Dining	Dining room/area	40 dB LAeq,16hour	-
Sleeping (daytime resting)	Bedroom	35 dB LAeq,16hour	30 dB LAeq,8hour

4.5 It is also considered appropriate in this case to assess the potential impact of noise emissions from individual noise events on the bedrooms of the development during the night-time. This is in line with guidance given in BS8233:2014 and ProPG, which both point out that regular individual noise events during the night have the potential to cause sleep disturbance.

4.6 Appropriate design criteria for acceptable maximum noise levels in habitable rooms of new residential developments are given in the ProPG guidance, which states that "*In most circumstances in noise-sensitive rooms at night (e.g. bedrooms) good acoustic design can be used so that individual noise events do not normally exceed 45 dB LAmax,F more than 10 times a night.*"

4.7 The following acoustic design criteria have therefore been adopted for the development:

- Average noise levels in living rooms and dining rooms during the day should not exceed 35 dB LAeq,0700-2300hrs and 40 dB LAeq,0700-2300hrs respectively;
- Average noise levels in bedrooms should not exceed 35 dB LAeq,0700-2300hrs during the day and 30 dB LAeq,2300-0700hrs during the night;
- Maximum noise levels should not regularly exceed 45 dB LAmax in bedrooms during the night.

4.8 Full construction details for the development have not been finalised as the project is at an early design stage. It has therefore been assumed that the external walls of the development will be constructed using a standard masonry construction (e.g. 102mm brick, 100mm insulated cavity, 100mm concrete block) or a light-weight construction designed to achieve a similar level of sound insulation (this is technically achievable subject to detailed design). Consequently, internal noise levels would be dictated by external noise ingress via glazing and ventilators.

4.9 The ventilation scheme for the project is Mechanical Ventilation with Heat Recovery (MVHR) i.e. System 4 from Building Regulations Part F. Therefore, there will be no background ventilators in the external façades (e.g. trickle ventilators etc).

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4.10 The MVHR system will be selected to ensure that noise from air supply and extract ductwork does not exceed acceptable levels within habitable rooms. Appropriate specifications for noise levels from the MVHR system (operating at typical maximum duty) would be as follows:

- Bedrooms and living rooms – 30 dB LAeq,T at 1.5m from any ventilation aperture; and,
- Other habitable areas – 35 dB LAeq,T at 1.5m from any ventilation aperture.

4.11 Calculations were carried out using facade modelling software in accordance with the methodology given in BS8233:2014 to calculate the sound insulation performance required of the glazing and ventilation to achieve the nominated internal noise criteria in the 'worst-case' habitable rooms of the development (i.e. the habitable rooms that will be subject to the highest external noise levels). The calculations included a 3 dBA design margin.

4.12 If acceptable internal noise levels can be achieved in 'worst case' habitable rooms then it follows that acceptable internal noise levels can be achieved in all other habitable rooms of the development using similar glazing and ventilator types.

4.13 The calculations were carried out based on the following typical dimensions/details for facade elements:

- Glazing – 1.5m^2 for bedrooms and 2m^2 for living rooms; and
- External walls – 8m^2 for bedrooms and 15m^2 for living rooms.

4.14 The results of the calculations are shown in Appendix 2 and are summarised in Table 2 below.

Table 2 Acoustic Requirements for 'Worst Case' Habitable Rooms

'Worst Case' Rooms	Glazing Performance Requirements (inc. Frames)	Ventilator Performance Requirements (in Open Position)
All habitable rooms	31 dB Rw+Ctr	MVHR

Note The requirements given are approximate only and should be confirmed at the detailed design stage when full design details are available.

4.15 The required sound insulation performance values in Table 2 could typically be achieved by the glazing types shown in Table 3.

Table 3 Typical Glazing Acoustic Performances

Glazing (in Good Quality Sealed Frames)	Typical Weighted Sound Reduction (Rw + Ctr)
6/16/6.4mm thermal double glazing	31

4.16 It can be seen from the above that acceptable internal noise levels will be achievable in the development subject to the specification of suitable glazing and ventilation systems at the detailed design stage (which could be secured with a suitable planning condition). It is our view therefore that the proposed development is, in principle, acceptable with regards to the noise levels that will exist within the habitable rooms.

4.17 It should be noted that it will be possible to use lower acoustic performance facade elements for facades that are further from or acoustically screened from the surrounding noise sources. This could be investigated further at the detailed design stage.

4.18 It should be noted that the above assessment is based on windows being closed whereas the ProPG guidance suggests that internal noise levels should also be assessed with windows in the open position, which will likely be required at times to control overheating. This can be assessed further at the detailed design stage when full details of the construction of the development will be available and a full overheating assessment can be carried out. If units are predicted to overheat for long periods with windows closed then an enhanced mechanical ventilation system may be required. This could be controlled by the Council through the imposition of a planning condition and would not normally be a barrier for granting planning permission.

Stage 2 – Element 3 – Noise levels in external amenity areas

4.19 BS8233 states that it is desirable that noise levels in external amenity areas of residential developments do not exceed 50 dB LAeq and that 55 dB LAeq,T should be regarded as an upper guideline value. BS8233 recognises however that these guideline values will not always be achievable in city centres or urban areas adjoining main roads or other transport sources. In these cases, BS8233 states that the development should be designed to achieve the lowest practical noise levels in the amenity spaces.

4.20 Based on the results of the noise survey, noise levels in external amenity areas would be expected to exceed the BS8233 recommended levels by up to 12dB. However, whilst this is not ideal, in our view, exceeding the BS8233 recommended levels does not normally mean that the external amenity areas such as terraces or balconies would be unacceptable to future residents. The reasons for this are as follows:

- Most developments in urban areas will be subject to noise levels above the BS8233 recommended levels for balconies[1].
- It is common for noise levels in external amenity areas facing main roads and/or railway lines to exceed the BS8233 recommended noise levels in Hillingdon and elsewhere.
- It is reasonable to assume that residents would prefer the option to have a noisier external amenity area as opposed to having no external amenity area at all.

4.21 The development is in the early design stage, therefore the layout of external amenity areas will be reviewed as the design of the development progresses.

[1] Table 2 from BS8233 notes that daytime noise levels will typically exceed 50-55 dB LAeq,16hr in areas close to busy main roads. It was also found in the UK National Noise Incidence Study 2000/2001 that 90% of UK homes were exposed to daytime noise levels >50dB LAeq,16hr and 54% of UK homes were exposed to noise >55dB LAeq,16hr. It is reasonable to assume that a high percentage of these were in urban areas.

Stage 2 – Element 4 – Other relevant issues

4.22 In our view the acoustic approach outlined above is in line with both local and national noise policy. It is common for residential properties to be situated near to major transport links and this is an acceptable scenario provided that the properties are acoustically upgraded where necessary to achieve acceptable noise levels in habitable areas.

Recommendation to decision maker

4.23 It is our view that planning permission should be granted in relation to noise affecting habitable areas of the development subject to the imposition of suitable planning conditions to ensure that acceptable noise levels are achieved in the finished development.

5. GROUND-BORNE VIBRATION AFFECTING THE DEVELOPMENT

5.1 The vibration levels that will exist within the habitable areas of the finished development have been assessed based on the existing ground-borne vibration levels at the site.

Design criteria – Ground-borne vibration

5.2 Appropriate criteria for ground-borne vibration affecting residential dwellings are given in BS 6472-1:2008 *'Guide to evaluation of human exposure to vibration in buildings - Part 1: Vibration sources other than blasting'*. The criteria in BS6472-1 are provided as Vibration Dose Values, as summarised in Table 4.

Table 4 BS6472-1:2008 Vibration Criteria

Place	Low Probability of Adverse Comment (VDV) $m{\cdot}s^{-1.75}$ 1)	Adverse Comment Possible (VDV) $m{\cdot}s^{-1.75}$	Adverse Comment Probable (VDV) $m{\cdot}s^{-1.75}$ 2)
Residential buildings 16 h day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8 h night	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8

5.3 Measured ground-borne vibration levels at the site have been assessed against the criteria above.

Existing ground-borne vibration levels

5.4 Ground-borne vibration measurements were carried out as part of the site survey. The methodology and results of the measurements are outlined in Appendix 1.

5.5 Tri-axial Vibration Dose Value (VDV) measurements were taken across the low-frequency range (1-80Hz) and logged at 10 second intervals for one hour on 7th April 2022 and one hour on 13th April 2022, to ensure an adequate quantity of train movements was captured. 21 train passes were recorded on 7th April 2022 and 20 train passes were recorded on 13th April 2022. Train timetables indicate that up to 21 trains pass the site in any one hour during the daytime (0700hrs-2300hrs) and a total of approximately 60 during the whole of the night-time period (2300hrs-0700hrs).

5.6 Using the measured VDV levels during the survey, the total day and night-time VDV levels have been calculated based on the total number of train passes that occur on the railway per day. The extrapolated VDV levels are summarised below in Table 5:

Table 5 Vibration Data Summary (Vibration Dose Values)

Period	X Axis ($m{\cdot}s^{-1.75}$) Wd	Y Axis ($m{\cdot}s^{-1.75}$) Wd	Z Axis ($m{\cdot}s^{-1.75}$) Wb
Daytime (0700-2300)	<0.01	<0.01	<0.04
Night-time (2300-0700)	<0.01	<0.01	<0.03

It can be seen that vibration levels were highest in the vertical Z-axis (compared to the X and Y axes).

5.7 It can be seen from a comparison of Table 4 and Table 5 that vibration levels at the site fall well below the *"Low probability of adverse comment"* rating for both day- and night-time periods according to BS6472:1992.

5.8 The results of the BS6472 assessment are in line with subjective opinion formed during the survey that there are insignificant ground-borne vibration levels at the site.

5.9 It is subsequently reasonable to conclude that levels of vibration at the site are acceptable for the proposed development.

6. CONCLUSIONS

6.1 Cass Allen was instructed by Polaris Property Developments Limited to assess the suitability of the site for the proposed development with regards to noise and vibration.

6.2 The assessment was carried out in accordance with relevant local and national planning guidance.

6.3 A noise and vibration survey was carried out at the site. Noise levels at the site are dictated by road traffic on Rickmansworth Road and train passes on the London Underground Metropolitan Line.

6.4 Noise affecting the development has been assessed in accordance with the ProPG guidance. The design of the development is considered to be acceptable subject to the adoption of acoustically upgraded glazing and ventilation. This can be investigated further at the detailed design stage and may be secured by the imposition of a noise related planning condition by the Local Planning Authority.

6.5 The layout of external amenity areas will be reviewed as the design of the development progresses to ensure the development is designed to achieve the lowest practical noise levels in the amenity spaces.

6.6 Ground-borne vibration levels at the site have been measured and are considered to be acceptable for the development.

6.7 In summary of the above it is our view that the site is suitable for the development in terms of noise and vibration levels and that planning permission should be granted subject to the imposition of suitable planning conditions.

Appendix 1 Survey Results

Survey Summary:

The survey comprised short-term operator attended noise and vibration measurements and longer-term unattended noise monitoring at the site. Noise levels at the site were generally dictated by road traffic on surrounding roads and noise from train passes on the adjacent railway. Vibration levels at the site were very low.

Survey Period:

07/04/2022 to 13/04/2022

Survey Objectives:

- To identify noise and vibration sources that contribute to ambient noise levels at the site;
- To measure noise and vibration levels around the site over a typical day and night-time period.

Equipment Used:

Type	Manufacturer	Model	Serial Number
Sound level meter[1]	Bruel & Kjaer	2250	3029152
Sound level meter[1]	Bruel & Kjaer	2250	3007539
Calibrator	01dB	CAL31	83380
Sound level meter[1] (noise logger)	Rion	NL-32	00530374
Calibrator	Rion	NC-74	34551703
Tri-Axial Vibration Meter	Rion	XV-2P	00380055
Tri-axial accelerometer	Rion	PV-83C	73649

Note 1: All sound level meters were calibrated before and after measurement periods and no significant drift in calibration was found to have occurred. The results of the measurements are therefore considered to be representative.

Weather Conditions:

The observed weather conditions were acceptable for acoustic measurement throughout the attended survey periods (low-medium wind speeds and no rain). Weather records for the area confirmed that weather conditions were also generally acceptable for acoustic measurement during the unattended monitoring.

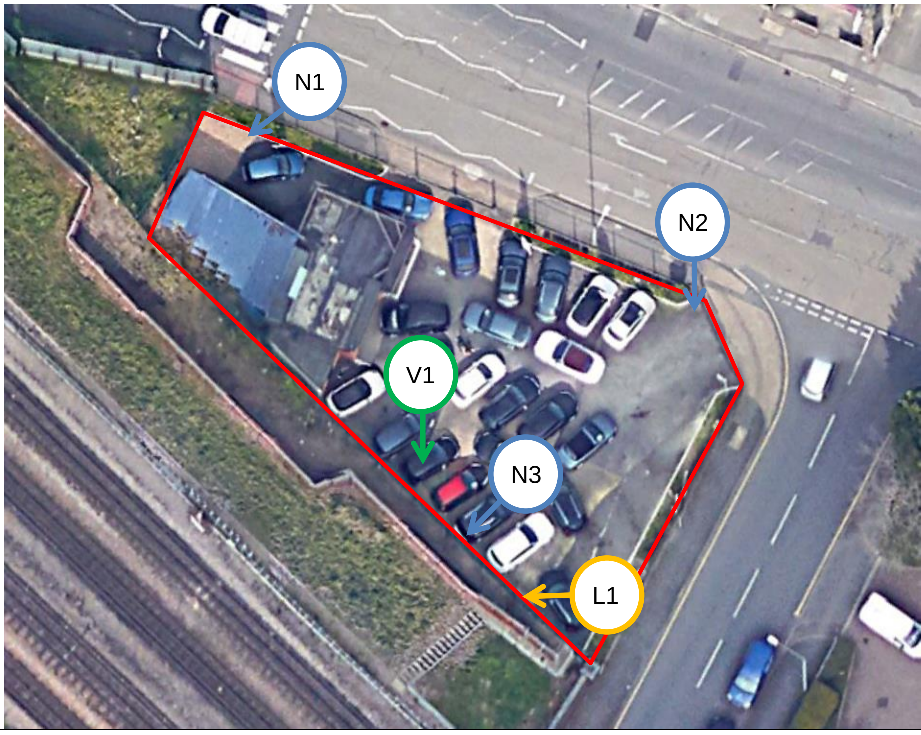
Measurement Positions:

Position (refer plan below)	Description
N1	Attended noise monitoring position. 1.5m above ground. Free-field. Direct line of sight to Rickmansworth Road.
N2	
N3	Attended noise monitoring position. 2m above ground. Free-field. Direct line of sight to railway and Rickmansworth Road.
L1	Unattended noise logging position. 5m above ground level. Free-field. Direct line of sight to railway and Rickmansworth Road.

Measurement Positions:

Position (refer plan below)	Description
V1	Attended ground-borne vibration monitoring position. The vibration measurements were taken on top of the existing concrete, 1m away from the site boundary.

Site Plan showing Measurement Positions:



Attended Noise Monitoring Results:

Date	Position	Time	Meas. Length	LAeq, dB	LAmax, dB	LA90, dB	Observations
07/04/2022	N1	11:55	5 mins	68	76	59	Noise dictated by road traffic on Rickmansworth Road.
		12:00		70	86	61	
		12:06	33 secs	71	77	64	Noise dictated by car and van passes on Rickmansworth Road.
		12:08	45 secs	71	77	67	
	N2	12:10	5 mins	69	78	64	Noise dictated by road traffic on Rickmansworth Road.
		12:15		70	80	64	
		12:38	12 secs	69	73	68	Noise dictated by single bus pass on Rickmansworth Road.
		12:46	11 secs	68	74	64	
	N3	12:29	20 secs	67	71	63	Noise dictated by two train passes.
		12:36	15 secs	66	69	64	Noise dictated by single train pass.
13/04/2022	N1	12:25	5 mins	70	81	59	Noise dictated by road traffic on Rickmansworth Road.
		12:30		69	84	61	

Attended Noise Monitoring Results:

Date	Position	Time	Meas. Length	LAeq, dB	LAmax, dB	LA90, dB	Observations
	N2	12:35		70	84	63	
		12:40		69	76	62	

Unattended Noise Monitoring Results:

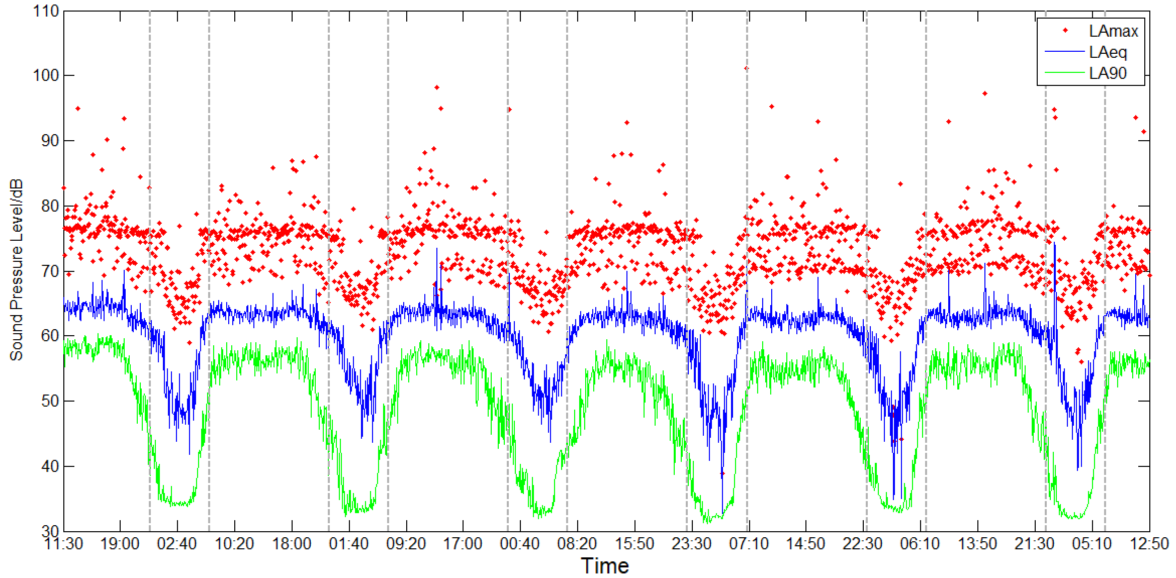
Meas. Period	Position	Daytime (0700-2300hrs)		Night-time (2300-0700hrs)		
		LAeq,16hr, dB	LA90,1hr dB[1]	LAeq,8hr, dB	LA90,5mins, dB[1]	LAmax, dB[2]
07/04/2022 to 13/04/2022	L1	63	56	58	34	75-76

Note 1: Typical lowest measured during the period shown.

Note 2: Highest typical maximum noise level during the night-time (not exceeded more than 10-15 times per night).

Unattended Noise Monitoring Results:

Meas. Period	Position
07/04/2022 to 13/04/2022	L1



Attended Ground-borne Vibration Monitoring Results:

Date	Position	Time	Meas. Length	X VDV	Y VDV	Z VDV	Observations
07/04/2022	V1	11:40	10 secs	0.00031	0.00042	0.00457	8-carriage underground passenger train traveling south
		11:41		0.00042	0.00069	0.00744	8-carriage underground passenger train traveling north

Attended Ground-borne Vibration Monitoring Results:

Date	Position	Time	Meas. Length	X VDV	Y VDV	Z VDV	Observations
		11:44		0.00047	0.0006	0.00423	4-carriage underground passenger train traveling north
		11:47		0.00046	0.00075	0.00714	8-carriage underground passenger train traveling south
		11:50		0.00034	0.00049	0.00514	8-carriage underground passenger train traveling south
		11:50		0.00029	0.00035	0.00389	8-carriage underground passenger train traveling north
		11:54		0.00045	0.00082	0.00755	8-carriage underground passenger train traveling north
		11:55		0.00054	0.00066	0.00433	4-carriage passenger train traveling south
		11:57		0.00061	0.00094	0.00704	8-carriage underground passenger train traveling south
		12:03		0.00033	0.00053	0.00524	8-carriage underground passenger train traveling north
		12:04		0.00057	0.00103	0.00763	8-carriage underground passenger train traveling north
		12:11		0.00047	0.00074	0.00791	8-carriage underground passenger train traveling south
		12:16		0.00039	0.00089	0.00485	8-carriage underground passenger train traveling north
		12:17		0.0007	0.00072	0.00441	2-carriage passenger train traveling south
		12:19		0.00048	0.00088	0.00763	8-carriage underground passenger train traveling north
		12:20		0.00041	0.00043	0.00458	8-carriage underground passenger train traveling south
		12:23		0.00034	0.00054	0.00537	8-carriage underground passenger train traveling north
		12:29		0.00052	0.00081	0.00612	4-carriage passenger train traveling south
		12:32		0.00041	0.00069	0.00466	8-carriage underground passenger train traveling south
		12:34		0.00048	0.00093	0.00751	8-carriage underground passenger train traveling north
		12:38		0.00078	0.00124	0.0078	8-carriage underground passenger train traveling south
13/04/2022		11:11		0.00039	0.00054	0.00717	8-carriage underground passenger train traveling north

Attended Ground-borne Vibration Monitoring Results:

Date	Position	Time	Meas. Length	X VDV	Y VDV	Z VDV	Observations
		11:15		0.00035	0.00049	0.00749	8-carriage underground passenger train traveling south
		11:17		0.00042	0.00068	0.0065	8-carriage underground passenger train traveling north
		11:25		0.00046	0.00059	0.00635	5-carriage overground passenger train traveling north
		11:25		0.0005	0.0006	0.00645	8-carriage underground passenger train traveling south
		11:27		0.00035	0.00039	0.0045	8-carriage underground passenger train traveling north
		11:28		0.00049	0.00062	0.00602	8-carriage underground passenger train traveling south
		11:33		0.00041	0.00081	0.00682	5-carriage overground passenger train traveling north
		11:39		0.00039	0.00039	0.00445	4-carriage overground passenger train traveling south
		11:39		0.00036	0.00056	0.00722	8-carriage underground passenger train traveling south
		11:42		0.00043	0.0004	0.00446	8-carriage underground passenger train traveling north
		11:46		0.00029	0.00041	0.0054	8-carriage underground passenger train traveling south
		11:48		0.00033	0.00034	0.00459	8-carriage underground passenger train traveling north
		11:48		0.00042	0.00064	0.00668	5-carriage overground passenger train traveling north
		11:49		0.00049	0.00079	0.00728	8-carriage overground passenger train traveling south
		11:54		0.00041	0.00047	0.00552	8-carriage underground passenger train traveling north
		11:55		0.00043	0.00056	0.00735	7-carriage overground passenger train traveling north
		11:59		0.00043	0.00054	0.00594	8-carriage underground passenger train traveling south
		12:02		0.00029	0.00028	0.00449	3-carriage overground passenger train traveling south
		12:03		0.00047	0.00088	0.00776	8-carriage underground passenger train traveling south

Note 1: Vibration measurements were taken across the low-frequency range (0.5-80Hz)

Appendix 2 Facade Calculations

PROJECT:	PINNER ROAD, NORTHWOOD	Room Dimensions [m]	W 4.0	X	L 3.0	X	H 2.4
ROOM:	Bedroom						
VARIANT:	Daytime Noise Levels (LAeq,16hr)	Room Volume =	28.8	m3			
NOTES:	22224	Partition Area =	9.5	m2			
		Ventilation ref area =	10.0	m2			
	SELECT Free Field or Façade SPL for model input >>>	Free Field SPL K =	3	dB			

NOTES:

EXTERNAL SPECTRUM (A weighted)

	dBA	63	125	250	500	1000	2000	4000	
Direct input - Free Field SPL (A weighted octave bands) dB ----->	-								**No data**
Road traffic spectrum (according to BS 8233:1999 section 6)	67.0								
		48.8	52.9	56.4	59.8	63.0	60.2	55.0	**Reference spectrum**

REVERBERATION TIME

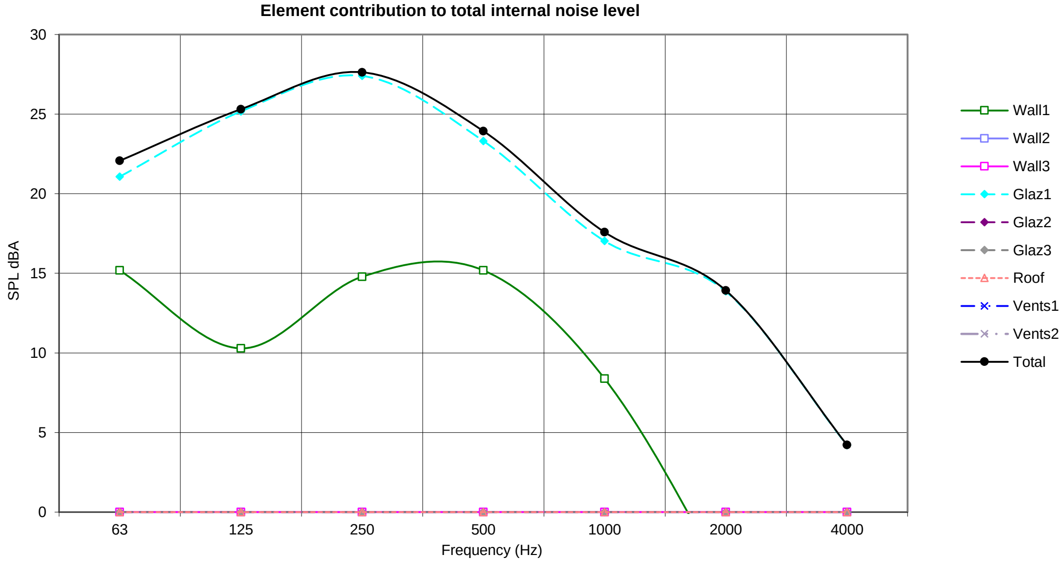
DIRECT INPUT ----->									**No data**
EQUAL RT for all bands ----->									
		0.5	0.5	0.5	0.5	0.5	0.5	0.5	**Default - RT set to 0.5s**

Façade Element		Area [m2]	SRI dB to BS EN ISO 140-3:1995								Rw	C	Ctr
Wall 1	Typical - 102mm brick/50mm cavity/100mm block	8.0	36	45	44	47	57	67	77	8%	54	0	-4
	ATTENUATION												
Wall 2	WALLS		0	0	0	0	0	0	0	0%			
	ATTENUATION												
Wall 3	WALLS		0	0	0	0	0	0	0	0%			
	ATTENUATION												
Glazing 1	31 dB Rw + Ctr - Acoustically Upgraded Double Glazing	1.5	23	23	24	32	41	41	46	92%	31 (inc Ctr)	-	-
	ATTENUATION												
Glazing 2	GLAZING		0	0	0	0	0	0	0	0%			
	ATTENUATION												
Glazing 3	GLAZING		0	0	0	0	0	0	0	0%			
	ATTENUATION												
Roof	ROOF / FLOOR		0	0	0	0	0	0	0	0%			
	ATTENUATION												
	Resultant composite Façade SRI		30	31	32	39	49	49	54				
	Resultant SPL inside room excluding ventilators dB	31.5	22	25	28	24	18	14	4	100%			

Ventilator Type		Num	$D_{n,e}$ dB to BS EN 20140-10:1992								Dnew	C	Ctr
Ventilation	MVHR		0	0	0	0	0	0	0	0%			
	ATTENUATION												
Ventilation	VENTS		0	0	0	0	0	0	0	0%			
	ATTENUATION												
	Resultant SPL inside room through ventilators dB	-99.0	-96	-96	-96	-96	-96	-96	-96	0%			

Total SPL inside room	**31.5**	22	25	28	24	18	14	4

Element contribution to total internal noise level



PROJECT:	PINNER ROAD, NORTHWOOD	Room Dimensions [m]	W 4.0	X	L 3.0	X	H 2.4	
ROOM:	Bedroom							
VARIANT:	Night-time Average Noise Levels (LAeq,8hr)				Room Volume =		28.8	m3
NOTES:	22224				Partition Area =		9.5	m2
					Ventilation ref area =		10.0	m2
	SELECT Free Field or Façade SPL for model input >>>				Free Field SPL K =		3	dB

NOTES:

EXTERNAL SPECTRUM (A weighted)

	dBA	63	125	250	500	1000	2000	4000	
Direct input - Free Field SPL (A weighted octave bands) dB ----->	-								**No data**
Road traffic spectrum (according to BS 8233:1999 section 6)	62.0								
		43.8	47.9	51.4	54.8	58.0	55.2	50.0	**Reference spectrum**

REVERBERATION TIME

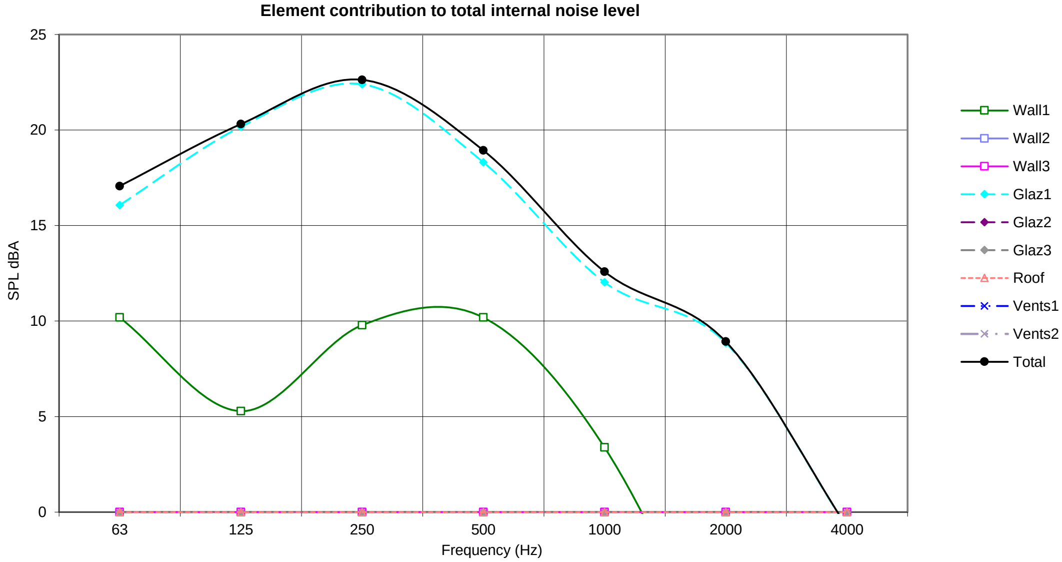
		63	125	250	500	1000	2000	4000	
DIRECT INPUT ----->									**No data**
EQUAL RT for all bands ----->									
		0.5	0.5	0.5	0.5	0.5	0.5	0.5	**Default - RT set to 0.5s**

Façade Element		Area [m2]	SRI dB to BS EN ISO 140-3:1995								Rw	C	Ctr
Wall 1	Typical - 102mm brick/50mm cavity/100mm block	8.0	36	45	44	47	57	67	77	8%	54	0	-4
	ATTENUATION												
Wall 2	WALLS		0	0	0	0	0	0	0	0%			
	ATTENUATION												
Wall 3	WALLS		0	0	0	0	0	0	0	0%			
	ATTENUATION												
Glazing 1	31 dB Rw + Ctr - Acoustically Upgraded Double Glazing	1.5	23	23	24	32	41	41	46	91%	31 (inc Ctr)	-	-
	ATTENUATION												
Glazing 2	GLAZING		0	0	0	0	0	0	0	0%			
	ATTENUATION												
Glazing 3	GLAZING		0	0	0	0	0	0	0	0%			
	ATTENUATION												
Roof	ROOF / FLOOR		0	0	0	0	0	0	0	0%			
	ATTENUATION												
	Resultant composite Façade SRI		30	31	32	39	49	49	54				
	Resultant SPL inside room excluding ventilators dB	26.5	17	20	23	19	13	9	-1	100%			

Ventilator Type		Num	$D_{n,e}$ dB to BS EN 20140-10:1992								Dnew	C	Ctr
Ventilation	MVHR		0	0	0	0	0	0	0	0%			
	ATTENUATION												
Ventilation	VENTS		0	0	0	0	0	0	0	0%			
	ATTENUATION												
	Resultant SPL inside room through ventilators dB	-99.0	-96	-96	-96	-96	-96	-96	-96	0%			

Total SPL inside room	**26.5**	17	20	23	19	13	9	-1

Element contribution to total internal noise level



PROJECT:	PINNER ROAD, NORTHWOOD
ROOM:	Bedroom
VARIANT:	Night Time Maximum Noise Levels (LAmax)
NOTES:	22224

	W		L		H	
Room Dimensions [m]	4.0	X	3.0	X	2.4	

Room Volume =	28.8	m3
Partition Area =	9.5	m2
Ventilation ref area =	10.0	m2
Free Field SPL K =	3	dB

SELECT Free Field or Façade SPL for model input >>>

NOTES:

EXTERNAL SPECTRUM (A weighted)

	dBA	63	125	250	500	1000	2000	4000	
Direct input - Free Field SPL (A weighted octave bands) dB ----->	80.0	55.6	58.3	65.0	71.3	77.6	73.5	63.7	
Road traffic spectrum (according to BS 8233:1999 section 6)									
		55.6	58.3	65.0	71.3	77.6	73.5	63.7	Direct input

REVERBERATION TIME

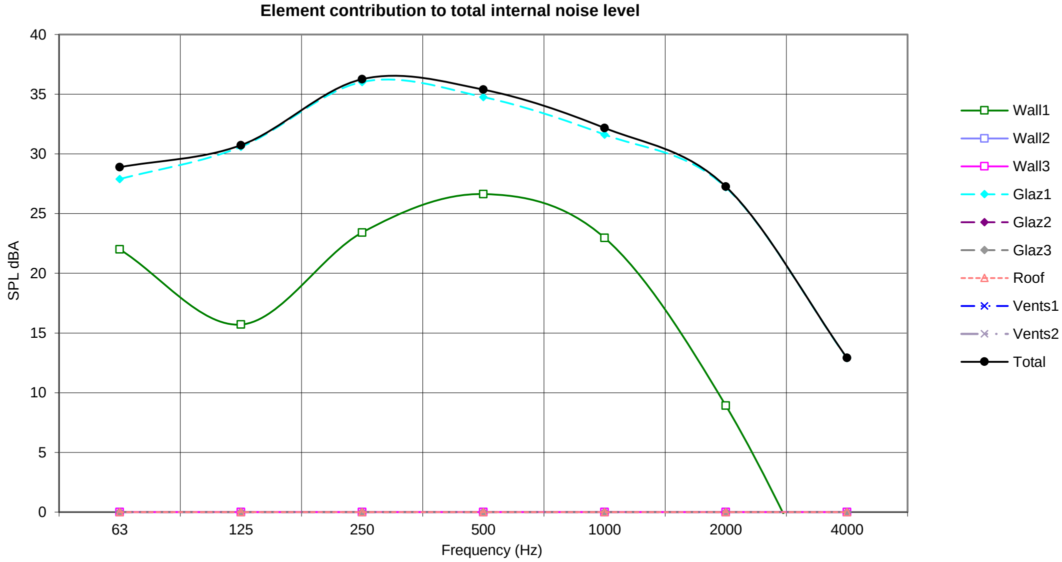
DIRECT INPUT ----->									No data
EQUAL RT for all bands ----->									
		0.5	0.5	0.5	0.5	0.5	0.5	0.5	Default - RT set to 0.5s

Façade Element		Area [m2]	SRI dB to BS EN ISO 140-3:1995								Rw	C	Ctr
Wall 1	Typical - 102mm brick/50mm cavity/100mm block	8.0	36	45	44	47	57	67	77	9%	54	0	-4
	ATTENUATION												
Wall 2	WALLS		0	0	0	0	0	0	0	0%			
	ATTENUATION												
Wall 3	WALLS		0	0	0	0	0	0	0	0%			
	ATTENUATION												
Glazing 1	31 dB Rw + Ctr - Acoustically Upgraded Double Glazing	1.5	23	23	24	32	41	41	46	91%	31 (inc Ctr)	-	-
	ATTENUATION												
Glazing 2	GLAZING		0	0	0	0	0	0	0	0%			
	ATTENUATION												
Glazing 3	GLAZING		0	0	0	0	0	0	0	0%			
	ATTENUATION												
Roof	ROOF / FLOOR		0	0	0	0	0	0	0	0%			
	ATTENUATION												
Resultant composite Façade SRI			30	31	32	39	49	49	54				
Resultant SPL inside room excluding ventilators dB		40.7	29	31	36	35	32	27	13	100%			

Ventilator Type		Num	$D_{n,e}$ dB to BS EN 20140-10:1992								Dnew	C	Ctr
Ventilation	MVHR		0	0	0	0	0	0	0	0%			
	ATTENUATION												
Ventilation	VENTS		0	0	0	0	0	0	0	0%			
	ATTENUATION												
Resultant SPL inside room through ventilators dB		-99.0	-96	-96	-96	-96	-96	-96	-96	0%			

	dBA	63	125	250	500	1000	2000	4000
Total SPL inside room	**40.7**	29	31	36	35	32	27	13

Element contribution to total internal noise level



FACSIM V2.7.7 - MODELLING OF FACADE ACOUSTIC INSULATION TO BS12354-3 and BS8233

			W		L		H
PROJECT:	PINNER ROAD, NORTHWOOD	Room Dimensions [m]	4.0	X	5.0	X	2.4
ROOM:	Living Room						
VARIANT:	Daytime Noise Levels (LAeq,16hr)	Room Volume =	48.0 m3				
NOTES:	22224	Partition Area =	17.0 m2				
		Ventilation ref area =	10.0 m2				
	SELECT Free Field or Façade SPL for model input >>>	Free Field SPL K =	3 dB				

NOTES:

EXTERNAL SPECTRUM (A weighted)

	dBA	63	125	250	500	1000	2000	4000	
Direct input - Free Field SPL (A weighted octave bands) dB ----->	-								**No data**
Road traffic spectrum (according to BS 8233:1999 section 6)	67.0								
		48.8	52.9	56.4	59.8	63.0	60.2	55.0	**Reference spectrum**

REVERBERATION TIME

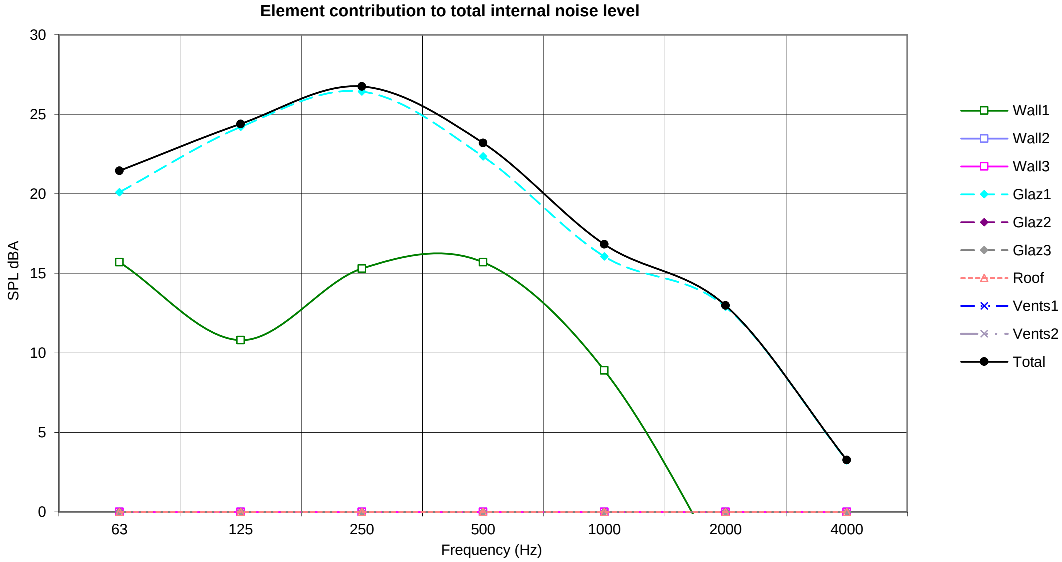
		63	125	250	500	1000	2000	4000	
DIRECT INPUT ----->									**No data**
EQUAL RT for all bands ----->									
		0.5	0.5	0.5	0.5	0.5	0.5	0.5	**Default - RT set to 0.5s**

Façade Element		Area [m2]	SRI dB to BS EN ISO 140-3:1995								Rw	C	Ctr
Wall 1	Typical - 102mm brick/50mm cavity/100mm block	15.0	36	45	44	47	57	67	77	11%	54	0	-4
	ATTENUATION												
Wall 2	WALLS		0	0	0	0	0	0	0	0%			
	ATTENUATION												
Wall 3	WALLS		0	0	0	0	0	0	0	0%			
	ATTENUATION												
Glazing 1	31 dB Rw + Ctr - Acoustically Upgraded Double Glazing	2.0	23	23	24	32	41	41	46	89%	31 (inc Ctr)	-	-
	ATTENUATION												
Glazing 2	GLAZING		0	0	0	0	0	0	0	0%			
	ATTENUATION												
Glazing 3	GLAZING		0	0	0	0	0	0	0	0%			
	ATTENUATION												
Roof	ROOF / FLOOR		0	0	0	0	0	0	0	0%			
	ATTENUATION												
	Resultant composite Façade SRI		31	32	33	40	50	51	55				
	Resultant SPL inside room excluding ventilators dB	30.7	21	24	27	23	17	13	3	100%			

Ventilator Type		Num	$D_{n,e}$ dB to BS EN 20140-10:1992								Dnew	C	Ctr
Ventilation	MVHR		0	0	0	0	0	0	0	0%			
	ATTENUATION												
Ventilation	VENTS		0	0	0	0	0	0	0	0%			
	ATTENUATION												
	Resultant SPL inside room through ventilators dB	-99.0	-96	-96	-96	-96	-96	-96	-96	0%			

	dBA	63	125	250	500	1000	2000	4000
Total SPL inside room	**30.7**	21	24	27	23	17	13	3

Element contribution to total internal noise level



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If you have any queries with this report, please click here to send us an email and we will call you back to discuss

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